

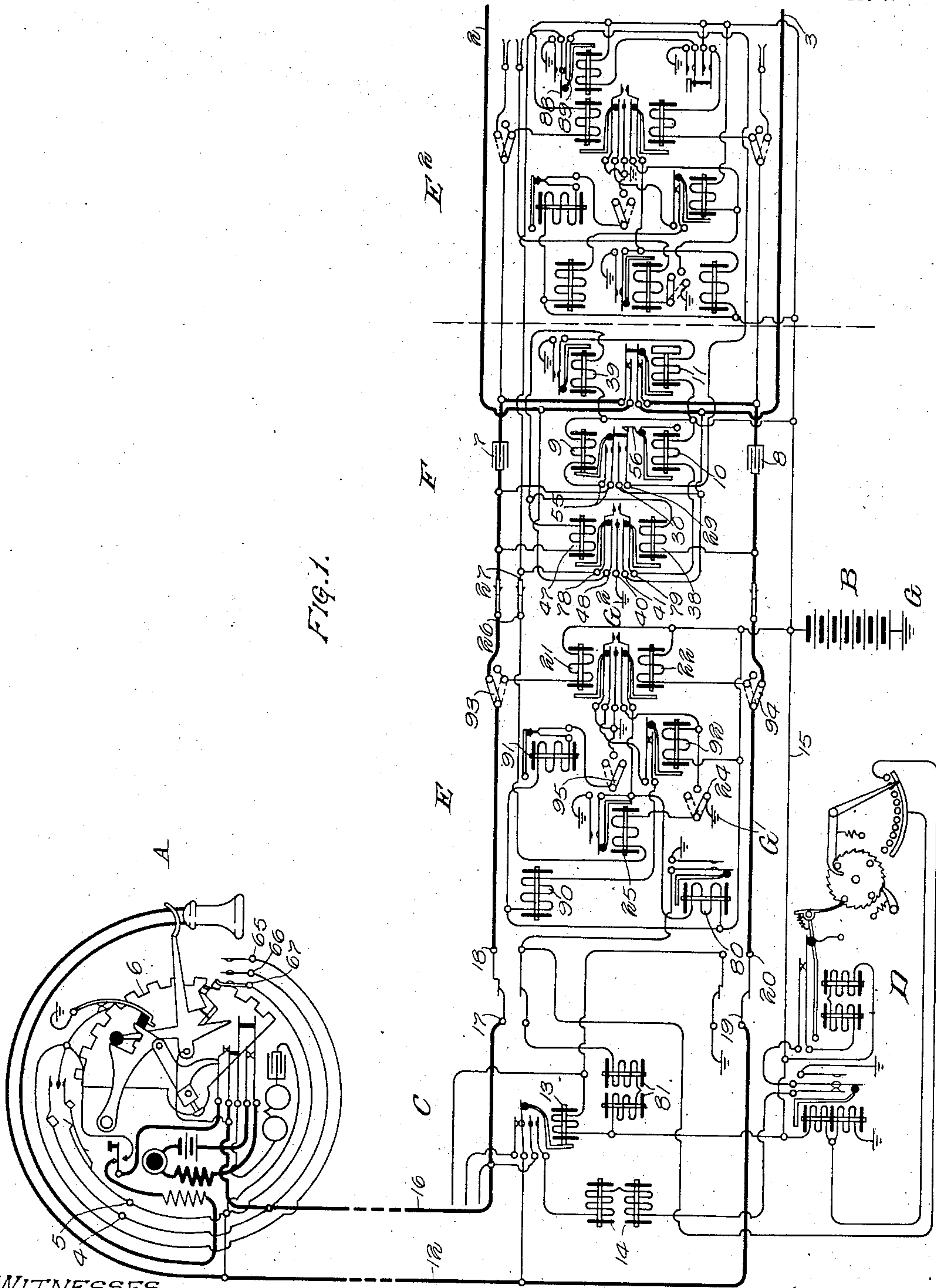
C. E. STEPHENSON.
 TELEPHONE TRUNKING SYSTEM.
 APPLICATION FILED FEB. 14, 1912.

1,172,402.

Patented Feb. 22, 1916

3 SHEETS—SHEET 1.

FIG. 1.



WITNESSES

A. J. Ray
 A. Andersen.

INVENTOR:

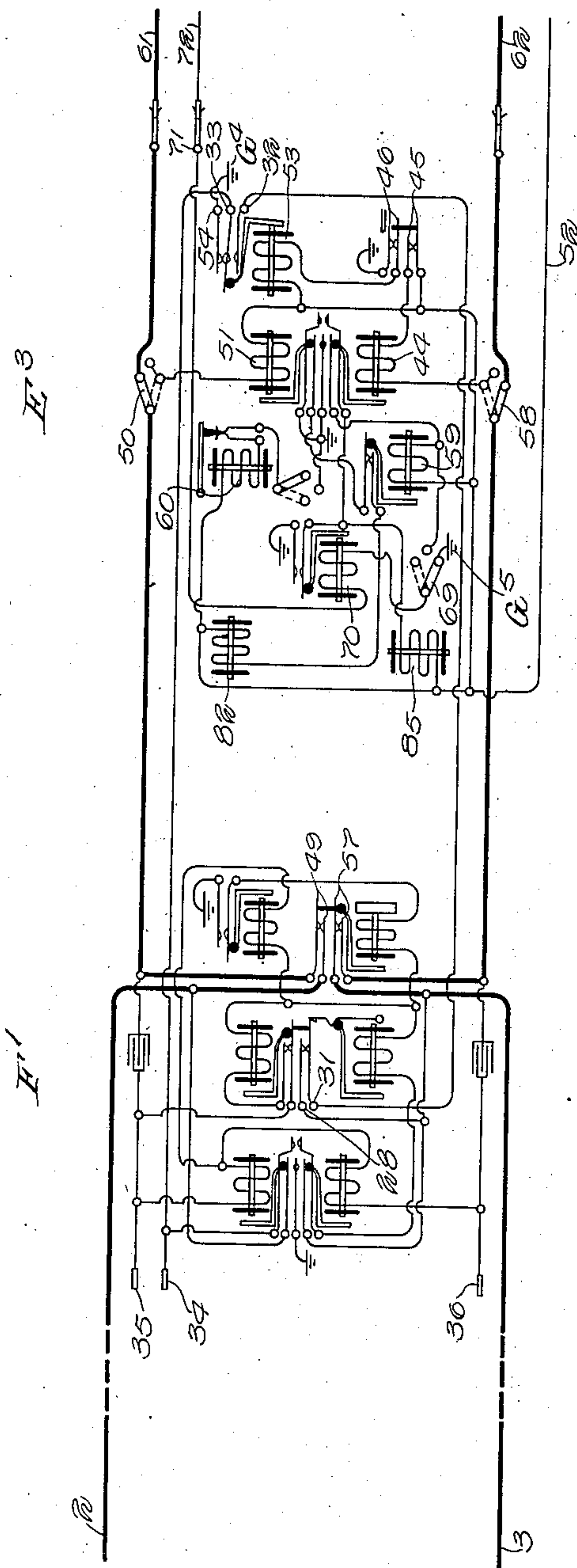
Charles E. Stephenson
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 ATTORNEYS.

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3 SHEETS—SHEET 2.

FIG. 2.



WITNESSES

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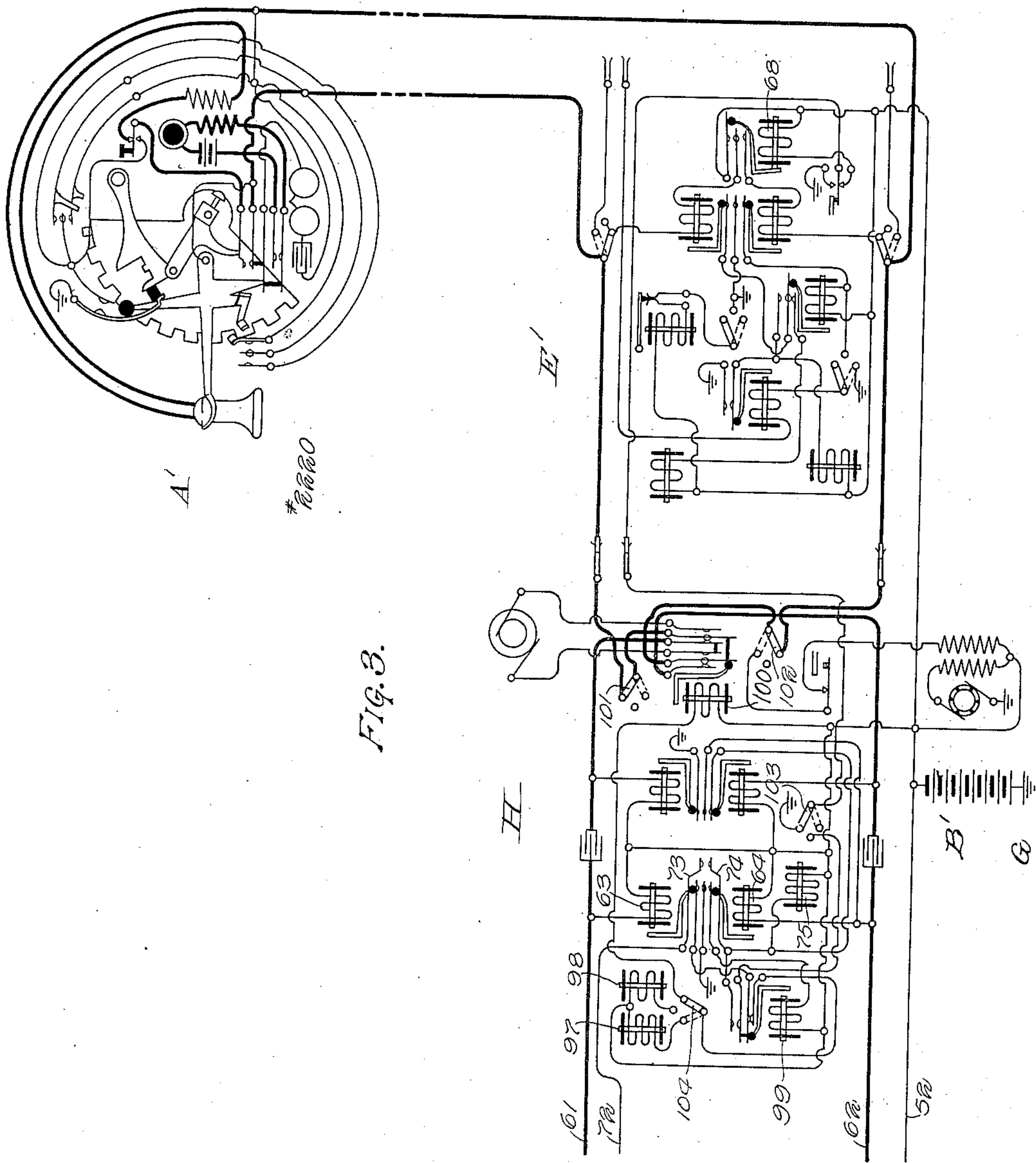
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3 SHEETS—SHEET 3.



WITNESSES
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CHARLES E. STEPHENSON, OF SIOUX CITY, IOWA, ASSIGNOR TO AUTOMATIC ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TELEPHONE TRUNKING SYSTEM.

1,172,402.

Specification of Letters Patent.

Patented Feb. 22, 1916.

Application filed February 14, 1912. Serial No. 677,532.

To all whom it may concern:

Be it known that I, CHARLES E. STEPHENSON, a citizen of the United States of America, and resident of Sioux City, in the county of Woodbury and State of Iowa, have invented certain new and useful Improvements in Telephone Trunking Systems, of which the following is a specification.

My invention relates to a telephone trunking system, and more particularly to a trunking system in which a two-way trunk is employed for automatically trunking from one exchange to another, or between two parts of the same exchange.

In systems in which two-way trunk lines are employed—that is, trunk lines over which a connection may be extended in either direction—difficulty has been experienced in maintaining a proper guarding potential upon the multiple terminals of said trunk at both ends thereof when said trunk is seized. Various systems have been devised for accomplishing this result, but heretofore they have proved commercially unsatisfactory.

One of the principal objects of my invention is the provision of an improved system in which the selector bank contacts at each end of the trunk are provided with guarding potentials as soon as the trunk is seized at either end. I accomplish this result without the employment of a third conductor in the trunk line, and supply the guarding potential for the opposite end of the trunk to that seized over one of the conductors of the trunk itself.

These and other objects of my invention will be more readily understood by reference to the accompanying drawings, in which—

Figures 1, 2 and 3 show a complete connection between a calling substation A and a called substation A' in an automatic telephone system embodying the principles of my invention.

The automatic telephone system in connection with which I have chosen to illustrate my invention is of the well-known type of system embodying subscribers' pre-selector or line switches, selectors and connectors. The connection shown is extended from the substation A through its individual switch C at the central station to a first selector E, and through said selector E

to a repeater F in the same exchange, and thence over a trunk line comprising the conductors 2 and 3 to a second exchange. At the second exchange the connection extends through a selector E³ and connector H to the called substation A'. The trunk line, composed of the two conductors 2 and 3, which extends between the exchanges, is a two-way trunk line—that is, it may be used either for extending a connection from the exchange represented in Fig. 1 to the exchange represented in Figs. 2 and 3, or vice versa. At each exchange this trunk line is connected to a selector switch and a repeater, for example, the repeater F and the selector E² in Fig. 1, and the repeater F¹ and the selector E³ in Fig. 2.

The subscriber's individual or line switch C, its master switch D, the selector switches E, E', E² and E³ and the connector H are of the well-known type of central office switching apparatus disclosed in British patent to R. W. James, No. 26,301 of 1906, and in the *Western Electrician* of Chicago, Illinois, of January 11, 18 and 25, 1908. The construction of the selector and connector switches is also disclosed in United States Letters Patent Nos. 815,321 and 815,176, respectively, granted March 13, 1906, to Keith, Erickson and Erickson. The selector E comprises the usual vertical and rotary line relays 21 and 22, the vertical magnet 90, rotary magnet 91, release relay 25, release magnet 80, private magnet 92 and the side switch comprising the wipers 93, 94, 95 and 24. The selectors E² and E³ are essentially the same as the selector E, with the addition of one relay and two pairs of off normal springs. (See the relay 53 and the springs 45 and 46 in the selector E³ and the corresponding relay and springs in the selector E²). The connector H comprises the usual vertical and rotary line relays 63 and 64, vertical and rotary magnets 97 and 98, release magnet 75, private magnet 99, ringing relay 100 and side switch comprising the wipers 101, 102, 103 and 104. The selector E' is similar to the selector E, with the addition of a bridge-cut-off relay 68. The selector E' is individual to the line of the substation A', while the selector E is accessible in common to a plurality of substations through the medium of their line switches C.

The substations A and A' may be of any

suitable type of substation provided with an automatic calling device of the proper character for operating the central office apparatus. As shown herein, the substation A is provided with a pair of impulse springs 4 and 5, which springs are controlled through the medium of an impulse wheel 6, the latter being in turn controlled by the calling subscriber through the medium of a dial (not shown) provided with finger holes. Such a substation is well known in the art, and it is not thought necessary to give a detailed description of the same herein. As is well known, when the calling device of a substation of this character is operated to call any digit, a preliminary ground impulse is transmitted over the so-called rotary side of the line from the substation to the central office, then the vertical line is grounded a number of times corresponding to the digit called, after which the rotary line is grounded once more.

The repeater F (Fig. 1) is provided for the purpose of repeating impulses from the calling substation around the condensers 7 and 8 to the trunk conductors 2 and 3. The relay 9 is adapted, when energized, to become locked in its operated position, from which it can be released by the energization of the magnet 10. The relay 11 is a slow-acting relay—that is, a relay which is slow to deenergize after its energizing circuit has been broken. The repeater F' is in all respects the same as the repeater F.

In order to give a complete understanding of my invention, the complete operations by which the calling subscriber A obtains connection with the called subscriber A' will now be explained. Since the operation of the switching apparatus disclosed herein is in general well known in the art, it is not thought necessary to describe its operation in detail, only sufficient description being given to enable a complete understanding of my invention. The number of the called substation will be assumed to be 2220. When the calling subscriber, after removing his receiver from the switch hook, operates his calling device for the first digit 2, the preliminary impulse over the rotary line conductor 12 passes through the springs of the cut-off relay 13 of the line switch C, and through the trip magnet 14 to the battery lead 15, thence through battery B to ground G. The magnet 14, upon energizing, releases the plunger of the line switch C, allowing it to enter its bank, whereby the line conductors 12 and 16 are extended through the line switch bank springs 17 and 18 and 19 and 20 to the selector E. After the line switch C has operated, its master switch D operates in a well-known manner to advance the plungers of the remaining line switches of the group to which the switch C belongs to an idle trunk line. After the connection

has thus been extended to the first selector E, two impulses are transmitted from the substation A over the vertical line 16 and through the selector vertical line relay 21 to the battery lead 15, followed by one impulse over the rotary line and through the rotary line relay 22 of the selector. The selector E operates in response to these impulses transmitted through its vertical and rotary line relays to extend the line connection to an idle trunk line 2—3 leading to the distant exchange, which trunk line has associated with it in the exchange of the substation A the repeater F and selector E². When the connection is thus extended to this trunk line, the usual guarding ground is extended to its selector private bank contacts from ground G' in the selector E, through the side switch wiper 24, relay 25 and selector private wiper 26 to the bank contact 27 and the corresponding contact in the banks of all the selectors which have access to the same trunk line. From the selector private bank contact 27 this ground potential also extends through the relay springs 88 and 89 in the selector E², thence through the springs 29 and 30 in the repeater to the trunk conductor 3, thence over said conductor 3 to the second exchange, and through the springs 28, 31, 32 and 33 to the selector private bank contact 34, thence to the corresponding private bank contact in the banks of all the selectors in the second exchange which have access to the trunk 2—3 for extending a connection from said second exchange to the first exchange. It will thus be seen that at the instant the selector E obtains connection with the trunk line between exchanges, said trunk line is immediately protected from being seized by any other selector switch, not only in the first exchange, but also in the second exchange as well.

When the calling device at the substation A is operated for the second digit 2, one impulse is transmitted over the rotary line conductor 12, followed by two impulses over the vertical line 16 and then by one more over the rotary line. The first impulse over the rotary line conductor 12 passes through the line switch C and the first selector E, thence through the rotary line relay 38 of the repeater F and through the relay 39 to the battery lead 15. The relay 39 is energized by this impulse and operates to close the circuit of the relay 11, which operation is, however, without function at this time. The relay 38, upon energizing, completes a connection from ground G² through the springs 40 and 41 to the trunk conductor 3, which, however, is without effect, because the rotary line relay 44 of the selector E³ (Fig. 2) is disconnected from battery until after the switch shaft has been raised one or more steps from its vertical position to

permit the springs 45 and 46 to close their contacts. The two impulses for the second digit, which are transmitted over the vertical line conductor 16, pass through the switches C and E, thence through the repeater vertical line relay 47 and the relay 39 to the battery lead 15. The relay 39, upon energizing, operates to close the circuit of the relay 11, which relay, upon energizing, connects the selector E^2 from the trunk conductors 2 and 3. The relay 11 being a slow acting relay does not have time to return to its normal position during the interval which elapses between the vertical impulses, and therefore maintains the selector E^2 and the condensers 7 and 8 disconnected from the trunk during the entire time the impulses are being transmitted to the second exchange. The vertical relay 47, upon energizing, completes a circuit extending from ground G^2 through the springs 40 and 48, thence over the trunk conductor 2 and through the springs 49 (Fig. 2), side switch wiper 50 and the selector vertical line relay 51 to the battery lead 52, thence through battery B' to ground G. The relay 51, upon energizing, operates to close the circuit of the selector vertical magnet 82, which, upon energizing, operates to raise the switch shaft one step. Since the digit called is 2, the repeater vertical line relay 47 of the repeater F operates to transmit two impulses through the relay 51 of the selector E^3 , thereby causing the vertical magnet 82 to raise the switch shaft two steps. Upon the first movement of the shaft of the selector E^3 the springs 45 and 46 are permitted to close. The springs 45, upon closing, connect the rotary line relay 44 with the battery lead 52, while the springs 46, upon closing, close the circuit of the relay 53. The relay 53, upon energizing, disconnects the selector private bank contact 34 of the trunk 2—3 from the trunk conductor 3 and supplies said contact with a new guarding ground which extends from ground G^4 through the springs 54 and 33 to said contact. At the repeater F (Fig. 1) the selector private bank contact 27 is disconnected from the trunk conductor 3 by the first vertical impulse in the following manner: It will be seen that in the repeater the relay 9 is normally connected with the vertical side of the line through its own springs 55. Therefore, when the first impulse is transmitted to the repeater over the vertical side of the line, the relay 9 energizes and disconnects itself from the line, and its springs become locked in their operated positions by the engagement of the spring 29 with the catch 56. The separation of the springs 29 and 30 by the operation of the relay 9 disconnects the private bank contacts from the rotary trunk conductor 3. When the final rotary impulse is transmitted over the rotary line 12, it energizes the repeater rotary

line relay 38 in the manner previously explained, which operates to transmit an impulse from ground G^2 through the springs 40 and 41, trunk conductor 3, springs 57 (Fig. 2), side switch wiper 58, rotary line relay 44 of the selector E^3 and springs 45 to the battery lead 52. The rotary line relay 44, upon energizing and deenergizing, transmits a single impulse through the private magnet 59, which latter operates in response thereto to cause the side switch to pass from first to second position, after which the rotary magnet 60 operates in a well-known manner to rotate the wipers of the selector onto a trunk line leading to an idle connector H, after which the side switch of the selector E^3 passes to third position in the usual manner.

The operation of the substation calling device for the last two digits of the called number causes the repeater F to operate in the same manner as just described to transmit the vertical and rotary impulses over the vertical and rotary trunk conductors 2 and 3, respectively, and through the selector E^3 , over the trunk conductors 61 and 62, thence through the connector vertical and rotary line relays 63 and 64 to the battery lead 52. The connector H operates in response to these impulses in the usual and well-known manner to complete the connection with the called line. The entire talking circuit between the calling and the called substations is outlined by heavy conductors. When the connection has been extended to the called line and the side switch of the connector passes to third position, a guarding ground is extended to the connector private bank contacts of the called line, and the cut-off relay 68 of its selector E' is energized. The relay 68, upon energizing, disconnects the bridge across the called line through the line relays of the selector E' . After the conversation is completed the entire connection is released by the hanging up of the receiver at the calling substation. As the switch hook at the substation A descends, it momentarily presses together the springs 65, 66 and 67, thereby grounding both the vertical and rotary line conductors 12 and 16 simultaneously. This energizes both the line relays 47 and 38 of the repeater F, which relays in turn operate to ground the trunk conductors 2 and 3 to energize the connector line relays 63 and 64. The relays 63 and 64, upon energizing, complete a circuit extending from ground G^5 at the selector E^3 through the side switch wiper 69, relay 70, wiper 71, conductor 72, springs 73 and 74 and the connector release magnet 75. The magnet 75, upon energizing, immediately releases the connector H. The relay 70, upon energizing, closes the circuit of the selector release magnet 85. At the repeater F the simultaneous energization of the relays 47

and 38, besides grounding the trunk conductor 2, also completes a circuit extending from ground G' at the selector E through the side switch wiper 24, relay 25, wiper 26, contact 27, springs 78 and 79 and the relay 10 to the battery lead 15. The relay 10, upon energizing, operates to unlock the springs of the relay 9, while the relay 25 of the selector, upon energizing, closes the circuit of the selector release magnet 80. The magnet 80, upon energizing, closes the circuit of the release magnet 81 of the line switch C. The release magnets 85, 80 and 81 of the switches E³, E and C, respectively, upon energizing, attract their armatures and hold them in readiness to release their respective switches when the switch hook at the substation descends far enough to permit the springs 65, 66 and 67 to separate, whereupon the relays 47 and 38 of the repeater and all relays and magnets whose circuits were closed as a result of their energization become deenergized, and all switches employed in the connection are restored to normal position.

In the description of the operation of the two-way trunk line 2-3, it will be seen that the repeater F (Fig. 1) and the selector E³ (Fig. 2) were used, the selector E² (Fig. 1) and the repeater F' (Fig. 2) remaining inoperative. Since both ends of the trunk line are exactly the same, it will be evident that said trunk line could be used to extend a connection in the opposite direction by being seized through the selector bank contacts 34, 35 and 36 in the second exchange. The operation of the trunk line in this case would be exactly the same as that which has been described, except that the repeater F' and the selector E² would now be used instead of the repeater F and the selector E³.

While I have chosen to illustrate my invention in connection with a certain type of automatic system of the three-wire type, and one in which the opposite ends of the trunk line are provided with both a repeater and a selector, it is to be understood that in certain broader aspects my invention is not so limited.

What I claim as my invention is:—

1. In a telephone system, a trunk line having one or more line conductors extending from one end to the other of said trunk line, automatic means for seizing one end of said trunk line, and a circuit including one of said line conductors for supplying a guarding potential to the opposite end of said trunk.

2. In a telephone system, a two-way trunk line having one or more line conductors extending from one end to the other of said trunk line, automatic means for seizing either end of said trunk line, and a circuit including one of said line conductors for supplying a guarding potential to the dis-

tant end of said trunk when either end of same is seized.

3. In a telephone system, a two-way trunk line, a plurality of multiple terminals for each end of said trunk line, automatic means for seizing either end of said trunk, and means for connecting a line conductor of said trunk with the multiple terminals at the distant end for placing a guarding potential on the multiple terminals at the distant end thereof when either end of said trunk is seized.

4. In a telephone system, a two-way trunk line, an automatic selector switch at either end of said line for seizing the same, whereby connection can be extended over said trunk in either direction, and a guarding potential extending over a line conductor of said trunk for preventing the selector at the distant end from seizing the same when one of said selectors has been operated to seize said trunk.

5. In a telephone system, a two-way trunk having a plurality of multiple contacts at each end thereof, a plurality of automatic switches for seizing said trunk through said multiple contacts, and means for connecting one of the talking conductors of said trunk with the multiple terminals at the distant end for placing a guarding potential upon the multiple contacts at the distant end thereof when one of said switches operates to seize said trunk.

6. In a telephone system, a two-way trunk having multiple terminals at either end thereof, a selector for seizing one end of said trunk through one of said multiple terminals, and a circuit including one of the talking conductors of said trunk for placing a guarding potential on the multiple terminals at the distant end thereof.

7. In a telephone system, a two-way trunk, means for seizing either end thereof, a selector and a repeater at each end of said trunk, means for operating said repeaters to transmit impulses over said trunk to operate the selector at the opposite end thereof, and a circuit including one of the talking conductors of said trunk for establishing a guarding potential when said trunk is seized to prevent the opposite end of said trunk being seized.

8. In a telephone system, a two-way trunk having multiple terminals at each end thereof, means for seizing either end of said trunk, a repeater and a selector for each end of said trunk, means for operating said repeater to repeat impulses over said trunk to operate the selector at the distant end thereof, and a circuit including a talking conductor of said trunk for placing a guarding potential on the multiple terminals at the distant end thereof when said trunk is seized.

9. In a telephone system, a two-way trunk

having multiple terminals at either end thereof, means for seizing either end of said trunk, a selector associated with each end of said trunk for extending connection from said trunk, a circuit including a line conductor of said trunk for initially placing a guarding potential on the multiple contacts at the distant end of said trunk when one end of same is seized, and means for removing this guarding potential and placing a second guarding potential on said multiple terminals when the selector switch associated with the distant end of said trunk is operated.

10. In a telephone system, a two-way trunk having multiple terminals at either end thereof, means for seizing either end of said trunk, an automatic switch associated with either end of said trunk for extending connection from said trunk, a circuit including one of the line conductors of said trunk for establishing a guarding potential on the multiple terminals at the distant end thereof when said trunk is seized, and means for breaking this circuit and closing a second guarding potential circuit for said multiple terminals when the selector switch at the distant end of the trunk is moved from normal position.

11. In a telephone system, a two-way trunk having multiple terminals at either end thereof, means for seizing either end of said trunk, a selector switch at each end of said trunk for extending connection therefrom, a pair of relays connected to opposite sides of said trunk line for controlling the operation of said selector switch, means for releasing said selector switch by simultaneously energizing said relays, a circuit including one side of said trunk line for establishing a guarding potential upon the multiple terminals at the opposite end thereof when one end of said trunk line is seized, and an off normal switch for maintaining the circuit of the relay associated with the above-mentioned side of said trunk open when said selector switch is in normal position.

12. In a telephone system, a two-way trunk having multiple terminals at either end thereof, means for seizing either end of said trunk, a selector switch for extending connection from either end of said trunk, a pair of relays connected to opposite sides of said trunk line for controlling the operation of said selector switch, means for releasing said selector switch by simultaneously energizing said relays, a circuit including one side of said trunk line for establishing a guarding potential upon the multiple terminals at the opposite end thereof when one end of said trunk line is seized, an off normal switch for maintaining the circuit of the relay associated with the above-mentioned side of said trunk when said switch is in normal position, and means for breaking said guarding potential circuit and establishing a

second guarding potential circuit when said selector switch is moved from normal position.

13. In a telephone system, a two-way trunk having a plurality of multiple contacts at each end thereof, a plurality of automatic selecting switches for seizing said trunk, each of said switches having a bank of contacts including one of said multiple contacts, and means for connecting one of the talking conductors of said trunk with the multiple terminals at the distant end for placing a guarding potential upon the multiple contacts at the distant end thereof when one of said switches operates to seize said trunk, said selectors having one motion to select groups and a second motion to find a line in the selected group.

14. In a telephone system, a two-way trunk having multiple terminals at each end thereof, a group of selecting switches at each end of said trunk for seizing either end of the same having bank contacts including one of said multiple terminals, a repeater and a second selector associated with each end of said trunk, means for operating one of said repeaters when the associated end of said trunk is seized to repeat impulses over said trunk to operate the second selector at the distant end thereof, and a circuit including a line conductor of said trunk for placing a guarding potential on the multiple terminals at the distant end thereof to prevent the selecting switches at the distant end of said trunk from seizing the same, said selectors having one motion to select groups and a second motion to find a line in the selected group.

15. In a telephone system, a two-way trunk having multiple terminals at either end thereof, a group of selecting switches at each end of said trunk for seizing the same, each of said selectors having a bank of contacts including one of said multiple terminals, a second selector associated with each end of said trunk for extending a connection from said trunk, a circuit including a line conductor of said trunk for initially placing a guarding potential on the multiple terminals at the distant end thereof when one end of the same is seized, and means for removing this guarding potential and placing a second guarding potential on said multiple terminals when the second selector associated with the distant end of the trunk is operated, said selectors having one motion to select groups and a second motion to find a line in the selected group.

16. In a telephone system, a two-way trunk having multiple terminals at either end thereof, a group of selectors at each end of said trunk for seizing the same, said selectors each having a bank of contacts including one of said multiple terminals, a second selector switch at each end of said

trunk for extending connection therefrom, a pair of relays connected to opposite sides of said trunk line for controlling the operation of said second selector switch, means for releasing said second selector switch by simultaneously energizing said relays, a circuit including one side of said trunk line for establishing a guarding potential upon the multiple terminals at the distant end thereof when one end of said trunk line is seized, and an off normal switch for maintaining the circuit of the relay associated with the above-mentioned side of said trunk open when said second selector switch is in normal position, said selector switches having one motion to select groups and a second motion to find a line in a selected group.

17. In a telephone system, a two-way trunk having multiple terminals at either end thereof, a group of selectors at each end of said trunk for seizing the same, said selectors each having a bank of contacts including one of said multiple terminals, a second selector switch at each end of said trunk for extending connection therefrom, a pair of relays connected to opposite

sides of said trunk line for controlling the operation of said second selector switch, means for releasing said second selector switch by simultaneously energizing said relays, a circuit including one side of said trunk line for establishing a guarding potential upon the multiple terminals at the distant end thereof when one end of said trunk line is seized, an off normal switch for maintaining the circuit of the relay associated with the above-mentioned side of said trunk open when said second selector switch is in normal position, and means for breaking said guarding potential circuit and establishing a second guarding potential circuit when said second selector switch is moved from normal position, said selector switches having one motion to select groups and a second motion to find a line in a selected group.

Signed by me at Sioux City, in the county of Woodbury, and State of Iowa, this 3rd day of February, 1912.

CHARLES E. STEPHENSON.

Witnesses:

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D. L. MCCARTHY.