March 10, 1925. 1,528,763

C. L. GOODRUM ET AL

SWITCHING DEVICE

Filed May 2, 1922 3 Sheets-Sheet 1

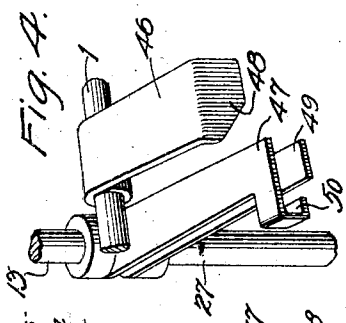


Fig. 4.

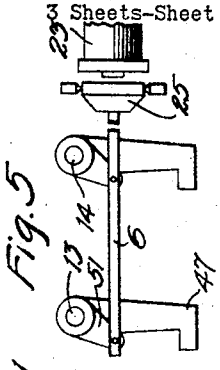


Fig. 5

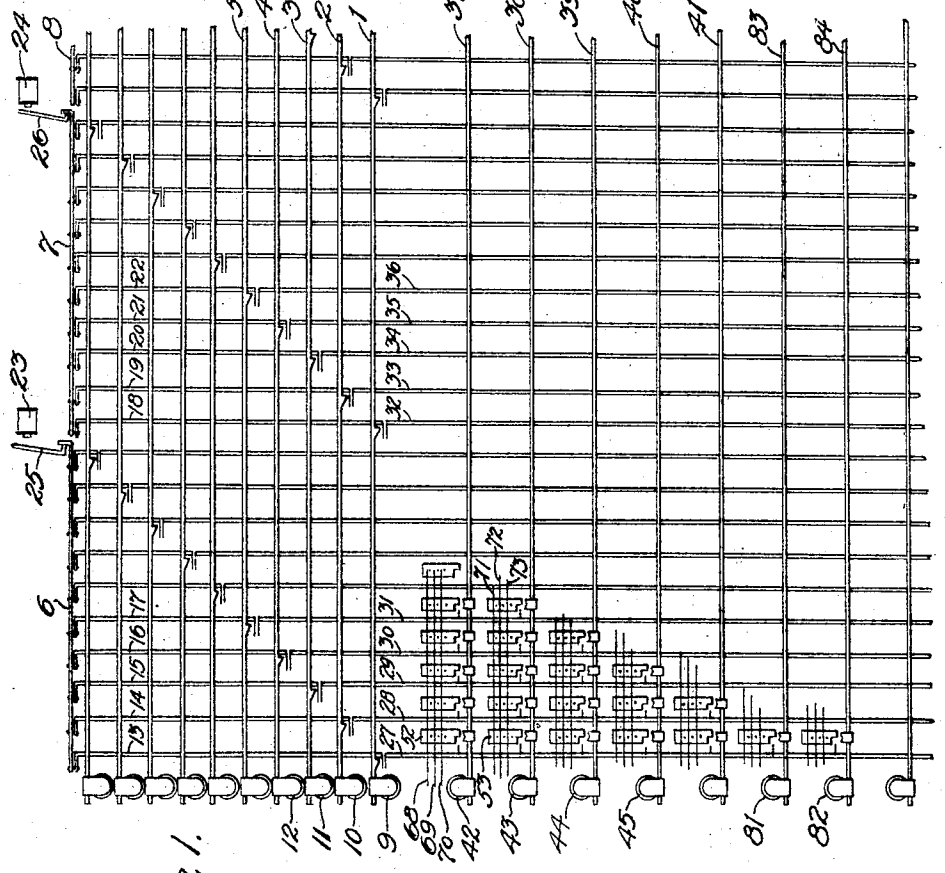


Fig. 1.

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Charles L. Goodrum,
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Att'y.

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SWITCHING DEVICE

Filed May 2, 1922 3 Sheets-Sheet 2

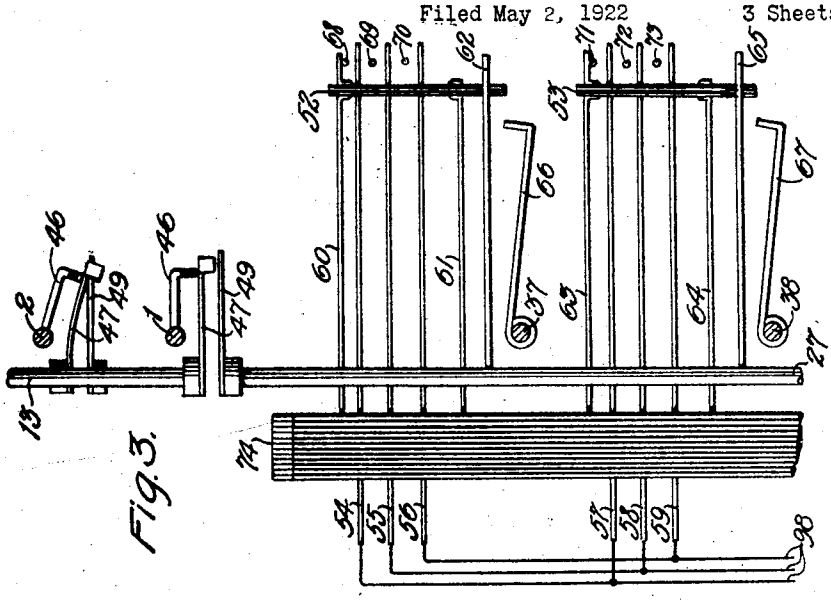


Fig. 3.

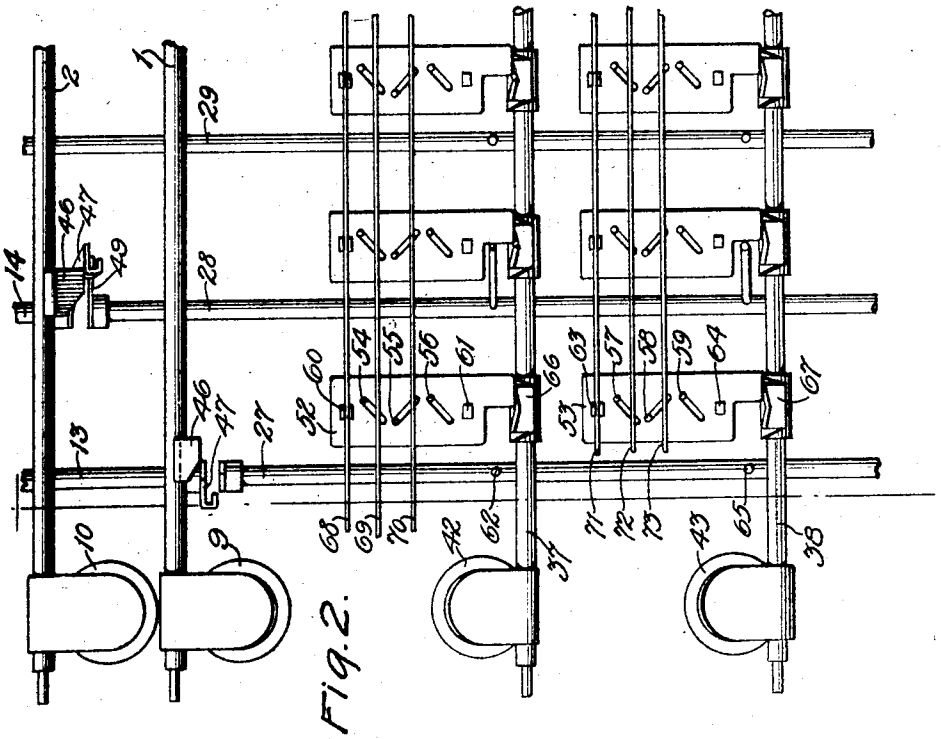


Fig. 2.

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SWITCHING DEVICE

Filed May 2, 1922

3 Sheets-Sheet 3

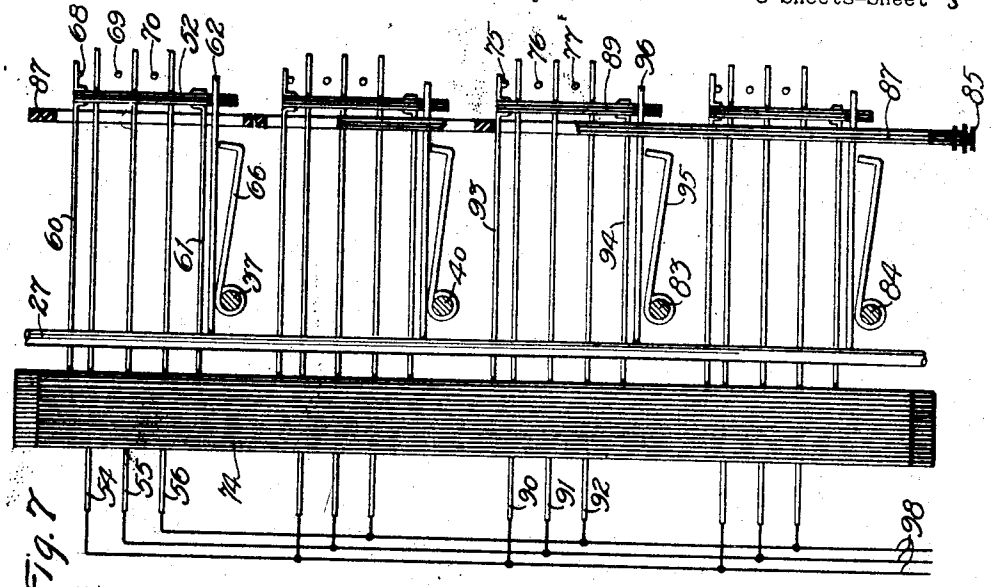


Fig. 7

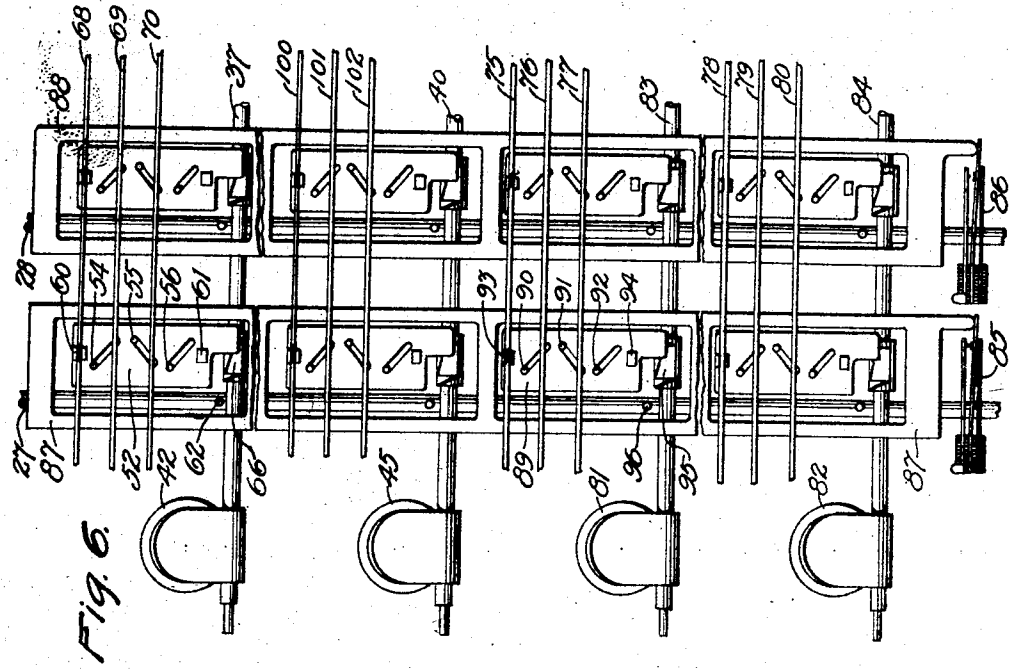


Fig. 6.

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Patented Mar. 10, 1925. 1,528,763

UNITED STATES PATENT OFFICE.

CHARLES L. GOODRUM AND CHARLES J. HENDRICKSON, OF NEW YORK, N. Y., ASSIGNORS TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N, Y., A CORPORATION OF NEW YORK.

SWITCHING DEVICE.

Application filed May 2, 1922. Serial No. 557,845.

To all whom it may concern:

Be it known that we, CHARLES L. GOODRUM and CHARLES J. HENDRICKSON, citizens of the United States, residing at New York, in the county of New York, State of New York, 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 electrical switching devices and particularly to those employed in the establishment of telephone connections.

In certain types of switching mechanisms the circuit making contacts, which serve to interconnect lines or other circuits, are arranged to undergo only a slight movement to engage their cooperating contacts. The acting contacts of a given line may comprise bare wires, cooperating with the passive contacts of all other lines or circuits with which connection is required. The contacts representing each line may be controlled by a mechanical switching member, as for example, a rotatable bar. In order to select the bar representing the line, which is desired to be connected to some other line or circuit, it is proposed to provide sets of operating members or bars. By the joint operation of an operating bar in each of these sets the proper switching bar is selected and operated to prepare the line for connection.

Accordingly, the object of the present invention is an improved switching device of the foregoing description, characterized by an economical disposition of the constituent parts and also by simplicity in operation.

A feature of the invention is the provision of a switch having sets of operating members, a plurality of which cooperate to select and actuate one of a plurality of switching members to connect a corresponding line to other lines, and in which the switching members are disposed in substantially the same plane as said operating members.

Another feature relates to the provision, in a switch having a line equipped with a plurality of independently operable contacts and a set of circuit controlling contacts operable with each of said first contacts, of means for varying the time of operation of said controlling contacts relative to the time of operation of said first contacts.

Such other and further features as are contemplated by the present invention will become more thoroughly understood from the following description and also from the appended claims.

In the drawing, Fig. 1 illustrates, partially in schematic manner, a portion of the switching structure showing the relative disposition of the various elements.

Fig. 2 is an enlarged view illustrating more in detail the cooperation between the operating parts.

Fig. 3 is a detailed view illustrating a side elevation of the structure shown in Fig. 2.

Fig. 4 is a perspective showing the details of certain parts of the switch.

Fig. 5 is a detail showing a top view of one of the operating members.

Fig. 6 is a front view of a portion of the switch showing common means for operating circuit controlling contacts.

Fig. 7 is a side view of the structure seen in Fig. 6.

The switching device embodying this invention, while applicable to various uses, is particularly suited for establishing connections from a group of subscribers' lines to a group of trunk circuits. Conversely, it is equally well adapted to the establishment of connections from trunk circuits to subscribers' lines. For convenience in description, the switch is illustrated as having a capacity for establishing connections between any line in a group of one hundred subscribers' lines and any trunk in a group of ten trunks or, conversely, for establishing connections from any trunk in the group to any subscriber's line. It will be obvious, however, that the switch may be constructed to accommodate groups of varying sizes without departing from the scope of the invention, and moreover, it may be employed as a connecting medium between two groups of trunks or between groups of circuits of any character.

As shown in the present embodiment, the connections between the different lines and the trunks are accomplished by means of circuit making contacts comprising plain bare wires, the movable wires being ad-

vanced into engagement with the passive wires by operating members. Manifestly, other types of circuit making contacts may be substituted if desirable.

A detailed description will now be given of the construction and method of operation of the switch. Referring to Fig. 1 the switching device is seen to comprise three sets of operating or switching members suitably journaled in the switch frame (not shown), the cooperation of which determines the selection of the particular line to be connected to a trunk. The first set consists of ten operating bars of which three bars, 6, 7 and 8, are shown. The operating bar 6 pertains to the first group of ten subscribers' lines, the operating bar 7 to the second group of ten lines, the operating bar 8 to the third group, and so on.

The second set of operating members consists of ten longitudinal bars 1, 2, 3, 4, 5, etc. These bars are arranged in substantially the same plane with the operating bars 6, 7, 8, etc. and extend throughout the entire length of the structure. The operating bar 1 identifies the first line in each of the ten groups of lines. Similarly, the operating bars 2, 3, 4, 5, etc. represent the second, third, fourth, fifth, etc. lines in each of the ten groups of subscribers' lines.

The operating bar 6 is connected to a series of ten rotatable rods 13, 14, 15 and 17 which extend to points where they cooperate, respectively, with the ten operating bars 1, 2, 3, 4 and 5. As best seen in Fig. 5, the rod 13, for instance, is attached to the bar 6 through the medium of the link 51, the link 51 being pivoted to the bar 6 and rigidly secured to the rod 13. Each of the remaining rods is similarly attached to the operating bar 6. Likewise, the operating bar 7 is connected to a series of ten rotatable rods 18, 19, 20, 21, 22, etc., which are secured to the said bar 7 by similar links. The same is true with respect to the operating bar 8 and the remaining bars in the set, not shown.

For imparting motion to the operating bar 6 an electromagnet 23 is provided, the armature 25 of which is adapted to engage the end of the bar 6. The magnet 23 when energized attracts its armature and displaces the bar 6 longitudinally causing the ten rods 13, 14, 15, 16, etc. to rotate through a slight angle for a purpose to be explained hereinafter. Similarly, the operating bar 7 is provided with an electromagnet 24 having an armature 26 for displacing said bar in a longitudinal direction to cause the rotation of the associated rods.

Each of the ten operating bars 1, 2, 3, 4, etc., in the second set is arranged for rotation through a slight angle in order to cooperate with the rotatable rods attached to each of the operating bars 6, 7, 8. The rotation of bars 1, 2, 3, 4, etc. is accomplished by individual electromagnets 9, 10, 11, 12, each having armatures secured to the respective bars.

The third set above mentioned, which will be referred to hereinafter as switching bars, consists of one hundred bars 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, etc. arranged in groups of ten. These one hundred switching bars are individual, respectively, to the one hundred subscribers' lines and are arranged in substantially the same plane with the other two sets of operating bars. By the novel mechanical arrangement employed in this switch, the several operating and switching bars are so disposed that the entire structure occupies a relatively small amount of space. All elements are contained in substantially one plane, permitting easy access to the several parts for adjustment and repair.

The ten switching bars 27, 28, 29, 30, 31 which pertain to the first group of ten lines, extend to points where they cooperate, respectively, with the corresponding rods 13, 14, 15, 16, 17 and also with the operating bars 1, 2, 3, 4, 5. Likewise, the ten switching bars 32, 33, 34, 35, pertaining to the second group of ten lines, extend to points where they, respectively, cooperate with the rotatable rods 18, 19, 20, 21 and also with the operating bars 1, 2, 3, 4, 5. As will be brought out hereinafter the switching bars are selected and rotated by the joint actuation of an operating member in each of the two first mentioned sets. For example, the operation of the member 6 in the first set prepares for selecting any one of the ten switching bars 27, 28, 29, 30. Any one of the operating bars 1, 2, 3, 4 of the second set in conjunction with the bar 6 mechanically selects and rotates the corresponding one of the ten switching bars. Thus, by operating the bar 6 and any one of the ten rotatable bars 1, 2, 3, 4, 5, any one of the switching bars 27, 28, 29, 30, may be selected and rotated. The rotation of a particular switching bar determines the line to be connected to one of the ten different trunks.

For the ten different trunks to which the lines may be connected there are provided ten trunk switching bars 37, 38, 39, 40, 41, 83, 84, etc. arranged in intersecting relation with the one hundred switching bars previously mentioned and are also disposed in substantially the same plane. Each of the ten bars 37, 38, 39 is individual to a trunk and is arranged for rotation by means of the respective magnets 42, 43, 44. The cooperation between the trunk bars 37, 38, 39, and the switching bars 27, 28, 29, is such that whenever two of these bars are rotated conjointly, the corresponding subscriber's line is connected to the corresponding trunk. The first trunk, shown in Figs.

1, 2, 3, 6 and 7 comprises three bare wire conductors 68, 69 and 70 extending before all of the one hundred switching bars. The second trunk, comprising the three conductors 71, 72 and 73, likewise extends before all switching bars and is individual to the trunk bar 38. The remaining trunks are similarly disposed.

The first subscriber's line 98 in the first group of ten (Fig. 3) is served by the switching bar 27 and is provided with a set of movable or active contacts for each of the ten trunks. As is best seen in Figs. 2 and 3, the line 98 has a set of bare wire contacts 54, 55 and 56 for cooperation with the trunk conductors 68, 69 and 70 of the first trunk. These wire contacts are secured to an insulating block 74 attached to the switch frame and extend through diagonal slots in an insulating card 52 to a point adjacent to the trunk conductors. The insulating card 52 is supported by springs 60 and 61 in a position such that the movable contacts 54, 55 and 56 are normally out of engagement with the trunk conductors. The line 98 likewise is provided with a similar set of movable wire contacts 57, 58 and 59 which extend through diagonal slots in the card 53 to a point where they cooperate with the conductors 71, 72 and 73 of the second trunk. Similarly, the line 98 is equipped with movable contacts for all remaining trunks and the same holds true with respect to the remaining lines.

The switch bar 27 individual to the first line 98 is provided with a series of flexible wires 62, 65, one for each of the insulating cards 52, 53. Normally these flexible wires are out of contact with the insulating cards. When, however, the bar 27 is rotated, these wires are carried into engagement with the notches provided on the lower ends of the cards 52, 53, respectively.

The trunk bar 37 has secured thereto a lever 66 arranged in alignment with the insulating card 52 and also a similar lever for each of the remaining cards pertaining to the trunk 68, 69, 70. Likewise, the trunk bar 38 individual to the trunk 71, 72, 73 has a lever 67 in alignment with the insulating card 53 and a corresponding lever for each of the remaining insulating cards pertaining to this trunk. When one of the switching bars such as the bar 27, for example, is rotated, the flexible wires 62, 65 etc. are carried into engagement with the notches on the respective insulating cards 52, 53, etc. This position is illustrated in connection with the switching bar 28. If now the trunk bar 37 is rotated carrying its levers upwardly, the particular lever 66 engages the flexible wire 62 (see Fig. 3) and moves the insulating card 52 upwardly. The upward motion of the card 52 first carries the line contact wires 54, 55 and 56 into engagement with trunk wires 68, 69 and 70. The continued upward movement of the card 52 causes the wires 54, 55 and 56, through the action of the diagonal slots in the card 52, to rub over the surface of the trunk wires, thus insuring a good contact. The same would be true if any of the other trunk bars were operated, namely the corresponding movable line wire contacts would be connected to the trunk to which the operated bar is individual.

A description will now be given of the construction and operation of the operating and switching bars whereby the joint operation of any two of these bars mechanically selects and actuates the corresponding switching bars. The rod 13, as seen in Figs. 2, 3, 4 and 5, is provided at its lower end with a resilient projecting lever 47, the tip end of which is overturned to form a hook 50. The switching bar 27 pertaining to the rod 13 is provided at its upper end with a finger 49 which extends to a point where it is adapted to be engaged by the hook 50 when the lever 47 is bent downwardly. This arrangement is brought out most clearly in Fig. 3. The operating bar 1 pertaining to the first switching bar in each group of ten bars has a lever 46 with a bevelled surface 48 adapted to be encountered by the lever 47 when the rod 13 is rotated, provided the rod 1 has previously been rotated.

Assume that it is desired to establish a connection between the first line 98 and one of the ten trunks and that the first trunk 68, 69, 70 is idle. By any suitable circuit arrangement, such as shown in the application of C. J. Hendrickson, Serial No. 556,935, filed April 27, 1922, the electromagnet 9 may be energized. Magnet 9 attracts its armature and rotates the operating bar 1, tilting the lever 46 downwardly as seen in the upper portion of Fig. 3. Next, a circuit is established for the electromagnet 23. Magnet 23 attracts its armature displacing the bar 6 longitudinally, rotating each of the rods 13, 14, 15 etc. The rod 13 rotates the lever 47 to the right as seen in Fig. 4. Lever 47 immediately encounters the bevelled edge 48 of the lever 46 and is bent downwardly such that a continued movement causes the hook 50 to engage the finger 49 on the bar 27. Thereupon the switching bar 27 is rotated with the rod 13 and the flexible wires 62, 65, etc. are carried against their respective insulating cards, 52, 53, etc.

A circuit is then established for the magnet 42 and the trunk bar 37 is rotated, tilting the lever 66 upwardly. Lever 66 engages the wire 62, moving the card 52

upwardly to carry the wire contacts 54, 55 and 56 of the line 98 into engagement with the wires 68, 69, 70 of the idle trunk, thus establishing a connection. Although the remaining rods 14, 15, 16, 17, etc. were rotated with the rod 13, none of them cause the rotation of the respective switching bars 29, 30, 31, etc., since none of the remaining operating bars 2, 3, 4, 5, etc. is operated.

After the connection has been established the electromagnets 23 and 9 may be deenergized, permitting their corresponding operating bars to restore to normal position. The electromagnet 42, however, is maintained energized to retain the connection. When the operating bars 1 and 6 restore, the switching bar 27 also returns to normal. The restoration of bar 27 carries all of the remaining flexible wires 65, etc. back to their normal positions as shown in Fig. 2. The flexible wire 62 however, is held in by the notched surface of the lever 66 against the lower edge of the insulating card 52.

When the connection is no longer required the magnet 43 is deenergized, permitting the rod 37 to restore. The flexible wire 62 now returns to its normal position and the insulating card 52 carries the contacts 54, 55 and 56 out of engagement with the trunk wires.

As was hereinbefore discussed, a switch of this type may be used for connecting lines to trunks or, conversely, for connecting trunks to the lines. In the first case it is the usual practice to operate the cut-off springs which control the subscriber's line relay after the line has been extended through to an idle trunk. On the other hand, if the connection is one which is being extended from the trunk to the subscriber's line, it is desirable to operate the subscriber's cut-off springs slightly in advance of the time that the trunk is connected to the line. This prior operation of the cut-off springs prevents the accidental energization of the line relay and the false initiation of a call.

Referring to Fig. 6, it may be considered that the switch employed for illustrating this invention serves in both of the above mentioned capacities. Assume, for example, that the subscriber's line 98 is adapted for connection with a number of trunks for outgoing calls and is also adapted to be connected to by a number of trunks for incoming calls. For example, the trunks 68, 69, 70 and 100, 101, 102 are for handling calls originated on the subscriber's line 98. On the other hand, trunks 75, 76, 77 and 78, 79, 80 are for routing incoming calls to the subscriber's line 98. Therefore, whenever the line 98 is connected to the trunk 68, 69, 70, it is necessary that the subscriber's cut-off springs should be operated subsequent to the connection of the trunk to the line. Also when a connection is extended from the trunk 75, 76, 77 to the line 98, it is desirable that the subscriber's cut-off springs should be actuated slightly in advance of the connection.

A set of cut-off springs 85 is illustrated individual to the line 98, and serve the same purpose as the springs usually operated by the cut-off relay of the subscriber's line. Also a set of contact springs 86 is shown individual to a second subscriber's line. A common operating card 87 is provided for all trunks and is individual to the subscriber's line 98. Similarly the card 88 is common to all trunks and pertains to the second subscriber's line. These cards have a series of windows through which the line contact sets project to cooperate with the respective trunks.

Considering Figs. 6 and 7, it will be noted that a given distance is provided between the spring 60 and the upper edge of the window in the common operating member 87. The same is true with respect to the trunk 100, 101, 102. Whenever the insulating card 52 is moved upwardly by the trunk bar 37 to carry the contacts 54, 55 and 56 into engagement with the trunk conductors 68, 69, 70 to establish a connection between the line 98 and the trunk, the spring 60 engages the upper edge of the window in the member 87 and moves this member upward bodily. The upward movement of the member 87 releases the cut-off contacts 85 to open the circuit of the usual relay (not shown). The distance between the strip 60 and the upper edge of the window in the member 87 is so calculated that the member 87 is not moved to operate the springs 85 until slightly after the contacts 54, 55, 56 have engaged the trunk conductors 68, 69, 70. Hence, the cut-off springs 85 are not operated until after the line is extended to the trunk.

Considering an incoming call over the trunk 75, 76, 77 to the line 98, it will now be explained how the cut-off springs 85 are actuated in advance of the connection. Observing the window in the member 87 pertaining to the insulating card 89, it will be seen that the distance between the spring 93 and the upper edge of this window is considerably less than the distance between the spring 60 and the edge of the corresponding window. This distance is so taken that when the trunk bar 83 is operated to move the insulating card 89 upwardly, the spring 93 engages the upper edge of the window in the member 87 in advance of the time when the wire contacts 90, 91, 92 engage the trunk conductors 75, 76, 77. Thus, the cut-off springs 85 are actuated prior to the connection of the trunk to the line 98.

While the circuit controlling springs 85 have been described in connection with the

line relay operation, it will be understood that they may be used for controlling any desired circuit wherein similar requirements are found.

What is claimed is:

1. The combination in a switching device of a plurality of rotatable switching members arranged in a plane, operating members, certain of said operating members being arranged in the same plane with said switching members, individual magnets for said operating members for rotating a plurality thereof, said rotated operating members cooperating to select and rotate one of the switching members, lines, and means controlled by said switching members for interconnecting said lines.

2. The combination in a switching device of switching members arranged in a plane, a plurality of sets of operating members, certain of said sets of operating members being arranged in the same plane with said switching members, means for actuating operating members in different sets, said actuated members cooperating to select and actuate any one of said switching members, lines, and means controlled by said switching members for interconnecting said lines.

3. The combination in a switching device, of switching members arranged in a plane, a plurality of sets of operating members, certain of said sets of operating members being arranged in the same plane with said switching members, means for actuating any operating member in each of said sets, the actuated members in the different sets cooperating with each other to select and actuate one of said switching members, lines, and means controlled by said switching members for interconnecting said lines.

4. The combination in a switching device of switching members, two sets of operating members, one of said sets of operating members being arranged in the same plane with said switching members, magnets for actuating any operating member in one set and any operating member in the other set, said operating members coacting to select and actuate any one of said switching members, lines, and means controlled by said switching members for connecting one of said lines to another of said lines.

5. The combination in a switching device of a plurality of switching bars, operating bars, certain of said operating bars being arranged in the same plane with said switching bars, means for actuating a plurality of said operating bars, said actuated bars cooperating to select and actuate one of said switching bars, lines, and means controlled by said switching bars for interconnecting said lines.

6. The combination in a switching device of switching bars, a plurality of operating bars, certain of said operating bars being arranged in the same plane with said switching bars, means for actuating an operating bar in each set, said actuated bars cooperating to actuate any one of said switching bars, lines, and means controlled by said switching bars for interconnecting said lines.

7. The combination in a switching device of switching members, lines, one for each switching member, operating members, certain of said operating members being arranged in the same plane with said switching members, and means for actuating a plurality of said operating members, said actuated members cooperating to select and actuate one of said switching members for connecting the corresponding line with any of said other lines.

8. The combination in a switching device of switching bars, lines, one for each bar, operating bars, certain of said operating bars being arranged in the same plane with said switching bars, means for actuating a plurality of said operating bars, said actuated bars cooperating to select and operate one of said switching bars, other lines, and contacts controlled by a switching bar for connecting the corresponding line to said other lines.

9. The combination in a switching device of a first and a second set of operating members, a first and second set of switching members said first set of operating members being arranged in the same plane as said first set of switching members, lines, one for each switching member of said first set of switching members, other lines, one for each member of said second set of switching members, means for actuating a member in the first set of operating members to cooperate with a member of the second set of operating members in the selection and actuation of a member of the first set of switching members, said latter member cooperating with any member of the second set of switching members to connect the corresponding one of said first lines to any one of said other lines.

10. The combination in a switching device of a plurality of switching members, a corresponding plurality of operating rods arranged in groups, a set of operating members, one for each group of rods, a second set of operating members, means for actuating a plurality of said operating members, said actuated members cooperating to select and actuate one of said switching members, lines, and means controlled by said switching members for interconnecting said lines.

11. The combination in a switching device of a plurality of switching members, a corresponding plurality of operating rods arranged in groups, a set of operating members one for each group of rods, a second set of operating members common respec-

tively to the corresponding rods of each of said groups of rods, means for actuating said operating members whereby the actuation of an operating member in each set selects and actuates one of said switching members, lines, and means controlled by said switching members for interconnecting said lines.

12. The combination in a switching device of a plurality of switching members, a corresponding plurality of operating rods arranged in groups, couplings between said members and said rods, respectively, a set of operating members one for each group of rods, a second set of operating members common respectively to the corresponding rods of each of said groups of rods, means for actuating said operating members whereby the actuation of an operating member in each set couples one of said switching members to the corresponding rod and actuates said switching member, lines, and means controlled by said switching members for interconnecting said lines.

13. The combination of a line, a plurality of other lines, circuit contact sets for said first line, one for connecting the same to each of said other lines, operating means for actuating any set of contacts, a set of controlling contacts, and means operable upon the actuation of any set of said circuit contacts for actuating said controlling contacts at different times relative to the time of actuation of said circuit contacts.

14. The combination of a line, a plurality of other lines, circuit contact sets for said first line, one for connecting the same to each of said other lines, operating means for actuating any set of contacts, a set of controlling contacts, means operable upon the actuation of any set of said circuit contacts for operating said controlling contacts, and means for timing the actuation of said controlling contacts with respect to the time of actuation of said circuit contacts.

15. The combination of a line, a plurality of other lines, circuit contact sets for said first line, one for connecting the same to each of said other lines, operating means for actuating any set of contacts, a set of controlling contacts, means operable upon the actuation of any set of said circuit contacts for operating said controlling contacts, and means for timing the actuation of said controlling contacts depending on which set of circuit contacts is actuated.

16. The combination of a line, a plurality of other lines, circuit contact sets for said first line, one for connecting the same to each of said other lines, operating means for actuating any set of contacts, a set of controlling contacts, and means operable upon the actuation of any set of said circuit contacts for operating said controlling contacts in advance of the actuation of certain circuit contacts and subsequent to the actuation of other of said circuit contacts.

17. The combination of a line, a plurality of other lines, circuit contact sets for said first line, one for connecting the same to each of said other lines, operating means for actuating any set of contacts, a set of controlling contacts, and means operable upon the actuation of any set of said circuit contacts for operating said controlling contacts, said last mentioned means being a member common to all circuit contact sets for timing the actuation of said controlling contacts relative to the time of actuation of the circuit contacts.

18. The combination of a line, a plurality of trunks, circuit contact sets for said line, one for connecting the same to each of said trunks, operating bars for actuating any set of said contacts, a set of controlling contacts, and means operable upon each operation of said bars for operating said controlling contacts at different times relative to the time of actuation of said circuit contacts.

19. The combination of a line, a plurality of other lines, circuit contact sets for said first line, one for connecting the same to each of said other lines, a plurality of operating means, each individual to a contact set, a member common to said operating means and actuated thereby each time a set of contacts is operated, and a device controlled by said common member.

20. The combination of a line, a plurality of other lines, circuit contact sets for said first line, one for connecting the same to each of said other lines, a plurality of operating means, each individual to a contact set, a member common to said operating means and actuated thereby each time a set of said contacts is operated, and controlling contacts operated by said common member.

In witness whereof, we hereunto subscribe our names this 26th day of April, A. D. 1922.

CHARLES L. GOODRUM.
CHARLES J. HENDRICKSON.