June 30, 1925. 1,543,824

E. B. CRAFT

SWITCHING DEVICE

Filed Dec. 24, 1921

Fig. 1.

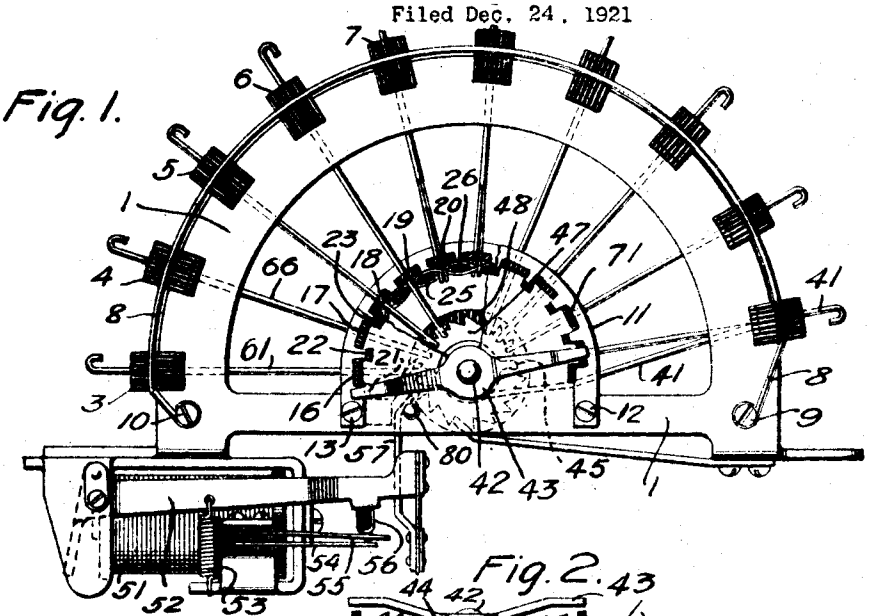


Fig. 2.

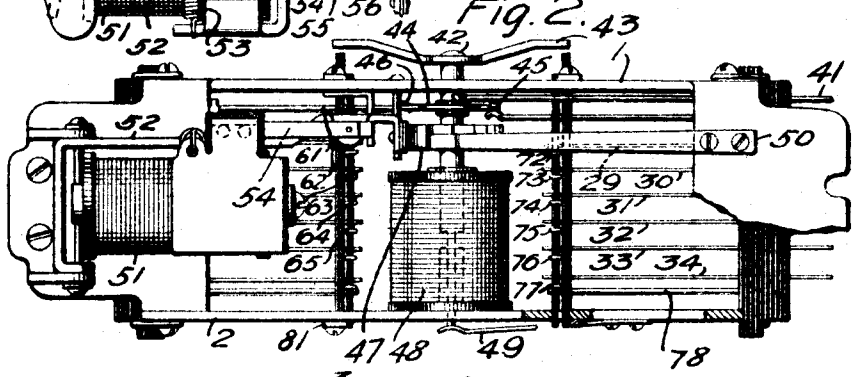


Fig. 3.

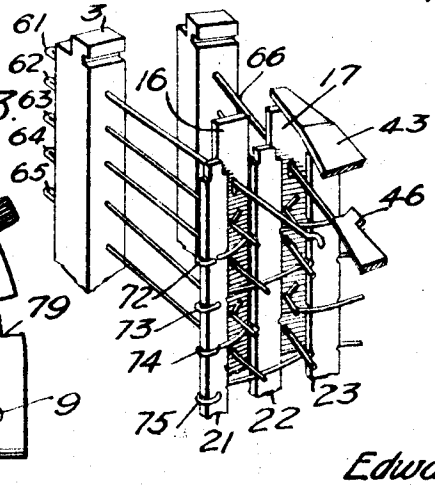
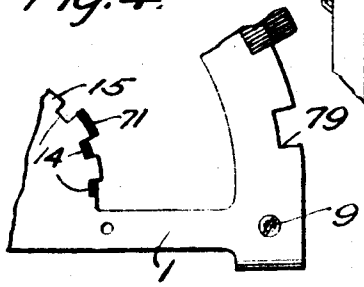


Fig. 4.



Inventor:
Edward B. Craft.

by W. E. Beatty. Atty.

UNITED STATES PATENT OFFICE.

EDWARD B. CRAFT, OF HACKENSACK, NEW JERSEY, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

SWITCHING DEVICE.

Application filed December 24, 1921. Serial No. 524,564.

To all whom it may concern:

Be it known that I, EDWARD B. CRAFT, a citizen of the United States, residing at Hackensack, in the county of Bergen, State of New Jersey, have invented certain new and useful Improvements in Switching Devices, of which the following is a full, clear, concise, and exact description.

This invention relates to selective switching devices, and more particularly to devices of the character commonly employed in automatic telephone exchange systems for establishing circuit connections.

The object of the invention is to provide a selective switching mechanism suitable for use in telephone and other systems which is characterized by the simplicity of its structural design and its principle of operation, and also by the relative economy with which it is capable of being manufactured.

A feature of the invention relates to the provision, in a switching mechanism wherein a passive terminal element consisting of a bare wire conductor is arranged to coact with a plurality of movable bare wire conductors, each movable wire having a point of cooperation with the passive wire, of means for selecting any one of said movable wires and moving the same into contact with the passive wire.

A further feature of the invention consists in providing a switch having a set of passive wires arranged in cooperative relation to each of a plurality of sets of movable wires with a step-by-step selective mechanism for selecting and moving any set of movable wires into physical engagement with said set of passive wires.

Other and further features of the invention will become clearly understood from the description given hereafter and from the appended claims.

In the drawing, which forms a part of the application, Fig. 1 is a top plan view illustrating one type of selective switching mechanism to which the invention is applicable. In this figure a portion of the frame structure is broken away in order to reveal more clearly the disposition of the interior elements.

Fig. 2 shows a side view of the switching structure.

Fig. 3 shows a perspective view illustrating the relative arrangement of the movable and stationary terminal elements, and also the method employed for securing these elements to the stationary parts of the switch.

Fig. 4 is a detailed view of one of the frame plates.

As previously observed, switching devices of the type disclosed in this application are especially suitable for use in telephone exchange systems where connections are desired between an incoming circuit and any one of a plurality of outgoing circuits. In order to simplify the construction of the cooperating contact making elements and also to simplify the operation of these elements whereby a resultant structure is attained which is economical to manufacture and reliable in service, it is proposed to utilize bare wire conductors for the movable contacts and to move these conductors physically into engagement with passive or stationary contacts, likewise consisting of bare wire conductors. Depending upon the purpose for which the switch is used, the set or sets of stationary contact elements may comprise as many individual elements or conductors as necessary. These stationary conductors are of any suitable form and are supported by insulating members in position to be engaged by the coacting movable conductors. As shown in the switch illustrating the present invention, the stationary conductors are woven in and out among a series of supporting insulating strips arranged in a circular fashion about the selecting elements of the device. The several conductors of each set have a separate point of cooperation with the corresponding conductors of the passive set. As shown in Fig. 1, these movable conductors extend radially toward the center of the structure where they have a crossing point with the several corresponding stationary conductors. A suitable selecting element which may be operated in a step-by-step fashion as shown in the present disclosure, or which might be operated in any kind of motion, serves to select any one of a set of movable conductors and thereafter to cause this set of conductors to make engagement with the stationary conductors.

Manifestly a switching device of this general character may be devised for any one of a wide variety of purposes in telephone and other systems. It may serve as a line switch which is operated automatically

extending the line over an idle outgoing trunk. It may serve in the capacity of a directive switch, in which case the movable selecting device is advanced in a directive movement under the control of impulses for selecting a certain one of the movable contact elements to extend the connection over the desired path. It may also be utilized as a register for recording the value of digits.

Referring particularly to the drawing, a description will now be given of the construction of the switching device. The frame consists among other elements of the two supporting plates 1 and 2 made from thin material and skeletonized as illustrated in Fig. 1 to permit of inspection and accessibility. The plates 1 and 2 are formed with two concentric semi-circular portions, as best seen in Figs. 1 and 4. The inner portion of plate 1, for example, according to Fig. 4, has a series of equally spaced notches 14 around the circumference thereof. The solid material between the notches 14 constitutes a corresponding series of teeth 15 which are somewhat wider than the notches themselves. The notches 14 and teeth 15 of plate 1 lie in alignment with the corresponding notches and teeth in the lower frame plate 2 at the bottom of the structure. The purpose of the notches 14 is to receive and retain the insulating strips 21, 22, 23, etc. upon which the stationary bare wire conductors are woven.

Considering first the construction of the stationary terminal portion of the switch, it will be seen in Figs. 1, 2 and 3 that a series of vertically arranged strips 21, 22, 23, 24, 25 and 26, etc., made of insulating material, are arranged in a circular manner and serve to support the stationary conductors. The stationary conductors 72, 73, 74, 75, 76 and 77 are each secured to the insulating strip 21, and each conductor is then woven in and out alternately among the succeeding insulating strips 22, 23, 24, 25, 26, etc. and is again secured at the other end to the last of these vertical strips. The fabric, thus formed of the conductors and insulating strips, is assembled in the switch structure so that the upper and lower ends of the several insulating strips 21, 22, 23, etc. enter the corresponding notches 14 formed in the frame plates 1 and 2.

A series of slidable operating bars 16, 17, 18, 19, 20, etc. the purpose of which will be described hereinafter, are arranged as shown in Figs. 1 and 4 in co-operation with the several teeth 15 on the frame plate 2. With the insulating strips 22, 23, 24, etc. in their respective notches 14 and with the selectable operating bars in position, the upper and lower guide bands 11 and 81 are adjusted to hold the insulating strips and slidable bars notched around their inner peripheries in correspondence with the notching of the frame plates 1 and 2. The upper guide plate 11, for example, viewed in Fig. 1, is retained in place by means of screws 12 and 13, thus securing the elements mentioned, whereby the fabric forming the stationary contact portion of the switch is retained rigidly in place, while the slidable bars 16, 17, 18, etc. are permitted sufficient freedom to move upwardly and downwardly. The slidable bars are in their normal position at the uppermost extent of their movement, seen in Fig. 2. In order to hold these bars in their upward position, springs 78 are provided, the resilient ends of which pass through the lower ends of the slidable bars.

In the switch shown, the passive terminal set consists of six terminal wires 72, 73, 74, 75, 76 and 77. It is obvious, however, that a less number or a greater number of passive terminal wires may be employed, these being dependent wholly upon the nature of the system in which the switch is used. To increase the capacity of the switch in this respect it would only be necessary to add in a vertical direction other conductors to the woven fabric.

The movable terminal elements which coact with the passive terminal conductors are also comprised of plain bare wires arranged, as best seen in Figs. 1 and 3, in sets extending radially toward the center of the structure. There are shown to be ten different sets of movable terminal elements corresponding to the digits of the decimal system, although of course the number of sets of movable terminal elements may be varied to suit the requirements. Each set of movable terminal elements consists of a plurality of bare wire conductors corresponding in number to the number of passive wires with which they cooperate. With particular reference to Fig. 3, the first set of movable elements is seen to consist of the wires 62, 63, 64, 65, etc. These bare wires are supported by an insulating block 3, through which their rigid ends pass to the exterior of the structure and are there overturned to provide a means for making soldered connections. Each of the remaining nine sets of movable wires is likewise secured to a corresponding insulating block such as the blocks 4, 5, 6, 7, etc. The last set of movable conductors is visible in Fig. 2 and comprises the conductors 29, 30, 31, 32, 33 and 34. The springs for holding the bars 16, 17, 18, etc. in place, one of which is shown at 78, are carried by the respective insulating blocks 3, 4, 5, etc.

The insulating blocks 3, 4, 5, 6, 7, etc. when assembled in the structure are received by a series of notches 79 arranged around the outer circumference of the frame plates 1 and 2. They are retained in their assembled po-

illustrated in Fig. 1. The ends of the wire strap 8 are secured to the frame plate by means of screws 9 and 10, thus binding the insulating blocks and holding them firmly in position.

The free ends of the movable terminal wires extend radially toward the center of the structure and pass through apertures in the corresponding slidable insulating bars 16, 17, 18, 19, 20, etc. These apertures, as best seen in Fig. 3, are disposed at an acute angle, to the vertical, the purpose of which will be explained later on. After passing through the diagonal apertures in the slidable bar, the several conductors of a movable set extend in intersecting relation with the corresponding passive wire terminals 72, 73, 74, 75, 76 and 77. Normally, when a slidable bar is in its uppermost position under the influence of a spring 78, the several movable conductors 62, 63, 64, 65, etc. rest in the bottom of the diagonal slots and are held at an appreciable distance from the corresponding passive elements.

Besides the movable terminal wires, such as in wires 62, 63, 64, 65, etc. of the first set, each set is provided with an additional wire terminal 61, likewise secured to the terminal block and also passing through a slot in the slidable bar 16. This wire is arranged at the top of the set, and as seen extends inwardly to the center of the structure to a greater distance than connecting wires of the set. Its function will be explained hereinafter.

A rotatable shaft 42 is located at the center of the switch and is journaled for rotation in any suitable fashion in the frame plates 1 and 2. The uppermost end of the shaft 42 carries a member 43 having two diametrically extending arms, the outer ends of which traverse the arc of a circle coincident with the circle around which the slidable bars 16, 17, 18 and 19 are arranged. As seen in Fig. 1, selecting arm 43 is always in a position to advance one of its projections over the top of one of the slidable bars. As one arm moves away from the last slidable bar, the dimetrically opposite arm is moved over the first slidable bar at the other extremity of the semi-circumference.

A ratchet wheel 47 is mounted on the shaft 42 at some convenient point between the frame plates 1 and 2. The ratchet wheel 47 is acted upon by a stepping pawl 57 for rotating the shaft 42 in a step-by-step manner to advance the selecting arm 43 from one slidable bar to another. The stepping pawl 57 is attached to the armature 52 of an electromagnet 51, which is mounted in any desirable manner upon the frame of the switch. Normally the armature 52 is held in its position, shown in Fig. 1, by the action of a retractile spring 53. With the armature 52 in withdrawn from engagement with the teeth of the ratchet wheel 47 and rests against a stop pin 80. Moreover, a pair of electrical contacts 54 and 55 are held in engagement with each other by an insulating stud 56 carried on the armature 52, while the magnet is deenergized and its armature is in normal position.

The lower portion of the shaft 42 serves as the plunger element for a solenoid 48. The winding of the solenoid 48 is mounted on the frame plate 2 surrounding the plunger shaft 42. The shaft 42 is therefore slidable in a longitudinal direction as well as being arranged for rotation. Normally, said shaft is held in its uppermost position by means of a spring 49. When in its normal condition, the selecting arm 43 is disposed with its projecting arms slightly clearing the tops of the slidable bars 16, 17, 18, etc.

A conducting ring 44 having two oppositely extending brushes 45 and 46 is securely fastened to the shaft 42 between the ratchet 47 and the upper frame plate 1. The brushes 45 and 46 are turned upwardly, as seen in Fig. 3, and are adapted to cooperate with the topmost wire of each set of movable wires. In Fig. 3, the brush 46 is seen to be in engagement with the wire conductor 66. In order to feed current to the rotating ring 44, there is provided a feed brush 41, which extends inwardly, as seen in Fig. 2, and bears on the continuous surface of the ring 44, thereby making contact therewith constantly.

A brief description will next be taken up giving the operation of the switch. Assume that the switching device is in its normal position when the selecting arm 43 is disposed as illustrated in Fig. 1. By any suitable circuit arrangement, a number of directive impulses may be sent to energize electromagnet 51 a corresponding number of times. Upon energizing, the magnet 51 attracts its armature, forcing the pawl 57 against a tooth of the ratchet wheel 47 and rotating the shaft 42 together with the selecting arm 43 and the feed ring 44 forward one step, positioning said arm directly above the first slidable bar 16. Upon the deengization of the stepping magnet 51, the pawl 57 is withdrawn, and for each following energization, the shaft 42 is stepped forward until the selecting arm 43 is positioned above the slidable bar corresponding to the number of impulses sent to the switch. During the rotation of the shaft 42, the teeth of the ratchet wheel pass over the free end of a retaining spring 50, which serves to accurately position the shaft at the end of each impulse, and determines that the forward movement of said shaft takes place in increments corresponding to the teeth on the ratchet wheel.

After the set of movable terminal wires

dition is created in the circuits of the system for causing the energization of the solenoid 48. The solenoid 48 draws down the shaft 42, moving the selecting arm 43 against the end of the slidable bar corresponding to the selected set of movable wires. The continued downward motion of the shaft 42 also moves the slidable bar downwardly against the resistance of the spring 78. At the first downward movement of the slidable bar, the movable wires passing through the diagonal slots of this bar are carried into physical contact with the respective stationary wires. The continued movement of the bar, through the agency of the diagonal slots, produces a camming action on the movable wires, causing them to be displaced laterally while in physical contact with the passive wires. The purpose of this action is to produce a rubbing effect between the movable and stationary wires in order to maintain good electrical contact surfaces.

When the connection is no longer required, the solenoid 48 is deenergized and the shaft 42 is permitted to restore to its normal upward position, releasing the slidable bar and thereby permitting the movable contacts of the corresponding set to disengage the stationary wires. The switch may be restored to its normal position by energizing the stepping magnet 51 the proper number of times.

It may also be desirable to use a device of this character in the capacity of an automatic hunting switch. In this case the circuit for the electromagnet 51 extends through the contacts 54 and 55, which are normally closed when the armature is in its retracted position. By closing the energizing circuit, the magnet 51 attracts its armature, advances the shaft 42 forward one step, opens the contacts 54 and 55, thereby severing the stepping circuit of the magnet, which in turn becomes deenergized and retracts its armature. The retraction of the armature closes the contacts 54 and 55, and again the switch takes another step forward. At each step one of the brushes 45 and 46 makes engagement with the upper wires 61, 66, etc. which may be adapted in any well known manner to form a test. If the set of movable contacts at a given position is non-selectable, then the brush 45 or 46 will discover an electrical condition upon the test wires 61, 66, which determines that the stepping circuit of the switch shall be maintained closed. When a selectable set of movable contacts is reached, a different electrical condition is found by the brush 45 or 46, and in any obvious manner the stepping circuit of the magnet 51 is opened, causing the switch to come to rest.

type of a switching structure, it will be understood that the same is applicable to a wide variety of forms of switch mechanism, and should not be limited to immaterial details of construction. For example, the invention is also applicable to a switching structure in which the selecting element moves in a straight line, or in which two or more separate and distinct movements are performed by the selecting device.

What is claimed is:

1. In a switching mechanism, a bare wire conductor serving as a passive terminal element, a plurality of movable terminal elements, each having a point of cooperation with said passive wire, and a single selectively operable device for selecting one of said movable terminal elements and for moving the selected element into contact with said passive wire.

2. In a switching mechanism, a bare wire conductor serving as a passive terminal element, a plurality of movable terminal elements, each having a point of cooperation with said passive wire, a single selectively operable device for selecting one of said movable terminal elements, and electromagnetic means for moving the selected element into contact with said passive wire.

3. In a switching mechanism, a bare wire conductor serving as a passive terminal element, a plurality of movable terminal elements, each having a point of cooperation with said passive wire, a selecting device, means for selectively moving said device to the point of cooperation corresponding to any one of the movable elements, and means for moving the selected element into contact with said passive wire.

4. In a switching mechanism, a bare wire conductor serving as a passive terminal element, a plurality of movable terminal elements, each having a point of cooperation with said passive wires, and a step-by-step operated device for selecting one of said movable terminal elements and for moving the selected element into contact with said passive wire.

5. In a switching mechanism, a bare wire conductor serving as a passive terminal element, a plurality of movable terminal elements, each having a point of cooperation with said passive wire, a rotatable selecting device for selecting one of said movable terminal elements, an electromagnet for operating said selecting device, and means for moving the selected element into contact with said passive wire.

6. In a switching mechanism, a bare wire conductor serving as a passive terminal element, a plurality of movable terminal elements, each arranged to cooperate with said passive wire, a selecting device for selecting

one of said movable terminal elements, an electromagnet for operating said selecting device, and an electromagnet for moving the selected element into contact with said passive wire.

7. In a switching mechanism, a bare wire conductor serving as a passive terminal element, a plurality of movable terminal elements, each arranged to cooperate with said passive wire, a rotatable selecting member, an electromagnet for rotating said member to select one of said movable elements, and a second electromagnet for moving said rotatable member in a second direction to move the selected terminal element into contact with said passive wire.

8. In a switching mechanism, a bare wire conductor serving as a passive terminal element, a plurality of movable terminal elements arranged in intersecting relation with said passive wire, and a single selectively operable device for selecting one of said movable elements and moving the same into contact with said passive wire.

9. In a switching mechanism, a bare wire conductor serving as a passive terminal element, a plurality of movable terminal elements, each having a point of cooperation with said passive wire, a plurality of slidable bars, one for each point of cooperation, a selectively operable device for selecting and operating any one of said bars to move the corresponding movable terminal element into contact with said passive wire.

10. In a switching mechanism, a bare wire conductor serving as a passive terminal element, a plurality of movable bare wires serving as movable terminal elements and arranged to cooperate with said passive wire, and a single selectively operable device for selecting one of said movable wires and for moving the same into contact with said passive wire.

11. In a switching mechanism, a bare wire conductor serving as a passive terminal element, a plurality of movable bare wires serving as movable terminal elements and arranged in intersecting relation with said passive wire, and a single selectively operable device for selecting one of said movable wires and for moving the same into contact with said passive wire.

12. In a switching mechanism, a set of bare wire conductors serving as passive terminal elements, a plurality of sets of movable bare wire conductors arranged in cooperative relation with said set of passive wires, and a selectively operable device for selecting one of said sets of movable wires and for moving the same into contact with the corresponding wires of said passive set.

13. In a circuit controller, a pluralty of passive contact elements, a plurality of movable contact elements, a plurality of contact operating devices, an operating member common to said devices and selectively engageable therewith, and means for moving said operating member to cause said movable contact elements to move in more than one direction with respect to said passive contact elements.

14. In a circuit controller, a plurality of passive contact elements, a plurality of movable contact elements, a plurality of contact operating devices arranged in the arc of a circle, an operating member common to said devices and selectively engageable therewith, and means for moving said operating member to cause said movable contact elements to move in more than one direction with respect to said passive contact elements.

15. A circuit controller comprising a series of movable contact operating devices arranged in the arc of a circle, sets of movable contacts carried thereby, other sets of passive contacts, an operating member common to said series of contact operating devices, and means for moving said operating member to cause a rubbing action between said movable contacts and said passive contacts.

In witness whereof, I hereunto subscribe my name this 22nd day of December A. D., 1921.

EDWARD B. CRAFT.