

C. S. DEMAREST.
 TESTING CIRCUIT FOR REPEATERS EQUIPPED WITH AUTOMATIC NETWORK SELECTORS.
 APPLICATION FILED DEC. 5, 1918.

1,355,897.

Patented Oct. 19, 1920.

4 SHEETS—SHEET 1.

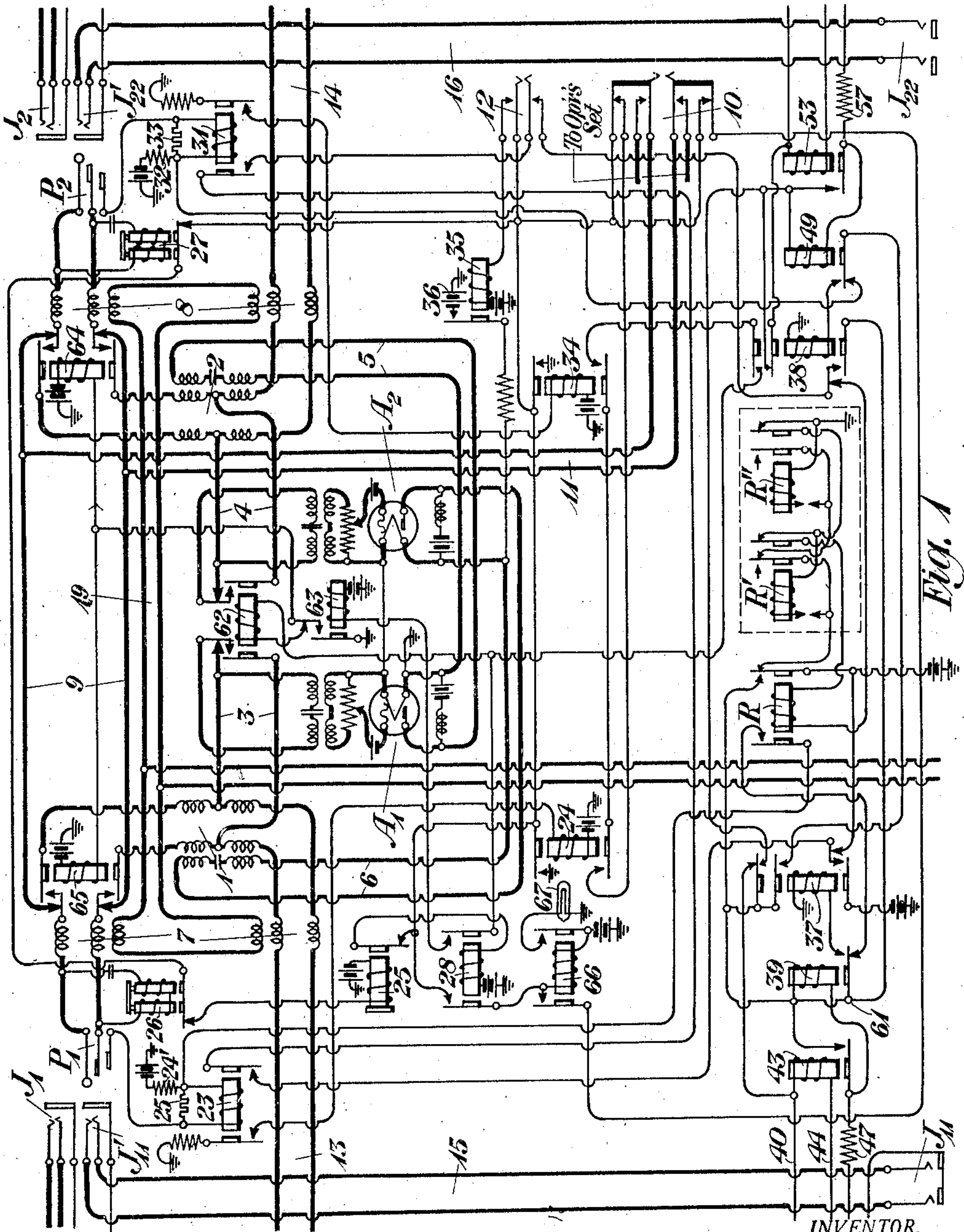


Fig. 1

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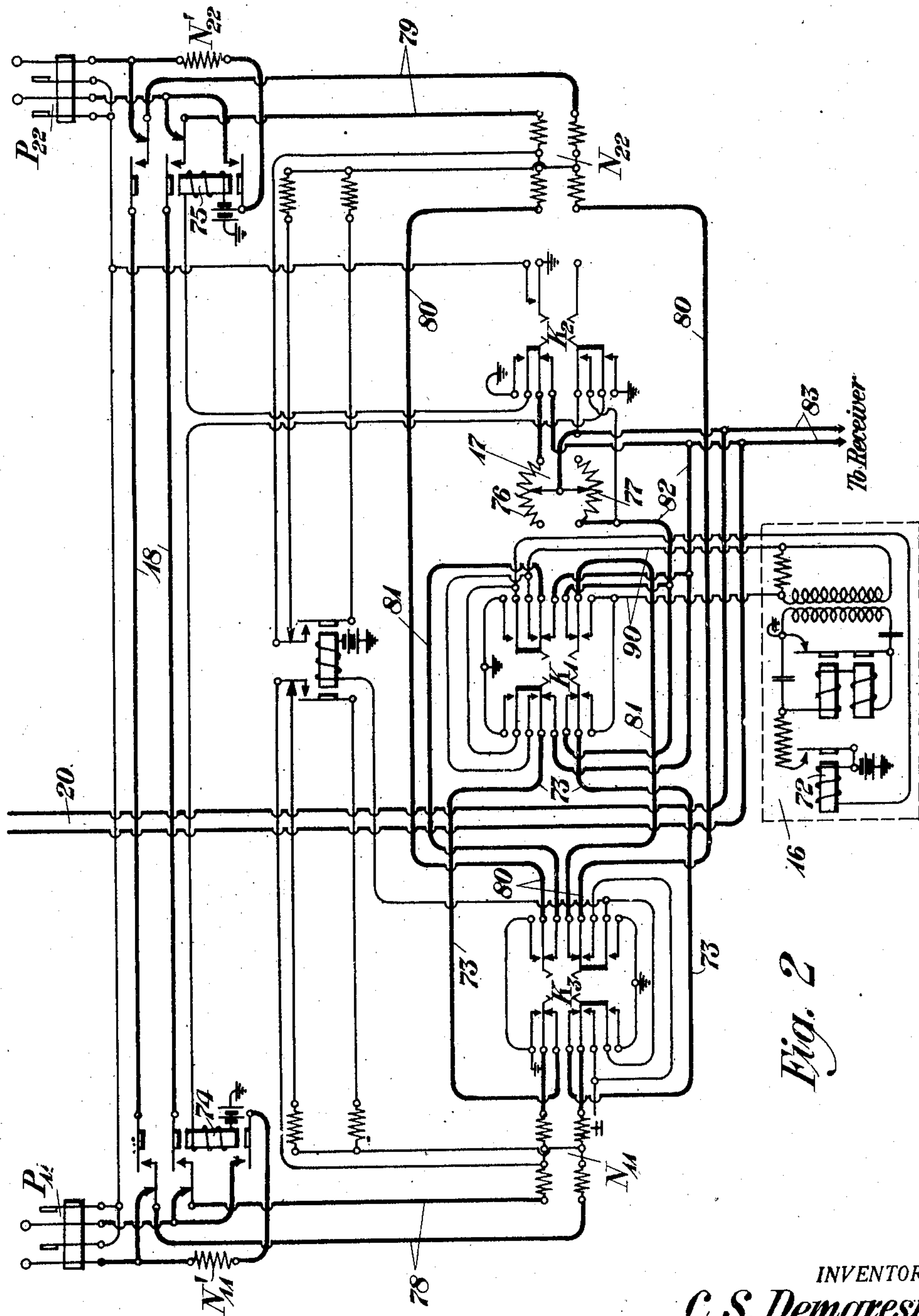


Fig. 2

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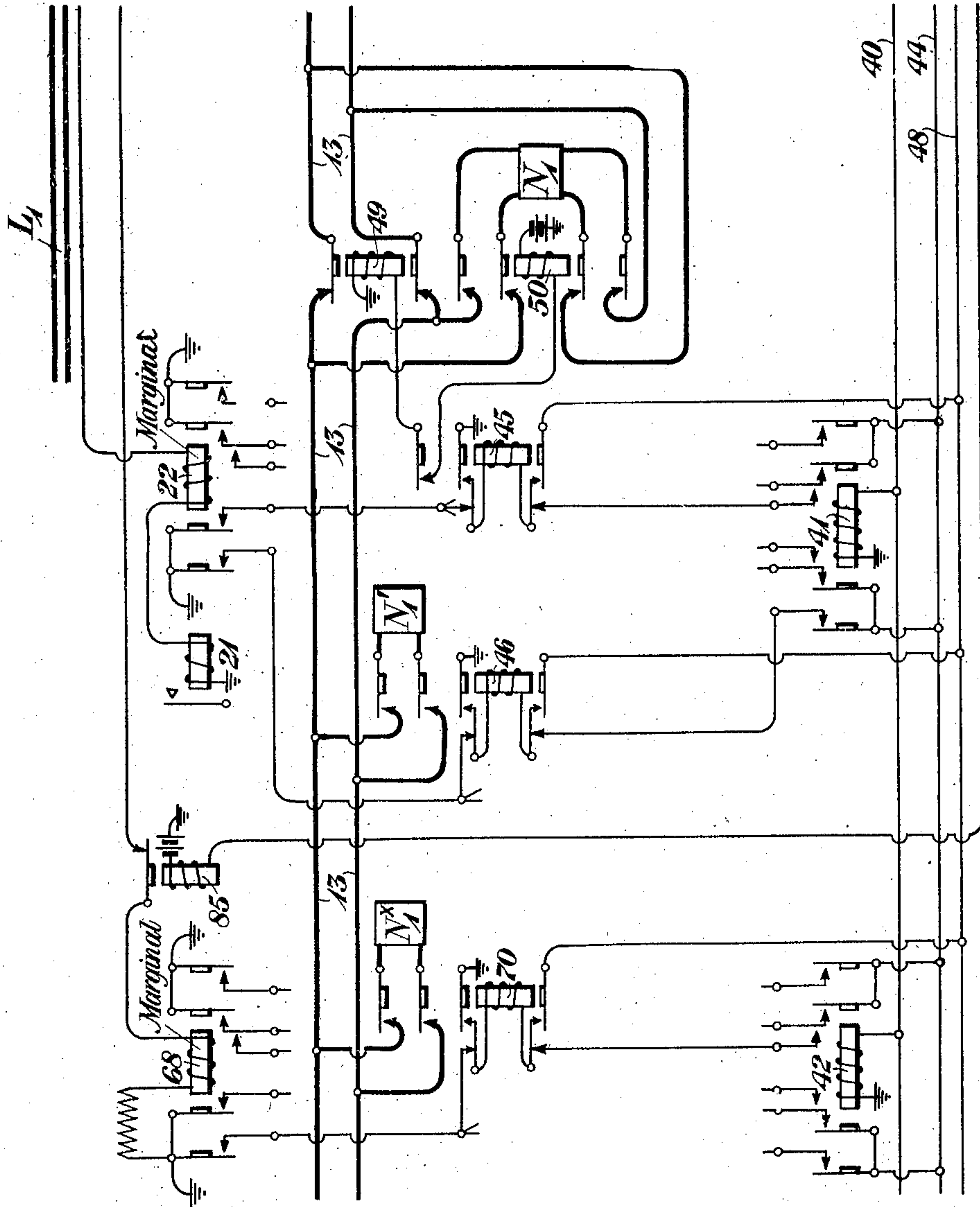


Fig. 3

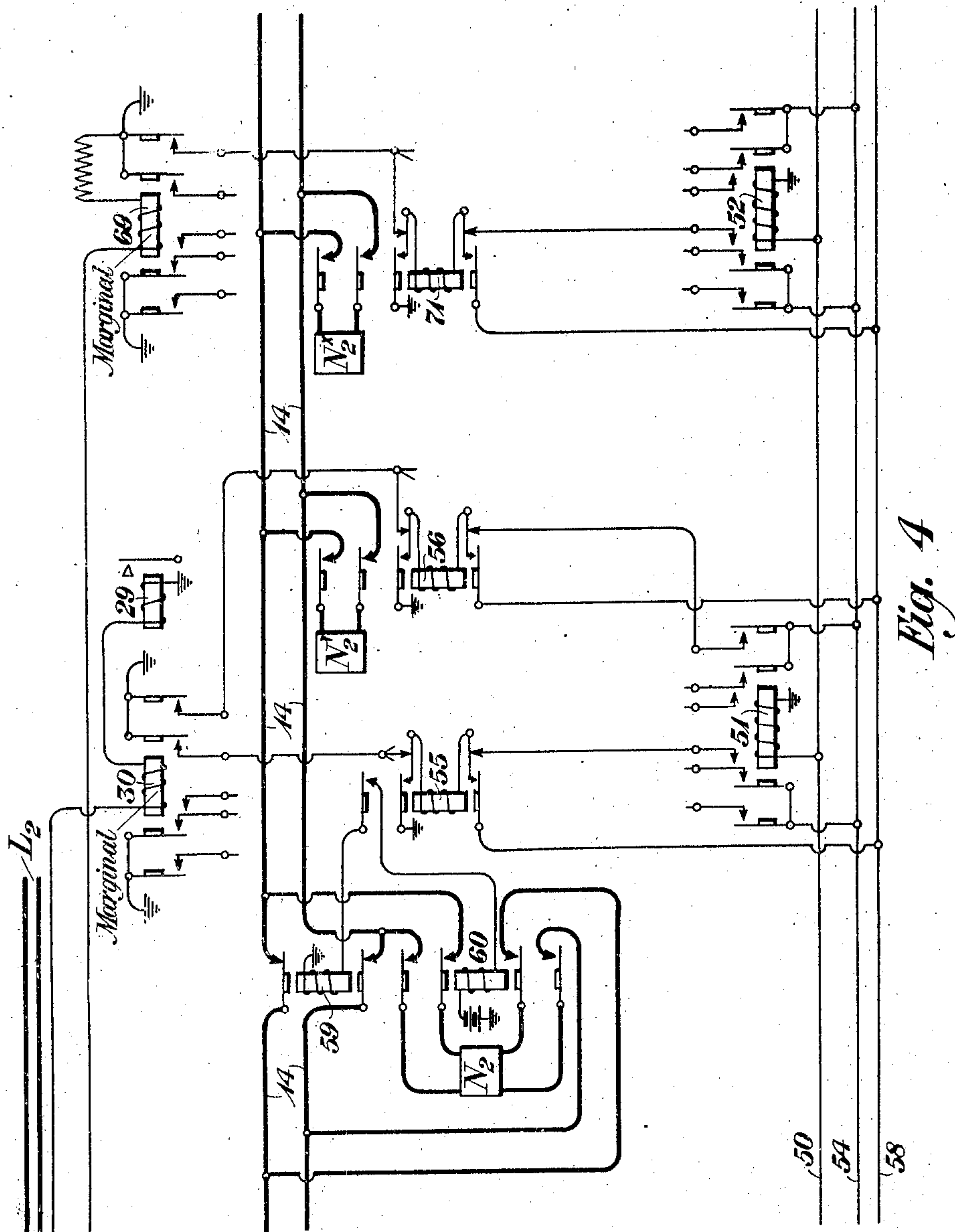
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4 SHEETS—SHEET 4.



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UNITED STATES PATENT OFFICE.

CHARLES S. DEMAREST, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

TESTING-CIRCUIT FOR REPEATERS EQUIPPED WITH AUTOMATIC NETWORK-SELECTORS.

1,355,897.

Specification of Letters Patent.

Patented Oct. 19, 1920.

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To all whom it may concern:

Be it known that I, CHARLES S. DEMAREST, residing at Brooklyn, in the county of Kings and State of New York, have invented certain Improvements in Testing-Circuits for Repeaters Equipped with Automatic Network-Selectors, of which the following is a specification.

This invention relates to transmission circuits in which repeaters are employed for the purpose of amplifying the signals transmitted over such circuits and more particularly it relates to arrangements whereby the repeaters may be tested.

In order to test the efficiency of a repeater circuit a testing circuit is usually provided with which the repeater may be associated, said testing circuit including net works for simulating the transmission lines with which the repeater is ordinarily used, a source of current variations, and a suitable indicating arrangement usually consisting of a telephone receiver and a receiver shunt. In order to make a transmission test, current from the source is transmitted through the net works and through an auxiliary circuit to the receiver, and the resultant sound observed. The current is then transmitted through the net works and the repeater and receiver shunt to the receiver. By adjusting the receiver shunt until the same sound results as before, the transmission gain due to the repeater may be obtained. This process involves disconnecting the net works from the repeater, while the current is being transmitted over the auxiliary path. Since the net works are normally balanced by suitable test net works associated with the repeater, the disconnection of the line simulating net works causes the repeater to sing, and it is now necessary to make the repeater inoperative by opening the filament circuit while the testing current is being transmitted over the auxiliary path. One of the objects of this invention is to overcome this defect by providing an arrangement whereby auxiliary net works are associated with the repeater when the line simulating net works are disconnected therefrom during the testing operation.

In certain types of repeater equipment arrangements are provided whereby artificial lines or net works suitable for balancing any given transmission line and its asso-

ciated equipment may be automatically selected. It is desirable that the selecting operation should be performed without causing the repeater to sing and without causing any undue inductive disturbances upon the line. A further object of the invention has reference to the provision of means in connection with the testing circuit whereby it may be determined whether or not the automatic selecting apparatus is functioning properly. In order to accomplish this result a key is provided in connection with the testing equipment whereby the net work selecting apparatus may be restored to normal and then caused to go through the process of selecting a net work anew, the test operator in the meantime monitoring on the circuit to determine whether or not the operation is performed satisfactorily.

Other and further objects of the invention will be apparent from the following description when read in connection with the accompanying drawing, Figures 1, 2, 3 and 4 of which constitute a circuit diagram of a preferred embodiment of the invention.

For convenience in understanding the diagram, Fig. 2 should be arranged below Fig. 1, while Figs. 3 and 4 should be arranged to the left and to the right respectively of Fig. 1. The repeater equipment of a cord circuit repeater is shown in Fig. 1 and comprises the usual amplifiers A_1 and A_2 , three winding induction coils 1 and 2, input circuits 3 and 4, output circuits 5 and 6 and monitoring coils 7 and 8. The repeater circuit terminates in plugs P_1 and P_2 whereby the repeater may be associated with transmission lines such as L_1 and L_2 through the corresponding line jacks J_1 and J_2 . Normally the plugs P_1 and P_2 are connected to a cord circuit 9 across which the operator's telephone set may be bridged by means of key 10 and conductors 11. A repeater controlling key 12 is provided, however, and when this key is operated, the plugs P_1 and P_2 may be disconnected from the cord circuit 9 and connected directly to the repeater equipment above described. Balancing circuits 13 and 14 are connected to the repeater and associated with these balancing circuits as illustrated in Figs. 3 and 4 are net works N_1 , N_1' , etc., and N_2 , N_2' , etc., for balancing the various lines

and associated pieces of apparatus with which the repeater may be connected. Selecting circuits are provided for these net works, said selecting circuits being so arranged that when the repeater is associated with a pair of transmission lines and the repeater controlling key 12 is actuated, a proper combination of net works is connected to the balancing circuits 13 and 14 to balance the particular line and associated apparatus with which the repeater is connected.

The testing equipment is illustrated in Fig. 2 and comprises a testing circuit including net works N_{11} and N_{22} for simulating the characteristics of the transmission lines with which the repeater to be tested is ordinarily associated. The testing circuit terminates in twin plugs P_{11} P_{22} adapted to cooperate with twin jacks J_{11} and J_{22} of repeater testing trunks 15 and 16 to which the repeater may be connected by inserting plugs P_1 and P_2 in the jacks J_{11}' and J_{22}' of said trunks. A source of current variations 16 and an operator's receiver are associated with the testing circuit and by means of a key K_1 current from said source may be transmitted through the net works N_{11} and N_{22} and the repeater to be tested, to the operator's receiver. A receiver shunt 17 is included in this path and may be used in determining the gain of the repeater in the manner hereinafter described. A key K_2 is also provided and this key is so arranged that when thrown to the left the testing circuit including the net works N_{11} and N_{22} is disconnected from the repeater and interconnected through an auxiliary path 18. During this operation the receiver shunt 17 is eliminated from the circuit and auxiliary balancing net works N_{11}' and N_{22}' are connected to the repeater in place of the net works N_{11} and N_{22} in order to maintain the balance of the repeater. By observing the sound heard in the receiver when the testing circuit is connected with the auxiliary path 18 and then restoring the key K_2 to normal so that the repeater is again connected in the circuit the receiver shunt 17 may be adjusted until the same sound is heard as before. The loss now introduced by the receiver shunt is equal to the gain due to the repeater and if the receiver shunt is properly calibrated this gain may be read directly in terms of some suitable unit.

A key K_3 is also provided in connection with the testing circuit which, when thrown either to the right or to the left, applies ringing current over one end or the other of the testing circuit to the repeater to test the ringing apparatus associated therewith. In order that the repeater may be balanced with respect to the line simulating net works N_{11} and N_{22} or the equivalent net works N_{11}' and N_{22}' , test net works N_1^x and N_2^x are as-

sociated with the balancing circuits 13 and 14, and the circuit is so arranged that when the plugs P_1 and P_2 are inserted in the jacks J_{11}' and J_{22}' of the testing trunks 15 and 16 and the repeater controlling key 12 operated, the test net works N_1^x and N_2^x are automatically connected to the balancing circuits by means of a selecting circuit similar to that for selecting the other balancing net works. In order to determine whether or not the operation of selecting the net work is properly performed, the key K_2 is so arranged that when thrown to the right the test net works N_1^x and N_2^x will be disconnected. Upon restoring the key K_2 to normal the process of selecting these net works is again repeated and by listening in over the monitoring circuit 19, which is connected to the operator's receiver by means of conductors 20, it may be determined whether or not this operation is satisfactorily performed.

Further details of the apparatus may now be understood from a description of the operation which is as follows: Assuming that a call has come in over the line L_1 , the operator inserts the plug P_1 in the jack J_{11} , thereby completing a circuit from ground through the winding of relay 21, winding of marginal relay 22, sleeve contacts of the jack and plug, and through the winding of sleeve relay 23, in parallel with noninductive resistance 25, and thence through resistance 24' to battery. Relays 21 and 23 are operated over this circuit but marginal relay 22 is not actuated. Relay 23 completes a circuit over its left hand front contacts from ground, through the winding of relay 24 which is thereby energized. Relay 24 completes a circuit from battery through the winding of relay 25, back contacts of ringing responsive relays 26 and 27 and over the upper front contact of relay 24 to ground. Relay 25 upon being energized holds open the circuit which would otherwise be closed from ground over the upper front contact of relay 24, contact of relay 25, and through the winding of relay 28. The purpose of the relays 25 and 28 is to control the actuation of the ringing signal as hereinafter described.

Since the plug P_1 is normally connected with the cord circuit 9, the operator by actuating key 10 may bridge her telephone set across the cord circuit 9 by means of conductors 11 and communicate with the line L_1 . Upon learning that the call is to be completed to line L_2 the operator inserts a plug P_2 in the jack J_2 of said line, thereby completing a circuit from ground, relay 29, through the winding of marginal relay 30, sleeve contacts of jack J_2 and plug P_2 and through the winding of relay 31 in parallel with noninductive resistance 33, and thence through resistance 32 to battery. Relays 29

and 31 are actuated but marginal relay 30 is not operated over the circuit thus traced. Relay 31 at its right hand front contact completes a circuit through the winding of relay 34 which, at its upper front contact, connects the ground in parallel with the ground connection controlled over the upper front contact of relay 24.

The operator now actuates the repeater controlling key 12, thereby completing a circuit from ground over the upper front contact of relay 34, upper make contact of key 12, and through the winding of relay 35 to battery. Relay 35 connects battery 36 to the filaments of amplifiers A_1 and A_2 thereby rendering the amplifier tubes operative. Upon operating the repeater controlling key 12 a circuit is also completed from battery over the lower back contact of relay 37, right hand front contact of relay 23, left hand front contact of relay 31, lower make contact of key 12, lower back contact of relay 38, through the winding of the relay R corresponding to the repeater now being described, and thence in series over the right hand back contacts of similar relays R' , R'' , etc., of other repeaters to ground. It will be seen that this circuit is so arranged that if the R relay of any other repeater is operated the circuits of all other R relays are held open thereby preventing selection by other repeaters. The R relays are maintained energized only during the brief period required for selecting a net work and consequently the R relay of no other repeater can be energized until the repeater which is at that moment selecting has completed the selection of its net work.

As soon as the circuit just described for the relay R is complete said relay is energized and at its two right hand contacts opens the initial energizing circuits for the R relays of all other repeaters. At its inner right hand front contact relay R completes a circuit from battery over said contact, over the back contact of relay 39, left hand front contact of relay R, through the winding of sleeve relay 23, sleeve contacts of the plug P_1 and jack J_1 and through the windings of relays 22 and 21 to ground. Since battery is connected directly through the winding of sleeve relay 23 to the winding of marginal relay 22 over the circuit above described, marginal relay 22 is energized and over its front contacts connects the ground to the various selecting circuits for selecting basic net works, composite balancing net works, phantom balancing net works, etc. As illustrated, selecting circuits for the basic net work N_1' and composite balancing net work N_1 only are shown.

Returning to the relay R battery is connected over the inner right hand front contact of said relay, over the upper back contact of relay 37, and over conductor 40, and

thence in parallel through the winding of relays 41, 42, etc. Battery is also applied over the inner right hand front contact of relay R and upper back contact of relay 37, through the winding of relay 43 to conductor 44. Relays 41, 42, etc., upon being energized, connect battery from conductor 44 to the various selecting circuits. Consequently a circuit is completed from battery over the inner right hand front contact of relay R, upper back contact of relay 37, winding of relay 43, conductor 44 and thence in parallel through the front contacts of relay 41, lower back contacts of selecting relays 45 and 46, through the windings and upper back contacts of said relays and over the contacts of relay 22 to ground. Selecting relay 39, resistance 47, conductor 48, and over the circuit just described, the latter relay functioning to close a short-circuit about the relay 39 to prevent the energization of said relay.

Relays 45 and 46, upon being energized, open their initial energizing circuits, thereby deenergizing the relay 43 and completing locking circuits from battery over the inner right hand front contact of relay R, through the winding of relay 39, resistance 47, conductor 48, and thence in parallel over the lower front contacts of relays 45 and 46, through the windings and upper front contacts of said relays, to ground. Relay 45 at its upper front contact completes a circuit from ground through the windings of relays 49 and 50 to battery. Relay 49 opens the direct connection between the two sections of balancing circuit 13 and relay 15 includes therein the composite balancing net work N_1 . Relay 46 at its upper front contacts connects the basic line balancing net work N_1' to the balancing circuit 13.

Returning to the relay 39, said relay upon being energized opens the direct battery connection previously traced over its lower back contact to the sleeve circuit, thereby causing the marginal relay 22 to be deenergized. Relay 22 upon being deenergized disconnects ground from the various selecting circuits. Relay 39 at its lower front contact completes a circuit from battery over the inner right hand front contact of relay R and over the front contact of relay 39, through the winding of relay 37 to ground. Relay 37 upon being energized at its lower front contact establishes a new circuit for the relay R from battery over the lower front contact of relay 37, right hand front contact of relay 23, left hand front contact of relay 31, lower make contact of repeater controlling key 12, lower back contact of relay 38 and thence through the winding of relay R to ground over the circuit previously traced.

At its middle front contact relay 37 applies battery directly to the sleeve circuit

of plug P_2 and jack J_2 as follows: from battery over the inner right hand front contact of relay R, middle front contact of relay 37, lower back contact of relay 49 through the winding of relay 31, sleeve contact of plug P_2 and jack J_2 , through the winding of marginal relay 30 and the winding of relay 29 to ground. Marginal relay 30 is now energized and applies ground to the various selecting circuits associated with the right hand side of the repeater.

A circuit is completed over the upper front contact of relay 37 from battery, inner right hand front contact of relay R, upper front contact of relay 37, middle back contact of relay 38, conductor 50 and through the windings of relays 51, 52, etc., in parallel to ground. Relays 51, 52, etc., upon being energized apply battery to the various selecting circuits so that selecting circuits are completed over the contacts of relay 51 as follows: from battery, inner right hand front contact of relay R, upper front contact of relay 37, middle back contact of relay 38, winding of relay 53, conductor 54, and thence in parallel over the front contacts of relay 51, lower back contacts of relay 55 and 56, windings and upper back contacts of said relays, front right hand contacts of marginal relay 30, to ground. Relays 53, 55 and 56 are energized over the circuit above traced, the former relay at its lower front contact completing a short-circuit about the winding of relay 49 to prevent the energization of said relay. Relays 55 and 56, upon being energized, open the circuit just traced through the windings of relay 53, which relay is de-energized, and opens the short-circuit about the winding of relay 49. Locking circuits for relays 55 and 56 are completed from battery over the inner right hand front contact of relay R, upper front contact of relay 37, middle back contact of relay 38, winding of relay 49, resistance 57, conductor 58 and thence in parallel over the lower front contacts, windings and upper front contacts of relays 55 and 56 to ground. Relay 55 at its upper contact completes a circuit for relays 59 and 60, the former of which opens the direct connection between the two sections of balancing circuit 14, and the latter of which includes the balancing net work N_2 between the two sections. Relay 56 at its upper front contacts connects balancing net work N_2' to the balancing circuit 14.

Relay 49, upon being energized, disconnects the direct battery connection from the sleeve circuit, thereby deenergizing marginal relay 30, which removes the ground from the selecting circuits. At its lower front contact relay 49 completes a circuit for the relay 38 from battery, inner right hand front contact of relay R, middle front con-

tact of relay 37, lower front contact of relay 49, winding of relay 38, to ground. Relay 38, upon being energized, at its lower contact, opens the holding circuit for the relay R which is now deenergized, thereby permitting other repeaters to select, if they are in selecting condition. Locking circuits independent of the relay R for relays 37, 39, 49 and 38, are closed over the lower front contact of relay 38, as follows: from battery, lower front contact of relay 37, right hand front contact of relay 23, left hand front contact of relay 31, lower make contact key 12, lower front contact of relay 38, to point 61, from which point parallel circuits extend over the lower front contact of relay 39 and through the winding of relay 37 to ground, through the winding of relay 39, resistance 47, conductor 48, and over the holding circuits of relays 45 and 46 to ground, over the upper front contact of relay 37, winding of relay 49, resistance 57, conductor 58, and over the locking circuits of relays 55 and 56 to ground, and over the middle front contact of relay 37, lower front contact of relay 49 and winding of relay 38 to ground. These locking circuits will now be maintained so long as the sleeve relays 23 and 31 are energized and the repeater controlling key 12 remains actuated.

Relay 38, by opening its middle back contact, disconnects battery from conductors 50 and 54, thereby deenergizing relays 51, 52, etc., to restore the initial energizing circuits of the selecting relays to normal. Relay 38 at its upper front contact completes a circuit as follows: from ground, over the upper front contacts of relays 24 and 34, over the upper contact of listening key 10, lower front contact of relay 24, lower front contact of relay 34, upper front contact of relay 38, winding of relay 62, back contact of relay 63, and thence in parallel through the windings of relays 64 and 65, to battery. Relays 65 disconnect the plugs P_1 and P_2 from the cord circuit 9 and connect the plugs directly to the circuits of the amplifiers A_1 and A_2 , while relay 62 opens the short-circuits normally existing across the input circuits of the amplifiers, thereby rendering the repeater circuits operative. The transmission lines L_1 and L_2 are now interconnected through the repeater which is balanced by net works conforming to the requirements of these transmission lines and transmission may take place over the circuit.

Should a ringing signal be transmitted over one of the transmission lines, as for instance, line L_1 , ringing responsive relay 26 will be actuated, thereby opening the circuit of relay 25. Relay 25 is slightly slow acting and after an interval completes a circuit for relay 28 from battery, through the winding of said relay, back contact of relay 25, and

over the upper front contacts of relays 24 and 34 to ground. Relay 28 at its left hand front contact completes a circuit for relay 66 from battery, through the winding of said relay, left hand front contact of relay 28, and over the upper front contacts of relays 24 and 34 to ground. Relay 66 completes a locking circuit from battery, through its winding, and over its left hand front contact, over the lower contact of listening key 10, and over the upper front contacts of relays 24 and 34 to ground. At its right hand front contact, relay 66 completes a circuit for signal lamp 67 to apprise the operator of the fact that a ringing signal has come in. Relay 28, at its right hand front contact, completes a circuit for relay 63, from battery, winding of said relay, right hand front contact of relay 28, upper front contact of relay 38, lower front contact of relay 34, lower front contact of relay 24, upper contact of listening key 10, and over the upper front contacts of relays 24 and 34 to ground. Relay 63, at its left hand front contact, completes a holding circuit for relays 64 and 65, and at the same time opens the circuit of relay 62 which again short-circuits the input circuits of the amplifiers A_1 and A_2 to prevent ringing current from being transmitted to the amplifiers.

The operator, upon observing the glowing of the signal lamp 67, actuates the listening key 10 which, at its lower contact, opens the locking circuit of relay 66, thereby extinguishing the lamp 67. As soon as the ringing current ceases, relay 25 is again energized, thereby opening the circuit of relay 28, which in turn opens the circuit of relay 63. The circuit of relay 63 is also opened at the upper contact of the listening key 10. The circuits of relays 62, 64 and 65 are also opened at the upper contact of the listening key 10 so that the plugs P_1 and P_2 are disconnected from the repeater and again connected to the cord circuit 9, the relay 62 at the same time maintaining the input circuits of the repeater short-circuited. The operator's set is now bridged across the cord circuit and she may listen in upon the connection. As soon as she restores the listening key 10 to normal, the circuits of relays 62, 64 and 65 are again completed over the upper contact of said key and the repeater is again connected into the transmission circuit.

Upon taking down the connection, relays 23 and 31 are deenergized when the plugs P_1 and P_2 are withdrawn from the jacks. These relays, at their right hand and left hand contacts respectively, open the holding circuit previously traced for relays 37, 39, 49 and 38, which are thereupon restored to normal. Selecting relays 45, 46, 55 and 56 are restored to normal at the same time, thereby disconnecting the balancing net works from

the balancing circuits of the repeater. Relays 23 and 31, at their left hand and right hand contacts respectively, open the circuits of relays 24 and 34. Relays 24 and 34 open the circuits of relays 35, 62, 64, 65 and 25 so that the repeater apparatus is all restored to normal ready for a new connection.

If it is desired to test the repeater circuits shown in Fig. 1 by means of the testing circuit illustrated in Fig. 2, the plugs P_{11} and P_{22} of the testing circuit are inserted in the jacks J_{11} and J_{22} of testing trunks 15 and 16, while the plugs P_1 and P_2 of the repeater are inserted in the jacks J_{11}' , J_{22}' of said trunks. Relays 23 and 31 are energized over the sleeve circuits of the jacks J_{11}' and J_{22}' , their circuits being extended to marginal relays 68 and 69 respectively. Relays 68 and 69 are not energized, however, because of the resistance included in the sleeve circuits. Relays 23 and 31 energize relays 24 and 34 over circuits already described. Relays 24 and 34 in turn complete a circuit for the relay 25 over the contacts of the ringing responsive relays 26 and 27. The operator at the switchboard by actuating the repeater controlling key completes circuits whereby the filaments of the amplifiers are energized, net works are selected to balance the repeater, and the plugs P_1 and P_2 are disconnected from the cord circuit and connected to the repeater. Since these circuits are, for the most part, identical with the circuits previously described in connection with the setting up of a regular connection, they need not be described in detail and only the features which are different will be pointed out.

It will be noted that the plugs P_{11} and P_{22} are connected to net works N_{11} and N_{22} in the testing circuit, these net works being designed to simulate the characteristics of the transmission lines with which the repeater is ordinarily used. It is necessary that these net works be balanced with respect to the repeater and for this purpose test net works N_{1x} and N_{2x} are provided, the selecting circuit being so arranged that these test net works are selected instead of the usual balancing net works. It will be remembered that the actuation of the repeater controlling key completed a circuit for the relay R of the repeater, which in turn applied battery directly to the sleeve circuit through the relay 23. Marginal relay 68 is therefore energized and connects ground to the test net work selecting circuit. Relay R also applies battery to conductors 40 and 44 so that relays 41, 42, etc., are energized and the circuit for the selecting relay 70 is completed from battery over a circuit previously traced, to the winding of relay 43, through the winding of said relay, over conductor 44, front contacts of relay 42, lower back contact, winding and upper back con-

tact of relay 70, and left hand front contact of relay 68, to ground.

Relay 70 is now energized, opening the circuit of relay 43 and completing a locking
 5 circuit over its front contacts, over conductor 48, and through the winding of relay 39, to battery, over a circuit previously traced. Relay 70, at its upper front contacts, connects the test net work N_1^* to the
 10 balancing circuit 13. Relay 39 opens the direct battery connection to the sleeve circuit, so that relay 68 is deenergized, at the same time completing the circuit of relay 37. Battery is now connected directly to the sleeve
 15 of the jack J_{22}' thereby energizing marginal relay 69 which connects ground to the selecting circuits. Battery is also applied to conductors 50 and 54 over circuits already traced, thereby energizing the relays 51, 52,
 20 etc. A selecting circuit is now completed from battery, through the winding of relay 53, over the conductor 54, front contacts of relay 52, lower back contact, winding and upper back contact of relay 71, over the
 25 right hand front contact of relay 69 to ground. Relay 71 now opens its initial energizing circuit through relay 53 and completes a locking circuit over the conductor 58 and through the winding of relay 49 to
 30 battery, over a circuit previously traced. At its upper front contacts relay 71 connects the test net work N_2^* to the balancing circuit 14. Relay 49 disconnects the direct battery connection from the sleeve circuit, there-
 35 by deenergizing relay 69, and completes a circuit previously traced for the relay 38. The circuits whereby the relays 37, 39, 49 and 38 are locked up, and whereby the repeater is rendered operative and connected
 40 to the plugs P_1 and P_2 are similar to those previously traced and need not be further described.

In order to make a transmission test, the key K_1 of the testing circuit may be thrown
 45 to the left, thereby completing a circuit from ground, over its upper left hand make contact and through the winding of relay 72, to battery. Relay 72 sets the generator 16 into operation. The key K_2 may also be
 50 thrown to the left, completing circuits for relays 74 and 75 over its upper and lower make contacts and opening the shunt element 76 and short-circuiting the series element 77 of the receiver shunt 17. Relays 74
 55 and 75 at their upper contacts disconnect the testing circuit from the repeater and interconnect the terminal conductors 78 and 79 of the testing circuit, through the auxiliary path 18. Over the lower front contacts
 60 of relays 74 and 75, said relays connect auxiliary net works N_{11}' and N_{22}' to the repeater circuit to maintain its balance while the net works N_{11} and N_{22} are disconnected therefrom.

65 The tone generated by the generator 16

is now transmitted over conductors 90, left hand make contacts of the key K_1 , conductors 73, left hand normal contacts of key K_3 , net work N_{11} , conductors 78, upper front contacts of relay 74, auxiliary path 18, upper front contacts of relay 75, conductors 79, net work N_{22} , conductors 80, right hand normal contacts of key K_3 , conductors 81, right hand normal contacts of key K_1 , conductors 82, and conductors 83 to the receiver. The
 75 tone transmitted over this circuit having been observed by the operator, the key K_2 will be restored to normal, thereby deenergizing relays 74 and 75 to connect the repeater to the testing circuit and removing
 80 the short-circuit from the series element 77 of the receiver shunt, at the same time bridging shunt element 76 across the receiver circuit. The tone is now transmitted over the circuit previously traced to conductors 78 of
 85 the testing circuit and thence over the normal contacts of relay 74, tip contacts of plug P_{11} and jack J_{11} , conductors 15, tip and ring conductors of jack J_{11}' and plug P_1 , over the front contacts of relay 65, input circuit 3 of
 90 amplifier A_1 , through the amplifier, over the output circuit 5 of the amplifier, through the induction coil 2, where the energy is divided, half being transmitted through the balancing circuit 14 and the other half being
 95 transmitted over the front contacts of relay 64, tip and ring contacts of plug P_2 and jack J_{22}' , conductors 16, tip contacts of jack J_{22} and plug P_{22} , upper back contacts of relay 75, conductors 79, net work N_{22} , conductors
 100 80, normal right hand contacts of key K_3 , conductors 81, normal right hand contacts of key K_1 , conductors 82, through the receiver shunt 17 and over conductors 83, to the receiver. The receiver shunt 17 may now be
 105 adjusted in a well known manner until the same tone is heard in the receiver as in the case of the previous circuit. The transmission loss due to the receiver shunt 17 is now equal to the gain due to the repeater and if
 110 the receiver shunt is calibrated in terms of some suitable unit, the gain due to the repeater may be read directly. In a similar manner, by throwing key K_1 to the right, a test may be made for transmission in the
 115 opposite direction, through the amplifier A_2 .

If it is desired to test the ringing equipment of the repeater, the key K_3 may be thrown either to the right or to the left. If
 120 thrown to the left, ringing current will be applied over a circuit through the net work N_{11} , over conductors 78, upper back contacts of relay 74, tip contacts of plug P_{11} , and jack J_{11} , conductors 15, tip and ring contacts of jack J_{11}' and plug P_1 , to the wind-
 125 ing of ringing responsive relay 26. The ringing responsive relay, upon being actuated, sets the same succession of circuits into operation, whereby the lamp 67 is caused to glow, as already described. The glowing
 130

of the lamp 67 indicates that the ringing apparatus is functioning properly. Whenever the key K_3 is actuated a circuit is completed over the lower contact of said key for a relay which operates to change the value of the shunt impedance of the networks N_{11} N_{22} . This is done for the purpose of changing the impedance of the circuit to a value simulating that of an ordinary transmission line for low frequency ringing current. As this feature forms no part of the present invention it need not be described in further detail.

If it is desired to test the net work selecting equipment in order to determine whether or not it is operating satisfactorily, the key K_2 may be thrown to the right, thereby completing a circuit over the sleeve contacts of plug P_{11} and jack J_{11} , and through the winding of relay 85. Relay 85 opens the sleeve circuit through the relay 23 of the repeater, thereby deenergizing said relay, which in turn deenergizes the relay 24. Relay 23, at its right hand contact, opens the locking circuits for relays 37, 39, 49 and 38 which are restored to normal, thereby deenergizing selecting relays 70 and 71 so that the test net works are disconnected from the balancing circuits. Relay 24, at its lower contact, opens the circuit for relays 62, 64 and 65, thereby disconnecting the repeater from the plugs P_1 and P_2 and rendering the repeater inoperative. As soon as the key K_2 is restored, however, the relay 85 is deenergized, thereby again closing the sleeve circuit and energizing relay 23, whereupon the operation of selecting the test net works is again repeated. The operator may listen in by means of her receiver, which is connected over conductors 20 to the monitoring circuit 19, to determine whether this operation is performed without the repeater singing and without undue clicks or inductive disturbances. Should the operation thus observed not be satisfactory, a defect in the circuit is indicated which should be given attention.

It will be seen that by means of the arrangements above described a simple and efficient means is provided for making the usual routine transmission test of cord circuit repeaters and in addition thereto testing the net work selecting equipment. Furthermore it will be obvious that the general principle herein disclosed may be embodied in many other organizations widely different from those illustrated, without departing from the spirit of the invention, as defined in the following claims.

What is claimed is:

1. In a signaling system, transmission line sections, a repeater for interconnecting said sections, a testing circuit for said repeater including networks for simulating the characteristics of line sections with

which the repeater is ordinarily used, artificial lines associated with said repeater for balancing said networks, means to disconnect said testing circuit and networks from said repeater and to associate them with an auxiliary path, and means to associate auxiliary balancing means with said repeater to maintain the repeater balanced while the testing circuit and net works are associated with said auxiliary path.

2. In a signaling system, transmission line sections, a repeater for interconnecting said sections, a testing circuit for said repeater including net works for simulating the characteristics of line sections with which the repeater is ordinarily used, artificial lines associated with said repeater for balancing said net works, a source of current variations and an indicating means associated with said testing circuit, switching means whereby current from said source may be transmitted to said testing circuit and through said net works and said repeater to said indicating means, an auxiliary path, switching means whereby said testing circuit and net works may be disconnected from said repeater and associated with said auxiliary path so that current from said source may be transmitted through said net works and over said path to the indicating means, and means to associate auxiliary balancing means with said repeater to maintain the repeater balanced while the testing circuit and net works are associated with said auxiliary path.

3. In a signaling system, a repeater, balancing net works associated therewith for balancing said repeater with respect to line sections with which it is associated, test net works associated with said repeater, automatic net work selecting means associated with said repeater, a testing circuit, means to associate said repeater with said testing circuit, means responsive to the association of said repeater with said testing circuit to cause said selecting means to select said test net works, and means associated with said testing circuit to test the operation of said selecting means.

4. In a signaling system, a repeater, balancing net works associated therewith, automatic net work selecting means also associated with said repeater, a testing circuit, means to associate said repeater with said testing circuit, and means operative upon the association of said repeater with said testing circuit to cause said selecting means to select balancing net works for the repeater.

5. In a signaling system, a repeater, balancing net works associated therewith, automatic net work selecting means also associated with said repeater, a testing circuit, means to associate said repeater with said testing circuit, and means operative upon

the association of said repeater with said testing circuit to cause said selecting means to select balancing net works for the repeater and means to test the operation of selecting net works.

6. In a signaling system, a repeater, balancing net works associated therewith for balancing said repeater with respect to line sections with which it is associated, test net works associated with said repeater, automatic net work selecting means associated with said repeater, a testing circuit, means to associate said repeater with said testing

circuit, means responsive to the association of said repeater with said testing circuit to cause said selecting means to select said test net works, means associated with said testing circuit to restore the selecting means to normal and thereafter cause the selecting operations to be repeated, and means to observe the selecting operation.

In testimony whereof I have signed my name to this specification this fourth day of December, 1918.

CHARLES S. DEMAREST.