No. 825,623. PATENTED JULY 10, 1906.

H. G. WEBSTER.

COMBINED TELEPHONE AND ALARM SYSTEM.

APPLICATION FILED APR. 26, 1904.

11 SHEETS—SHEET 1.

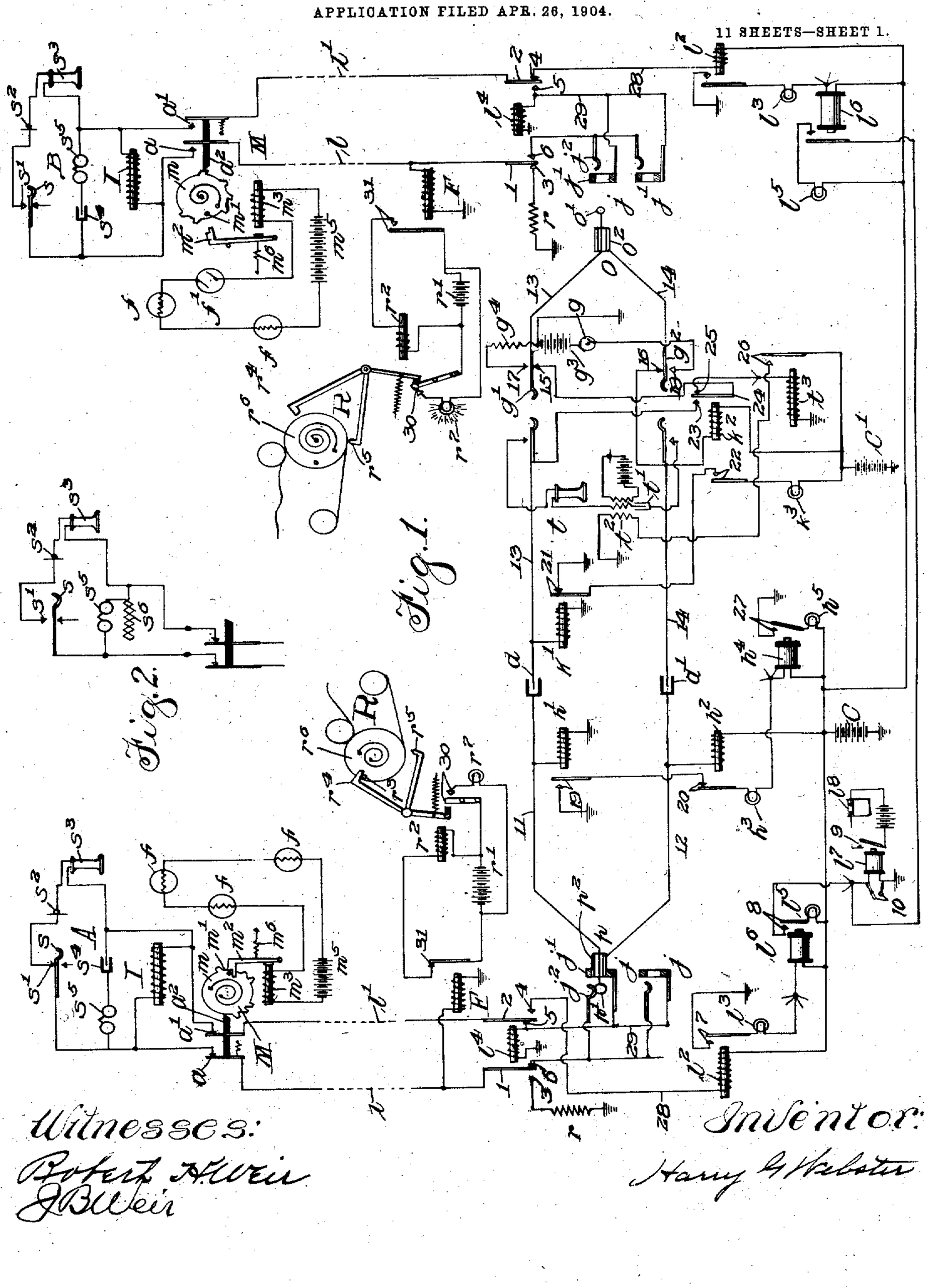

Fig. 1.

Fig. 2.

Witnesses:
Robert A. Weir
J. B. Weir

Inventor:
Harry G. Webster

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11 SHEETS—SHEET 2.

Fig. 2a

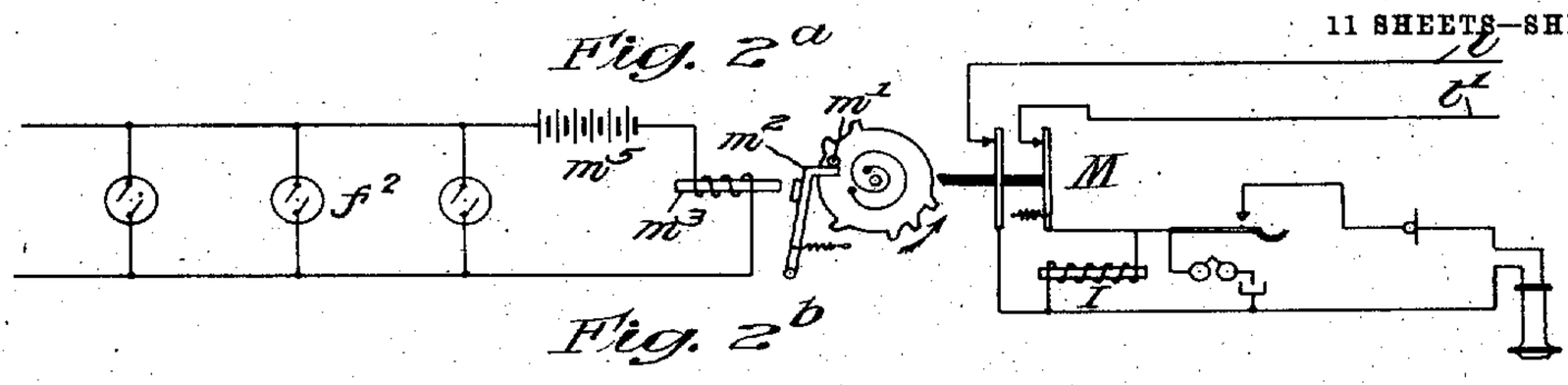


Fig. 2b

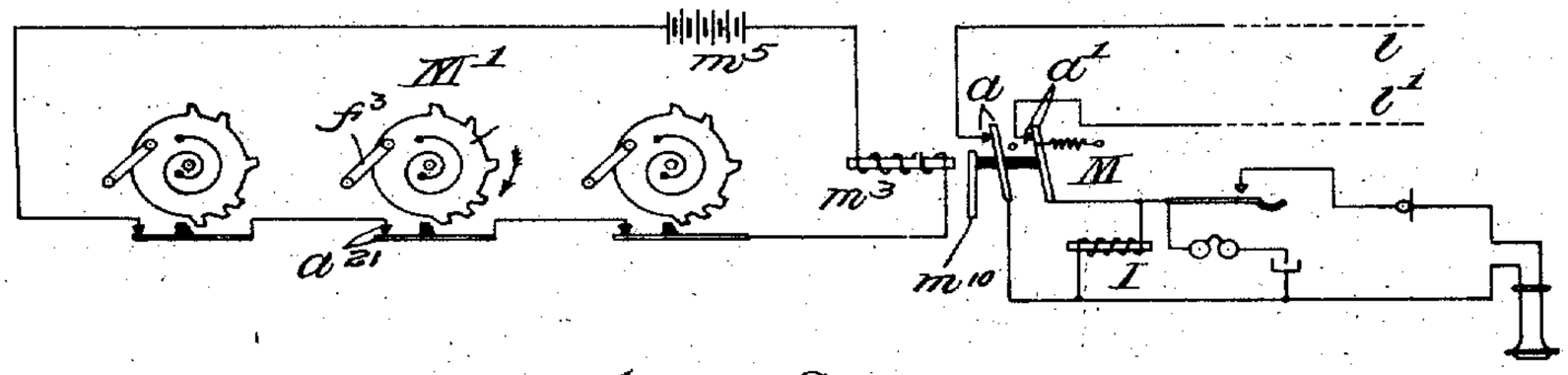


Fig. 2c

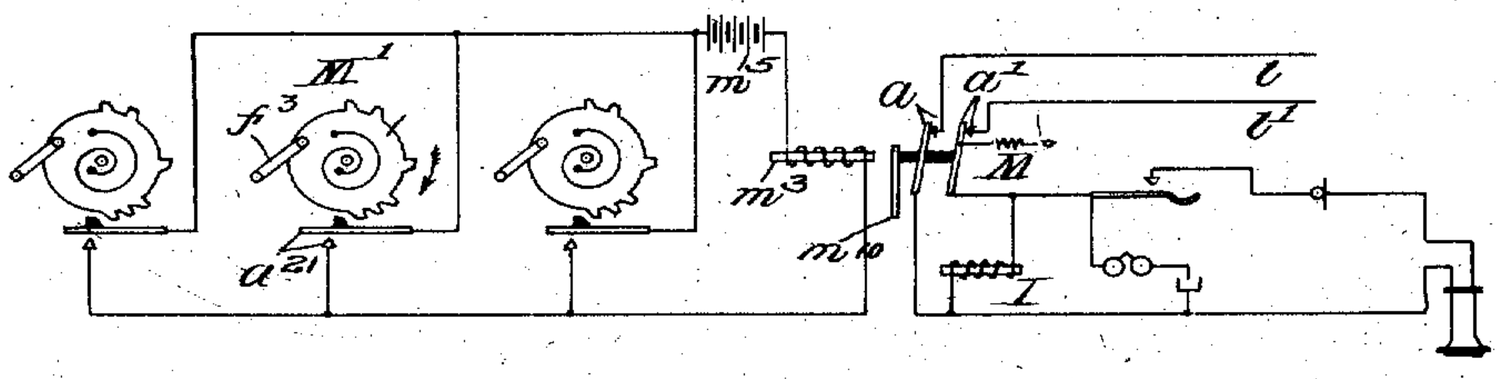


Fig. 2d

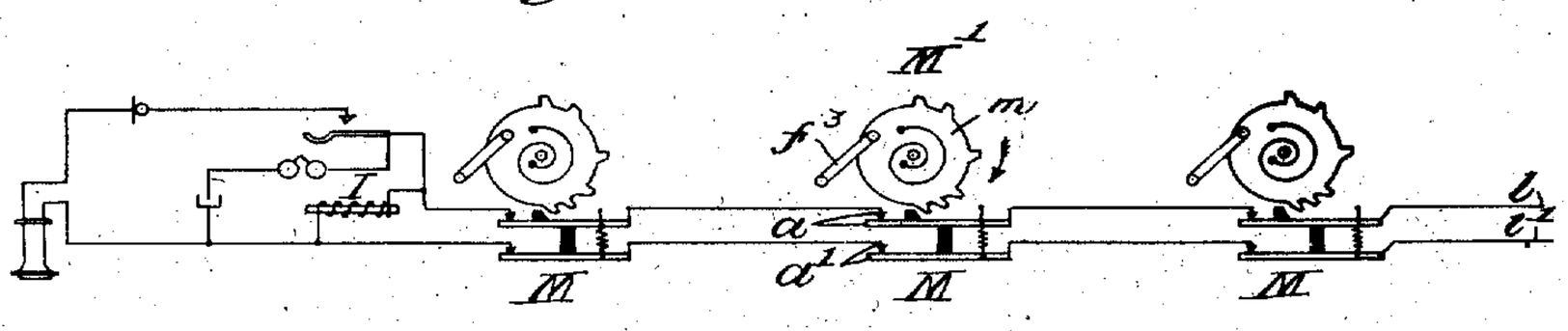
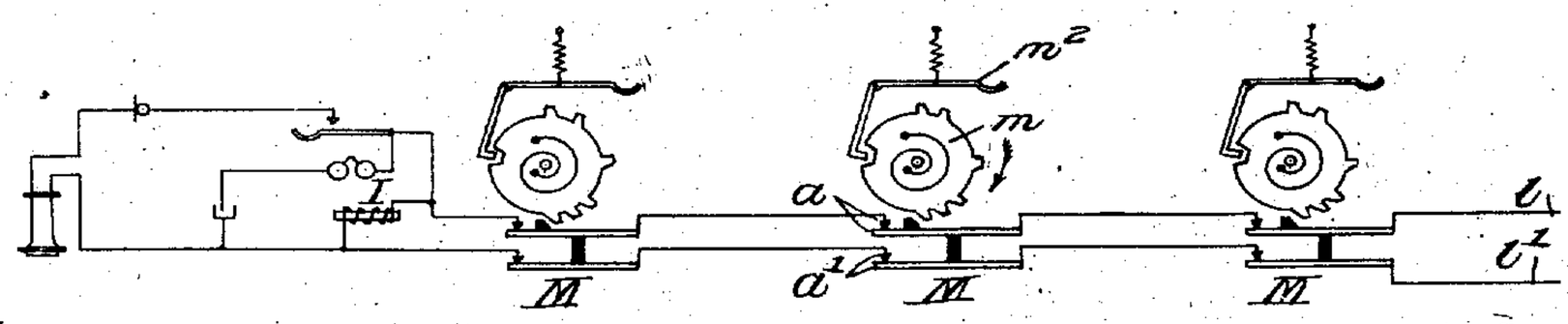


Fig. 2e



Witnesses:

Robert Weir

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Inventor:

Harry G. Webster

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11 SHEETS—SHEET 3.

Fig. 3.

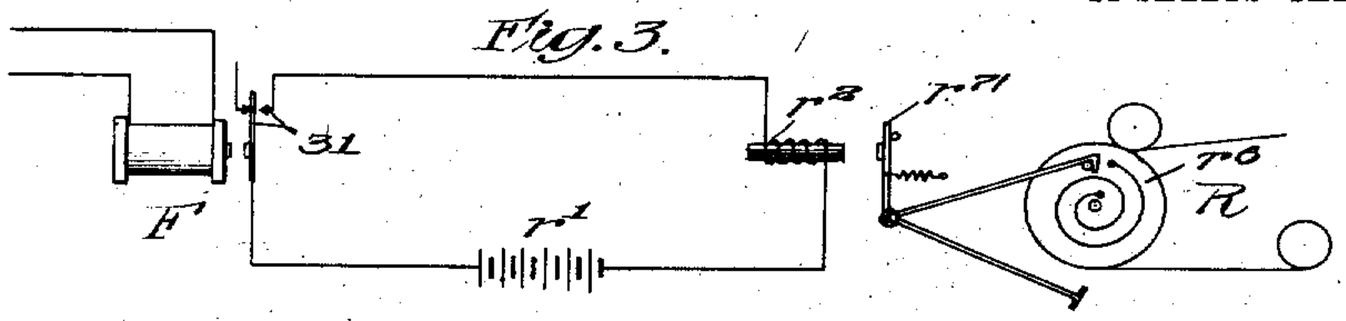
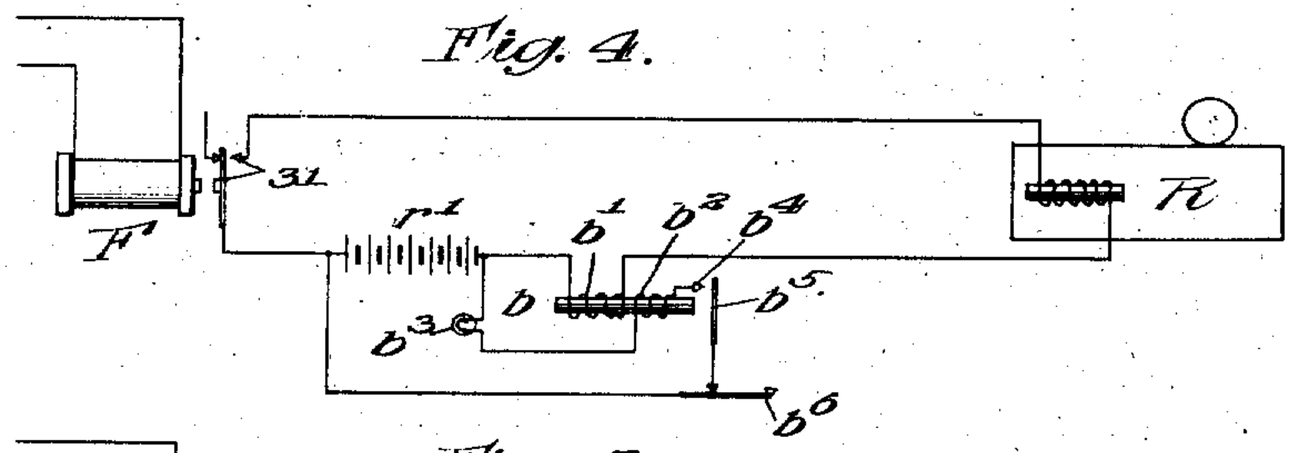


Fig. 4.



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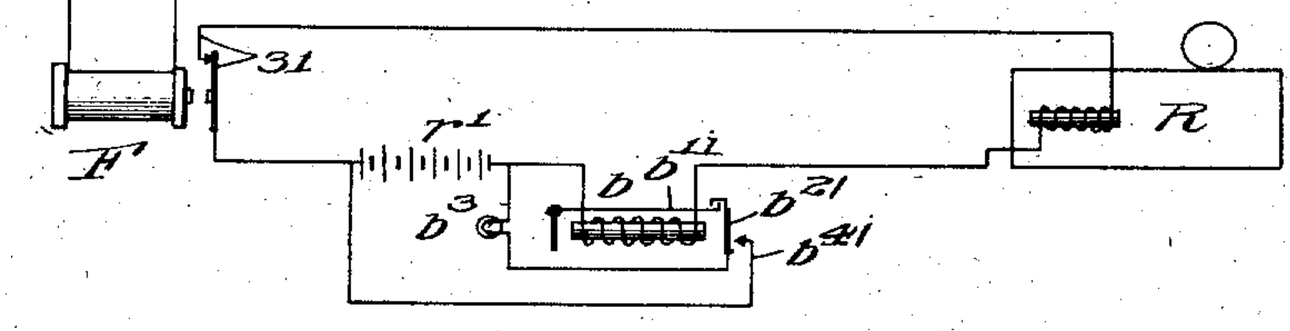


Fig. 6.

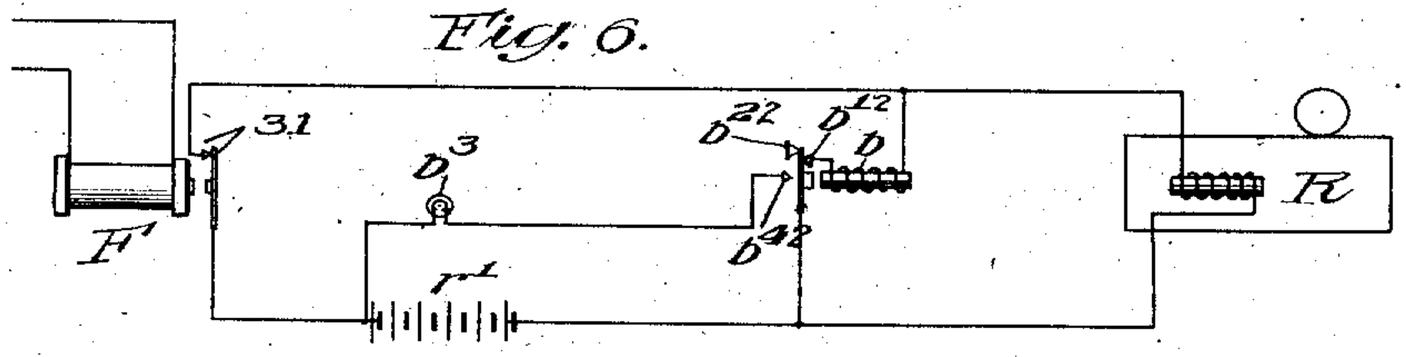


Fig. 7.

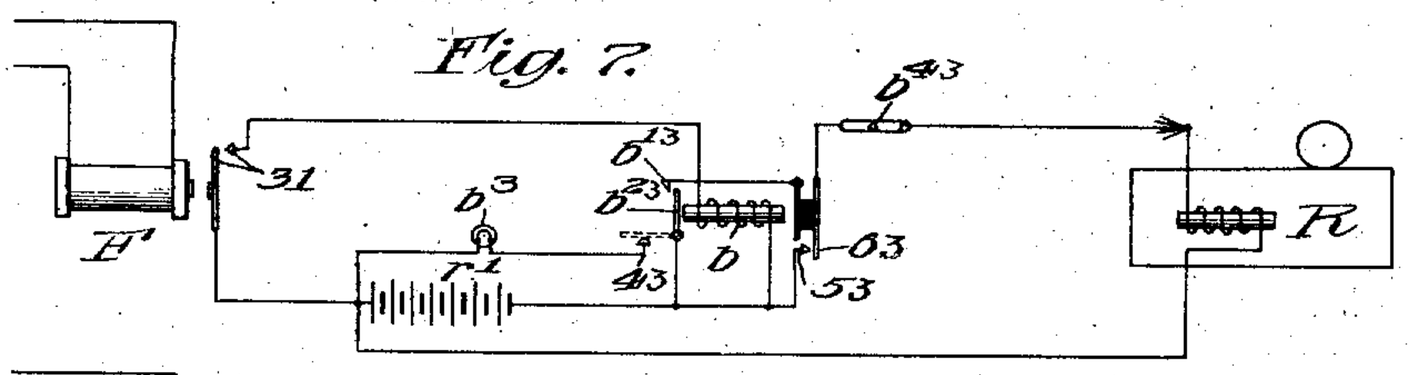
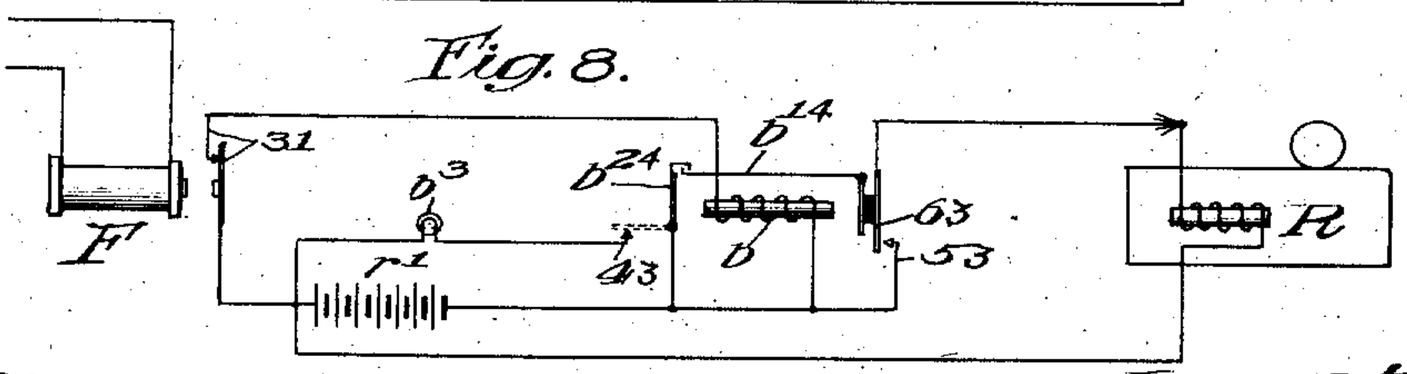


Fig. 8.



Witnesses:
Robert N. Wein
J. B. Wein

Inventor:
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11 SHEETS—SHEET 4.

Fig. 9.

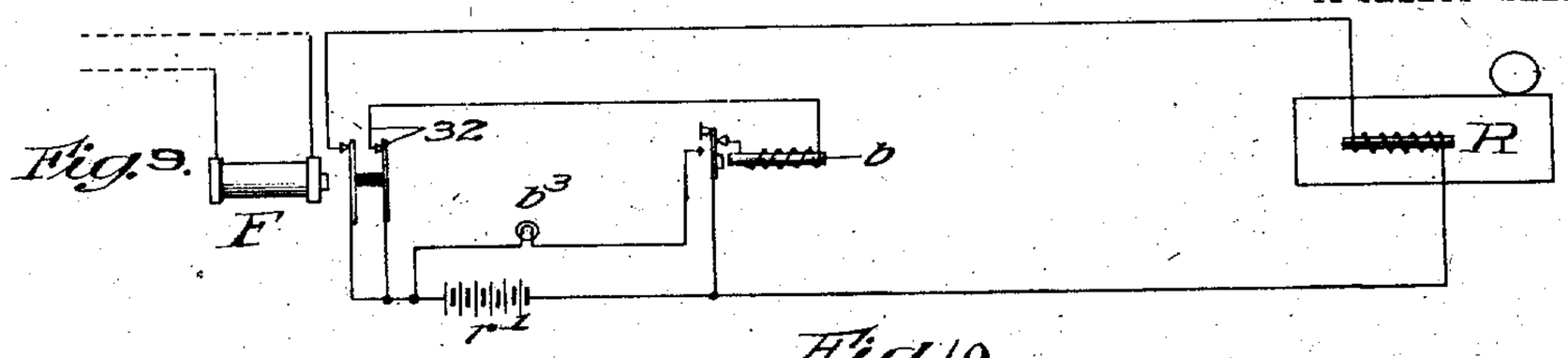


Fig. 10.

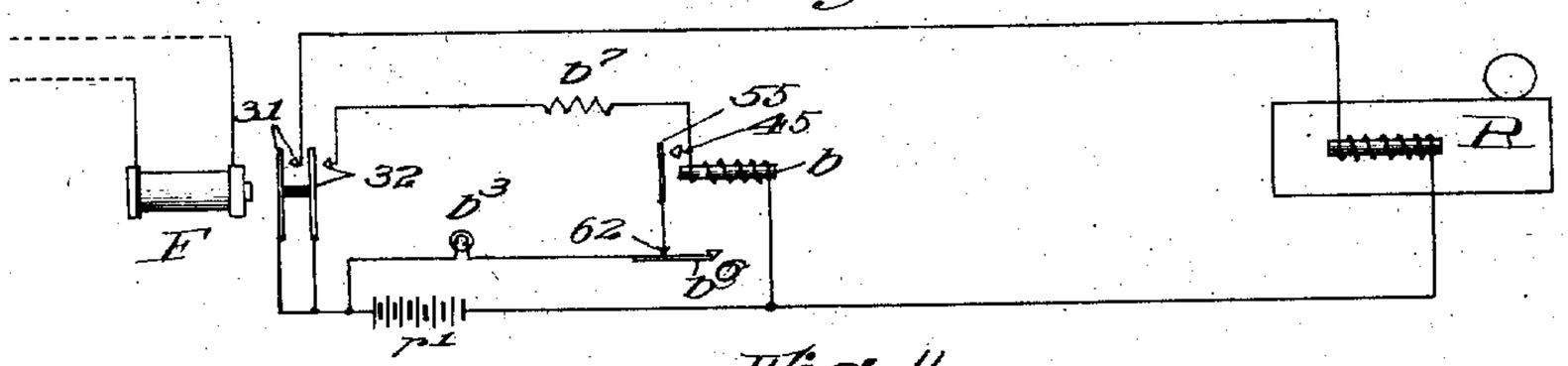


Fig. 11.

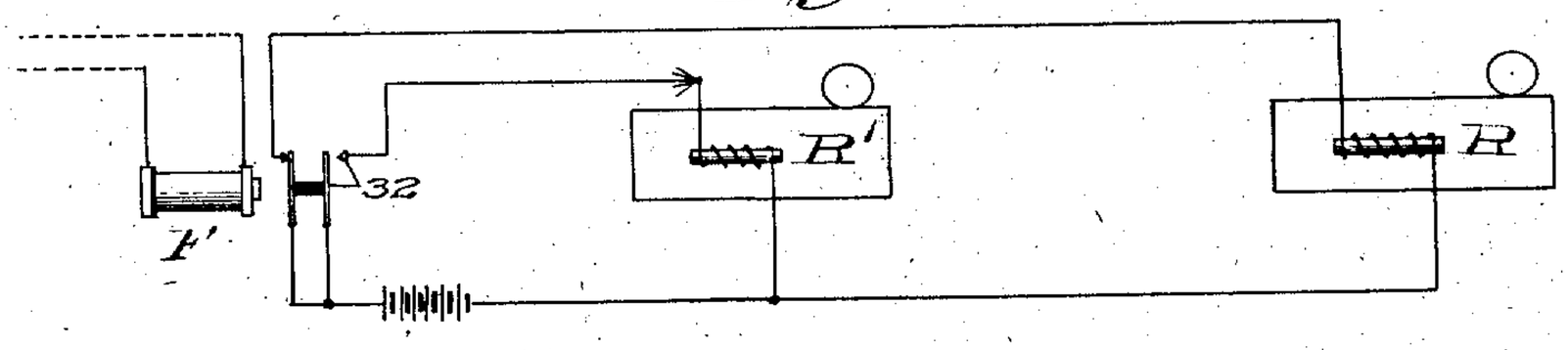


Fig. 12.

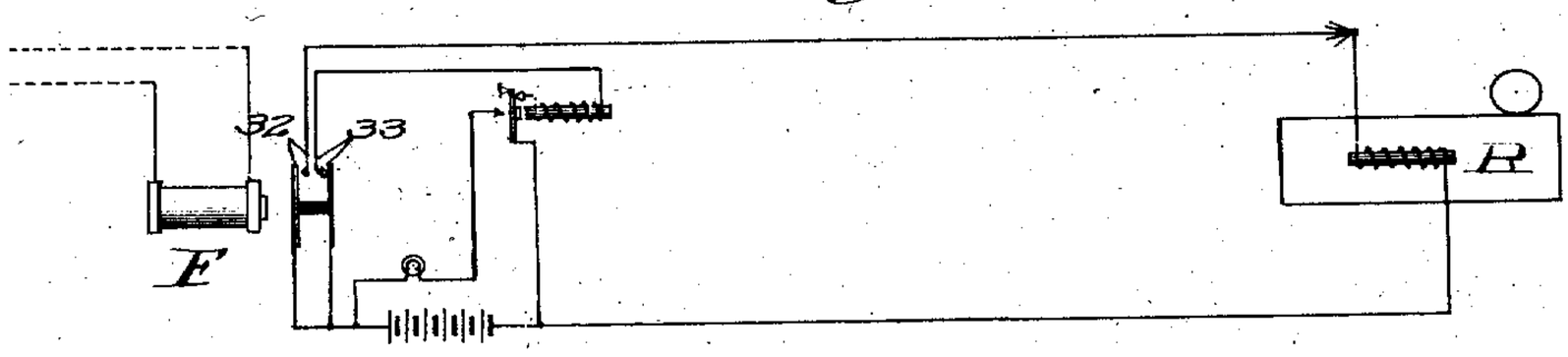


Fig. 13.

Fig. 14.

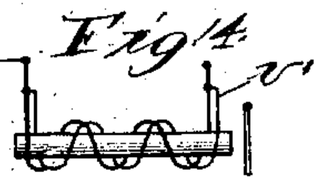
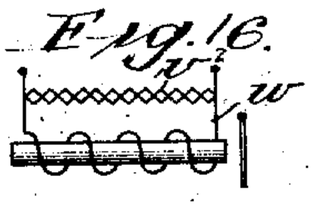


Fig. 15.

Fig. 16.



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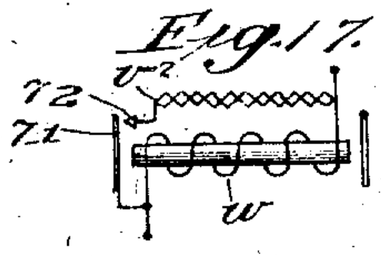

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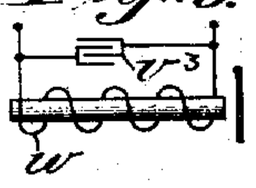

Witnesses:

Robert Weir

J. B. Weir

Inventor:

Harry G. Webster

No. 825,623. PATENTED JULY 10, 1906.

H. G. WEBSTER.

COMBINED TELEPHONE AND ALARM SYSTEM.

APPLICATION FILED APR. 26, 1904.

11 SHEETS—SHEET 5.

Fig. 19.

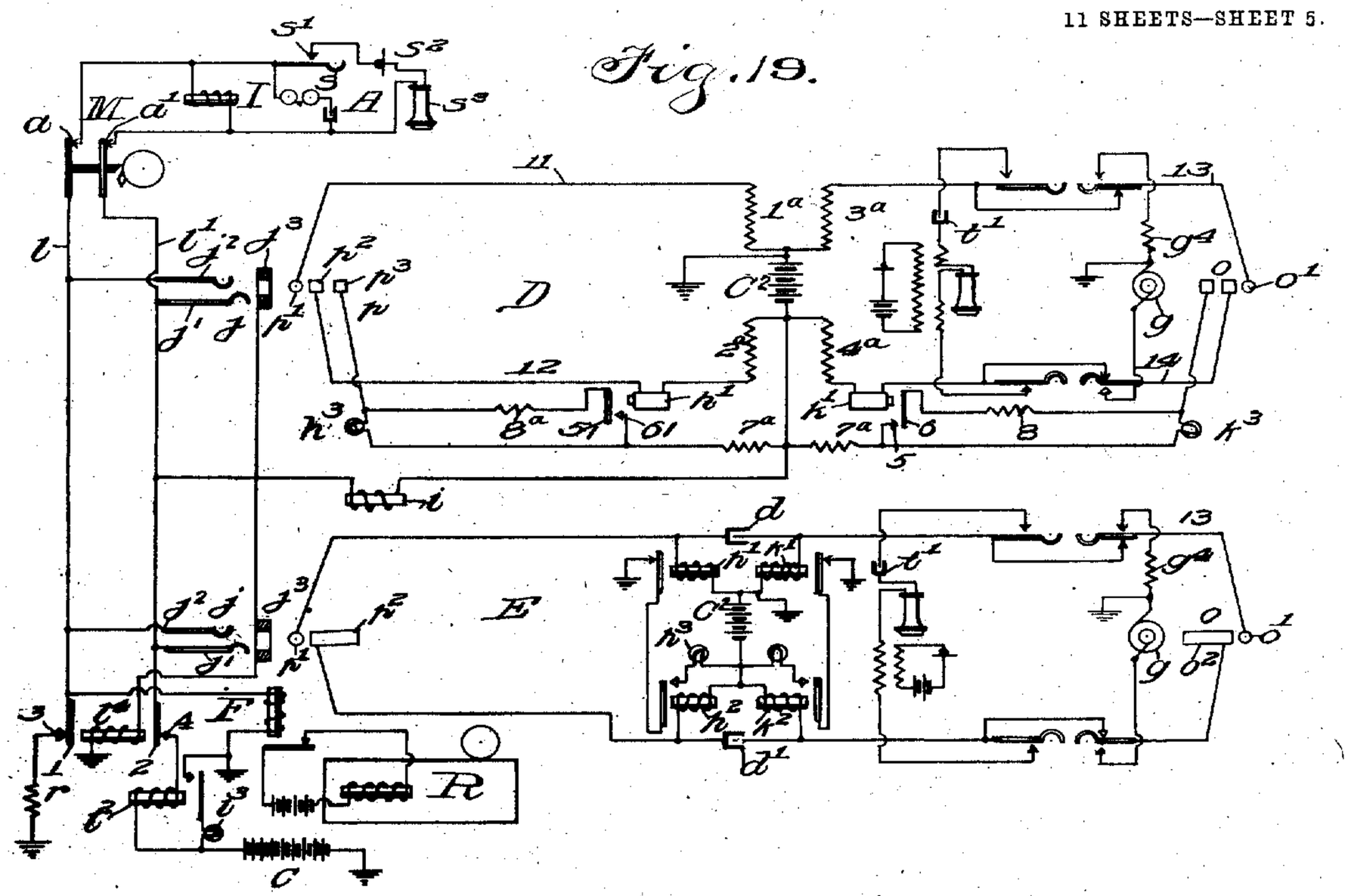

Fig. 20.

Witnesses:

Robert F. Allen

J. B. Allen

Inventor:

Harry G. Webster

No. 825,623. PATENTED JULY 10, 1906.

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11 SHEETS—SHEET 6.

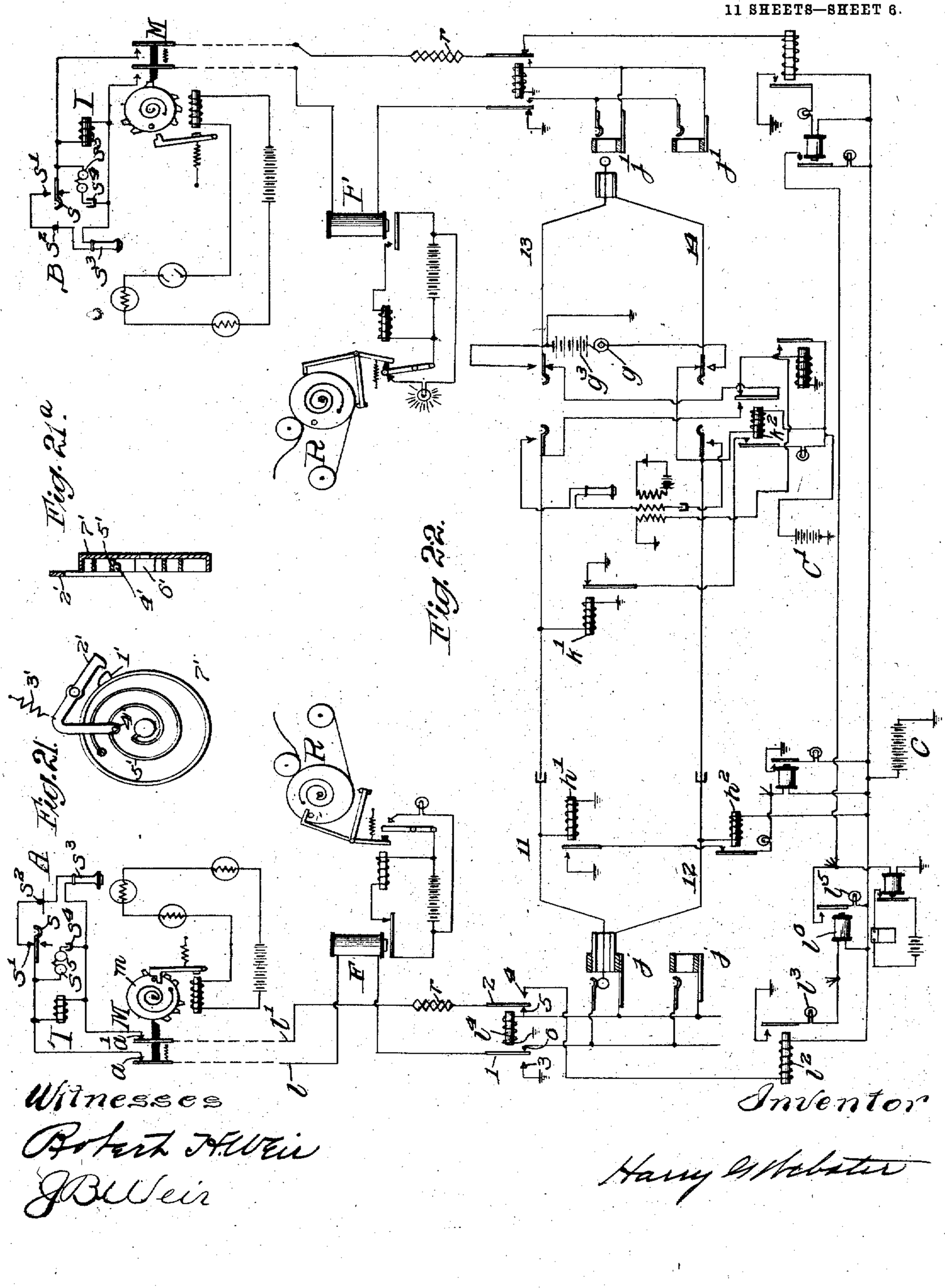

Fig. 2a.

Fig. 2b.

Witnesses

Robert N. Weir

J. B. Weir

Inventor

Harry G. Webster

No. 825,623. PATENTED JULY 10, 1906.

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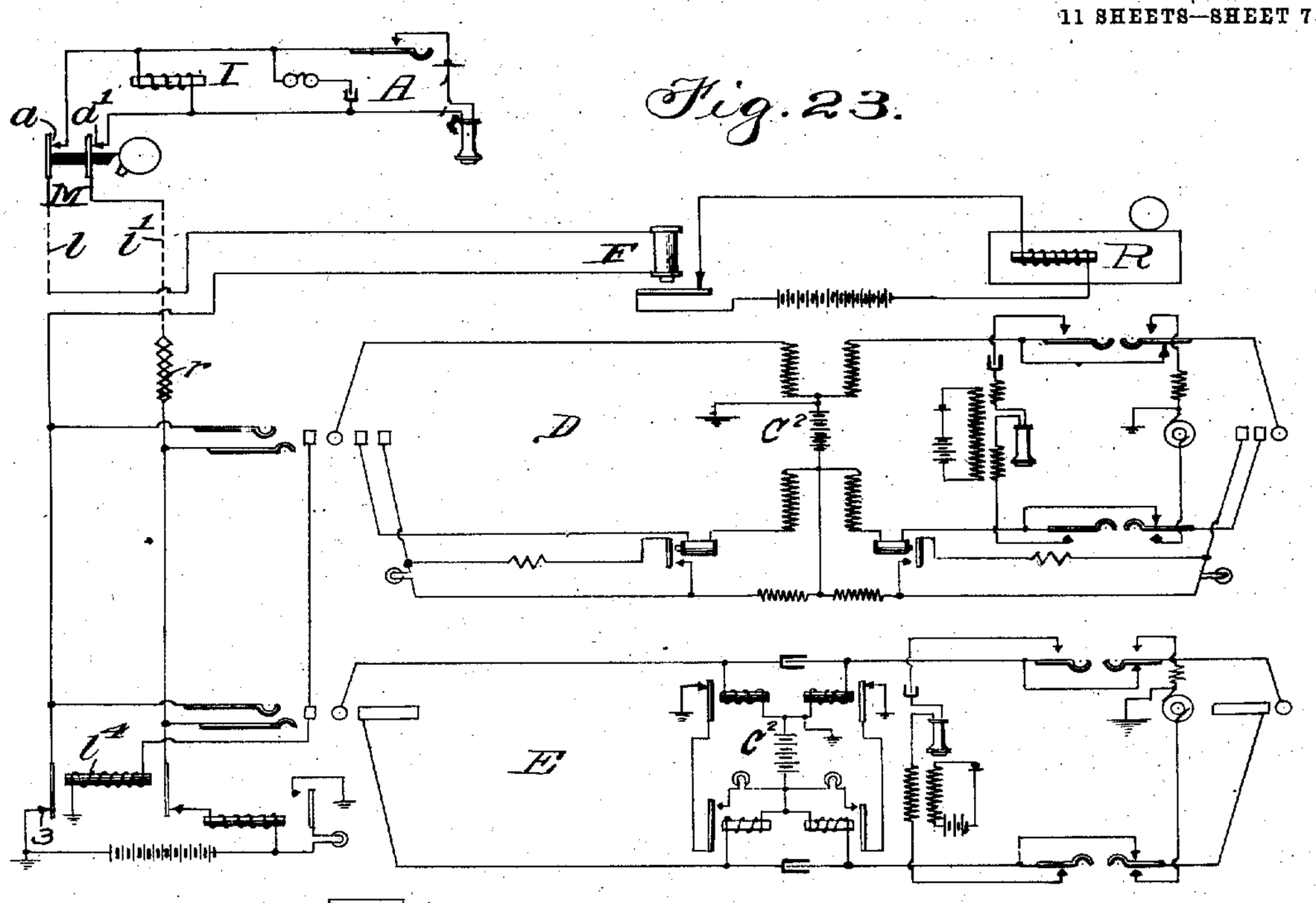
11 SHEETS—SHEET 7.

Fig. 23.



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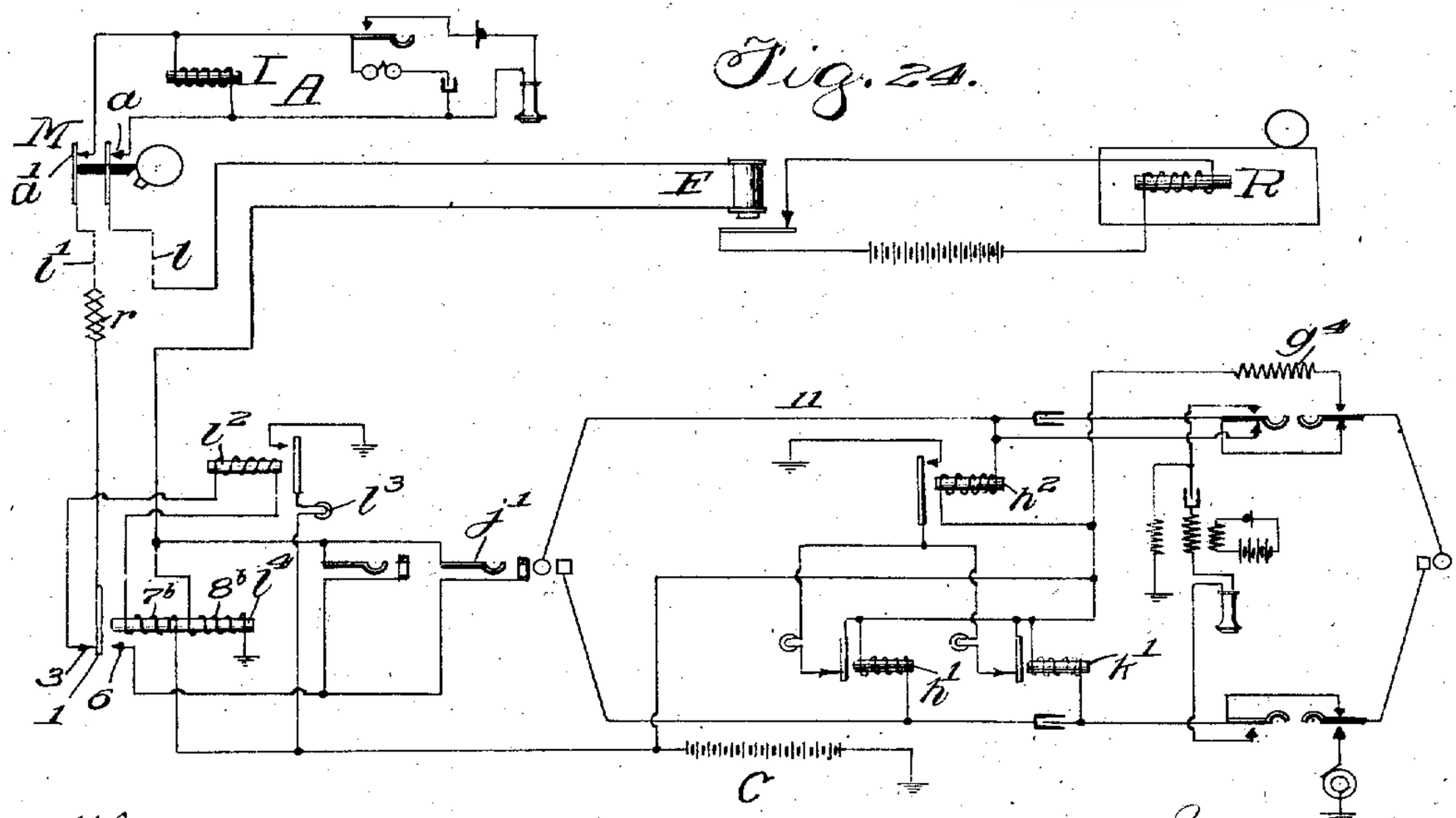

Witnesses:

Robert H. Weir

J. B. Weir

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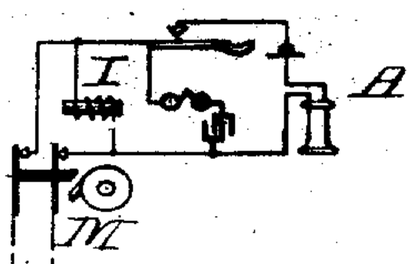
11 SHEETS—SHEET 8.



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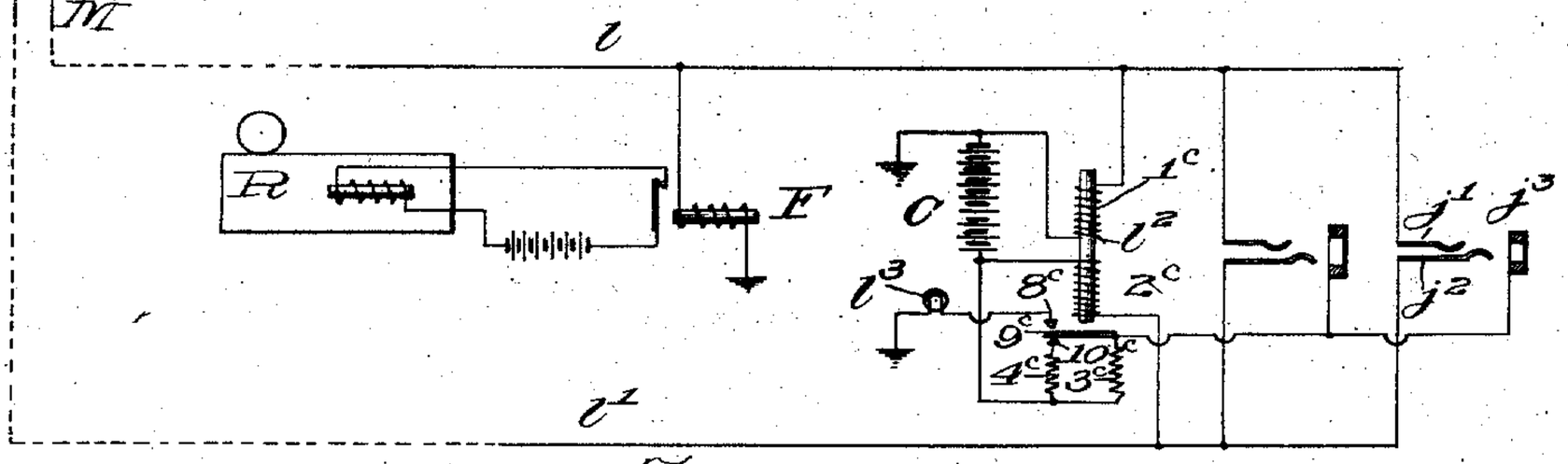

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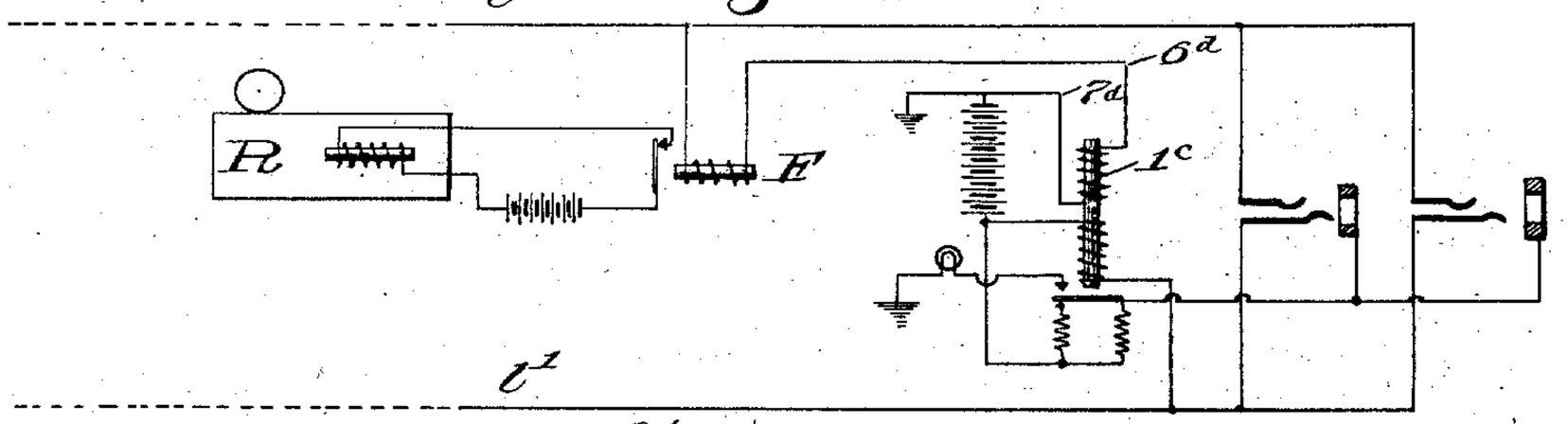

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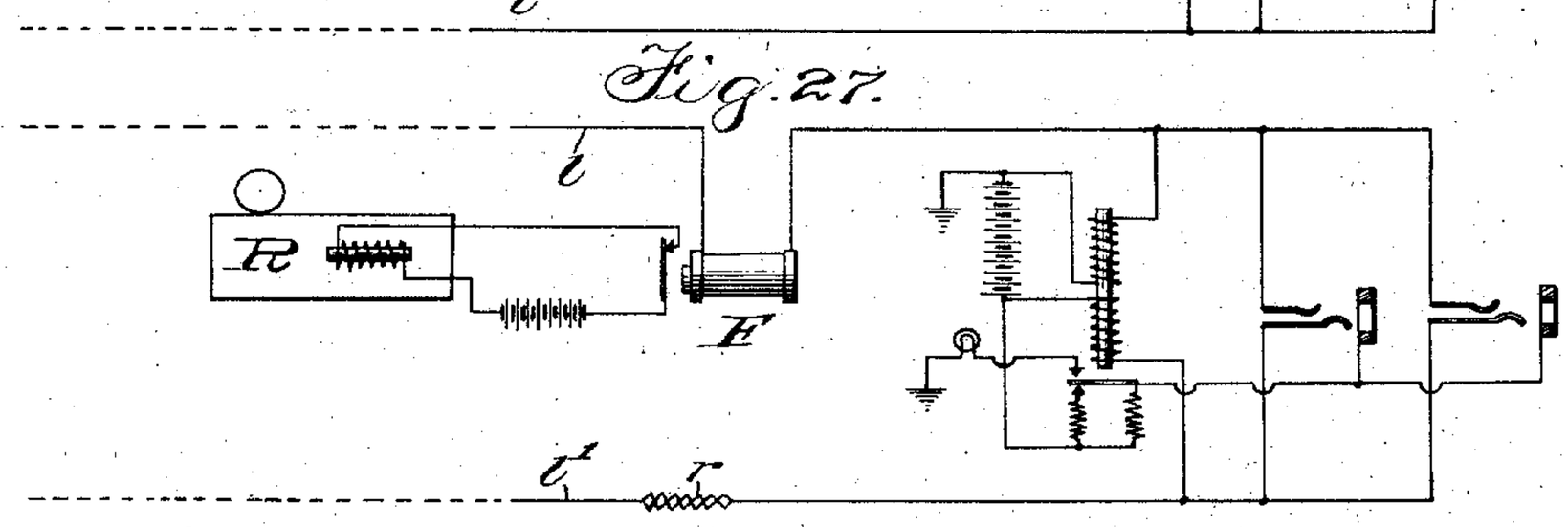

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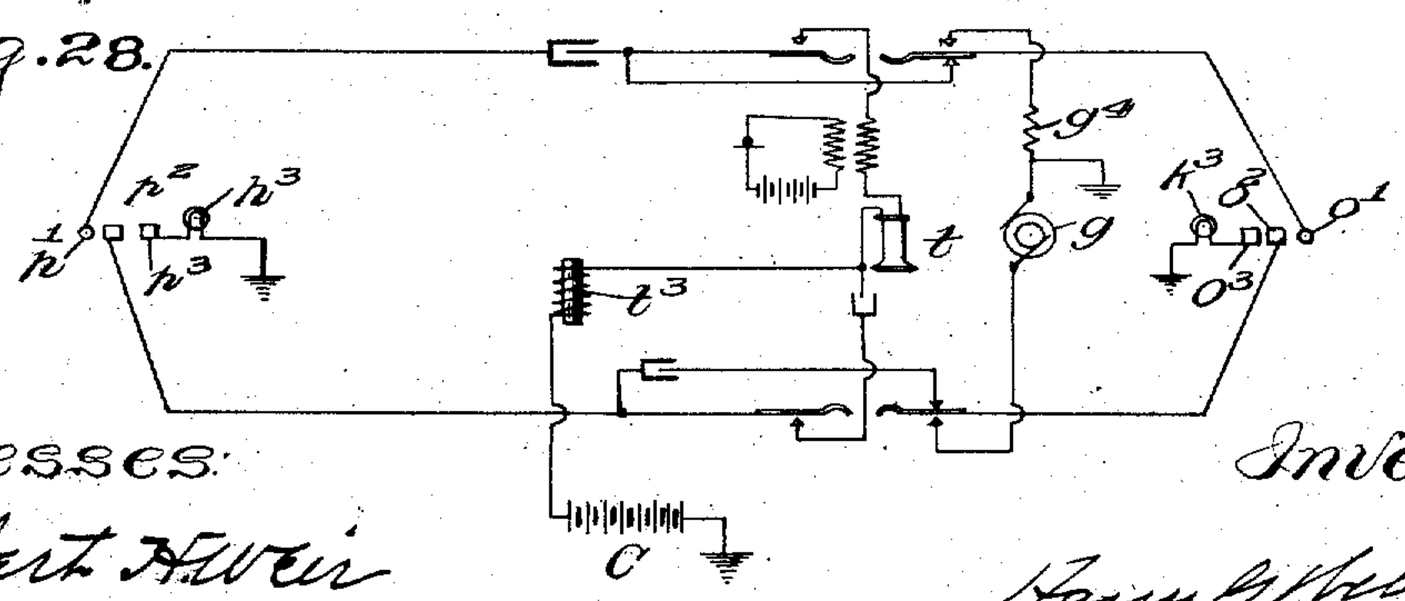

Witnesses:
Robert H. Weir
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Inventor:
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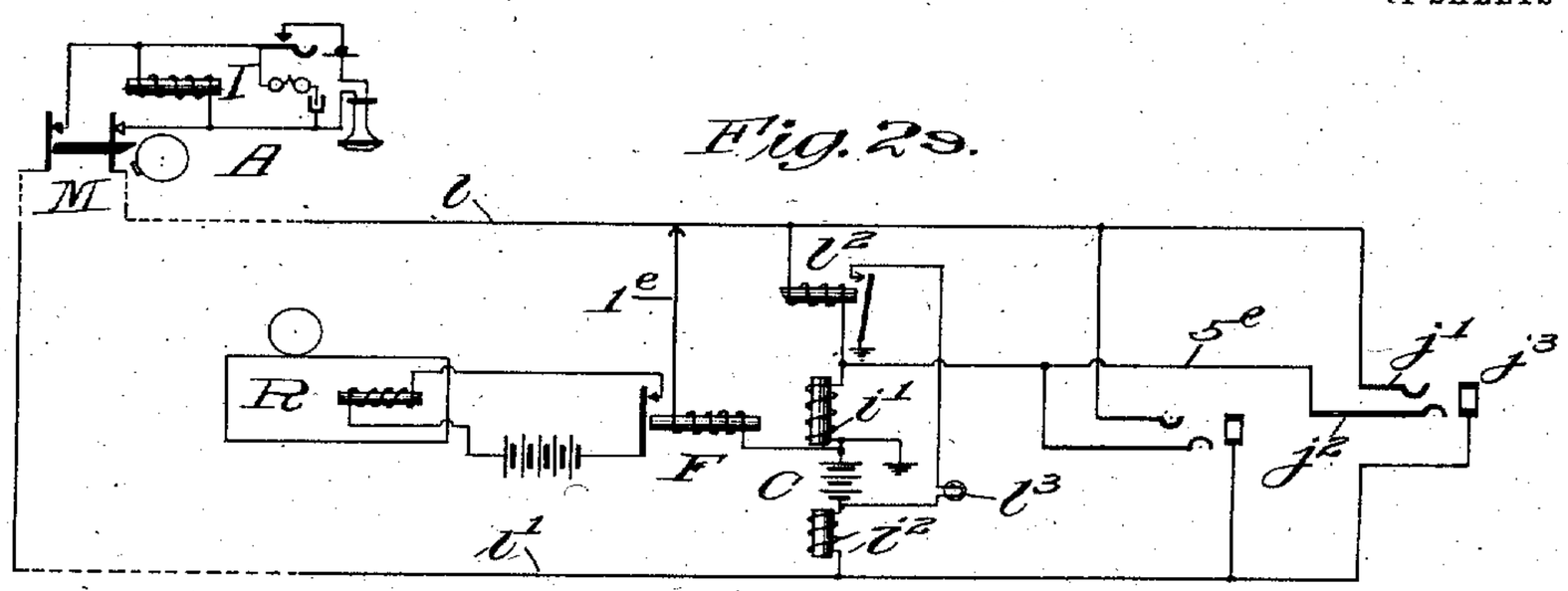
11 SHEETS—SHEET 9.

Fig. 29.



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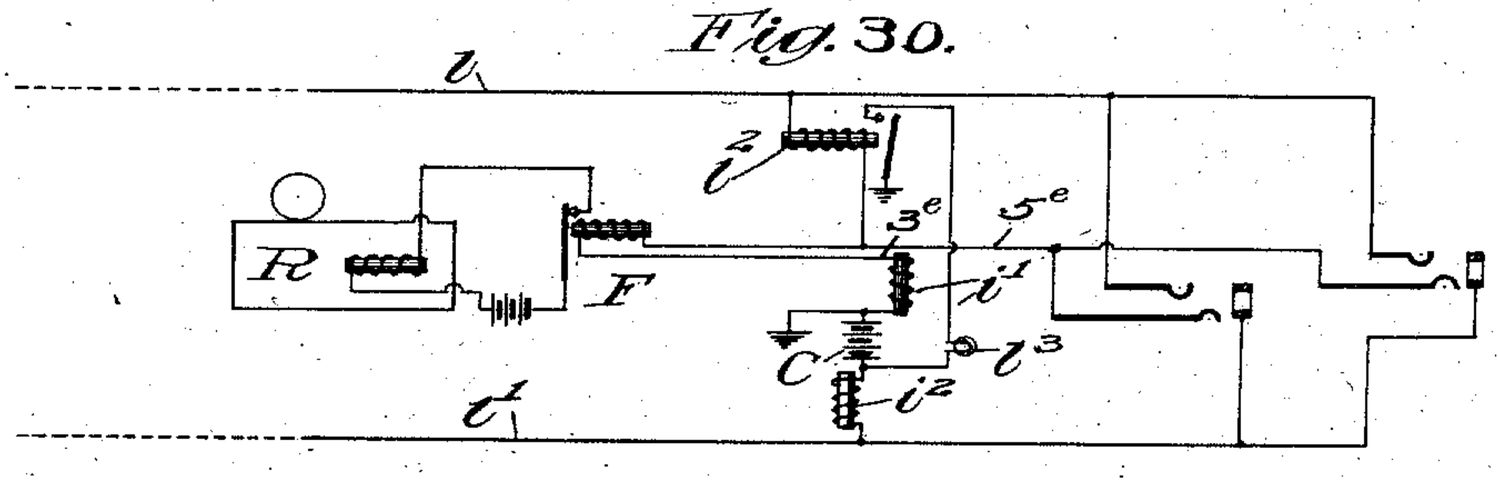

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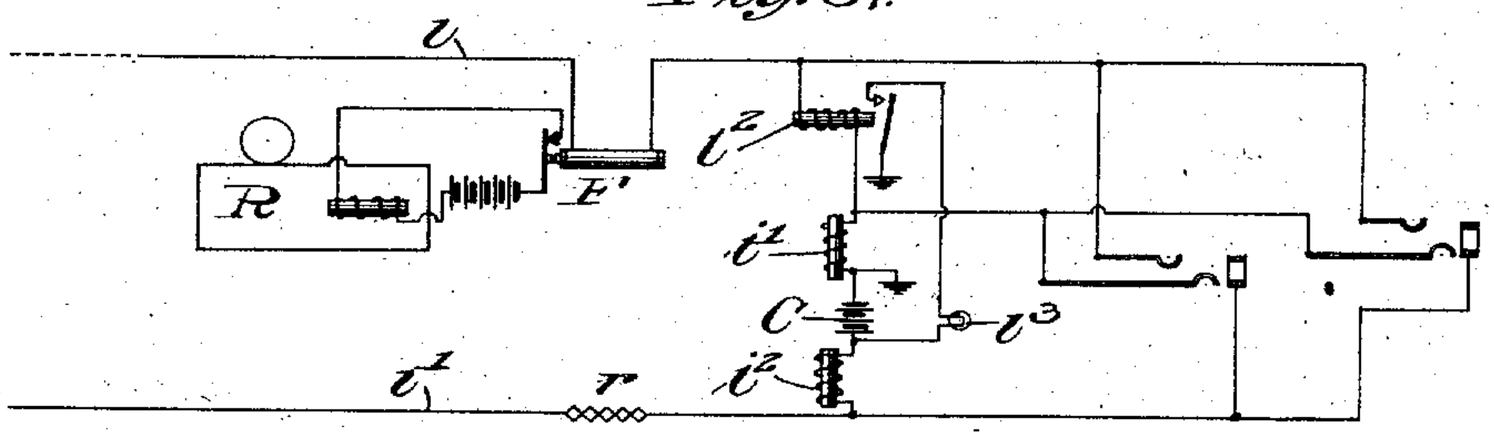
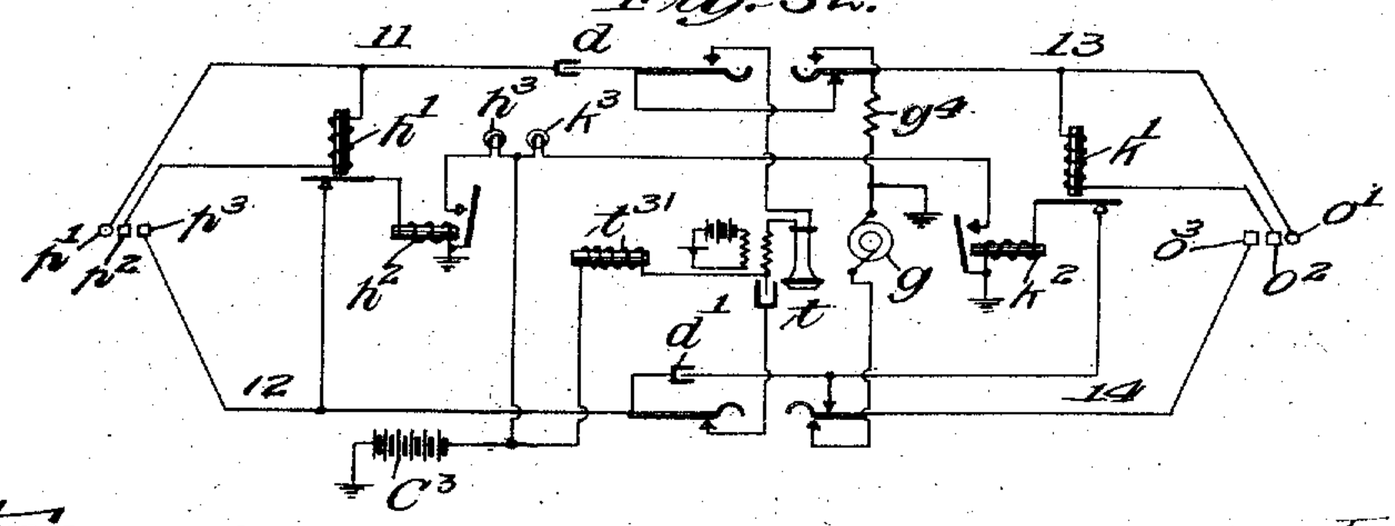


Fig. 32.



Witnesses:

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11 SHEETS—SHEET 10.

Fig. 33.

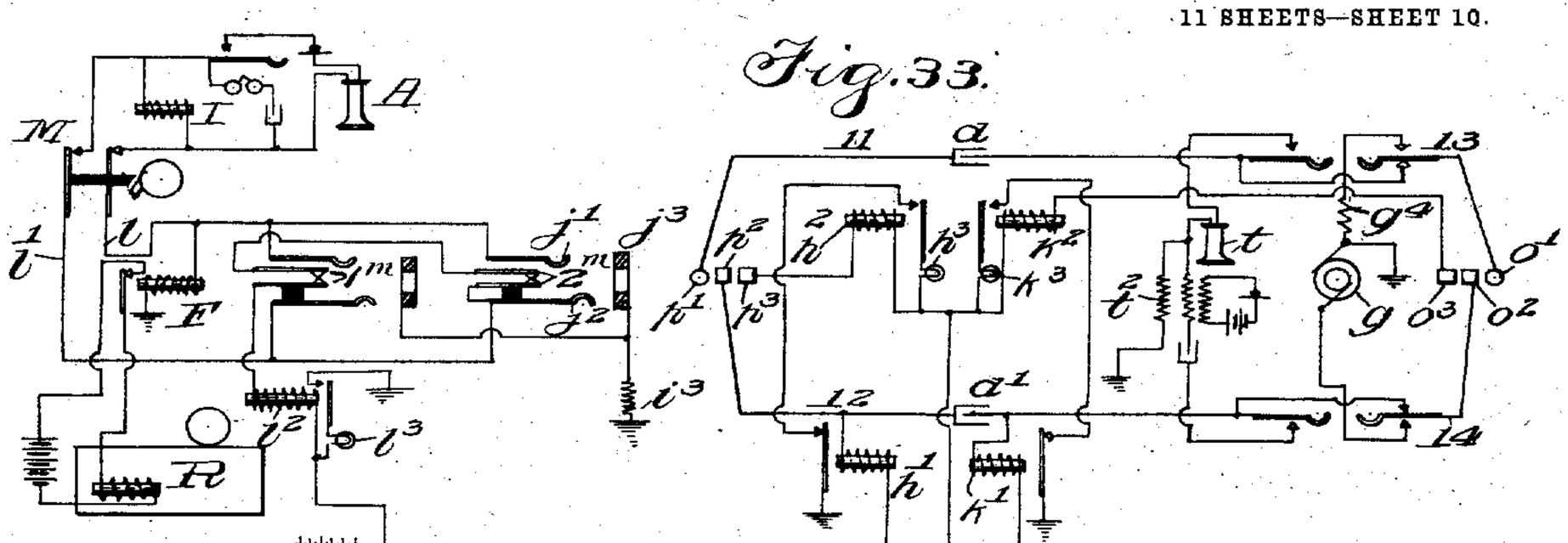


Fig. 34.

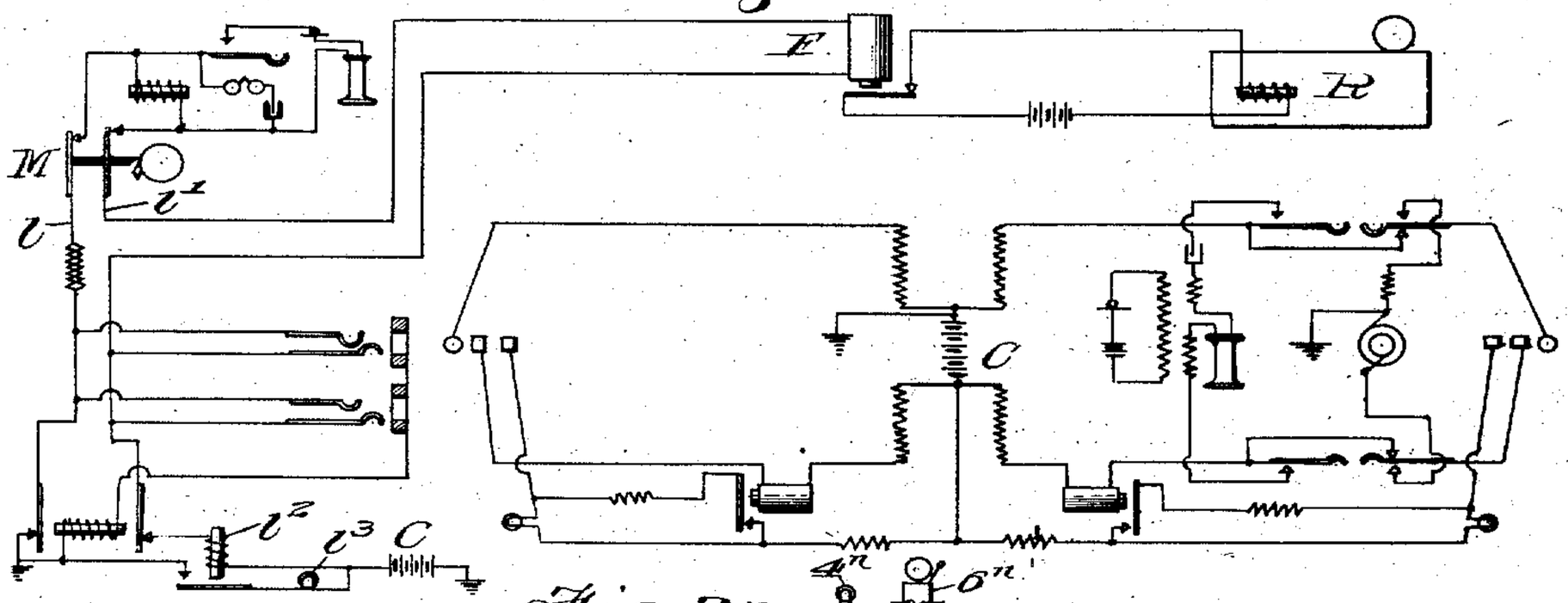
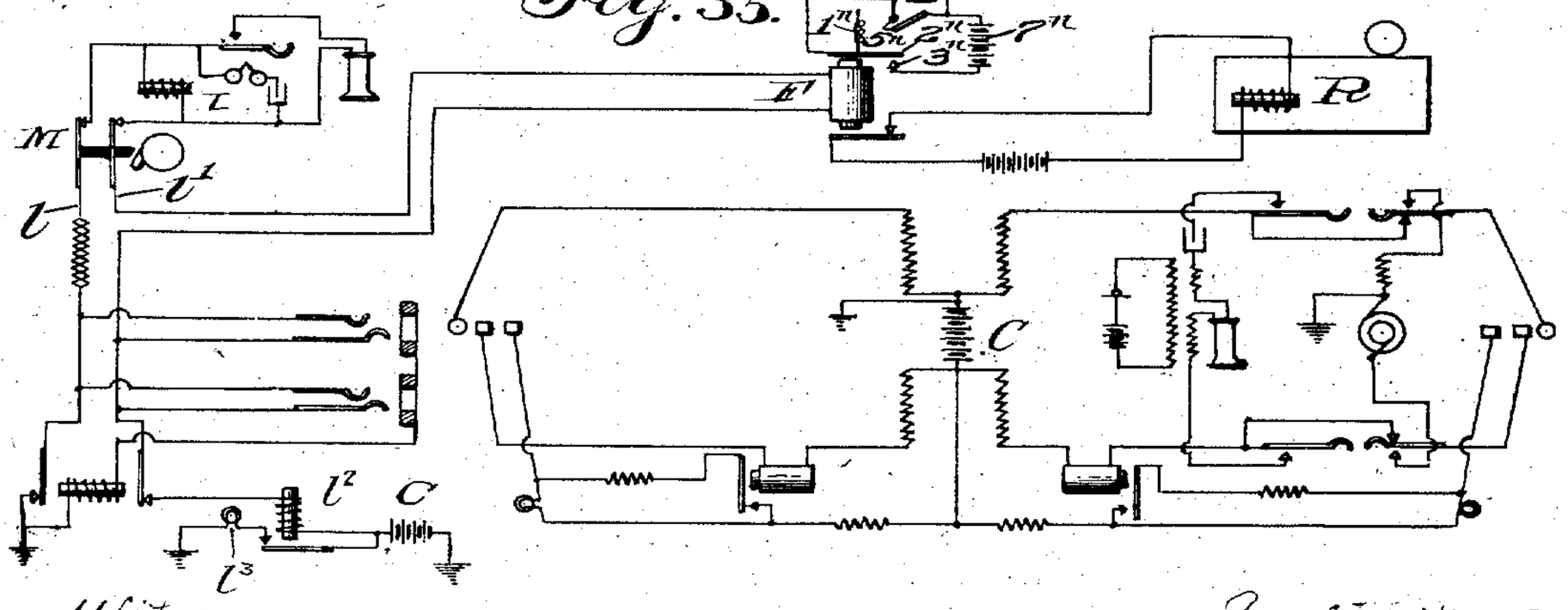


Fig. 35.



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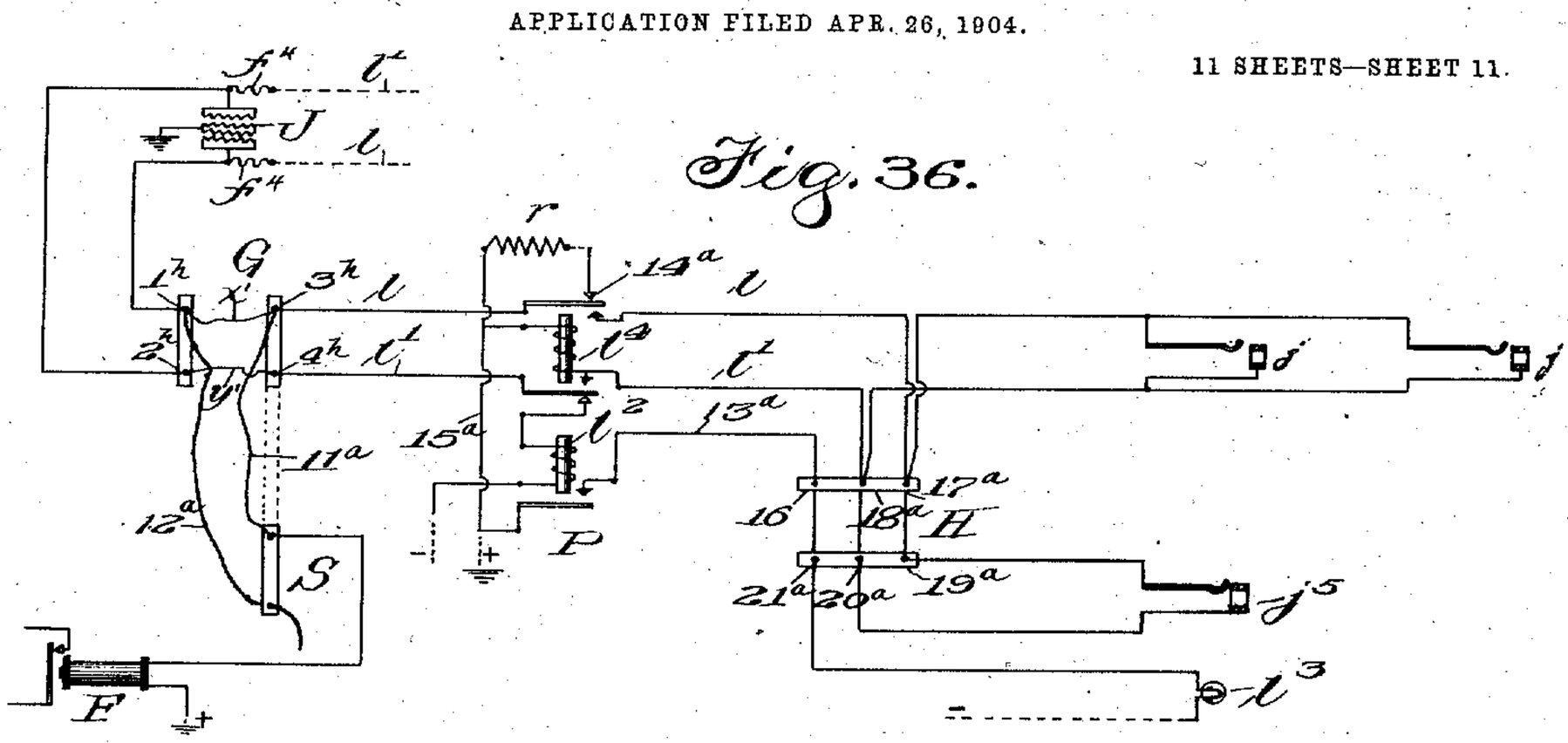
APPLICATION FILED APR. 26, 1904.

11 SHEETS—SHEET 11.

Fig. 36.



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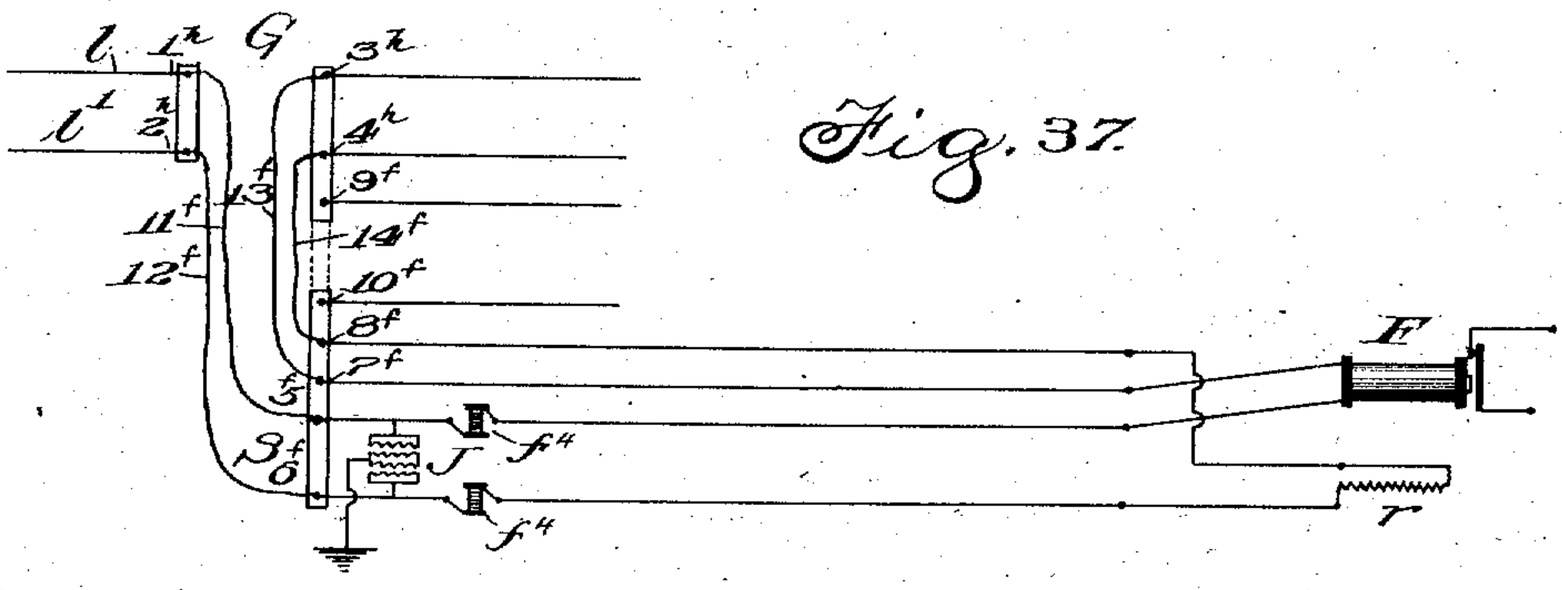
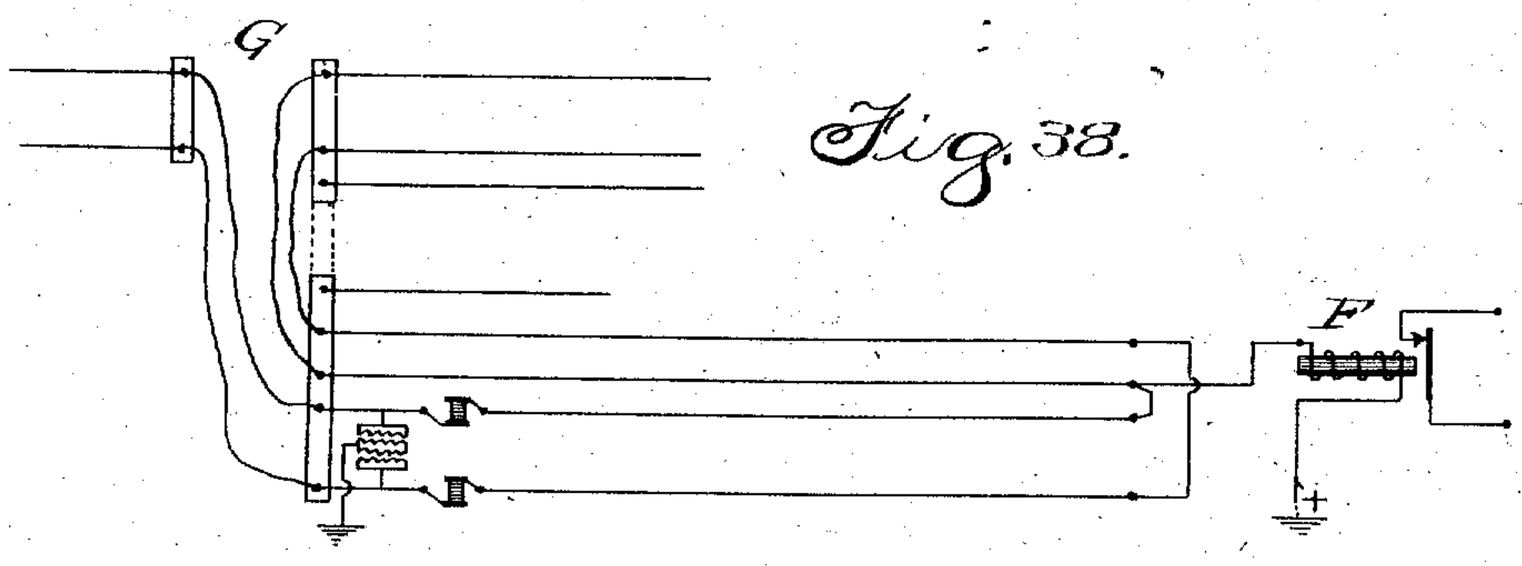


Fig. 38.



Witnesses
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J. B. Wen

Inventor
Harry G. Webster

UNITED STATES PATENT OFFICE.

HARRY G. WEBSTER, OF CHICAGO, ILLINOIS, ASSIGNOR TO MILO G. KELLOGG, OF CHICAGO, ILLINOIS.

COMBINED TELEPHONE AND ALARM SYSTEM.

No. 825,623. Specification of Letters Patent. Patented July 10, 1906.

Application filed April 26, 1904. Serial No. 204,978.

To all whom it may concern:

Be it known that I, HARRY G. WEBSTER, a citizen of the United States of America, and a resident of Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in a Combined Telephone-Exchange and Alarm System, of which the following is a specification.

My invention relates to systems in which telephone-circuits extending from a telephone exchange to subscribers' stations adapted to be interconnected for conversation are also utilized for the transmission of fire, burglar, or other alarm-signals. It is evident that when such telephone-circuits can be successfully utilized for alarm-signaling, as well as for telephone-exchange service, great economy in construction and maintenance may be effected over arrangements in which separate circuits are used for the two classes of service. Numerous plans have been proposed for such combined systems, but none in which the necessary requirements of each class of service, as hereinafter stated, are provided for.

The object of my invention is to provide a system in which the necessary conditions for each class of service shall be at all times maintained, particularly in their relations each to the other. In such a system, while the circuit is seldom used for transmitting alarm-signals, it is necessary that it should always be in readiness for such use, and such a signal when transmitted must reach its proper alarm-receiving station without error or loss of time. It is also necessary that the alarm-receiving station should receive an immediate indication in case the circuit-wires become broken or open, and preferably that such an indication be given if they become grounded or crossed. It is also eminently desirable, if not absolutely necessary, that the alarm-signal be recorded or permanently maintained at the alarm-receiving station until acted upon by the alarm operator. Finally, the circuit and apparatus must be adapted for the successful transmission of telephonic signals and speech, except when actually in use in giving an alarm-signal, during which time any interference with its telephonic service may be disregarded.

My invention is made to meet the above conditions; and it consists, briefly, in the combination of a telephone-exchange, a source of current, a circuit to a subscriber's station, alarm-receiving and alarm-sending apparatus associated with the said circuit, a telephone at the subscriber's station, and circuit arrangements by which a substantially continuous flow of current is maintained in the circuit except when interrupted by the alarm-sending apparatus.

In the preferred embodiment of my invention I employ in connection with a common-battery telephone-exchange means by which the line-circuit is normally closed through a high resistance or impedance located in the bridge of the circuit at the substation or intermediate of the subscriber's telephone and the point at which the alarm-sending apparatus is associated with the line. This resistance or impedance, while allowing sufficient current to flow to preserve the normal condition of the alarm-receiving apparatus, is sufficiently high to prevent a normal current-flow which would interfere with the operation of the telephone-signals and is so designed and connected as to avoid interference with the transmission of speech. The alarm-receiving apparatus consists, preferably, of a special relay associated with the line-controlling local-circuit apparatus to indicate or record the alarm-signal and so designed and adjusted as to attract its armature when energized by any current equal to or greater than the normal current-flow or by the alternating current used in calling subscribers. Such relays are well known, one type being that having a heavy armature retracted by gravity and which, as it does not depend upon spring-tension for its retraction, will not break contact through an instantaneous opening of its circuit, as might occur in making a telephone switch connection. This relay may be connected from ground (or from the grounded side of the central battery) to the corresponding side of the line-circuit, and in such case would be of such resistance and impedance as to best adapt it to the particular telephone-exchange circuit with which it is associated. An alternative arrangement would be to connect this special relay serially in the circuit, preferably in that side connected with the grounded side of the central battery, although it might be placed in the other side of the circuit by sacrificing some of the advantages of the other connection. The serially-included relay would be necessarily

so designed and connected as to present little or no impedance to voice-currents nor resistance to the direct current required for operating the transmitters and telephone-signals. Relays of this type are well known, such as those having a copper shell or shunted by a condenser or by a non-inductive winding. It is to be noted that the special relay may be located at the telephone-exchange, although when desirable it may be at the same location as the rest of the alarm-receiving apparatus. It will also be seen that, while all of the lines of a telephone system might be wired for the connection of the special alarm apparatus, in practice only certain of the lines will have this apparatus, and these lines will not be confined necessarily to any particular group, but will be scattered throughout the entire system, also that it is desirable to avoid changing the normal wiring of the telephone system except for such lines as have the special equipment. To this end I provide means whereby the alarm-receiving apparatus may be assembled at any desired place and connections made and changed between this apparatus and any lines of the telephone system in a systematic and orderly manner and without altering the permanent wiring of the telephone-exchange. It is evident that apparatus for indicating the alarm-signal, such as a telegraph-register, might be connected directly with the line-circuit; but the use of a special relay is preferable. The alarm-sending apparatus consists, preferably, of the well-known make-and-break wheel or equivalent device (such as is used in district-messenger boxes) located between the high-resistance bridge and the central telephone-exchange and having one or both sides of the line-circuit carried through its normally closed contacts. This make-and-break device, normally under tension, may be released manually or by an electromagnet in a local circuit or may be of special construction to be released by the direct action of heat. When so released, it will give a characteristic number of makes and breaks, repeated several times, indicating the particular circuit from which the alarm comes, or it may simply give a continuous make and break of regular duration to indicate simply that an alarm is being given. It is also desirable that the make-and-break wheel shall come to rest at a point which shall leave the circuit open. It is thus seen that my invention comprises an organization of a normal telephone-circuit system with an alarm-circuit system, in which there is a comparatively weak but continuous direct current-flow, which serves to preserve the normal condition of the alarm-receiving apparatus. When this current is increased or momentarily interrupted or an alternating current substituted therefor in the use of the telephone, the normal condition of the alarm-receiving apparatus is not interfered with. In case an alarm-signal is to be transmitted, the breaking of the circuit (and consequent interruption of all current in the line) by the alarm-sending apparatus, releases the armature of the special relay and transfers the signal automatically and instantaneously to the alarm-receiving station, which may be located adjacent to the telephone-exchange or at some distant point, and in case the circuit-wires are broken or grounded the consequent diversion of current from the circuit or interruption of all current also immediately indicates these conditions at the alarm-receiving station by the prolonged actuation of the apparatus without the characteristic signal.

In the accompanying drawings, illustrating my invention, I have indicated the make-and-break mechanism of the alarm-sending apparatus, as M, the special relay, as F, and the register or recording device, as R. The high resistance or impedance is shown as I.

Figure 1 shows two complete line-circuits embodying my invention in a telephone-exchange of the well-known two-wire type, in which the connecting-jacks are normally disconnected from the line, together with the regular cord connecting apparatus. In this figure the special relay F is shown as in bridge or from the ground side of the line to ground. Fig. 2 shows one alternative arrangement of the subscriber's telephone, to provide a high-resistance bridge in place of the impedance I. Figs. 2^a, 2^b, 2^c, 2^d, and 2^e indicate various modifications of the alarm-sending apparatus over that shown in Fig. 1. Figs. 3 to 12, inclusive, indicate various modifications of the alarm-receiving apparatus. Figs. 13 to 18, inclusive, show diagrammatically several methods of arranging for the special relay F when it is to be serially included in the line-circuit. Fig. 19 illustrates my invention as embodied in a telephone system of the well-known three-wire type, in which there is a cut-off relay operated over a local circuit, the special relay F being bridged to one side of the line. Fig. 20 shows one method of embodying my invention in that telephone system normally using a differentially-wound cut-off relay. In this figure, as in the previous one, the special relay F is bridged to ground, and in both figures I have shown the cord connecting apparatus which is ordinarily employed. Figs. 21 and 21^a indicate means by which the make-and-break wheel of the alarm-sending apparatus may be stopped, after making a certain number of revolutions, at a point to leave the line-circuit open. Fig. 22 shows two complete line-circuits of a telephone-exchange embodying my invention, in which the special relay F is included serially in the line. This exchange is of the two-wire type, in which the connecting-jacks are normally disconnected from the line, and the regular cord connecting appa-

ratus is shown. Fig. 23 shows my invention having the relay F serially included in the line in the same three-wire exchange system as is shown in Fig. 19, with regular cord connecting apparatus. Fig. 24 shows the serially-included relay F in the exchange system having a differentially-wound cut-off relay. Figs. 25, 26, and 27 illustrate different embodiments of my invention in a telephone system of that type in which there is a relay permanently connected with the line and source of current and in which a three-wire circuit is used, the calling-signal and supervisory or cord signals being located in a local circuit and controlled by the permanently-connected relay. Fig. 28 illustrates one cord-circuit regularly used in such a system. Figs. 29, 30, 31, and 32 illustrate different embodiments of my invention in that type of three-wire telephone systems in which a line-relay, a source of current, and an impedance-coil (or coils) are permanently connected in bridge of the line, and in which the line-relay is shunted by a low-wound supervisory relay in the cord-circuit when a plug is inserted into a jack of the line. Fig. 32 shows one cord-circuit regularly employed in such a system. Fig. 33 illustrates my invention as embodied in a telephone-exchange system in which the line relay or signal is disconnected by separable contacts in the jacks. In this arrangement the special relay F is in permanent bridge of the line and provides the sole path of direct current-flow for telephone transmission and signaling. Fig. 34 indicates a system similar to that of Fig. 23, but having a special relay F included in that side of the line-circuit leading from the active or ungrounded side of the central battery. It is here evident that in case the line should become grounded intermediate of this relay and the contacts of the make-and-break device the only indication would be the continued display of the line-signal of the telephone-exchange, and under such a condition the relay F would not respond to an alarm-signal. Fig. 35 illustrates a similar arrangement in which the relay F, provided with special contact, is so arranged that it may be balanced for any given current-flow and will give a special indication in case this flow is increased, as by a ground or short-circuit on the line. Figs. 36, 37, and 38 illustrate special arrangements of terminals and wiring by which the special alarm-receiving apparatus may be associated with any of the lines of a telephone system in a systematic and orderly manner.

Like characters refer to corresponding parts in all of the drawings.

Referring to the drawings, Fig. 1 illustrates my invention as embodied in one of the well-known type of central-energy or common-battery telephone systems, in which the subscribers can automatically signal the exchange for connection or supervision and in which the current for voice transmission and for signaling is supplied from a central source of current located at the exchange. Considered first as a telephone system it corresponds in operative result to all of the exchange systems illustrated in the other drawings, and its description will apply equally well to the others in so far as it relates to the control of the signals and to the various manipulations on the part of the operator. In this Fig. 1 subscriber A is indicated as having removed his receiver from its hook-switch to call for a connection, and a plug has been inserted into his line-jack in response to such a call. The telephone-line from subscriber A extends in two limbs l l' to the central station, where the limbs terminate, respectively, in springs 1 and 2, the former resting normally against contacts 3 and the latter against contact 4. Contact 4 is connected by wire 28 through the individual line-relay l^2 to the ungrounded or active side of the battery C. Contact 3 of those lines which are not equipped with the special alarm apparatus is connected directly to the grounded side of the battery. When the special alarm apparatus is used, this ground-path may include the resistance r or may be omitted entirely, in which case the circuit of the line would be normally completed to ground through the permanently-connected relay F. At the substation the usual microphone s^2, receiver s^3, and hook-switch s are provided, and the bell s^5, with condenser s^4, is permanently connected in bridge of the circuit. The impedance-coil I and the contacts a a' of the make-and-break mechanism M are only present in such lines as have the special-alarm equipment, and as they have no effect upon the normal operation of the telephone system they will be for the present disregarded. The switch-hook s is adapted when the receiver is removed therefrom to engage contact s', which is connected with the microphone and telephone-receiver. The springs 1 2 carry armatures adapted to be attracted by the relay l^4 when it is energized, and this relay has its winding connected at one side to ground and at the other side to contact 5. The contact 5 is connected with the sleeves j', and the contact 6 with the springs j^2 of the connection-terminals j j. The line-relay l^2 is adapted when energized to close by its contacts 7 the circuit of the line signal-lamp l^3, which circuit is completed from battery C through the pilot-relay l^6 and contacts 7 to ground. This pilot-relay is common to all lines whose lamp-signals appear in front of any one operator and has contacts 8, adapted when it is energized to close the circuit of the pilot-lamp l^5, which is likewise common to all of the line-lamps at one operator's position. The circuit of this pilot-lamp l^5 is completed from battery C through contacts 8

and relay l' to ground. Relay l' is a night-bell relay common to the entire exchange and is provided with contacts 9, adapted to close the local circuit of the night-bell l^8 when the relay is excited. Switch-contacts 10 are provided to short-circuit this relay when the night-bell indication is not required. The answering-plug p is provided with a tip p' and a sleeve p^2, the former being connected with strand 11 and the latter with strand 12. The calling-plug o is provided with a tip o' and a sleeve o^2, the former being connected with strand 13 and the latter with strand 14. The strands 11 and 13 are united through condenser d and strands 12 and 14 through condenser d'. The levers g' g^2 of the ringing-key normally rest against contacts 15 and 16, respectively, and are adapted when actuated to engage contacts 17 and 18. Contact 17 is connected through the resistance g^4 to the grounded side of battery g^3, and contact 18 to one side of the calling-generator g, which has its other terminal carried to the active or ungrounded side of the same battery. The operator's telephone set t is adapted to be bridged between the strands 13 14, and a condenser t' is included in circuit therewith. The relay h' is connected from strand 11 to ground and the relay h^2 from strand 12 to battery C. The relay k' is connected from strand 13 to ground and the relay k^2 from strand 14 to battery C'. The relay h' controls contacts 19 and the relay h^2 controls contacts 20. The relay-contacts and the lamp h^3 are adapted to be included in circuit with the relay h^4 and battery C. Likewise the relay k' controls contacts 21, and the relay k^2 controls contacts 22. These contacts of relays k' and k^2 are adapted to be included with lamp k^3 in the circuit of battery C'. The relay h^4 is a pilot-relay common to all the cord-circuits of one operator's position, and has contacts 27 adapted to control the circuit of the supervisory pilot-lamp h^5 from battery C. The relay k^2 has an armature-contact 24 normally resting against contact 25, which is connected through the busy-test relay t^3 to ground. The contact 24 is adapted when actuated to engage the contact 23, which is connected with strand 13 of the cord. The relay t^3 is common to all of the cords of an operator's position and has contacts 26, adapted to be included with induction-coil winding t^2 in the circuit of battery C'.

Assuming that subscriber A wishes to talk to subscriber B, he lifts his telephone-receiver from the hook, thereby closing circuit of battery C through the relay l^2, the limbs l l', and the comparatively low resistance of his receiver and transmitter. The relay l^2 is thus actuated and the circuit of battery C completed through contacts 7, lamp l^3, and relay l^6, lighting the lamp, and thus conveying to the operator the signal for connection. The completion of this lamp-circuit actuates relay l^6, and another circuit of battery C is completed through contacts 8, pilot-lamp l^5, and relay l', lighting the lamp to indicate to the operator that some one of her group of subscribers desires connection. If not short-circuited by the switch-contacts 10, the completion of the circuit through lamp l^5 actuates the common night-bell relay l', thus closing the contacts 9 and completing the local circuit of the night-bell l^8. The operator upon the illumination of lamps l^3 and l^5 inserts answering-plug p into the connection-terminal j, belonging to line A, and the circuit of battery C is thus closed from ground through relay h^2, strand 12, thimble j', and cut-off relay l^4 to ground. The relay l^4 will thus be energized to actuate the armature-contacts 1 2, separating them from contacts 3 4 and engaging contacts 6 5, respectively. The separation of contacts 2 4 opens the circuit of relay l^2, thereby also releasing the relays l^6 and l', extinguishing the lamps l^3 l^5 and interrupting the circuit of the night-bell. The closing of contacts 1 6 and 2 5 connects the connection-terminals j to the limbs l l', and a circuit of battery C is completed from ground through relay h^2, strand 12, limbs l l', strand 11, and relay h' to ground. Under this condition, which is that shown in the diagram of Fig. 1, the circuit of lamp h^3 remains open, for the reason that although closed at contacts 20 upon completion of the circuit through relay l^4 it is interrupted at contacts 19 by the energization of relay h'. The operator now connects her telephone set in circuit and receives the number of the subscriber wanted, as B. She then lifts the calling-plug o and touches the tip thereof to the sleeve j' of the connection-terminal belonging to line B. If she hears a click in her telephone, she knows that the line is busy. Otherwise, hearing no click, she will know that the line is idle. If the line B is connected for conversation at another board, one of the charging-batteries C or C' of the cord connectors used for such connection at the other board will be connected between ground and the sleeves j', and consequently when the tip o' is touched to the sleeve j' current passes through the tip o', strand 13, spring g', and contact 15 of the ringing-key, contacts 24 and 25 of relay k^2, through relay t^3 to ground. The opening and closing of this circuit causes contacts 26 of relay t^3 to make and break a circuit of battery C' through the winding t^2 of the operator's induction-coil, thereby causing a click in her receiver, which indicates that the line is busy. Assuming that the line is not busy, the operator inserts the calling-plug in the connection-terminal belonging to line B, thereby sending the current of battery C' through the relay k^2, strand 14, and the relay l^4 to ground. The

relay k^2 being thus energized, the circuit of lamp k^3 is closed at contacts 22 and the lamp lighted. The contacts 24 and 25 are separated, disconnecting the relay t^3, and the contacts 23 and 24 closed, completing the circuit of cord-strand 13. The relay l^4 of line B being energized, the connection-terminals will be connected with the limbs of the line and the line-relay l^2 disconnected. The operator then actuates her ringing-key levers g' g^2 to send calling-current from ground through the circuits of battery g^3, generator g, sleeve o^2, terminal sleeve j', limb l', condenser s^4, bell s^5, limb l, spring j^2, tip o', strand 13, spring g', contact 17, and resistance g^4 to ground. The actuation of the ringing-key serves to open the strands 13 14; but as circuit is completed from battery g^3 and generator g, through strand 14, wire 29, and relay l^4 to ground, the relay l^4 remains energized during the sending of the calling-current. The function of battery g^3 is to prevent the chattering of the relay l^4, which would be caused by the alternating current from generator g, unless said relay be specially constructed so as to retain its armature in an attracted position when traversed by alternating currents. It is also apparent that a relay may be used at F, which would allow its armature to chatter when traversed by alternating currents, but that such chattering will be prevented by the employment of battery g^3. Unless said battery g^3 be employed, however, both relays l^4 and F must be so constructed as to respond to and be operated by alternating currents. When subscriber B lifts his telephone from the hook, circuit is completed over limbs l l', strand 13, and relay k', which by its actuation opens the circuit of lamp k^3 at contacts 21, and the lamp is thus extinguished. The two subscribers being now united for conversation, the current from battery C passes through the instrument of subscriber A, and current from battery C′ passes through the instrument of subscriber B. The actuation of the microphone of either subscriber causes a variation of the difference of potential at the terminals of the condensers d d', thereby producing correspondingly-varying currents through the receiver of the other subscriber. When the subscribers have completed their conversation or in case the operator's attention is desired, the hanging up of the receiver will light the lamp associated with the plug which is inserted into the connection-terminal of the line. Thus when subscriber A hangs up his receiver the circuit of battery C through relay h' is opened and contacts 19 are closed together. The current from battery C continues, however, to flow from ground through relay h^2, strand 12, and relay l^4 to ground, and these relays remain energized. The circuit of lamp h^3 is thus closed at relays h' and h^2, lighting the lamp. The relay h^4 being included in circuit of lamp h^3 is also energized and by its contacts 27 closes the circuit of the supervisory pilot-lamp h^5, lighting the same to give a more conspicuous signal to the operator. The circuit of lamp k^3 is controlled in a similar manner by the hook-switch of subscriber B, and it is evident that either subscriber may by vibrating his hook cause an intermittent lighting of the lamp associated with his line, and thus get the operator's attention. When both subscribers have hung up, lighting both their lamps, the operator understands this condition as a signal for disconnection and removes the plugs p o, and the apparatus assumes its normal condition. This description has so far referred only to the telephonic operation of the system and is equally descriptive in that respect of those lines which have the special alarm apparatus and of those which are not so equipped. Referring now to this special apparatus, the limbs l l' of the line are carried through contacts a a' of a make-and-break device M, which is indicated diagrammatically by the spring-actuated wheel m with its stop-pin m', which normally engages the armature-lever m^2 of the electromagnet m^3. This electromagnet is included in closed circuit with the thermostats or other circuit-breaking devices f and battery m^5. The impedance I is included in permanent bridge of the circuit at a point beyond (or more distant from the exchange than) the contacts a a'. The relay F is permanently connected from limb l of the line to ground and has contacts controlling the continuity of the normally closed circuit of battery r'. The register or recording device, which may be an ordinary telegraph-register, is indicated at R and has a stop r^3, which is normally engaged by the releasing-arm r^4 until released by the retraction of the armature of the electromagnet r^2. The recording-point r^5 is also controlled by the magnet-armature and is adapted to be brought into contact with the spring-actuated wheel r^6 and its tape or ribbon in response to the retraction of the armature. Switch-contacts 30 are provided adapted to be closed by the first retraction of the magnet-armature to complete the circuit of battery r' through lamp r^7 and to remain closed without interfering with subsequent movements of the armature until manually separated. It will be seen that when a plug is inserted the relay F is in shunt with relay h' or k'. When an especially-sensitive adjustment of relay F is required, it is desirable that a corresponding shunt be maintained at all other times, and the resistance r is shown connected to indicate that such a connection may be made to equalize the current-flow through relay F or for other balancing purposes. The impedance of the coil I is sufficiently great to prevent undue shunting of the telephonic voice-current or calling-cur-

rent and has sufficiently high resistance to prevent a flow of current which would attract or hold up the armatures of the relays l^2, h', or k'. The relay F is so wound and adjusted that its armature will be held attracted at all times, except when there is a complete interruption of current in the limb l. Under normal conditions the circuit of battery C is closed from ground through the relay l^2, the limbs $l\ l'$, the contacts $a\ a'$, the coil I, and the relay F to ground. The current under this condition is not of sufficient strength to actuate relay l^2, but does hold the armature of relay F. When subscriber A removes his telephone from the hook-switch, this current is increased in volume and the armature of relay F remains attracted. In case the operator actuates her ringing-key to call a subscriber there is a circuit of generator g and battery g^3 completed from ground through strand 14, impedance I, limbs $l\ l'$, and relay F to ground, and owing to the nature of its construction the relay is energized by this calling-current to hold its armature attracted. The normal condition is indicated in the diagram of line A. The diagram of line B shows the alarm apparatus in operation. Here the circuit of battery m^5 and electromagnet m^3 has been broken at the device f'. It is to be understood that the spring of the make-and-break wheel m is normally under tension. When the circuit of magnet m^3 is opened, it ceases to attract its armature-lever m^2, which being retracted by the spring m^6 disengages the stop m' and allows the wheel m to revolve a predetermined number of times. As it revolves the projections on its periphery engage the part a^2, controlling contacts $a\ a'$, and the circuit of relay F is thus interrupted to correspond with such projections. At the first interruption the circuit of the register-magnet r^2 is broken at contacts 31 of magnet F, and its armature engages and closes the contacts 30, thus completing the circuit of battery r' through lamp r^7. At the same time the tape-wheel r^6 is released by the arm r^4, and the number and sequence of the interruptions is recorded in the well-known manner by the point r^5. It may be readily seen that in case either limb of the line becomes broken or open the consequent deënergization of relay F will result in lighting the lamp r^7, and the register will record a continuous interruption. Likewise, in case either limb $l\ l'$ should become grounded to an extent to interfere with the desired operation of relay F the contacts will be separated and give a similar indication. In this Fig. 1 diagram, as in the subsequent drawings, where the various ground connections for the telephonic apparatus are shown, it is to be understood that these ground connections represent the common office return or a direct connection to the grounded terminals of the main batteries $C'\ C'$. The ground connection of relay F may be the same central-office ground or may be a ground at some other point, as is most desirable. It is also to be understood that current for the circuits of the various minor central-office batteries, as r', g^3, and others, may be supplied from one of the main batteries C C', if desired. The make-and-break device M and the recording device R are only intended as diagrammatic illustrations for purpose of description of devices which are old and well known without regard to their specific mechanical construction. It will be seen from this description that the operation of the alarm apparatus is not at any time interfered with in the use of the telephonic apparatus. There is normally a comparatively weak current flowing through limbs $l\ l'$ and relay F, which suffices to attract its armature. When this current is increased in volume by the removal of the receiver from the hook-switch, the armature is still attracted. When the operator by plugging into a line substitutes the battery connections of the cord for those of the line, a sufficient current-flow is still maintained. The relay F is of such construction that when ringing-current is put on the line its armature will be attracted by this current. If under any of these conditions an alarm-signal is to be transmitted, the opening of contacts $a\ a'$ deprives the relay F of all current, and its contacts separate, thus controlling the other receiving apparatus and indicating an alarm.

Fig. 2 shows an alternative arrangement of the substation apparatus. In this figure the condenser s^4 and impedance I are omitted; but a high resistance s^6 is included in the bridge with the bell s^5. This bell, while not of very high resistance, has sufficient impedance to prevent undue shunting of voice-currents, and the resistance, which may be a part of the winding of the bell-magnets or exterior thereto, is included in the bell-bridge to reduce the normal direct current-flow to a point where it will not interfere with the action of the telephone-relay.

Fig. 2^a indicates an arrangement of the alarm-sending apparatus similar to that of Fig. 1, except that the make-and-break device is controlled by means of a normally open circuit. In this arrangement a thermostat or other circuit-controlling device is shown at f^2, in which its terminals are normally not connected. Upon its operation, as by heat, its terminals become connected and complete the circuit of battery m^5 through magnet m^3, thus attracting armature-lever m^2. This disengages the stop m' and allows the wheel to revolve and transmit the alarm-signal over the limbs $l\ l'$ in the manner previously described.

Fig. 2^b shows an arrangement of the alarm-sending apparatus in which the contacts $a\ a'$ of the make-and-break device M are directly controlled by a relay in the local circuit. In

this case the circuit of battery m^5 is normally completed through the winding of relay m^3 and contacts a^{21} of the thermostatic device M′. The armature m^{10} of the relay m^3 being thus constantly attracted, the contacts a a' in the limbs l l' are normally closed. This device M′ partakes of the nature of a make-and-break wheel; but when its spring is under tension it is held in the normal position shown by a piece of fusible metal or other heat-responsive device, (indicated at f^3.) Under the action of heat this piece by fusing or otherwise releases the wheel, which revolving a predetermined number of times breaks and makes the circuit of battery m^5 at contacts a^{21} in accordance with the projections on its periphery. The armature of relay m^3 is consequently released each time the circuit is broken and controls the contacts a a' to correspond with the characteristic interruptions of the device M′. This transmits the signal over the limbs l l' to the receiving-station, as hereinbefore described.

Fig. 2^c shows a similar arrangement to that shown in Fig. 2^b, except that the circuit of battery m^5 and relay m^3 is normally open instead of being normally closed. In this case the device M′ when released closes the circuit of battery m^5 through relay m^3 and contacts a^{21}, and at each time of closing the magnet m^3 being energized opens the contacts a a' to transmit the signal, as before.

Fig. 2^d illustrates an arrangement in which the contacts a a' of the line-limbs l l' are directly controlled by the thermostatic device M′. In this case the contacts a a' are associated with the make-and-break wheel m and are included in the limbs l l' intermediate of the bridged impedance I and the alarm-receiving apparatus. When the wheel is released under the influence of heat, the contacts a a' are open and closed to give the characteristic signal, as hereinbefore explained.

Fig. 2^e shows an arrangement in which the make-and-break device M might be said to correspond to the regular district messenger-box. The limbs l l' are carried through the contacts a a' and thence to the bridged impedance I and the subscriber's instrument. The wheel m when actuated (in the diagram by depressing the lever m^2) breaks and makes the contacts a a' in the manner to transmit the characteristic alarm-signal.

While the foregoing diagrams, as well as subsequent ones, indicate that a contact a or a' is included in each limb l l' of the line, it is obvious that one contact might be omitted, if desired, and the corresponding limb made permanently continuous at that point without interfering with the operativeness of the system.

Fig. 3 indicates an alternative arrangement of the alarm-receiving device to that shown in Fig. 1. In this arrangement the circuit of battery r', which includes the register-magnet r^2, is normally open at contacts 31 of the relay F. In receiving a signal these contacts are closed at each interruption of current in the relay F, the magnet r^2 is correspondingly energized, and attracting its armature r^{71} releases the wheel r^6 and records the signals in the well-known manner.

In Fig. 4 and subsequent drawings the recording device is indicated by a simple conventional diagram at R, and it is to be understood that this device may be any approved type of telegraph-register or equivalent mechanism. In Figs. 1 and 3 it has been assumed that the register R is individual to the line of relay F—in other words, that each telephone-line using the special alarm apparatus has a separate register. Fig. 4 shows the individual register arrangement of Fig. 3 in association with an individual pilot-lamp. The circuit of battery r' through register R is normally open at contacts 31 and includes a winding b' of the relay b. This relay has another winding b^2 in circuit with lamp b^3 and battery r', terminating at the normally open contact b^4. There is an armature-contact b^5, connected through the contact of key b^6 to the other side of battery r'. When contacts 31 are closed in response to an alarm-signal or other interruption of the current in relay F, the relay b is energized by current from battery r' through the winding b', the magnet of register R, and contacts 31. Circuit is thus completed from battery r' through lamp b^3, winding b^2, contacts b^4 b^5, and key b^6, lighting the lamp. When the circuit of winding b' is subsequently broken at contacts 31, current through winding b^2 will continue to energize the relay b and maintain the circuit of the lamp closed until it is momentarily broken by the operator at key b^6, after which the circuit will assume its normal condition. By this arrangement the pilot-lamp b^3 is lighted in response to the first movement of the armature of relay F and remains lighted until extinguished by the alarm operator, thus giving him a special and conspicuous indication.

Fig. 5 shows an arrangement of an individual register and pilot-lamp, the register being in a normally closed circuit. In this figure a circuit of battery r' is normally closed through the winding of the electromagnet b, the register R, and contacts 31. This magnet b carries on its armature a catch b^{11}, which normally engages a corresponding catch on the contact-piece b^{21}. This contact-piece is connected through lamp b^3 to one side of battery r' and is adapted when released to engage contact b^{41}, which is connected to the other side of the battery. When contacts 31 are separated, as in response to an alarm-signal, the magnet b is thus deënergized and its armature retracted, releasing the contact-piece b^{21}, which engages contact

b^{41}, thus completing the circuit of lamp b^3 and lighting the same. The contact-piece b^{21} will remain in its released position until manually restored, and the pilot-lamp b^3 will thus remain lighted and be unaffected by any subsequent movement of contacts 31 until the attention of the operator is attaracted.

Fig. 6 indicates means different from that of Fig. 5 for securing an individual pilot-lamp signal associated with an individual register in a normally closed circuit. In this arrangement there is a relay b, having an armature-contact b^{22}, adapted to be manually restored. The relay is normally in shunt of the register R, its circuit being completed from one side of battery r' through armature-contact b^{22}, front contact b^{12}, the relay-winding, and contacts 31. As long as this circuit is closed at contacts 31 (and consequently the circuit of registerR) relay b is energized and attracts its armature-contact to engage contact b^{12}. When contacts 31 are separated, as in receiving a signal, the circuit of relay b is interrupted, and its armature-spring breaks contact b^{12} and engages contact b^{42}, completing the circuit of pilot-lamp b^3 and battery r'. A subsequent movement of contacts 31, while still controlling the register, will not affect the relay b, for the reason that its circuit now stands open at contact b^{12} and the pilot-lamp will continue to burn until extinguished by the manual restoration of armature-contact b^{22} to its normal position.

Fig. 7 indicates an arrangement in which the register R is common to two or more lines, each line being provided with an individual pilot-lamp. In this arrangement each line has a relay b inserted in circuit with battery r' and contacts 31, which stand normally open. The relay-armature controls contacts 53 63 and has also a catch b^{13}, which normally engages contact-piece b^{23}. This contact-piece is connected with battery r' and is adapted when released to drop forward and engage contact 43, which is connected through lamp b^3 to the opposite side of the battery. The contact-piece will remain in its released position until manually restored. The contacts 53 of the relays b of all lines which utilize the same register are connected to one side of the battery r', and the contacts 63 of all of these relays are connected through the register to the opposite side of the battery. A switch b^{43} is indicated for each line, by which a line-circuit may be disconnected from the common register in case of trouble on lines to prevent interference with the operation of the register by other lines. The first motion of contacts 31, as in receiving a signal, completes a circuit of battery r' through relay b, and its armature being attracted releases contact-piece b^{23}, and thus closes the pilot-lamp circuit, lighting the lamp. At the same time the relay b acting in response to the intermittent closing of its circuit at contacts 31 operates the register R by closing its common circuit at contacts 53 63. While this arrangement, as well as those of Figs. 8 and 12 following, has the disadvantage of a possible interference in case two alarm-signals are received at the same time, it makes it possible to arrange the apparatus in a compact manner and reduces the amount of apparatus required.

Fig. 8 indicates a closed-circuit arrangement of the individual pilot-lamp with a common register. Here the circuit of relay b and battery r' is normally closed at contacts 31, and by the attraction of its armature the catch b^{14} engages contact-piece b^{24}. The contacts 53 63 of each relay form normally open terminals of the circuit of register R and battery r'. When the circuit of relay b is opened at contacts 31, as in receiving a signal, the consequent retraction of the relay-armature releases contact-piece b^{24}, allowing it to fall forward and complete the circuit of lamp b^3 through battery r' and contact 43. The lamp then remains lighted until the contact-piece b^{24} is restored by the operator. The relay b also closes contact 53 63 at each interruption of its circuit, and thus controls the register R in the regular manner.

Fig. 9 illustrates a closed-circuit arrangement for individual register and pilot-lamp somewhat similar to that of Fig. 6. In this system the relay b instead of being in shunt of the register R is in a separate circuit of battery r' and is controlled by an extra pair of contacts 32 on relay F. The operation is similar to that of Fig. 6.

Fig. 10 shows an open-circuit arrangement for individual register and pilot-lamp in which there is an extra pair of contacts 32 on relay F for controlling the lamp. In this arrangement contacts 31 control the register, as before. At the same time when contacts 32 are first closed a circuit of battery r' is completed through relay b and resistance b^7, energizing the relay b and closing its contacts. A circuit of battery r' is thus completed through relay b, contacts 45 55, key b^6, and lamp b^3, and it is obvious that the lamp will remain permanently lighted until this circuit is broken at contact 62 of key b^6. The resistance b^7 is provided to prevent the circuit through contacts 32 from short-circuiting the lamp after it is lighted.

Fig. 11 indicates the use of an individual register for each line, which may be in a normally open or closed circuit, as desired, here shown in a normally closed circuit. A register R′ is also shown as common to a part or all of the lines and is controlled by an extra pair of contacts 32 on each of the relays F in the usual manner. It is obvious that the common register R′ might be included in a normally closed circuit by including all of the contacts 32 of all of the group of relays F serially in the circuit of this register,

and a similar modification of Figs. 7 and 8 might be readily made. It has not, therefore, seemed necessary to illustrate such modifications by separate drawings, and this will also apply to the next figure.

Fig. 12 indicates a common register controlled by one pair of contacts 32 in combination with an individual pilot-lamp controlled by another pair of contacts 33. The pilot-lamp circuit is the closed-circuit arrangement of Fig. 9, the nature and operation of which has been made clear in the foregoing descriptions. It is apparent that the open-circuit pilot-lamp arrangement of Fig. 10 could be substituted for that shown in this figure by the use of a back contact for the relay F at 33.

In the foregoing drawings, Figs. 3 to 12, inclusive, it is assumed that the relay F is associated with limb $l\,l'$ or of the line, as indicated in this application.

Figs. 13 to 18, inclusive, indicate diagrammatically well-known methods of arrangement for relay F, by which it may be serially included in the line-limbs without presenting undue impedance to voice-currents. In Fig. 13 the active winding w has a parallel or twin winding v, the ends of which are connected together or short-circuited. In Fig. 14 the active winding w is shunted by a winding of higher resistance v', having substantially the same number of turns, but connected in opposition thereto, so that current in one winding opposes that in the other. In Fig. 15 the core x of the relay-magnet is inclosed in a shell y of copper or other non-magnetic metal. In Fig. 16 the active winding w has a permanent shunt v^2 of non-inductive resistance, and in Fig. 17 this shunt-path includes contacts 71 72 of the relay, which engage after the relay-armature is actuated. In Fig. 18 the winding w is permanently bridged by the condenser v^3.

In the drawings where the relay F is serially in the talking-circuit of the telephone-line it has only been indicated conventionally, and it is to be understood, as indicated, that the relay is so arranged as to present no undue interference or impedance to the telephonic currents.

Fig. 19 illustrates my invention as embodied in an exchange system of the three-wire type. The line-circuit A differs from that of Fig. 1 only in that the connection-terminals j have two line-springs permanently connected to the limbs $l\,l'$ and a sleeve or test-thimble j^3, which is connected by a local-circuit wire with the cut-off relay l^4. Two cord-circuits ordinarily used in such a system are shown at D and E. That at D differs from the cord-circuit of Fig. 1 with regard to structure; but in general results its operation, as will be seen, is the same. Instead of uniting the cord-strands 11 13 and 12 14 by condensers they are inductively related by the repeating-coil windings 1^a 3^a and 2^a 4^a, which windings are connected to the terminals of the central battery C^2. Relays h' k' are included in the circuits of strands 12 and 13 and control the circuits in shunt of lamps h^3 and k^3, respectively, in response to the manipulation of the subscriber's hook-switch. Subscriber A calls in the usual manner by removing his receiver from its hook, thus completing a low-resistance path in circuit of battery C through the line-relay l^2, lighting the lamp l^3. The operator by the insertion of the answering-plug p completes the local circuit of battery C^2 from ground through resistance 7^a, lamp h^3, plug-contact p^3, thimble j^3, and cut-off relay l^4 to ground, energizing the relay to disconnect the line-relay l^2, and (when used) the resistance r, extinguishing the line-lamp l^3. The subscriber's circuit is now completed from ground through battery C^2, repeating-coil winding 2^a, relay h', strand 12, contact p^2, spring j', limbs l' l, spring j', contact p', strand 11, and winding 1^a to ground. In the operation of the transmitter the resistance of this circuit is varied in accordance with the voice-vibrations, and the current-flow through windings 1^a 2^a of the repeating-coil varies accordingly. This variation in current induces alternating currents in windings 3^a 4^a of corresponding value, and thus energizes the receiver of the subscriber associated with the calling-plug o. As long as circuit is closed through the hook-switch contacts s s' relay h' is energized and by its contacts 51 61 completes a circuit in shunt of lamp h^3 through the low resistance 8^a, keeping the lamp dark. As soon, however, as the receiver is replaced, the contacts of relay h' separate, the lamp l^3 receives the full current in the circuit of relay l^4 previously traced and becomes lighted. In making a busy test it is obvious that under normal conditions the touching of tip o' to a thimble j^3 will not affect the operator's receiver. If, however, this thimble is connected to the active terminal of battery C^2 through the local circuit of the cord, which includes resistance 7^a, it is evident what when the test is made there will be a flow of current from the thimble j^3 through tip o', strand 13, and winding 3^a to ground. This flow will change the potential at the terminals of condenser t' and cause the busy "click" in the operator's receiver in a manner well understood. The operator listens and rings in the usual manner, and the circuits under such conditions are evident from the drawings. When both subscribers have hung up, the lighting of their corresponding cord-lamps provides the usual disconnect signal. When necessary, the impedance-coil i may be connected between battery C^2 and limb l' to obtain a more perfect balance of the circuit. The function of resistance r is the same as in Fig. 1. The cord-circuit E of Fig. 19 operates in substantially

the same manner as that of Fig. 1, except with regard to the busy test and the use of the calling-generator. Upon the insertion of the plug *o* the sleeve o^2 makes contact with thimble j^3 and spring j', thus completing the circuit of battery C^2 through relays k' k^2 and limbs *l l'* to the subscriber and another circuit through thimble j^3 and relay l^4 to ground, which likewise includes relay k^2. The other operations of this combination will be clear from the drawings and the foregoing descriptions, it being understood that current from the calling-generator *g* actuates the relay l^4 while ringing a subscriber. The busy test is secured by a flow of current to relay k' and condenser t' in a manner similar to that of circuit D. With regard to the alarm apparatus the special relay F is permanently connected with limb *l*, and the arrangement of the alarm-sending and alarm-receiving apparatus and impedance I is that indicated in previous figures. Under normal conditions the current flowing through impedance I suffices to energize relay F, but does not affect relay l^2. Upon the insertion of a plug sufficient current-flow is maintained through the battery connections of the cord to energize relay F (which is then in shunt of winding 1^a or 3^a of cord D or of relay h' or k' of cord E) without affecting the operation of relays h' or k'. The relay F remains in its normal energized condition when the current-flow is increased during the use of the telephone, and when the subscriber is being called by the operator the relay comes into shunt of resistance g^4 and is energized by current from the generator *g* through the impedance I and limbs *l l'*. If under any of these conditions the contacts *a a'* are opened by the sending of an alarm-signal, the relay F will be deprived of all current and will operate the receiving or recording apparatus indicated at R, as hereinbefore described. It is also evident that a break or a ground of limbs *l l'* will be indicated, as described in Fig. 1. In this Fig. 19 while three separate batteries are shown at C^2 it is to be understood that they may be one and the same.

Fig. 20 illustrates the application of my invention in that telephone system which normally has differentially-wound cut-off relays. In such a system the lines which are not equipped with the alarm apparatus have a cut-off relay l^4, with two windings connected in opposition, one winding being normally included in each of the limbs *l l'*. The operation of such lines is illustrated and described under Fig. 24, and the present description will simply cover the system as modified to include my invention. In the drawings, Fig. 20, the alarm apparatus and the substation equipment are the same as indicated in previous drawings. The two windings of the relay l^4 are connected cumulatively, (or in series,) and the limb *l* includes a condenser d^2, located between the relay l^4 and the relay F. The cord-circuit shown is one commonly used in a system of this general type. Subscriber A in calling completes a low-resistance circuit through the line-relay l^2, the limbs *l l'*, and the special relay F. Upon the insertion of the plug a circuit of the battery C is completed through relay h^2, strand 11, and relay l^4, operating both relays. The operation of relay l^4 disconnects the line-relay and connects the normally open thimbles j^2 to limb *l'* of the line. The operation of relay h^2 closes the local circuit of lamps h^3 k^3, which circuit is also controlled by relays h' k'. Subscriber A having removed the receiver, a circuit of battery C is completed through relay h', strand 12, limbs *l' l*, and relay F, thus energizing the relays and furnishing current for transmission. The contacts of relay h' are now separated, and lamp h^3 remains unlighted until subscriber A replaces his receiver, breaking the low-resistance circuit of the relay and allowing the contacts to close the lamp-circuit. It will be noted that relay h^2 is normally connected with strand 13 through the inner contact 2^b of the listening-key. When the operator is answering or making a busy test, this contact is broken, and the condenser *d* then unites strands 11 and 13. In making such a test if the line tested is not switched for connection the thimbles j^2 are in their normally open condition, and no effect is produced by touching the plug-tip *o'* to such thimbles. If, however, a connection exists when the test is made, a circuit of battery C will be completed from ground through relay h' or k' and sleeve p^2 or o^2 of the cord connected, thence through thimble j^2, tip *o'* of the testing-cord, contact 3^b of the listening-key, and winding t^2 of the operator's induction-coil, thus inducing the current in the circuit of her receiver to give the busy click. When ringing a subscriber, relay l^4 is energized by current through resistance g^4, and the circuit of generator *g* is completed through limbs *l l'* and relay F. When a called subscriber answers, his battery-circuit is completed through relays k' and F, the lamp k^3 being thus extinguished. When two connected subscribers have replaced their receivers, the consequent illumination of lamps h^3 and k^3 constitutes the signal for disconnection. It will thus be seen that in this system the operation of the signals and the various manipulations on the part of the operator are the same as in those previously described. This is also the case with regard to the special-alarm apparatus. The slight normal current through I maintains the closed contacts of relay F, but does not affect relays l^2, h', or k'. When a plug is inserted, this flow is maintained through the battery connection of relay h' or k'. When the receiver is removed, the increased current does not alter the normal condition of relay F. When

the calling-generator g is connected to the line, its current through I continues to energize the special relay. If during any of these conditions the limbs l l' become broken or grounded or if the contacts a a' are separated by the operation of the alarm-sending apparatus, the relay F is deprived of all current and by its contacts controls the other alarm-receiving apparatus.

In Fig. 21 I have indicated means by which the make-and-break wheel m of the alarm-sending device M may be made to stop at the necessary point to leave the contacts a a' open after revolving the necessary number of times to transmit an alarm-signal. Fig. 21ª shows the mechanism in cross-section. A revolving drum 7′ contains the actuating-spring 5′ and is connected to the make-and-break wheel in a suitable manner. This drum has a projection 1′, adapted to be engaged by the lever 2′ when the lever is retracted by spring 3′. This lever has a pin 4′, which comes inside of spring 5′ and is engaged thereby when the spring is placed under tension by means of the winding-stem 6′, as is shown in the drawings. When the drum revolves, as in case of an alarm-signal, the unwinding of the spring disengages the pin 4′, allowing the spring 3′ to retract the lever 2′ and bring it into engagement with the projection 1′, and thus stops the drum and its connected make-and-break mechanism at the required point in its revolution. It is obvious that other equivalent means may be used for the same purpose.

Fig. 22 illustrates my invention with the relay F serially included in the line-limb. The structure of this drawing is identical in its arrangement and method of operation as a telephone system with that of Fig. 1, and a detailed description is therefore unnecessary. As was pointed out in the description of Fig. 1, all lines which are not equipped with a special-alarm apparatus had the contact 3 of relay l^4 connected directly with the central-office return, or the grounded side of battery C. In the present structure this connection is used for the specially-equipped lines as well. The drawings indicate the resistance r as being non-inductive and included in the circuit of limb l' when necessary in order to balance the line. The resistance g^4, associated with the circuit of generator g in Fig. 1, is omitted. The alarm apparatus is similar to that indicated in the previous drawing and operates in substantially the same manner; but owing to the fact that the relay F is serially included the circuit conditions are somewhat different. In the systems previously described the relay is connected in bridge of the line or between one side of the line and ground, and is therefore not in the path of current-flow of the rapidly-changing voice-currents. With such a connection the impedance of the relay is a desirable factor, and its resistance and number of turns can be made as great as is necessary to conform to the other conditions without interfering with transmission. It will be seen, however, that under various conditions of the telephonic apparatus the relay F does not receive all currents flowing over the line-limb, but is at times shunted by other portions of the apparatus, as relays h' or k'. When the relay F is serially included in the line-limb, as in Fig. 22 and others, an exactly opposite condition prevails. The relay-windings are at all times traversed by the full current flowing over the line-limbs, but on account of being in the direct path of voice-currents the relay must be so designed and connected that it will not introduce undue impedance into the circuit, and its resistance must be sufficiently low as not to unduly reduce the direct current which energizes the transmitters and signal-relays. Various arrangements by which this can be accomplished were indicated in Figs. 13 to 18, inclusive, and it is to be understood that where the drawings indicate a serially-included relay its construction and connections are to be as indicated in the said figures. In Fig. 22 the relay F is normally energized by the comparatively weak current flowing from ground through battery C, relay l^2, contact 4, spring 2, resistance r, limb l', impedance I, limb l, the windings of relay F, spring l, and contact 3 to ground. Upon the insertion of the plug into a jack of the line this normal flow is still maintained through the battery connections of the cord-relays and the contacts 5 6 of the cut-off relay l^4. The removal of the receiver at the substation simply increases the current through relay F and the line. When calling a subscriber, the circuit of battery g^3 and generator g is completed through the limbs l l', the impedance I, and the relay F and keeps the relay energized. If under any of these conditions the contacts a a' are separated, as in the operation of the alarm-sending apparatus, or if limb l or l' becomes accidentally broken or grounded, relay F will be deprived of current and will consequently release its contacts to give the desired signal. In Fig. 22, as in Fig. 1, the alarm apparatus of line A is indicated as in its normal unoperated condition and that of line B as in operation.

Fig. 23 illustrates my invention using a serially-included relay F instead of the bridged relay in the three-wire system previously described in Fig. 19. In this system, as shown in Fig. 19, those lines without the special-alarm apparatus were provided with a direct-ground connection to contact 3 of relay l^4. When the series relay is used, all lines have this connection, as shown in Fig. 23, which also indicates that resistance r may be included in limb l' when necessary for balancing the line instead of the impedance-coil i, which is omitted. Aside from these differ-

ences the structures of the two drawings are identical, and a detailed description of Fig. 23 is unnecessary. It will be evident from the foregoing descriptions that there will be sufficient current flowing through the limbs $l\ l'$ to energize the relay F under all conditions; except when the circuit is opened at contacts $a\ a'$; are accidentally broken or grounded. When the relay is thus deprived of current, the necessary indications will be given through the separation of its contacts.

Fig. 24 illustrates the use of the series relay F in the system referred to in the description of Fig. 20 as employing a differentially-wound cut-off relay. In the arrangement of the present figure the telephonic apparatus of all lines is connected, as shown in the drawings, irrespective of whether the special-alarm apparatus is provided or not. Winding 8^b of relay l^4 is permanently connected from limb l to ground, and winding 7^b is connected from battery C through relay l^2 to the separable contacts 3–1 of limb l'. These two windings have an equal number of turns, and when circuit is closed through the subscriber's instrument the relay l^2 will be energized and lamp l^3 lighted, but relay l^4 will be unaffected. When the operator inserts a plug either in answering or to call a subscriber, a circuit of battery C will be completed through relay h^2 or resistance g^4 to the tip of the plug, and thence to line-spring j' and winding 8^b to ground. The current flowing through this path will actuate relay l^4, opening contacts 3–1 to disconnect the line-relay and winding 7^b and closing contacts 1–6. When the hook switch-contact is then closed, the relay l^4 is still further energized by the current then flowing through relay h' or k' and line-limbs $l\ l'$. In other respects the operation of the telephone apparatus is as set forth in the description of Fig. 20, and the cord-circuits of the two drawings are identical. It will be seen in this as in the previous drawings that there is current in the line at all times to energize relay F except when one of the limbs is opened or grounded, in which case the necessary indication is given through the separation of the relay-contacts.

Figs. 25 to 28, inclusive, illustrate my invention as embodied in that type of telephone system in which the line-relay and source of current are in a permanent bridge of the line and the line and supervisory lamp are in a local circuit controlled by the line-relay. In Fig. 25 the relay l^2 has cumulative windings 1^c and 2^c, connected between the battery-terminals and limbs l and l', respectively. The line-lamp l^3 is connected with the normally open contact 8^c of the relay and to the battery-ground. Resistances 3^c 4^c are connected from the battery C to the relay-contacts 9^c 10^c, respectively, and contact 9^c is permanently connected to the test-thimble j^3. The substation equipment is the same as indicated in previous drawings. The cord-circuit, Fig. 28, is one in common use, having a tip and sleeve strand, each of which includes a condenser and a third or local contact p^3 o^3 of the plug connected through the supervisory lamps h^3 k^3 to the battery-ground. The subscriber A in calling completes a low-resistance circuit through his instrument for relay l^2, which becoming energized closes the contacts 8^c 9^c, thus completing a local circuit of battery C through resistance 3^c and lamp l^3, lighting the lamp. Upon the insertion of the plug in answering such a call a shunt-circuit of lamp l^3 is completed from contact 9^c through thimble j^3, plug-contact p^3, and lamp h^3 to ground. The resistances of the lamps are so proportioned that when they are thus in multiple in the circuit of resistance 3^c the current through the branches will be insufficient to light either lamp. The line-lamp is thus extinguished and both lamps remain dark. The lamps h^3 k^3 are preferably of considerably lower resistance than the lamp l^3 and will not be lighted when alone in circuit with resistance 3^c. As long as the subscriber's circuit is closed this local circuit is maintained by the continued energization of relay l^2. When the receiver is replaced, the relay-contacts assume their normal position, breaking the circuit of lamp l^3 and bringing resistance 4^c into multiple circuit with resistance 3^c. The consequent lowering in resistance of the circuit of lamp h^3 allows sufficient current-flow to illuminate this lamp. It is thus seen that each of a pair of connected subscribers controls his associated supervisory lamp, and the illumination of both lamps constitutes the disconnect-signal, as in the systems previously described. In making a busy test it will be readily seen that under normal conditions no effect will result from touching tip o' to a thimble j^3; but if circuit is closed through the line-lamp or if a plug is in a jack circuit will be completed from ground through battery C, impedance t^{31}, receiver t, and tip o' and the test indication thus given on making such a contact. The subscriber is called over limbs $l\ l'$ in the usual way by current from generator g, the impedance of relay l^2 being sufficient to prevent an undue shunting of calling-current by the permanent bridge. The alarm apparatus of the drawings is similar to that previously indicated. Fig. 25 shows the relay F in partial bridge of the circuit and in multiple with winding l of the relay l^2. In Fig. 26 the relay F is indicated by line 6^d 7^d as being included in the circuit of winding 1^c in the permanent bridge. Fig. 27 shows the relay serially included in limb l' and a balancing resistance is indicated at r. In each drawing it will be seen that there is always a closed circuit for relay F, normally through impedance I and abnormally through the subscriber's instrument as well,

irrespective of the manipulations of the cord-circuit apparatus. As hereinbefore described, the current through impedance I will not interfere with the regular operation of relay l^2. The interruption or grounding of limb l or l' deprives relay F of current under all conditions of operation, and thus actuates the signal-receiving mechanism in the manner previously described.

Figs. 29 to 32, inclusive, show a system embodying my invention which resembles that of Figs. 25 to 28, in that the line-relay l^2 and source of current C are in a permanent bridge of the line. This permanent bridge also includes the impedance i' i^2, and the jack-springs j^2 are connected by wire 5^E to a point intermediate of the relay and impedance-coil i'. Three conductor cords and plugs are used, as shown in Fig. 32, the tip and sleeve strands being united by condensers d d', and the third strand being connected from the intermediate plug-contacts p^2 o^2 through relays h' k' to strands 11 13, respectively. The substation equipment is the same as previously indicated. Subscriber A in calling closes the low-resistance circuit through relay l^2, lighting the lamp l^3. Upon the insertion of the answering-plug a shunt of relay l^2 is completed through wire 5, spring j^2, contact p^2, relay h', strand 11, contact p', and spring j' to limb l. The relays h' and k' being of very low resistance, current is thus diverted from relay l^2, allowing its contacts to separate and extinguish the lamp. The direct-current circuit being now completed from battery C, impedance i^2, the substation instrument and limbs l l', spring j', relay h', and impedance i' to battery, the relay h' is energized and its contacts separated, the lamp h^3 remaining unlighted. When the receiver at A is replaced and the circuit thus interrupted, the relay h' is deënergized and its contacts closed. Current will now flow from ground through battery C^3, impedance i^2, thimble j^3, contact p^3, strand 12, and relay h^2 to ground, thus closing the relay-contacts and completing the circuit of lamp h^3. In completing a connection and calling a subscriber the apparatus operates in a corresponding manner and needs no further description. The actuation of the ringing key completes a circuit of calling-generator g through strands 13 14 to limbs l l', and while it has been found that calling current will sometimes flow through relay k' and the impedance-coils i' i^2 in sufficient quantity to vibrate the relay this does not interfere with the operation of the subscriber's bell and has not been deemed a serious objection. In making a busy test if the line tested is not in use or switched for conversation the potential of the tip o' and the thimble j^3 will be substantially the same (that of battery C) and no effect will be noticeable in the operator's receiver when they are brought into contact. If, however, the subscriber's circuit is closed or a plug is in a spring-jack, the potential of the thimble j^3 will be considerably reduced and when tested current will flow through impedance t^{31} and receiver t to give the required click. From this description it will be seen that the control of the signals and the required manipulations of the apparatus are the same as in the systems previously described. The special-alarm apparatus of the drawings is the same as that previously indicated. A circuit of battery C is always completed through limbs l l' and relay F as long as the limbs remain intact and free from accidental ground. In case a limb becomes accidentally grounded or open or the make-and-break device at M operates the relay F is deprived of current and the necessary signal thus given. Fig. 29 shows the relay F in partial bridge of the line, line 1^E indicating its direct connection from limb l to ground. Fig. 30 shows the relay F as included in the permanent bridge, line 3^E indicating its location between impedance i' and the point of connection of wire 5^E. Fig. 31 shows the relay F as serially included in limb l and resistance r to balance the circuit in limb l'.

Fig. 33 indicates the use of the special-alarm apparatus in a telephone system in which the line-relay and signal are cut out by separable contacts in the jacks and in which the special relay F constitutes the impedance for one side of the battery-bridge of the circuit. Subscriber A in calling completes a circuit of battery C through relay l^2, separable jack-contacts 1^m 2^m, limbs l l', and relay F, thus lighting the lamp l^3. On the insertion of the answering-plug the separation of contacts 1^m or 2^m breaks the circuit of relay l^2, extinguishing the lamp, and circuit is completed from battery C through relay h', strand 12, contact p^2, and spring j^2 to line-limbs l l', and relay F. Upon the insertion of the plug a local circuit is also completed from battery C through relay h^2, contact p^3, thimble j^3, and resistance i^3, energizing relay h^2 to close its contacts which are in the circuit of lamp h^3. This lamp-circuit also includes the normally closed contact of relay h', and as long as this relay is excited by current through the subscriber's instrument the lamp remains dark. When the circuit is broken at the substation, the contacts close, lighting the lamp h^3 until the circuit of relay h^2 is broken by the removal of the plug. The apparatus associated with the line of a called subscriber operates in a similar manner and needs no specific explanation. In making a busy test the thimble j^3 has no normal connection to the active side of battery C and no current will flow to tip o' when it is brought into contact with the thimble unless a plug is in a jack of the line tested. Under the latter condition when the test is made current will flow from battery C through relay h^2 or k^2 of

the busy cord to thimble j^3 and thence through a path in shunt of resistance i^3, which is completed through tip o', strand 13, receiver t, and induction-coil winding t^2, giving the busy indication. In calling a subscriber the actuation of the ringing key completes the circuit of generator g from ground through strand 14, contact o^2, spring j^2, limbs $l\,l'$, and relay F to ground. The circuit is also completed from limb l through spring j', contact o', strand 13, and resistance g^4 back to generator g, and this latter circuit constitutes a shunt of relay F, but does not interfere with its energization by the calling-current. When two subscribers are united for conversation, their talking-circuit is completed through the condensers $d\ d'$ in the cord-strand and the display of the signals and the manipulations on the part of the subscribers and operator are identical with those of the other systems described. As for the alarm apparatus, the relay F is normally energized by direct current or calling-current through impedance I or the instrument at A. If the contacts at M are separated or a line-limb becomes broken or grounded, the relay F is de-energized and the necessary indications given, as in the other systems described. It is to be understood that lines of this system which do not include the special-alarm apparatus would have the relay F replaced by an impedance at the exchange.

The systems of Figs. 34 and 35 are identical with that shown at A and B of Figs. 19 and 23, except for the location of the relay F, and their telephonic operation will therefore be understood without further description. In all of the previous drawings the relay F has been associated with that line-limb leading from the grounded side of the central battery. With such a connection an accidental ground on either limb of sufficient conductivity to interfere with the operation of the alarm apparatus will divert the current from the relay and deënergize it, thus giving an indication of such ground. In Fig. 34 it is indicated that relay F may be serially included in the line-limb l' leading from the active terminal of the battery C. When so connected, the relay F will control the other signal-receiving apparatus in the required manner as long as limb l' remains free from accidental ground. In case, however, limb l' should become grounded the relay would be continually energized by current from battery C through the accidental ground connection and opening the circuit at a point beyond the ground either accidentally or by the operation of the make-and-break device M would not affect the relay. If the accidental ground were of a low resistance, its presence would be indicated to the telephone-operator by the continued illumination of lamp l^3 through the energization of relay l^3, but if of high resistance might not give any indication whatever. This modification is therefore one which, while entirely operative, does not possess all of the advantages of those previously described.

In Fig. 35 the relay F is connected as in Fig. 34, but is provided with means by which a ground or short circuit of limb l' may be indicated. This means consists in the drawings of the extra contacts 2^n 3^n, normally separated by the adjustable tension-spring 1^n or its equivalent. It is evident that with such an arrangement the lower contacts may be held closed by the currents which flow through the entire circuit, while the tension of armature-contact 2^n may be so adjusted that it will not be actuated by such current, but will respond when the current is increased to a predetermined amount, as by the accidental grounding or short-circuiting of limb l'. When so actuated, a special signal will be given, as in the drawings. The closing of contacts 2 3 completes the circuit of battery 7^n through lamp 4^n and bell 6^n, and the latter may be cut out when desired by the short-circuiting switch 5^n. With this arrangement the various indications given by the alarm apparatus will therefore be substantially the same as in all of the systems shown, except that of Fig. 34.

Figs. 36, 37, and 38 indicate means by which the special alarm-receiving apparatus and its wiring may be arranged in a systematic and orderly manner and allow the association of any particular alarm-receiving circuit or device with any line of the telephone-exchange without disturbing the permanent wiring of either circuit. Fig. 36 shows the line-circuit wiring of the system of Figs. 1 and 22 and is generally illustrative of the arrangement commonly employed in all of the systems described. The limbs l, l' on entering the exchange, pass through fuses $f^4\ f^4$ of the protective device J and are permanently connected to terminals 1^h and 2^h upon the line side of the main distributing-rack G. Removable jumper-wires $x'\ y'$ connect terminals 1^h and 3^h and terminals 2^h and 4^h through the interior of this rack, and the limbs are then carried through a permanently-connected cable to the contacts of relay l^4 at the rack P, which holds all of the line and cut-off relays of the telephone system. From the inner contacts of the relay the limbs extend, by a permanently-connected cable, to the clips 17^a and 18^a upon the multiple side of the intermediate distributing-rack H. This cable also contains the wire 13^a, terminating on clip 16^a, which forms a part of the circuit of lamp l^3. Clips 17^a and 18^a are permanently connected to another cable to the multiple jacks $j\ j$, and the answering-jack j^5 and lamp l^3 are similarly connected to clips 19^a, 20^a, and 21^a upon the opposite side of the intermediate rack. Removable jumper-wires unite corresponding clips through the inte-

rior of this rack. It will be seen that in such an arrangement it is possible by shifting the removable jumpers to connect any pair of outside wires to any line of the switchboard and also to associate any answering-jack and lamp with any set of multiple jacks in the system and this without disturbing the permanent wiring. In order to give the same flexibility to the alarm system, a special set of clips S is provided on the main distributing-rack, to which the relays F are permanently connected. It is then only necessary to run an additional jumper from a special clip to a clip 3^h of the telephone-line to bring about the required association, and these jumpers may be quickly shifted from one line to another without disturbing any of the permanent connections. The wire 11^a of the drawings indicates the connection when the relay is in bridge, and resistance *r* may be located on the relay-rack and connected as shown, if required. The contact 14^a of those lines without the alarm apparatus would be connected directly to wire 15^a and ground, and this would also hold good if the relay F is to be serially included in the line-limb. In the latter case both terminals of the relay would be wired to the special clips and a second jumper-wire (indicated by line 12^a) would be required, as well as the removal of jumper *x'*. Fig. 37 indicates another similar construction, which also provides special protective devices for the alarm-equipped circuit, with an arrangement of cabling to prevent any possibility of cross-talk. In this case, which shows the series connection, the relay F and the balancing-resistance *r* are permanently wired from one side to the special clips 5^f and 6^f, being carried through the fusible devices f^4 f^4 of the lightning-arrester J. These fusible devices may be of any approved type of sneak-current protector, and when used the use of the corresponding protective devices of the telephone system ordinarily located on the switchboard side of the main distributing-rack would be unnecessary. The opposite sides of the relay and resistance are permanently connected to the special clips 7^f and 8^f. When it is desired to equip any telephone-line with the special apparatus, the regular jumpers *x' y'* of Fig. 36 are replaced by the wires 11^f 13^f and 12^f 14^f, as indicated in Fig. 37. It will thus be seen that the limbs *l l'* are carried to and through the special alarm-receiving station as a parallel pair and connect at terminals 3^h and 4^h with the regular permanent wiring of the exchange. The lines at 9^f and 10^f indicate that additional clips and wiring may be provided for the modifications shown in Figs. 26, 29, and 30 when necessary. Fig. 38 shows the arrangement of Fig. 37 with the relay F connected in bridge instead of serially and requires no special explanation.

It is evident that one skilled in the art may utilize my invention in other systems than those shown without departing from its spirit, and I therefore do not wish to limit myself to the specific structure illustrated and described.

What I claim as new and novel, and desire to secure by Letters Patent of the United States, is—

1. The combination in a telephone-exchange system of a central battery for supplying current to the subscriber's instrument and for signaling, means for interconnecting subscribers' circuits for conversation, a subscriber's instrument, a circuit thereto, means for maintaining a normally continuous flow of current in the circuit of insufficient strength to affect the telephone signaling apparatus, alarm-receiving apparatus associated with the circuit and adapted to be maintained in its normal condition as long as any current is present in the circuit, and alarm-sending apparatus associated with the circuit adapted to deprive said circuit of all current.

2. The combination of a telephone-exchange, a telephone instrument, a circuit extending from the instrument to the exchange, alarm-receiving apparatus responsive to any interruption of current in the circuit, alarm-sending apparatus adapted when operated to interrupt the current in the circuit, means for maintaining normally a weak continuous current in the circuit of a character adapted to prevent the operation of the alarm-receiving apparatus, and a telephone-signal at the exchange irresponsive to the normal current but responsive to the current set up by the use of the telephone.

3. The combination of a telephone-line extending from an exchange to a substation, a source of current at the exchange normally closed through a high resistance during the disuse of the telephone and abnormally closed through a low resistance during the use of the telephone, an electromagnet adapted to be energized by current through either the high or low resistance, alarm-receiving apparatus controlled by the electromagnet, a telephonic signal adapted to be operated by current through the low resistance, but not by current through the high resistance, and alarm-sending mechanism adapted to interrupt the circuit of said source of current and thus de-energize the electromagnet and cause the operation of the signal-receiving mechanism.

4. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an alarm-receiving apparatus including in said circuit energized by the normal current therein and by the current therein when the telephone is in use but responsive only to the interruptions of current in said circuit, an alarm-sending apparatus included in said cir-

cuit and adapted to interrupt the current therein, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus located at the central office and adapted to be operated only when the telephone is in use but unaffected by the current in said circuit when the telephone is not in use.

5. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an alarm-receiving apparatus included in said circuit responsive only to interruptions of the current therein, an alarm-sending apparatus normally maintaining the continuity of said circuit but adapted when operated to open and close it, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus located at the central office and adapted to be operated only when the telephone is in use but unaffected by the current in said circuit when the telephone is not in use.

6. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an alarm-receiving apparatus included in said circuit responsive only to interruptions of the current therein, an alarm-sending apparatus adapted to control the continuity of said circuit in a predetermined manner, telehone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus located at the central office and adapted to be operated only when the telephone is in use but unaffected by the current in said circuit when the telephone is not in use.

7. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an electromagnet-controlling alarm-receiving apparatus permanently included in the said circuit and responsive only to interruptions of the current therein, an alarm-sending apparatus normally maintaining the continuity of said circuit but adapted when operated to open and close it, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus located at the central office and adapted to be operated only when the telephone is in use but unaffected by the current in said circuit when the telephone is not in use.

8. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an electromagnet-controlling alarm-receiving apparatus permanently included in the said circuit and responsive only to interruptions of the current therein, an alarm-sending apparatus adapted to control the continuity of said circuit in a predetermined manner, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus located at the central office and adapted to be operated only when the telephone is in use but unaffected by the current in said circuit when the telephone is not in use.

9. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an electromagnetic alarm-receiving device included in said circuit and energized by the currents therein but responsive only to the interruption thereof, an alarm-sending apparatus normally maintaining the continuity of said circuit but adapted when operated to open and close it, a telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus located at the central office and adapted to be operated only when the telephone is in use but unaffected by the current in said circuit when the telephone is not in use.

10. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an electromagnetic alarm-receiving device included in said circuit and energized by the currents therein but responsive only to the interruption thereof, an alarm-sending apparatus adapted to control the continuity of said circuit in a predetermined manner, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus located at the central office and adapted to be operated only when the telephone is in use but unaffected by the current in said circuit when the telephone is not in use.

11. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an alarm-receiving apparatus included in said circuit energized by the normal current therein and by the current therein when the telephone is in use but responsive only to the in-

terruptions of current in said circuit, an alarm-sending apparatus normally maintaining the continuity of said circuit but adapted when operated to open and close it, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus located at the central office and adapted to be operated only when the telephone is in use but unaffected by the current in said circuit when the telephone is not in use.

12. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an alarm-receiving apparatus included in said circuit energized by the normal current therein and by the current therein when the telephone is in use but responsive only to the interruptions of current in said circuit, an alarm-sending apparatus adapted to control the continuity of said circuit in a predetermined manner, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus located at the central office and adapted to be operated only when the telephone is in use but unaffected by the current in said circuit when the telephone is not in use.

13. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an alarm-receiving apparatus included in said circuit responsive only to interruptions of the current therein, an alarm-sending apparatus included in said circuit and adapted to interrupt the current therein, telephone apparatus located at the substation associated with said circuit adapted when the telephone is in use to vary the resistance of said circuit, and signal-receiving apparatus located at the central office and adapted to be operated only when the telephone is in use but unaffected by the current in said circuit when the telephone is not in use.

14. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an electromagnet-controlling alarm-receiving apparatus permanently included in the said circuit and responsive only to interruptions of the current therein, an alarm-sending apparatus included in said circuit and adapted to interrupt the current therein, telephone apparatus located at the substation associated with said circuit adapted when the telephone is in use to vary the resistance of said circuit, and signal-receiving apparatus located at the central office and adapted to be operated only when the telephone is in use but unaffected by the current in said circuit when the telephone is not in use.

15. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an electromagnetic alarm-receiving device included in said circuit and energized by the currents therein but responsive only to the the interruption thereof, an alarm-sending apparatus included in said circuit and adapted to interrupt the current therein, telephone apparatus located at the substation associated with said circuit adapted when the telephone is in use to vary the resistance of said circuit, and signal-receiving apparatus located at the central office and adapted to be operated only when the telephone is in use but unaffected by the current in said circuit when the telephone is not in use.

16. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an alarm-receiving apparatus included in said circuit energized by the normal current therein and by the current therein when the telephone is in use but responsive only to the interruptions of current in said circuit, an alarm-sending apparatus included in said circuit and adapted to interrupt the current therein, telephone apparatus located at the substation associated with said circuit adapted when the telephone is in use to vary the resistance of said circuit, and signal-receiving apparatus located at the central office and adapted to be operated only when the telephone is in use but unaffected by the current in said circuit when the telephone is not in use.

17. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an alarm-receiving apparatus included in said circuit responsive only to interruptions of the current therein, an alarm-sending apparatus normally maintaining the continuity of said circuit but adapted when operated to open and close it, telephone apparatus located at the substation associated with said circuit adapted when the telephone is in use to vary the resistance of said circuit, and signal receiving apparatus located at the central office and adapted to be operated only when the telephone is in use but unaffected by the current in said circuit when the telephone is not in use.

18. The combination in a telephone-exchange system of a normally closed circuit extend ng from the central office to a substation, a source of current in said circuit, an alarm-receiving apparatus included in said circuit responsive only to interruptions of the

current therein, an alarm-sending apparatus adapted to control the continuity of said circuit in a predetermined manner, telephone apparatus located at the substation associated with said circuit adapted when the telephone is in use to vary the resistance of said circuit, and signal-receiving apparatus located at the central office and adapted to be operated only when the telephone is in use but unaffected by the current in said circuit when the telephone is not in use.

19. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an electromagnet-controlling alarm-receiving apparatus permanently included in the said circuit and responsive only to interruptions of the current therein, an alarm-send ng apparatus normally maintaining the continuity of said circuit but adapted when operated to open and close it, telephone apparatus located at the substation associated with said circuit adapted when the telephone is in use to vary the resistance of said circuit, and signal-receiving apparatus located at the central office and adapted to be operated only when the telephone is in use but unaffected by the current in said circuit when the telephone is not in use.

20. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an electromagnet-controlling alarm-receiving apparatus permanently included in the said circuit and responsive only to interruptions of the current therein, an alarm-sending apparatus adapted to control the continuity of said circuit in a predetermined manner, telephone apparatus located at the substation associated with said circuit adapted when the telephone is in use to vary the resistance of said circuit, and signal-receiving apparatus located at the central office and adapted to be operated only when the telephone is in use but unaffected by the current in said circuit when the telephone is not in use.

21. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an electromagnetic alarm-receiving device included in said circuit and energized by the currents therein but responsive only to the interruption thereof, an alarm-sending apparatus normally maintaining the continuity of said circuit but adapted when operated to open and close it, telephone apparatus located at the substation associated with said circuit adapted when the telephone is in use to vary the resistance of said circuit, and signal-receiving apparatus located at the central office and adapted to be operated only when the telephone is in use but unaffected by the current in said circuit when the telephone is not in use.

22. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an electromagnetic alarm-receiving device included in said circuit and energized by the currents therein but responsive only to the interruption thereof, an alarm-sending apparatus adapted to control the continuity of said circuit in a predetermined manner, telephone apparatus located at the substation associated with said circuit adapted when the telephone is in use to vary the resistance of said circuit, and signal-receiving apparatus located at the central office and adapted to be operated only when the telephone is in use but unaffected by the current in said circuit when the telephone is not in use.

23. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an alarm-receiving apparatus included in said circuit energized by the normal current therein and by the current therein when the telephone is in use but responsive only to the interruptions of current in said circuit, an alarm-sending apparatus normally maintaining the continuity of said circuit but adapted when operated to open and close it, telephone apparatus located at the substation associated with said circuit adapted when the telephone is in use to vary the resistance of said circuit, and signal-receiving apparatus located at the central office and adapted to be operated only when the telephone is in use but unaffected by the current in said circuit when the telephone is not in use.

24. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an alarm-receiving apparatus included in said circuit energized by the normal current therein and by the current therein when the telephone is in use but responsive only to the interruptions of current in said circuit, an alarm-sending apparatus adapted to control the continuity of said circuit in a predetermined manner, telephone apparatus located at the substation associated with said circuit adapted when the telephone is in use to vary the resistance of said circuit, and signal-receiving apparatus located at the central office and adapted to be operated only when the telephone in use but unaffected by the current in said circuit when the telephone is not in use.

25. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an alarm-receiving apparatus included in said

circuit responsive only to interruptions of the current therein, an alarm-sending apparatus included in said circuit and adapted to interrupt the current therein, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus located at the central office normally included in said circuit and adapted to respond to give its signal when said telephone is in use.

26. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an alarm-receiving apparatus included in said circuit responsive only to interruptions of the current therein, an alarm-sending apparatus included in said circuit and adapted to interrupt the current therein, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus normally included in said circuit and unaffected by the normal current therein, but adapted to respond to give its signal when the telephone is in use.

27. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an electromagnet-controlling alarm-receiving apparatus permanently included in the said circuit and responsive only to interruptions of the current therein, an alarm-sending apparatus included in said circuit and adapted to interrupt the current therein, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use and signal-receiving apparatus located at the central office normally included in said circuit and adapted to respond to give its signal when said telephone is in use.

28. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an electromagnet-controlling alarm-reciving apparatus permanently included in the said circuit and responsive only to interruptions of the current therein, an alarm-sending apparatus included in said circuit and adapted to interrupt the current therein, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus normally included in said circuit and unaffected by the normal current therein but adapted to respond to give its signal when the telephone is in use.

29. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an electromagnetic alarm-receiving device included in said circuit and energized by the currents therein but responsive only to the interruption thereof, an alarm-sending apparatus included in said circuit and adapted to interrupt the current therein, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus located at the central office normally included in said circuit and adapted to respond to give its signal when said telephone is in use.

30. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an electromagnetic alarm-receiving device included in said circuit and energized by the currents therein but responsive only to the interruption thereof, an alarm-sending apparatus included in said circuit and adapted to interrupt the current therein, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus normally included in said circuit and unaffected by the normal current therein but adapted to respond to give its signal when the telephone is in use.

31. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an alarm-receiving apparatus included in said circuit energized by the normal current therein and by the current therein when the telephone is in use but responsive only to the interruptions of current in said circuit, an alarm-sending apparatus included in said circuit and adapted to interrupt the current therein, and signal-receiving apparatus located at the central office normally included in said circuit and adapted to respond to give its signal when said telephone is in use.

32. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an alarm-receiving apparatus included in said circuit energized by the normal current therein and by the current therein when the telephone is in use but responsive only to the interruptions of current in said circuit, an alarm-sending apparatus included in said circuit and adapted to interrupt the current therein, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance

of said circuit when the telephone is in use, and signal-receiving apparatus normally included in said circuit and unaffected by the normal current therein but adapted to respond to give its signal when the telephone is in use.

33. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an alarm-receiving apparatus included in said circuit responsive only to interruptions of the current therein, an alarm-sending apparatus normally maintaining the continuity of said circuit but adapted when operated to open and close it, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus located at the central office normally included in said circuit and adapted to respond to give its signal when said telephone is in use.

34. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an alarm-receiving apparatus included in said circuit responsive only to interruptions of the current therein, an alarm-sending apparatus normally maintaining the continuity of said circuit but adapted when operated to open and close it, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus normally included in said circuit and unaffected by the normal current therein but adapted to respond to give its signal when the telephone is in use.

35. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an alarm-receiving apparatus included in said circuit, responsive only to interruptions of the current therein, an alarm-sending apparatus adapted to control the continuity of said circuit in a predetermined manner, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus located at the central office normally included in said circuit and adapted to respond to give its signal when said telephone is in use.

36. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an alarm-receiving apparatus included in said circuit responsive only to interruptions of the current therein, an alarm-sending apparatus adapted to control the continuity of said circuit in a predetermined manner, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus located at the central office normally included in said circuit and adapted to respond to give its signal when said telephone is in use.

37. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an electromagnet controlling alarm-receiving apparatus permanently included in the said circuit and responsive only to interruptions of the current therein, an alarm-sending apparatus normally maintaining the continuity of said circuit but adapted when operated to open and close it, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus located at the central office normally included in said circuit and adapted to respond to give its signal when said telephone is in use.

38. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an electromagnet-controlling alarm-receiving apparatus permanently included in the said circuit and responsive only to interruptions of the current therein, an alarm-sending apparatus normally maintaining the continuity of said circuit but adapted when operated to open and close it, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus normally included in said circuit and unaffected by the normal current therein but adapted to give its signal when the telephone is in use.

39. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an electromagnet-controlling alarm-receiving apparatus permanently included in the said circuit and responsive only to interruptions of the current therein, an alarm-sending apparatus adapted to control the continuity of said circuit in a predetermined manner, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus located at the central office normally included in said circuit and adapted to respond to give its signal when said telephone is in use.

said circuit and unaffected by the normal current therein but adapted to respond to give its signal when the telephone is in use.

47. A combined telephone and alarm system comprising a circuit extending from a substation to a central office, means for supplying a relatively small current to said circuit, means operated only by an increase of said relatively small current to receive a telephone-signal, means operated by a decrease of said relatively small current to receive an alarm, telephone-signaling means for sending an increased current through said telephone-signal-receiving means to cause its operation, alarm-signal-transmitting means for sending a decreased current through said alarm-receiving means to cause its operation, and means at the substation and central office for holding conversation over said circuit.

48. A combined telephone and alarm system comprising a circuit extending from a substation to a central office, means for supplying a relatively small current to said circuit, means operated only by an increase of said relatively small current to receive a telephone-signal, means operated only by a decrease of said relatively small current to receive an alarm and to indicate an open circuit, telephone-signaling means for sending an increased current through said telephone-signal-receiving means to cause its operation, alarm-signal-transmitting means for sending a decreased current through said alarm-receiving means to cause its operation, and means at the substation and central office for holding conversation over said circuit.

49. A combined telephone and alarm system comprising a circuit extending from a substation to a central office, means for supplying a relatively small current to said circuit, means operated only by an increase of said relatively small current to receive a telephone-signal, means operated by a decrease of said relatively small current to receive an alarm and to indicate a ground at any point in said circuit beyond the central office, telephone-signaling means for sending an increased current through said telephone-signal-receiving means to cause its operation, alarm-signal-transmitting means for sending a decreased current through said alarm-receiving means to cause its operation, and means at the substation and central office for holding conversation over said circuit.

50. A combined telephone and alarm system comprising a circuit extending from a substation to a central office, means for supplying a relatively small current to said circuit, means operated only by an increase of said relatively small current to receive a telephone-signal, means operated by interruptions of current to receive an alarm, telephone-signaling means for sending an increased current through said telephone-signal-receiving means to cause its operation, alarm-signal-transmitting means for interrupting the current supplied to said alarm-receiving means to cause its operation, and means at the substation and central office for holding conversation over said circuit.

51. A combined telephone and alarm system comprising a circuit extending from a substation to a central office, means for supplying a relatively small current to said circuit, means operated only by an increase of said relatively small current to receive a telephone-signal, means operated only by interruptions of current to receive an alarm and to indicate an open circuit, telephone-signaling means for sending an increased current through said telephone-signal-receiving means to cause its operation, alarm-signal-transmitting means for interrupting the current supplied to said alarm-receiving means to cause its operation, and means at the substation and central office for holding conversation over said circuit.

52. A combined telephone and alarm system comprising a circuit extending from a substation to a central office, means for supplying a relatively small current to said circuit, means operated only by an increase of said relatively small current to receive a telephone-signal, means operated by interruptions of current to receive an alarm and to indicate a ground at any point in said circuit beyond the central office, telephone-signaling means for sending an increased current through said telephone-signal-receiving means to cause its operation, alarm-signal-transmitting means for interrupting the current supplied to said alarm-receiving means to cause its operation, and means at the substation and central office for holding conversation over said circuit.

53. A combined telephone and alarm system comprising a circuit extending from a substation to a central office, a source of current included in said circuit, a relatively high resistance included in said circuit to cut down the current therein to a relatively small value, means operated only by an increase of said relatively small current to receive a telephone-signal, means operated by a decrease of said relatively small current to receive an alarm, means for decreasing the said relatively high resistance in said circuit whereby said telephone-signal-receiving means is operated by the resulting increased current in said circuit, alarm-signal-transmitting means for sending a decreased current through said alarm-receiving means to cause its operation, and means at the substation and central office for holding conversation over said circuit.

54. A combined telephone and alarm system comprising a circuit extending from a substation to a central office, a source of current included in said circuit, a relatively high

40. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an electromagnet-controlling alarm-receiving apparatus permanently included in the said circuit and responsive only to interruptions of the current therein, an alarm-sending apparatus adapted to control the continuity of said circuit in a predetermined manner, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus normally included in said circuit and unaffected by the normal current therein but adapted to respond to give its signal when the telephone is in use.

41. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an electromagnetic alarm-receiving device included in said circuit and energized by the currents therein but responsive only to the interruption thereof, an alarm-sending apparatus normally maintaining the continuity of said circuit but adapted when operated to open and close it, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus located at the central office normally included in said circuit and adapted to respond to give its signal when said telephone is in use.

42. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an electromagnetic alarm-receiving device included in said circuit and energized by the currents therein but responsive only to the interruption thereof, an alarm-sending apparatus normally maintaining the continuity of said circuit but adapted when operated to open and close it, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus normally included in said circuit and unaffected by the normal current therein but adapted to respond to give its signal when the telephone is in use.

43. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an electromagnetic alarm-receiving device included in said circuit and energized by the currents therein but responsive only to the interruption thereof, an alarm-sending apparatus adapted to control the continuity of said circuit in a predetermined manner, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus located at the central office normally included in said circuit and adapted to respond to give its signal when said telephone is in use.

44. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an electromagnetic alarm-receiving device included in said circuit and energized by the currents therein but responsive only to the interruption thereof, an alarm-sending apparatus adapted to control the continuity of said circuit in a predetermined manner, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus normally included in said circuit and unaffected by the normal current therein but adapted to respond to give its signal when the telephone is in use.

45. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an alarm-receiving apparatus included in said circuit energized by the normal current therein and by the current therein when the telephone is in use but responsive only to the interruptions of current in said circuit, an alarm-sending apparatus normally maintaining the continuity of said circuit but adapted when operated to open and close it, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus located at the central office normally included in said circuit and adapted to respond to give its signal when said telephone is in use.

46. The combination in a telephone-exchange system of a normally closed circuit extending from the central office to a substation, a source of current in said circuit, an alarm-receiving apparatus included in said circuit energized by the normal current therein and by the current therein when the telephone is in use but responsive only to the interruptions of current in said circuit, an alarm-sending apparatus normally maintaining the continuity of said circuit but adapted when operated to open and close it, telephone apparatus associated with said circuit at the substation and adapted to be included in and to decrease the resistance of said circuit when the telephone is in use, and signal-receiving apparatus normally included in

resistance included in said circuit to cut down the current therein to a relatively small value, means operated only by an increase of said relatively small current to receive a telephone-signal, means operated by interruptions of current to receive an alarm, means for decreasing the said relatively high resistance in said circuit whereby said telephone-signal-receiving means is operated by the resulting increased current in said circuit, alarm-signal-transmitting means for interrupting the current supplied to said alarm-receiving means to cause its operation, and means at the substation and central office for holding conversation over said circuit.

55. A combined telephone and alarm system comprising a circuit extending from a substation to a central office, a source of current included in said circuit, a relatively high resistance branch at the substation included in said circuit to cut down the current therein to a relatively small value, means operated only by an increase of said relatively small current to receive a telephone-signal, means operated by a decrease of said relatively small current to receive an alarm, means for closing a low resistance branch around said relatively high resistance whereby said telephone-signal-receiving means is operated by the resulting increased current in said circuit, alarm-signal-transmitting means for sending a decreased current through said alarm-receiving means to cause its operation, and means at the substation and central office for holding conversation over said circuit.

56. A combined telephone and alarm system comprising a circuit extending from a substation to a central office, a source of current included in said circuit, a relatively high resistance branch at the substation included in said circuit to cut down the current therein to a relatively small value, means operated only by an increase of said relatively small current to receive a telephone-signal, means operated by interruptions of current to receive an alarm, means for closing a low-resistance branch around said relatively high resistance whereby said telephone-signal-receiving means is operated by the resulting increased current in said circuit, alarm-signal-transmitting means for interrupting the current supplied to said alarm-receiving means to cause its operation, and means at the substation and central office for holding conversation over said circuit.

In witness whereof I hereunto subscribe my name this 22d day of April, A. D. 1904.

HARRY G. WEBSTER.

Witnesses:
E. M. KLATCHER,
GEO. E. WALDO.

Corrections in Letters Patent No. 825,623.

It is hereby certified that in Letters Patent No. 825,623, granted July 10, 1906, upon the application of Harry G. Webster, of Chicago, Illinois, for an improvement in a "Combined Telephone and Alarm System," errors appear in the printed specification requiring correction, as follows: Page 3, line 84, the word "contacts" should read *contact;* page 6, line 65, the reference-letters "C' C'" should read *C C';* page 7, line 30, a comma should be inserted after the word "closing;" page 9, line 20, the word "or" after the reference-letter "*l'*" should be stricken out and inserted after the reference-letter "*l*" same line; page 9, line 87, the reference-letter "*j'*" following the word "spring," second occurrence, should read j^2; page 10, line 46, the reference-letter *C* should be inserted before "C^2;" page 11, line 97, reference-letter "*l*" should read reference-numeral *1;* page 12, line 121, reference-letter "*l*" should read reference-numeral 1^e; page 13, lines 16, 85, 88, and 90 the reference numerals "5^E, 1^E, 3^E, 5^E" should read 5^e, 1^e, 3^e, and 5^e, respectively; page 13, line 29, reference-numeral "5" should read 5^e; page 13, line 82, a comma should be inserted after the word "operates;" and page 14, line 87, reference-numerals "2 3" should read 2^n 3^n; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 13th day of November, A. D., 1906.

[SEAL.]

F. I. ALLEN,
Commissioner of Patents.

resistance included in said circuit to cut down the current therein to a relatively small value, means operated only by an increase of said relatively small current to receive a telephone-signal, means operated by interruptions of current to receive an alarm, means for decreasing the said relatively high resistance in said circuit whereby said telephone-signal-receiving means is operated by the resulting increased current in said circuit, alarm-signal-transmitting means for interrupting the current supplied to said alarm-receiving means to cause its operation, and means at the substation and central office for holding conversation over said circuit.

55. A combined telephone and alarm system comprising a circuit extending from a substation to a central office, a source of current included in said circuit, a relatively high resistance branch at the substation included in said circuit to cut down the current therein to a relatively small value, means operated only by an increase of said relatively small current to receive a telephone-signal, means operated by a decrease of said relatively small current to receive an alarm, means for closing a low resistance branch around said relatively high resistance whereby said telephone-signal-receiving means is operated by the resulting increased current in said circuit, alarm-signal-transmitting means for sending a decreased current through said alarm-receiving means to cause its operation, and means at the substation and central office for holding conversation over said circuit.

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