W. A. LONG.

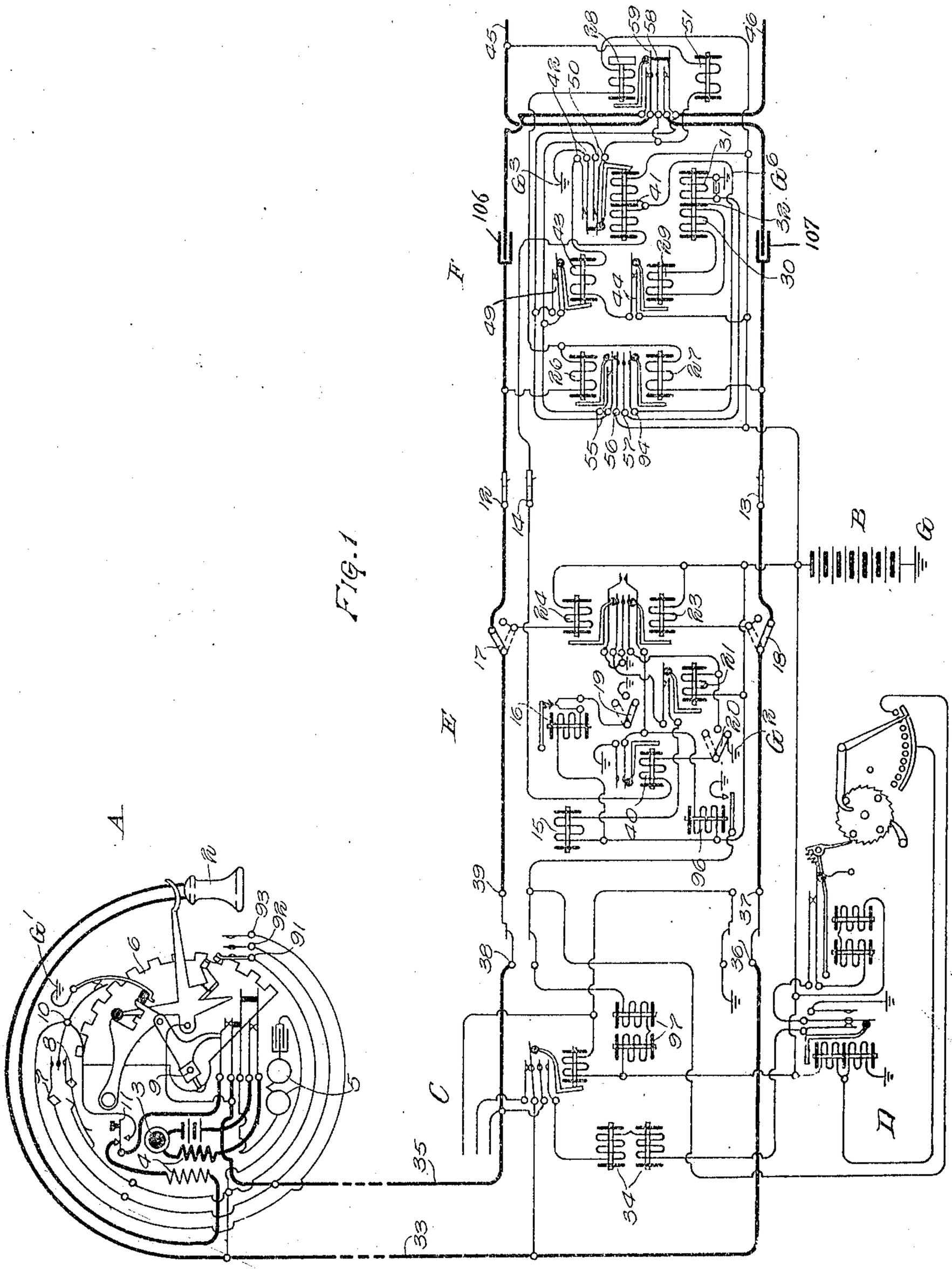
AUTOMATIC TELEPHONE REPEATER.

APPLICATION FILED JUNE 27, 1912. RENEWED FEB. 1, 1918.

1,291,950. Patented Jan. 21, 1919.

2 SHEETS—SHEET 1.

FIG. 1



WITNESSES

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A. Andersen.

INVENTOR:

William A. Long

By Bulkley & Dunand

ATTORNEYS

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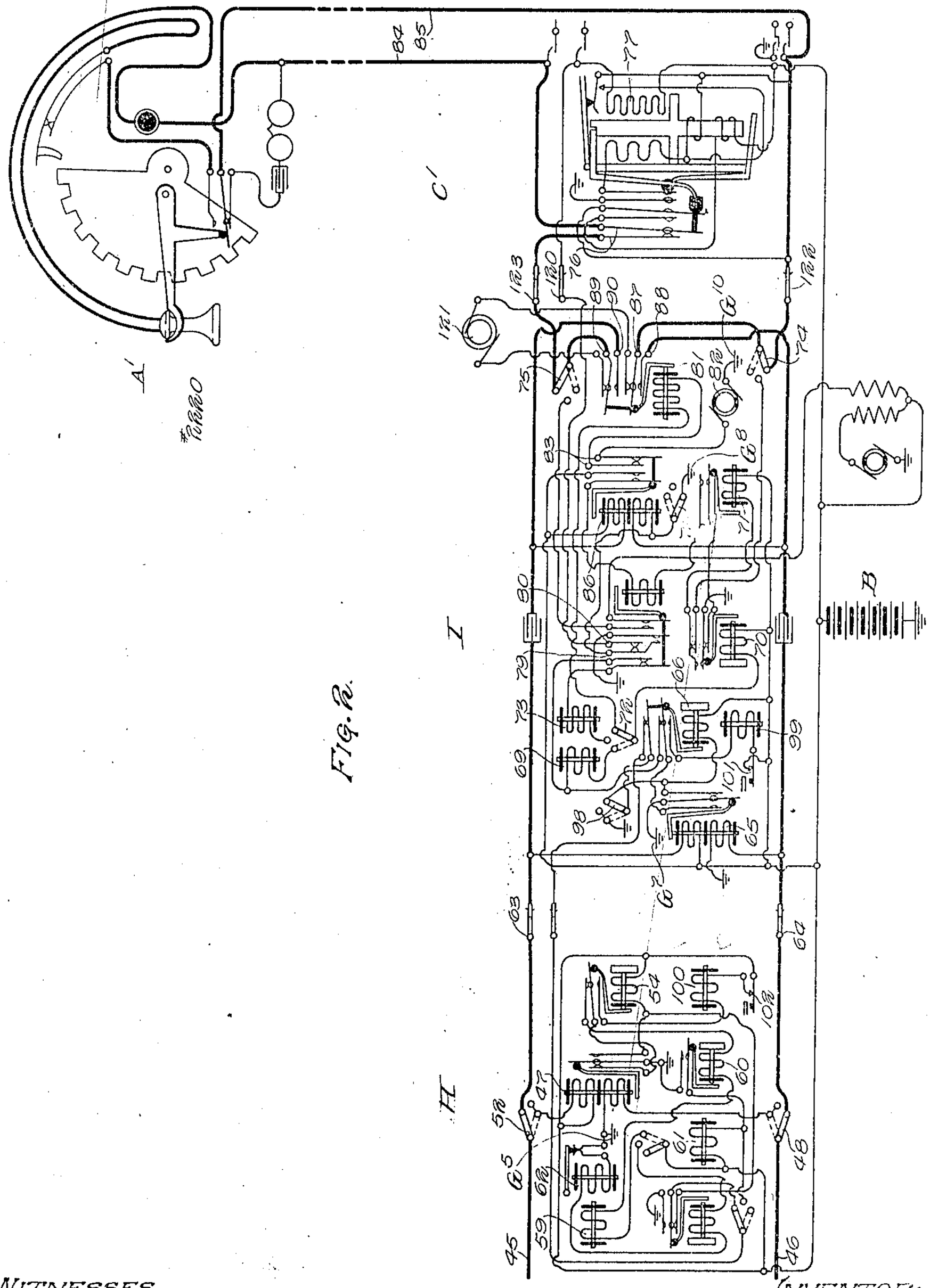

FIG. 2.

WITNESSES

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UNITED STATES PATENT OFFICE.

WILLIAM A. LONG, OF SIOUX CITY, IOWA, ASSIGNOR TO AUTOMATIC ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

AUTOMATIC TELEPHONE-REPEATER.

1,291,950. Specification of Letters Patent. Patented Jan. 21, 1919.

Application filed June 27, 1912, Serial No. 706,199. Renewed February 1, 1918. Serial No. 214,985.

To all whom it may concern:

Be it known that I, WILLIAM A. LONG, a citizen of the United States of America, and resident of Sioux City, Woodbury county, Iowa, have invented certain new and useful Improvements in Automatic Telephone-Repeaters, of which the following is a specification

My invention relates to automatic telephone repeaters for use in connection with automatic telephone systems. It relates more specifically to what are known as three-wire to two-wire repeaters—that is, repeaters which are included in the trunk lines which connect a three-wire automatic system with a two-wire automatic system. By a "three-wire" system is meant one in which the automatic switches are controlled by impulses delivered over two sides of the calling line separately in conjunction with ground and a third conductor, while a two-wire system is one in which these switches are controlled by impulses delivered over two sides of the calling line in series without requiring the use of a third conductor.

A repeater for use between two such systems must be designed to receive the usual vertical and rotary impulses which are delivered to the line by the calling device of a three-wire substation, and must transform these impulses into impulses which are transmitted over the two sides of the trunk line in series. In the operation of such a system, when the substation calling device is operated to call any digit after the connection has been extended to the repeater, a number of ground impulses corresponding to the digit called are transmitted through the vertical line relay of the repeater. This line relay then operates in response to these impulses to cause the bridge across the two-wire trunk line to be opened a corresponding number of times

In three-wire systems as ordinarily constructed the calling subscriber, in order to ring the called subscriber after connection has been completed, is required to depress a button at his telephone in order to ground the vertical side of the line. This ground will be maintained as long as the subscriber continues to press this ringing button. This prolonged grounding of the vertical line would tend to maintain the bridge across the two-wire trunk open for a corresponding length of time. If this bridge were maintained open for this period of time, the switches of an ordinary two-wire system would be released. As a subscriber cannot be supposed to know whether he is calling another three-wire subscriber or calling a two-wire subscriber, it becomes necessary to provide means whereby when a subscriber grounds his vertical line in order to ring, as he supposes, a subscriber, the switches of the two-wire exchange will not be released.

An object of my invention is to provide a repeater which is so arranged that the momentary grounding of the vertical line at the substation, while the impulses corresponding to the various digits of the called number are being transmitted, will momentarily open a bridge across the two-wire trunk a corresponding number of times in order to operate the two-wire switches, but the prolonged grounding of the vertical line will not open the bridge across this trunk a corresponding length of time, but will merely momentarily open the bridge, which is not sufficient to cause the release of these two-wire switches.

A further object of my invention is the general improved construction and operation of a repeater.

My invention will be more readily understood by reference to the accompanying drawings, in which I have illustrated a system in which my improved repeater is employed.

In the accompanying drawings Figs. 1 and 2 taken together 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 system herein represented is of the well-known type of system employing subscribers' individual or preselector switches, group selectors and connectors. The apparatus shown in Fig. 1 is of the type generally known as three-wire. The apparatus shown in Fig. 2 is of the type generally known as two-wire. The apparatus shown in Figs. 1 and 2 may be either in the same or different exchanges. The connection shown extends from the calling substation A through its individual line switch C, the first selector E, the repeater F, the selector H and the connector I to the line of the called substation A′. For the purpose of furnishing current for operating the central office apparatus, a

plurality of grounded batteries B is shown. If desired, only one battery need be employed, but preferably one in each exchange when there is a plurality of exchanges.

The substation A, as herein represented, comprises, in addition to the usual receiver 2, transmitter 3, induction coil 4 and ringer 5, an automatic calling device for producing impulses for controlling the central apparatus. The calling device represented herein is of a well-known type comprising a pair of impulse springs 7 and 8 and a toothed impulse wheel 6, which latter is controlled by the subscriber through the medium of a dial (not shown) provided with finger holes. Such a calling device 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 a calling subscriber rotates the dial of a calling device of this character preparatory to calling any digit, the so-called rotary impulse spring 8 is forced into contact with the ground post 10 once. Then as the dial and impulse wheel return to normal position after being released by the subscriber, the so-called vertical impulse spring 7 is forced into contact with the ground post 10 a number of times, corresponding to the digit called, after which the rotary impulse spring 8 is once more grounded. The substation A is also provided with a push button 11 which, when depressed, opens the bridge across the line through the secondary winding of the induction coil 4 and the receiver 2 and connects one side of the line to ground.

The subscriber's individual switch C, its master switch D and the selector E 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 of 1908. The construction of the selector E is also disclosed in United States Letters Patent No. 815,321, granted March 13, 1906, to Keith, Erickson and Erickson. As shown herein, the selector comprises the usual line and private wipers 12, 13 and 14 which are carried by a shaft (not shown) having a vertical motion controlled by the vertical magnet 15 and a rotary motion controlled by the rotary magnet 16. The usual side switch, comprising the wipers 17, 18, 19 and 20, is controlled by the private magnet 21 in a well-known manner. The usual release magnet for restoring the mechanism to normal position is represented at 96. The usual vertical and rotary line relays are represented at 24 and 23, respectively. The selector H (Fig. 2) is similar in construction to the selector E, the circuits being changed, however, in order to adapt it to operate in a two-wire system, as fully disclosed in British patent to T. G. Martin, No. 1419 of 1910.

The connector I is of the general type of connector switches disclosed in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson, the circuits being modified, however, in order to operate in a two-wire system, as shown in the said Martin British patent. Likewise, the line switch C′ and the substation A′ are specially adapted for operation in such a two-wire system.

The repeater F (Fig. 1) is the connecting link between the three-wire system and the two-wire system, this repeater being adapted to receive impulses of the character which are produced by the three-wire substation A and to transform them into impulses of the proper character for operating the switches of the two-wire system represented in Fig. 2. This repeater comprises the usual vertical and rotary line relays 26 and 27. The relay 28 is a slow acting relay—that is, a relay which deënergizes slowly after the energizing current is withdrawn from it. The proper operation of this relay may be obtained by securing a ring of copper or other conducting material around one end of the core. The winding of the relay 29 is simply connected in a local circuit with one winding 30 of a double-wound induction coil 32. The relation of the windings 31 and 30 of the coil 32 is such that whenever a circuit is closed through the winding 31, a current is set up in the winding 30 by induction, which current flows through the winding of the relay 29 and is of sufficient strength to momentarily energize said relay. It will thus be seen that an impulse is transmitted to the relay 29 each time the circuit of the winding 31 is closed, and that the impulse received by the relay 29 is only momentary, even though the circuit of the winding 31 be closed for a considerable length of time. The talking circuit through the repeater is divided into two sections which are inductively connected by the condensers 106 and 107.

In order to give a complete understanding of my invention, the operations by which the calling subscriber A obtains connection with the called subscriber A′ will now be explained. Since the construction and operation of the switching apparatus disclosed herein is in general well known in the art, and is fully described in the publications hereinabove referred to, it is not thought necessary to describe its operation in detail. Sufficient description will be given to enable my invention to be completely understood. It will be assumed that the number of the called substation A′ is 2220. When the calling subscriber, after removing his receiver from the switch hook, operates his calling device for the first digit 2, the preliminary engagement of the substation impulse springs 8 and 10 upon the initial movement of the dial transmits an impulse of current

over a circuit extending from ground G' at the substation through said impulse springs and over the line conductor 33 and through the trip magnet 34 of the line switch C to battery B. The magnet 34, upon energizing, releases the plunger of the line switch, allowing it to enter its bank, whereby the line conductors 33 and 35 are extended through the line switch bank springs 36 and 37 and 38 and 39 to the first 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 over a circuit extending from ground G' at the substation A through the ground post 10 and the vertical impulse spring 7, vertical line conductor 35, springs 38 and 39, side switch wiper 17 and the vertical line relay 24 of the first selector E to battery B. The selector E operates in response to these two impulses through its vertical relay to cause the vertical magnet 15 to raise the switch shaft and wipers 12, 13 and 14 two steps to a position opposite the second row or level of bank contacts, which contacts are assumed to be the terminals of trunk lines leading through the repeaters F to the two-wire system shown in Fig. 2. After the two impulses are delivered over the vertical line, one more impulse is transmitted over the rotary line 33 and through the selector rotary line relay 23 to battery. This impulse through the relay 23 causes the private magnet 21 to operate in the usual manner to advance the side switch from first to second position, whereupon the rotary magnet 16 operates to rotate the switch shaft until the wipers 12, 13 and 14 engage the contacts of an idle trunk line, whereupon the side switch passes to third position, thereby completing the connection between the calling substation and an idle repeater F. When connection is thus extended to the repeater, it is protected from seizure by any other selector E by a guarding potential which extends from ground G^2 through the side switch wiper 20 of the selector, relay 40 and the private wiper 14 to all the selector private bank contacts of the seized trunk. From the wiper 14 a circuit also extends through the private bank contact through the two windings of the relay 41 in the repeater in series to the batery B. The relay 41 is energized by the closure of this circuit, but it possesses a sufficiently high resistance to prevent sufficient current from flowing to operatively energize the relay 40 of the selector E. The relay 41, upon energizing, completes a circuit extending from ground G^3 through the springs 42, relay 13 and the springs 44 to the battery B, and also closes a bridge across the trunk conductors 45 and 46, whereby an energizing circuit is completed for the line relay 47 of the selector H. The complete circuit of the relay 47 extends from ground G^5 through the lower winding of said relay, side switch wiper 48, conductor 46, springs 49 and 55 of the relays 43 and 26 in parallel, springs 50, impedance coil 51, conductor 45, side switch wiper 52 and the upper winding of the relay 47 to battery B. The relay 47, upon energizing, completes an energizing circuit through the relay 54. The apparatus is now in position to receive the impulses for the second digit 2, which impulses will be repeated by the repeater F from the calling substation to the selector H.

When the calling device at the substation A is operated for the second digit 2, one impulse is transmitted over the rotary line 33, followed by two impulses over the vertical line 35, and then one more over the rotary line in the usual manner. The rotary impulses for this digit, as well as for all succeeding digits, are functionless. These impulses over the rotary line pass through the rotary line relay 27 of the repeater F and the relay 28 to battery B. These relays are momentarily energized by these impulses. The rotary line relay 27, when energized, closes a circuit extending from ground G^6 through winding 31 of coil 32, springs 57 and 94 and right hand winding of coil 41 to battery B. The energization of winding 31 induces a current in winding 30, which is included in a local circuit with relay 29. Relay 29 thereupon energizes and opens the contact of springs 44, thereby opening the energizing circuit of relay 43. Relay 43, upon deënergizing, opens the contact of springs 49. The springs 49, however, are in multiple with springs 55 and therefore their operation is without effect at this time. The vertical impulses for the second digit 2 pass from the substation ground over the vertical line conductor 35 and through the vertical line relay 26 and the relay 28 in the repeater to battery. The engagement of the springs 56 and 57, upon the energization of the relay 26, completes a circuit extending from ground G^6 through the winding 31 of the coil 32 and the springs 57 and 56 to battery B. This closure of the circuit through the winding 31 induces a current in the winding 30 which flows through the relay 29, thereby momentarily energizing the latter relay, which operates to open the circuit of the relay 43 at the springs 44. It will thus be seen that a momentary impulse is transmitted through the relay 29 each time an impulse is transmitted from the substation through the vertical line relay 26. In its energized position the relay 29 opens the circuit of the relay 43, which allows the springs 49 to be separated, while at the same time the springs 55 are opened by the ener-

gization of the relay 26, whereby the continuity of the bridge across the two-wire trunk conductors 45 and 46 is opened momentarily each time an impulse is transmitted from the substation through the relay 26. The relay 28, which is included in the energizing circuit of the vertical line relay 26, is a slow acting relay and is therefore energized upon the receipt of the first impulse and remains in its energized position continuously until after the last impulse is delivered. In its energized position the relay 28 opens the talking circuit through the repeater and short-circuits the impedance coil 51 through the springs 58 and 59, so as to remove it from the operating circuit of the line relay 47 of the selector H (Fig. 2). Each time the bridge across the trunk is opened at the springs 55 and 49, the line relay 47 of the selector H deënergizes momentarily. The slow acting relay 54 does not deënergize during the momentary interruptions of its circuit by the relay 47, and therefore, each time the line relay is deenergized, a circuit is closed through the vertical magnet 59 in series with the slow acting relay 60. Since the digit called is 2, the vertical magnet operates to raise the switch shaft and wiper two steps. The slow acting relay 60 operates in response to these impulses to close the circuit of the private magnet 61 and to keep it closed until after the last impulse is delivered, when the private magnet deënergizes and permits the side switch to pass to second position, whereupon the rotary magnet 62 automatically rotates the wipers step by step in the usual and well-known manner onto the contacts of an idle trunk, whereupon the side switch passes to third position and extends the connection through its wipers 52 and 48 and the shaft wipers 63 and 64 to the connector I. When connection is thus extended to the connector, its line relay 65 becomes energized in the same manner in which the line relay 47 of the selector H first became energized and closes a circuit through the relay 66.

When the calling subscriber operates his calling device for the next digit 2, the repeater F operates in the same manner as for the previous digit to momentarily open the bridge across the trunk conductors 45 and 46 twice, each time causing the relay 65 of the connector E to deënergize. Each time the relay 65 deënergizes in response to the impulses for this digit, it closes a circuit from ground G^7 through the vertical magnet 69 and the relay 70 to battery B. Since two impulses are transmitted over this circuit, the vertical magnet operates to raise the switch shaft and wipers two steps, while the slow acting relay 70 causes the private magnet 71 to step the side switch from first to second position. In second position the side switch wiper 72 transfers the battery connection from the vertical magnet 69 to the rotary magnet 73. When the calling subscriber operates his calling device for the last digit 0, ten impulses are transmitted to the vertical line relay 26 of the repeater, which latter operates in turn to momentarily interrupt the circuit of the connector line relay 65 ten times. Each time the relay 65 deënergizes in response to these impulses it closes a circuit through the rotary magnet 73 and the relay 70. The relay 70 operates to rotate the switch shaft ten steps to carry the wipers onto the contacts of the called line No. 2220, after which the private magnet, under the influence of the relay 70, causes the side switch to pass from second to third position. The side switch wipers 74 and 75, upon reaching third position, complete the talking circuit between the calling and the called substations, as outlined by heavy conductors in the drawings. The contact 76 in the talking circuit at the line switch C′ is closed by the energization of the winding 77, which is energized over a circuit extending from ground G^3 at the connector through the side switch wiper 78 (in third position), springs 79 and 80, private wiper 120, bank contact upon which it is resting and the winding 77 to battery B. The connection of ground G^8 with the connector private bank contacts of the called line over a portion of the circuit just traced provides a guarding potential for said contacts to prevent a second connector from obtaining connection with the same line while it is in use. The engagement of the side switch wiper 72 of the connector with its third-position contact point closes the circuit of the ringing relay 81, said circuit extending from ground G^{10} through the interrupter 82, springs 83, relay 81, side switch wiper 72 and the relay 70 to battery B. The relay 81, upon energizing, disconnects the calling line from the called line and connects a ringing current generator 121 with the called line to signal the called subscriber. The circuit of the relay 81 is interrupted intermittently by the interrupter 82, so as not to ring the called subscriber continuously.

When the talking circuit of the called substation is bridged across the line conductors 84 and 85 upon the response of the called subscriber, or as soon thereafter as the ringing relay 81 deënergizes, if it happens to be energized at the time, the called substation is provided with talking current over a circuit extending from ground G^8 at the connector through the side switch wiper 78, lower winding of the relay 86, ringer relay springs 88 and 87, side switch wiper 74, wiper 122, line 85, receiver and transmitter at the substation A′, line 84, contact 76, wipers 123 and 75, springs 89 and 90 and the

upper winding of the relay 86 to the battery B. The relay 86 is energized by this talking current and by separating the springs 83 the circuit of the ringing relay 81 is opened.

It will thus be seen that after the connection is completed with a two-wire substation A′, the ringing current is automatically supplied to said line without any control of the calling subscriber, and is automatically cut off when the called subscriber answers. If, after calling the two-wire substation, the calling three-wire subscriber should depress his push button 11, as he is required to do when calling a three-wire subscriber, the circuit of the vertical line relay 26 of the repeater F will be closed. The relay 26 would operate in response to the closure of this circuit to open the bridge across the two-wire trunk conductors 45 and 46 in the same manner as when digits are being called. However, since the relay 29 is energized only momentarily, even when the circuit of the relay 26 is closed for a prolonged period of time, the relay 43 will be deënergized only for an instant, and then return to its energized position and close the bridge across the conductors 45 and 46, even though the relay 26 remains energized. Thus it will be seen that the prolonged energization of the vertical line relay 26 of the repeater, by the pressing of the ringing button at the calling substation A′, can do no more than transmit a momentary impulse to the connector line relay 65, which impulse endures only as long as the relay 29 in the repeater F remains energized. This short impulse does not cause the connector line relay 65 to open the circuit of the slow acting release relay 66 long enough to cause the connection to be released.

After the conversation is completed, the connection is released by the hanging up of the receiver at the calling substation A. As the switch hook at the substation A descends when the receiver is hung up, the springs 91, 92 and 93 are momentarily forced into contact, whereby the vertical and rotary line conductors 35 and 33 are grounded simultaneously, thereby energizing both the vertical and rotary line relays 26 and 27 of the repeater F. The combined energization of these two relays completes a connection from the battery B through the springs 56, 57 and 94 to the common terminal of the two windings of the relay 41. This connection short-circuits the right-hand winding of said relay 41 and thereby increases the current in the relay 40 of the selector E sufficiently to cause it to be operatively energized. The relay 40, upon energizing, closes the circuit of the release magnet 96. The magnet 96, upon energizing, closes the circuit of the release magnet 97 of the line switch C. The magnets 96 and 97, upon energizing, attract their armatures and hold them in readiness to release their respective switches, when their circuits are broken as a result of the deënergization of the repeater line relays when the switch hook at the substation has descended far enough to permit the springs 91, 92 and 93 to separate. The release of the first selector E destroys the energizing circuit of the relay 41 of the repeater F, whereby the bridge across the trunk conductors 45 and 46 is broken and the connector line relay 65 is permitted to deënergize permanently. The relay 65, upon deënergizing, breaks the circuit of the connector release relay 66 and also the circuit of the release relay 54 of the selector H, which circuit is maintained closed directly by the springs of the relay 65 after the side switch wiper 98 of the connector reaches third position. The relays 66 and 54, upon deënergizing, close the circuits of their respective release magnets 99 and 100 which, upon energizing, immediately restore the mechanisms of their respective switches to normal position; and when the switch shafts reach their lowest positions, the circuits of the release magnets are opened at the springs 101 and 102, respectively.

It will be seen that I have provided a very efficient form of three to two wire repeater, and one in which there is no danger of the two-wire switches being released by the prolonged grounding of the vertical line by a subscriber.

While I have illustrated one particular embodiment of my invention and have shown this in connection with an automatic telephone system of a particular type, it is to be understood that I do not wish to be limited to the exact construction shown and described, and that, furthermore, my repeater is adapted for use in connection with many other automatic telephone systems or semi-automatic systems, as will be readily understood.

What I claim as my invention is:—

1. In a telephone system, an automatic switch, a repeater, means for transmitting a plurality of momentary impulses to said repeater, means controlled by said repeater for repeating a corresponding series of momentary impulses to said switch, means for transmitting a prolonged impulse to said repeater, and means controlled by said repeater for transmitting a momentary impulse in response to said prolonged impulse.

2. In a telephone system, a trunk line, a repeater in said trunk for controlling a bridge across the same, means controlled by said repeater in response to a plurality of momentary impulses for momentarily opening said bridge a corresponding number of times, and means controlled by said repeater in response to a prolonged impulse for momentarily opening said bridge a single time.

3. In a telephone system, a trunk line, a repeater in said trunk, means for transmitting impulses to said repeater over one side of said trunk and ground, means controlled by said repeater for repeating said impulses over two sides of said trunk in series, means for transmitting a prolonged impulse over one side of said trunk, and means controlled by said repeater for transmitting a momentary impulse over two sides of the trunk in series in response to said prolonged impulse.

4. In a telephone system, a trunk line, a repeater in said trunk comprising a line relay, means for transmitting a plurality of impulses over one side of said trunk and ground through said line relay, means controlled by said line relay for repeating said impulses over two sides of said trunk line in series, means for transmitting a prolonged impulse over one side of said trunk to said repeater, and means controlled by said repeater for transmitting a momentary impulse over two sides of said trunk line in response to said prolonged impulse.

5. In a telephone system, a trunk line, a repeater in said trunk, a bridge across said trunk, a line relay for said repeater, means for operating said line relay by impulses transmitted over one side of said trunk and ground, a second relay, means controlled by the operation of said line relay for inducing impulses through said second relay, and means controlled by said second relay for controlling said bridge.

6. In a telephone system, a trunk line, a repeater in said trunk, a bridge across said trunk line, a line relay for said repeater, a second relay, means for transmitting a plurality of momentary impulses over one side of said trunk and ground to operate said line relay, means controlled by the operation of said line relay for momentarily energizing said second relay, means controlled by the energization of said second relay for opening said bridge, and means for transmitting a prolonged impulse through said line relay, said prolonged energization of said line relay adapted to momentarily energize said second relay to thereby again momentarily open said bridge.

7. In a telephone system, a trunk line, a repeater in said trunk, a bridge across said trunk, a pair of parallel connections for controlling the continuity of said bridge, a line relay for said repeater for controlling one of said parallel connections, and a second relay controlled by induced impulses by said line relay for controlling the other of said connections.

8. In a telephone system, a trunk line, a repeater in said trunk, means for seizing said trunk, a bridge across said trunk adapted to be closed when said trunk is seized, a pair of parallel connections in said bridge for controlling the continuity of the same, a line relay adapted to be energized by impulses transmitted over said trunk for controlling one of said parallel connections, and a second relay controlled by said line relay for controlling the other of said parallel connections.

9. In a telephone system, a trunk line, a repeater in said trunk, means for seizing said trunk, a bridge across said trunk adapted to be closed when said trunk is seized, a pair of parallel connections in said bridge for controlling the continuity of the same, a line relay adapted to be energized by impulses transmitted over said trunk for controlling one of said parallel connections, and a second relay controlled by induced impulses by said line relay for controlling the other of said parallel connections.

10. In a telephone system, a trunk line, a repeater in said trunk, a bridge across said trunk, a pair of parallel connections in said bridge controlling the continuity of the same, a line relay for controlling one of said connections, a second relay controlling the other of said connections and closing said connections when energized, means for energizing said line relay by a prolonged impulse to open one of said parallel connections, and means controlled by said prolonged energization for momentarily de-energizing the other of said relays to thereby momentarily open said bridge.

11. In a telephone system, a trunk line, a repeater in said trunk, a relay in said repeater, and means for operating said relay by induced impulses, said repeater adapted to receive impulses over one side of the trunk and ground and to repeat said impulses over two sides of the trunk in series.

12. In a telephone system, a trunk line, an automatic progressively movable switch associated with said trunk line, a bridge across said trunk line, means for transmitting impulses in said bridge for operating said switch, said means comprising a relay, and means for operating said relay by induced impulses.

13. In a telephone system, the combination of an automatic progressively movable switch, trunk lines, an electromagnetic impulse reproducer for operating the switch to connect with one of said trunk lines, and means for operating said reproducer by induced impulses for the purpose set forth.

14. In a telephone system, the combination with a trunk line divided into two sections, of a repeater for repeating impulses from one section to the other, said repeater including means responsive to impulses of variable lengths received over one section for transmitting impulses of uniform lengths over the other section.

15. In a telephone system, the combination with a trunk line divided into two sec-

tions, of a repeater for repeating impulses from one section to the other, said repeater including a relay responsive to impulses of variable duration received over one section of said trunk, an induction coil energized responsive to said relay, and a second relay controlled by the induced current from said coil for transmitting impulses of uniform duration over the other section of said trunk.

16. In a telephone system, the combination with a trunk line divided into two sections, of a repeater for repeating impulses from one section to the other, said repeater including a relay responsive to impulses of variable duration received over one section of said trunk, and a second relay controlled by said first relay for transmitting impulses of uniform duration over the other section of said trunk.

17. In a telephone system, the combination with a trunk line divided into two sections, of a repeater for repeating impulses from one section to the other, said repeater including a relay responsive to impulses of variable duration received over one section of said trunk, an induction coil comprising a pair of windings, one of said windings being controlled by said relay for the purpose of inducing a current in the other of said windings, and a second relay controlled by said induced current for transmitting impulses of uniform duration over the other section of said trunk.

18. In a telephone system, a relay, an automatic progressively movable trunking switch controlled by said relay, and means for operating said relay by induced impulses.

Signed by me at Sioux City, Woodbury county, Iowa, this 19 day of June, 1912.

WILLIAM A. LONG.

Witnesses:
C. R. METCALFE,
E. B. LYSTER.