J. J. SKIDMORE.

TELEPHONE REPEATING APPARATUS AND CIRCUIT.

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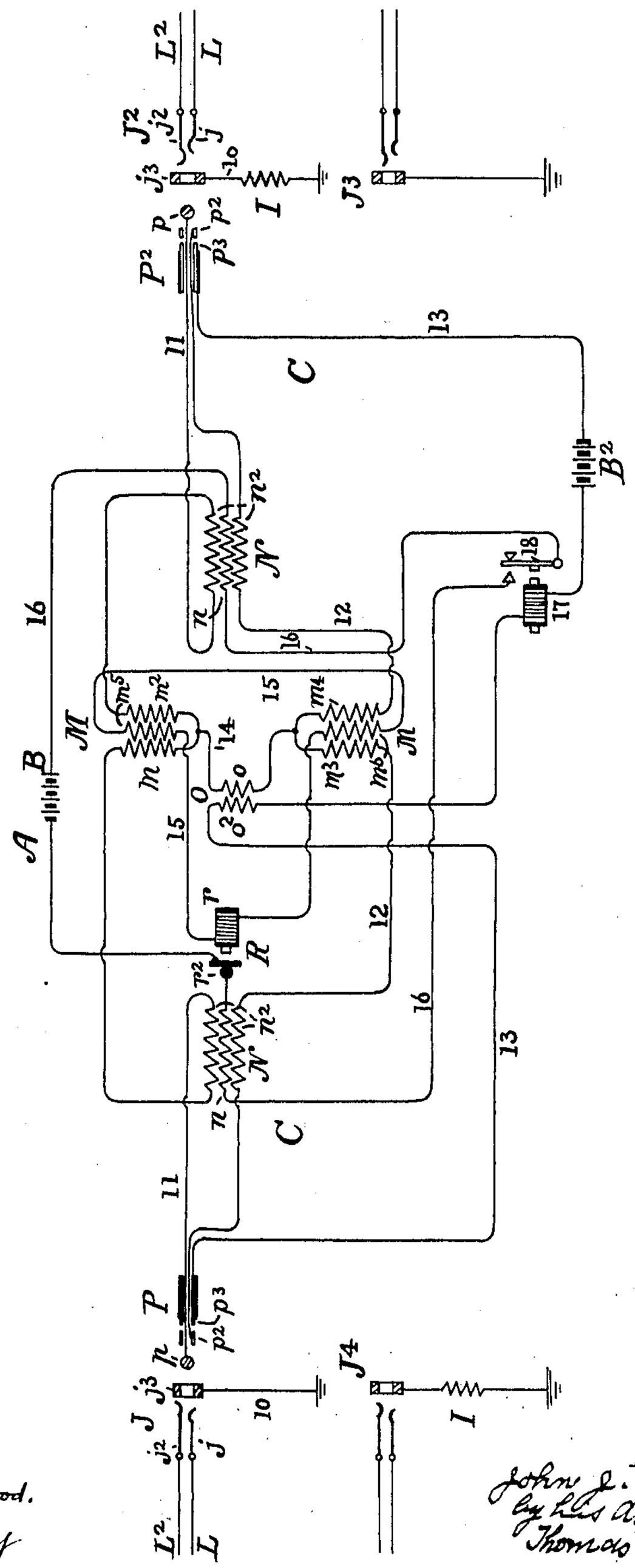
912,908. Patented Feb. 16, 1909.



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UNITED STATES PATENT OFFICE.

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TELEPHONE REPEATING APPARATUS AND CIRCUIT.

No. 912,908. Specification of Letters Patent. Patented Feb. 16, 1909.

Application filed May 9, 1907. Serial No. 372,701.

To all whom it may concern:

Be it known that I, JOHN J. SKIDMORE, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented certain Improvements in Telephone Repeating Apparatus and Circuits, of which the following is a specification.

Telephone repeating apparatus in practice is frequently included in the circuit connections of switchcords, thus securing a reinforcing action between whatever lines the cord may be used to unite. Since the lines will naturally not always be of the same length and character, the repeater is obviously often called upon to act between sections of the complete circuit which differ materially as to their electrical properties. As is well known, in repeating circuits which are commercially in use, such, for example, as that disclosed in the patent to Shreeve, No. 835,037, November 6, 1906, it is necessary to have something approaching an electrical balance between the line sections to prevent reactive disturbances between the receiving and transmitting elements of the apparatus. Instead of adjusting at the repeater the resistance and capacity of the sections which it connects, as described in the above-mentioned patent, the so-called "singing" of the apparatus may be prevented by somewhat decreasing its sensitiveness.

The purpose of the present invention is to provide a system in which this change in the condition of the repeater will be made whenever necessary without attention upon the part of the switching operator.

The accompanying drawing illustrates diagrammatically a repeating apparatus included in a cord-circuit arranged in accordance with my invention.

Upon a switchboard at a station A is situated switching means, which is here shown as consisting of the usual jacks, of which four are illustrated, these being designated by the characters J J^2 J^3 and J^4. The springs j j^2 of the jacks are connected to line or main conductors L and L^2, which may represent either a substation or trunk line constituting a section of the entire transmitting circuit. The substation or trunk lines are assumed to be of different lengths, those joined to the jacks J and J^3 being comparatively long while those of the jacks J^2 and J^4 are much shorter. The sleeve contact j^3 of each jack is shown as grounded or secured to a common return by a conductor 10. In this conductor belonging to the jacks J^2 and J^4 are included resistances I, which will be hereinafter more particularly referred to.

Associated with the switchboard are a suitable number of connecting or cord circuits C adapted when in use to constitute sections of complete transmitting circuits. Only one cord circuit is represented, this terminating in plugs P and P^2 for coöperation with the jacks. The tips p and rings p^2 of the plugs are connected respectively to conductors 11 and 12, while between the sleeves p^3 extends a conductor 13. Included in the cord is a reinforcing apparatus and circuit, the other mechanisms usually present in connecting circuits being omitted from the drawing to render the present invention more clear. In the strands 11 and 12 are the primary windings of a repeating induction coil M, which acts to deliver energy to the reinforcing circuit. This coil has said primary windings arranged in sections m m^2 m^3 and m^4, of which m and m^2 are in the conductor 11, while sections m^3 and m^4 are in the conductor 12. In each pair of sections the terminals other than those joined to the cord strands are united, and connected by a bridge conductor 14, which contains the primary winding o of a regulating induction coil O, its secondary o^2 being in the third conductor 13 of the cord. Both windings of the induction coil O are preferably of comparatively low resistance. The secondary winding of the coil M is shown in sections m^5 and m^6 included in a circuit 15 closed through the winding of the receiving element r of the repeating apparatus R. The transmitting element r^2 of the repeater forms a part of a circuit 16, which also contains a battery B and the primary winding n of a transmitting induction coil N, the sectional secondary n^2 of which is comprised in the cord strands 11 and 12 at opposite sides of the bridge 14. This coil N returns reinforced energy to the line, operating in a manner now familiar to those skilled in the art.

The third conductor 13 of the cord contains a battery B^2 and the winding of a low-resistance sensitive relay 17, and the armature 18 and front contact of said relay cooperate to complete the circuit 16 for the transmitting element r^3 of the repeater.

In considering the operation of the sys-

tem, it should first be noted that if the short lines of jacks J^2 and J^4 are connected to one another it will not be necessary to seek to reinforce the voice currents, since transmission will be sufficiently good without this, and a switchcord not comprising a repeater may be used, so that my invention does not here come into play. If the lines joined are the longer ones J and J^3, the condition here encountered may be considered to be such that the fluctuating terminal impedance has been offset by the line capacity, so that the impedance as a whole has become substantially constant. These lines are sufficiently balanced for the purposes of the herein-described repeating apparatus. The operation will then be as follows: When the operator places the plugs P and P^2 in the jacks J and J^3 a circuit is completed from ground to ground through the conductors 10 10, sleeve contacts of the jacks, sleeves of the plugs, conductor 13 and winding of relay 17, resulting in the energization of the relay from the battery B^3. By attracting its armature this relay closes the circuit 16 of the transmitting element r^2 and prepares the repeater for operation. The normally open condition of the circuit 16 prevents waste of the battery B, and the initial singing which would follow the condition of extreme unbalance if but one plug were placed in a jack, while the circuit of the transmitting element were closed. As there is no resistance in the conductors 10 of the jacks, and as the winding of the relay 17 and secondary o^2 of the induction coil O are of low resistance, the total resistance of the grounded third conductor circuit of the cord will be small. Then since the impedance of the primary o of the coil O is dependent upon the resistance in series with its secondary winding, the impedance of the bridge conductor 14 is low. This being the case, voice currents originated at the station connected, for example, to the line of jack J will flow through the cord conductor 11 and the primary section m of the coil M, and, on account of the relatively slight impedance of the bridge, will practically all pass therethrough, then through the coil section m^3 and back by conductor 12 to line. The current in the primary sections m and m^3 exercises an inductive effect upon the companion primary sections m^2 and m^4, as a result of which the voice currents are transmitted to a certain extent directly through the cord into the line conductors of the jack J^3. These pairs of primary windings are so connected that the current flowing in both sections of each pair is neutralized as regards its effects upon the secondary winding, and therefore the only inductive action on the latter is from the current traversing the bridge. The current generated thereby in the secondary energizes the receiving element of the repeating apparatus, which, operating the transmitting element, causes the circuit 16 to throw upon the line through the coil N reinforcing currents from the battery B. On account of the length and consequent approximate balance of the connected lines, the extremities of the bridge conductor 14 are at the same potential with respect to the energy put upon the line by the secondary windings n^2 of the transmitting induction coil and the reinforcing currents do not react upon the repeater. Now suppose the long line of jack J is to be joined to the relatively short line of jack J^2, in which the impedance is considerably lower and perhaps variable. Upon the connection of the lines by the cord-circuit C the ends of the bridge are now no longer at equipotential as regards the returned energy, and therefore said bridge and the receiving element are traversed by the reinforcing as well as the originating current, tending to cause the apparatus to sing. But we now have in the circuit of conductor 13 the resistance I, which is so selected that it bears some predetermined relation to the impedance of the line connected to its jack, the less the impedance the greater being the resistance. This resistance in series with the secondary winding o^2 of the coil O increases the impedance of its primary, so that less of the original transmitted current traverses it. The reinforcing effect of the repeating apparatus is therefore somewhat decreased, though not enough to materially impair its efficiency, and it is rendered less sensitive. This being true, the reactive effect upon it due to the lack of balance of the lines is less, and, when this adjustment is properly provided for by inversely proportioning the resistance to the impedance of the line with which it is associated, the singing becomes so slight as not to disturb transmission. It will be seen that this control is made wholly incident to another act upon the part of the operator necessary to the switching of the lines, and as an adjustment requires no thought.

I claim:

1. The combination of a telephone circuit or circuit section; telephone apparatus associated therewith; two other telephone circuits or circuit sections which are unequal or dissimilar with relation to each other; means for connecting the first named circuit with and disconnecting it from each of said two other circuits, and means associated with one of said two unequal circuits adapted upon connection of its circuit with said first named circuit to control the sensitiveness of the telephone apparatus associated therewith.

2. A telephone system comprising lines and jacks to which they are joined; telephone apparatus which may be associated

with said lines; and a resistance connected to an element of a jack for coöperation with said apparatus and bearing a predetemined relation to the line to which the jack belongs.

3. The combination of a telephone circuit or circuit section; telephone apparatus associated therewith; two other telephone circuits or circuit sections which are unequal or dissimilar with relation to each other; a switch element united to each of said circuits for connecting the first named circuit to either of the other two; and means connected to the switch element of one of the two unequal circuits for varying the sensitiveness of the telephone apparatus of the first named circuit when said circuits are joined by their switch elements.

4. The combination with two sections of a telephone transmitting circuit, of means for connecting and disconnecting said sections; telephone apparatus associated with one of the sections; a bridge across the last-named section through which current passes to actuate the telephone apparatus; and means adapted to be brought into coöperative relation with the bridge by connection of the two circuit sections and acting to vary the electrical impedance of the bridge.

5. The combination with two sections of a telephone transmitting circuit, of means for connecting and disconnecting said sections; telephone apparatus associated with one of the sections; a bridge across the last-named section through which current passes to actuate the telephone apparatus; and means permanently associated with the other section adapted to be brought into coöperative relation with the bridge by connection of the two circuit sections and acting to vary the electrical impedance of the bridge.

6. The combination with two sections of a telephone transmitting circuit, of a plug and a jack for connecting and disconnecting said sections; telephone apparatus associated with the section having the plug; a bridge across the last-named section through which current passes to actuate the telephone apparatus; and a resistance permanently connected to an element of the jack and adapted upon engagement of the plug with the jack to be brought into coöperative relation with the bridge and thereby vary the electrical impedance of said bridge, said resistance having a predetermined relation to the circuit section to the jack of which it is connected.

7. A telephone system comprising line circuit conductors and jacks to which they are joined; a connecting circuit having plugs for coöperating with the jacks and a bridge through which current passes to actuate the repeating apparatus; a repeating apparatus included in the connecting circuit; and a resistance associated with a jack and adapted, by the insertion of a plug of the connecting circuit in said jack, to be brought into coöperative relation with the bridge to vary the impedance thereof.

8. The combination with telephone lines and jacks to which they are joined, the sleeve contacts of said jacks being grounded, of a three-conductor cord-circuit comprising plugs for coöperation with the jacks; a repeating apparatus included in the line strands of the cord; a resistance included in the ground connection of a jack; and means contained in the third conductor of the cord for inductively associating the resistance with the repeating circuit, substantially as described.

9. In a telephone system, the combination with a transmitting circuit, of a reinforcing circuit; reinforcing apparatus associated with said reinforcing circuit; a bridge across the transmitting circuit, said bridge being adapted to carry current for the supply of energy to the reinforcing circuit; and a resistance inductively associated with the bridge to affect the sensitiveness of said reinforcing apparatus.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses, this seventh day of May 1907.

JOHN J. SKIDMORE.

Witnesses:
GEO. WILLIS PIERCE,
JAMES E. LYNCH.