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C. S. DEMAREST ET AL

REPEATER CONTROL ARRANGEMENT

Filed Feb. 26, 1921 2 Sheets-Sheet 1

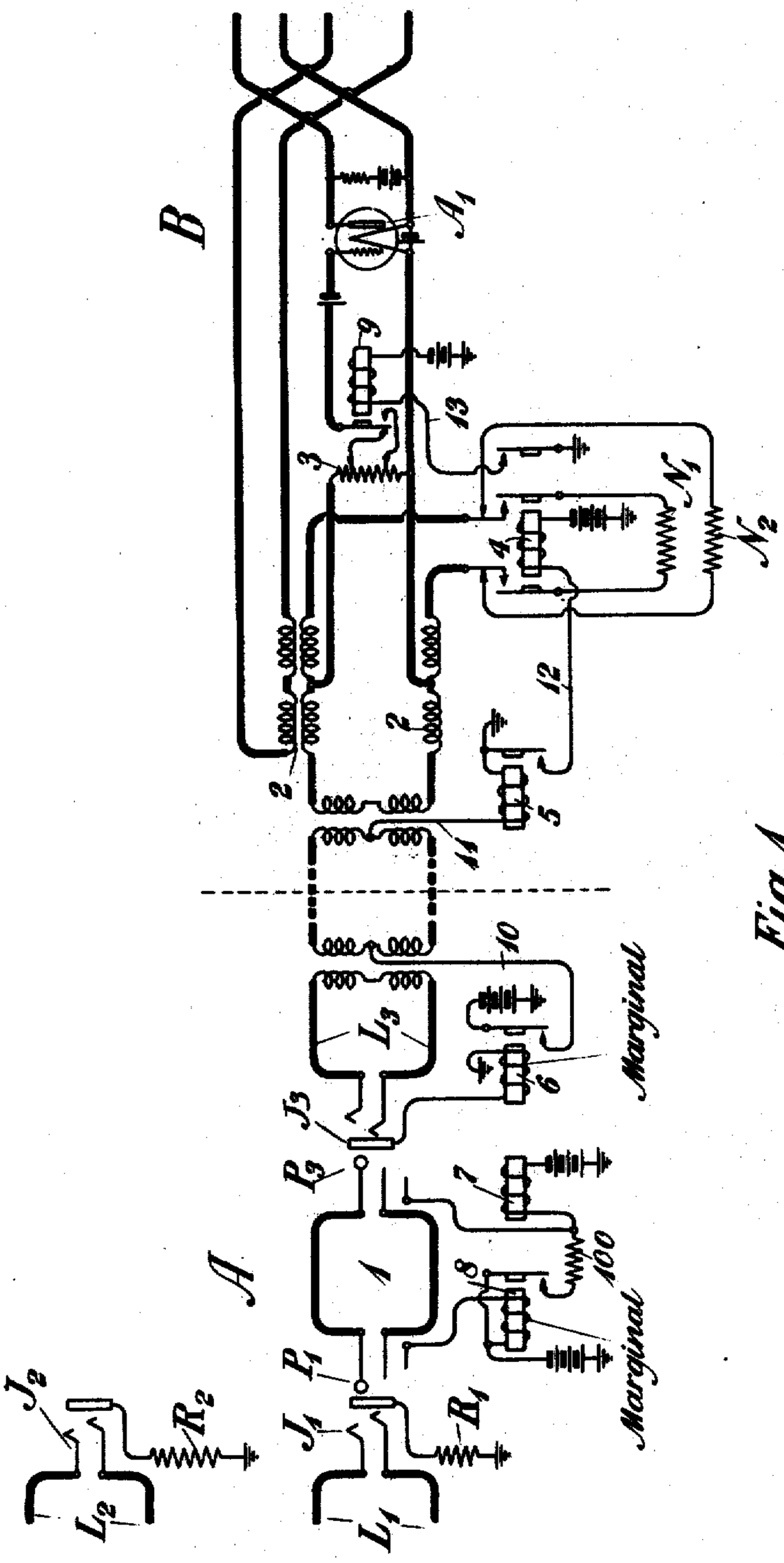

Fig. 1

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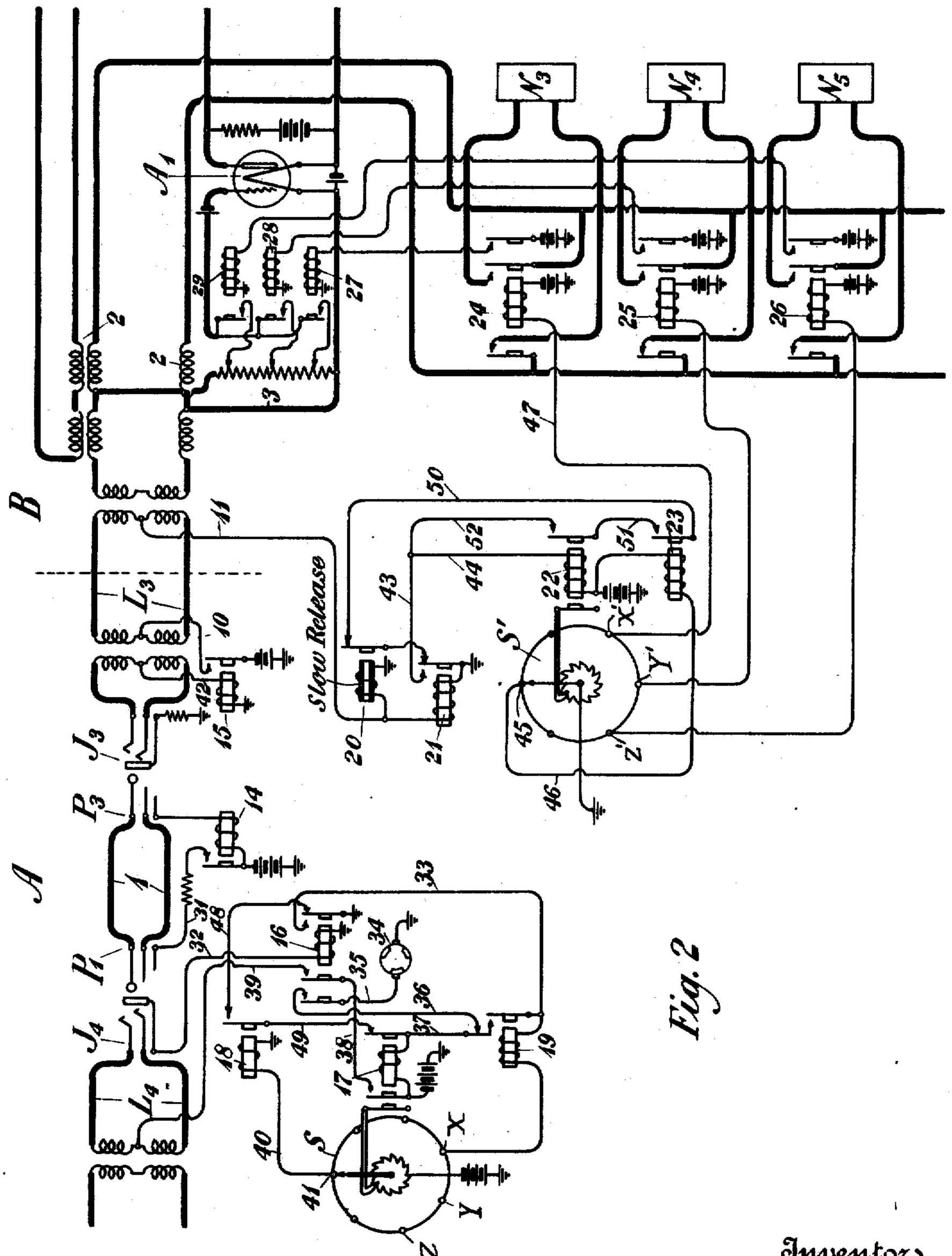

Fig. 2

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Patented Aug. 14, 1923. 1,464,563

UNITED STATES PATENT OFFICE.

CHARLES S. DEMAREST AND OWEN H. LOYNES, OF WOODRIDGE, NEW JERSEY, ASSIGNORS TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

REPEATER-CONTROL ARRANGEMENT.

Application filed February 26, 1921. Serial No. 448,062.

To all whom it may concern:

Be it known that we, CHARLES S. DEMAREST and OWEN H. LOYNES, residing at Woodridge, in the county of Bergen and State of New Jersey, respectively, have invented certain Improvements in Repeater-Control Arrangements, of which the following is a specification.

This invention relates to transmission lines and particularly to lines including repeater apparatus.

An objective of the invention is to provide arrangements whereby repeater apparatus at an intermediate station in a line may be automatically controlled from a terminal or switching station located at a distance from the intermediate repeater station. As the line, including the repeater apparatus might be connected at the terminal or switching station to either subscribers' lines or to various types of toll lines, it is apparent that the impedance of the circuit thus associated with the repeater apparatus might have a considerable range of variation. If the repeater were provided with but a single balancing network the degree of balance in the repeater set would thus be materially disturbed as the impedance of the connecting circuits varied. With the arrangements of this invention a plurality of types of balancing networks are provided at the intermediate repeater station suitable for balancing the various types of lines with which a connection may be established. When a connection is established with a line at the terminal or switching station automatically operating means will function to connect to the repeater set the proper network for balancing said type of line. A further feature of the arrangements of the invention consists in the provision of means for automatically controlling the repeater gain for the various types of connections from the terminal or switching station. Other features and objects of the invention will appear more fully from the detailed description hereinafter given.

The invention may be more fully understood from the following description together with the accompanying drawing in the Figures 1 and 2 of which are illustrated a preferred form of the invention and a modification thereof.

In Fig. 1 the invention is illustrated in simple form as an intermediate repeater station B included in the transmission line L_3, which terminates in the jack J_3 at a terminal or switching station A. At station A is illustrated schematically the cord circuit 1 whereby connections may be established between the line L_3 and lines such as L_1 and L_2, the line L_1 representing a subscriber's line and the line L_2 representing a toll line. While only two types of lines, such as a subscriber's line and a toll line have been illustrated, it is understood that the arrangements of the invention are suitable for use in other circuit arrangements whereby other types of connections might be established, as will be pointed out more fully with regard to Fig. 2. In the sleeve circuits of the toll line L_2 and the subscriber's line L_1, are shown the resistance elements R_2, R_1, respectively, it being pointed out that the sleeve resistance of a toll line is relatively greater than the sleeve resistance of a local line. At the intermediate repeater station B, there is illustrated a portion of the repeater apparatus, comprising the vacuum bulb amplifier A_1, the hybrid windings 2, the potentiometer device 3 and the balancing networks N_1 and N_2. The network N_2 is normally connected to the repeater apparatus and is suitable for balancing the repeater set when a connection is established with a toll line, such as the line L_2. The network N_1 may be associated with the repeater apparatus over the make contacts of a relay 4 and is suitable for balancing the repeater set when a connection is established with a local or subscriber's line such as L_1. A simplex circuit is shown associated with the line L_3 and the cord circuit 1, which includes the relays 5, 6, 7 and 8. the relays 6 and 8 being marginal. When a connection is established with a toll line, such as the line L_2, the relays of the simplex circuit will not operate and the proper network, such as N_2, will be connected to the repeater set. However, when a connection is established with a local or subscriber's line, such as L_1, the relays of the simplex circuit will operate and will disconnect the network N_2 from the repeater set and connect to the repeater set the proper network, such as the network N_1 for

balancing the repeater set under such conditions. Under the control of relay 4 is the relay 9, which serves to change the gain of the potentiometer device 3 for the different connections established.

The operation of the arrangements of Fig. 1 is as follows: When a connection is established between the line L_3 and another toll line, such as L_2, the plug P_3 will be inserted in the jack J_3 and the plug P_1 will be inserted in the jack J_2. The insertion of plug P_3 in jack J_3 will close a circuit from ground and battery, winding of relay 7, sleeve circuit of plug P_3, sleeve contacts of plug P_3 and jack J_3, sleeve circuit of jack J_3, through the winding of relay 6 to ground. However, the relay 6 is marginal and is adjusted so that it will not operate upon the completion of this circuit. When the plug P_1 is inserted in the jack J_2 the following circuit will be completed: from ground and battery, winding of relay 8, sleeve circuits of plug P_1, sleeve contact of plug P_1 and jack J_2, sleeve circuit of jack J_2, through the resistance R_2 to ground. As has been formerly pointed out, the value of the resistance R_2 in the sleeve circuit of a toll line is relatively high compared to that of a local or subscriber's line and the relay 8, which is marginal, is adjusted so that it will not operate upon the completion of the above circuit. Accordingly, the marginal relay 6 will remain unenergized and the simplex circuit 10—11 will not be closed and, accordingly, neither of the relays 5 or 4 will be operated. Under such conditions the network N_2 which is the proper balancing network for a toll connection of this character, will remain associated with the repeater set. As the relay 4 was not operated, the relay 9 will remain unoperated. It is pointed out that two settings are illustrated for the potentiometer device 3, one of these being over the break contact of relay 9 and the other setting being completed over the make contact of relay 9. The setting completed over the break contact of relay 9 is the proper setting for the gain of the repeater in a toll to toll connection of this character. If a connection should be established between the toll line L_3 and a local or subscriber's line, such as the line L_1, the plug P_3 would be inserted in the jack J_3 and the plug P_1 would be inserted in the jack J_1. As has been formerly pointed out, the insertion of plug P_3 in jack J_3 will cause a circuit to be completed from ground and battery through the relay 7 and the marginal relay 6, but the marginal relay 6 will not operate on the completion of this circuit alone. When the plug P_1 is inserted in the jack J_1, the following circuit will be closed: from ground and battery on the winding of marginal relay 8, sleeve circuit of plug P_1 and jack J_1 through the resistance R_1 to ground. The resistance such as R_1 in the sleeve circuit of a local or subscriber's line is relatively small compared with the resistance in the sleeve circuit of a toll line and, accordingly, the marginal relay 8 will be operated upon the completion of this circuit. Upon the operation of marginal relay 8, the circuit through relay 6 will also be completed through a resistance 100, contact and armature of relay 8 to battery and ground. This resistance 100 sufficiently shunts the winding of relay 7 so that the battery applied to the sleeve circuits of plug P_3 and jack J_3 and thence through the marginal relay 6 to ground will be sufficient to cause the operation of the marginal relay 6. The operation of relay 6 will cause the simplex circuit 10—11 to be completed as follows: from ground and battery, armature and contact of relay 6, conductor 10, over the talking strands of line L_3 in parallel, conductor 11, winding of relay 5 to ground. The closing of this circuit will operate the relay 5 which, in turn, will cause the following circuit to be completed: from ground, armature and contact of relay 5, conductor 12, winding of relay 4 to battery and ground. The closing of this circuit will energize relay 4, which will pull up its armatures and disconnect at its break contact the network N_2 from the hybrid windings 2 and will connect to said windings over its make contacts the balancing network N_1, which is suitable for balancing the repeater set over a toll to local connection of this character. The operation of relay 4 will also close the following circuit: from ground, armature and contact of relay 4, conductor 13, winding of relay 9, to battery and ground. The closing of this circuit will operate the relay 9. The operation of relay 9 will change the normal setting of the potentiometer device 3 from the break contact of said relay to the make contact of said relay, thereby changing the setting of the potentiometer to regulate the gain for the repeater apparatus for this type of connection.

In Fig. 2 is illustrated a modification of the invention in which the intermediate repeater station B is shown as included in a line L_3 with which connections may be established with lines of many different types. Similar reference characters have been utilized to denote like parts with respect to Fig. 1. At the terminal or switching station A is shown a cord circuit 1 for interconnecting line L_3 with different types of lines. The line L_4 terminating at jack J_4 may represent one of the many types of lines with which connections may be established. At each of the lines with which a connection may be established, such as line L_4, there is provided a selecting switch S and suitable relay arrangements. When a connection is established with line L_4, the switch S will select a predetermined one of its contacts,

herein illustrated as contact X, this contact being different for different types of lines and being predetermined by the impedance and type of the line. At the intermediate repeater station B there is provided a plurality of types of balancing networks, such as N_3, N_4 and N_5, adapted for balancing the various types of lines with which connections may be established. These networks may be connected to the repeater apparatus by the relays 24, 25 and 26, respectively. The relays 24, 25 and 26 are connected to the contacts of a selecting switch S' and controlled thereby. The selecting switch S' is similar to switch S and is controlled by relay means which in turn are controlled over a simplex circuit by the arrangements associated with switch S. Accordingly the switches S and S' will operate in a synchronous manner, and the setting of switch S will determine the ultimate operation of switch S', and thus the operation of the proper one of the relays, such as 24, 25 and 26, and the selection of the proper balancing network of the networks, such as N_3, N_4 and N_5. The relays 24, 25 and 26 furthermore control the relays 27, 28 and 29, respectively, which in turn control the setting of the potentiometer device 3, so that the gain of the repeater may be varied for the different connections established.

The invention may be more fully understood from the following description of its operation. To establish a connection between lines L_3 and L_4, the plug P_3 of the cord circuit 1 is inserted in jack J_3 and plug P_1 is inserted in jack J_4. This will complete the following circuit: from ground and battery, winding of relay 14, sleeve circuits of plug P_3 and jack J_3 to ground, thereby operating relay 14. The operation of relay 14 closes the following circuit: from ground and battery, armature and contact of relay 14, conductor 31, sleeve contacts of plug P_1 and jack J_4, conductor 32, winding of relay 16, to ground, thereby operating relay 16. The relay 16 will pull up its right hand armature and apply ground to contact X of switch S over conductor 33 and winding of relay 19. By pulling up its outer left hand armature the relay 16 will close the following circuit: from ground, through the interrupter 34, conductor 35, outer left hand armature and contact of relay 16, conductor 36, break contact of relay 19, conductor 37, winding of relay 17, to battery and ground. As this circuit includes the interrupter 34 it will be closed intermittently and will cause the intermittent operation of relay 17. Relay 17 is mechanically connected by a pawl and ratchet mechanism to the switch S and will now start to step the arm of switch S around over its contacts. When the arm of switch S leaves its normal contact 41, the following circuit will be broken: from ground and battery, arm of switch S, contact 41, conductor 40, winding of relay 18, to ground, thereby deenergizing the normally operated relay 18 for purposes which will be pointed out later. The intermittent operation of relay 17 will allow the following circuit to be closed intermittently: from ground and battery, left hand armature and contact of relay 17, conductor 38, armature and contact of relay 16, conductor 39, thence over the talking strands of line L_4, cord circuit 1, talking strands of jack J_3 and thence over conductor 42, winding of relay 15, to ground. This will operate relay 15 intermittently, which in turn will cause the following circuit to be closed intermittently: from ground and battery, armature and contact of relay 15, conductor 10, thence over the talking strands of line L_3, conductor 11, through the windings in parallel of the relays 20 and 21, to ground. Relay 20, being slow to release, will remain operated. The closing of circuit 15 will cause relay 21 to operate intermittently, which in turn will cause the following circuit to be closed intermittently: from ground, armature and make contact of relay 21, conductors 43 and 44, winding of relay 22, to battery and ground. This will cause the relay 22 to operate intermittently. The relay 22 is mechanically connected by a ratchet and pawl mechanism with the switch S', and the intermittent operation of said relay will step the arm of switch S' over its contacts. When the switch arm leaves its normal contact 45, the following circuit will be broken: from ground, arm of switch S', contact 45, conductor 46, winding of relay 23, to battery and ground, thereby deenergizing the normally operated relay 23 for purposes which will be pointed out later. The relay 17 will in this manner continue to operate intermittently and to step the arm of switch S at station A around, until said arm reaches a predetermined contact such as X. When the arm reaches contact X, the following circuit will be closed: from ground and battery, arm of switch S, contact X, winding of relay 19, conductor 33, make contact and armature of relay 16 to ground, thereby operating relay 19. The operation of relay 19 will open at its break contact the previously traced circuit through the interrupter 34 for energizing the relay 17. The relay 17 will now cease functioning intermittently and will be locked up over the following circuit: from ground and battery, winding of relay 17, conductor 37, contact and armature of relay 19, conductor 33, make contact and armature of relay 16, to ground. Accordingly, when the arm of switch S reaches a predetermined contact of the switch, such as X, the relay 17 will cease to function intermittently and the above simplex circuit, which as has been

pointed out, controls the relay 22, will cease to be intermittently opened and closed, but will remain closed. Accordingly, the relay 22 will remain operated and the rotation of the arm of switch S′ will cease. As the switch S′ is similar in construction to the switch S, the arm of switch S′ will at this time be on a contact similarly situated to contact X, such, for example, as contact X′. Accordingly, the following circuit will now be closed: from ground, arm of switch S′, contact X′, conductor 47, winding of relay 24, to battery and ground. This will energize relay 24, which will pull up its armatures and connect to the hybrid windings 2 the network N_3, which is of a suitable type for maintaining the repeater set in a condition of balance when a connection is established with a line such as the line L_4. If a connection were established with lines of different characteristics from those of the line L_4, the winding of the relay such as 19, would be connected to a different contact of the switch S at station A, such, for example, as the contacts Y or Z. Under such conditions, the arms of the switches S and S′ would be stepped along until they had reached this contact. It is pointed out that the contacts Y′ and Z′ of the switch S′ control the relays 25 and 26 and these relays in a manner similar to that of relay 24, control the association with the hybrid windings 2 of other networks, such as N_4 and N_5, which would be suitable for maintaining a condition of balance in the repeater set when connections were made with lines of characteristics other than those of the line L_4. Accordingly, by supplying the necessary number of networks and the necessary number of contacts on the switches S and S′, the proper condition of balance may be automatically obtained for a great variety of connections.

When the connection has been terminated, the cord circuit 1 will be removed from the lines L_3 and L_4. The removal of plug P_1 from jack J_4 will open the previously traced circuit through the relay 16, thereby deenergizing the relay 16. This will open the previously traced locking circuit for relay 17 and in turn will close the following circuit: from ground, right hand armature and break contact of relay 16, conductor 48, contact and armature of relay 18, conductor 49, right hand break contact and armature of relay 17, winding of relay 17, to battery and ground. The closing of this circuit will operate the relay 17 again. As this operating circuit is completed over the armature and contact of said relay, the relay will operate in an intermittent manner and will continue to step the arm of switch S around. When the arm of switch S reaches contact 41, the formerly traced circuit through relay 18 will again be completed, and the relay 18 will be energized again, thereby opening at its armature and contact the last mentioned energizing circuit for relay 17. This will release relay 17 and the apparatus will thus be restored to normal. When the plug P_3 was removed from the jack J_3, the relay 15 released and the previously traced operating circuit for the relays 20 and 21 will be opened. This will release the relays 21 and 20. The release of relay 21 will allow the following circuit to be completed: from ground, armature and back contact of relay 21, armature and back contact of relay 20, conductor 50, armature and back contact of relay 23, conductor 51, armature and back contact of relay 22, conductor 52, conductor 44, winding of relay 22, to battery and ground, thereby energizing the relay 22. However, as this energizing circuit is completed over the back contact and armature of relay 22, the relay 22 will function in an intermittent manner. This operation of relay 22 will continue to step the arm of switch S′ along over its contacts. When the switch arm reaches contact 45, the previously traced circuit for the relay 23 will again be completed and the relay 23 will be operated. The operation of relay 23 will open the last mentioned energizing circuit for the relay 22 and will cause the relay 22 to stop operating. In this manner the apparatus will be restored to normal.

It is pointed out that each of the relays, such as relays 24, 25 and 26, are provided with additional armatures and contacts from which there are leads to the relays 27, 28 and 29, which relays in the manner shown, control the settings of the potentiometer 3, so that the gain of the repeater set may be automatically controlled, as well as the process of network selection.

While the invention has been disclosed as embodied in certain specific arrangements, which are deemed desirable, it is understood that it is capable of embodiment in many and widely varied forms, without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. A transmission line interconnecting distant stations, a repeater set at one of said stations, switching means at said other station whereby said transmission line may be connected to different types of lines, a plurality of balancing artificial lines of different types associated with said repeater set, and means associated with said transmission line and controlled by the operation of said switching means for connecting different ones of said artificial lines to said repeater set.

2. A transmission line including a repeater station and terminating at a distant station, a plurality of balancing artificial lines of

different types at said repeater station, switching means at said distant station for connecting said transmission line to different types of lines, a simplex circuit associated with said transmission line and extending from said distant station to said repeater station, means at said repeater station controlled by said simplex circuit for connecting different ones of said artificial lines to the repeater set thereat, and means at said distant station controlled by the operation of said switching means for controlling said simplex circuit.

3. A transmission line including an intermediate repeater station and terminating at a distant station, a simplex circuit associated with said transmission line and extending between said stations, said simplex circuit controlling the repeater arrangements at said intermediate repeater station, and means at said distant station controlled by the type of line connected to said transmission line thereat for controlling said simplex circuit.

4. A transmission line including a repeater station and terminating at a distant station, a plurality of balancing artificial lines of different types at said repeater station, a potentiometer device at said repeater station, switching means at said distant station for connecting said transmission line to different types of lines, a simplex circuit associated with said transmission line and extending from said distant station to said repeater station, means at said repeater station controlled by said simplex circuit for connecting different ones of said artificial lines to the repeater set thereat, means at said repeater station controlled by said simplex circuit for controlling said potentiometer device, and means at said distant station controlled by the operation of said switching means for controlling said simplex circuit.

5. A transmission line including an intermediate repeater station and terminating at a distant station, a plurality of balancing artificial lines of different types at said repeater station, relays for connecting each of said artificial lines to one of the repeaters at said repeater station, operating circuits for each of said relays, a sequence switch at said repeater station, each of said operating circuits being associated with a different setting on said switch, relay arrangements at said repeater station for operating said sequence switch, a simplex circuit for controlling said relay arrangements associated with said transmission line between said repeater station and said distant station, a plurality of lines of different types at said distant station, a sequence switch associated with each of said lines, each of said switches associated with the different types of said lines having different settings, and means operative when a connection is established between said transmission line and one of said lines at said distant station for controlling said simplex circuit in accordance with the setting of the sequence switch associated with said line at said distant station whereby the sequence switch at said repeater station may be operated to the same setting as the switch at the distant station.

6. A transmission line, including an intermediate repeater station and terminating at a distant station, a plurality of relays at said intermediate station for controlling the operation of a repeater set thereat, operating circuits for each of said relays, a sequence switch at said repeater station, each of said operating circuits being associated with a different setting on said switch, a simplex circuit for controlling the operation of said sequence switch associated with said transmission line between said repeater station and said distant station, a plurality of lines of different types at said distant station, a sequence switch associated with each of said lines, each of said switches associated with the different types of said lines having different settings, and means operative when a connection is established between said transmission line and one of said lines at said distant station for controlling said simplex circuit, in accordance with the setting of the sequence switch associated with said line at said distant station whereby the sequence switch at said repeater station may be operated to the same setting as the switch at the distant station.

7. A transmission line, including an intermediate repeater station and terminating at a distant station, a plurality of balancing artificial lines of different types at said repeater station, relays for connecting each of said artificial lines to one of the repeaters at said repeater station, a potentiometer device at said repeater station, means controlled by said relays for controlling said potentiometer device, operating circuits for each of said relays, a sequence switch at said repeater station, each of said operating circuits being associated with a different setting on said switch, relay arrangements at said repeater station for operating said sequence switch, a simplex circuit for controlling said relay arrangements associated with said transmission line between said repeater station and said distant station, a plurality of lines of different types at said distant station, a sequence switch associated with each of said lines, each of said switches associated with the different types of said lines having different settings, and means operative when a connection is established between said transmission line and one of said lines at said distant station for controlling said simplex circuit in accordance with the setting of the sequence switch associated

with said line at said distant station whereby the sequence switch at said repeater station may be operated to the same setting as the switch at the distant station.

8. A transmission line including an intermediate repeater station and terminating at a distant station, a plurality of balancing artificial lines of different types at said repeater station, relays for connecting each of said artificial lines to one of the repeaters at said repeater station, operating circuits for each of said relays, a sequence switch at said repeater station, each of said operating circuits being associated with a different setting on said switch, relay arrangements at said repeater station for operating said sequence switch, a simplex circuit for controlling said relay arrangements associated with said transmission line between said repeater station and said distant station, a plurality of lines of different types at said distant station, a sequence switch associated with each of said lines, each of said switches associated with the different types of said lines having different settings, means operative when a connection is established between said transmission line and one of said lines at said distant station for controlling said simplex circuit in accordance with the setting of the sequence switch associated with said line at said distant station whereby the sequence switch at said repeater station may be operated to the same setting as the switch at the distant station, and means operative when said connection has been terminated for restoring all of said switching apparatus to normal.

In testimony whereof, we have signed our names to this specification this 24th day of February, 1921.

CHARLES S. DEMAREST.
OWEN H. LOYNES.