C. D. LANNING.

SYSTEM FOR THE TRANSMISSION OF ELECTRICAL ENERGY.

APPLICATION FILED AUG. 8, 1907.

1,002,711.

Patented Sept. 5, 1911.

8 SHEETS—SHEET 1.

Fig. 1.

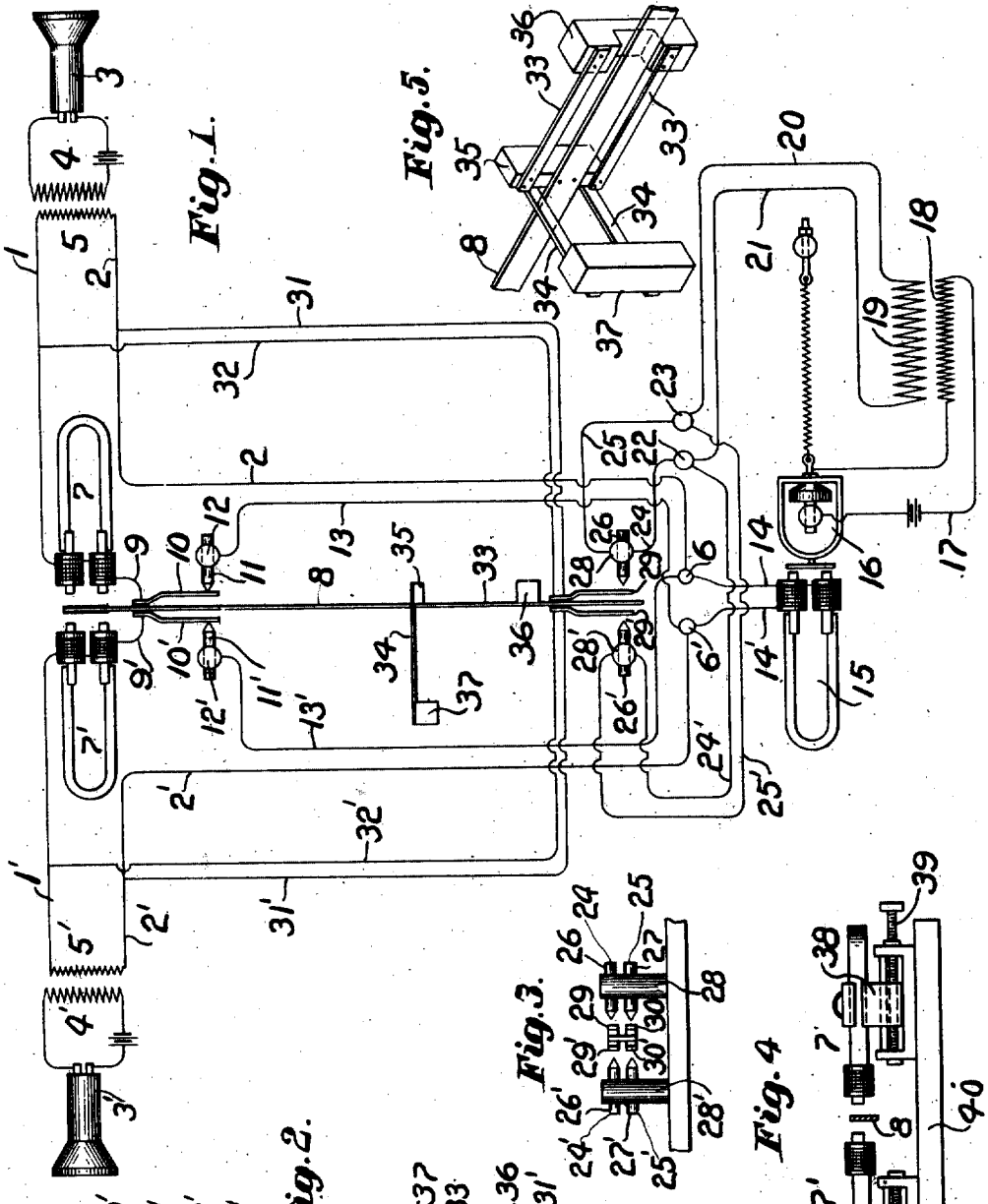
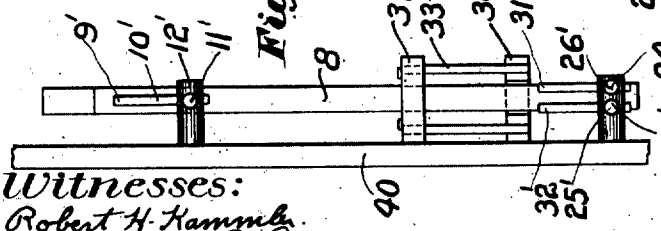


Fig. 5.

Fig. 3.

Fig. 4

Fig. 2.



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8 SHEETS—SHEET 2.

Fig. 6.

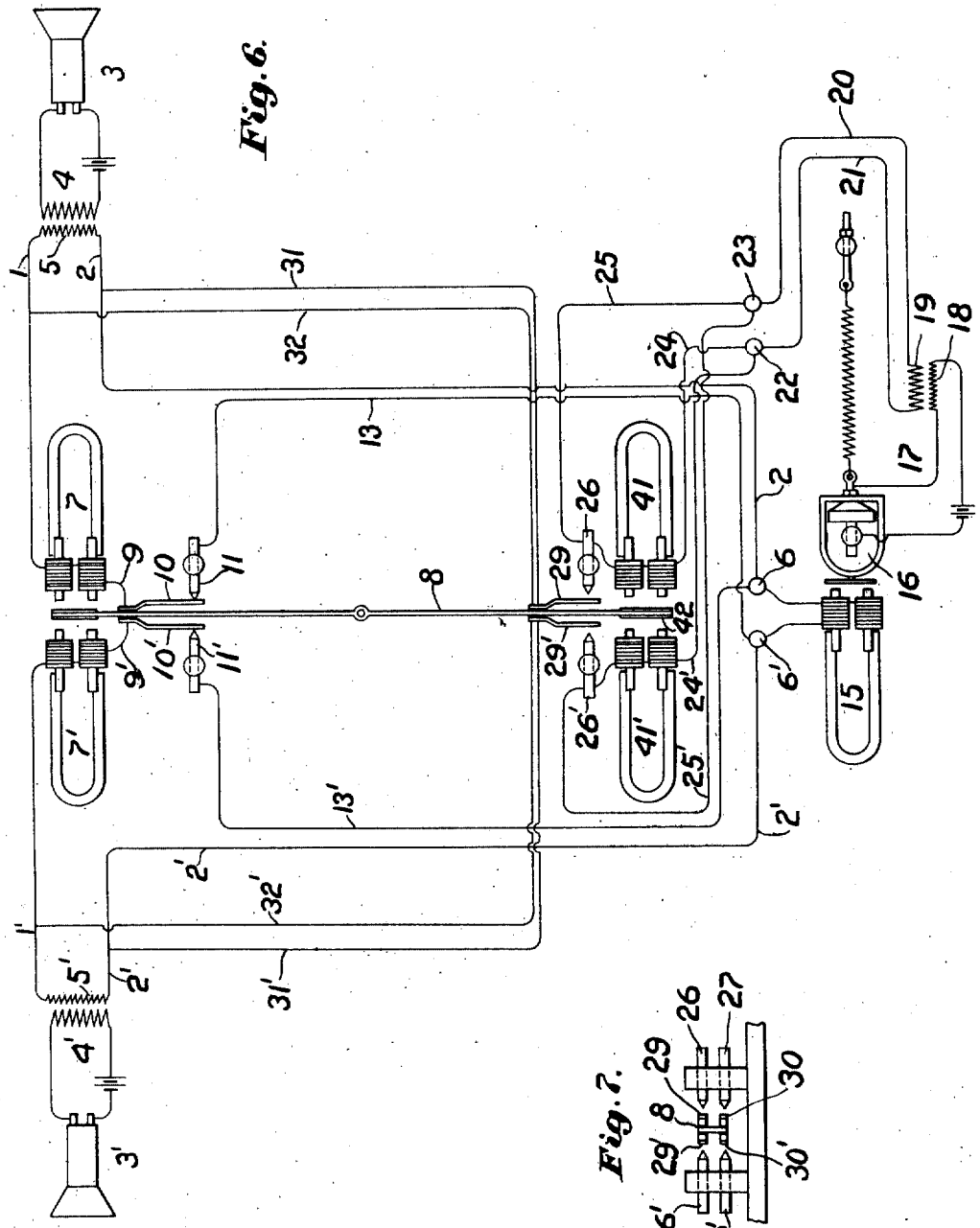

Fig. 7.

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8 SHEETS—SHEET 3.

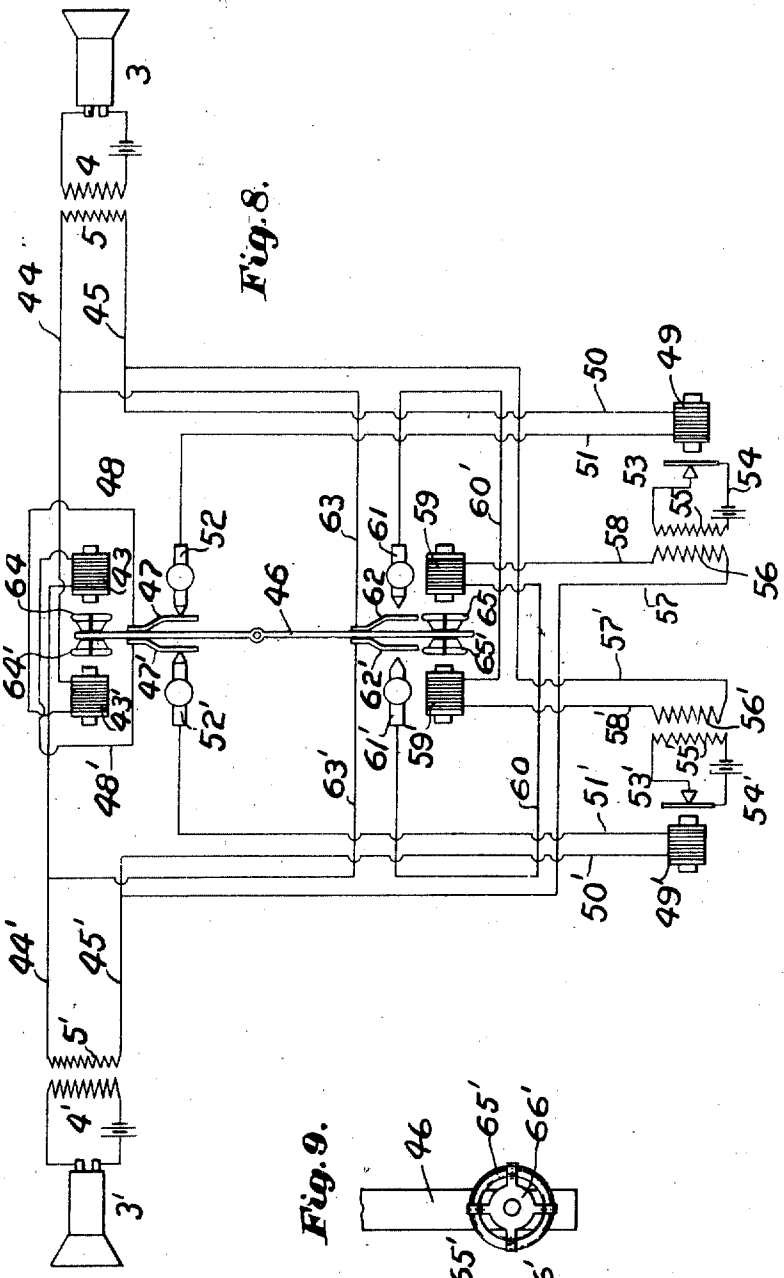

Fig. 8.

Fig. 9.

Fig. 10.

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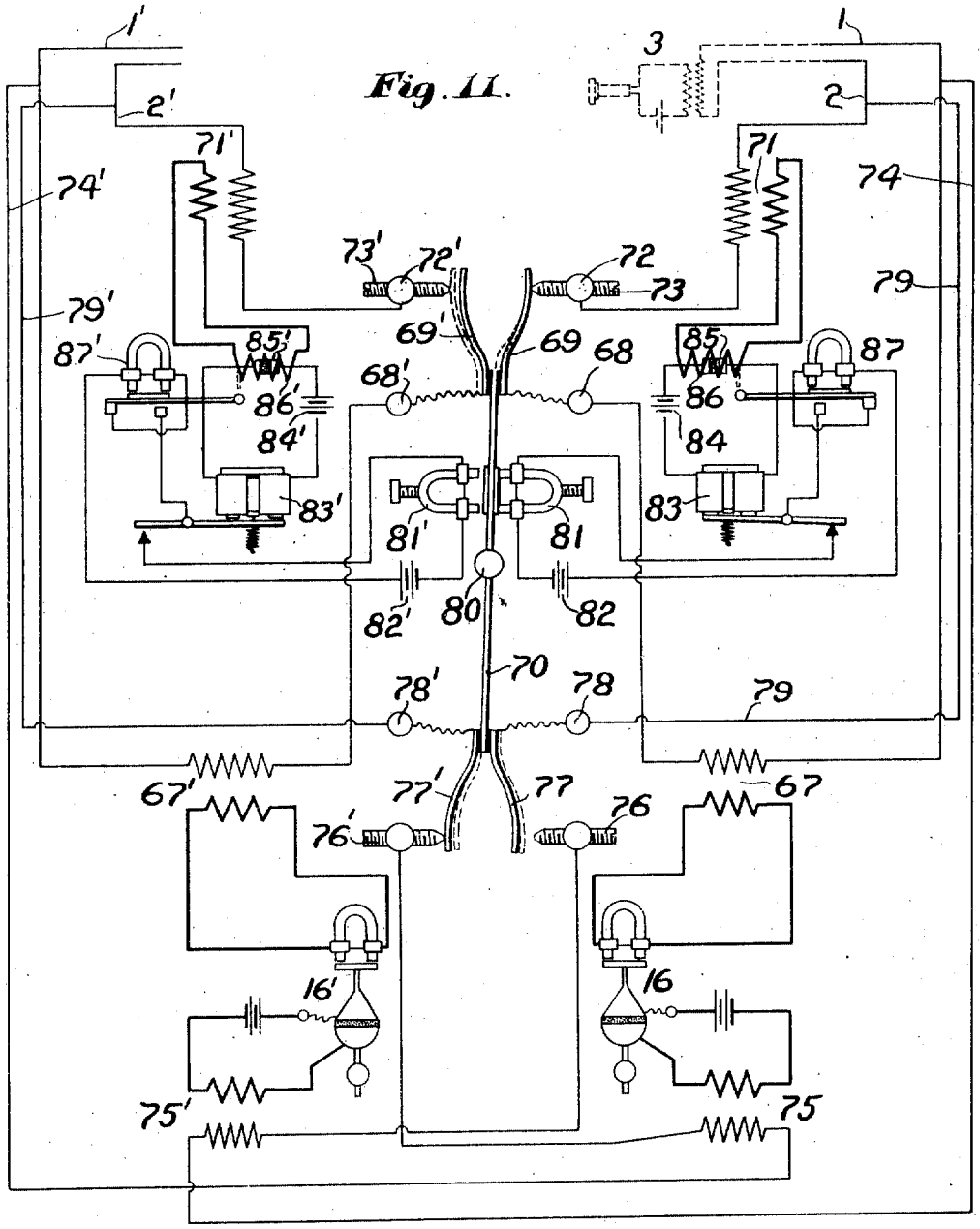
8 SHEETS—SHEET 4.

Fig. 11.



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8 SHEETS—SHEET 5.

Fig. 12.

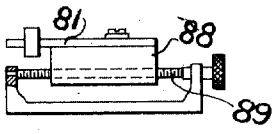


Fig. 13.

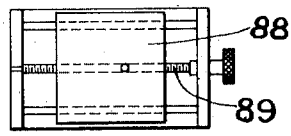


Fig. 16

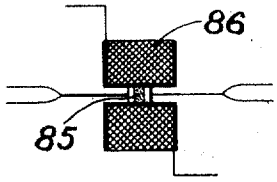


Fig. 14.

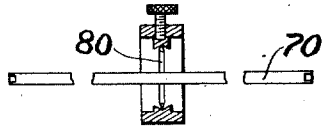
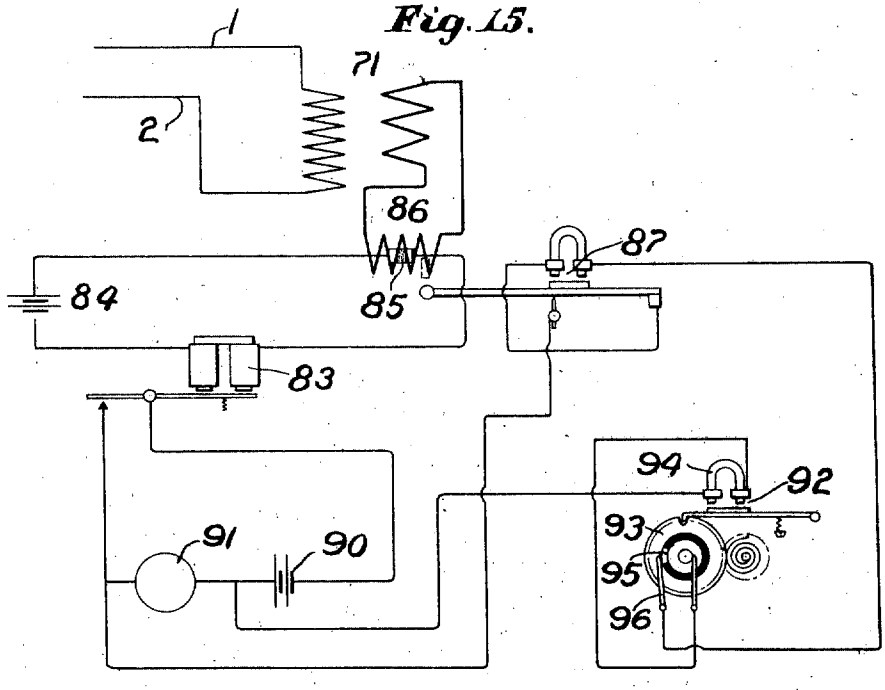


Fig. 15.



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8 SHEETS—SHEET 6.

Fig. 17.

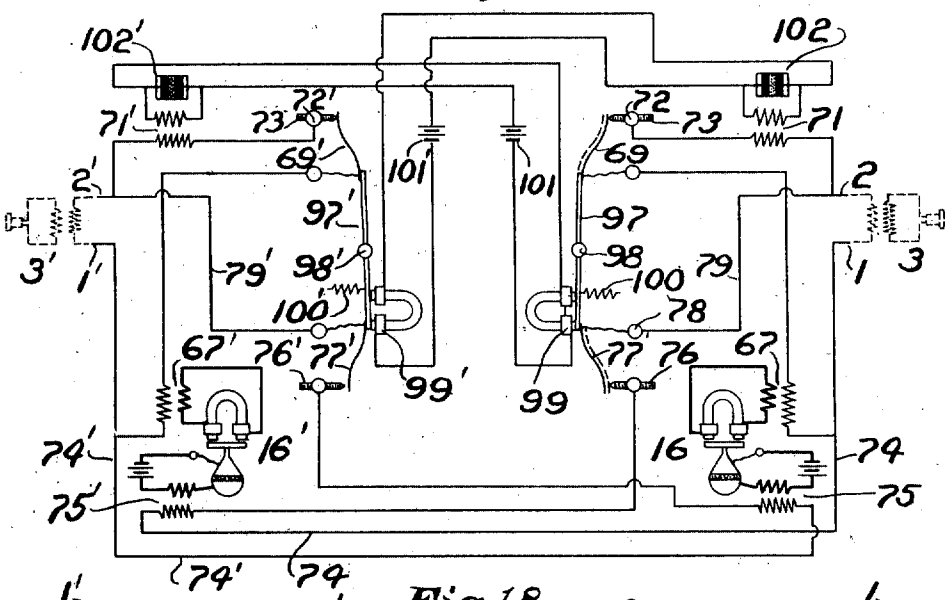
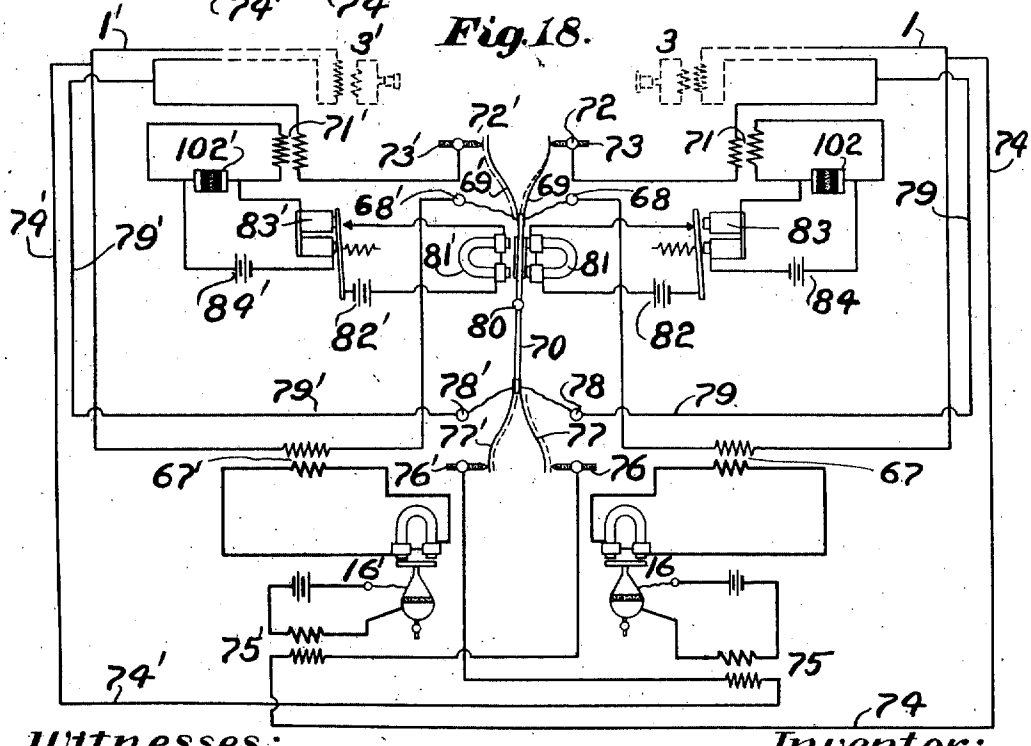


Fig. 18.



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8 SHEETS—SHEET 7.

Fig. 19.

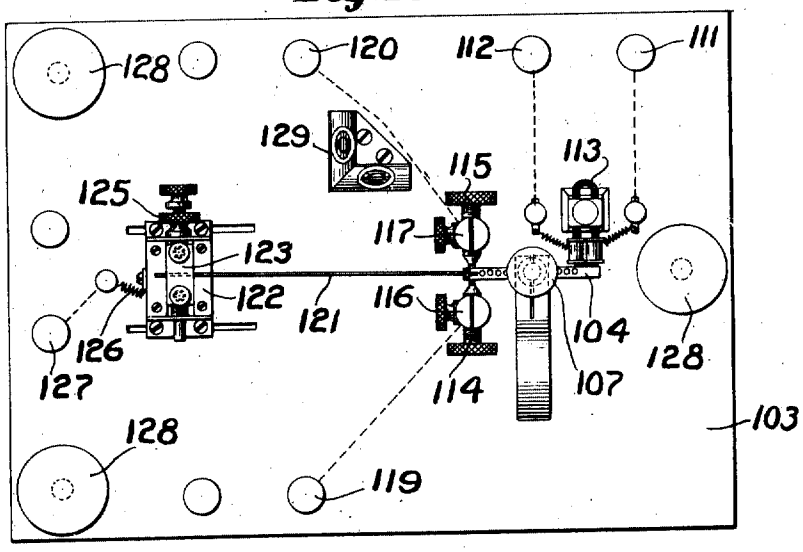


Fig. 20.

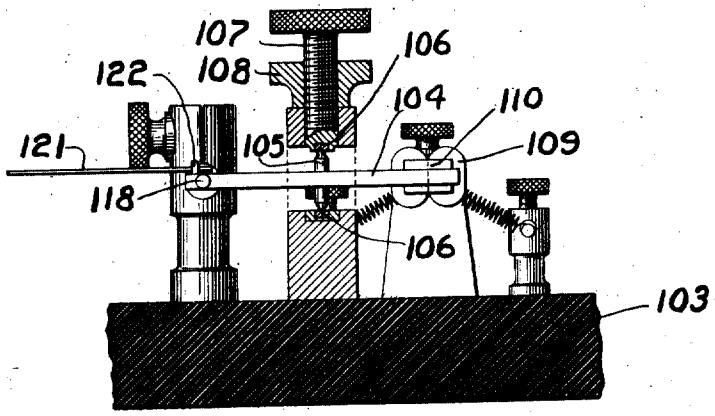
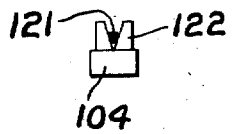


Fig. 21.



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8 SHEETS—SHEET 8.

Fig. 22.

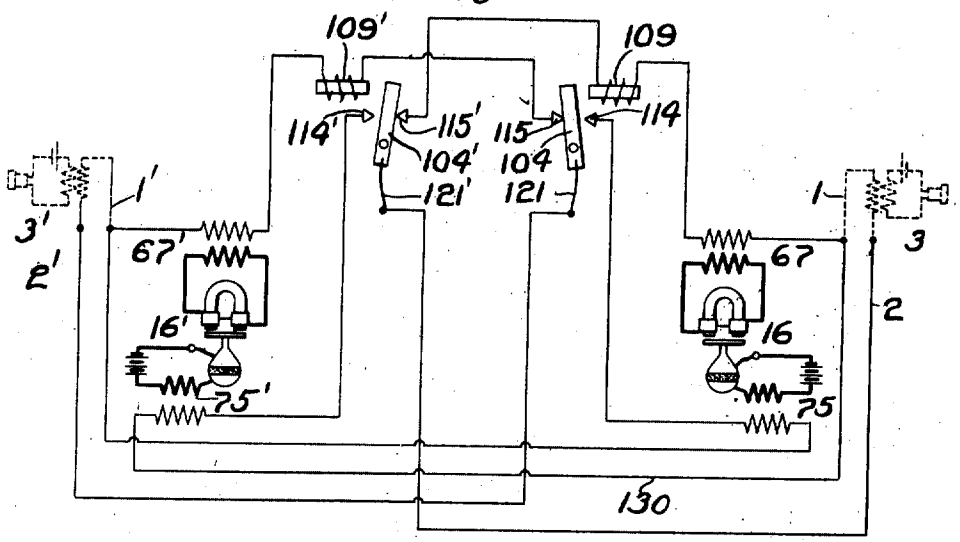
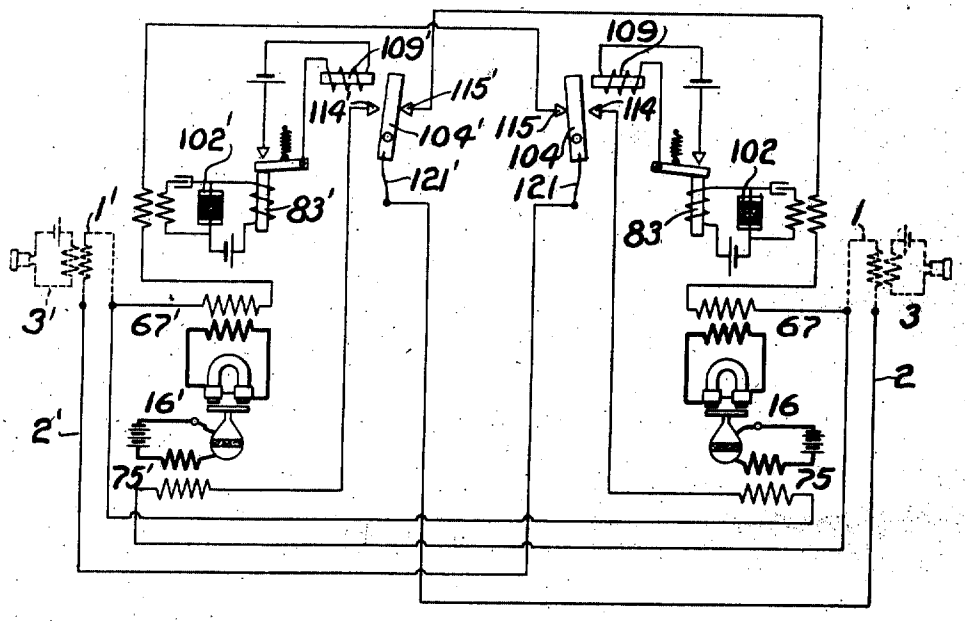


Fig. 23.



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UNITED STATES PATENT OFFICE.

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SYSTEM FOR THE TRANSMISSION OF ELECTRICAL ENERGY.

1,002,711. Specification of Letters Patent. Patented Sept. 5, 1911.

Application filed August 8, 1907. Serial No. 387,647.

To all whom it may concern:

Be it known that I, CHARLES D. LANNING, a citizen of the United States, residing in Boston, in the county of Suffolk and State of Massachusetts, have invented an Improvement in Systems for the Transmission of Electrical Energy, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention relates to the transmission of electrical energy, being more particularly concerned with the reinforcement of transmitted energy.

While my invention may have extensive and varied applications, it possesses particular advantages in connection with the art of electrical telephony, and I have therefore described and illustrated one embodiment thereof in connection with an improved telephonic relay or repeating device.

In telephone relays, unless some circuit changing means is provided for controlling the circuits and establishing them accurately with reference to the desired direction of speech-transmission, the reactive effect of the closely associated circuits which is a necessary consequence of a two-way repeater constructed under such limitations, results in a reactive noise effect of the associated circuits upon each other or in a conflict and distortion of the voice currents flowing therein.

Circuit changing or switching devices heretofore employed in two-way repeater systems have depended for their operation upon forces extraneous to the usual telephonic currents and have not been automatic.

When employed in connection with a two-way repeater my invention automatically accomplishes the correct circuiting at a repeating point so as to maintain the desired current strength and at the same time eliminate reactive noise effects.

My invention will be best understood from the following description and accompanying illustration of one specific embodiment thereof, while its scope will be more particularly pointed out in the appended claims.

In the drawings: Figure 1 represents diagrammatically one form of circuit arrangement for carrying out my invention; Fig. 2 shows the relay controlling switch of Fig. 1 in side elevation; Fig. 3 shows an end elevation of the same; Fig. 4 shows in side elevation the switch controlling magnets and their supports, and the switch lever in cross-section; Fig. 5 is a perspective view of the pivotal support for the switch lever shown in Fig. 1; Fig. 6 shows a modified arrangement of circuits; Fig. 7 is a view similar to Fig. 3 of the switch lever shown in Fig. 6; Fig. 8 is another modified arrangement of circuits; Figs. 9 and 10 are fragmentary side elevational and cross-sectional views of the form of switch lever represented in Fig. 8; Fig. 11 is a diagrammatic view showing still another arrangement of circuits by which my invention may be carried out; Fig. 12 is a detail elevation partially in section of the adjustable switch operating magnet shown in Fig. 11; Fig. 13 is a plan view of the same; Fig. 14 is a detail partially in section of the switch lever represented in Fig. 11; Fig. 15 is a diagrammatic view showing an improved arrangement of tapper circuits for the system shown in Fig. 11; Fig. 16 is a detail partially in section of my improved coherer with its actuating coil; Fig. 17 is a view showing diagrammatically another arrangement of circuits embodying still a different form of my invention; Fig. 18 is a similar but somewhat modified diagrammatic view; Fig. 19 is a plan view of an improved form of circuit controlling switch; Fig. 20 is a central section in elevation partially broken away, and on an enlarged scale, showing the construction of switch illustrated in Fig. 17; Fig. 21 is a detail of the connection between the switch arm and its controlling spring; Fig. 22 is a diagrammatic arrangement of circuits which may be employed in connection with the switch shown in Fig. 19; and Fig. 23 is a similar but somewhat modified diagrammatic view.

Referring to the drawings and to the embodiment of my invention which is there illustrated, the same contemplates the employment of one or more relay or repeating instruments, through which sound undulations will be conveyed between two lines in either direction desired.

In the illustrated embodiment of the invention the sound-caused electric impulses themselves act to set the relay connections for repeating in the desired direction, the instrumentalities comprising electro-mag-

netic means embraced in normally complete line circuits, two-way relaying connections between the two line circuits, and a controller of said relay connections subject to the influence of said electro-magnetic means so that current strength in the talking line effects completion of relaying connections for repeating to the other line. In the use of the term "electro-magnetic means" not only are the usual magnetic effects upon common and polarized armatures contemplated, but also the repellent effects of alternating current magnets upon appropriate material, preferably copper, in suitable form, known technically as electro-inductive repulsion.

Referring to Fig. 1, 1 and 2 represent the two sides of a line circuit intended for the transmission of electrical energy in any form. In this particular instance I will describe the same as a telephonic circuit and I have, therefore, indicated conventionally at 3 a telephone station which it is to be understood is adapted both for the transmission and the receipt of telephonic voice-actuated currents. The station 3 is shown as connected with a supposedly distant station 3' having circuits and connections similar and corresponding to those of the station 3. The stations are provided with the usual battery circuit including the primaries 4 and 4' of the induction coils, the secondaries 5 and 5' of which (in the system shown in Figs. 1 and 6) have corresponding ends connected by conductors 2 and 2' with binding posts 6 and 6' respectively. The other ends of said secondaries are connected by conductors 1 and 1' with electro-magnets 7, 7', respectively, said magnets being here shown (that is, in Figs. 1 and 6) as of the horse shoe type with double poles confronting each other.

One end of the lever 8 is positioned between said confronting double poles and is faced on each side with para-magnetic material so that this end of the lever will provide an armature for each magnet. Conductors 9 and 9' connect the said magnets respectively with springs 10 and 10' secured to the said lever on opposite sides thereof with interposed insulation. Said springs may contact normally with pins 11 and 11', respectively, mounted in posts 12 and 12' and are connected by conductors 13 and 13' with the binding posts 6' and 6 respectively. The latter are connected by conductors 14 and 14' with an electro-magnet 15 which constitutes the receiver of the repeating instrument, here conventionally shown as of the balanced type. The transmitter 16 of this instrument is embraced in a local battery circuit 17 which includes the primary 18 of an induction coil, the secondary 19 of which is connected by conductors 20 and 21 with binding posts 22 and 23 respectively. Conductors 24 and 25 lead from said binding posts 22 and 23 to pins 26 and 27 respectively (Fig. 3) mounted in a post 28 and insulated from each other. Conductors 24' and 25' lead from the same binding posts 22 and 23 respectively to pins 26' and 27' mounted in a post 28' and insulated from each other.

The lever 8 extends between the two pairs of pins 26, 27 and 26', 27' and carries at one side a pair of springs 29 and 30, and on the opposite side for contact with the pins 26 and 27 respectively a similar pair of springs 29' and 30' for contact with the pins 26' and 27' respectively, said springs being insulated from each other and from the lever.

The conductors 31 and 32 lead from the springs 29 and 30, respectively, and connect with conductors 2 and 1, respectively; and conductors 31' and 32' lead from the springs 29' and 30', respectively, and connect with the conductors 2' and 1', respectively.

The lever 8 (Figs. 2 and 5) is pivoted at a point intermediate its ends preferably by means of resilient bars 33 and 34 connected together at right angles to each other by cross piece 35 to which said lever is secured, the said resilient bars being fastened to supporting posts 36 and 37. The pivot pin of the lever is in the line of intersection of the resilient bars and this form of pivoting means is adopted because of its obviating lost motion and insuring accurate and uniform action of the lever.

Under normal conditions the power end of the lever is intended to be exactly balanced between the electro-magnets 7 and 7', and fine adjustment of these magnets is therefore provided for and illustrated in Fig. 4 wherein said magnets are shown as mounted upon blocks 38 and 38' through which extend adjusting screws 39 and 39', the latter being journaled in suitable bearings upon a base 40.

In the balanced position of the lever the springs 29, 30 and 29', 30', are removed from contact with the pins 26, 27 and 26', 27', while each inductive line circuit is completed by contact between the springs 10 and 10' and the pins 11 and 11'.

When sound undulations are imposed upon either of these circuits, the electro-magnets 7 or 7' of the circuit overcomes the balance of the lever 8, and, by attracting one end of the latter, effects interruption of the circuit of the other line through the opposed electro-magnet by breaking the contact between the spring 10 or 10' and the post 11 or 11' and at the same time one of the pairs of springs 29, 30 or 29', 30' is brought into contact with one of the pairs of pins 26, 27 or 26', 27', thus completing an inductive relay transmitting circuit in the line which is to receive the repeated sound undulations. When talking ceases at one

end of the system and is taken up at the other end a reversal of the relay connections is effected so that sound undulations will be repeated in the opposite direction to what they were before.

The mounting and construction of the switch lever, as described and shown, provides a vibratory circuit controller, namely, the lever 8 having a very low natural rate of vibration and lower, in fact, than that of the lowest audible tone of the human voice. This characteristic, it will be obvious, is a highly important one since it avoids the natural tendency of a vibratory member, having a relatively high rate of vibration, temporarily to pass out from the control of the alternating magnetic flux, which latter is synchronous with the vibrations of the voice at the transmitting end.

I may, in order to assist in establishing and maintaining the position of the switch lever, employ electro-magnetic controlling means in the relay transmitter circuits, and such an arrangement is illustrated in Fig. 6. Here electro-magnets 41 and 41′ of the horse shoe type are incorporated in the connections between the binding posts 22 and 23 and the pins 26 and 26′ respectively, with the double poles of said magnets confronting each other, and the lever 8 is extended between said double poles as shown at 42 and faced on each side with para-magnetic material so as to provide an armature for each magnet. It will be seen that when a relay transmitter is completed by contact between the springs 29, 30 or 29′, 30′, and the pins 24, 25 or 24′, 25′, one or the other of the magnets 41 or 41′ will coöperate with the magnet 7 or 7′ maintaining the lever in the position to which it has been brought by the latter so long as sound undulations continue in the line embracing the same.

In Figs. 8–10 I have shown another form which the details of circuit connections and contacts may assume. In this form the switch lever is actuated by the repulsive effect of the alternating magnetic field on the induced current in the copper ring, such effect being well-known in experimental science and being electric rather than magnetic when the latter term is restricted to the action of the magnetic field on para-magnetic and dia-magnetic materials. Accordingly the magnetic repulse ring and current are so arranged as to establish and maintain the appropriate relay connections by the repulsion of the lever or circuit controller in contra-distinction to attraction thereof, as in the other form shown. A further difference in arrangement is shown in that there is but one set of make and break contacts for the establishment of the relay transmitter circuit. Furthermore, two independent repeating instruments are employed circuited for talking each oppositely from the other, but governed by the same circuit controller. This is of advantage in avoiding split or divided circuits or possible weakening of currents.

The magnets 43, 43′ of the inductive telephonic line circuit are here shown as of the single pole type, and the conductors 44, 45 and 44′, 45′ leading to them from the secondaries 5 and 5′ cross over so that the line on one side of the switching lever 46 connects with the magnet on the opposite side thereof. Contact springs 47, 47′ are mounted upon the switching lever, as in the previously described form, the spring 47 connecting with the magnet 43 by conductor 48, and the spring 47′ with the magnet 43′ by the conductor 48′. The receivers of the two repeating instruments are shown as single pole magnets 49 and 49′ connected respectively by conductors 50 and 50′ with the secondaries 5 and 5′, and by conductors 51 and 51′ with the contact pins 52 and 52′. The transmitter of these repeating instruments are shown conventionally at 53 and 53′ in local battery circuits 54 and 54′ with primaries 55 and 55′ of inductive coils. The secondaries 56 and 56′ have corresponding ends connected by conductors 57 and 57′ with the line conductors 45 and 45′ respectively. The other ends of said secondaries are connected respectively by conductors 58 and 58′ with juxtapositioned single pole electro-magnets 59 and 59′, which are, in turn, connected respectively by conductors 60 and 60′ with contact pins 61′ and 61. The switching lever carries a single pair of springs 62 and 62′ normally out of contact with said pins respectively, and conductors 63 and 63′ connect the springs with the line conductors 44 and 44′ respectively.

The switching lever 46 is pivoted intermediate its end, and one end extends between the magnets 43 and 43′, and at the other between the magnets 59 and 59′, being equipped at each end with a pair of copper rings. The two rings 64, 64′ at one end are mounted at opposite sides of the lever, so as to face the magnets 43 and 43′, respectively, in concentric relation to the poles thereof, and the two rings 65 and 65′ at the other end of the lever are similarly disposed with relation to the magnets 59 and 59′. Details of construction in respect to the mounting or the rings are illustrated in Figs. 9 and 10, wherein reference numerals 66, 66′ designate ring-supports of spider form fastened to opposite sides of the lever with proper insulation.

It will be seen that with the above described form of apparatus reversals in the relay connections will be automatically effected in the manner hereinbefore explained with reference to the other forms or embodiments of the invention, the lever, how-

ever, being repellently instead of attractively actuated, and two separate and independent repeating instruments being employed for the two directions of transmission of speech.

It is to be particularly noted that the system of my invention operates in a strictly automatic manner, no manipulation of keys or other means being required in order to effect reversals in the relay connections. It is further to be noted that the inductive line circuits are normally completed and no interruption in the sending line is required in order to set the relay connections for repeating sound undulations in the receiving line.

While preferably both relay secondary circuits are normally in a broken state and the appropriate one is made by effecting the proper contact as above set out, thus completing the line, yet the same result may be accomplished by having both said circuits as well as those leading to the relay normally complete and kept so, the establishment and maintenance of the proper circuits as desired to transmit speech, being effected by increasing pressure to promote conductivity between the appropriate contacts and decreasing pressure to reduce conductivity between the reciprocal contacts, by the same means in substantially the same manner as hereinbefore explained without actually breaking any contact. In such case the material used at contact points might be of any appropriate sort such as platinum, or perhaps carbon.

It is apparent that the armature carried by and communicating power to the circuit controlling device to move the same may be polarized so as to secure greater responsiveness to the stationary magnet or magnets.

In lieu of the lever any approved form of suspended or otherwise movably maintained circuit controlling device may be adopted, the necessary delicacy of arrangement being accomplished by use of any of the well known means employed in allied arts.

In the embodiment of my invention above described control of the relaying switch is effected by electro-magnetic means excited directly through the pulsations of the voice-caused currents. In Figs. 11–16 I have illustrated a modification similar to the above described form, employing, however, electro-magnetic switch actuating means excited by the voice-caused currents and through the interposition of a sensitive responding device, such, for example, as some form of coherer.

Referring particularly to Fig. 11 the line 1 passes through the primary of the step-down transformer 67 and thence to the binding post 68, which is electrically connected preferably by a flexible conductor with the spring contact 69 carried by, but insulated from, the pivotally mounted switch 70. The conductor 2 passes through the primary of the step-down transformer 71 to the binding post 72, the latter being adapted to contact with the switch contact 69 through the adjustable contact screw 73, thereby completing the circuit from the station 3. A branch 74 connects the side of the circuit 1, 2 through the secondary of the step-up transformer 75′ with the adjustable contact screw 76, the latter being adapted upon suitable movement of the switch 70 to make contact with the switch contact piece 77, which latter is electrically connected through a flexible conductor with the terminal 78, connecting through the branch 79 with the conductor 2. The switch operating lever 70 is pivotally mounted at 80, being normally so held that the contacts 69 and 77 are in the position shown in dotted lines, but adapted to be actuated by the switch actuating magnet 81 and thereby caused to assume the position indicated in the full lines and illustrating the said contacts 69 and 77. Circuits 1′, 2′, corresponding to 1 and 2, lead from a second station (not shown) through connections corresponding to those already described and which it will be unnecessary again to enumerate, there being provided for the circuits similar switch contacts 69′ and 77′, contact screws 73′ and 76′ and a switch actuating magnet 81′.

In the normal position of the switch lever the spring contacts 69 and 69′ each touch the contact screws 73 and 73′ respectively and offer, through their elasticity, a sufficient resistance to the movement of the lever to maintain the same in its normal position except when the lever arm is attracted by the switch actuating magnet 81 or 81′. When the lever arm is attracted by either such actuating magnet the connection between the opposite switch contact and its screw is thereby broken, the other contact piece, however, being compressed sufficiently to return the switch arm to its normal position when the magnet is again deënergized.

The contacts 77 and 77′ are normally separated from their corresponding contact screws, but are each brought into contact with its respective screw on the actuation of the oppositely arranged switch magnet, the relation between the two sets of contacts being preferably such, however, that the contact at 69 or 69′ is always broken before the corresponding contact at 77 or 77′ is made. This, as before, provides a main line or transmitting circuit from each station and a branch line or receiving circuit from each station with switch connections and a switch actuating magnet for each line such that on the actuation of the switch magnet corresponding to one line, the other main

line or transmitting circuit will be broken and immediately thereafter its branch or receiving circuit, which is normally interrupted, will be closed.

The switch magnet 81 is energized on the completion of the relay circuit containing the battery 82, which completion is effected, on the excitation of the magnetic coil 83, by the battery 84. The circuit containing the battery 84 and the coil 83 is in series with and normally interrupted by the coherer or imperfect contact 85, which will be described more in detail. This is within the magnetic influence of the coil 86, which latter is in series with the secondary of the transformer 71, and is accordingly energized therewith, on the passage of electrical undulations through the primary of the transformer. It will thus be seen that I have provided in conjunction with the translating device,—herein the magnet coil 83,—a circuit containing the said translating device and an imperfect contact, which latter, when influenced by the energy of the transmitter circuit, serves in turn to cause energization of the said translating device.

In Fig. 16 I have shown a form of coherer which is adapted to carry out my invention, but to which particular construction my invention is in no wise limited. This coherer comprises a number of loose magnetic particles, such for example, as fine iron filings interposed between appropriate terminal plugs, suitably, and preferably adjustably mounted, within and along the axis of the actuating coil or helix 86. I have discovered that by a suitable selection of the materials composing this coherer and by a suitable design of the coil actuating the same, the loose, non-conductive contact of the particles, one upon the other, which normally interrupts the circuit of which the same forms a part when the said particles are at rest or in an unexcited condition, is transformed, when the actuating coil or helix is energized, into an electrically conductive contact, and the coherer circuit, which is normally incapable of transmitting an appreciable amount of energy, becomes a circuit of high, electrical conductivity and the energy transmitted therethrough readily actuates a relay or other similar device.

Referring again to Fig. 11 the manner in which the movement of the switch takes place under the actuation of the switch magnet will now be evident. On the transmission through the circuit 1, 2, of electrical undulations of any character, undulations corresponding to the same are produced in the secondary of the transformer 71, the coherer actuating coil 86 is energized, the normally interrupted coherer circuit is completed through the coherer, the magnet coil 83 is excited and, by its armature, completes the switch magnet circuit, thereby attracting the switch lever arm. In series with the switch magnet circuit I have shown a conventional form of tapper 87, which may conveniently engage a stud or pin attached to the core of the actuating coil 86 by means of which a de-coherer effect may be maintained so long as the switch magnet is energized.

As in the arrangement previously described, interposed between the primary of the transformer 67 which is in the main circuit 1, 2, and the secondary of the step-up transformer 75, is a repeater 16 which I have shown in conventional diagrammatic form, and which may be of any suitable design or construction, being adapted to reproduce electrical undulations in the circuit containing the primary transformer 67 again in the secondary of the transformer 75 and preferably with increased intensity. This repeater herein shown consists of a magnet coil in circuit with the secondary of the transformer 67 having an armature adapted to vary the pressure in a suitable form of carbon contact, varying thereby the current flowing in the primary circuit of transformer 75. The undulations in the main line circuit 1, 2, being thus reproduced in the secondary of the transformer 75 are transmitted when the switch is in full line position shown, to the main line circuit 1′, 2′, through the branch or transmitting circuit 74′, 79′, and thence to the distant station, the receiving circuit on the line 1′, 2′, having been already broken by the switch, and the coherer and its associated receiving apparatus having been rendered inoperative. The switch shown is thus automatically responsive to the ordinary voice currents transmitted over telephone lines, or to the slightest electric undulations in the line circuits, as was the case with the arrangement previously described. The relaying of any telephone message, therefore, is automatically effected by the voice currents themselves, the switch through its actuating coherer being instantly thrown to break the opposite receiving or main circuit, and to make the opposite branch or transmitting circuit. On the cessation of the voice currents or other undulations on the deënergization of the coherer actuating coil 86 decoherence is effected, and the switch restored to its normal position.

It will be obvious that additional coherers may be employed in the transmitting or branch circuits if desired, and that instead of the transmitting circuits with their corresponding repeaters as shown, which I prefer in practice, other circuit connections may be employed. It will also be apparent that when my invention is employed for purposes other than the specific one herein described, changes and modifications suitable to the occasion may be made without departing from the spirit thereof.

In Figs. 12 and 13 I have indicated a convenient means for adjusting the switch operating magnets, consisting of the supporting, magnet-carrying slide 88 suitably engaged by the adjusting screw 89, and in Fig. 14 I have indicated the pivotal construction of the switch lever 70.

In Fig. 15 I have diagrammatically shown a construction by means of which a de-coherence is effected at periodic intervals only, during the energization of the coherer actuating coil. The main relay circuit containing the battery 90 and the translating device 91, which may be any suitable electromotive device, is provided with a shunt circuit about the translating device including the de-coherer 87 and the electrically controlled interrupter 92. The latter comprises the contact disk 93 normally locked in position by the armature of the electro-magnet 94 but adapted to be released thereby on the energization of said magnet, and rotated through a suitable clock-work train, temporarily completing the shunt tapper circuit but once a revolution through the revolving contact 95 and the wiper 96. By this means a periodically interrupted de-coherence is effected.

As a sensitive responder to the voice-caused current on the line circuit, other devices may be employed than the particular one shown. In connection with Figs. 11–16 and Figs. 18 and 19 I have represented different forms of circuit arrangements wherein there is employed some form of anti-coherer, which, as is well-known to those skilled in the art, has the property of maintaining a relatively low resistance during the passage of a direct current of low tension therethrough, but of having its resistance increased to a relatively great amount on its excitation through the agency of electrical impulses of relatively high frequency and tension. Referring to Fig. 17, it will be seen from an inspection that the general circuiting of the main line or transmitting circuits and the receiving circuits is the same as in Fig. 11, and like numerals will be used to designate corresponding parts. In the arrangement shown in Fig. 17, however, independent switches 97 and 97′ are employed, the former controlled by the voice-caused currents in the transmitting circuit from the station 3′, and the latter by the voice-caused currents from the station 3.

The switch lever 97 is pivotally mounted at 98 and is normally held, by the excitation of the switch magnet 99, in the full line position shown, so that the circuit between the spring contact 77 and the screw contact 76 is broken and that between the contacts 69 and 72 maintained closed. When the magnet 99 is deënergized the switch is automatically moved through any appropriate means, such as the spring 100 into its reverse position indicated in dotted line, whereby the circuit at the contacts 69 and 73 is broken and that at the contacts 76 and 77 closed. The companion switch 97′ operates in the same fashion to make and break like circuits similarly related to the opposite side of the line.

The switch magnet 99 is normally maintained energized by current from the battery 101 included in the circuit therewith, the switch magnet circuit also including means for either stopping or sufficiently decreasing the current flow therethrough to cause the release of the switch 97 and its movement under the influence of the spring 100 into its reversed position. For this purpose I have herein shown a form of anti-coherer conventionally represented at 102. This may be constructed in any of its usual and generally known operative forms, and the details thereof are herein unnecessary. One important advantage of the anti-coherer is its extreme sensitiveness and its capacity for self-restoration which renders the repeating devices always in a condition to respond to voice-caused energy. This obviously avoids the necessity for any additional apparatus, such as the tapper 87 shown in Fig. 11, to automatically restore the circuit to its normal condition.

In circuit with the anti-coherer 102′ is the secondary of the transformer 71′, the same being thereby placed in inductive relation to the side 2′ of the main line circuit 1′, 2′, whereby on the receipt of the voice-caused telephonic currents from the station 3′ there is caused to be communicated to the anti-coherer 102′ electric impulses sufficient in potential and frequency to change the condition of the anti-coherer from one of relatively high conductivity to one of relatively low conductivity, thereby sufficiently deënergizing the magnet 99 to cause the latter to release the switch. This, as in the case of the circuit arrangements previously described, interrupts the transmitting circuit from the station 3 and completes the receiving circuit leading thereto through the branches 74 and 79. Under such conditions the voice currents generated at the station 3′ are reproduced at station 3 through the intermediation of suitable repeating devices. During this transmission the transmitting circuit from the station 3, having been already broken by the switch, its anti-coherer and the associated receiving apparatus are therefore unaffected by any energization transmitted over the line from station 3′ to station 3.

On the cessation of the voice energy from the station 3, the self-restoring anti-coherer 102′ instantly reassumes its original condition of relatively low conductivity and the magnet 99 thereby freshly energized moves

the switch 97 again to make the transmitting branch of the line circuit 1, 2, and break the receiving branch 74, 79 thereof.

If voice energy is transmitted from the station 3 to the station 3′ the transmitting circuit of station 3′ is immediately broken while its receiving circuit 74′ and 79′ is immediately made and the action previously described takes place in the reverse direction. The relation of the two contacts 69 and 77 are preferably such that the contact at 69 is broken before the contact at 77 is made. The circuit control is therefore automatically effected by the voice-currents themselves, the switch corresponding to that terminal station toward which the voice energy is transmitted, being instantly thrown through the medium of its controlling anti-coherer to break its transmitting circuit and place its receiving circuit in condition to receive the message. The anti-coherer being instantly self-restoring, the apparatus is always in condition to reproduce the telephonic undulations in either direction immediately upon the cessation of the previous transmission, no matter in what direction such previous transmission has taken place.

Obviously an automatically or self-restoring coherer, that is, one restored to its normal condition of conductivity without the employment of extraneous restoring means, or any form of auto, circuit-controller might be employed, it being merely important as a practical advantage that the coherer, anti-coherer, or whatever other sensitive responder may be employed, should be quickly and automatically restored to its normal condition of receptiveness to the telephone currents.

A repeating station of the type described may be developed through a variety of circuit arrangements. In Fig. 18 I have shown a slight modification over the arrangement of Fig. 17, there being substituted for the two-part switch 97, 97′, which latter, during the period of inactivity or no transmission, is under the constant control of its normally energized switch magnets, the single switch 70 similar to that shown in Fig. 11, which, during periods of activity, is attracted by one or the other of the oppositely arranged switch magnets 81 or 81′, the latter being in a normally deënergized condition.

In the modification shown in Fig. 18 the transmitting and receiving circuits and the repeating circuits for the two terminal stations are substantially the same as those described in connection with Fig. 17. The circuit connections for controlling the switch, however, resemble those illustrated in Fig. 11, save that the anti-coherer 102 is employed, which leaves the relay magnet 83 in a normally energized condition, the armature thereof being so disposed as to normally break the controlling circuit for the magnet 81 on the energization of the relay magnet 83, as shown at the left in connection with the magnet 83′, instead of breaking the said circuit on the deënergization of the said relay magnet, as in the arrangement shown in Fig. 11.

In Figs. 19–21 I have shown a form of circuit controlling switch which is especially adapted for the system herein described and particularly when an arrangement such as shown in Fig. 1 is employed, where the electro-magnetic, switch-controlling means is excited directly by the telephone currents themselves, although the said switch may be employed effectively in connection with the system shown in Fig. 17, or in connection with the other modified circuiting arrangements described. As previously stated, where the switch is intended to respond directly to the voice-caused impulses it is important to provide for the switch a relatively low natural rate of vibration. It is also important that it should be light and mechanically capable of responding to the low energy telephone currents, and that the controlling magnet should be capable of quick discharge in order that its full strength may be availed of under the rapidly alternating telephone currents.

It will be noted that in connection with Figs. 1, 6, 11, 17 and 18 I have shown controlling magnets of the telephone-receiver type, that is, with initially magnetized pole pieces, while in Figs. 8 and 19 the controlling magnet is substantially free from initial magnetism. In either case, however, it is desirable that they should be quick acting to respond readily to the alternating telephone currents.

While the switch described in connection with Figs. 1–5 inclusive has a normally low rate of vibration, lower than that of the lowest audible tone of the human voice, I have shown in Figs. 19–21 a switch construction which is of preferable form in fulfilling this and other conditions attendant upon practical use.

Referring to Figs. 19–21 the parts of the switch are represented as mounted upon a base 103 of insulating material. The switch arm 104 is a small piece of some light conductive material, preferably aluminum, which is also shown as drilled out further to lighten the same. The switch arm is delicately and sensitively supported by a pivot pin 105 mounted in jeweled cup bearings 106, so that it may execute the slight movement necessary with a minimum amount of friction and inertia. The upper bearing is shown adjustable by means of thumb screw 107 and lock-nut 108. The switch controlling magnet 109 is suitably supported upon the base to face a thin,

light armature 110, preferably a piece of soft, thin sheet iron secured to the end of the switch arm.

The magnet coils are connected to the terminal binding posts 111 and 112 and are mounted upon ends of the horse shoe core 113 as close to the armature as possible. The core 113 is preferably of soft laminated iron, preferably free from carbon, and otherwise so constructed as to render the magnet quick to discharge.

The stationary contacts are shown in the form of adjustable screws 114 and 115 adjustably mounted in posts 116 and 117, and preferably tipped with platinum ends which coöperate with platinum contacts 118 upon the switch arm. The posts 116 and 117 are connected respectively to terminal posts 119 and 120. The switch arm 104 is normally held in contact with one of the contact screws, as shown with screw 115, by means of a resilient restoring member, the same herein comprising a relatively long, fine, flexible wire 121, with one end resting in the V-shaped groove of an upturned ear 122 (see Fig. 21) on the rear end of the switch arm, and the opposite end held fixed in a block 123 which may be slidably adjusted transverse the axis of wire in the fixed frame 124 by means of the fine differential adjusting screw 125.

The wire 121 is preferably of iridium-platinum and so finely dimensioned as to exert a very delicate restoring tendency upon the switch arm, while having a rate of vibration less than that of the lowest tone of the human voice. Connection may be made to the switch arm through the platinum wire 121, the sliding block 123 and the frame 122 by means of the lead wire 126 and binding post 127. By adjusting the block 123 the restoring tendency of the spring may be very delicately adjusted.

To obtain the best results and maintain the switch in perfect balance, the base 103 is provided with leveling screws 128 and the spirit level 129.

In Figs. 22 and 23 I have shown diagrammatically the circuit connections where a switch like that shown in Fig. 19 is employed, the arrangement of Fig. 22 corresponding to that previously described in connection with Figs. 1, 6 and 8, and that shown in Fig. 23 corresponding to the arrangement illustrated in Fig. 18.

In Fig. 22 the main transmitting circuit of each station, for example station 3, after passing through the primary of the transmitting coil 67 passes to the switch controlling magnet 109 and thence to the normally closed switch controlled contact 115′ at the opposite switch 104′. The same side 1 of the transmitting circuit is branched at 130 to form the receiving circuit, which branch leads to the secondary of the receiving coil 75′ and thence to the normally open switch controlled contact 114′ of the switch 104′. The opposite side 2 of the circuit is permanently connected to the switch 104′ through the platinum restoring spring 121′. The opposite side of the circuit of station 3′ is similarly connected and related to the switch 104.

With speech transmitted from station 3 the transmitting circuit of station 3′ is immediately broken by the movement of the switch 104, this insuring the continuance of switch 104′, in the position shown. The movement of switch 104 also makes the receiving circuit at station 3′ through contact 114.

In Fig. 23 the same result is obtained, the only difference being that the voice-caused currents from the sending station act directly to excite the magnet 109 through the intervention of the anti-coherer 102 and the relay magnet 83, as described in connection with Fig. 18.

It will be obvious that, if desired, a relay circuit might be employed in connection with the system illustrated in Figs. 1, 6, 8 or 22; that is to say, instead of having the controlling magnet, which is energized by the telephone currents, act directly upon the switch, it might serve to make or break a relay circuit, thereby energizing or deënergizing a second electro-magnetic device, which latter, directly or indirectly, might operate the switch. In such event, the relay circuit might be a normally closed circuit, as in the case in the system shown in Fig. 19, or the same might be normally open, as in the case of the system shown in Fig. 23.

This application is a continuation of my prior co-pending application, Serial No. 57,864, filed April 29, 1901 as to the subject matter disclosed in Figs. 1 to 10 inclusive, of Serial No. 133,336 filed December 1, 1902 as to the subject matter disclosed in Figs. 11 to 16 inclusive, and of Serial No. 286,483 filed November 9, 1905, as to the subject matter disclosed in Figs. 17 and 18.

While I have shown and described several slightly differing forms of my invention for the sake of illustrating the principles thereof, it will be understood that the same is not limited either in the details of construction or relative arrangement of parts, to the described embodiment thereof nor to its application as herein illustrated, but that extensive departures may be made from the described forms of the invention without departing from the spirit thereof.

Claims:

1. In a telephone relay system, a two-way repeating device comprising one or more repeating instruments and circuit controlling means, the latter controlled by sound-caused electric currents and so disposed as to vary, establish and maintain the circuits to and

from the repeating device in response to the direction of sound-transmission from the speaking to the listening station.

2. In a telephone relay system, a two-way repeating device, consisting of two lines leading to the relay, each line being split at the relay into two circuits, one leading to a relay-receiver, the other leading to a relay-transmitter, of repeating instruments properly connected with said circuits, and a circuit controlling device, operatively related to said circuits, adapted to be actuated by magnetic influences in said circuit and so disposed that sound-caused electric currents in said circuit will vary, establish and maintain appropriate circuit connections to and from said two-way repeating device reciprocally to the direction of speech-transmission from station to station.

3. In a telephone system the combination with a telephone repeater normally out of repeating relation to said system of a voice actuated, circuit making and breaking device and circuit changing means controlled by the same for placing said repeater in repeating relation.

4. In a telephone system, the combination with telephone circuits, of a telephone repeater means responsive to sound-caused electric currents for changing the transmitting circuit relations and then maintaining the same changed relation.

5. In a telephone relay system, a two-way repeating device comprising repeating means and circuit controlling means, the latter controlled by sound caused electric currents and so disposed as to vary, establish and maintain the circuits to and from the repeating device in response to the direction of sound transmission from the speaking to the listening station.

6. In a telephone relay system, a two-way repeating device and a line circuit leading from each station thereto, said repeating device including a circuit changing device for placing either station in suitable repeating communication with the other, according to the direction of sound transmission, and means actuated by the voice currents in either line circuit for operating said circuit changing device.

7. In a telephone relay system, a repeating station, terminal stations having line circuits leading to said repeating station, a transmitting circuit and a receiving circuit for each line circuit at said repeating station, and means for automatically breaking the receiving circuit from one station and making the corresponding transmitting circuit on the passage of voice currents from the opposite terminal station.

8. In a telephone system, the combination of a telephone repeater, a voice actuated circuit making and breaking device, and circuit changing means controlled by the same.

9. In a telephone system, the combination with a telephone circuit, of means for generating and transmitting voice-caused currents over said telephone circuit, a second circuit, and means actuated by said voice-caused currents for connecting said telephone circuit with said second circuit.

10. In a telephone circuit, the combination with a line circuit of a transmitter, a voice-actuated device associated with said line circuit at a point remote from said transmitter, and a circuit changing device controlled by said voice-actuated device through the voice energy transmitted through said transmitter.

11. A telephone apparatus of the class described having means for reproducing telephonic speech, sounds or the like, alternately from one main line circuit into another main line circuit, consisting of an electro-magnetic telephonic transmitter, induction coils, batteries and circuit connections, and electro magnetic apparatus actuated and controlled by the act of speaking into the transmitter at either sending station for automatically selecting or connecting the two main line circuits.

12. A telephone apparatus of the class set forth, for reproducing in one main line circuit, electric currents, vibrations or impulses corresponding to the original electric currents, vibrations or impulses in the primary main line circuit, having in duplicate electro-magnetic means for selecting and connecting the main line circuits as required, in combination with electro-magnetic telephone transmitting apparatus operating to automatically. retransmit the telephonic messages from one circuit to another, the electro-magnetic means being actuated and controlled by the act of speaking into the transmitting apparatus at either sending station.

13. In a telephone repeater, the combination of an electro-magnetic line controlling device, an electro-magnetic transmitting apparatus including induction coils, local batteries and circuit connectors coöperating with one main line circuit, and a duplicate apparatus in a second main line circuit, the electro-magnetic line controlling devices being actuated by the act of speaking into the transmitting apparatus at either sending station for controlling the relation of the transmitting apparatus to the main line circuits.

14. A telephone repeater characterized by an electro-magnetic line controlling device, the coils of which are included in one main line circuit, an induction coil having its secondary coil normally open and connected by the operation of the controlling device to a second main line circuit, the primary coil of said induction coil being included in a local circuit having a battery, an electro-

magnetic transmitter provided with a variable contact or microphone, the coils of which are included in the main line circuit with the coils of the controlling device, the latter being actuated by speaking into the transmitter.

15. A telephone repeater including as a part thereof an electro-magnetic transmitter having a magnet with extended pole pieces surrounded by coils or helices included in a main line circuit, a vibrating diaphragm having an armature attached thereto and arranged in front of the said magnet, variable contacts or microphone parts also cooperating with said diaphragm and actuated by the latter, in combination with an induction coil, the primary of which is included in circuit with the variable contacts and a local battery, the secondary of the coil being automatically connectible to a second circuit.

16. In a telephone system, the combination with a main line telephone circuit, of means for generating and transmitting voice-caused currents over said circuit, a second main line telephone circuit, and means actuated by said voice-caused currents for automatically connecting the two circuits.

17. In a telephone system, the combination with a main line telephone circuit, of means for generating and transmitting voice-caused currents over said circuit, a second main line telephone circuit, and means actuated by said voice-caused currents for automatically and interchangeably connecting the two main line telephone circuits.

18. In a telephonic repeating system, the combination with two transmission-lines leading to a repeating station, of a repeating-relay for each line, each relay having its receiving-coils normally connected with one line and its transmitter adapted for the control of voice-currents in the other line, and electro-magnetic switching mechanism controlled by said repeating-relays.

19. In a telephonic repeating station, the combination with two transmission lines leading to a repeating station, of a repeating-relay for each line, each relay having its receiving coils normally connected with one line and its transmitter adapted for the control of voice-currents in the other line, and electro-magnetic switching mechanism controlled by said repeating-relays.

20. In a telephonic repeating system, the combination with two transmission lines leading to a repeating station, of a repeating-relay for each line, each relay having its receiving coils normally connected with its line and its transmitter adapted for the control of voice-currents in the other line, and switching mechanism controlled by said repeating-relays.

21. In a telephonic repeating system, the combination with two transmission lines leading to a repeating station, of a repeating-relay for each line, each relay having its receiving coils normally connected with its line and its transmitter adapted for the control of voice-currents in the other line, and switching mechanism controlled by said repeating-relays.

22. In a telephonic repeating system, the combination with a pair of transmission lines terminating at a repeating station, of a repeating-relay for each line, an induction coil for each repeating relay, the circuit for the primary coil of each induction coil being controlled by the transmitter of one of said repeating-relays and the secondary coil of each induction coil being adapted for connection with one of said transmission lines but normally disconnected therefrom, and means whereby the passage of telephonic voice-currents from one line to its repeating relay causes a connection of the secondary coil of the associated induction coil with the other transmission line.

23. In a telephonic repeating system, the combination with a pair of transmission lines terminating at a repeating station, of a repeating-relay for each line, an induction coil for each repeating-relay, the circuit for the primary coil of each induction coil being controlled by the transmitter of one of said repeating relays, the secondary coil of each induction coil being adapted for connection with one of said transmission lines but normally disconnected therefrom, and means whereby the passage of telephonic voice-currents from one line to its repeating-relay causes a connection of the secondary coil of the associated induction coil with the other transmission line and causes a break in the connection between this other transmission line and the receiving coils of its repeating relay.

24. In a telephonic repeating system, the combination with a pair of transmission lines terminating at a repeating station, of a repeating relay for each line, transformer means for inductively transferring telephonic voice-currents from one line to the other, the primary currents through said transformer means being controlled by said repeating relays, the secondary winding of said transformer means being adapted for connection with said transmission lines but normally disconnected therefrom, and means whereby the passage of telephonic voice-currents from one line to its repeating relay causes the closure of a telephonic circuit including said transformer means from the transmitter portion of said repeating relay to the other transmission line.

25. In a telephonic repeating system, the combination with a pair of transmission lines terminating at a repeating station, of

a repeating-relay for each line, transformer means for inductively transferring telephonic voice-currents from one line to the other, the primary currents through said transformer means being controlled by said repeating relays, the secondary windings of said transformer means being adapted for connection with said transmission lines but normally disconnected therefrom, and means whereby the passage of telephonic voice-currents from one line to its repeating-relay causes the closure of a telephonic circuit including said transformer means from the transmitter portion of said repeating relay to the other transmission line and causes a break in the connection between this other transmission line and the receiving coils of its repeating relay.

26. In a telephonic repeating system, the combination with a pair of transmission lines terminating at a repeating station, of a repeating relay for each line, transformer means for inductively transmitting telephonic voice-currents from one line to the other, the primary currents through said transformer means being controlled by said repeating relays, the secondary windings of said transformer means being adapted for connection with said transmission lines but normally disconnected therefrom, and means whereby the passage of telephonic voice-currents from either line to its repeating relay causes the closure of a circuit from the secondary windings of said transformer means to the other transmission line.

27. In a telephonic repeating system, the combination with a pair of transmission lines terminating at a repeating station, of a repeating-relay for each line, transformer means for inductively transmitting telephonic voice-currents from one line to the other, the primary currents through said transformer means being controlled by said repeating relays, the secondary windings of said transformer means being adapted for connection with said transmission lines but normally disconnected therefrom, and means whereby the passage of telephonic voice-currents from either line to its repeating relay causes the closure of a circuit from the secondary windings of said transformer means to the other transmission line and causes a break in the connection between this other transmission line and the receiving coils of its repeating relay.

28. In a telephone system, a line circuit, a circuit-changing device, means for operating said circuit-changing device, and a circuit in inductive relation to said line circuit and adapted to be energized by the voice-caused currents in said line circuit for actuating said operating means.

29. In a telephone relay system, a repeating station, a plurality of sending and receiving stations having each a line circuit leading to said repeating station, a circuit-changing device at said repeating station for placing either sending and receiving station in suitable repeating communication with the other according to the direction of sound transmission, means for operating said circuit-changing device, and a circuit in inductive relation to each of said line circuits and adapted to be energized by voice-caused currents in the line circuit for operating said circuit-changing device.

30. In a telephone relay system, the combination with a sending station and a receiving station, of a repeating station between the two, means for normally maintaining the circuits between said stations in such relation as to prevent the repeating of the voice-caused currents from said sending station to said receiving station, means for changing said circuits to permit the repeating of voice-caused currents transmitted from said sending station, and means inductively related to the line circuit for operating said circuit-changing means.

31. In a telephone relay system, a line circuit and a repeating device comprising repeating means, circuit-controlling means, and means inductively related to the line circuit and controlled by sound-caused electric currents to operate said circuit-controlling means whereby the latter is caused to vary, establish and maintain the circuits to and from the repeating device in response to the direction of sound transmission from the speaking to the listening station.

32. In a telephone relay system, a line circuit and a repeating device comprising repeating means, circuit-controlling means and means including an imperfect contact so controlled by sound-caused electric currents as to operate said circuit-controlling means whereby the latter is caused to vary the circuits to and from the repeating device in response to the direction of sound transmission from the speaking to the listening station.

33. In a telephone system, a line circuit, a circuit-changing device, means for operating said circuit-changing device, and means including an imperfect contact controlled by the voice-caused currents in said line circuit for actuating said operating means.

34. In a telephone system, a line circuit, a circuit-changing device, and means including a resistance-varying device for operating said circuit-changing means, said means being controlled by the voice-caused currents upon the line circuit.

35. In a telephone system, a line circuit, a circuit-changing device, means for operating said circuit-changing device, a circuit provided with a source of electrical energy for energizing said operating means, and means for varying the energization of said

operating means through the voice-caused currents upon the line circuit.

36. In a telephone relay system, a repeating station, a plurality of sending and receiving stations having each a line circuit leading to said repeating station, a circuit-changing device at said repeating station for placing either sending and receiving station in communication with the other according to the direction of sound transmission, means for operating said circuit-changing device, a circuit having a source of electrical energy for energizing said operating means, and means controlled by voice-caused currents on the line circuit for varying the energization thereof.

37. In a telephone relay system, the combination with a sending station and a receiving station, of a repeating station between the two, means for normally maintaining the circuits between said stations in such relation as to prevent the repeating of the voice-caused currents from said sending station to said receiving station, means for changing said circuits to permit the repeating of voice-caused currents transmitted from said sending station, a circuit provided with a source of electrical energy for actuating said circuit-changing means, and means controlled by the voice caused currents upon the line circuit for varying the energization thereof.

38. In a telephone relay system, a line circuit, a repeating device comprising repeating means, circuit controlling means, a circuit provided with a source of electrical energy for controlling said circuit-controlling means, and means controlled by the line circuit energy for varying the energization of said controlling circuit whereby the circuit-controlling means is caused to vary the circuits to and from the repeating device.

39. In a telephone system, a line circuit, a circuit-changing device, and means for operating said circuit-changing device including an imperfect contact within the electro-magnetic influence of the currents flowing in said line circuit.

40. In a telephone relay system, a line circuit and a repeating device comprising repeating means, circuit-controlling means, and an imperfect contact within the electromagnetic influence of the line circuit energy and controlling said circuit-controlling means, whereby the latter is caused to vary the circuits to and from the repeating device in response to the direction of sound transmission from the speaking to the listening station.

41. In a telephone relay system, a two-way repeating device comprising circuit-controlling means, the latter controlled by sound-caused electric currents and so disposed as to vary, establish and maintain the circuits to and from the repeating device in response to the direction of sound transmission from the speaking to the listening station, and a separate repeating device for each station.

42. In a telephone relay system, the combination with terminal stations, of a repeating station, a transmission and receiving circuit and a repeating circuit for each terminal station, circuit-controlling means for varying the circuits to and from the repeating device in accordance with the direction of sound transmission from the speaking to the listening station, said circuit-controlling means being adapted to break the transmission circuit of the listening station before making the receiving circuit thereof.

43. In a telephone system, a telephone circuit, a transmitter, circuit-changing means, and means including a circuit of variable conductivity controlled by energy from said transmitter for actuating said circuit-changing means.

44. In a telephone system, a telephone circuit, a transmitter, a circuit-changing device, and means including an imperfect contact for operating said circuit-changing device.

45. In a telephone system, a telephone circuit, a transmitter, a circuit-changing device, and means including an imperfect contact controlled by energy from said transmitter for operating said circuit-changing device.

46. In a telephone relay system, a line circuit, a transmitting station and a repeating device comprising repeating means and circuit controlling means and means including an imperfect contact controlled by energy from said transmitting station to operate said circuit-controlling means whereby the latter is caused to vary the circuits to and from the repeating device in response to the direction of sound transmission from the speaking to the listening station.

47. In a telephone-system, a line circuit, a circuit-changing device, means for operating said circuit-changing device, and means, including an anti-coherer controlled by the voice-caused currents in said line circuit for actuating said operating means.

48. In a telephone relay system, a line circuit, and a repeating device comprising repeating means and circuit controlling means and means including an anti-coherer so controlled by sound-caused, electric currents as to operate said circuit-controlling means, whereby the latter is caused to vary the circuits to and from the repeating-device in response to the direction of sound transmission from the speaking to the listening station.

49. In a telephone-system, a line circuit, a circuit-changing device, means for operating said circuit-changing device, and means including a self-restoring, imperfect contact

controlled by the voice-caused currents in said line circuit for actuating said operating means.

50. In a telephone relay system, a line circuit and a repeating device comprising repeating means, circuit controlling means, and means including a self-restoring, imperfect contact so controlled by sound-caused, electric currents as to operate said controlling means, whereby the latter is caused to vary the circuits to and from the repeating device in response to the direction of sound transmission from the speaking to the listening station.

51. In a telephone relay system, the combination with a normally energized circuit for controlling the direction of sound-transmission, of means for deënergizing said circuit on the transmission of voice-caused currents.

52. In a telephone relay system, the combination with repeating means, of a circuit for controlling the direction of sound-transmission through said repeating means, and means for varying the energy in said circuit through change of its normal, electrical condition, said circuit being automatically self-restoring to its normal condition.

53. In a telephone relay system, the combination with repeating means, of a circuit for controlling the direction of sound transmission through said repeating means, and means for decreasing the energy in said circuit through change of its normal, electrical condition, said circuit being automatically self-restoring to its normal condition.

54. In a telephone relay system, the combination with repeating means, and a circuit for controlling the direction of sound transmission through said repeating means, of an anti-coherer in said circuit.

55. In a telephone relay system, the combination with repeating means and circuit-controlling means, of a normally energized circuit for controlling said controlling-means, said circuit including a contact of variable conductivity subject to control at the sending station.

56. A telephone apparatus of the class described, having means for reproducing telephonic speech, sounds, or the like, alternately, from one main line circuit into another main line circuit, consisting of an electro-magnetic transmitter, induction coil, batteries, and circuit connections, and an anti-cohering means controlled by the act of speaking into the transmitter at either sending station for automatically selecting or connecting the two main line circuits.

57. In a telephone system, the combination with repeating means, circuit-controlling means, a normally energized circuit of variable conductivity for controlling the same, and means for decreasing the conductivity thereof on the passage of voice-currents over the main-line.

58. In a telephone repeater, the combination with repeating means, and circuit-changing means controlling the same, of a self-restoring, imperfect contact in inductive relation to the main-circuit for actuating said circuit-controlling means.

59. In a telephone system, a telephone transmitter, a telephone line circuit, an anti-coherer associated with said telephone line circuit and actuated by the voice-currents from said transmitter, and a circuit-changing device operated by the actuation of said anti-coherer.

60. In a telephone relay system, a line circuit, an anti-coherer, a local circuit normally energized through said anti-coherer, and a circuit-changing device actuated on the deënergization of said local circuit, said anti-coherer being subject to the influence of the line circuit energy.

61. In a telephone system, the combination with a telephone circuit, of a second circuit, and a voice actuated anti-coherer for connecting said second circuit with said telephone circuit.

62. In a telephone system, a line circuit, a transmitter, a circuit changing device, and means including an anti-coherer controlled by energy from said transmitter, for actuating said circuit-changing means.

63. In a telephone system, a line circuit, a circuit-changing device, means for operating said circuit-changing device, and means, including an automatically self-restoring voice-influence-actuated circuit-controlling device, for actuating said operating means.

64. In a telephone system, the combination with a line circuit of a transmitter, a voice-actuated electro-magnetic device associated with the line circuit at a point remote from the transmitter and a vibratory circuit-changing device having a relatively low rate of vibration controlled by the said voice-actuated electro-magnetic device.

65. In a telephone system, the combination with a vibratory circuit-controlling device having a rate of vibration less than the lowest audible tone of the human voice, of an electro-magnetic device energized by the voice-caused currents for actuating said controlling device.

66. In a telephone system, the combination with a delivery transmitting circuit of a circuit connecting device and a quickly discharging controlling magnet therefor associated with said delivery transmitting circuit and energized through the voice-actuated currents transmitted therethrough.

67. In a telephone system, the combination with a transmitting circuit, of a circuit-controlling switch, electro-magnetic means associated with and energized by the voice-

actuated currents passing over the transmitting circuit for controlling said switch, an elastic restoring member for the switch, a stationary switch-contact, and a movable contact, the latter having circuit connections through the said restoring member.

68. The method of relaying telephonic currents, which consists in alternately reversing the relay circuit connections for speech transmission in opposite directions through the influence of the sound-caused telephone currents.

69. The method of repeating telephonic currents in either direction, which consists in establishing repeating connections for the transmission of said currents in one direction through the influence of the telephone currents themselves, and in establishing different repeating connections for transmission of telephone currents in the opposite direction, also through the influence of the said currents themselves.

70. In an electrical transmitting system for high frequency alternating currents, an electro-magnetic receiving device, an auxiliary circuit and a vibratory switch device controlling said auxiliary circuit and adapted to be initially moved by said receiving device, said vibratory device having such a low vibration rate as to be non-vibrative under the continued action of the electro-magnetic receiving device.

71. In an electrical transmitting system for telephonic currents an electro-magnetic receiving device, an auxiliary circuit, and a resilient vibratory switch device controlling said circuit and adapted to be initially moved by said receiving device, said vibratory device being mechanically responsive to the energization of the receiving device through the low energy telephone currents.

72. In a telephone repeating system, in combination, two opposed main line sections, relaying instrumentalities, and a reciprocally arranged pair of automatic circuit controlling instruments, each being adapted to be energized by one of said main line sections and upon actuation to disconnect the other from its controlling circuit; said instruments being further adapted through actuation by voice-caused currents to establish and maintain relaying connections through said relay instrumentalities from the voice-actuated main line section to the opposed main line section; and each of said circuit-controlling instruments comprising a quick-acting magnet adapted to respond magnetically to telephone current actuation and an armature-controlled contact-governing member, said member having an inherent vibratory or oscillatory rate less than the vibratory or oscillatory rate of the actuating currents energizing said magnet.

73. In a telephone repeating system in combination, two opposed main line sections and repeating instrumentalities adapted to repeat automatically from one section into the other responsively to the energization of either section by voice-caused currents; said instrumentalities comprising a reciprocally arranged pair of relays and a related reciprocally arranged pair of circuit controlling devices, each circuit section being normally complete when the line is inactive through the magnet of one of the controllers, the circuit of one of the relays and the normal contact of the other controller, but provided with a shunt around said controller magnet and said relay, said shunt comprising the repeating circuit of the second relay and being completed through the normally inactive contact and the other controller; whereby energization of either main line section cuts out of the other section the controller and relay controlled thereby and cuts into said other section the relay operated by the first mentioned section; said controllers each comprising a quick-acting electro-magnet adapted to respond magnetically to voice-caused currents, and an operatively related armature controlled contact governing member, said member being of relatively light inertia and having an inherent vibratory or oscillatory rate lower that the vibratory or oscillatory rate of the voice-caused currents received by said electro-magnet.

74. In a telephone system of the class specified, the combination with a telephone circuit, of means for generating and transmitting voice-caused currents thereover, a second telephone circuit independent of the first circuit, the said circuits being normally closed, and independent means in each circuit actuated by said voice-caused currents for controlling the circuits, said means comprising a quick-acting magnet adapted to respond magnetically to telephone current actuation, and an armature-controlled contact-governing member having a vibratory rate less than the vibratory rate of the actuating currents.

75. In a telephone apparatus of the class described, two independent main line circuits each provided with means for generating and transmitting voice-caused currents thereover, and independent means in each circuit actuated by said voice-caused currents for connecting the circuits and including a quick-acting magnet and an armature-controlled contact-governing member having a low vibratory rate and adapted to be attracted and held in one position when said magnet is energized by the voice-caused currents passing over the circuit of which each independent means is a part for selecting and completing the other main line circuit.

76. In a telephone apparatus of the class described, two independent normally closed main line circuits, means for generating and

transmitting voice-caused currents over said circuits and independent means in each circuit automatically operated by said voice-caused currents for connecting the two circuits and including a quick-acting magnet and an armature-controlled, contact governing member moving at a low rate of vibration.

77. A telephone repeating apparatus embodying normally closed independent main line circuits each having means for opening and closing the other while still leaving its own circuit closed, and electric transmitting means.

78. A telephone repeating apparatus characterized by independent normally closed main line circuits each having an electro-magnetic controlling device, electro-magnetic telephone transmitters having their coils connected to the independent main line circuits and provided with a variable contact, batteries, and induction coils, the variable contacts being connected up in one set of circuits with the batteries and primary coils of the induction coils, the secondary coils of the induction coils being also connected up to the main line circuits and the coils of the electro-magnetic controlling devices being included in the main line circuits and serving to automatically connect the secondary coils of the induction coils to the respective circuits for the purpose of repeating and reproducing in one main line circuit with relation to the other electric currents, vibrations or impulses corresponding to the electric currents, vibrations or impulses being produced in either of the main line circuits by words, sentences, and sounds uttered into the transmitters of either of the main line circuits.

79. In a telephone apparatus of the class described, two independent main line circuits, means for generating and transmitting voice-caused currents over said circuits, and means in each circuit actuated by said voice-caused currents to automatically select and connect in the other or second circuit to enable the operator of either of the main line circuits to control the two independent main line circuits by the act of speaking into the transmitter of either of the said circuits.

80. In a telephone apparatus of the class described, independent main line circuits, means for generating and transmitting voice-caused currents over said circuits, and means in each circuit actuated by the voice-caused currents over the circuit of which each of said means is a part for interchangeably selecting and completing automatically either of the two main line circuits for the reception of the repeated or retransmitted messages at the will of an operator speaking from either of the main line circuits.

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

CHARLES D. LANNING.

Witnesses:

AGNUS B. DUDSON,

BLANCHE A. SPENCER.