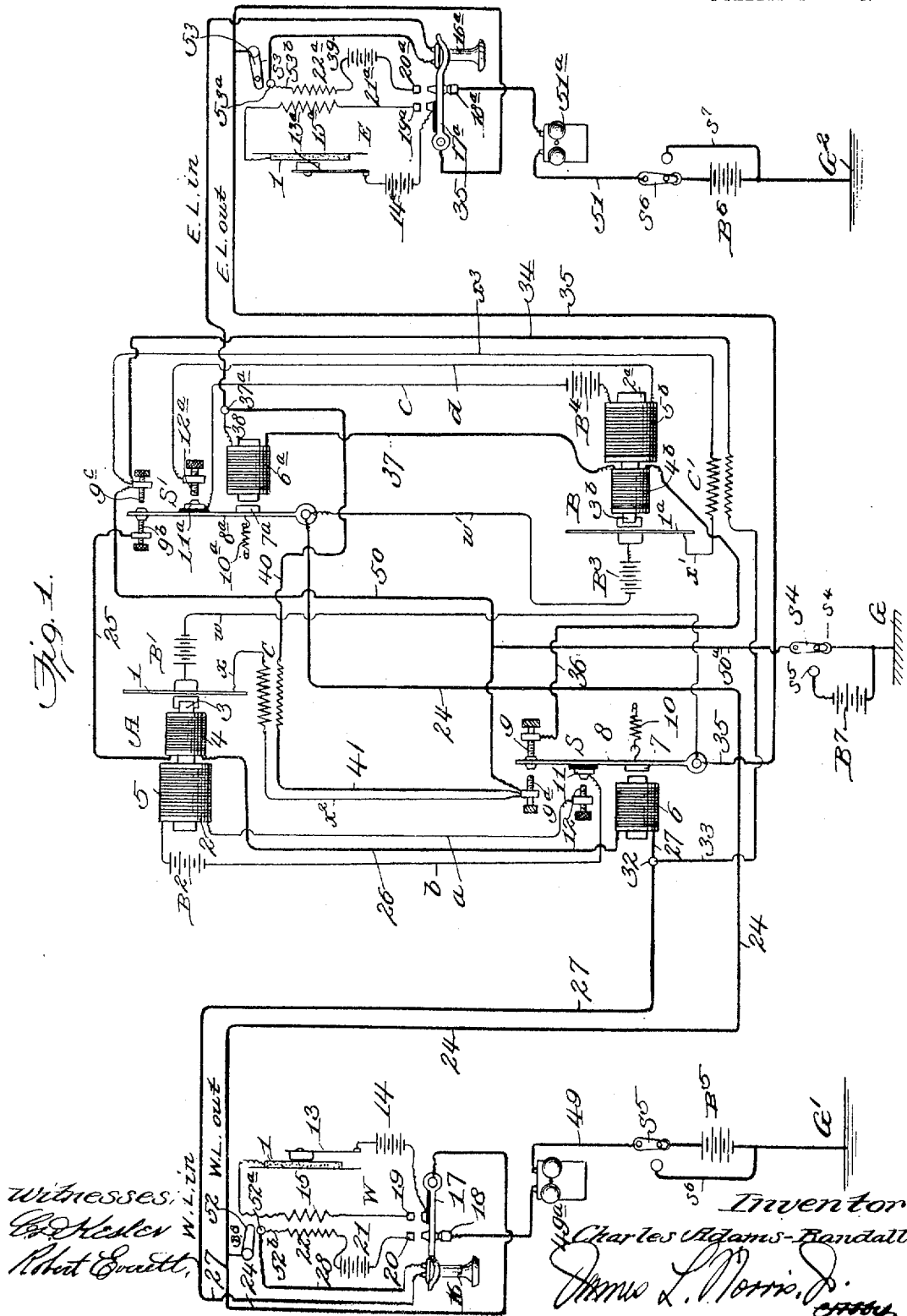


C. ADAMS-RANDALL.  
TELEPHONE REPEATING SYSTEM AND APPARATUS.  
APPLICATION FILED APR. 2, 1910.

1,018,226.

Patented Feb. 20, 1912.

2 SHEETS—SHEET 1.

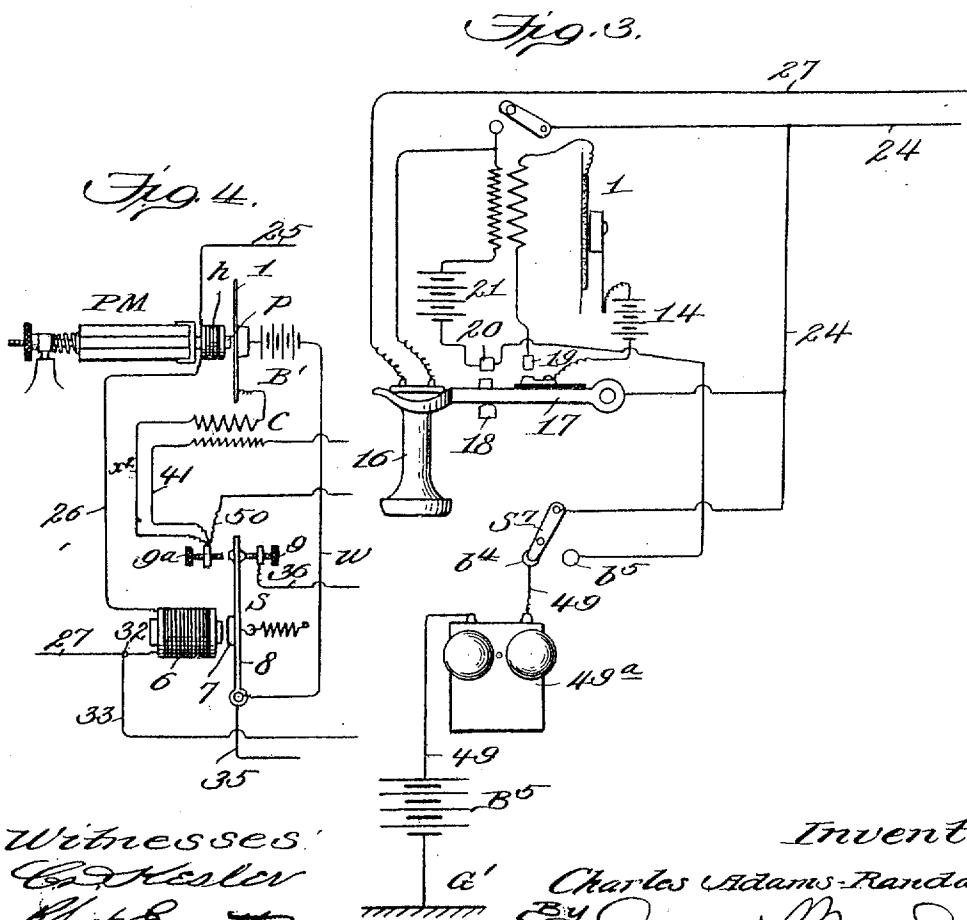
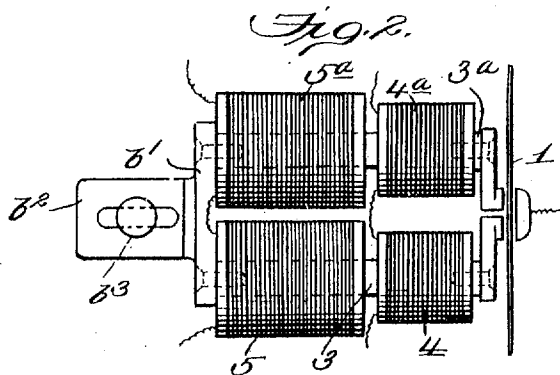


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2 SHEETS—SHEET 2.



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# UNITED STATES PATENT OFFICE.

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TELEPHONE REPEATING SYSTEM AND APPARATUS.

1,018,226.

Specification of Letters Patent.

Patented Feb. 20, 1912.

Application filed April 2, 1910. Serial No. 553,073.

*To all whom it may concern:*

Be it known that I, CHARLES ADAMS-RANDALL, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented new and useful Improvements in Telephone Repeating Systems and Apparatus, of which the following is a specification.

This invention relates to a telephone repeating system and electro-magnetic repeating means necessary thereto and which is automatic in its action, and under the influence or operation of voice-caused, or telephonic or electric currents, impulses or vibrations operate to retransmit or repeat telephonic messages from one independent circuit into one or more independent circuits, in contradistinction to the transmission of such messages inductively over sections of a circuit, or conductively over sections of a circuit joined together as a whole. Technically, such apparatus is known as a "repeater" when repeating or retransmitting from one independent main line circuit into or over another main line circuit, and as a "relay" when it serves to control or utilize a local battery in a local circuit in which directly or indirectly suitable receiving, reproducing, or recording apparatus is included at the local station or in a short local or subscriber's circuit. In an automatic telephone repeating system, the interconnection or coöperation, through intermediate means, of one separate and independent telephone circuit with one or more independent telephone circuits, whereby telephone messages transmitted over one of such circuits can be automatically retransmitted over or upon another independent circuit, or over or upon other independent circuits, without any electrical or mechanical connection between such circuits is a vital or essential element of the system and apparatus, and not only the repeating device itself must be considered and included in the invention constituting such a system and apparatus, but also means for automatically controlling two or more independent main line circuits; means for controlling from either distant terminal the devices employed

to produce a complete telephone repeater for operation intermediate the terminals of said independent main line telephone circuits.

To this end the objects of the present invention are as follows: the production of an automatic electro-magnetically operated telephone repeating apparatus for use intermediate two distinct independent telephone circuits; producing means for obtaining absolute control of an electromagnetic repeating apparatus intermediate the sending and receiving stations; producing means for the automatic control of the telephone repeater, namely, its transmitting means having its local battery or batteries, its coil or coils and the necessary circuits and circuit connections therefor; to provide for automatically retransmitting or repeating telephonic messages transmitted over or upon one independent circuit by manually or electro-magnetically operated transmitting means and reproduced in one or more independent circuits by electro-magnetic means actuated by the electric currents, vibrations or impulses caused or produced by the transmitter in the first or primary transmitting circuit, whether caused by the act of speaking into or upon a telephone transmitter, or by the operation of a transmitter by electromagnetic means; to control from either terminal of two coöperating independent telephone lines or circuits of an automatically acting intermediate repeating apparatus for retransmitting telephonic messages; and to produce means for controlling two independent circuits from either terminal.

In my pending application for a telephone repeater, Serial Number 255,754, filed April 15, 1905, certain parts are shown and described similar and corresponding in action to some of the means forming a part of this invention. In my previous application, however, the electro-magnetic controlling switch has a different construction and operation and is arranged to be actuated directly by the telephone currents passing over its coils and others in series therewith in the main line. Owing to the low energy or power of telephone currents on compara-

tively long telephone circuits a very delicate and perfect construction of the movable parts of this class of controlling switches is necessary to assure operation, and even under these favorable conditions of construction many disadvantages are present.

The present invention is an improvement on that disclosed by my prior application and seeks not only to overcome the objections and disadvantages found to exist in the earlier form of the apparatus, but also to provide means for effecting other operations as will be hereinafter explained, and for more positively and effectually controlling the action of the electromagnetic transmitter of the repeater and its cooperating parts; the use of a current of any required power, from a battery or other source of electrical energy, in contradistinction to the telephone induced current, for actuating the electromagnetic controlling switch over circuits of greater length; and to obtain a more positive and efficient control of the independent main line and local circuits.

The invention consists generally in the combination of an electro-magnetically operated telephone transmitter, a battery or other source of electric energy, an induction coil, transformer or repeating coil as elements thereof acting as a repeater to retransmit messages from one independent main line over or upon another or other main lines; an electro-magnetic controlling switch or circuit changing means actuated independently of the electro-magnetic transmitter, together with the circuits and circuit connecting means therefor and appertaining thereto, and arranging such parts or means and the circuits in duplicate in the one apparatus or telephone repeating instrument.

The invention further consists, in combination with a telephone repeating system having means at the terminals of the independent circuits operative to continuously close from either terminal for and during the transmission of messages from either terminal, of a main line battery that actuates an electro-magnetic switch means in the transmitting circuit for closing the local and main line circuit connections of the repeater, the said terminal switch means being adapted to cut out of the circuit when receiving, if desired, the main line battery and the transmitting coil at the terminal.

In the drawings: Figure 1 is a diagrammatic view of the operative means of the repeater and the circuits connected therewith and the independent main line circuits together with the means and circuits employed at the terminals of the independent main line circuits. Fig. 2 is a top plan view of a portion of the apparatus. Fig. 3 is a dia-

grammatic view showing a modification of the means for controlling the calling apparatus and its battery. Fig. 4 is a diagrammatic view of a portion of the apparatus showing a further modification.

The essential operative parts of the apparatus consist of electro-magnetically operated repeater organizations A and B, respectively having in cooperation therewith electro-magnetic controlling switches S, S', the terminal stations for convenience being hereinafter respectively designated "West" and "East."

The operative parts of the repeater A consist, as shown by Figs. 1 and 2, of an electro-magnetically operated transmitter 1 having a battery B', an induction coil, transformer or repeating coil C, and a battery B<sup>2</sup>. Combined with the transmitter 1, which may be of any of the well known forms of battery transmitters arranged to be operated electro-magnetically, is an electro-magnet 2 having extended pole pieces 3, 3<sup>a</sup> supporting coils 4, 4<sup>a</sup>, said coils being included in one of the independent main line circuits, the electro-magnet coils 5, 5<sup>a</sup> being in a local circuit *a, b* with the battery B<sup>2</sup> which serves to energize the electro-magnet when required, by the automatic closing of its circuit at 11, 12 by the action of the controlling switch S, the latter also simultaneously closing the circuit of the battery B' including the transmitter 1 and the primary coil of the induction coil, transformer or repeating coil C. It will be understood that the electro-magnet 2 on the transmitter 1, or both, may be adjusted to and from the other to obtain the best results, and a simplified means of adjustment is shown by Fig. 2 and consists in supporting the electro-magnet 2 on a bed or base plate *b'* having slotted means such as an arm or projection *b''* engaged by an adjusting screw *b'''*, Fig. 2. This construction or the provision of means for adjusting the electro-magnet is not essential and it is proposed to use any suitable device or devices for this purpose.

The electro-magnetic controlling switch S may be of any preferred form of construction adapted to the use of a direct battery current. The form shown is that of an ordinary telegraph relay and consists of a suitable electro-magnet having coils 6, arranged opposite to an armature 7 supported on a fulcrumed lever 8, the free end of the said lever being movable between two properly supported adjustable contact points 9, 9<sup>a</sup>, a retractile spring 10 acting to hold the said lever in normal position in contact with the point 9 as shown. A supplemental circuit closer controlled by the action of the main switch S is used and consists of a contact point 11 on the lever 8 and insulated

from the latter, and a suitably supported adjustable contact point 12, said contact points 11 and 12 being included in the local circuit  $a$ ,  $b$  of the battery  $B^2$  and magnetic coils 5 and 5<sup>a</sup> and serve to open and close the said circuit.

The operative parts of the repeater B are duplicates of those included in the repeater organization A and are indicated by reference characters 2<sup>a</sup>, 3<sup>b</sup>, 4<sup>b</sup>, 5<sup>b</sup>, B<sup>3</sup>, B<sup>4</sup>, battery circuit  $c$ ,  $d$ , S', 6<sup>a</sup>, 7<sup>a</sup>, 8<sup>a</sup>, 9<sup>b</sup>, 9<sup>c</sup>, 10<sup>a</sup>, 11<sup>a</sup>, 12<sup>a</sup>, and 1<sup>a</sup> respectively. Fig. 1 shows diagrammatically and symbolically all of the devices connected up in their proper main and local circuits, in normal positions. The independent circuits or lines are marked respectively W. L. from the west terminal W, and E. L. from the east terminal E. The independent main line circuits are indicated by heavy lines to distinguish them from the remaining or local circuits which are indicated by light lines. The independent local circuits include the coils of the electro-magnet 2 and its battery B<sup>2</sup> and also the coils 5<sup>b</sup> of the electro-magnet 2<sup>a</sup> and its battery B<sup>4</sup>. The independent local circuits also include the transmitter 1, its battery B', and the induction coil or transformer C and also the transmitter 1<sup>a</sup>, its battery B<sup>3</sup> and induction coil or transformer C', all of which devices are at the repeater station, and which, combined with the electro-magnetic controlling switches S and S', form essential elements of the automatic repeating apparatus. The battery B' is connected to the transmitter 1, and also by a wire  $w$  to the switch lever 8 of the switch S, and from the transmitter 1 by wire  $x$  to the primary of C, and by wire  $x^2$  to the contact point 9<sup>a</sup>, such circuit being automatically closed when the lever 8 and the point 9<sup>a</sup> are in contact. The battery B<sup>3</sup> is connected to the transmitter 1<sup>a</sup>, and by wire  $w'$  to the switch lever 8<sup>a</sup> of the switch S', and from the transmitter 1<sup>a</sup> by wire  $x'$  to the primary of C', and by wire  $x^3$  to the contact point 9<sup>c</sup>, such latter circuit being automatically closed when the point 9<sup>c</sup> and the lever 8<sup>a</sup> are in contact. Connection is also made from the contact point 9<sup>a</sup> of the switch S with the contact point 9<sup>c</sup> of the switch S' by wire 50 which has a branch 50<sup>a</sup> to ground G for purposes which will be hereinafter more fully explained, the said ground being normally open. The coils 3 and 4<sup>a</sup> on the pole pieces 3 and 3<sup>a</sup> are connected by wires 25 and 26 to the contact point 9<sup>b</sup> and the coils 4 and 4<sup>a</sup> of the electro-magnet controlling switch S of the repeating organization A, and likewise the repeating organization B has a wire 36 connecting the coil 4<sup>b</sup> with the contact point 9 of the switch S and also running from the coil or coils 4<sup>b</sup> is a wire or con-

nection 37 which is associated with the electro-magnetic coil or coils 6<sup>a</sup> of the switch S'. A wire 24 constituting a part of one of the main line circuits and serving as the west line out from the repeater connects with the lever 8<sup>a</sup> of the switch S' and runs to the west terminal W, and a wire 27 forming the remaining part of one of the main line circuits and serving as the west line in to the repeater connects with the coil or coils 6 of the electro-magnet of the switch S and also with the west terminal W. From a point 32 a branch of the main line circuit just specified is established by means of a wire 33 constituting in the repeater organization a part of the west line and which runs to the secondary of the induction coil or transformer C', the latter also being connected by a wire 34 to the contact point 9<sup>c</sup>. A wire 35 forming part of an independent main line circuit and serving as the east line out from the repeater is connected to the lever 8 of the switch S and runs to the east terminal E, a wire 40 from the secondary of the induction coil or transformer C constituting the east line in to the repeater and also running to the east terminal E. The wire 40 has connection through the medium of a point 37<sup>a</sup> and a wire 38 with the coil or coils 6<sup>a</sup> of the electro-magnet controlling the switch lever 8<sup>a</sup>, and also to the secondary of the induction coil or transformer C which is connected by a wire 41 with the contact point 9<sup>a</sup> cooperating with the switch S.

The subsidiary terminal apparatus at W and E embodies in each instance a voice-operated telephone transmitter of any preferred or usual form indicated at the terminal W as at 13 and having a battery 14 and induction coil 15. As shown by Fig. 1, a receiver 16 is normally supported on a well known form of automatic hook lever 17 cooperating with the usual contact piece 18 and also connected to the battery 14, the lever 17 making contact with the piece 18 when the receiver is disposed thereon in normal position. The contact piece 18 is connected by a wire 49 through a bell or other calling device 49<sup>a</sup> and a battery B<sup>5</sup> to ground G', and when the lever is in engagement with the contact piece 18 the terminal W is arranged to receive a call from the east terminal apparatus E through the independent east line circuit. When the receiver is removed from the hook lever 17, the latter makes contact with two independent contact points 19 and 20, the contact point 19 being connected to the primary of the induction coil or transformer 15 and which is also connected to the transmitter 13. The contact point 20 is connected to one pole of the battery 21, the latter having its opposite pole connected

to the secondary 22 of the induction coil or transformer 15, the receiver 16 being also connected to the said secondary by wire 28. The wire 27 constituting the west line in to the repeater is connected to the receiver 16 and the wire 24 constituting the west line out from the repeater is attached to the lever 17.

The wire 35 constituting the east line out from the repeater and the wire 40 constituting the east line in to the repeater are respectively connected to a hook lever 17<sup>a</sup> and receiver 16<sup>a</sup> embodied in the terminal apparatus E and including a voice-operated telephone transmitter 13<sup>a</sup> similar to the transmitter 13. The lever 17<sup>a</sup> is connected to one pole of a battery 14<sup>a</sup> and the transmitter 13<sup>a</sup> is connected to the opposite pole of the battery. When the receiver 16<sup>a</sup> is removed from the lever 17<sup>a</sup>, the latter makes contact with contact pieces 19<sup>a</sup> and 20<sup>a</sup>, but normally the said lever is held in engagement with a contact piece 18<sup>a</sup>. The contact piece 18<sup>a</sup> is connected by a wire 51 through a bell or other suitable signaling means 51<sup>a</sup> and battery B<sup>a</sup> to ground G<sup>a</sup>. The contact pieces 19<sup>a</sup> and 20<sup>a</sup> are respectively connected to the primary of the induction coil 15<sup>a</sup> and to one pole of a battery 21<sup>a</sup>, the opposite pole of the latter battery being connected to the secondary 22<sup>a</sup> of the induction coil or transformer 15<sup>a</sup>. The secondary 22<sup>a</sup> is connected by a wire 39 to the receiver 16<sup>a</sup>.

The west line 27 out to the repeater from the terminal W is connected to a switch S<sup>a</sup> consisting of a switch lever 53 cooperating with a switch point 52<sup>a</sup> connected by a wire 52<sup>b</sup> to the secondary 22 of the induction coil or transformer 15. The east line out from the repeater is connected to a switch S<sup>b</sup> embodying a switch lever 53<sup>a</sup> cooperating with a contact point 53<sup>b</sup> connected by a wire 53<sup>b</sup>, forming part of wire 39, with the secondary 22<sup>a</sup> of the induction coil or transformer 15<sup>a</sup>. These two switches S<sup>a</sup> and S<sup>b</sup> and the specific connections explained provide for the opening or closing of the shunts thus formed with relation to the several instrumentalities at the terminals and the main line circuits for the purpose of shunting the secondaries of the induction coils 15 and 15<sup>a</sup> and the batteries 21 and 21<sup>a</sup>, when receiving, but it will be understood that when the system or apparatus as a whole is arranged normally the said switches will preferably be open.

The circuits at and from the west and east terminals W and E are normally ready for a call. Assuming that a call has been sent from the east terminal E and answered by the W terminal, the operation is as follows: The operator called, W, removes his receiver 16 from the lever 17 and preferably closes

the switch S<sup>a</sup> at 52<sup>a</sup> cutting out the coil 92 and battery 28, thus putting the line in best condition for receiving. The operator calling, E, removes his receiver 16<sup>a</sup> from the lever 17<sup>a</sup> and speaks when the messages are transmitted over the west circuit and automatically repeated at the repeater into and over the east circuit.

The switches S<sup>a</sup> and S<sup>b</sup> are preferably closed when receiving, but must be open when sending.

Any form of circuit closer, such as a telegraph key or a push-button, can be used in lieu of the switches S<sup>a</sup>, S<sup>b</sup>.

It will be understood that the coils 4, 6, 4<sup>b</sup> and 6<sup>a</sup> are preferably of the well known double form of an electro-magnet and may be connected up in multiple instead of in series as indicated in the drawings, thereby reducing the line resistance. As well understood in the art, the coils 5 and 5<sup>b</sup> may be of double form, and serve with their respective batteries B<sup>2</sup>, B<sup>4</sup> to magnetize or polarize the soft iron pole-pieces 3, 3<sup>b</sup> having the main line coils 4, 4<sup>b</sup> thereon, such pole pieces acting as permanent magnets so long as the batteries remain closed.

When one subscriber, as at W, desires to call another, the receiver 16 is removed and the battery 21 is connected in the line in series with the said receiver and the coils 6, 4. This closes the circuit from battery 21 to conductor 27 through the coils 6 and 4, over conductor 25 to contact 9<sup>b</sup>, over armature lever 8<sup>a</sup> and back to conductor 24 and to battery 21. Relay 6 is thus energized and in addition to closing the circuits of batteries B<sup>2</sup> and B<sup>4</sup> closes the circuit of the called subscriber's battery B<sup>a</sup>, (since the switches S<sup>a</sup>, S<sup>b</sup>, S<sup>c</sup> are, when the system is idle, in the position shown in Fig. 1) thereby ringing the bell 51<sup>a</sup>. This circuit of the bell 51<sup>a</sup> extends from ground at G<sup>a</sup> to the battery B<sup>a</sup>, the bell 51<sup>a</sup>, normally closed contact of the switch hook 17<sup>a</sup>, line conductor 35, armature lever 8, contact 9<sup>a</sup>, and conductors 50, 50<sup>a</sup> to ground at G. After calling the wanted station the calling subscriber replaces his receiver so that the response of the wanted party will notify the calling subscriber by ringing the latter's bell. This is accomplished by the called party lifting his receiver before closing the switch S<sup>a</sup>, so that the battery 21<sup>a</sup> is connected in the line in series with the receiver 16<sup>a</sup> and coils 6<sup>a</sup>, 4<sup>b</sup>, thus energizing the relay 6<sup>a</sup>, and grounding, for the moment, the calling subscriber's battery B<sup>a</sup> through the bell 49<sup>a</sup> and conductor 24, contact 9<sup>a</sup> and conductors 50, 50<sup>a</sup>, to ground at G. As soon as the called party closes the switch S<sup>b</sup> the relay 6<sup>a</sup> is deenergized, and when the calling subscriber again lifts his receiver the relay 6 is energized and

the repeater is in condition to transmit from station W to station E. When the subscriber at E desires to talk, he opens his switch S<sup>a</sup> and the subscriber at W closes his switch S<sup>b</sup>.

Without departing from the spirit of the invention a permanent steel magnet P, M having soft iron pole pieces *p* supporting helices *h* can be used in lieu of the electro-magnet 2 or 2<sup>a</sup> heretofore described, as shown by Fig. 4, and thereby dispense with the battery B<sup>2</sup> or B<sup>3</sup> and associated parts, as shown by Fig. 1. Otherwise the devices shown by Fig. 4 are similar to those heretofore described and are indicated by corresponding reference numerals.

The repeating apparatus herein disclosed can be used as a "relay" and installed at a central exchange to be used in connection with long distance and subscribers' short circuits, or between subscribers' lines, to "boost up" or improve the transmission between any two subscribers using the telephone. In this particular application as a "relay" the apparatus will be installed at "central" and connected in, intermediate the subscribers' lines, by the central operator as required, similarly as subscribers' lines are now connected together at central.

It will be understood that the repeater organization may be used to retransmit or repeat into or over a local circuit or circuits, instead of main line circuits, to actuate telephone receivers included in such local circuits.

It will be noted from the foregoing description that the electro-magnetic controlling switches are important, essential elements of the repeater organization, and that they are actuated by a battery or other current of greater energy than the speaking telephone current, to insure positive operation. Further, it will be seen that the apparatus as described is strictly automatic in its operation and adapted for the transmission of telephone messages in either direction at will, through and by means of the automatically operating apparatus of the repeater organization intermediate the sending and receiving stations and without requiring the attention or aid of an operator at the intermediate station. Furthermore, there is no continuous inductively connected circuit between the sending and receiving station in the present system and apparatus and consequently the disadvantageous loud, humming sounds set up in the inductively connected circuits under certain conditions are absent, and hence there is no interference with a clear and invariable reproduction of the messages at the receiver.

What is claimed is:

1. In a telephone repeating system, a re-

peater organization having electro-magnetically operated transmitting means in duplicate, electro-magnetic switch means in duplicate for automatically opening and closing the respective line and local circuits of the repeater organization, a current supply of greater energy than the telephone current for operating the switch means during transmission from the terminal stations on either side of the repeater organization and included in series in the main line, and means at the terminal stations for controlling said main line current from the sending terminal station.

2. In a telephone repeating system, in combination with two separate, independent coöperating main line telephone circuits, of a repeating organization having electro-magnetically operative transmitting means in duplicate, electro-magnetic controlling means in duplicate for automatically selecting and making and breaking the main line and local circuit connections of the repeater organization, a main line electric current supply included in series in the main line and of greater energy than the telephone current, and means at the terminal stations of the coöperating independent telephone circuits for controlling said battery current or other current supply of greater energy than the telephone current.

3. In a telephone repeating system, the combination with two separate, distinct and independent telephone circuits, of apparatus for transmitting and receiving telephone messages at the distant terminals of the two independent telephone circuits, a repeater organization intermediate the said two independent telephone circuits having electro-magnetic switch means in duplicate disposed respectively in the two independent telephone circuits for selecting and closing the line and local circuits of the repeater organization, a main line current supply of greater energy than the telephone or speaking currents and independent thereof for operating either of the electro magnetic switch means as required, and means at the terminal stations for controlling the said main line current simultaneously with the transmission of telephone messages.

4. In a telephone repeating system, in combination with two distinct, independent telephone circuits, of an intermediate telephone repeater organization comprising electro-magnetically operated transmitting means in duplicate, electro-magnetic switching means in duplicate, a main line battery in each of the two independent circuits for operating the electro-magnetic switch means, terminal station apparatus in each of the two independent main line circuits adapted to transmit and receive telephone messages,

and means at the terminal stations adapted to close the main line battery when transmitting.

5 A telephone repeating system embracing, in combination, two separate, distinct, independent main line telephone circuits, means intermediate said circuits adapted to receive telephone messages transmitted over either of said circuits and to automatically  
10 retransmit said messages into, over, or upon the other circuit, a main line battery in each of said circuits for operating the said means, when transmitting, with means at the ter-

minal stations for transmitting and receiving messages together with means for closing at the transmitting station when messages are being transmitted, the respective main line battery. 15

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses. 20

CHARLES ADAMS-RANDALL.

Witnesses:

F. C. JOUTRAS,

E. McAVINEY.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."