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H. E. SHREEVE.

CIRCUIT SYSTEM FOR TELEPHONE REPEATING APPARATUS.

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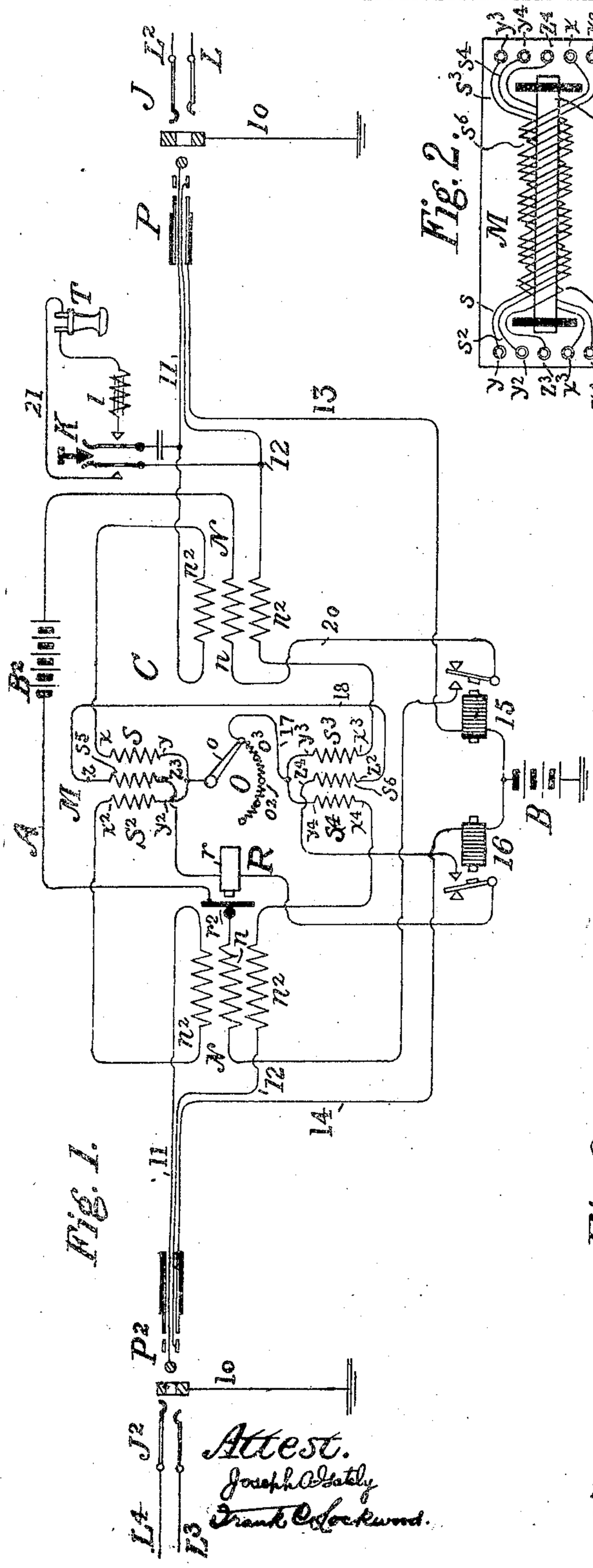

Fig. 1.

Fig. 2.

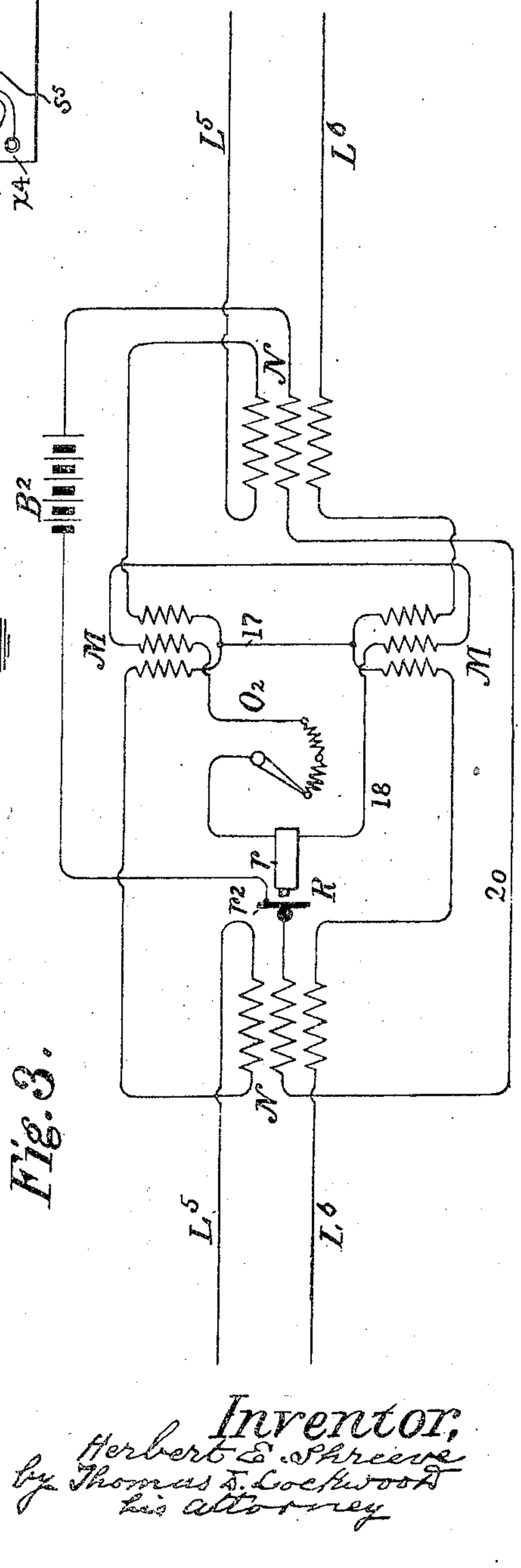

Fig. 3.

Witnesses.
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UNITED STATES PATENT OFFICE.

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CIRCUIT SYSTEM FOR TELEPHONE REPEATING APPARATUS.

No. 897,028. Specification of Letters Patent. Patented Aug. 25, 1908.

Application filed March 15, 1907. Serial No. 362,569.

To all whom it may concern:

Be it known that I, HERBERT E. SHREEVE, residing at Newton, in the county of Middlesex and State of Massachusetts, have invented certain Improvements in Circuit Systems for Telephone Repeating Apparatus, of which the following is a specification.

In telephone current reinforcing circuits in which the receiving element of the repeating apparatus is supplied with energy from a bridge connection across the main circuit, it has heretofore been necessary for satisfactory operation, to secure an approximate balance of electrical conditions in the line sections upon opposite sides of the bridge and thus to avoid reactive disturbances in the repeating apparatus and a displacement between the phase of the original and renewed voice currents.

The leading considerations in the present invention are the provision of such a bridged reinforcing circuit which is largely independent of the above noted conditions, and which, when disturbed thereby, may be adjusted with a minimum effort on the part of the operator to overcome the effect of unbalance.

The accompanying drawings illustrate the invention, Figure 1 showing diagrammatically one embodiment in connection with a switchcord; Fig. 2 a diagrammatic top plan view of the repeating induction coil; and Fig. 3 a simplified arrangement of the circuit of Fig. 1 with the adjusting resistance differently disposed.

In all figures similar characters have reference to the same parts.

The invention is of particular utility when employed for successively connecting a number of lines having different electrical properties, since here is encountered not only a state of unbalance, but also one in which the conditions may rapidly vary. Such service is required of repeaters situated in the switchcords used for joining toll lines; and Fig. 1 of the drawings presents schematically my improved circuit in a form adapted for this purpose.

The letters J J^2 designate jacks at a toll board in a station A, these having connected to their tip and ring contacts, respectively, the line conductors L L^2 and L^3 L^4 of metallic circuits leading to other stations, and, when joined either conductively or inductively, furnishing portions or sections of a transmitting circuit between these last named stations. The sleeve contact of each jack is shown as grounded by a conductor 10. Coöperating with the jacks are plugs P P^2 having their tips and rings connected by strands or conductors 11 and 12, respectively, belonging to one of a plurality of cord circuits C situated at a toll operator's position. These cord conductors serve with the line conductors to complete the through transmitting circuit. From the sleeves of the jacks J and J^2, respectively, conductors 13 and 14 lead through the windings of relays 15 and 16 to the free pole of a battery B, the opposite pole of which is grounded. The purpose of these elements joined to the sleeves will be later described.

In the cord strands 11 and 12 are the primary windings of a repeating induction coil M which acts to deliver energy to the reinforcing circuit. This input coil, which is shown in greater detail in Fig. 2, has said primary windings arranged in sections s s^2 s^3 and s^4, of which s and s^2 are in the conductor 11 with their terminals x x^2 connected thereto, while sections s^3 and s^4 are in the conductor 12, which is joined to the terminals x^3 x^4. The other terminals y y^2 and y^3 y^4 of each pair of sections are united and connected by a bridge conductor 17 containing a preferably variable resistance device O, this being illustrated as having an arm o movable over fixed contacts o^2, between which are the resistance coils o^3. The primary sections of the coil M are wound upon a magnetic core m, common to all and to the secondary winding, which secondary, for the purpose of rendering the diagram more clear, is shown in Fig. 1 as having separate sections s^5 s^6 joined by a conductor 18, and being particularly associated with the pairs of primary sections s s^2 and s^3 s^4, respectively. In practice, however, as appears in Fig. 2, the secondary winding is continuous, the points z z^2 (Fig. 1) coinciding. The terminals z^3 and z^4 of the secondary of the repeating induction coil are connected in the circuit 18 with the receiving element r of a suitable relay or repeating apparatus R, such as that disclosed in my Patents No. 791,655 and No. 791,656 of June 6, 1905. The transmitting element r^2 of the repeater is included in a circuit 20, which also contains a battery B^2 and the primary winding n of a transmitting induction coil N, the sectional secondary windings n^2 of which are

comprised in the cord strands at opposite sides of the bridge 17. This coil N returns energy to the line, it being organized and adapted to operate as in my Patent No. 791,656, previously referred to, and need not be considered in detail. The circuits 18 and 20, respectively, contain the normally separated armature and front contact of the relays 16 and 15.

In addition to the apparatus already described, an operator's set T is shown as bridged across the cord in a conductor 21, it being controlled by a key K. An impedance 1 in series in the conductor 21 prevents the operator's circuit from taking so much current as to sensibly affect the line section with which the plug P connects the cord.

The operation of the system is as follows: In response to an order to connect the lines terminating in the jacks J J^2, the operator selects the plugs P and P^2 of a cord circuit not in use and inserts them in said jacks. Upon the connection of the plugs and jacks, current flows from the battery B through the relays 15 and 16, conductors 13 and 14, plug sleeves and jack contacts to ground by conductors 10. The relays thereupon attract their armatures to complete the circuits 18 and 20 through both the receiving and transmitting elements of the repeater. The normally open condition of the circuits 18 and 20, until both plugs are in place, prevents the state of maximum unbalance which would follow the connection of the repeating circuit to a single line section and which would produce a singing disturbance in the apparatus, and as respects the circuit 20 the said open condition also avoids waste of the battery B^2 when the cord is not in use.

The normal position of the lever *o* of the resistance device O is upon its first contact, or that to the extreme right as seen in Fig. 1, the resistance of the bridge at such time being substantially zero, and we will assume that the present connection is between line sections which, while not possessing the same electrical properties, are not excessively out of balance. Voice currents originated, for example, at the station connected to the lines L L^2 will flow through the cord conductor 11 and the primary section *s* of the coil M, and, on account of the absence of resistance in the bridge, will practically all pass therethrough, through the coil section s^3 and back by conductor 12 to line. The current in the primary sections s s^3 exercises an inductive effect upon the companion primary sections s^2 and s^4, as a result of which the voice currents are transmitted to a certain extent directly through the cord into the line conductors L^3 and L^4. These pairs of primary windings are so connected that the current flowing in both sections of each pair is neutralized as regards its effect upon the secondary winding, and therefore the only inductive action upon the latter is from the current traversing the bridge. The current generated thereby in the secondary energizes the receiving element of the repeating apparatus R, which, operating the transmitting element, causes the circuit 20 to throw upon the line through the output coil N reinforcing currents from the battery B^2. As the extremities of the bridge conductor 17 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, the reinforcing currents do not react upon the repeater. When transmission takes place from the opposite station, or that of the lines L^3 L^4, the general action is the same, the energizing current merely passing in the opposite direction through the induction coils.

It will be seen that although, as in previous bridge repeating circuits, the herein described bridge connection presents a low impedance tending to absorb current originated in either line portion, its passage through the repeating coil secures an important result not heretofore attained. For when the line sections are unbalanced a simple bridge connection between the opposite sides of the line, as in my Patent No. 791,656, shunts through it practically all current put upon either section of the line, preventing an equalization thereof between said sections in absence of an adjustment of their electrical properties, as described in my Patent No. 835,037, dated November 6, 1906, and consequently causing the well known reactive disturbances in the repeating apparatus due to the presence of a difference of potential at the extremities of the bridge. But, with the repeating coil having coöperating windings in both line sections, there is assured a transfer of energy between them, compensating to a considerable extent for any lack of balance and decreasing the tendency of the repeater to sing. At the same time, this direct induction between primary windings situated in the line and the secondary winding included in the reinforcing circuit, holds the voice currents transmitted from one to another without material alteration of phase, the common magnetic core aiding to preserve the definite relation. It is also found that this arrangement proves beneficial in lessening the absorption of ringing current by the bridge. It may be, however, that the character and dimensions of the connected lines are such, that the above described effect of automatic compensation through the repeating coil will not be sufficient to prevent the singing of the reinforcing apparatus. In this case the difficulty can be readily obviated by the operator, who, listening in upon the cord by depressing the key K, notes the conditions.

If the repeater is found to be putting upon

the line a tone of such strength as to objectionally affect transmission, the lever *o* is moved to gradually introduce resistance into the bridge, decreasing the flow therethrough and instead sending more current directly to line. Since, as has been before pointed out, only that portion passing through the bridge acts upon the repeating circuit, it follows from this adjustment or regulation of the current that the reinforcing action of the repeater and its sensitiveness to disturbance are proportionally reduced. This variation in the resistance of the bridge may be continued until the efficiency of transmission is at a maximum. While this results in a decrease of direct reinforcement, this action may still be more effectual than in systems in which the adjustment of the values of the line sections is required, on account, in the present instance, of the removal of resistance and capacity therefrom. Though this single adjustment throws but a slight burden upon the operator, it may be further facilitated by determining in advance the best values to employ with particular lines, and this inserted in the cord to be used before putting up the connection. This practice also avoids the creation of a disturbance in the repeater by the adjusting process.

Fig. 3 of the drawings shows a simplified arrangement of the circuit, in which the primary windings of the repeating induction coil M and secondary windings of the transmitting induction coil N are included directly in the line conductors L^5 and L^6. The relays are, therefore, omitted, as is the operator's telephone circuit. The organization is otherwise generally the same as that previously described, except that the variable resistance O^2 is placed in the circuit with the receiving element of the repeater instead of in the bridge. This, when used, decreases the sensitiveness of the apparatus by a direct adjustment, regulation, or cutting down of the current induced in the circuit of the receiving element of the coil M. It is found that a somewhat greater resistance is necessary to accomplish the same result than when it is placed in the bridge, but the effect is generally the same. In absence of the switch-cord and associated operator's set, it may be assumed that in this case the function of the resistance is to adjust the apparatus for more or less permanent use between the same pair of line sections.

I claim as my invention:

1. In a current renewing system, a line circuit having sections, a reinforcing circuit, an input coil for delivering energy from the line to the reinforcing circuit, and an output coil for supplying renewed energy from the reinforcing circuit to the line, each of said coils having windings in both line sections and in the reinforcing circuit, the line windings of the input coil serving to inductively associate the line sections.

2. In a current renewing system, a line circuit having sections, a reinforcing circuit, an input coil for delivering energy from the line to the reinforcing circuit, and an output coil for supplying renewed energy from the reinforcing circuit to the line, each of said coils having windings in both line sections and in the reinforcing circuit, both the line windings and the reinforcing circuit winding of the input coil being about a magnetic core magnetically common to all.

3. A telephone system comprising a transmitting circuit, a reinforcing circuit and apparatus associated with said transmitting circuit, and means for altering or changing the current which the transmitting circuit supplies to the reinforcing circuit and thereby varying the sensitiveness of the reinforcing apparatus, said altering of the supplied current being other than or contradistinguished from variations therein corresponding to transmitted speech or sound, and said current varying means operating independently of the electrical balance of the transmitting circuit.

4. A telephone system comprising a transmitting circuit, a reinforcing circuit associated therewith, and means for altering or changing the current supplied by the transmitting circuit to the reinforcing circuit, said altering of the supplied current being other than or contradistinguished from variations therein corresponding to transmitted speech or sound, and said current varying means operating independently of the electrical balance of the transmitting circuit.

5. A telephone system comprising a transmitting circuit, a reinforcing circuit associated therewith, and means for adjusting or regulating the current supplied by the transmitting circuit to the reinforcing circuit, said current varying means operating independently of the electrical balance of the transmitting circuit.

6. A telephone system comprising a transmitting circuit, a reinforcing circuit associated therewith, a bridge in the transmitting circuit through which current passes in rendering the reinforcing circuit active, and means associated with said bridge for varying the electrical impedance thereof.

7. The combination with an electrical transmission circuit, of a reinforcing circuit, a bridge across the transmission circuit, said bridge being adapted to carry current for the supply of energy to the reinforcing circuit, and a variable resistance connected in the bridge.

8. The combination with a telephone line, of a repeating coil for delivering energy to the reinforcing circuit having pairs of inductively associated windings in each side of the

line, a reinforcing circuit containing windings coöperating with the line windings of the repeating coil, and a bridge connection between the sides of the line at points between the windings of each line pair of the repeating coil.

9. The combination with a telephone line, of a repeating coil having pairs of associated windings in each side of the line, a reinforcing circuit containing windings coöperating with the line windings of the repeating coil, all of the repeating coil windings being on a single magnetic core, a bridge connection between the sides of the line at points between the windings of each line pair of the repeating coil, and an adjustable resistance in the bridge connection, subsantially as described.

10. In a telephone system, a cord circuit, telephone current reinforcing mechanism including two circuits, means connected in the cord circuit for opening and closing one of said reinforcing mechanism circuits, said means being controlled by the connection and disconnection of one end of said cord circuit with a telephone line section, and other means connected in the cord circuit for opening and closing the other reinforcing mechanism circuit, said other means being controlled by the connection and disconnection of the other end of said cord circuit with a telephone line section.

11. In a telephone system, a cord circuit, a telephone current repeater including two circuits, one a receiving circuit and the other a transmitting circuit, a relay having its winding included in the cord circuit and its armature and a contact adapted to control said receiving circuit, and a second relay having its winding included in the cord circuit and its armature and a contact adapted to control said transmitting circuit.

12. The combination with a sectional line circuit, of a current reinforcing circuit, means for connecting the line sections, and means operable only upon the completion of the connection for closing the reinforcing circuit.

13. The combination with a telephone line, of a bridge connection across the line, a coil having pairs of associated windings in each side of the line, the windings of each pair being at opposite sides of the bridge connection and being adapted to repeat into one another and thus transmit current past the bridge, and a reinforcing circuit including windings coöperating with the line windings of the coil.

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

HERBERT E. SHREEVE.

Witnesses:
GEO. WILLIS PIERCE,
JOSEPH A. GATELY.