No. 833,817. PATENTED OCT. 23, 1906.

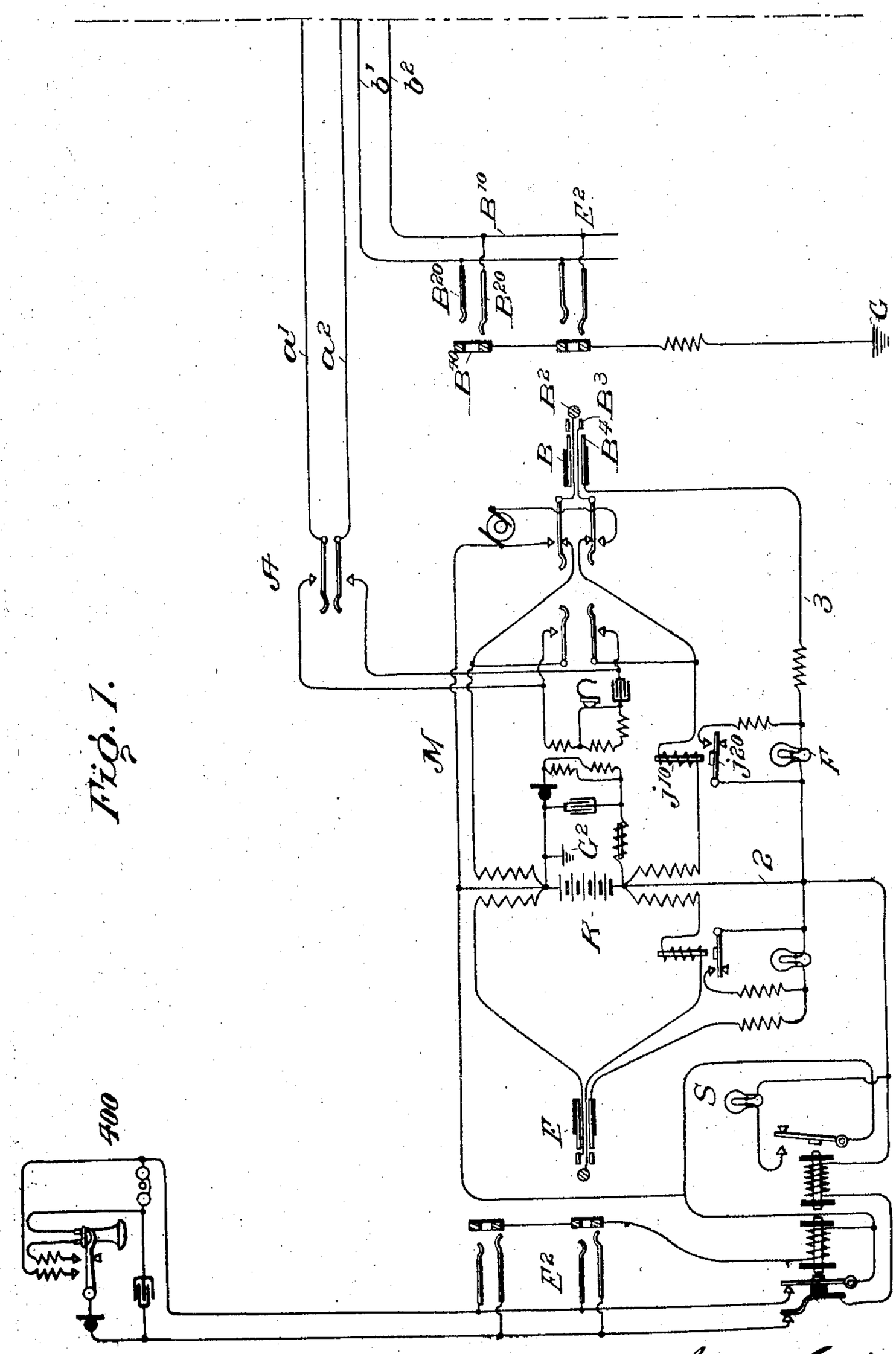
J. G. WRAY, H. T. GARDNER & W. G. KINTON.

TELEPHONE SWITCHING AND SIGNALING APPARATUS.

APPLICATION FILED MAR. 12, 1906.

2 SHEETS—SHEET 1.

FIG. 1.



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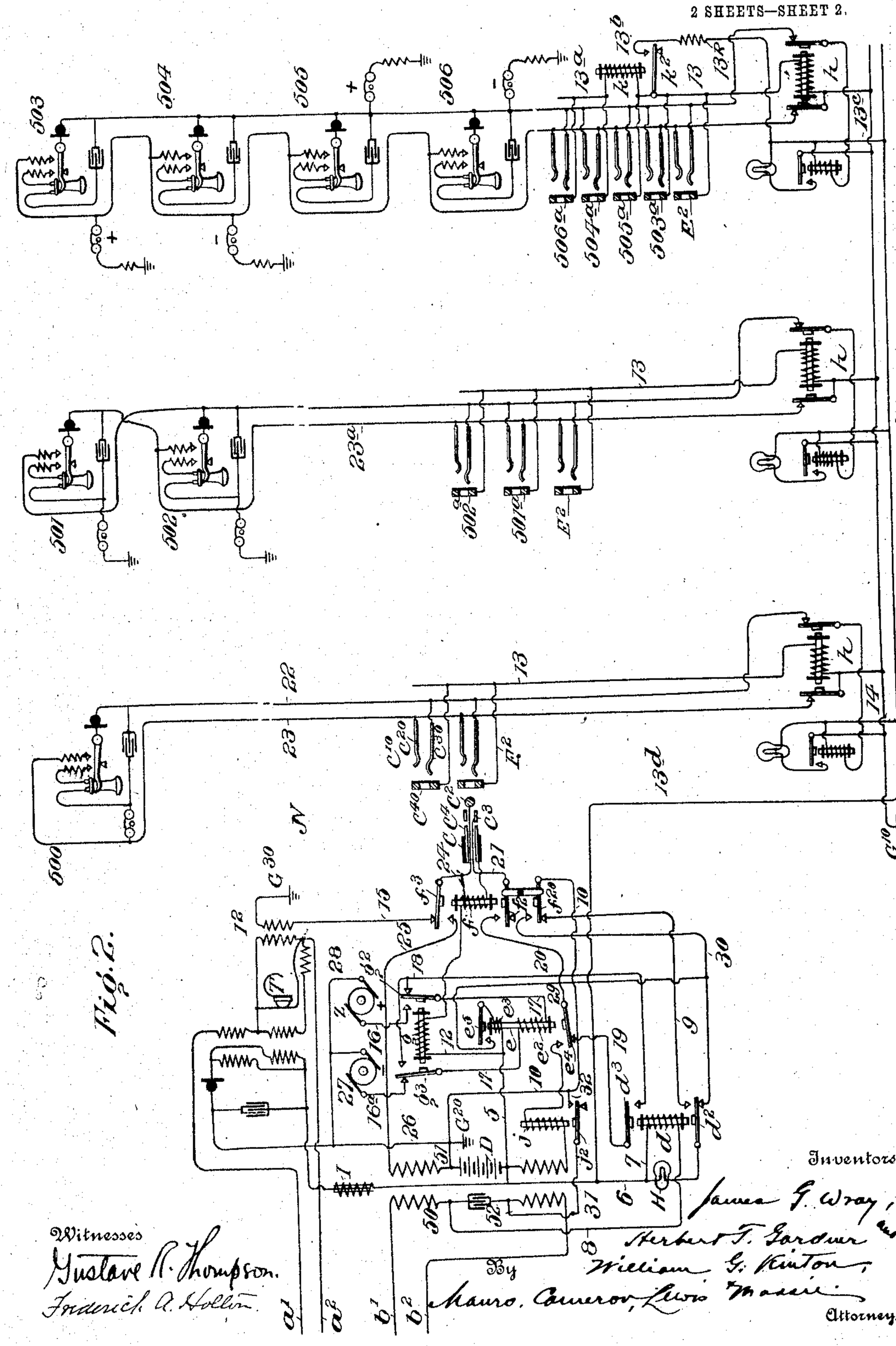

Fig. 2.

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TELEPHONE SWITCHING AND SIGNALING APPARATUS.

No. 833,817. Specification of Letters Patent. Patented Oct. 23, 1906.

Original application filed July 3, 1905, Serial No. 268,213. Divided and this application filed March 12, 1906. Serial No. 305,658.

To all whom it may concern:

Be it known that we, JAMES G. WRAY, residing at Chicago, HERBERT T. GARDNER, residing at Maywood, and WILLIAM G. KINTON, residing at Chicago, in the county of Cook, State of Illinois, have invented certain Improvements in Telephone Switching and Signaling Apparatus, of which the following is a specification.

The present invention relates to a telephone-exchange apparatus, and more particularly to automatic signaling means whereby the substations of a four-party line may be selectively signaled without, however, interfering with the proper signaling through the same arrangement on a selective two-party line or a single-party line.

In a prior application filed by us July 3, 1905, Serial No. 268,213, of which the present application is a division, we described a telephone-exchange apparatus in which the invention was expressed mainly in the arrangement of the signal-controlling devices in the cord-circuits, being especially adapted for use in connection with trunk-lines leading from one central station to another, although certain features of the invention were described as capable of use in connection with cord-circuits for connecting substations at the same central station.

In order that the present invention may be readily understood, we herewith describe so much of the apparatus and its mode of operation constituting the subject-matter of our former application above referred to as is necessary to a proper understanding of the present invention.

Briefly stated, the present invention consists in an arrangement whereby the substations of a four-party line may be selectively signaled without, however, interfering with the proper signaling through the same arrangement on a selective two-party line or on a single-party line. The selective signaling on the four-party line depends for its operation upon a relay located in the trunk-line cord-circuit which operates as a pole-changer to change the direction of a pulsating signaling-current, the said relay being prevented from operation by a suitable resistance in its local circuit when either of the two stations on one main circuit is connected by its special spring-jack with the switch-plug and ringing devices at the central station, but operating to change the direction of the current in said local circuit when either of the two other stations have their representative jacks plugged into. The substation call-signals on a four-party line are in earth branches, the signals of two of the substations being in branches to earth from one side of the line, while those of the other two substations are in branches to earth from the opposite side of the line, and the bells in the two branches on each side of the line are oppositely polarized, biased, or otherwise adjusted so as to operate in response to currents of opposite direction, respectively. By arranging a four-party line with multiple jacks, therefore, there being a jack corresponding to each station on the line, and by properly arranging the jack terminals any one of the stations may be signaled by merely placing the plug at the central office in the jack belonging to said station.

Figure 1 is a diagram of the circuits at the calling central station; and Fig. 2 is a diagram of the circuits at the called central station, Fig. 2 also showing the jacks for one, two, and four party lines, together with the circuit connections at the substations on said lines.

It is to be understood in tracing the circuits in connection with the following description that the conductors a' a^2 and b' b^2, Fig. 2, are continuations, respectively, of the conductors similarly characterized in Fig. 1, and, further, in describing the apparatus and its operation the successive acts of the central-station operators and the subscribers will be followed, beginning with the part performed by the operator at the calling subscriber's central station after receiving a call for connection with a substation at another central station.

Referring to the drawings, at substation 400, Fig. 1, the subscriber desires to be connected with the subscriber at substation 500, Fig. 2, for example. The subscriber at substation 400 takes down his receiver, thus causing the signal-lamp S to light in a manner well understood, the circuits being those ordinarily used in the central energy telephone system. The operator at the calling

subscriber's central station then inserts the plug E in the jack E^2, placing herself in communication with the calling subscriber and extinguishing the lamp S in the usual way. It may be assumed that the calling subscriber desires connection with a subscriber at another exchange, and upon ascertaining the desires of the subscriber the operator at the central station M of the calling-line, pressing the key A, places herself in communication, through the conductors a' and a^2, with the operator at the central station N of the called line and asks the operator at that station to assign her a trunk, no signal being necessary, since the connection is direct to the operator's set. As soon as the trunk has been assigned the operator at the central station M inserts the plug B in the jack B^{10}, which is assumed to belong to the trunk assigned, thus connecting the calling-substation, through the cord-circuit at central station M, with the trunk-line cord-circuit at the central station N through the conductors b' and b^2. This closes a circuit through a relay d in the cord-circuit at the central station N, which relay will be hereinafter termed the "primary signal-circuit-controlling relay" and also closes circuits through the supervisory lamps at both central stations.

The circuit through the supervisory lamp F at the call-originating central station M is the usual circuit, starting from the battery K and passing through conductors 2 and 3 to the sleeve B^4 of the plug B, the frame B^{40} of the jack B^{10} to ground G and back to ground G^2, thus completing the circuit through the lamp F and lighting the same. The current for the circuit through the relay 4 at the central station N is supplied from the battery D at said station and passes from said battery through conductors 6 and 7, coil of relay d, conductor 8, and winding 50 of induction-coil I in circuit with the conductor b', said conductor b', jack-spring B^{20}, tip-terminal B^3 of the plug B, and ground G^2, completing the circuit through ground G^{20} at the called central station N, which is connected with the other pole of the battery D. This energizes the relay d and causes the armatures d^2 and d^3 thereof to be attracted.

The supervisory lamp H, Fig. 2, is included in a circuit which may be traced as follows: battery D, conductor 6, armature d^2, conductor 9, armature f^{20} of relay f, and conductor 10, which is connected with the opposite terminal of the battery D.

So far as relates to the operator at the calling central station, nothing further is to be done except to ascertain that the proper connection has been made and answered, the fact that the signal at the called substation is in operation being imparted to her by an audible signal, as will be hereinafter described, while the fact that the called subscriber has answered is imparted by the cessation of the audible signal and by the extinguishing of the supervisory lamp F. Furthermore, since the signaling-current is controlled by the insertion of the plug at the called central station N, there being no circuit for said current until the plug is fully inserted, the operators at the central stations cannot under any circumstances receive shocks, as might be the case if the signaling-current were under the control of one of the operators only. Moreover, the relay d controls a switch in the signaling-circuit, said switch being closed when the said relay is energized, so that it is impossible for a signal to be sent out over the called line until the operator at the calling central station has made connection with the trunk-line. If, therefore, she has taken the wrong trunk by mistake, the subscriber will not be accidentally called.

Assuming that the operator at the central station N has placed the plug C in the jack C^{10}, which belongs to station 500, and that the operator at the calling-station M has inserted the plug in the jack, producing the condition above described, and presuming, further, that the bell at substation 500 is arranged to respond to plus current from the generator, the circuits controlling the signal at 500 may be traced as follows: In the first place, the insertion of the plug C in the jack C^{10} closes a circuit through the relay f from the battery D through the conductor 5, conductor 12, relay g, (the function and operation of which will be hereinafter described,) coil of relay f, sleeve C^4, frame C^{20}, conductor 13, cut-off relay h, conductor 14, and grounds G^{10} and G^{20} to the other terminal of the battery D. This energizes the relay f, attracting the armatures f^2 and f^{10}, which are shown as being connected together, and the armature f^3, which cuts out the ordinary busy-test circuit consisting of the conductor 15, induction-coil 12, the operator's receiver T, and ground G^{30}. The relays g and f both having been energized, the signaling-circuit is completed and may be traced as follows: Starting from the positive terminal of the generator Z the current passes through conductor 16 to armature g^2 and conductor 17, (which includes the principal winding e^2 of the double-coil relay e,) the armature g^3, its forward contact-point, conductor 18, armature d^3, conductor 19, armature e^4, conductor 20, armature f^2, conductor 21, ring-terminal C^3 of the switch-plug, long spring C^{30}, conductor 22, through the condenser and bell at station 500, conductor 23, spring C^{20}, tip-terminal C^2, conductor 24, armature f^3, conductor 25, and the induction-coil windings 51 therein to conductor 26, conductor 27, and conductor 28 to the other brush of the generator, thus completing the generator-circuit and causing the bell to ring. At the same time the attraction of the armature f^{20}

breaks the circuit containing the supervisory lamp H, so that the said supervisory lamp is extinguished.

As hereinbefore stated one of the induction-coil windings 51 is included in the generator-circuit, so that the induced current in its associated winding 50 produces an audible signal in the receivers at the calling subscriber's central station and substation, indicating that the signal at the called substation is ringing, and thus obviating the necessity on the part of the operator at the calling central station M of requesting another ring if the called subscriber does not promptly answer. The ringing will continue until the called subscriber takes down his receiver to answer, and the taking down of the receiver short-circuits the condenser and bell at his station and by cutting out the resistance thereof admits of sufficient increase of generator-current over the circuit to energize the coil e^2 of the relay e to such an extent that the armature e^4 will be attracted, breaking the generator-circuit at that point and stopping the signal. At the same time the armature e^5 is attracted, closing a circuit through the coil e^3, the energizing effect of which is sufficient to maintain the armatures attracted, although insufficient to attract them in the first place. This circuit passes from the battery D through the conductor 5, coil e^3, armature e^5, conductor 29, conductor 30, armature f^{20}, and conductor 10 back to the other terminal of battery D. The closing of the circuit through the armature e^4 also completes the line or talking circuit through the induction-coil and the telephone at the called substation 500, the said circuit including the relay j, so as to attract the armature j^2 thereof, thereby closing a circuit which controls the operation of the supervisory lamp F at the calling subscriber's central station M. The circuit thus closed is from the battery K to ring-terminal B^3 of plug B and line conductor b^2 through winding 52 of the induction-coil at the called central station N through conductor 31, armature j^2, its forward contact, conductor 32, and conductor 10 to ground G^{20} and back to the battery K through ground G^2. This circuit includes the relay j^{10} at the central station M of the calling-line, the armature j^{20} of which when attracted closes a shunt around the lamp F, extinguishing the same, and thus withdrawing the signal and indicating that the wanted subscriber has responded to the call. Thus when the called subscriber has finished conversation and has replaced his receiver, breaking the conductive connection around the condenser, consequently opening the main metallic circuit, the relay j at the central station N will become deënergized, breaking the circuit thus traced and causing the armature j^{20} at the call-originating central station M to drop back and open the shunt around the lamp F, so that the lamp F lights. Since, however, the supervisory lamp H is controlled, as previously stated, through the operation of the plug at the said central station M, said lamp will not be lighted until the operator there has removed her switch-plug B, so that the supervision of the line is wholly under the control of one operator.

The removal of the plug B from the switch-socket B^{10} at the central station M pursuant to the appearance of the signal F causes the relay d to become deënergized, thus establishing a circuit through the lamp H from battery D through conductor 6, armature d^2 and its back contact, conductor 30, armature f^{20}, (still attracted,) and conductor 10 to the other terminal of the battery D. The lighting of this lamp notifies the operator at the central station N that conversation is finished, and she then removes the plug C from the jack C^{10}, restoring all the parts to their normal condition, the circuit through the lamp H being broken by the armature f^{20} of relay f.

In signaling a two-party line the operation is substantially the same as above described, except that the bells at the two substations, both of which are arranged to respond to plus current from the generator, are branched to ground from opposite sides of the line, and the line is provided with two jacks, one for each station, the long spring of one jack being connected to one side of the line and the long spring of the other jack being connected to the opposite side of the line. If, for example, it is desired to call station-number "501" the plug is inserted in jack 501^a, the ring-terminal C^3 thus being connected with the line conductor 23^a. The circuit from the generator Z is then as follows: conductor 16, armature g^2, conductor 17, armature g^3, conductor 18, armature d^3, conductor 19, armature e^4, conductor 20, armature f^2, conductor 21, ring C^3, long spring of jack 501^a, line conductor 23^a, and the condenser and bell at station 501 to the ground, and thence back from the ground G^{20} through the conductors 26 and 27 to the other brush of the generator Z. In this case, as in the one-party line, the generator-current is strengthened by short-circuiting the condenser when the receiver is taken down, thus giving the necessary increase in current to attract the armature e^4 and stop the signal.

What has been described above relating to automatic signal-controlling devices is not herein specifically claimed, as the same forms the subject-matter of our application Serial No. 268,213, above referred to.

Reference will now be had to the means for signaling substations of a four-party line, (illustrated in Fig. 2,) said means constituting the subject-matter of the invention of the present specification and claims.

In a four-party line two of the substations are provided with bells which are arranged to respond to minus currents from the generator and the other two substations with bells which are arranged to respond to plus currents, one plus bell and one minus bell being each in an independent earth branch from each side of the line, the operation of the two bells of the same character, but connected with different line conductors, being controlled by the arrangement of the jacks, as described in connection with the two-party line. The two bells on this circuit which are arranged to operate in response to plus currents from the generator are operated exactly as in the two-party line above described, the circuits being the same. In order to separate the minus bells, however, it is necessary to change the direction of the current coming from the generator at the central office, and this is accomplished through the agency of an electromagnetic pole-changing switch, herein shown as embodied in the relay g in connection with a relay k, included in series with the cut-off relay h in the jack-frame of the plug-sleeve conductor-circuit of the two spring-jacks representing the two stations having the minus bells. The relay g is so wound that when the additional resistance above referred to is in series therewith it will not become sufficiently energized to attract the armatures g^2 and g^3, so that the said armatures will remain in the position shown in Fig. 2, thus causing the minus side of the generator to be connected in circuit through the conductor 16^a, armature g^3, conductor 17, armature g^2, conductor 18, &c., the remainder of the circuit being the same as previously traced in connection with the plus side of the generator.

Referring to the illustration of the four-party line in Fig. 2, the bells at the substations 503 and 505 are arranged to operate in response to plus current from the generator, the frames of the jacks 503^a and 505^a being directly connected to the cut-off-relay conductor 13, as in the one and two party lines. The frames of the jacks 504^a and 506^a, corresponding to the stations 504 and 506, the bells of which are adapted to operate in response to current pulsations of minus sign or direction, are connected with a conductor 13^a, which passes through the coils of a special relay k to the conductor 13, relay h, conductor 14, to the ground, as before. In this case, therefore, the coils of relay k are included in circuit with the coils of the relays f and g, the latter being so arranged or adjusted as not to respond to current diminished by the resistance of the relay k, while the former is so arranged or adjusted as to respond whether this resistance is in the circuit or not. Assuming now that the operator at the central station M has placed the plug C in the jack 506^a, which belongs to station 506, with a minus bell on the four-party line and that the operator at the calling-station M has inserted the plug in the jack assigned to her, the signal is given at substation 506, as will now be described. Under the conditions named above relay d is holding its armatures d^2 d^3 against their forward contacts. Relay f likewise is holding its armatures f^2, f^{20}, and f^3 against their forward contacts, whereas relay g does not attract its armatures g^2 g^3 because of the resistance of the relay k, included in series with the cut-off relay h in the jack-frame of the plug-sleeve-conductor circuit of the two spring-jacks 504^a 506^a, representing the two stations having the minus bells. The circuits controlling the signal may be traced as follows: Starting from the negative terminal of the generator Z, the current passes through conductor 16^a to the armature g^3, through conductor 17, including the principal winding e^2 of the double-coil relay e, to armature g^2, its forward contact, conductor 18, armature d^3, conductor 19, armature e^4, conductor 20, armature f^3, conductor 21, ring-terminal C^3 of the switch-plug, long spring of spring-jack 506^a, and thence along the line-wire and through minus bell and resistance at station 506 to ground, returning to generator Z through ground G^{20}, conductors 26 and 27. When the called subscriber at station 506 takes down the receiver, the bell is short-circuited, and the generator-current now returns by metallic circuit, one brush of the generator being connected with the ring C^3 of the plug C, while the other brush is connected with the tip C^4. The resulting reduced resistance in the generator-circuit causes an increased flow of current through relay e^2, thereby attracting armature e^4 and discontinuing the signal at station 506.

What has here been stated respecting signaling by one minus bell on one side of the line equally applies to the minus bell on the opposite side of the line, it only being necessary to insert the plug C into the spring-jack corresponding to the station having the other minus bell. The operation of signaling with the plus bells is similar to that described in connection with one and two party lines and needs no further explanation.

We may when desired provide means for maintaining an additional flow of current through the coils of the cut-off relay h when the circuit thereof includes the resistance of the special relay k, and for this purpose the armature k^2 of the relay k is arranged to close a circuit through the conductor 13^b, containing the resistance 13 R, conductors 13^c, 13^d, and 6, the current then passing from the battery D over the conductors 6 13^d, &c., and the armature k^2 to the conductor 13, relay h, and conductor 14 to the ground G^{10} and ground G^{20} to the opposite terminal of the battery. Under these circumstances the cut-

off relay *h* receives current through the plug-circuit and special relay *k* and also by way of conductor 13[b].

It will be noted that the bells in connection with four-party lines are connected directly from the line to the ground through a resistance instead of being connected through condensers. The additional generator-current, which is necessary to energize the relay e^2 upon the removal of the receiver, is caused by including the two sides of the line in the generator-circuit when the receiver has been removed, one brush of the generator being connected with the ring of the plug, while the other brush is connected with the tip.

The connections controlled by the armatures g^2 and g^3 are such that the same terminal of the coil e^2 is connected to the same brush of the generator, whether the current is flowing over the signal-circuit in one direction or the other. Consequently in any case the flow of current through the coil e^2 is in the same direction as the flow of current through the coil e^3, so that the magnetization caused by the flow of current through one coil will harmonize with that caused by the flow of current through the other.

It is to be understood, of course, that the drawing is a conventional illustration of the system, the relays being shown where the control of two or more circuits is involved as provided with two or more armatures. In practice each relay may be and usually is provided with a single armature adapted to actuate such contacts as may be necessary for the control of the several circuits.

In order to avoid any possibility of misunderstanding, it may be stated that the lowermost jack E^2 of each set of jacks shown in the drawings is the answering-jack for the line to which it belongs, the operation of said answering-jacks not being referred to except in connection with the calling-substation 400, Fig. 1, since no novelty is involved, the jacks being shown simply to complete the illustration of the system in general.

What we claim is—

1. In a telephone signaling system for selectively signaling the substations on four-party lines, a plus bell and a minus bell in separate earth branches from each side of the line; a call-current generator; means for connecting one terminal of said generator to either side of the line, and the other terminal thereof to earth; an electromagnetic pole-changing switch to control said means; circuits to control said pole-changing switch corresponding respectively to the substations on the line; and means for introducing resistance in two of said circuits to reduce the current and prevent the operation of said pole-changing switch.

2. In a telephone signaling system for selectively signaling substations on four-party lines, a plus bell and a minus bell in separate earth branches from each side of the line; a call-current generator; an electromagnetic pole-changing switch for connecting one terminal of said generator to either side of the line, and the other terminal thereof to earth; circuits to control said pole-changing switch, one for each substation on the line; and one or more relays in two of said circuits, the resistance of which is sufficient to pervent the operation of said switch.

3. In a telephone signaling system for selectively signaling substations on four-party lines, a plus bell and a minus bell in separate earth branches from each side of the line; a call-current generator; an electromagnetic pole-changing switch for connecting one terminal of said generator to either side of the line, and the other terminal thereof to earth; circuits to control said pole-changing switch, one for each substation on the line; one or more relays in two of said circuits, the resistance of which is sufficient to prevent the operation of said switch; means for closing circuits through said switch, said circuits corresponding respectively to the several substations and also passing through the coils of the cut-off relay; a circuit-controlling armature operated by said relay; and a separate circuit controlled by said relay and passing through the winding of the cut-off relay.

4. In a selective signaling system, a call-current generator; an electromagnetic pole-changing switch therefor; a generator-circuit in which the direction of flow of current from said generator is determined by said pole-changing switch; a circuit-breaker for said circuit; a relay in the generator-circuit controlling said circuit-breaker; and circuit-controllers operated by said pole-changing switch for connecting the same terminals of the said relay to the positive and negative terminals of the generator respectively when the pole-changing switch is in either position.

In testimony whereof we have signed our names to this specification, in the presence of two subscribing witnesses, this 8th day of March, 1906.

JAMES G. WRAY.
HERBERT T. GARDNER.
WILLIAM G. KINTON.

Witnesses:
LEWIS S. EATON,
WALTER D. HERRICK.