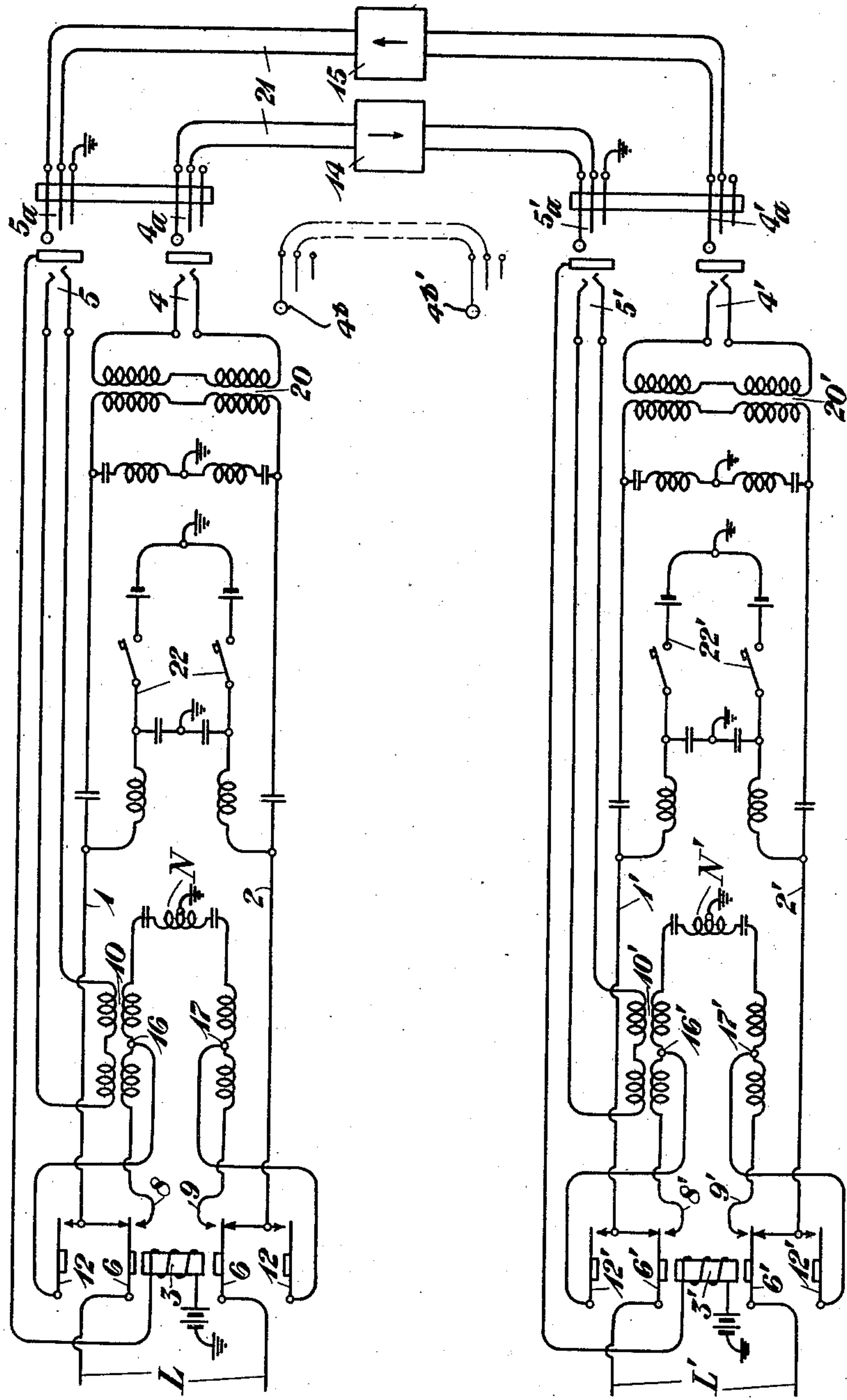


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O. B. JACOBS
TELEPHONE REPEATER

Filed Oct. 18, 1919



INVENTOR.
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UNITED STATES PATENT OFFICE.

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TELEPHONE REPEATER.

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To all whom it may concern:

Be it known that I, OLIVER B. JACOBS, residing at Morris Plains, in the county of Morris and State of New Jersey, have invented certain Improvements in Telephone Repeaters, of which the following is a specification.

My invention relates to repeaters, particularly to repeaters of the cord circuit type.

It is an object of the invention to provide for each telephone line entering a repeater station, a separate balancing network and repeater transformer designed to correspond to the impedance of the line and to place the amplifying elements of the repeaters into the cord circuits, so that any one of the repeater cords may be used to establish connection between any desired pair of lines. To permit of the making of non-repeater connections, I provide for each line a relay which is arranged to disconnect the repeater transformer and the net work from the line, except when a repeater cord is associated with the line.

One form and arrangement of apparatus and circuits embodying the invention is shown in diagrammatic view in the accompanying drawing in which reference character L designates a telephone transmission line, which is normally associated with switchboard conductors 1 and 2 by means of the back contacts 6 of a relay 3, a transformer 20 being provided to associate conductors 1 and 2 with the tip and ring contacts of a jack 4. A line L' is associated with a jack 4' by apparatus designated by similar characters of reference, the prime mark (') being used to distinguish the apparatus of line L' from that of line L. Both lines L and L' are thus normally associated with the jacks 4 and 4' and an ordinary non-repeater connection may be established between the two lines by connecting the two jacks by an ordinary cord circuit.

For the purpose of connecting the two lines through a repeater there is provided adjacent jack 4 of line L a jack 5, the sleeve of which is connected to the circuit of relay 3 so that this relay is energized when ground is connected to the sleeve, as described hereinafter. The winding of one side of a repeater transformer 10 is connected to the tip and ring contacts of jack 5 and the windings of the other side of this transformer are connected by means of conductors 8 and

9 to the front contacts 6 of relay 3, the other terminals of these windings being connected to a network N, which has the same characteristic impedance as the line L. The midpoints 16 and 17 of the transformer windings are associated with contacts 12 of relay 3, these contacts being arranged to connect the said midpoints with the switchboard conductors 1 and 2 when relay 3 is energized. For associating jacks 4 and 5 with the corresponding jacks in line L' there are provided repeater cord circuits 21, comprising amplifying devices 14 and 15, and terminated by twin plugs 4^a, 5^a, and 4^{a'}, 5^{a'}.

When the operator desires to establish a repeater connection between lines L and L', she merely associates the plugs of the repeater cord with the corresponding jacks. As plug 5^a is thus introduced into its jack, the sleeve of the jack is connected to ground so that relay 3 becomes energized and connects network N to the line, in place of jack 4. The points 16 and 17 in the windings of transformer 10 are now points of symmetry between the line and the network, the impedance of the line circuit to the left thereof being substantially equal to the impedance of the network circuit to their right. The front contacts 12 of relay 3 connect the jack 4 with points 16 and 17, so that when current flows in line L a portion of the current is shunted from the line by means of conductors 1 and 2, which current flows through transformer 20 over the tip and ring contacts of jack 4 into the amplifying device 14 in the cord circuit, by means of which device the current is augmented in value and caused to flow through jack 5' into the primary winding of transformer 10'. The secondary windings of this transformer cause this current to flow into line L' and network N', the front contacts of relay 3' having been closed at the time when the operator associated the plugs of cord circuit 21 with the jacks of line L'. Current in line L' is repeated in similar manner into line L, the current flowing from the midpoints 16' and 17' of transformer 10' over switchboard conductors 1' and 2' through transformer 20', jack 4', amplifier 15, jack 5 and transformer 10 into line L and network N.

For the purpose of sending Morse and other signaling currents over the conductors of the telephone lines, there is associated with each switchboard conductor a compos-

ite set 22 of the type well known in the art. Under ordinary circumstances the Morse currents flow over the back contacts 6 of relay 3 into the line conductors. When re-
 5 peater connections are established over the lines the Morse currents flow through the front contacts 12 of relay 3 to the points of symmetry 16 or 17, from which points half of the current flows into the network
 10 and half through front contacts 6 of relay 3 into the line. The Morse apparatus is thus associated with the line at the point of symmetry between the line and its balancing network so that it causes no disturbance
 15 in the balance between the line and the network. The contacts 12 of relay 3 are arranged to close before back contacts 6 open so that there is no interruption of the continuity of the line relative to the Morse
 20 current. Other signaling apparatus may be associated with the line in similar manner. The networks N are preferably grounded at their midpoints so that the telegraphic cur-
 25 rent in one line circuit is unable to cause disturbances in the adjacent line circuit.

Although I have shown and described herein only one form and arrangement of apparatus embodying the invention, it is readily understood that various modifica-
 30 tions and changes may be made therein within the scope of the following claims without departing from the spirit and scope of the invention.

What I claim is:

35 1. In combination, a telephone line, a jack normally terminating said line, an amplifying repeater comprising a three-winding transformer, and means for at times inter-
 40 posing said transformer between said line and said jack.

2. In combination, a line, a jack normally terminating said line, an amplifying repeater comprising a three-winding transformer,
 45 a relay, and means for at times actuating said relay to interpose said transformer between said line and said jack.

3. In combination, a line, a jack normally terminating said line, a network for bal-
 50 ancing said line, a relay for at times disconnecting said jack from said line and connecting thereto said network in balancing relationship, and means operated by said
 55 relay for associating the points of symmetry between said line and said network with said jack.

4. In combination, a line, a jack, a relay associating said jack with said line, a net-
 60 work for balancing said line, a repeater element, means actuated by said relay for at times disconnecting said jack from said line and connecting thereto said repeater
 65 element and said network, and means actuated by said relay for connecting the midpoints of said element with said jack.

5. In combination, a pair of telephone

lines adapted to be connected for through service, a pair of jacks for each of said lines, a pair of cord circuits for associating
 70 said jacks an amplifying device in each of said circuits, a repeater input and output element for each of said lines and means actuated when said cord circuits are asso-
 75 ciated with said jacks for interposing one of the elements of each repeater between the line and one of its jacks.

6. In combination, a pair of telephone lines adapted to be connected for through service, a jack for terminating each line,
 80 a repeater element for each line, a relay for each line for interposing said element between said line and its jack, a second jack for each line, a second repeater element associated with each of said second jacks, a
 85 pair of cord circuits for associating the jacks of said lines and means for actuating said relays when said circuits are associated with said jacks.

7. In combination, a pair of telephone lines, a first jack for each line, a relay for each line for connecting the line with its
 90 jack, a network for each line for balancing the same, a second jack for each line, a pair of cord circuits for associating the jacks of one line with those of the other line, a re-
 95 peater comprising amplifying devices, one in each of said cord circuits, and a pair of input and output elements, means for associating one of said elements with each of said second jacks, means operated by said relay
 100 for interposing the other of said elements between said line and its first-mentioned jack and a circuit for said relay actuated when said cord circuits are associated with the said jacks.

8. In combination, a line, a source of sig-
 105 naling current associated with said line, a switch to control said source, a network for balancing said line, means for at times connecting said source and switch directly with
 110 said line and disconnecting said network and alternative means at other times for associating said network with said line and connecting said source to a point of symmetry between the line and the network.

9. In combination, a plurality of telephone
 115 lines, jacks therefor, respective networks and repeater transformers associating said lines with said jacks, and cord circuits comprising amplifying devices for associating said jacks.

10. In combination, two telephone lines
 120 normally adapted for direct connection, a two-way two-element repeater, and means to connect said lines directly, or alternatively, through said repeater.

11. In combination, two telephone lines
 125 normally adapted for direct connection, respective balancing networks and three-winding transformers, two repeater elements, and means to connect said lines directly, or al-
 130 ternatively, to their networks through the

transformer windings and to connect the repeaters to the transformers.

12. In combination, two telephone lines normally adapted for direct connection or
5 indirect connection, a two-way two-element repeater to be comprised in the indirect connection, means to connect said lines indirectly through said repeater, a telegraph signal branch connected directly to one side of
10 one of said lines in their normal state, and means to connect it to a neutral point when the lines are connected through the repeater.

13. In combination, two telephone lines normally ending in respective jacks at the
15 same station, telegraph signal branches connected to each side of each line, a repeater through which the lines may be connected, and means to change the telegraph signal branch connections to neutral points when
20 the lines are connected through the repeater.

14. In combination, two telephone lines normally ending in respective jacks at the same station, a two-way repeater set comprising two three-winding transformers,
25 supplemental jacks each permanently connected to a winding of the respective transformers, and twin plugs to connect the repeater between the lines.

15. In combination, two telephone lines
30 normally ending in respective jacks at the

same station, a two-way repeater set comprising two three-winding transformers, supplemental jacks each connected to a winding of the respective transformers, twin
35 plugs to connect the repeater between the lines, and relays controlled by the sleeves of the auxiliary jacks to connect the transformers in operative relation when the twin plugs are inserted in the jacks.

16. In combination, a plurality of telephone lines, respective artificial lines and
40 three-winding transformers associated with said telephone lines, two opposite-way amplifying elements, and means to connect said elements for two-way two-element repeating
45 between two of the said lines.

17. In combination, a plurality of telephone lines, respective artificial lines and
50 three-winding transformers associated with said telephone lines, two opposite-way amplifying elements, means to connect said elements for two-way, two-element repeating between two of the said lines, and alternative
55 means to connect two lines directly without amplifying repeating between them.

In testimony whereof, I have signed my name to this specification this 17th day of October, 1919.

OLIVER B. JACOBS.