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A. H. BLESSING.
TELEPHONE REPEATER.

APPLICATION FILED APR. 3, 1913.

Patented Mar. 21, 1916.

3 SHEETS—SHEET 1.

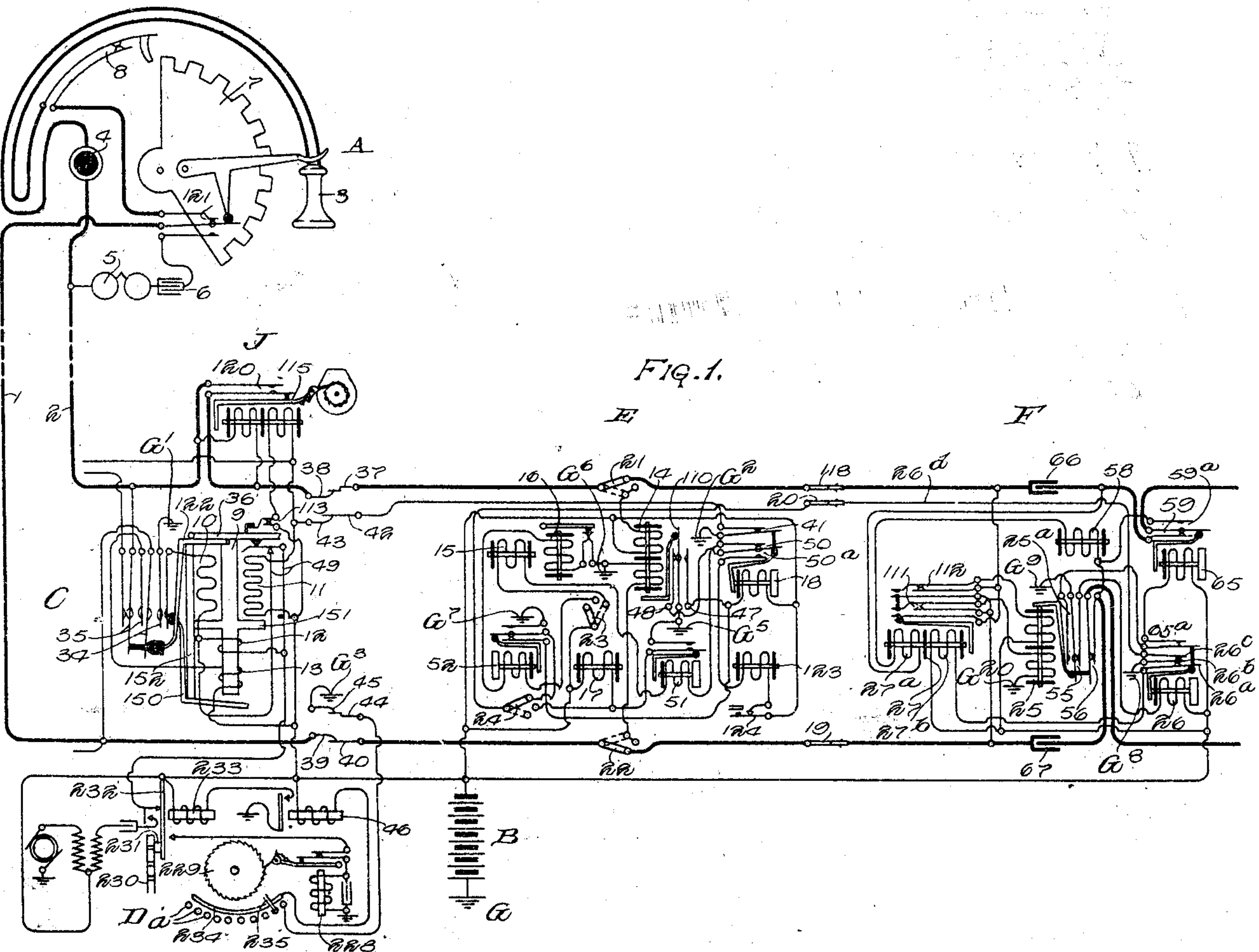


Fig. 1.

WITNESSES

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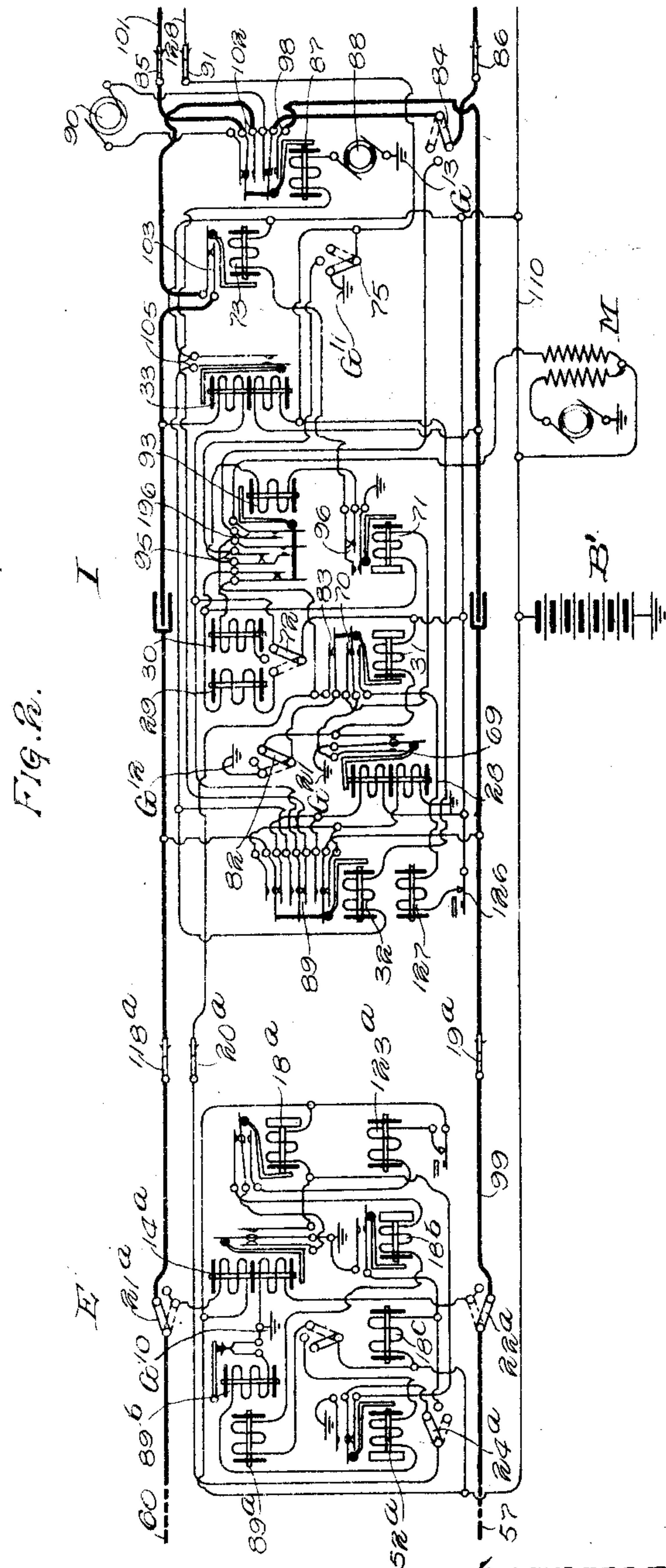
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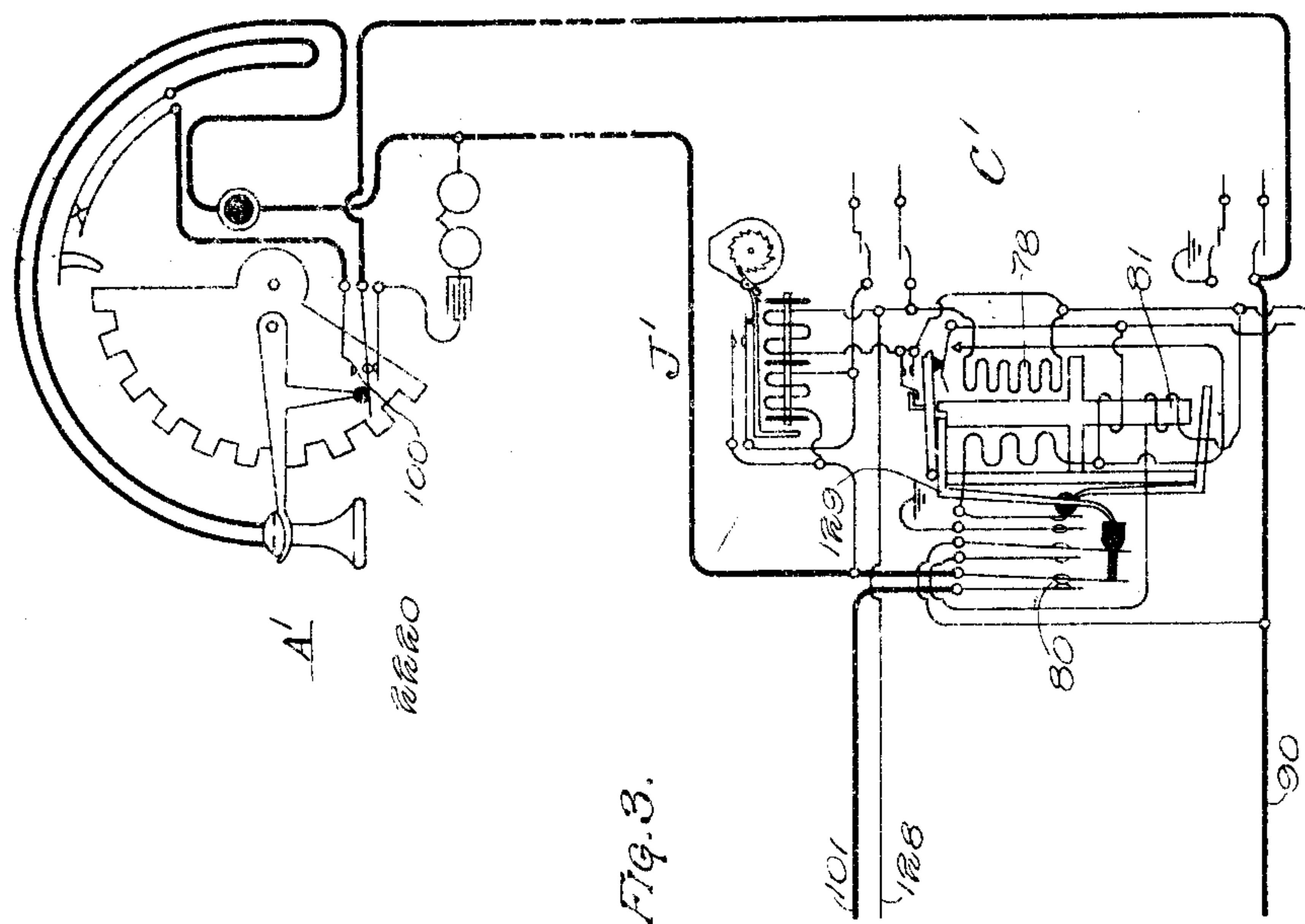
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TELEPHONE-REPEATER.

1,176,269.

Specification of Letters Patent.

Patented Mar. 21, 1916.

Application filed April 3, 1913. Serial No. 758,594.

To all whom it may concern:

Be it known that I, ALBERT H. BLESSING, a citizen of the United States of America, and resident of Fennimore, Grant county, Wisconsin, have invented a new and useful Improvement in Telephone-Repeaters, of which the following is a specification.

My invention relates to an improved repeater for automatic or semi-automatic telephone systems, and it relates more specifically to a common battery two-wire repeater—that is, a repeater adapted for use in a common battery telephone system in which the automatic switches are controlled over two sides of a line circuit in series.

Among the features of my invention are to provide a repeater in which a positive and efficient operation is insured, and one in which the operation of the line relay is uniform for all impulses.

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

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

The system herein described is of a well-known automatic type, known as a two-wire system, and is equipped with individual or line switches C divided into groups, each group controlled by a master switch, such as the master switch D, and also with group selectors E, repeaters F and connectors I, the operating current being supplied by the batteries B and B'. The subscriber's station is connected with the central office through the conductors 1 and 2, which terminate in a line switch C, said switch being in the group governed by the master switch D. By means of the line switch C the line is extended to the selector E, which in turn extends the connection to the repeater F. This repeater passes the impulses on to the second selector E', which operates in the same manner as the selector E to extend the connection to the connector I, which latter completes the connection to the called subscriber's telephone A'.

The telephone at the substation A is provided with a receiver 3, transmitter 4,

ringer 5 and condenser 6. It is also provided with a suitable impulse-sending device similar to that shown and described in British Patent No. 29,654 of 1910 to S. G. S. Dicker, and comprises an impulse wheel 7, springs 8 and a dial (not shown) which has holes around its periphery for convenience in rotating. The impulse wheel 7 and the dial are secured to the same shaft, which, upon being rotated according to the digit called, opens and closes the impulse springs 8 a corresponding number of times to send the necessary impulses over the line.

The line switch C and the master switch D are of the general type of line and master switches disclosed in British patent to R. W. James No. 26,301 of 1906, and more particularly of the form shown in British patent to T. G. Martin No. 1419 of 1910. As herein represented, the line switch C comprises among other details a plunger (not shown) which is attached to the end of a so-called plunger arm 36 that is controlled by the plural-wound magnet 9. The magnet 9 is also provided with armatures 122 and 150 and comprises four windings, namely, a pull-in winding 10, a holding or cut-off winding 11, a line winding 13 and an auxiliary winding 12. The lateral projection 151 near the center of the core of the magnet, by means of which said magnet is mounted upon the bracket 152, divides the magnetic circuit of the magnet into two parts, so that the windings upon one end of the core do not have any effect upon the armatures on the other end. Of the two windings upon the upper end of the magnet only the winding 10 is strong enough to attract the plunger arm 36 from its normal position. Although the winding 11 is not strong enough to operate the arm 36, it is strong enough to hold it in its operated position after it has once been pulled down. When the plunger arm 36 is attracted by the magnet 10, the plunger point of the switch is forced into a group of contact springs 37, 38, 39, 40, 42, 43, 44 and 45, forcing them into contact in pairs. Although only one set of springs, viz., 37 to 45, is shown, each switch is provided with a plurality of such sets, each set forming a terminal of a separate trunk line leading to a selector E. These sets of trunk line

terminals are, of course, multiplied to corresponding sets in the banks of the other line switches in the same groups. The plungers of all of the line switches of the group which is controlled by the master switch D engage a so-called plunger shaft (not shown), and through the medium of said master switch are normally maintained opposite the terminals of an idle trunk line.

The master switch consists essentially of a motor magnet 228 for rotating the ratchet wheel 229. The ratchet wheel 229 is connected with the plunger shaft in such a manner that a rotary motion of the ratchet wheel gives to the plunger shaft a reciprocating motion to carry the idle plungers back and forth in front of their trunk terminals. To the plunger shaft there is secured a locking plate 230 provided near its outer edge with a number of openings which are adapted to be engaged by a pin 231 upon the end of the armature 232 of the relay 233. The openings in the plate 230 are so spaced that the pin 231 can engage one of them and allow the armature 232 to resume its normal position only when the plungers of the idle line switches are directly opposite the terminals of a trunk line, in which position it will latch the shaft. The master switch is also provided with a bank of contacts comprising a common segment 234 and an individual contact *a* for each trunk line to which the line switches have access. The wiper 235 always maintains the segment 234 in electrical connection with the individual contact *a* of the trunk line before which the plungers of the idle line switches are being held by the master switch.

In connection with the line switch C there is shown a meter J for the purpose of tallying the number of calls made by the calling subscriber, and is arranged so as not to operate unless said calls are answered.

The selector E is of the general type of selector switches disclosed in United States Letters Patent No. 815,321, granted to Keith, Erickson & Erickson March 13, 1906, the circuits being modified, however, as shown in British Patent No. 1419 of 1910, above referred to, in order to operate in a two-wire system. It comprises among other details the line relay 14, vertical and rotary magnets 15 and 16 for operating the switch shaft and shaft wipers 19, 20 and 118, private magnet 17, release relay 18 and the side switch wipers 21, 22, 23 and 24 and the release magnet 123. The switch shaft (not shown), which has a vertical and rotary movement, and the line and private wipers 118, 19 and 20 are the direct means of connection between this switch and the repeater F.

The repeater F has a line relay 25, a slow relay 26 and a battery-reversing relay 27.

The line relay 25 is normally bridged across the trunk extending to the repeater from the selector E, and is arranged so that when its armature operates in accordance with the impulses from the subscriber's station A, it opens and closes the bridge across the trunk extending to the selector E' a corresponding number of times. Among the functions of this repeater switch is to receive the impulses transmitted from the subscriber's station and repeat them to the switches farther on. Furthermore, it supplies battery current to the calling line and maintains a holding circuit for the switches in front of it, without requiring a third conductor to be included in the trunk line extending to the switches beyond, and in this way the necessity for having a third conductor between offices is eliminated.

The trunk line extending from the repeater F terminates in a second selector E', which is essentially the same as the selector E. This selector, as already stated, extends the line connection to the connector I, which latter is of the same type as the switches disclosed in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson, but said connector is modified and adapted to be used in a two-wire system. Among other details the connector comprises the usual line relay 28, vertical and rotary magnets 29 and 30, release relay 31, release magnet 127, battery-reversing relay 32 and the back-bridge relay 33. Like the selector E, this switch has the usual shaft which carries the wipers 85, 86 and 91 onto the contacts of the called subscriber's line. The line switch C' and the calling device at the substation A' are the same as the line switch C and the calling device at the substation A.

Having given a general description of the central office apparatus, I will now describe how a subscriber at the substation A may obtain connection with the subscriber at substation A'. We will assume that the called subscriber's number is 2220. Upon the removal of the receiver 3 from the switch hook the line switch is tripped in the well known manner so as to thrust its plunger into the terminal bank, thereby connecting the calling line with the first selector E by means of the springs 38 and 37, 39 and 40. The two windings of the meter J become energized when the line switch operates in a manner heretofore described, but the direction of the flow of current in each winding opposes that in the other, thus rendering the meter inoperative for the time being. Upon the operation of the dial for the first digit the bridge across the line is momentarily opened twice at the impulse springs 8, thereby deenergizing the line relay 14 of the selector E a corresponding number of times to cause the selector to be stepped up two

steps, in the well-known manner, opposite the row of contacts in which terminate the trunk lines leading to the repeater F, whereupon the magnet 16 operates in the usual manner to rotate the shaft wipers onto an idle trunk line to extend the line into connection with the repeater F, thus energizing the line relay 25 in the usual manner. Upon the line relay 25 energizing a circuit is closed from ground G^9 through the contact springs 55 and the slow relay 26 to battery B. The relay 26, upon energizing, presses the springs 26^a and 26^b into contact, thereby setting up a circuit through the winding 27^b of the relay 27, but, as will be shown, does not yet energize this relay. At the same time ground is put on the trunk wire 26^a at G^8 to supply a holding circuit for the release relay 18 in the first selector, the original holding circuit of which is broken when the side switch passes to third position and extended to the repeater F by way of the wiper 20. Furthermore, and at the same time the relay 25, by pressing together the springs 56, closes a bridge across the outgoing trunk line, thus closing a circuit for the line relay 14^a of the second selector E'. The energization of this relay causes the circuit of the slow acting release relay 18^a in the selector E' to be closed. The circuit of the line relay 14^a is traced from ground G^{10} through the lower winding of said relay, side switch wiper 22^a, trunk line 57, through the contact of springs 56, through an impedance coil 53 and one of the windings of the battery-reversing relay 27, contact of springs 59, back over the trunk line 60, side switch wiper 21^a and through the upper winding of the line relay 14^a to battery B'. The current flowing through the winding 27^a of the relay 27 is opposed at this time by current flowing through the winding 27^b over the circuit extending from ground G^8 through the spring of the relay 26 and winding 27^b to battery, and the relay 27 is not operated.

The central office apparatus is now in a condition for the transmission of the second series of impulses, whereupon the dial is operated in the usual manner, opening the circuit of the line relay 25 in the repeater F twice momentarily. The slow relay 26 retains its armature in an operated position during the transmission of the impulses. Therefore, the ground at G^8 is kept on the release trunk, thus holding up the preceding switches. Each time an impulse is sent—that is, each time the line relay armature drops back while the slow acting relay 26 is retaining its armature in attracted position—a circuit is completed from ground G^9 through the contact 25^a of the line relay 25 and the springs 65^a of the relay 26, and through the relay 65 to battery B. The result is that the first time the circuit is broken for the second digit the relay 65 closes a

direct bridge across the trunk, and since the relay 65 is slow acting, this bridge is maintained closed at the contacts 59 and 59^a during the subsequent impulses; but the line relay 25, each time the armature drops back in unison with the breaking of the circuit at the calling subscriber's telephone, opens this bridge, thus repeating the impulses to the selector E'. The second selector line relay 14^a is thus operated, while the release relay 18^a, the side switch controlling relay 18^b, the vertical and rotary magnets 89^a and 89^b, respectively, the private magnet 18^c and the switching relay 52^a operate just as the corresponding parts operate in the selector E, cutting the line through to the connector I and energizing the line relay 28 of the connector, which, upon energizing, closes the circuit for the release relay 31, which in turn closes the holding circuit for release relay 18^a at the second selector E'. The circuit of the holding coil 18^a of the second selector E' is furnished from ground G^{12} through the side switch wiper 82, springs 83, through the private wiper 20^a, through the side switch wiper 24^a and the springs of the relay 52^a and through the relay 18^a to battery B', thus holding the circuit of the release magnet 123^a open. The calling device is now operated for the third digit 2, deenergizing the line relay 25 at the repeater twice. This action causes the deenergization of the line relay 28 at the connector I, the armature of which falls back the same number of times, closing a circuit from ground G^{21} through the springs 69 and 70, through the private magnet control relay 71 in series with the vertical magnet 29, and through the side switch wiper 72 to battery B'. The winding of the vertical magnet 29, being thus energized twice momentarily, moves the switch shaft up two steps opposite the row of contacts in which are situated the terminals of the called subscriber's line. The pause in the impulses then permits the private magnet controlling relay 71 to fall back, which in turn permits the private magnet 73 to fall back, letting the side switch escape from the first to the second position, when the side switch operates the side switch wiper 72, transferring main battery from the vertical magnet 29 to the rotary magnet 30. The subscriber now operates his dial for the last digit O, thus sending in ten impulses and thereby operating the line relay 25 of the repeater switch F the same number of times, which in turn operates the line relay 28 of the connector switch I in a manner already described. The relay 28 now operates a corresponding number of times to close a circuit through the rotary magnet 30, rotating the line and private wipers ten steps onto the contacts of the called subscriber's line. Guarding potential is then placed on all the private contacts in multiple

with the one engaged from ground G^{11} , thus preventing any other connector cutting in on the called line.

Assuming the called line to be idle, the connection is extended through to the called telephone and the ringing generator is intermittently placed across the line. Upon the subscriber at the substation A' removing his receiver to answer the call the springs 100 are pressed together, thus closing the circuit of the back-bridge relay 33, said circuit being traced from ground G^{11} through the lower winding of the relay 33, springs 98 (when the ringer relay is deenergized), through the side switch wiper 84, line wiper 86, conductor 90, through the called telephone, back over the conductor 101, line wiper 85, springs 102 and 103, through the upper winding of the relay 33, side switch wiper 72 to battery B'. Talking current is fed through this last-mentioned relay to the called substation, and upon the energization of said relay a circuit is closed from ground G^{11} through the battery-reversing relay 32 and contact of springs 105 to battery B'. Upon the battery-reversing relay 32 energizing, the direction of the flow of current is changed by means of the springs of said relay, switching the negative pole of battery onto the positive side and the positive pole of battery onto the negative side of the line through the respective windings of the line relay 28. This reversal of battery current, of course, changes the direction of flow through the winding 27^a of the double-wound relay 27 in the repeater F. It will be remembered that up to this time the flow of current in the two windings of this relay were opposed, and although current was flowing all the time, its armature was not attracted; but immediately upon the reversal of current through one winding the armature is pulled up to reverse the flow of current over the calling subscriber's loop and through one winding of the meter magnet J in the same manner that the flow of current was reversed at the connector switch I. Now that the flow of current through both of the windings of the meter is in the same direction, the armature 115 is attracted to register the call in the usual manner, and to shunt out, by means of the springs 120, the right-hand winding in order to keep the talking circuit balanced, leaving only one winding to retain the armature. After the connection is completed, the calling subscriber hangs up his receiver, thereby breaking the hook switch contact 121 at the substation A. This breaking of the contact at the springs 121 at the telephone opens the circuit of the line relay 25 at the repeater F. Upon this relay deenergizing, its armature drops back, thereby breaking the

circuit of the slow acting relay 26, which in turn deenergizes to remove the ground potential at G^8 from the release trunk, thus breaking the circuit of the holding coil 18 of the selector F. Upon the slow acting relay 18 deenergizing, a circuit is closed from ground G^5 through the contact 50^a, through the release magnet 123 and off-normal springs 124 to battery B. Upon the release magnet 123 becoming energized, the usual shaft-holding pawls are withdrawn and the switch shaft is released, and by means of a spring and gravitation is returned immediately to its normal position, at which point it opens the contact made by the off-normal springs 124, thereby opening the circuit of the release magnet 123. The circuit of the hold-down winding 11 at the line switch C is also broken by the deenergization of the slow acting relay 18, whereupon the plunger arm 36, together with the armature 122, is released, thus retracting the plunger from the line switch bank and once more bridging the line relay 13 across the line. The windings of the meter J also deenergize at this time, allowing the armature 115 to return to its normal condition. Thus the release of the switches preceding the repeater F is effected by the deenergization of the relays 25 and 26. The deenergization of the same relays 25 and 26, in addition to the above operation, causes the bridge across the called section of the trunk to be permanently opened at the springs 56, thereby breaking the circuit of the line relay 28 in the connector I, the armature of which falls back, thus opening the circuit of the relay 31, as well as that of the relay 18^a of the selector E', since the holding circuit of the latter relay is transferred from ground G^{12} to ground G^{21} through the springs of the relay 28 when the side switch wiper 82 of the connector passes from second to third position. Upon the deenergization of the coil 18^a, the circuit of the release magnet 123^a is closed to return said switch to its normal condition in the same manner as that described for the selector E (Fig. 1). Upon the spring 70 of the relay 31 falling back, a circuit is closed from ground G^{21} through the springs 69, back contact of the spring 70, through the connector release magnet 127 and off normal springs 126 to battery B', thus energizing said magnet to effect the release of the connector switch I in the same manner as that of the preceding selector switches. Upon the side switch wiper 75 returning to its normal condition, the circuit from ground G^{11} over the conductor 128 and through the cut-off winding 78 of the called subscriber's line switch C' is broken, which deenergizes and releases the armature 129, which allows the springs of

the line switch to return to their normal positions. Thus the central office apparatus is released and in readiness to be utilized for another call.

5 Had the called subscriber's line been busy, the side switch of the connector would have been held in the second position after the last digit was called, thus preventing the completion of the connection, for the usual
10 ground potential would have been found on the contact engaged by the private wiper 91, thus closing the circuit of the busy relay 93 over the private wiper 91, side switch wiper 75 (in second position), springs 95 and
15 through the busy relay 93, springs 96 (when the relay 71 deenergizes) and through the private magnet 73 to battery. Upon energizing, the busy relay 93 closes the contact of springs 196, and a busy tone is sent back
20 to the calling subscriber from the busy machine M by way of the side switch wiper 84, springs 98, conductor 99, through the calling subscriber's telephone to the negative battery, whereupon the receiver is replaced
25 on the switch hook and the connection is released in practically the same manner as described above.

In connection with the repeater, it will be seen that the bridge across the line through
30 the coils 58 and 27^a, together with the condensers 66 and 67, forms an inductive shunt around the line relay 25. This bridge necessarily contains an appreciable amount of impedance, so as to prevent undue leakage
35 of voice currents from one side of the line to the other. In order to insure prompt operation of the line relays of the switches beyond the repeater in response to impulses which are transmitted to them by the re-
40 peater, it is necessary, or at least advisable, to exclude all impedance from the operating circuit of said relays at the repeater while impulses are being transmitted. Upon
45 the deenergization of the line relay 25 of the repeater in response to the first break in the line circuit at the substation when any digit is called, the relay 65 operates to re-
50 move the coils 27^a and 58 from the circuit of the switch beyond the repeater by opening the contact 59, and, by closing the contact 59^a, the relay 65 closes a second bridge across the portion of the trunk leading to the switches beyond, which bridge is without
55 resistance or impedance. Thus it is seen that the line relays of the switches beyond the repeater are given an operating circuit free from resistance at the repeater, while at the same time the shunt around the line relay 25 is not altered. Since this shunt is
60 not altered, it insures that the line relay 25 responds to the succeeding breaks in the line circuit at the telephone with substantially the same degree of promptness as for the first break, thereby insuring that the im-

pulses delivered by the repeater shall be of 65 substantially a uniform length, which is not always the case if the shunt around the relay 25 is removed or its impedance short-circuited after the first impulse is received.

It will thus be seen that I have devised a 70 very efficient form of repeater and one which is adapted for use in various types of telephone systems. While I have illustrated the same in connection with a full automatic system of a particular type, it will be read- 75 ily apparent that my repeater is equally as well adapted for use with other types of automatic systems, or with semi-automatic systems. Various modifications and changes in the repeater itself will likewise be sug- 80 gested to those skilled in the art and come within the broader aspects of my invention.

What I claim as my invention is:—

1. In a telephone system, a trunk line, a repeater in said trunk for repeating im- 85 pulses over the same, said repeater including a line relay, and a permanently closed shunt circuit at the repeater around said line relay.

2. In a telephone system, a trunk line, a 90 repeater in said trunk for repeating impulses over the same, a line relay for said repeater, and a permanently closed high impedance shunt circuit at the repeater for
95 said line relay.

3. In a telephone system, a trunk line, a repeater in said trunk for repeating im- pulses over the same, a line relay in said re- peater bridged across said trunk, condensers
100 in said trunk, and a permanently closed shunt circuit for said line relay at said repeater including said condensers.

4. In a telephone system, a trunk line, a repeater in said trunk for repeating im- pulses over the same, a line relay in said re- 105 peater bridged across said trunk, condensers in said trunk, a permanently closed shunt circuit for said line relay at said repeater including said condensers, and an
110 impedance coil included in said shunt.

5. In a telephone system, a trunk line, a repeater in said trunk, a line relay for said repeater bridged across said trunk, a con- denser in each side of said trunk line at said
115 repeater, and a permanently closed shunt circuit at said repeater around said relay including both of said condensers.

6. In a telephone system, a trunk line, a repeater in said trunk, a line relay for said repeater bridged across said trunk, a con- 120 denser in each side of said trunk line at said repeater, a permanently closed shunt circuit at said repeater around said line relay including both of said condensers, and a coil having high impedance likewise included in
125 said shunt.

7. In a telephone system, a trunk line, a repeater in said trunk for repeating im-

pulses over the same, a bridge across said trunk, said bridge including a line relay for said repeater and a battery, and a permanently closed shunt in said repeater around
5 said bridge.

8. In a telephone system, a trunk line, a repeater in said trunk for repeating impulses over the same, a bridge across said trunk, said bridge including a line relay for
10 said repeater and a battery, and a permanently closed high impedance shunt in said repeater around said bridge.

9. In a telephone system, a trunk line, a repeater in said trunk for repeating impulses over the same, a bridge across said trunk, said bridge including a line relay for
15 said repeater and a battery, condensers in said trunk, and a permanently closed shunt in said repeater around said bridge including said condensers.

10. In a telephone system, a trunk line, a repeater in said trunk for repeating impulses over the same, a bridge across said trunk, said bridge including a line relay for
25 said repeater and a battery, condensers in said trunk, and a permanently closed shunt in said repeater around said bridge including said condensers and a high impedance.

11. In a telephone system, a trunk line, a repeater in said trunk for repeating impulses over the same, a line relay for said
30 repeater bridged across said trunk, a battery connected to said bridge for supplying current to said trunk, a current-reversing relay for reversing said battery connections, and
35 a permanently closed high impedance shunt for said line relay including a winding of said current-reversing relay.

12. In a telephone system, a trunk line, a repeater in said trunk for repeating impulses over the same, a line relay for said
40 repeater bridged across said trunk, a battery connected to said bridge for supplying current to said trunk, a current-reversing relay for reversing battery connections, condensers
45 in said trunk, and a permanently closed shunt for said line relay including said condensers and a winding of said current-reversing relay.

13. In a telephone system, a trunk line, a repeater in said trunk for repeating impulses over the same, a line relay for said
50 repeater, an impedance coil permanently bridged across said trunk, and means for operating said line relay to thereby close a
55 circuit to repeat impulses over said trunk, said circuit being independent of said impedance.

14. In a telephone system, a trunk line, a repeater in said trunk, condensers in the
60 two sides of said trunk at said repeater, a line relay for said repeater bridged across said trunk on the incoming side of said condensers, an impedance, a permanent shunt

for said relay including said impedance and
65 said condensers, and means controlled by said line relay for closing a repeating circuit over the outgoing side of said trunk, said repeating circuit excluding said impedance.

15. In a telephone system, a trunk line,
70 a repeater in said trunk, a line relay for said repeater bridged across said trunk, condensers in said trunk conductively dividing said trunk in two parts, an impedance permanently bridged across said condensers in
75 shunt of said line relay, means for receiving impulses over the incoming end of said trunk, and means controlled by the operation of said line relay for cutting off said
80 impedance bridge from the outgoing end of the trunk and for directly connecting the two sides of the trunk together, to thereby repeat impulses over the two sides of the trunk line in series.

16. In a telephone system, a trunk line,
85 a repeater in said trunk, a line relay for said repeater, condensers in said trunk dividing the same in two parts, means for transmitting impulses over the incoming end of said trunk through said line relay to
90 thereby operate the same, a high impedance bridge at the repeater permanently in shunt of said line relay across said trunk, and means controlled by the operation of said line relay for directly bridging the two sides
95 of the second part of said trunk together, whereby all impedance is excluded at the repeater from the circuit over which the repeated impulses are transmitted.

17. In a telephone system, a trunk line,
100 a repeater in said trunk, a pair of condensers in said trunk at said repeater, a line relay bridged across said trunk at one side of said condensers, an impedance coil, a permanently closed shunt for said line relay including said condensers and said impedance
105 coil, a slow-acting relay, an energizing circuit for said relay controlled by said line relay, whereby said slow-acting relay remains energized during the intermittent
110 operation of said line relay, means controlled by the operation of said line relay for connecting a direct bridge across the two sides of said trunk on the other side of said condensers for repeating impulses,
115 and means controlled by the operation of said slow-acting relay for eliminating all impedance at the repeater from said repeating circuit.

18. In a telephone system, subscribers'
120 lines, means for establishing connection between said lines, said means including trunk lines and a repeater in said trunk, a line relay in said repeater for repeating impulses over said trunk, a battery connected to said
125 trunk through said line relay for supplying talking current, a current-reversing relay for reversing said battery connections, said

relay having a pair of energizing windings normally opposing each other, a permanently closed shunt around said line relay including a winding of said current-reversing relay, and means operated upon the response of the called subscriber for reversing the current in one of the windings of said current-reversing relay, whereby the impedance in said shunt is increased.

19. In a telephone system, subscribers' lines, a trunk line, means including an automatic trunk-selecting switch for extending a connection from a calling line to said trunk, an automatic trunk-selecting switch at the opposite end of said trunk, a repeater in said trunk for repeating impulses to said last-mentioned switch, said repeater including a line relay, and a permanently closed shunt circuit at the repeater around said line relay.

20. In a telephone system, subscribers' lines, a trunk line, means including an automatic trunk-selecting switch for extending a connection from a calling line to said trunk, an automatic trunk-selecting switch at the opposite end of said trunk, a repeater in said trunk for repeating impulses to said last-mentioned switch, a line relay for said repeater, and a permanently closed high impedance shunt circuit at the repeater for said line relay.

21. In a telephone system, subscribers' lines, a trunk line, means including an automatic trunk-selecting switch for extending a connection from a calling line to said trunk, an automatic trunk-selecting switch at the opposite end of said trunk, a repeater in said trunk for repeating impulses to said last-mentioned switch, a line relay in said repeater bridged across said trunk, condensers in said trunk, and a permanently closed shunt circuit for said line relay at said repeater including said condensers.

22. In a telephone system, subscribers' lines, a trunk line, means including an automatic trunk-selecting switch for extending a connection from a calling line to said trunk, an automatic trunk-selecting switch at the opposite end of said trunk, a repeater in said trunk for repeating impulses to said last-mentioned switch, a line relay in said repeater bridged across said trunk, condensers in said trunk, a permanently closed shunt circuit for said line relay at said repeater including said condensers, and an impedance coil included in said shunt.

23. In a telephone system, subscribers' lines, a trunk line, means including an automatic trunk-selecting switch for extending a connection from a calling line to said trunk, an automatic trunk-selecting switch at the opposite end of said trunk, a repeater in said trunk for repeating impulses to said last-mentioned switch, a line relay for said

repeater bridged across said trunk, a condenser in each side of said trunk line at said repeater, and a permanently closed shunt circuit at said repeater around said line relay including both of said condensers.

24. In a telephone system, subscribers' lines, a trunk line, means including an automatic trunk-selecting switch for extending a connection from a calling line to said trunk, an automatic trunk-selecting switch at the opposite end of said trunk, a repeater in said trunk for repeating impulses to said last-mentioned switch, a line relay for said repeater bridged across said trunk, a condenser in each side of said trunk line at said repeater, a permanently closed shunt circuit at said repeater around said line relay including both of said condensers, and a coil having high impedance likewise included in said shunt.

25. In a telephone system, subscribers' lines, a trunk line, means including an automatic trunk-selecting switch for extending a connection from a calling line to said trunk, an automatic trunk-selecting switch at the opposite end of said trunk, a repeater in said trunk for repeating impulses to said last-mentioned switch, a bridge across said trunk, said bridge including a line relay for said repeater and a battery, and a permanently closed shunt in said repeater around said bridge.

26. In a telephone system, subscribers' lines, a trunk line, means including an automatic trunk-selecting switch for extending a connection from a calling line to said trunk, an automatic trunk-selecting switch at the opposite end of said trunk, a repeater in said trunk for repeating impulses to said last-mentioned switch, a bridge across said trunk, said bridge including a line relay for said repeater and a battery, and a permanently closed high impedance shunt in said repeater around said bridge.

27. In a telephone system, subscribers' lines, a trunk line, means including an automatic trunk-selecting switch for extending a connection from a calling line to said trunk, an automatic trunk-selecting switch at the opposite end of said trunk, a repeater in said trunk for repeating impulses to said last-mentioned switch, a bridge across said trunk, said bridge including a line relay for said repeater and a battery, condensers in said trunk, and a permanently closed shunt in said repeater around said bridge including said condensers.

28. In a telephone system, subscribers' lines, a trunk line, means including an automatic trunk-selecting switch for extending a connection from a calling line to said trunk, an automatic trunk-selecting switch at the opposite end of said trunk, a repeater in said trunk for repeating impulses to said

last-mentioned switch, a bridge across said trunk, said bridge including a line relay for said repeater and a battery, condensers in said trunk, and a permanently closed shunt in said repeater around said bridge including said condensers and a high impedance.

29. In a telephone system, subscribers' lines, a trunk line, means including an automatic trunk-selecting switch for extending a connection from a calling line to said trunk, an automatic trunk-selecting switch at the opposite end of said trunk, a repeater in said trunk for repeating impulses to said last-mentioned switch, a line relay for said repeater bridged across said trunk, a battery connected to said bridge for supplying current to said trunk, a current-reversing relay for reversing said battery connections, and a permanently closed high impedance shunt for said line relay including a winding of said current-reversing relay.

30. In a telephone system, subscribers' lines, a trunk line, means including an automatic trunk-selecting switch for extending a connection from a calling line to said trunk, an automatic trunk-selecting switch at the opposite end of said trunk, a repeater in said trunk for repeating impulses to said last-mentioned switch, a line relay for said repeater bridged across said trunk, a battery connected to said bridge for supplying current to said trunk, a current-reversing relay for reversing battery connections, condensers in said trunk, and a permanently closed shunt for said line relay including said condensers and a winding of said current-reversing relay.

31. In a telephone system, subscribers' lines, a trunk line, means including an automatic trunk-selecting switch for extending a connection from a calling line to said trunk, an automatic trunk-selecting switch at the opposite end of said trunk, a repeater in said trunk for repeating impulses to said last-mentioned switch, a line relay for said repeater, an impedance coil permanently bridged across said trunk, and means for operating said line relay to thereby close a circuit to repeat impulses over said trunk, said circuit being independent of said impedance.

32. In a telephone system, subscribers' lines, a trunk line, means including an automatic trunk-selecting switch for extending a connection from a calling line to said trunk, an automatic trunk-selecting switch at the opposite end of said trunk, a repeater in said trunk for repeating impulses to said last-mentioned switch, condensers in the two sides of said trunk at said repeater, a line relay for said repeater bridged across said trunk on the incoming side of said condensers, an impedance, a permanent shunt for said relay including said impedance and said condensers, and means controlled by

said line relay for closing a repeating circuit over the outgoing side of said trunk, said repeating circuit excluding said impedance.

33. In a telephone system, subscribers' lines, a trunk line, means including an automatic trunk-selecting switch for extending a connection from a calling line to said trunk, an automatic trunk-selecting switch at the opposite end of said trunk, a repeater in said trunk for repeating impulses to said last-mentioned switch, a line relay for said repeater bridged across said trunk, condensers in said trunk conductively dividing said trunk in two parts, an impedance permanently bridged across said condensers in shunt of said line relay, means for receiving impulses over the incoming end of said trunk, and means controlled by the operation of said line relay for cutting off said impedance bridge from the outgoing end of the trunk and for directly connecting the two sides of the trunk together, to thereby repeat impulses over the two sides of the trunk line in series.

34. In a telephone system, subscribers' lines, a trunk line, means including an automatic trunk-selecting switch for extending a connection from a calling line to said trunk, an automatic trunk-selecting switch at the opposite end of said trunk, a repeater in said trunk for repeating impulses to said last-mentioned switch, a line relay for said repeater, condensers in said trunk dividing the same in two parts, means for transmitting impulses over the incoming end of said trunk through said line relay to thereby operate the same, a high impedance bridge at the repeater permanently in shunt of said line relay across said trunk, and means controlled by the operation of said line relay for directly bridging the two sides of the second part of said trunk together, whereby all impedance is excluded at the repeater from the circuit over which the repeated impulses are transmitted.

35. In a telephone system, subscribers' lines, a trunk line, means including an automatic trunk-selecting switch for extending a connection from a calling line to said trunk, an automatic trunk-selecting switch at the opposite end of said trunk, a repeater in said trunk for repeating impulses to said last-mentioned switch, a pair of condensers in said trunk at said repeater, a line relay bridged across said trunk at one side of said condensers, an impedance coil, a permanently closed shunt for said line relay including said condensers and said impedance coil, a slow-acting relay, an energizing circuit for said relay controlled by said line relay, whereby said slow-acting relay remains energized during the intermittent operation of said line relay, means controlled by the operation of said line relay for connecting a

direct bridge across the two sides of said trunk on the other side of said condensers for repeating impulses, and means controlled by the operation of said slow-acting 5 relay for eliminating all impedance at the repeater from said repeating circuit.

36. In a telephone system, subscribers' lines, a trunk line, means including an automatic trunk-selecting switch for extending a 10 connection from a calling line to said trunk, an automatic trunk-selecting switch at the opposite end of said trunk, a repeater in said trunk for repeating impulses to said last-mentioned switch, a line relay in said re- 15 peater for repeating impulses over said trunk, a battery connected to said trunk through said line relay for supplying talking current, a current-reversing relay for reversing said battery connections, said relay 20 having a pair of energizing windings normally opposing each other, a permanently closed shunt around said line relay including a winding of said current-reversing relay, and means operated upon the response 25 of the called subscriber for reversing the current in one of the windings of said current-reversing relay, whereby the impedance in said shunt is increased.

37. In a telephone system, a trunk line 30 having a first and a second conductor, a condenser in each conductor, a line relay bridged across the trunk in front of said condensers, an auxiliary relay under the control of said line relay, said auxiliary relay 35 provided with means for disconnecting the first conductor from its condenser and for connecting it with the second conductor, and

means under the control of the line relay for breaking the circuit thus formed between the first and second conductors, said auxiliary 40 relay provided with means for maintaining the connection between the first conductor and the condenser of the second conductor while the line relay repeats the operation of connecting and disconnecting the second 45 conductor from the first conductor.

38. In a telephone system, a trunk line having a first conductor and a second conductor, a line relay associated with said line, an auxiliary relay under the control of said 50 line relay to connect the first conductor with the second conductor, and means under the control of the line relay for repeatedly making and breaking the circuit between the first and second conductors while the auxiliary 55 relay remains energized, and a permanently closed shunt circuit around the said line relay.

39. In a telephone system, a trunk line having a pair of conductors, a condenser in 60 each conductor, a line relay, contact springs controlled by said relay for opening one side of said trunk, an auxiliary relay, and means controlled thereby for disconnecting the 65 other side of said trunk from its condenser and connecting it with the condenser in the first side of said trunk.

Signed by me at Fennimore, Grant county, Wisconsin, this 26 day of March, 1913.

ALBERT H. BLESSING.

Witnesses:

E. J. ROETHE,
J. R. VILLOMONTE.