

J. F. TOOMEY AND C. S. DEMAREST.
SELECTING CIRCUIT FOR ARTIFICIAL LINES.
APPLICATION FILED JUNE 15, 1917.

1,308,725.

Patented July 1, 1919.

3 SHEETS—SHEET 1.

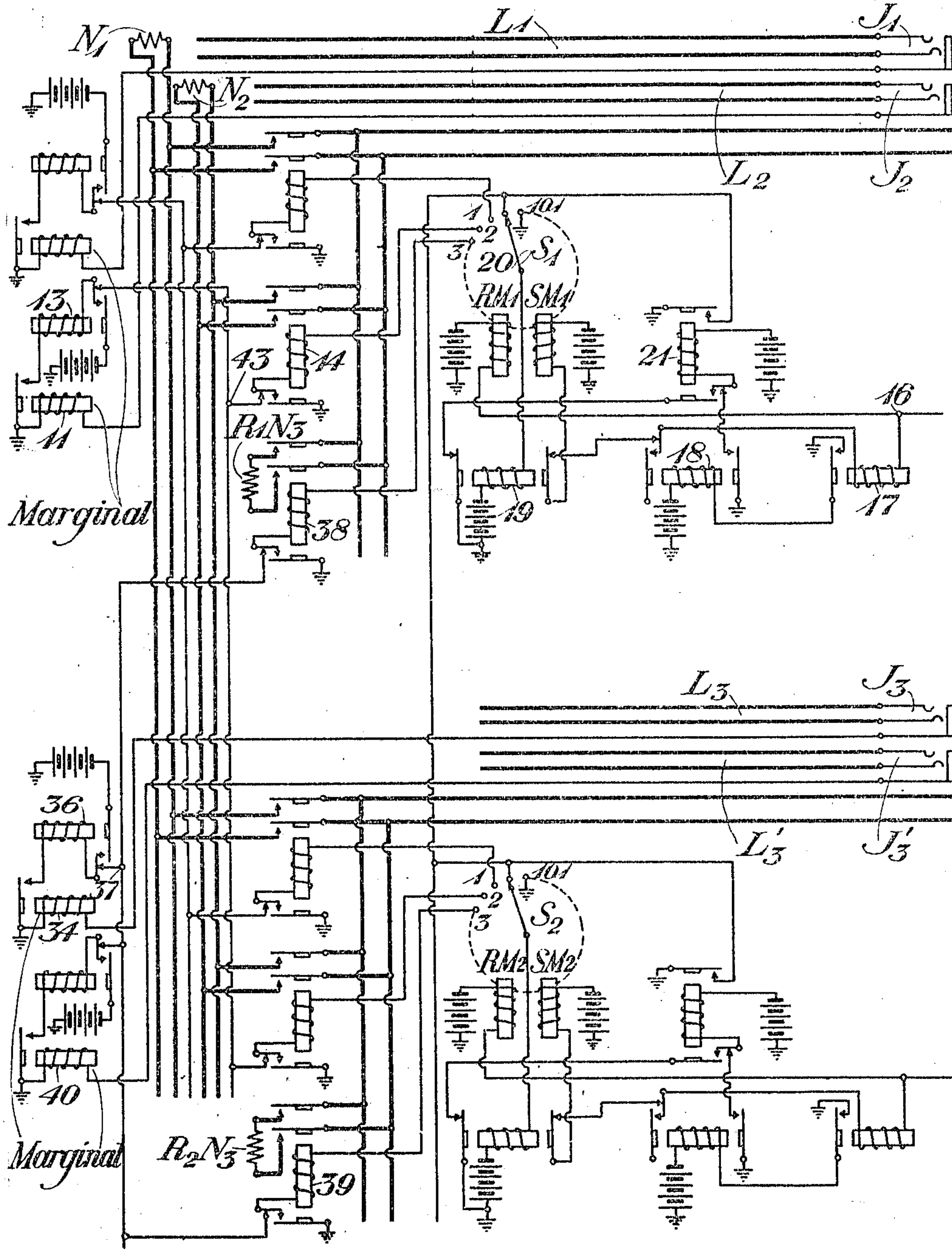


Fig. 1

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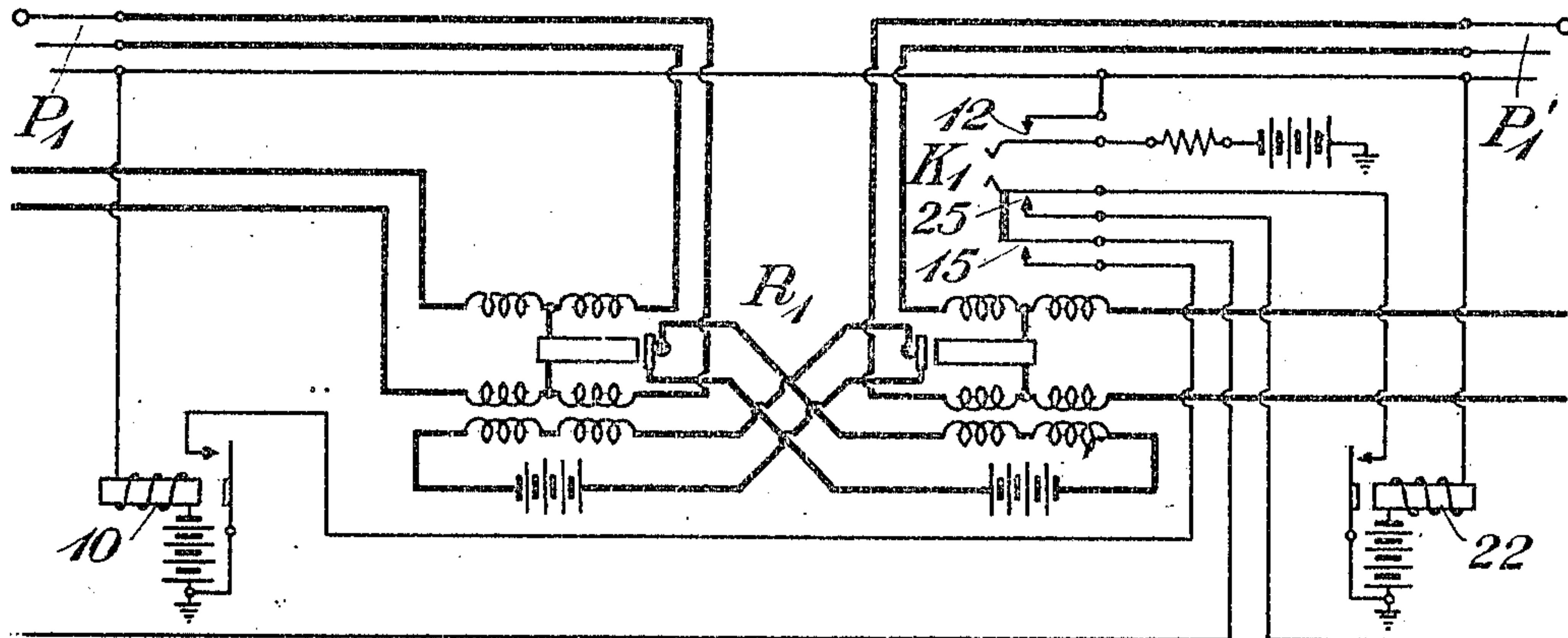
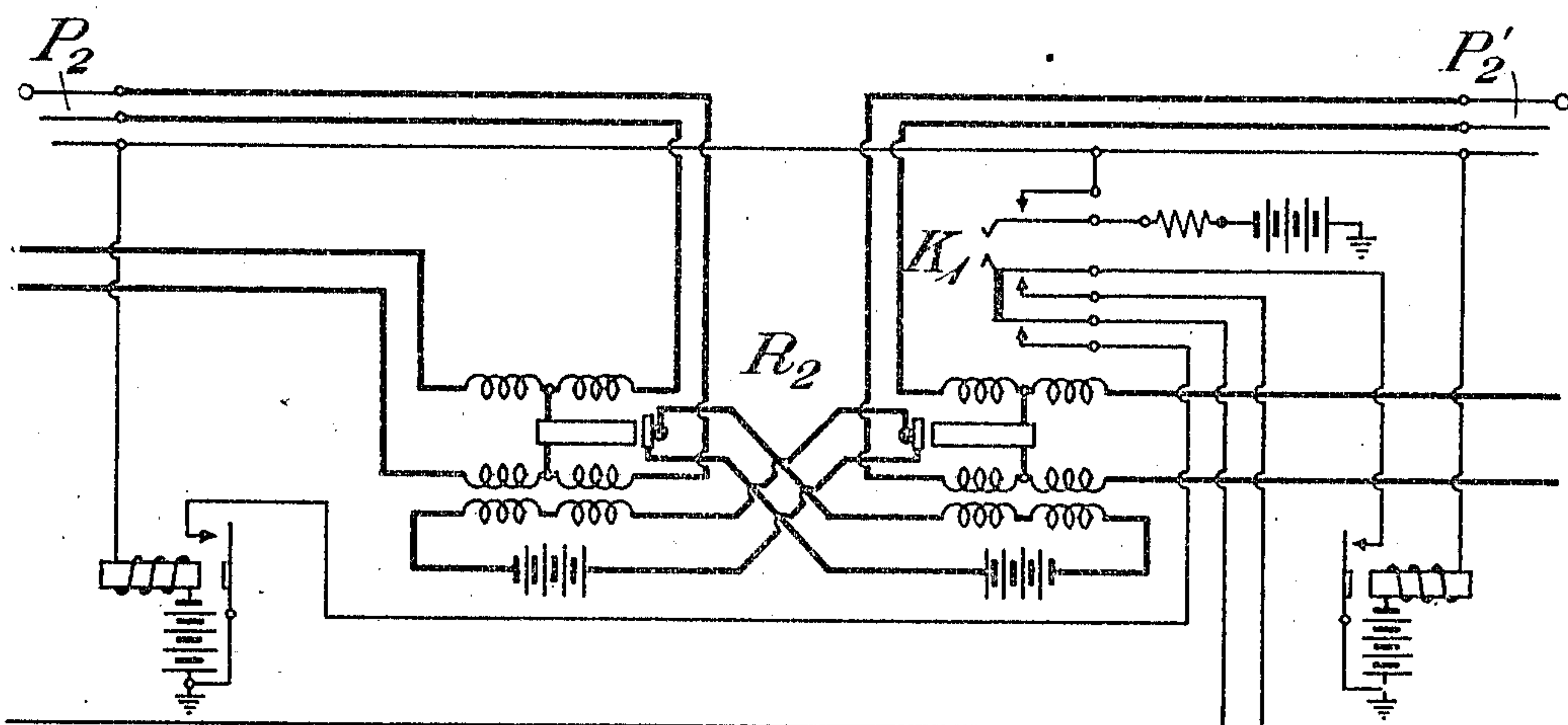


Fig. 2



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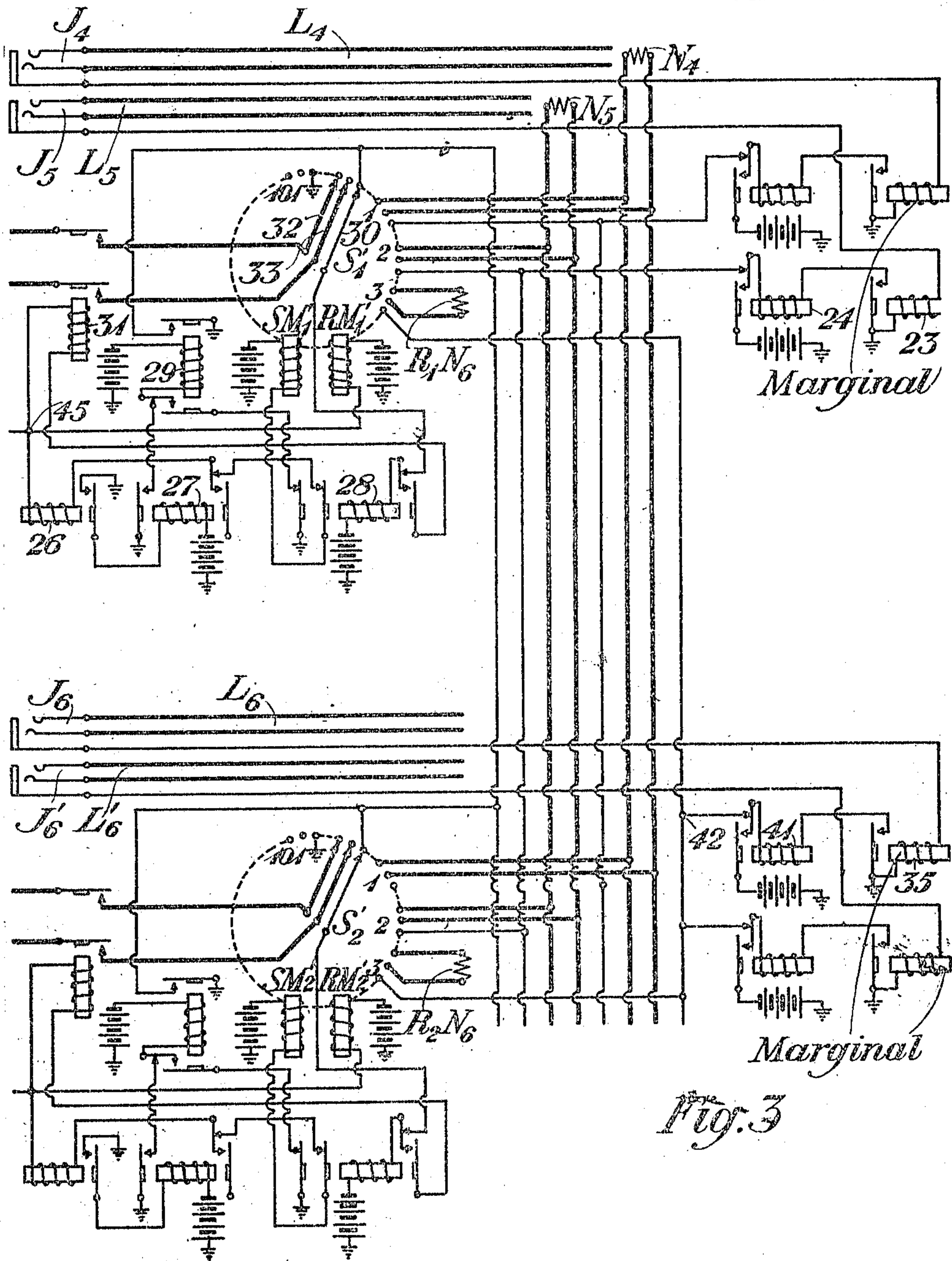


Fig. 3

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UNITED STATES PATENT OFFICE.

JOHN F. TOOMEY, OF NEW YORK, AND CHARLES S. DEMAREST, OF FLATBUSH, NEW YORK, ASSIGNORS TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

SELECTING-CIRCUIT FOR ARTIFICIAL LINES.

1,308,725.

Specification of Letters Patent.

Patented July 1, 1919.

Application filed June 15, 1917. Serial No. 174,899.

To all whom it may concern:

Be it known that we, JOHN F. TOOMEY and CHARLES S. DEMAREST, residing at New York and Flatbush, respectively, in the counties of New York and Kings, respectively, and State of New York, have invented certain Improvements in Selecting-Circuit for Artificial Lines, of which the following is a specification.

10 This invention relates to telephone repeater circuits and more particularly to a means for automatically selecting a suitable artificial line or net-work for balancing a line or trunk with which a repeater is temporarily associated.

15 It has heretofore been customary when a connection is made between two transmission circuits through a repeater, to provide a balancing artificial line or net-work for each line, said net-works being associated with the repeater. This necessitated either a special repeater circuit having the proper artificial lines or net-works associated therewith for each possible connection between lines of different characteristics, or else a manual switching means whereby the proper artificial line might be temporarily associated with the repeater for each connection. It is proposed by the present invention to provide automatic means, which shall operate, when a repeater is associated with a given transmission circuit, to associate with the repeater an artificial line of a type suitable for balancing such transmission circuit.

35 The lines or circuits to be connected through a repeater vary considerably with respect to their impedance characteristics and certain lines may require a special net-work for each line while other lines may be grouped into classes or types, the lines of each class having substantially the same impedance characteristics. In the latter case it is only necessary to provide a sufficient number of net-works of each type for handling the maximum traffic over lines of a given class. By this invention it is possible to reduce the number of net-works to the actual traffic requirements by providing for the automatic selection of the net-works. This result is secured by providing in certain cases artificial lines or net-works individual to corresponding lines, but common to some or all of the repeater circuits, and in other cases providing artificial lines or

net-works individual to a given repeater circuit but common to a group of lines with each of which a given artificial line is adapted to cooperate.

Means are provided so that when a repeater is associated with a line requiring an individual artificial line or net-work, the particular artificial line associated with that line is connected to the repeater, and when the repeater is associated with one of a group of lines having similar characteristics, an artificial line individual to the repeater and having characteristics suitable for that group of lines is associated with the repeater and through the repeater with the line.

The invention will be more fully understood by reference to the following description taken in connection with the accompanying drawings, Figures 1, 2 and 3 of which when placed side by side in numerical order constitute a circuit diagram of the invention as applied to a cord circuit repeater.

Referring to Figs. 1, 2 and 3 a plurality of lines or trunks L_1 , L_2 , L_4 and L_5 are shown terminating in jacks J_1 , J_2 , J_4 and J_5 . Each of said lines or trunks has an impedance characteristic which is individual to itself and differs from the impedance characteristic of the other lines, therefore necessitating an individual artificial balancing line or net-work for each line of this type. While only four such lines are shown it will be understood that any number of such lines may occur in a given system. Lines or trunks L_3 and L_3' are shown terminating in jacks J_3 and J_3' , said lines being illustrative of a group of lines having a common impedance characteristic so that each of the lines of this group may be balanced by the same artificial line or net-work. It will be understood that any number of lines having the same impedance may be included in this group. Lines or trunks L_6 and L_6' are shown terminating in jacks J_6 and J_6' , said lines being representative of another group of lines or trunks, all having the same impedance characteristic and hence capable of being balanced by the same artificial line. The impedance of the lines of this group may be the same as that of the lines in the group represented by lines L_3 and L_3' or it may be different. In the latter case this group will require an artificial balancing line of a different type from that of the

other group. For interconnecting the lines cord circuit repeaters R_1 and R_2 are provided, said repeaters terminating in plugs P_1 , P_1' and P_2 , P_2' respectively, said plugs being adapted to coöperate with the jacks of any of the lines. While for simplicity the repeater elements are illustrated as being of the well-known mechanical type, it is understood that the vacuum tube type or any other type of repeater may be employed if desired. In practice a sufficient number of repeaters would, of course, be provided to handle the traffic. Associated with each line of the type of lines L_1 and L_2 , L_3 and L_4 is a corresponding balancing artificial line or net-work. Thus an artificial line N_1 is provided to balance line L_1 , an artificial line N_2 to balance line L_2 , an artificial line N_3 to balance line L_3 and an artificial line N_4 to balance line L_4 . The particular means whereby the net-works are connected to the repeater for balancing purposes, in accordance with this invention, is an automatic selecting switch of a type which will be more fully hereinafter described. Lines such as L_5 , L_5' and L_6 , L_6' do not require an artificial line for each transmission line as all of the lines of the same type may be balanced by the same artificial line and it is only necessary to supply a sufficient number of artificial lines to satisfy the traffic requirements of these lines. This may be conveniently accomplished by providing each repeater with an artificial line individual thereto, for coöperation with any of the lines of the same type. Accordingly, an artificial line or net-work R_1N_5 is associated with the answering end of the cord circuit repeater R_1 whenever a connection is completed over any line of the type of lines L_5 , L_5' . The artificial line is connected to the repeater by means of the automatic switch already referred to. In a similar manner repeater R_2 is provided with an artificial line R_2N_5 , in all respects similar to artificial line R_1N_5 . Individual to the calling end of the repeater R_1 is an artificial line or net-work R_1N_6 for balancing all lines of the type of lines L_6 , L_6' , a similar artificial line R_2N_6 being associated with the calling end of repeater R_2 for the same purpose. These lines are connected to their respective repeaters by means of automatic selecting switches associated with said repeaters. Each repeater is provided with an automatic selecting switch individual to each end thereof. Thus the repeater R_1 is provided with a switch S_1 individual to the answering end thereof and a switch S_1' individual to the calling end thereof. These switches are illustrated in the drawing as being of different types for the purpose of disclosing two modifications of the invention but it will be understood that in practice switches of the same type may be used.

In a similar manner the repeater R_2 is provided with switches S_2 and S_2' individual to the answering and calling ends of the repeater respectively. Switch S_1 is provided with a single row of test contacts arranged in such manner that a rotating wiper may be caused to rest upon any one of the contacts. This wiper has a normal or zero position and when the answering end of the repeater is associated with a calling line, the switch is actuated by means of a stepping magnet SM_1 to advance step by step, carrying the wiper over the test contacts until it rests upon the contact corresponding to the calling line. When this occurs a test relay is energized and causes the switch to stop rotating so that the wiper remains in contact with the test contact corresponding to the calling line and completes a circuit for a switching relay which operates to switch an artificial line suitable to balance the calling line into connection with the repeater. Switch S_2 of repeater R_2 is in all respects similar to switch S_1 . The switch S_1' individual to the calling end of repeater R_1 is somewhat similar to switch S_1 but is provided with three wipers and with three rows of contacts although for convenience of illustration the corresponding contacts in each row are shown in groups arranged in the same circle. An artificial line is connected to two contacts of each group, the third contact being for test purposes. When the calling end of the repeater is associated with a line to which connection is desired, the stepping magnet SM_1' operates to advance the wipers of the switch step by step over the three rows of contacts until the third or test wiper is associated with the test contact individual to the line over which the connection is made, whereupon a test relay is energized and the switch is brought to rest. In a similar manner a switch S_2' is provided for the calling end of repeater R_2 , said switch being in all respects similar to the switch S_1' . Artificial lines such as N_4 and N_5 which are individual to certain lines or trunks are connected in parallel to corresponding contacts of all of the switches such as S_1' and S_2' . Net-work R_1N_6 is connected to contacts of switch S_1' only, while artificial line R_2N_6 is connected to contacts of switch S_2' only. Artificial lines such as N_7 and N_8 which are individual to certain lines or trunks are each provided with parallel connections to the contacts of connecting relays individual to each of the switches, such as S_1 and S_2 . Artificial line R_1N_3 is connected to the contacts of a connecting relay individual to switch S_1 only, the artificial line R_2N_3 being connected to a corresponding relay of switch S_2 only.

With this general description in mind the circuits will now be fully understood from a description of the operation. Assuming

that it is desired to connect line L_2 with line L_3 through the repeater R_1 the operator will insert the plug P_1 in jack J_2 and the plug P_1' in the jack J_5 . Considering first the operations in connection with the answering end of the repeater a circuit is closed from battery through the winding of relay 10, sleeve contacts of plug P_1 and jack J_2 , winding of relay 11 to ground. Relay 10 is energized over this circuit but relay 11 is marginal so that its winding is not sufficiently energized by a current flowing through the high resistance winding of relay 10 to attract its armature. The operator now actuates the controlling key K_1 whereby battery is connected through a low resistance directly to the sleeve contact of plug P_1 over the contact 12 of said key. Relay 11 now receives sufficient current to energize its winding and attracts its armature thereby applying ground to contact 2 of switch S_1 over a circuit from ground, contact of relay 11, winding and back contact of relay 13, lower back contact and winding of relay 14 to contact 2 of switch S_1 . At the time key K_1 was actuated a circuit was also closed from ground over the front contact of relay 10, make contact 15 of key K_1 to point 16 where the circuit divides, one path continuing through the winding of holding magnet RM_1 of switch S_1 to battery, the other path continuing through the winding of relay 17, left hand back contact of relay 18, right hand back contact of test relay 19 and the winding of stepping magnet SM_1 to battery. The holding magnet RM_1 is energized over this circuit and is so arranged that by its energization no effect is produced upon the switch S_1 , but upon being deenergized the switch if advanced from normal position is released and restored to normal. Relay 17 and stepping magnet SM_1 are also energized over the circuit just traced, the stepping magnet causing the switch to be advanced one step from its zero position so that its wiper 20 is in contact with the first contact of the switch. Relay 17 upon being energized closes a circuit through the relay 18 which at its right hand front contact closes a circuit from ground, right hand front contact of relay 18, lower back contact and winding of relay 21 to battery. Relay 21 is thereby energized and at its lower front contact closes a locking circuit from ground, left hand back contact of test relay 19, lower front contact and winding of relay 21 to battery. At its upper contact relay 21 closes a ground circuit whereby ground is applied to the zero contacts of all of the switches S_1, S_2 , etc., whereby the test relays of all switches other than switch S_1 will be energized to prevent said switches from operating. Relay 18 upon being energized, at its left hand contact opened the circuit previously traced through relay 17 and step-

ping magnet SM_1 , whereby relay 17 is deenergized and the circuit of relay 18 broken so that the circuit originally traced through relay 17 and stepping magnet SM_1 is again closed. It will thus be seen that the relay 18 acts as a vibrating relay to make and break the circuit of stepping magnet SM_1 , whereby the switch is advanced step by step until the test wiper 20 rests upon a grounded contact. In the case of the connection now being described the second contact is grounded and upon taking two steps the wiper 20 rests upon contact 2, whereby a circuit is closed from ground, contact of relay 11, winding and back contact of relay 13, lower back contact and winding of relay 14, contact 2 of switch S_1 , wiper 20, winding of relay 19 to battery. Relays 13, 14 and test relay 19 are energized over this circuit. Relay 13 upon being energized is locked over its front contact at the same time removing the ground which had been applied to the second contacts of all of the switches in parallel. Relay 14 upon being energized closes a locking circuit over its lower front contact, through the winding of said relay, over the second contact of switch S_1 and wiper 20 thereof and through winding 19 to battery. Relay 14 at its upper contacts connects the artificial line N_2 to the answering end of the repeater R_1 to balance the line L_2 . Test relay 19 upon being energized, at its left hand contact opened the locking circuit already traced for relay 21 thereby removing the ground from the zero contacts of the switches so that the switches of other repeaters are now in condition to be operated if desired. Relay 19 at its right hand contact opens the circuit previously traced through relay 17 and stepping magnet SM_1 so that this circuit is now permanently held open and the stepping magnet SM_1 is no longer actuated to advance the wiper 20 which now remains in contact with the second contact of the switch.

Turning now to the operations in connection with the calling end of the repeater, upon the insertion of lug P_1' in jack J_5 , a circuit is closed from battery, winding of relay 22, sleeve contacts of plug P_1' and jack J_5 , winding of relay 23 to ground. Relay 22 is energized over this circuit but relay 23, like relay 11, is marginal and is not actuated until the key K_1 is operated, whereby battery is applied directly through a low resistance over contact 12 of said key to the sleeve contact of plug P_1' . Upon the energization of relay 23, however, ground is connected to the second test contact of switches S_1', S_2' , etc., over a circuit from ground, contact of relay 23, winding and back contact of relay 24 and thence in parallel to the second test contact of each of the switches. Upon the actuation key K_1 a circuit was also closed

from ground, front contact of relay 22, make contact 25 of key K_1 to point 45 where the circuit divides, one path continuing through the winding of holding magnet RM_1' to battery, the other path continuing through winding of relay 26, right hand back contact of relay 27, middle back contact of test relay 28 and winding of stepping magnet SM_1' to battery. The holding magnet RM_1' is energized and like the holding magnet of switch S_1 does not thereby affect the switch but upon being deenergized will restore the switch to normal. Relay 26 and stepping magnet SM_1' are energized over the circuit just traced, the stepping magnet being actuated to advance the three wipers of the switch one step from the zero position so that the wipers rest upon the first set of contacts of the switch. Relay 26 upon being energized closes the circuit of relay 27 which at its left hand contact closes a circuit from ground, left hand front contact of relay 27, lower back contact and winding of relay 29 to battery. Relay 29 is thereby energized and at its lower front contact closes a locking circuit from ground, left hand contact of test relay 28, lower front contact and winding of relay 29 to battery. Relay 29 at its upper contact applies ground to the zero position test contact of each of the switches S_1', S_2' , etc. Relay 27 at its right hand contact opens the circuit previously traced for relay 26 and stepping magnet SM_1' so that relay 26 is deenergized and opens the circuit of relay 27, whereby the circuit previously traced through relay 26 and stepping magnet SM_1' is again closed thereby causing the switch to advance another step. It will thus be seen that the relay 27 operates as a vibrating relay to intermittently close the circuit of the stepping magnet SM_1' , whereby the switch is advanced step by step until the test wiper 30 thereof rests upon a grounded test contact. In the case now being described the second test contact is grounded and on taking two steps wiper 30 rests upon this contact, whereby a circuit is closed from ground, front contact of relay 23, winding and back contact of relay 24, second test contact and wiper 30 of switch S_1' , back right hand contact and winding of test relay 28 to battery. Test relay 28 and relay 24 are energized over this circuit, relay 24 closing at its front contact a locking circuit for itself and at the same time disconnecting the ground from the second test contact of the various switches S_1', S_2' , etc. Test relay 28 upon being energized, at its front right hand contact closes a locking circuit from battery, winding and front right hand contact of relay 28, winding of relay 31, point 45, make contact 25 of key K_1 and front contact of relay 22 to ground. Relay 31 is energized over this circuit and at its contacts com-

pletes a circuit whereby the artificial line N_5 is connected to the calling end of the repeater over the upper pair of the second set of contacts of the switch S_1' , wipers 32 and 33 thereof, and the front contacts of the relay 31. Test relay 28 at its middle contact holds open the circuit of the relay 26 and the stepping magnet SM_1' , so that the switch remains with its wipers in contact with the second set of contacts. Test relay 28 at its left hand contact opens the locking circuit previously traced for relay 29 which is thereby deenergized and removes the ground from the zero test contacts of the several switches so that the other switches are now ready to be operated if desired.

It will now be seen that lines L_2 and L_5 are interconnected through the repeater R_1 and that the corresponding artificial lines N_2 and N_5 are connected to the corresponding ends of the repeater by means of switches S_1 and S_1' . If now the operator restores the key K_1 upon taking down the connection, the circuits previously traced through the holding magnets RM_1 of switch S_1 and RM_1' of switch S_1' are broken so that the holding magnets cause the switches to be restored to normal. As soon as the wiper 20 of switch S_1 is removed from the second contact, the circuit previously traced for test relay 19 is broken and said relay is restored to normal. In the case of switch S_1' the circuit of test relay 28 and connecting relay 31, it will be recalled, was traced through a contact of key K_1 , so that upon restoring said key these relays are restored to normal. When the plugs are withdrawn from the jacks relays 10, 11, 22 and 23 together with the circuits controlled thereby are restored to normal.

Had the connection through the repeater R_1 been made between lines L_3 and L_6 the actuation of the controlling key K_1 would have caused the energization of relays 34 and 35 instead of relays 11 and 23. Relay 34 would have applied ground to the third contacts of each of the switches, S_1, S_2 , etc., over a circuit from ground, front contact of relay 34, winding and back contact of relay 36 to point 37 and thence in parallel through the lower back contact of relays 38, 39, etc., to the third contacts of the switches. The switch S_1 would therefore have come to rest with its wiper 20 in contact with the third contact of the switch thereby completing a circuit for the relay 38 which would have been energized to connect the artificial line R_1N_3 over its upper contacts to the answering end of the repeater. If the connection had been made to line L_3' , by means of a similar circuit the relay 40 would have been operated to apply the ground through the winding of relays 38, 39, etc., to the third contacts of the switches so that the relay 38 would have been operated to connect the

artificial line R_1N_3 to the repeater. It will be thus seen that this artificial line will be associated with the repeater when any one of the lines of the type of L_3 or L_3' is connected to the repeater R_1 . Returning now to the connection to line L_6 the relay 35 would have been actuated to apply ground to the third test contacts of the switches S_1' and S_2' , etc., over a circuit from ground, front contact of relay 35, winding and back contact of relay 41 to point 42 and thence in parallel to the third test contacts of the switches. Switch S_1' would therefore have come to rest with its test wiper 30 in contact with the third test contact of said switch, thereby extending the connection from the calling end of the repeater over the contacts of relay 31 and wipers 32 and 33 of the switch S_1' to the artificial line R_1N_6 . Had the connection been made to the line L_6' , by means of a similar circuit ground would again have been applied to the third test contact of the switches and the same result would be brought about. Had the connection been made between any of the lines through the repeater R_2 instead of repeater R_1 , the switches S_2 and S_2' would have been operated in a manner analogous to that already described. In case the repeater R_2 had been connected to line L_3 or L_3' the relay 39 would have been actuated to connect the artificial line R_2N_3 to the answering end of the repeater and if the repeater had been connected to lines such as L_6 , L_6' , the artificial line R_2N_6 would have been connected over the wipers of switch S_2' to the calling end of the repeater.

By means of the arrangements above described it will be seen that simple and efficient means for the automatic selection of an artificial line to balance a transmission line has been provided and while the invention has been disclosed as embodied in certain forms which are considered desirable, it will be understood that it may be embodied in many widely different organizations without departing from the spirit of the invention.

What is claimed is:

1. The combination with a repeater, of a plurality of transmission lines, a plurality of balancing artificial lines, and automatic switching means for associating one of said artificial lines with the repeater and any one of said transmission lines.

2. In combination, a plurality of transmission lines, a plurality of balancing artificial lines less in number than said transmission lines each adapted to balance any of said transmission lines, and automatic switching means for associating one of said artificial lines with one of said transmission lines.

3. In combination, a transmission line, a balancing artificial line for said transmission

line, and automatic means for associating said artificial line with said transmission line.

4. In combination, a transmission line, a plurality of repeaters, a balancing artificial line for said transmission line, and automatic means responsive to the connection of any one of said repeaters with said transmission line to associate the artificial line with the transmission line and said repeater.

5. In combination, a plurality of transmission lines divided into groups, the lines in certain of said groups having common characteristics, the lines in other of said groups having individual characteristics, artificial lines individual to the transmission lines having individual characteristics, other artificial lines common to the lines of a group having the same characteristics, and means for associating with any transmission line an artificial line adapted to balance the same.

6. In combination, a plurality of transmission lines divided into groups, the lines in certain of said groups having common characteristics, the lines in other of said groups having individual characteristics, repeaters for interconnecting the lines, artificial lines individual to each of the lines having individual characteristics, artificial lines individual to the repeaters for balancing any line of a group having common characteristics, and means for associating with any transmission line an artificial line adapted to balance the same.

7. In combination, a transmission line, an artificial line for balancing said transmission line, a repeater, an automatic selecting switch, and means operative when the repeater is associated with the transmission line to actuate said selecting switch to associate the artificial line with the repeater.

8. In combination, a plurality of transmission lines, a plurality of artificial lines less in number than said transmission lines, a repeater, an automatic selecting switch, and means operative when said repeater is associated with any one of said transmission lines to actuate said switch to select an artificial line to balance the transmission line.

9. In combination, a plurality of transmission lines, a plurality of artificial lines, a repeater, an automatic selecting switch, and means operative when said repeater is associated with any one of said transmission lines to actuate said switch to select an artificial line to balance the transmission line.

10. In combination, a plurality of transmission lines divided into groups, the lines in certain of said groups having common characteristics, the lines in other of said groups having individual characteristics, artificial lines individual to the transmission lines having individual characteristics, other artificial lines common to a group having the

same characteristics, and an automatic selecting switch for selecting an artificial line adapted to balance any one of said transmission lines.

11. In combination, a plurality of transmission lines divided into groups, the lines in certain of said groups having common characteristics, the lines in other of said groups having individual characteristics, repeaters for interconnecting the lines, artificial lines individual to each of the lines having individual characteristics, artificial lines individual to the repeaters for balancing any line of a group having common characteristics and an automatic switch responsive to the association of a repeater with a transmission line to select an artificial line adapted to balance said transmission line.

12. In combination, a plurality of transmission lines, a plurality of artificial lines less in number than the transmission lines, a plurality of repeaters for interconnecting the lines, and an automatic selecting switch individual to each repeater for selecting an artificial line adapted to balance a transmission line associated with said repeater.

13. In combination, a plurality of transmission lines, a plurality of artificial lines, a repeater for interconnecting the transmission lines, an automatic selecting switch having a plurality of contacts corresponding to said artificial lines, means controlled by each transmission line when a repeater is associated therewith for changing the electrical condition of one of said contacts corresponding to an artificial line adapted to balance said transmission line, means responsive to the association of a repeater with a trans-

mission line for causing said switch to select such contact, and means to connect the artificial line corresponding to said contact to the repeater when said contact is selected.

14. In combination, a plurality of transmission lines divided into groups, the lines of certain of said groups having the same characteristics, artificial lines individual to each of certain of said lines, an artificial line common to all of the lines of a group, an automatic selecting switch having a plurality of contacts one corresponding to each of said artificial lines, means controlled by each of the lines having an individual artificial line for rendering the contact corresponding to its artificial line selectable, and means whereby any of the lines of a group having a common artificial line may render the contact corresponding to said line selectable.

15. In combination, a plurality of transmission lines, a plurality of artificial lines, a plurality of repeaters for interconnecting the transmission lines, an automatic selecting switch associated with each repeater, means operative when a repeater is associated with a transmission line, to cause the corresponding switch to select an artificial line to balance the transmission line, and means to render the switches of other repeaters inoperative while the switch of one repeater is making a selection.

In testimony whereof, we have signed our names to this specification this seventh day of June 1917.

JOHN F. TOOMEY.
CHARLES S. DEMAREST.