No. 803,676. PATENTED NOV. 7, 1905.

F. W. DUNBAR.

TELEPHONY.

APPLICATION FILED NOV. 12, 1904.

3 SHEETS—SHEET 1.

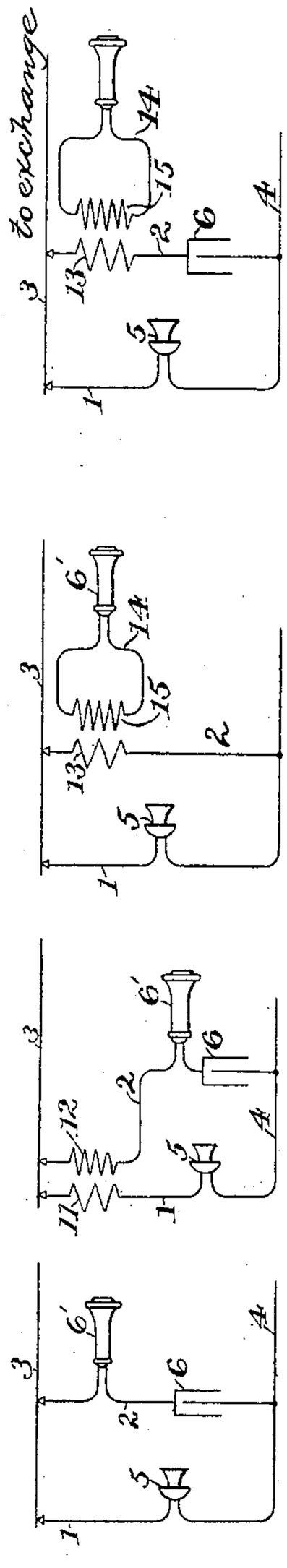

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

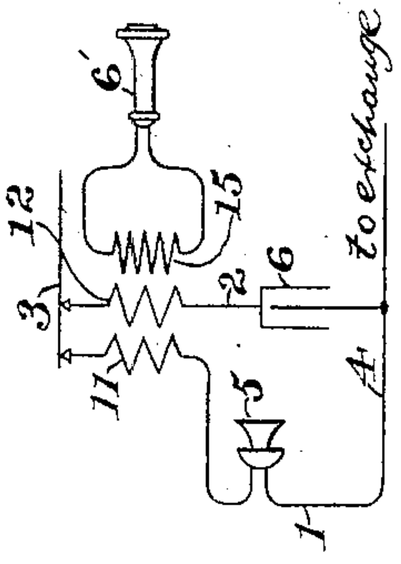

Fig. 5.

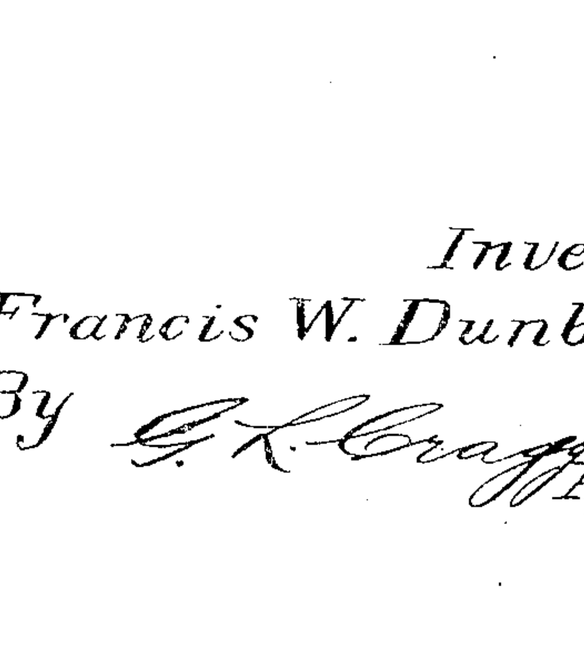

Fig. 6.

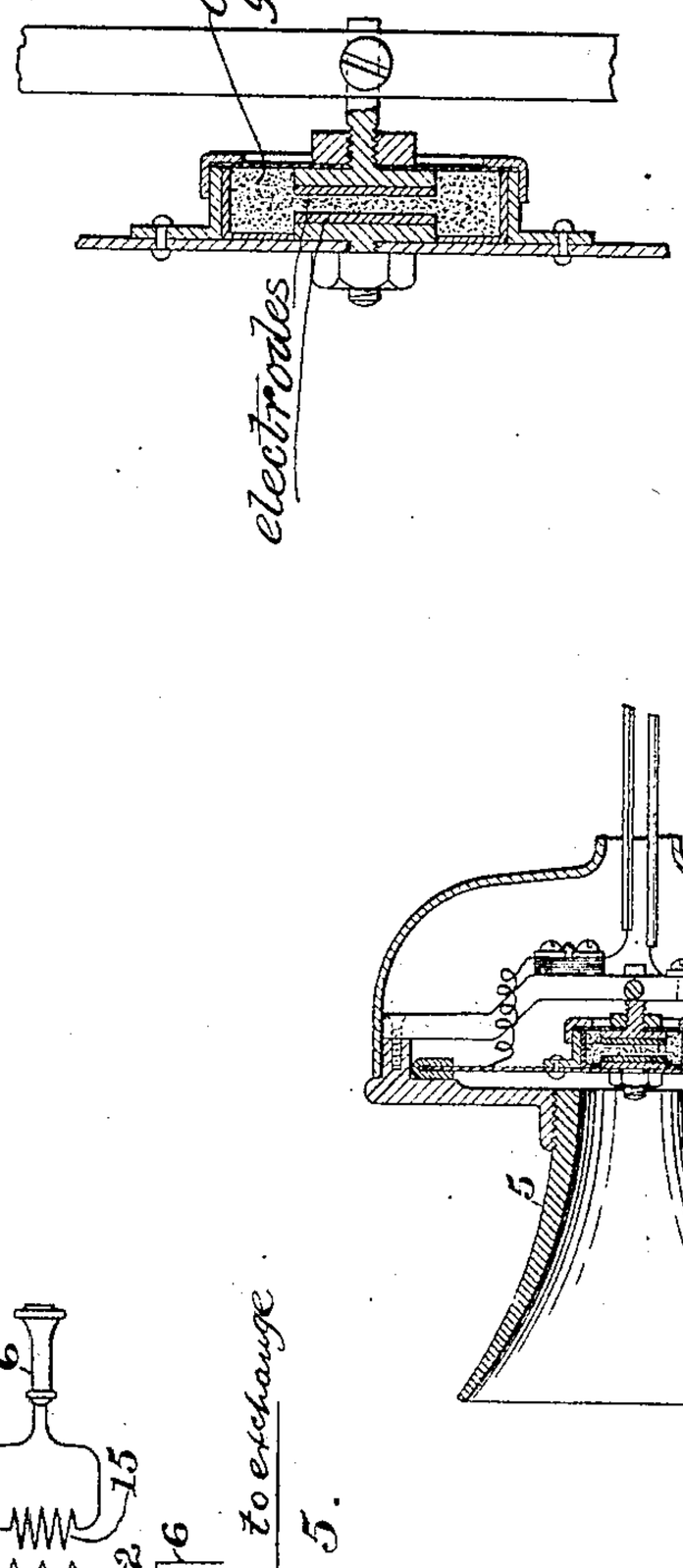

Fig. 7.

Witnesses:
A. J. Ostrander
Leon Stroh

Inventor:
Francis W. Dunbar
By G. L. Craig Atty.

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3 SHEETS—SHEET 2.

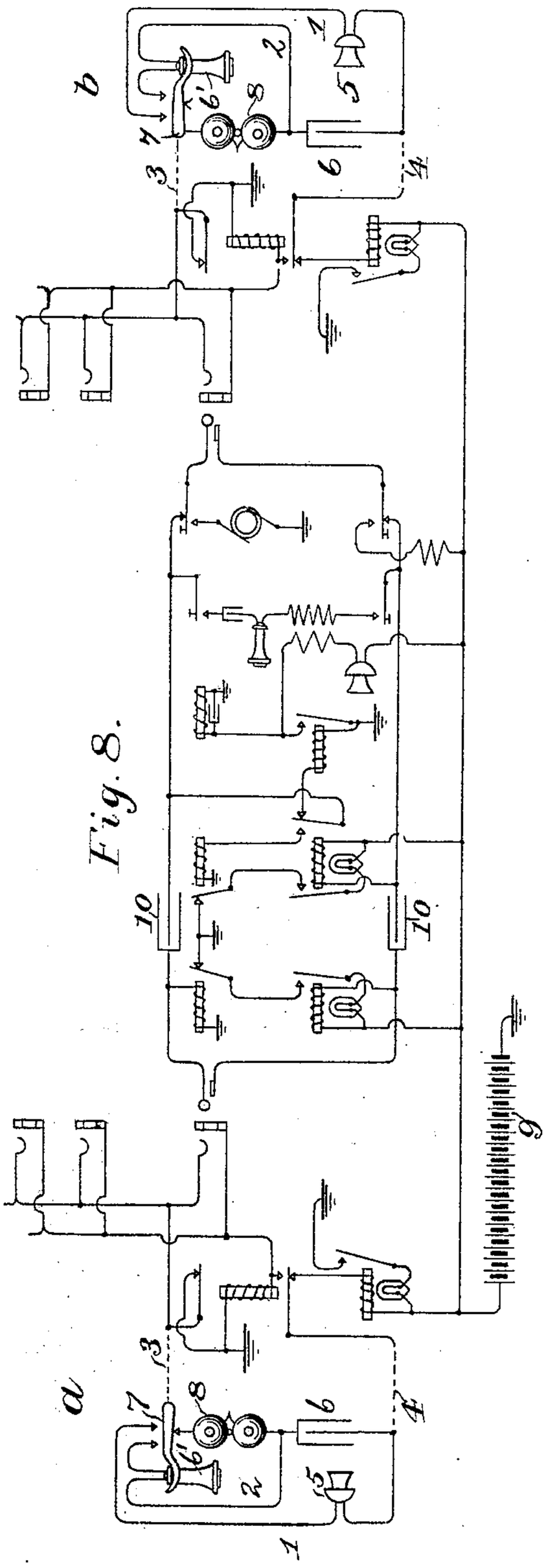

Fig. 8.

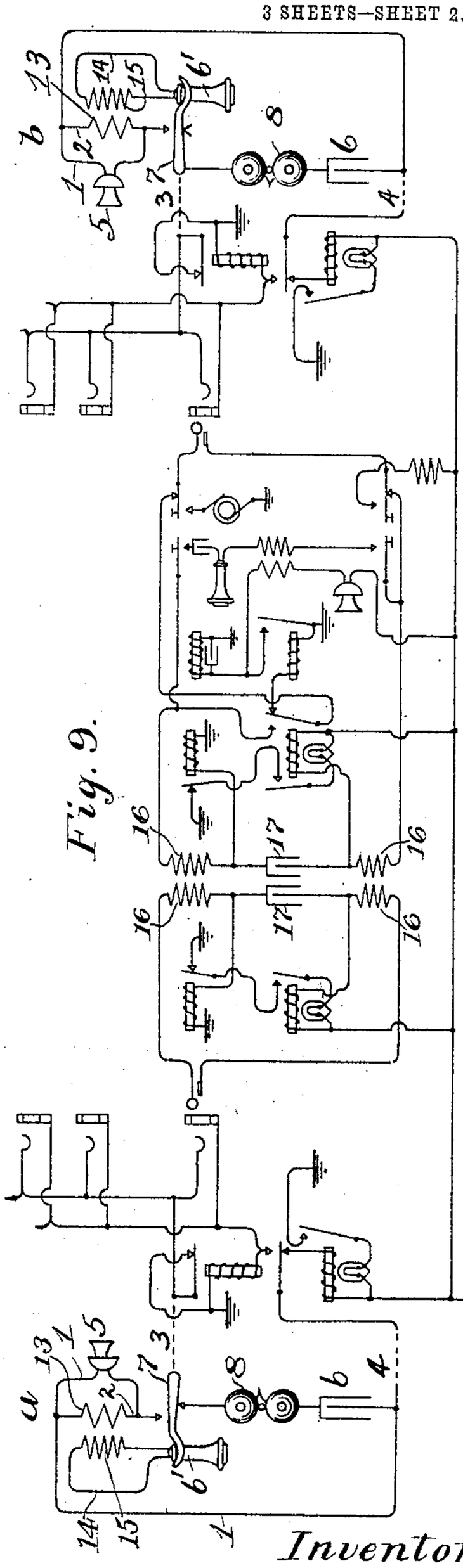

Fig. 9.

Witnesses:
A. J. Ostrander
Leon Stroh

Inventor:
Francis W. Dunbar
By C. L. Craig
Atty.

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3 SHEETS—SHEET 3.

Fig. 12.

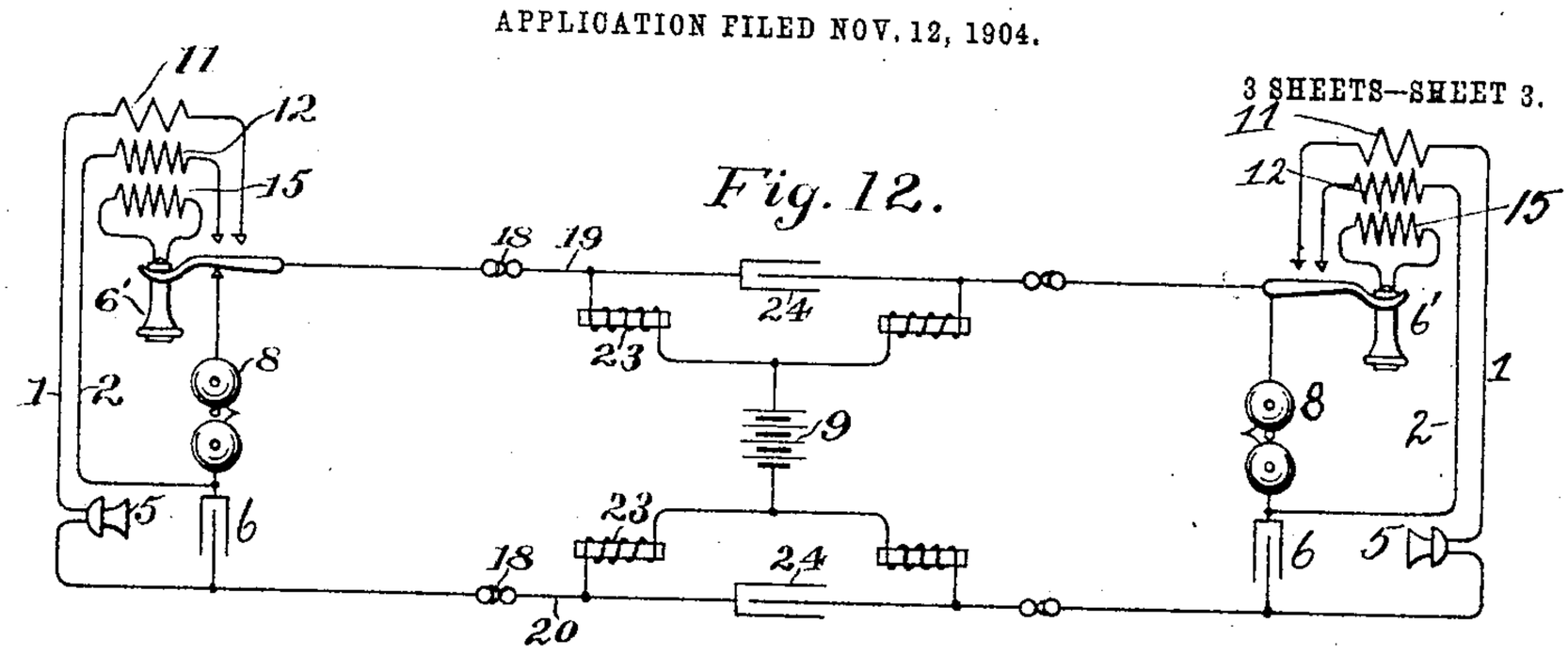


Fig. 10.

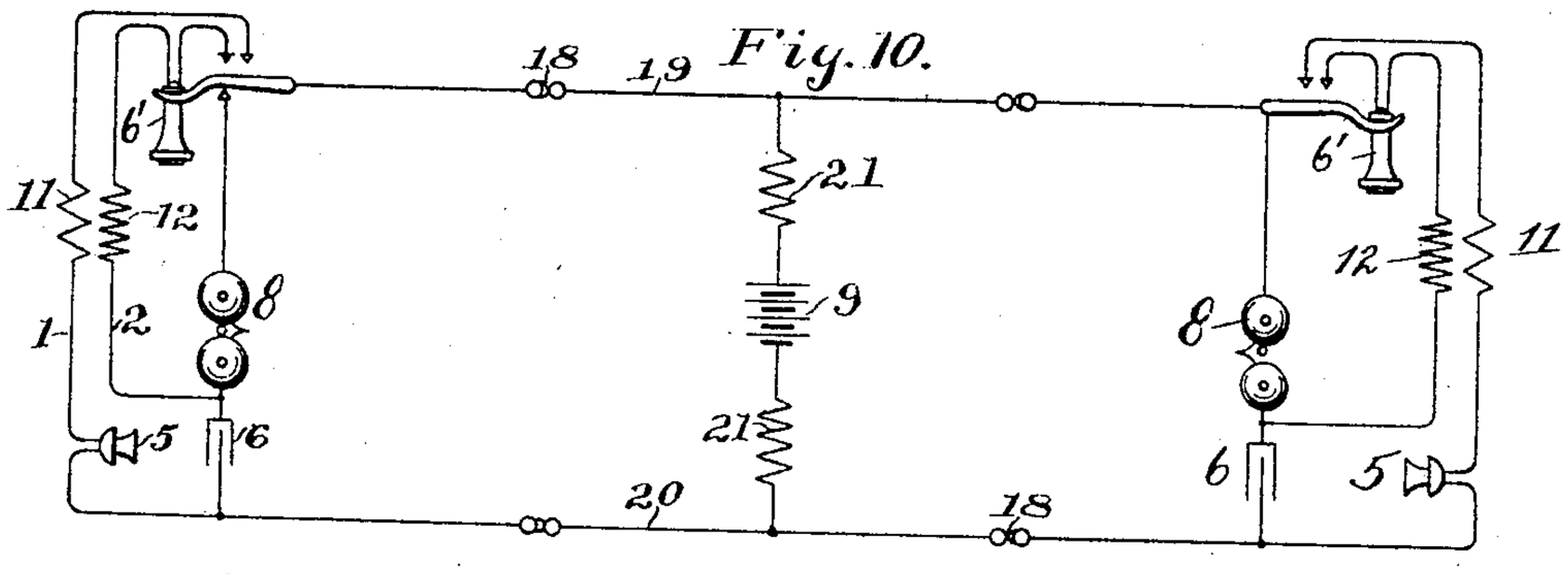


Fig. 11.

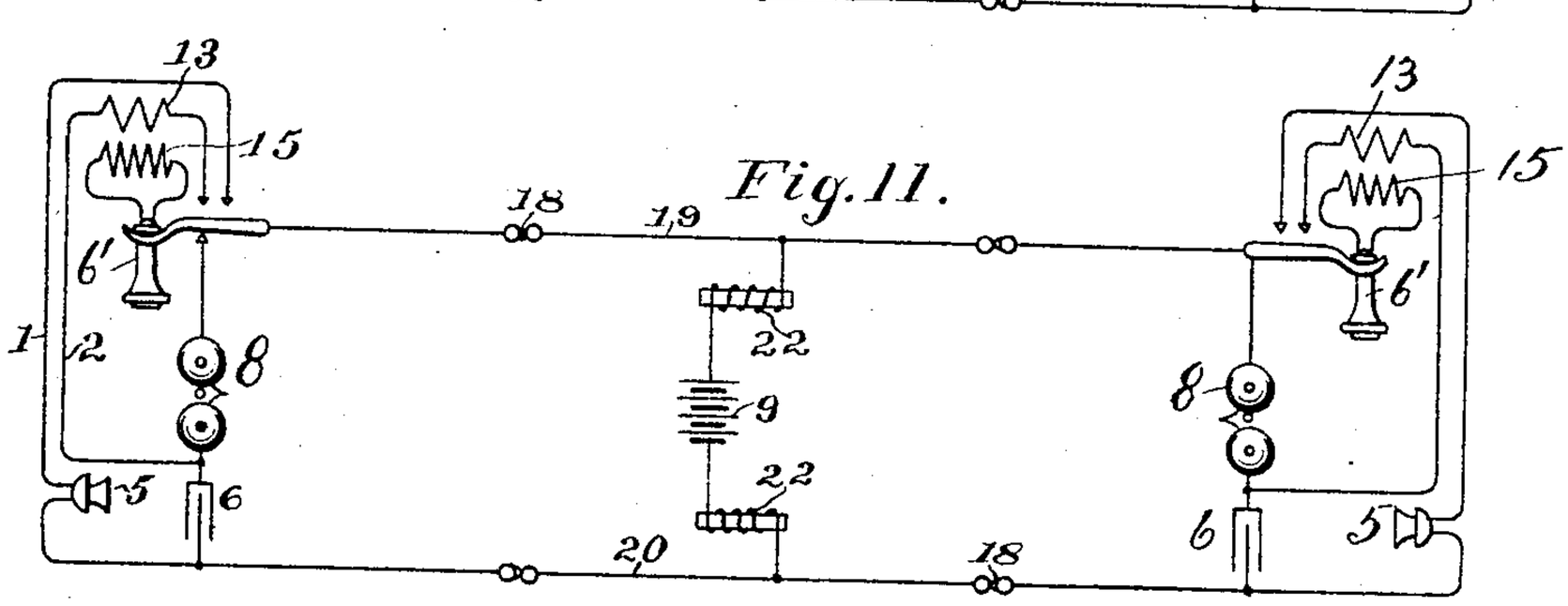
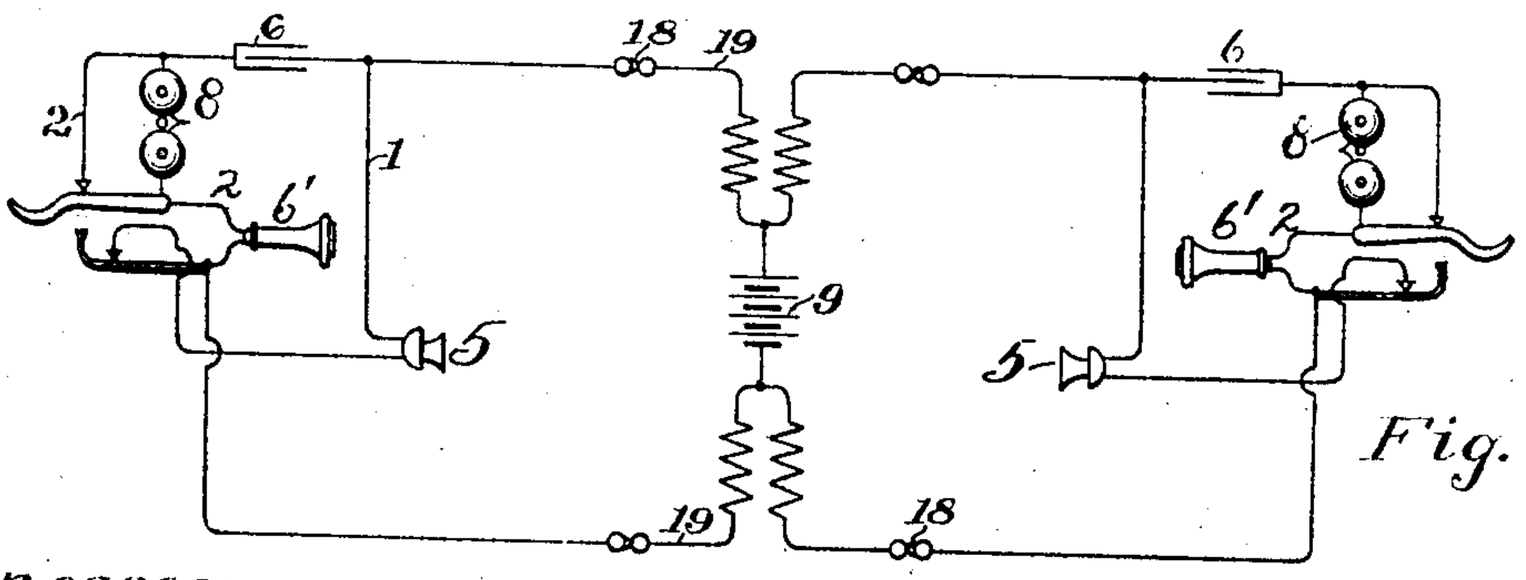


Fig. 13.



Witnesses:
A. J. Astrander
Leon. Stroh

Inventor:
Francis W. Dunbar
By G. L. Cragg Atty.

UNITED STATES PATENT OFFICE.

FRANCIS W. DUNBAR, OF CHICAGO, ILLINOIS.

TELEPHONY.

No. 803,676. Specification of Letters Patent. Patented Nov. 7, 1905.

Application filed November 12, 1904. Serial No. 232,439.

To all whom it may concern:

Be it known that I, FRANCIS W. DUNBAR, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Telephony, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to telephony, and has for its object the provision of an improved telephone system wherein the operation of receivers or receiving-windings at the substations of the various lines of the system may be substantially uniformly effective irrespective of line resistances and wherein voice-currents impressed upon a telephone-circuit at a substation will not encounter the impedance offered by the receiver at said station.

My invention relates more particularly to common-battery-telephone systems, wherein I am enabled to secure not only a proper control of the line and supervisory signals, but also an improved association of the subscribers' telephone instruments with the telephone-lines and the common or exchange batteries.

In practicing my invention I prefer to eliminate from the talking-circuits all the inductance possible between the subscribers' stations, though the invention may be successfully practiced with systems whose talking-circuits include a limited amount of inductance. In accordance with my invention I provide at each substation a receiving-conductor and a transmitting-conductor in bridge of the line. In the transmitting-conductor there is preferably included a transmitter which is adapted to vary the resistance of the transmitting-conductor through the action of the voice, this transmitter preferably including granular carbon. This transmitting-conductor preferably only includes such a transmitter, there being, desirably, no transmitter-winding therein. The receiving-conductor contains a receiver, there being in the preferred embodiment of the invention only the receiver-winding in the receiving-conductor, which winding is inductively related to a diaphragm, as in an ordinary telephone-receiver. There are embodiments of my invention, however, in which the receiving-conductor includes not only the receiving element, having a diaphragm in inductive relation to a winding, but another winding in inductive relation to a winding included in the transmitting-conductor. In certain circumstances it may be preferred to employ transmitting and receiving conductors in bridge of the telephone-line at each of the subscribers' stations that include each a winding, and I do not wish, therefore, to be limited to a system that is restricted purely to the receiver and to the transmitter without associate coils. The transmitter is desirably of high normal resistance—that is, when little is flowing therethrough—as compared with the average line resistance, which is, say, from twenty-five to fifty ohms in the average system. I have made the normal resistance of the transmitting-conductor as high as four hundred ohms, all of which resistance residing practically altogether in the transmitter. The parallel receiving-conductor has been made to have impedance substantially equivalent to the impedance possessed by the transmitting-conductor. Where the receiving-conductor is conductively continuous, the ohmic resistance included in the same is preferably practically equal to that included in the parallel transmitting-conductor. In some instances I have practiced my invention in connection with condensers included in the receiving-conductors, in which case the resistance of the receiver may be much less than where the receiving-conductor is conductively continuous. Telephone-lines, long and short, having their subscribers' stations thus equipped extend to the exchange, where they may terminate in the usual form of spring-jacks which may be associated with any suitable form of indicators and which lines may be united by any suitable form of cord connecting apparatus which are associated with common battery at each exchange for the purpose of supplying the transmitters at the subscribers' stations with current.

I use the term "battery" in the sense of any suitable form of direct current, the batteries now commonly used being preferred because the current furnished thereby is so steady. The "battery," using the term in the broad sense above noted, is desirably connected in bridge of the telephonic-line conductors; but I do not wish to be limited to the arrangement. The battery is thus preferably in parallel relation with the receiving and transmitting conductors at the subscribers' stations.

With the system organized as specified, two

very important results are accomplished, one being the attainment of a given watt variation in the voice-currents at the transmitting end of the line at a lower potential and greater amplitude of current than can be secured where the transmitting and receiving conductors are in series with each other at each subscriber's station, as a result of which the voice-currents are received at the distant receiving-conductor with less loss, due to the electrostatic capacity of the conductors over which the voice-currents are transmitted. The other result secured by the system of my invention resides in the fact that the transmitter automatically adjusts the range of variation in its resistance, so that the range will be greater over lines of greater resistance, automatically to compensate for the reduced current, and less over lines of shorter resistance, automatically to compensate for increased current, whereby the wattage over lines of widely-differing resistances, as well as over lines of substantially equivalent resistances, is more uniform than was possible with the practice obtaining hitherto, whereby the receivers at receiving-stations are operated with substantially uniform efficiency by the transmitters at transmitting-stations irrespective of the comparative lengths and resistances of the telephone-lines united by the cord connecting apparatus where the common battery is located. Lines that possess as little as five or ten ohms may be coupled with lines possessing as much as seven hundred ohms resistance without destroying the efficient operation of the receivers where the substations of such lines are equipped with the apparatus of my invention. I find that I am able to practice my invention with peculiar efficiency by the employment of transmitters using carbon granules, for this style of transmitter causes a decrease in the resistance of the transmitting-conductor when the current therethrough is increased and causes said resistance to increase when the current therethrough is decreased. It will be seen, therefore, that on the shorter lines there is a greater volume of current from the common battery. Hence the transmitter opposes less resistance to the passage of such current. On the longer lines the volume of current is decreased, owing to the increased line resistance, the carbon granules serving to increase the resistance offered to the decreased current, whereby the percentage variation of the entire transmitting-circuit is maintained substantially constant irrespective of the length of the connected lines. For example, a line whose sides possess fifty ohms resistance will have a variation in the resistance of the transmitting-conductor at its substation between limits that are far less in value than would be the range of variation of the resistance in the transmitting-conductor of a line possessing much greater ohmic resistance in its sides, though, as stated, the percentage variation may be practically uniform in the two cases.

I will explain my invention more fully by reference to the accompanying drawings, illustrating preferred embodiments thereof, in which—

Figures 1, 2, 3, 4, and 5 diagrammatically indicate telephone-substations equipped in accordance with the invention. Fig. 6 is a sectional view of the preferred type of transmitter employed. Fig. 7 is a detailed view in section of the cup for the carbon granules and adjacent parts. Figs. 8 and 9 are diagrammatic views illustrating common-battery multiple-switchboard telephone-exchange systems to which telephone-lines that are equipped with substations arranged in accordance with my invention extend. Figs. 10, 11, 12, and 13 diagrammatically indicate other forms of common-battery telephone-exchange systems the substations of whose lines are equipped in accordance with my invention.

Like parts are indicated by similar characters of reference through the different figures.

At each of the subscriber's stations (illustrated in the various figures of the drawings) there is a transmitting-conductor 1 and a receiving-conductor 2 in bridge between the sides 3 and 4 of telephone-lines, these transmitting and receiving conductors including transmitting and receiving apparatus which vary in character, according to the embodiment of the invention to be practiced.

The form of invention shown in Figs. 1 and 8 is preferred because of the simplicity of the construction and arrangement of the apparatus. In the transmitting-conductor 1 there is included a single transmitting element 5, which is desirably in the form of a transmitter employing carbon granules between its electrodes, such as exhibited in Figs. 6 and 7, which transmitter need not be specifically described, as the illustrations thereof in the latter two figures will be sufficient to disclose the same to those skilled in the art. I prefer to modify the precise form of transmitter indicated in Figs. 6 and 7 by making the normal resistance between the transmitter-electrodes very high—say four hundred ohms—with little current. The receiving-conductor 2 preferably has the same impedance that the transmitting-conductor has; but in order that the ohmic resistance may be reduced and the energizing-winding in the receiving-conductor may have fullest effect upon the receiver-diaphragm I employ a condenser 6 in the receiving-conductor in series with the receiver 6′. This condenser, combined with the ohmic resistance in the receiving-conductor, preferably causes the impedance of the entire conductor substantially to equal the impedance of the transmitting-conductor. In adapting the substation outfit to an actual telephone-substation a switch-hook 7 is employed that normally separates

one terminal of the transmitting-conductor and one terminal of the receiving-conductor from the telephone-line 3 4, the telephone-receiver accomplishing this result when supported by the switch-hook. The call-bells 8 may be separably in bridge of the line, as indicated at station A, Fig. 8, or may be permanently in bridge, as indicated at station B. In Fig. 8 the invention is shown as being embodied in a well-known common-battery multiple-switchboard telephone-exchange system, certain component parts of which exchange system are clearly indicated and which will not need to be specifically described, as the apparatus illustrated, its arrangement, and functions are well understood to those skilled in the art. Suffice it to say that when two lines are connected for conversation through the agency of the cord connecting apparatus shown a source of steady current 9 is connected in bridge between the sides of the telephonic circuit, whereby the transmitters at the subscribers' stations are supplied with current. I do not wish to be limited to the precise way in which the current from the battery 9 is supplied to the transmitting instruments. In the embodiment of the invention shown in Fig. 8 the condensers 10 10 are included in the tip and sleeve-strands of the cord-circuit, metallically effecting separation of the telephone-circuit into two parts, which parts, however, are telephonically united by said condensers. While I have shown one battery supplying the two sections of the telephonic circuit, I do not wish to be limited to such a single source of current.

In the arrangement illustrated in Fig. 2 there is disclosed the same circuit arrangement indicated in Fig. 1, excepting that there is provided a winding 11 in the transmitting-conductor and a winding 12 in the receiving-conductor, which windings are in inductive relation.

In the arrangement illustrated in Fig. 3 the transmitting-conductor 1 includes only the transmitter 5. The receiving-conductor 2 has as a component part thereof a winding 13, which instead of acting directly upon the diaphragm of the receiver is inductively related to a closed local circuit 14, this circuit including a winding 15 that is in transformer relation with the winding 13 and the energizing-winding of the receiver. The winding 13, however, constitutes a receiver-winding, for it is such winding that causes the operation of the receiver-diaphragm, ordinary receivers now in commercial service being the form of receiver that I prefer to employ in all embodiments of my invention. The arrangement shown in Fig. 3 is one wherein the receiving-conductor does not include a condenser, in which case I prefer to increase the ohmic resistance of such conductor to approximate the ohmic resistance of the transmitting-conductor, so that the impedance of these conductors will be substantially the same. The bulk of this resistance may reside in the winding 13 in order to secure the best telephonic effects.

The arrangement shown in Fig. 4 is similar to that indicated in Fig. 3, excepting that the impedance of the receiving-conductor is caused to approach that of the transmitting-conductor by providing the condenser 6 in the receiving-conductor, the ohmic resistance of the winding 13 being then reduced.

Fig. 5 illustrates a substation arrangement similar to that indicated in Fig. 4, excepting that the transmitting-conductor has added thereto the winding 11, the receiving-conductor having the winding 12 in inductive relation with the windings 11 and 15.

In Fig. 9 there is illustrated another type of multiple-switchboard common-battery telephone-exchange system subscribers' stations of whose lines are equipped with apparatus constructed and arranged in accordance with my invention. The cord-circuit is metallically disjointed, but is telephonically united through the agency of the repeating-coils 16, that are interposed together with condensers 17 between the cord-strands. The apparatus illustrated at the exchange and its functions being well understood to those skilled in the art, I do not deem a specific description thereof to be essential to an understanding of my present invention. The substation apparatus is equipped in accordance with the circuit arrangement illustrated in Fig. 3, the telephone switch-hook 7 serving normally to disconnect both the receiving and transmitting conductors from one side of the line. The bell at station A in Fig. 9 is separably included in bridge of the telephone-line, while at station B the said bell is permanently in bridge.

In Figs. 8 and 9 well-known apparatus is employed for inductively uniting metallically-disjointed sections of cord-circuits, in one case through the agency of condensers and in the other case through the agency of repeating-coils. Other cord connecting apparatus, however, may be employed that is well adapted to common-battery practice—such, for example, as that indicated in Figs. 10, 11, 12, and 13. In each of these figures the circles 18 diagrammatically indicate the separable terminals of jacks and plugs. In each instance the common battery 9 is included between the cord-strands 19 and 20.

In Fig. 10 high resistances 21 are included between the battery and its connections with the cord-strands, such resistances being non-inductive.

In Fig. 11 the windings 22 are included between the battery and its connections with the cord-strands, which windings may be of low ohmic resistance and high impedance.

In Fig. 12 the plan shown in Fig. 11 is generally followed, excepting that each impedance-winding is subdivided into coils 23, between each pair of which a terminal of the bat-

tery is connected, condensers 24 being included in the cord-strands between the connections thereof with the coils 23.

In Fig. 13 another well-known common-battery system is indicated.

My invention is well adapted to be praticed with all of the common-battery systems illustrated; but its application is not to be limited to these systems, as it is obvious to those skilled in the art that my invention possesses a very wide range of application.

I preferably omit from the telephonic circuits extending to the receivers as much electromagnetic winding or winding that has the choking effect of electromagnetic winding as possible in order that the best results may be achieved. In the systems illustrated practically no such electromagnetic winding is provided.

In Fig. 10 I have shown subscribers' stations that include the circuit arrangement illustrated in Fig. 2. The circuit arrangement illustrated in Fig. 4 is followed in the subscribers' stations of the system shown in Fig. 11. Fig. 12 has its subscribers' station arrangement similar to that indicated in Fig. 5.

In Figs. 10, 11, and 12 switch-hooks are employed at the subscribers' stations, normally opening the transmitting and receiving conductors. Some of the bells 8 are shown in permanent bridges and some in bridges opened by the switch-hooks when the receivers are removed.

In Fig. 13 the same general arrangement of circuits followed in the arrangement of Fig. 1 is used.

The switch-hook control of the substation instruments will be readily understood without specific description. I prefer the switch-hook control as illustrated in Fig. 8, however.

I prefer the arrangement wherein the receiving-winding in bridge of the telephone-circuit operates directly upon the receiver-diaphragm instead of through the intermediation of an induced winding or circuit, but do not limit myself to this arrangement.

In a common-battery system the switch-hooks prevent the operation of the line-indicators by the office-battery when said hooks support receivers by operatively interrupting the metallic continuity of the transmitting-conductors and in certain of the embodiments shown the receiving-conductors also. This operative interruption is preferably effected by causing an air-gap to be included between the transmitter and the line by the switch-hook, thereby opposing an extremely high resistance to the battery-current. This resistance is cut out or effaced when the receiver is removed. I do not wish to be limited to the extent of this resistance employed to have the effect stated. The operative connection of said conductors with the line by the switch-hooks upon the removal of the receivers therefrom causes battery-current to flow in the line, which current is governed by the switch-hooks to effect control of the line and supervisory signaling apparatus.

In all of the embodiments of the invention shown the metallic connection of the transmitter with the line and its disconnection from the line by the switch-hook change the operative condition of the signaling apparatus connected with the line.

It is obvious that various embodiments of my invention may have widely-differing applications, and I do not, therefore, wish to be limited to the precise systems and arrangements herein illustrated; but,

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. A common-battery telephone-exchange system having lines extending from subscribers' stations to an exchange and there connected in circuit with battery, each subscriber's station being equipped with two conductors of substantially the same impedance in bridge between the two sides of the line, one conductor including a condenser, a receiver subject to current in said conductor, the other conductor including a variable and high resistance transmitter including carbon granules, and a switch-hook serving operatively metallically to connect and disconnect the sides of the telephone-line at the subscriber's station and operatively metallically to connect the transmitter with and disconnect it from the telephone-line, substantially as described.

2. A common-battery telephone-exchange system having lines extending from subscribers' stations to an exchange and there connected in circuit with battery, each subscriber's station being equipped with two conductors in bridge between the sides of the line, said conductors being of substantially the same impedance, a receiver subject to current in one conductor, the other conductor including a high and variable resistance transmitter that includes carbon granules, and a switch-hook serving operatively metallically to connect and disconnect the sides of the telephone-line at the subscriber's station and operatively metallically to connect the transmitter with and disconnect it from the telephone-line, substantially as described.

3. A common-battery telephone-exchange system having lines extending from subscribers' stations to an exchange and there connected in circuit with battery, each subscriber's station being equipped with two conductors in bridge between the sides of the line, a receiver subject to current in one conductor, the other conductor including a high and variable resistance transmitter that includes carbon granules, and a switch-hook serving operatively metallically to connect and disconnect the sides of the telephone-line at the subscriber's station and operatively metallically to connect the transmitter with and disconnect it from the telephone-line, substantially as described.

4. A common-battery telephone-exchange system having lines extending from subscribers' stations to an exchange and there connected in circuit with battery, each subscriber's station being equipped with two conductors of substantially the same impedance in bridge between the two sides of the line, one conductor including a condenser, a receiver subject to current in said conductor, the other conductor including a variable and high resistance transmitter, and a switch-hook serving operatively metallically to connect and disconnect the sides of the telephone-line at the subscriber's station and operatively metallically to connect the transmitter with and disconnect it from the telephone-line, substantially as described.

5. A common-battery telephone-exchange system having lines extending from subscribers' stations to an exchange and there connected in circuit with battery, each subscriber's station being equipped with two conductors in bridge between the two sides of the line, one conductor including a condenser, a receiver subject to current in said conductor, the other conductor including a variable and high resistance transmitter, and a switch-hook serving operatively metallically to connect and disconnect the sides of the telephone-line at the subscriber's station and operatively metallically to connect the transmitter with and disconnect it from the telephone-line, substantially as described.

6. A common-battery telephone-exchange system having lines extending from subscribers' stations to an exchange and there connected in circuit with battery, each subscriber's station being equipped with two conductors in bridge between the two sides of the line, one conductor including a condenser, a receiver subject to current in said conductor, the other conductor including a variable and high resistance transmitter including carbon granules, and a switch-hook serving operatively metallically to connect and disconnect the sides of the telephone-line at the subscriber's station and operatively metallically to connect the transmitter with and disconnect it from the telephone-line, substantially as described.

7. A common-battery telephone-exchange system having lines extending from subscribers' stations to an exchange and there connected in circuit with battery, each subscriber's station being equipped with two conductors in bridge between the sides of the line, a receiver subject to current in one conductor, the other conductor including a high and variable resistance transmitter, and a switch-hook serving operatively metallically to connect and disconnect the sides of the telephone-line at the subscriber's station and operatively metallically to connect the transmitter with and disconnect it from the telephone-line, substantially as described.

8. A common-battery telephone-exchange system having lines extending from subscribers' stations to an exchange and there connected in circuit with battery, each subscriber's station being equipped with two conductors of substantially the same impedance in bridge between the two sides of the line, one conductor including a condenser, a receiver subject to current in said conductor, the other conductor including a high-resistance transmitter, and a switch-hook serving operatively metallically to connect and disconnect the sides of the telephone-line at the subscriber's station and operatively metallically to connect the transmitter with and disconnect it from the telephone-line, substantially as described.

9. A common-battery telephone-exchange system having lines extending from subscribers' stations to an exchange and there connected in circuit with battery, each subscriber's station being equipped with two conductors in bridge between the two sides of the line, one conductor including a condenser, a receiver subject to current in said conductor, the other conductor including a high-resistance transmitter, and a switch-hook serving operatively metallically to connect and disconnect the sides of the telephone-line at the subscriber's station and operatively metallically to connect the transmitter with and disconnect it from the telephone-line, substantially as described.

10. A common-battery telephone-exchange system having lines extending from subscribers' stations to an exchange and there connected in circuit with battery, each subscriber's station being equipped with two conductors in bridge between the sides of the line, said conductors being of substantially the same impedance, a receiver subject to current in one conductor, the other conductor including a high-resistance transmitter, and a switch-hook serving operatively metallically to connect and disconnect the sides of the telephone-line at the subscriber's station and operatively metallically to connect the transmitter with and disconnect it from the telephone-line, substantially as described.

11. A common-battery telephone-exchange system having lines extending from subscribers' stations to an exchange and there connected in circuit with battery, each subscriber's station being equipped with two conductors of substantially the same impedance in bridge between the sides of the line, a receiver subject to current in one conductor, the other conductor being of high variable resistance and including a transmitter, and a switch-hook serving operatively metallically to connect and disconnect the sides of the telephone-line at the subscriber's station and operatively metallically to connect the transmitter with and disconnect it from the telephone-line, substantially as described.

12. A common-battery telephone-exchange system having lines extending from subscribers' stations to an exchange and there

connected in circuit with battery, each subscriber's station being equipped with two conductors in bridge between the sides of the line, a receiver subject to current in one conductor, the other conductor being of high variable resistance and including a transmitter, and a switch-hook serving operatively metallically to connect and disconnect the sides of the telephone-line at the subscriber's station and operatively metallically to connect the transmitter with and disconnect it from the telephone-line, substantially as described.

13. A common-battery telephone-exchange system having lines extending from subscribers' stations to an exchange and there connected in circuit with battery, each subscriber's station being equipped with two conductors in bridge between the sides of the line, a receiver subject to current in one conductor, and the other conductor including a high-resistance transmitter, and a switch-hook serving operatively metallically to connect and disconnect the sides of the telephone-line at the subscriber's station and operatively metallically to connect the transmitter with and disconnect it from the telephone-line, substantially as described.

14. A common-battery telephone-exchange system having lines extending from subscribers' stations to an exchange and there connected in circuit with battery, each subscriber's station being equipped with two conductors of substantially the same impedance in bridge between the two sides of the line, one conductor including a condenser, a receiver subject to current in said conductor, the other conductor including a variable-resistance transmitter, and a switch-hook serving operatively metallically to connect and disconnect the sides of the telephone-line at the subscriber's station and operatively metallically to connect the transmitter with and disconnect it from the telephone-line, substantially as described.

15. A common-battery telephone-exchange system having lines extending from subscribers' stations to an exchange and there connected in circuit with battery, each subscriber's station being equipped with two conductors of substantially the same impedance in bridge between the two sides of the line, one conductor including a condenser, a receiver subject to current in said conductor, the other conductor including a variable-resistance transmitter including carbon granules, and a switch-hook serving operatively metallically to connect and disconnect the sides of the telephone-line at the subscriber's station and operatively metallically to connect the transmitter with and disconnect it from the telephone-line, substantially as described.

16. A common-battery telephone-exchange system having lines extending from subscribers' stations to an exchange and there connected in circuit with battery, each subscriber's station being equipped with two conductors of substantially the same impedance in bridge between the two sides of the line, one conductor including a condenser, a receiver subject to current in said conductor, the other conductor including a transmitter, and a switch-hook serving operatively metallically to connect and disconnect the sides of the telephone-line at the subscriber's station and operatively metallically to connect the transmitter with and disconnect it from the telephone-line, substantially as described.

17. A common-battery telephone-exchange system having lines extending from subscribers' stations to an exchange and there connected in circuit with battery, each subscriber's station being equipped with two conductors of substantially the same impedance in bridge between the sides of the line, a receiver subject to current in one conductor, the other conductor being of variable resistance and including a transmitter, and a switch-hook serving operatively metallically to connect and disconnect the sides of the telephone-line at the subscriber's station and operatively metallically to connect the transmitter with and disconnect it from the telephone-line, substantially as described.

18. A common-battery telephone-exchange system having lines extending from subscribers' stations to an exchange and there connected in circuit with battery, each subscriber's station being equipped with two conductors in bridge between the sides of the line, said conductors being of substantially the same impedance, a receiver subject to current in one conductor, the other conductor including a variable-resistance transmitter that includes carbon granules, and a switch-hook serving operatively metallically to connect and disconnect the sides of the telephone-line at the subscriber's station and operatively metallically to connect the transmitter with and disconnect it from the telephone-line, substantially as described.

19. A common-battery telephone-exchange system having lines extending from subscribers' stations to an exchange and there connected in circuit with battery, each subscriber's station being equipped with two conductors in bridge between the sides of the line, said conductors being of substantially the same impedance, a receiver subject to current in one conductor, the other conductor including a high and variable resistance transmitter, and a switch-hook serving operatively metallically to connect and disconnect the sides of the telephone-line at the subscriber's station and operatively metallically to connect the transmitter with and disconnect it from the telephone-line, substantially as described.

20. A common-battery telephone-exchange system having lines extending from subscribers' stations to an exchange and there connected in circuit with battery, each sub-

scriber's station being equipped with two conductors in bridge between the sides of the line, said conductors being of substantially the same impedance, a receiver subject to current in one conductor, the other conductor including a variable-resistance transmitter, and a switch-hook serving operatively metallically to connect and disconnect the sides of the telephone-line at the subscriber's station and operatively metallically to connect the transmitter with and disconnect it from the telephone-line, substantially as described.

21. A common-battery telephone-exchange system having lines extending from subscribers' stations to an exchange and there connected in circuit with battery, each subscriber's station being equipped with two conductors in bridge between the sides of the line, said conductors being of substantially the same impedance, a receiver subject to current in one conductor, the other conductor including a transmitter, and a switch-hook serving operatively metallically to connect and disconnect the sides of the telephone-line at the subscriber's station and operatively metallically to connect the transmitter with and disconnect it from the telephone-line, substantially as described.

In witness whereof I hereunto subscribe my name this 9th day of November, A. D. 1904.

FRANCIS W. DUNBAR.

Witnesses:
G. L. CRAGG,
LEON STROH.