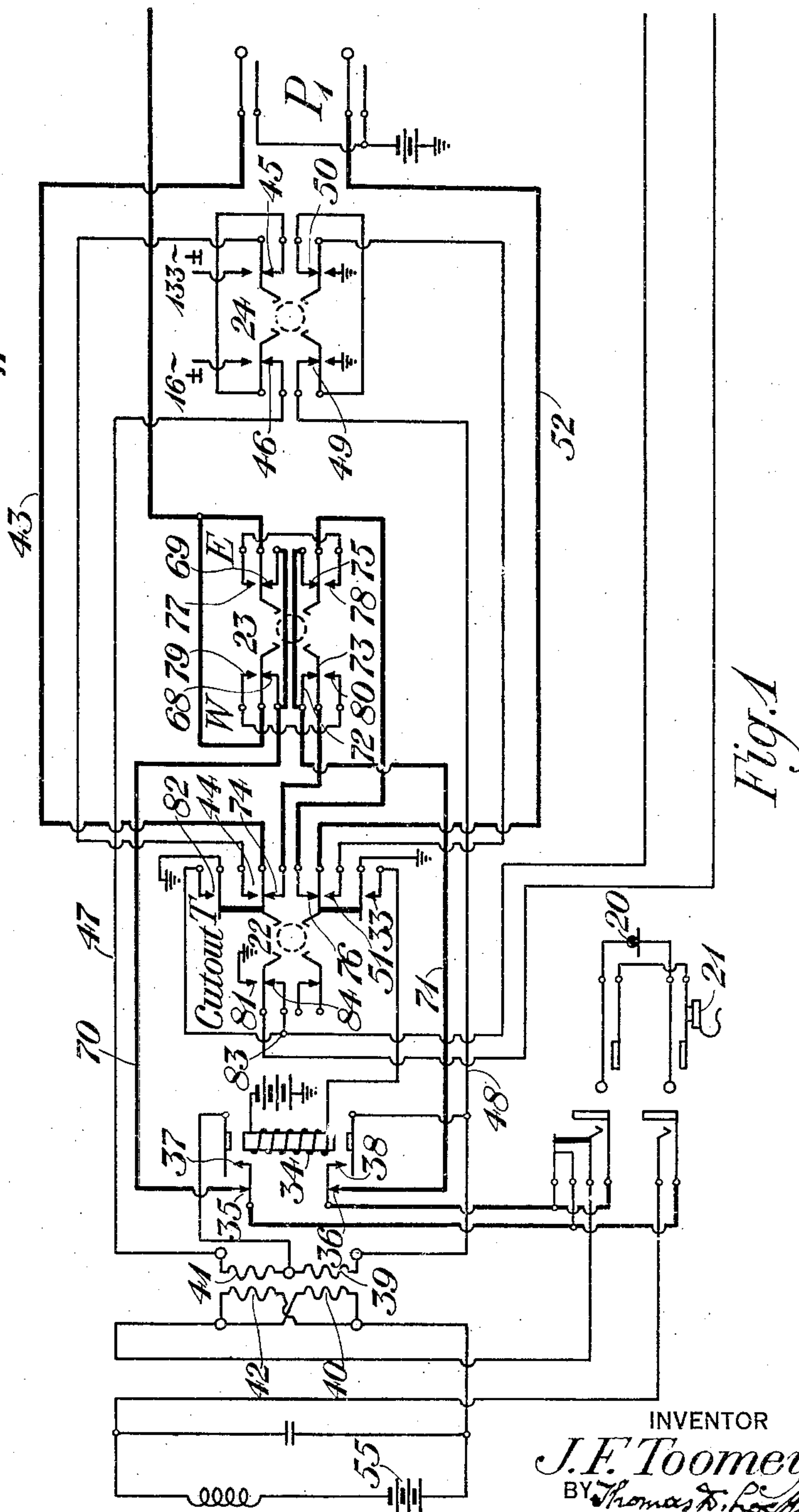
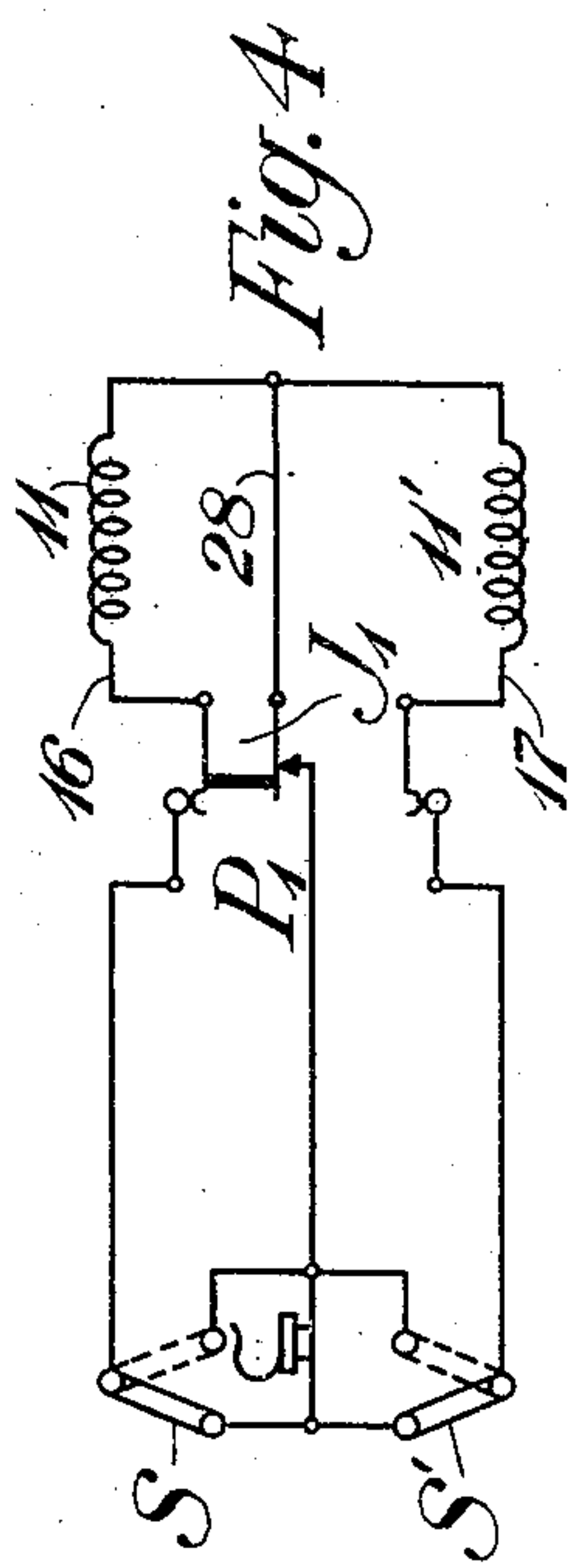


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 MONITORING CIRCUIT FOR TELEPHONE REPEATERS.
 APPLICATION FILED MAY 18, 1917.

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Patented Dec. 14, 1920.
 3 SHEETS—SHEET 1.

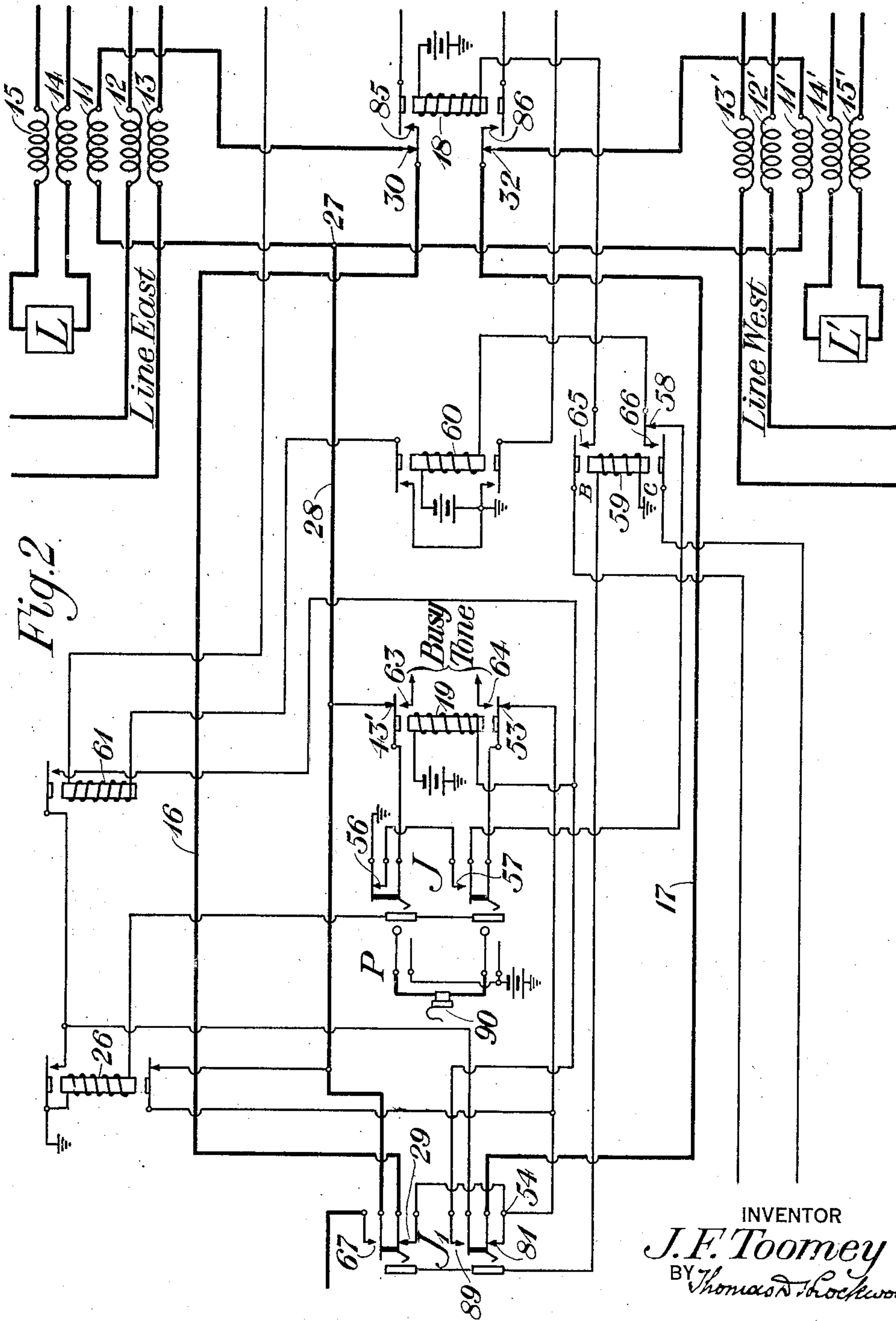


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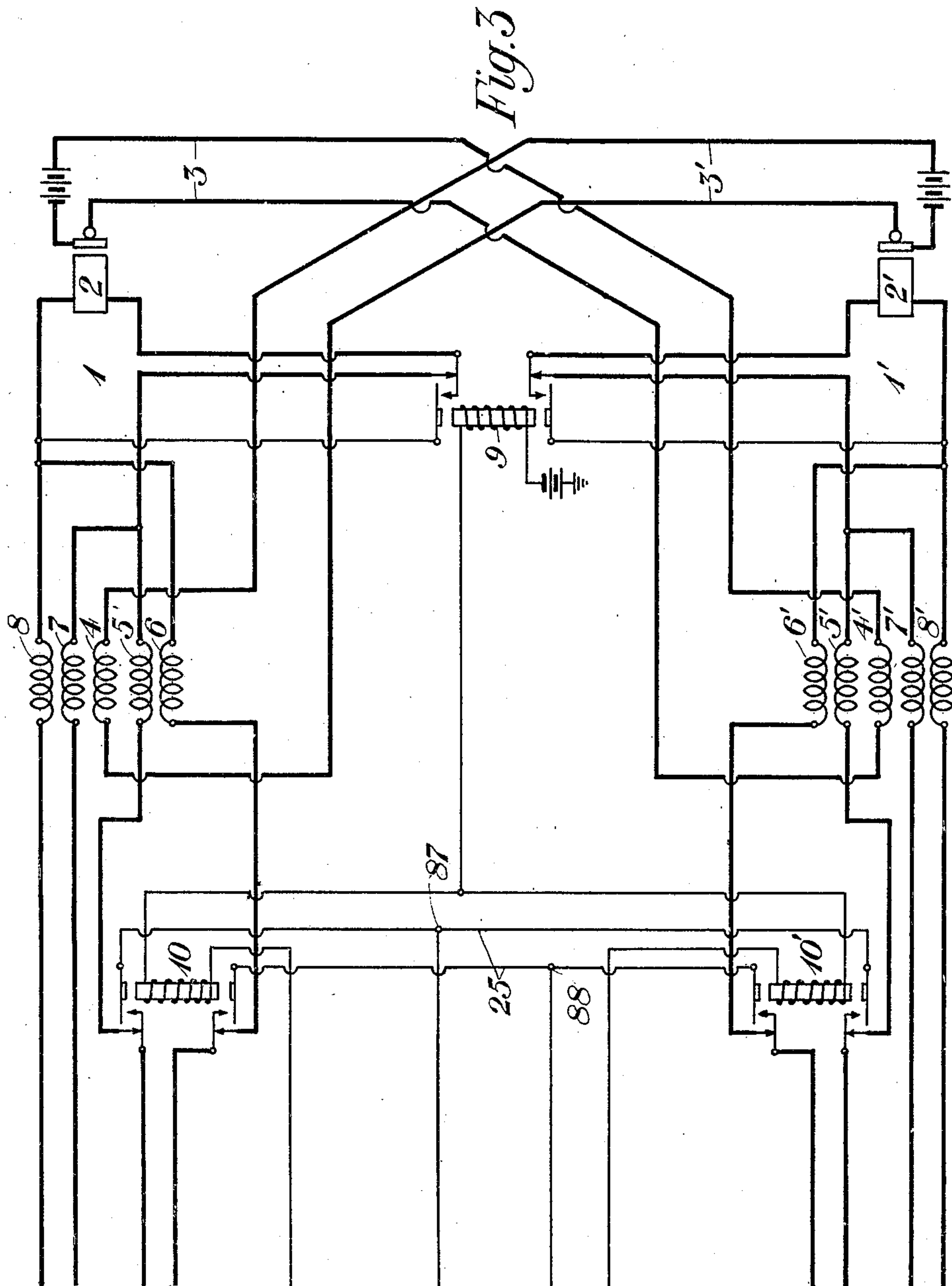
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UNITED STATES PATENT OFFICE.

JOHN F. TOOMEY, OF NEW YORK, N. Y., ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

MONITORING-CIRCUIT FOR TELEPHONE-REPEATERS.

1,361,929.

Specification of Letters Patent.

Patented Dec. 14, 1920.

Application filed May 18, 1917. Serial No. 169,523.

To all whom it may concern:

Be it known that I, JOHN F. TOOMEY, residing at New York, in the county of New York, and State of New York, have invented certain Improvements in Monitoring-Circuits for Telephone -Repeaters, of which the following is a specification.

This invention relates to telephone repeater stations and more particularly to the provision of monitoring equipment for telephone repeaters whereby the operation of a repeater interconnecting two lines may be observed.

One of the objects of the invention is the provision of means, whereby an operator at one type of monitoring station such as, for instance, an observation station remote from the repeater apparatus, may observe by means of a suitable listening set the operation of a repeater during telephonic transmission from one line to another through the repeater.

Another object of the invention is the provision of means whereby an operator at another type of monitoring station preferably located near the repeater apparatus, so that access may be had thereto for purposes of adjustment, etc., may connect a monitoring equipment to the repeater and by means of a listening set observe the operation of the repeater during transmission in either or both directions over lines interconnected through the repeater. Means are also provided whereby the operator at a monitoring station of the second type may disconnect the repeater from the transmission circuit and directly connect the lines so as to permit of observation of the transmission over the lines with the repeater disconnected.

Another object of the invention is the provision of means whereby an operator at a monitoring station of the second type may eliminate the repeater from an established connection and directly connect the lines, at the same time bridging the operator's set directly across the interconnected lines. Means are also provided whereby the operator may, with the circuit in this condition, apply ringing or signaling current over the lines to operate suitable signaling apparatus associated with the lines.

A further object of the invention relates to the provision of means whereby a busy signal will be given if an operator at a monitoring station of the first type attempts to

connect to a repeater with which connection has already been made at a station of the second type. Means are also provided to give a busy signal if an operator at a monitoring station of the first type attempts to listen in on the repeater circuit when the repeater is disconnected.

Other and further objects of the invention will be clear from the following description taken in connection with the accompanying drawing in which:

Figure 1 is a diagram of the circuit connections of the operator's monitoring equipment; Figs. 2 and 3 when placed end to end constitute a diagram of the repeater circuits and parts of the monitoring equipment associated therewith; and Fig. 4 is a simplified diagram of the monitoring circuit.

The repeater equipment shown in Figs. 2 and 3 comprises two pairs of line conductors designated on the drawing as "Line East" and "Line West," said lines terminating in input circuits 1 and 1' of repeaters 2 and 2'. The repeaters for convenience of illustration are shown as mechanical repeaters but may be of any other type, such as, for instance, the well known vacuum tube type. The lines are balanced by corresponding artificial lines L and L'. The output circuits 3 and 3' of the repeaters 2 and 2' are connected to primaries 4 and 4' of induction coils having secondary windings 5, 6 and 5', 6' in the line circuits, and secondary windings 7, 8 and 7', 8' in the artificial line circuits, the coils being so arranged that balancing potentials are applied to the input terminals of the repeaters with respect to variations received from the output circuits 3 and 3'. Relays 9, 10 and 10' are provided, relay 9 operating when energized to open the input circuits 1 and 1' and shortcircuit the repeaters 2 and 2', while relays 10 and 10' operate to disconnect the repeaters from the lines and to interconnect the lines through conductors 25.

Associated with the repeater equipment is a monitoring equipment shown in Figs. 1 and 2. There are two types of monitoring stations at which the repeater is represented by twin jacks J and J₁. The jack J may be multiplied at its corresponding station if desired. Jack J may be located at a test-board remote from the repeater apparatus, while jack J₁ is at a position convenient to the repeater for purposes of adjustment etc. Operators at these stations are enabled to

listen in on the repeater circuits by means of induction coils having primaries 11 and 11' connected to terminals of jacks J and J₁, said primaries being inductively related to secondaries 12, 13 and 12', 13' in the line circuits, and secondaries 14, 15 and 14', 15' in the artificial line circuits. Conductors 16 and 17 connecting primaries 11 and 11' to the tip springs of jack J₁ may be disconnected from said windings and connected to conductors 25 by a relay 18. Should an operator attempt to connect with the repeater by means of jack J when another operator has already connected with the repeater at jack J₁, a busy tone will be given the first operator over the contacts of relay 19.

The operator's monitoring equipment for use with jack J consists of a receiver 90 connected to the tip contacts of a twin plug P. The operator's monitoring equipment for use with jack J₁ is illustrated in Fig. 1 and comprises a twin plug P₁ adapted to be inserted in jack J₁, the terminals of said plug being connected to transmitter 20 and receiver 21 of an operator's set through contacts of keys 22, 23 and 24. If the plug P is inserted in jack J, receiver 90 will be connected in parallel with the primaries 11 and 11' over the tip contacts of the plug in such manner that the operator may listen in on the repeater circuit without affecting the repeater. If the plug P₁ is inserted in jack J₁ the operator's listening set is associated with primaries 11 and 11' in parallel. By throwing key 23 to the right, primary 11' is shortcircuited and the operator may listen on "Line East" exclusively. Incoming impulses on "Line East" are transmitted to receiver 21 without amplification but outgoing impulses are transmitted after being amplified by repeater 2'. Similarly by throwing key 23 to the left the operator can listen on "Line West" exclusively. The operator is thus enabled to determine whether the amplification in each direction is satisfactory. By throwing key 22 to the left, or "cut-out" position relays 9, 10 and 10' may be energized to disconnect the lines from the repeater and interconnect them over circuit 25. As the operator's receiver is connected to primaries 11, 11' the operator can thus listen in on the lines without the repeater and compare the transmission thus under this condition with the transmission when the repeater is in circuit. By throwing key 22 to the right or "talking" position the operator's transmitter, which is not normally connected to the circuit is connected to conductors 16, 17 and the relays 9, 10 and 10' are operated to disconnect the repeater and interconnect the lines over conductors 25. At the same time conductors 16 and 17 are disconnected from the primaries 11 and 11' and bridged across conductors 25 by means of the contacts of the relay 18 so that the operator's set is

bridged directly across the connected lines. With switch 22 in this position ringing key 24 may be thrown to apply either 16 cycle or 133 cycle ringing current over the lines connected through the conductors 25 to operate signaling apparatus associated with the lines at a distant station. With this general description in mind the invention may now be fully understood from a description of the operation.

For convenience the sheets of the drawing including Figs. 1, 2 and 3 should be arranged end to end with Fig. 1 on the left and Fig. 3 on the right. Assuming that an operator at the monitoring station at which the repeater is represented by jack J desires to observe the operation of the repeater, the plug P will be inserted in jack J, completing a circuit from battery over the sleeve contacts of plug P and jack J through the winding of relay 26 to ground. Normally windings 11 and 11' are shortcircuited, the circuit of winding 11 extending from the left hand terminal of said winding to point 27, thence over conductor 28, lower contact of relay 26, contact 29 of jack J₁, conductor 16, contact 30 of relay 18 to right hand terminal of winding 11. Similarly the circuit of winding 11' extends from the left hand terminal thereof to point 27, over conductor 28, lower contact of relay 26, contact 81 of jack J₁, conductor 17, contact 32 of relay 18 to the right hand terminal of winding 11'. Upon the energization of relay 26 the short circuit connection through conductor 28 is opened at the lower contact of said relay and the two windings are in a series circuit.

The operator's receiver 90 is now located in a bridge across the serial circuit including primaries 11 and 11' the circuit being as follows:

From point 27, over conductor 28, contact 43' of relay 19, upper tip contacts of jack J and plug P, receiver 90, lower tip contacts of plug P and jack J, contact 53 of relay 19, to terminal 54 where the circuit divides, one path continuing over contact 29 of jack J₁, conductor 16, contact 30 of relay 18, and through winding 11 back to point 27, and the other path extending in parallel thereto from terminal 54 over contact 81 of jack J₁, conductor 17, contact 32 of relay 18, and through winding 11' back to point 27.

The operator may now listen in on the lines interconnected through the repeater without affecting the repeater. Incoming voice currents from "Line East" actuate repeater 2 and the amplified currents in output circuit 3 act through winding 4' to induce potential variations in windings 5', 6', 7' and 8' whereby said amplified voice currents from "Line East" are transmitted over "Line West" and artificial line L'. The potentials in "Line West" and line L' are

in such direction that the input terminals of repeater 2' are at points of equal potential so that no effect is produced on repeater 2'. At the same time these potentials act cumulatively as to coils 12', 13', 14' and 15' to induce potential variations in winding 11', whereby the amplified voice currents are transmitted to receiver 90 over the circuit already traced. Similarly voice currents coming in over "Line West" are amplified by repeater 2' and thus amplified, are transmitted over "Line East" thereby actuating receiver 90 through inductive action on winding 11.

The operator at the monitoring station at which jack J is located may disconnect the repeater from the lines and interconnect the lines through conductors 25 by withdrawing plug P and inserting an idle plug in the lower half of twin jack J, thereby closing a circuit from ground, contacts 56 and 57 of jack J, contact 58 of relay 59, and through winding of relay 60 to battery. Relay 60 upon being energized closes the following circuits:

From ground, lower contact of relay 60, winding of relay 10', and winding of relay 9 to battery, and from ground, upper contact of relay 60, winding of relay 61, winding of relay 10 and winding of relay 9 to battery. Relays 9, 10, 10' and 61 are energized. Relay 9 operates to open the input circuits 1 and 1' and shortcircuit repeater elements 2 and 2'. Relays 10 and 10' disconnect the lines from the input circuits of the repeater elements and interconnect the lines through conductors 25. Should another operator at the same type of monitoring station insert a plug into a multiple of jack J in an attempt to bridge an operator's set across the tip contacts of such jack, relay 26 would be energized thereby closing a circuit from ground, over upper contact of relay 26, contact of relay 61 (now energized), through winding of relay 19 to battery. Relay 19 operates to open contacts 43' and 53 and close contacts 63 and 64, thereby applying a busy tone to the tip springs of jack J and its multiples, so that the operator receives a busy signal indicating that the repeater is either disconnected or under the control of another monitoring operator.

Assuming now that an operator at the monitoring station at which the repeater is represented by jack J₁ desires to connect with the repeater, the twin plug P₁ of an operator's monitoring equipment such as illustrated in Fig. 1 is inserted in the twin jack J₁, thereby closing an energizing circuit for relay 59 from battery, sleeve contacts of plug P₁ and jack J₁, winding of relay 59 to ground. Relay 59 pulls up, opening its contact 58 and closing contacts

65 and 66. The closing of these contacts does not at this time produce any effect. Upon inserting the plug P₁ in jack J₁, however, the operator's receiver 21 is bridged across the windings 11 and 11' as shown in the simplified diagram of Fig. 4. The circuit may be traced as follows:

From point 27, over conductor 28, contact 67 of jack J₁, over contacts 68 and 69 of key 23 in parallel, over conductor 70, contact 35, through receiver 21, contact 36, conductor 71 to spring 72 where the circuit branches, one path continuing over contact 73, contact 74, conductor 43, upper tip contacts of plug P₁ and jack J₁, conductor 16, contact 30, and through winding 11 back to point 27, the other path continuing from spring 72 over contact 75, contact 76, conductor 52, lower tip contacts of plug P₁ and jack J₁, conductor 17, contact 32 of relay 18 and through winding 11' to point 27. If the operator desires to listen in on "Line East" exclusively, key 23 may be thrown to the right or "E" position thereby shortcircuiting winding 11' as indicated schematically in Fig. 4 with switch S' in dotted line position. The receiver 21 is now in circuit with winding 11 over the circuit already traced, while the shortcircuit for winding 11' may be traced as follows:

From point 27, over conductor 28, contact 67, contacts 77 and 78 of key 23, contact 76 of key 22, conductor 52, lower tip contacts of plug P₁ and jack J₁, conductor 17, contact 32, and through winding 11' to point 27.

In a similar manner by throwing key 23 to the left or "W" position, winding 11 may be shortcircuited through contacts 79 and 80 of key 23, the winding 11' remaining in circuit with the receiver 21, so that the operator may listen in on "Line West" exclusively. The result is indicated in a conventional manner in Fig. 4 with the switch S in dotted line position.

Should the operator desire to disconnect the repeater, key 22 may be thrown to the left or "cut out" position, thereby closing a circuit from ground over contact 81 of said key, contact 63 of relay 59, (now operated), winding of relay 60 to battery. Relay 60 pulls up and closes circuits already traced through relays 9, 10, 10' and 61 whereby the repeater is disconnected and the lines interconnected through conductors 25 in a manner already described. As the receiver is connected with windings 11 and 11' over the circuits above traced, the transmission over the lines with the repeater disconnected may be observed and compared with the transmission with the repeater in circuit.

Should the operator desire to talk over the lines, key 22 may be thrown to the right or "talking" position, closing a circuit over

contact 33 for relay 34, whereby the receiver 21 is connected in parallel with winding 39. The operation of key 22 also closes a circuit from ground over contact 82 to terminal 83 where it branches, one path extending over contact 84, contact 66, winding of relay 60 to battery, and the other path continuing from terminal 83, over contact 65 of relay 59, (now operated), through winding of relay 18 to battery. Relays 60 and 18 are energized, the former actuating means to disconnect the repeater and interconnect the lines directly through conductors 25 in a manner already described, and the latter operating to open contacts 30 and 32 and close contacts 85 and 86, whereby conductors 16 and 17 are disconnected from windings 11 and 11' and connected to conductors 25. The operator's set is now bridged directly across the common terminals of the interconnected lines, the bridge being traced as follows:

From point 87, over contact 85, conductor 16, upper tip contacts of plug P_1 and jack J_1 , conductor 43, contacts 44, 45 and 46, conductor 47, winding 41, winding 39 and receiver 21 in parallel, conductor 48, contacts 49, 50 and 51, conductor 52, lower tip contacts of plug P_1 and pack J_1 , conductor 17, contact 86 to point 88. The operator's set is connected directly to the line and the repeater disconnected for the reason that if the set were connected to the line a condition of unbalance would occur which would set up singing. By directly connecting the set to the lines transformer losses are avoided.

By manipulation of the ringing key 24, the operator's set may be disconnected from the bridge above traced and ringing current applied thereto, 16 cycle current being applied if the key is thrown to the left, and 133 cycle current being applied if the key is thrown to the right. The operator is thus enabled to test signaling apparatus associated with the lines and responsive to ringing current.

If at any time while an operator's set is connected to the line through jack J_1 , another operator plugs into jack J , the latter operation results in the energization of relay 26 in a manner already described, whereby a circuit is closed from ground over upper contact of relay 26, contact 89 of jack J_1 , (closed by the insertion of plug P_1), and through winding of relay 19 to battery, energizing said relay, whereby contacts 43' and 53 are opened and contacts 63 and 64 are closed to apply a busy tone to the operator's set connected to the tip contacts of jack J .

While the invention has been illustrated and described as embodied in a specific organization it is to be understood that it is capable of embodiment in many and widely varied forms without departing from the scope of the appended claims.

What is claimed is:

1. In combination with a telephone repeater, monitoring stations at which the operation of said repeater may be observed, monitoring equipment at said stations, and means whereby when monitoring equipment is associated with said repeater at one of said stations, a busy test will be applied to monitoring equipment at the other station. 70

2. In combination, transmission lines, a repeater interconnecting said lines, a monitoring station, terminals of said repeater at said station, means whereby the repeater may be disconnected from the lines, and means whereby when the repeater is disconnected from the lines a busy test is applied to said terminals. 80

3. In combination, transmission lines, a repeater interconnecting said lines, a monitoring station, multiple terminals of said repeater at said station, means cooperating with one of said terminals whereby the repeater may be disconnected from said lines and a busy test applied to other of said terminals. 90

4. In combination, transmission lines, a repeater for interconnecting said lines, a plurality of monitoring stations, contacts of said repeater at each of said stations, means controllable over contacts at one of said stations for disconnecting said repeater from the lines, and for applying a busy test to the terminals at the other station. 95

5. In combination with a repeater, a plurality of monitoring stations, monitoring equipment at said stations, terminals corresponding to the repeater at each of said stations whereby monitoring equipment may be associated with said repeater, and means whereby when monitoring equipment is associated with said repeater over the terminals of one of said stations a busy signal will be applied to a monitoring equipment applied to the repeater terminals at the other station. 100 105 110

6. In combination with a repeater comprising two-repeater elements for repeating in opposite directions, transmission lines interconnected through the repeater, a monitoring station, monitoring equipment at said station, and means whereby said monitoring equipment may be associated with the circuit of each of said repeater elements independently of said lines. 115

7. In combination with a repeater comprising two-repeater elements for repeating in opposite directions, transmission lines interconnected through the repeater, an operator's set, and means whereby said set may be connected with the circuit of each of said repeater elements independently of said transmission lines. 120 125

8. In combination with a repeater having a plurality of output circuits, an operator's circuit, induction coils for associating the 130

operator's circuit with each of said output circuits, and an operator's set in a bridge with said induction coils in parallel with respect thereto.

5 9. In combination with a repeater having a plurality of output circuits, an operator's circuit, induction coils for associating the operator's circuit with each of said output circuits, a bridge connection shortcircuiting
10 said induction coils, an operator's set, and means whereby said set may be connected in said bridge.

10. In combination with a repeater having a plurality of output circuits, an operator's
15 circuit, induction coils for associating the operator's circuit with each of said output circuits, an operator's set in a bridge with said induction coils in parallel with respect thereto, and means for shortcircuiting said
20 induction coils at will.

11. In combination with a repeater having a plurality of output circuits, an operator's set, means for associating said set with all of said output circuits, and means operable
25 at will for disconnecting said operator's set from certain of said output circuits whereby the set may remain associated exclusively with the other circuits.

12. In combination, transmission lines, a
30 repeater for interconnecting said lines, monitoring equipment, means for associating said equipment with the repeater, and means operable only when the equipment is so associated for disconnecting the repeater from
35 the transmission lines.

13. In combination, transmission lines, a repeater for interconnecting said lines, an independent circuit for interconnecting said lines, a monitoring equipment including an
40 operator's set, means for associating said equipment with the repeater, and means operative at will for disconnecting said repeater and connecting said lines through said independent circuit, and for associating

said operator's set with said independent
circuit. 45

14. In combination, transmission lines, a repeater for interconnecting said lines, an independent circuit for interconnecting said lines, a monitoring equipment including an
50 operator's set, means for associating said equipment with the repeater, means operative at will for disconnecting said repeater and connecting said lines through said independent circuit, and for associating said
55 operator's set with said independent circuit, and means for applying ringing current to said independent circuit.

15. In combination, transmission lines, a repeater for interconnecting said lines, an
60 operator's equipment including a transmitter and a receiver, means for associating said equipment with a plurality of said lines with the receiver in separate inductive relation to each line, so that voice currents trans-
65 mitted over the lines and through the repeater will actuate said receiver, and means operative at will for directly connecting said receiver with said lines independently of the
70 repeater.

16. In combination, transmission lines, a repeater for interconnecting said lines, an operator's equipment including a transmitter and a receiver, means for associating said
75 equipment with a plurality of said lines with the receiver in separate inductive relation to each line, so that voice currents transmitted over said lines and through said repeater will actuate said receiver, and means opera-
80 tive at will for directly connecting said receiver with said lines independently of the repeater and for associating said transmitter therewith.

In testimony whereof, I have signed my name to this specification this eleventh day
85 of May, 1917.

JOHN F. TOOMEY.