

No. 893,414.

PATENTED JULY 14, 1908.

J. G. WRAY, H. T. GARDNER & W. G. KINTON.
TELEPHONE SWITCHING AND SIGNALING APPARATUS.

APPLICATION FILED JULY 3, 1905.

2 SHEETS-SHEET 1.

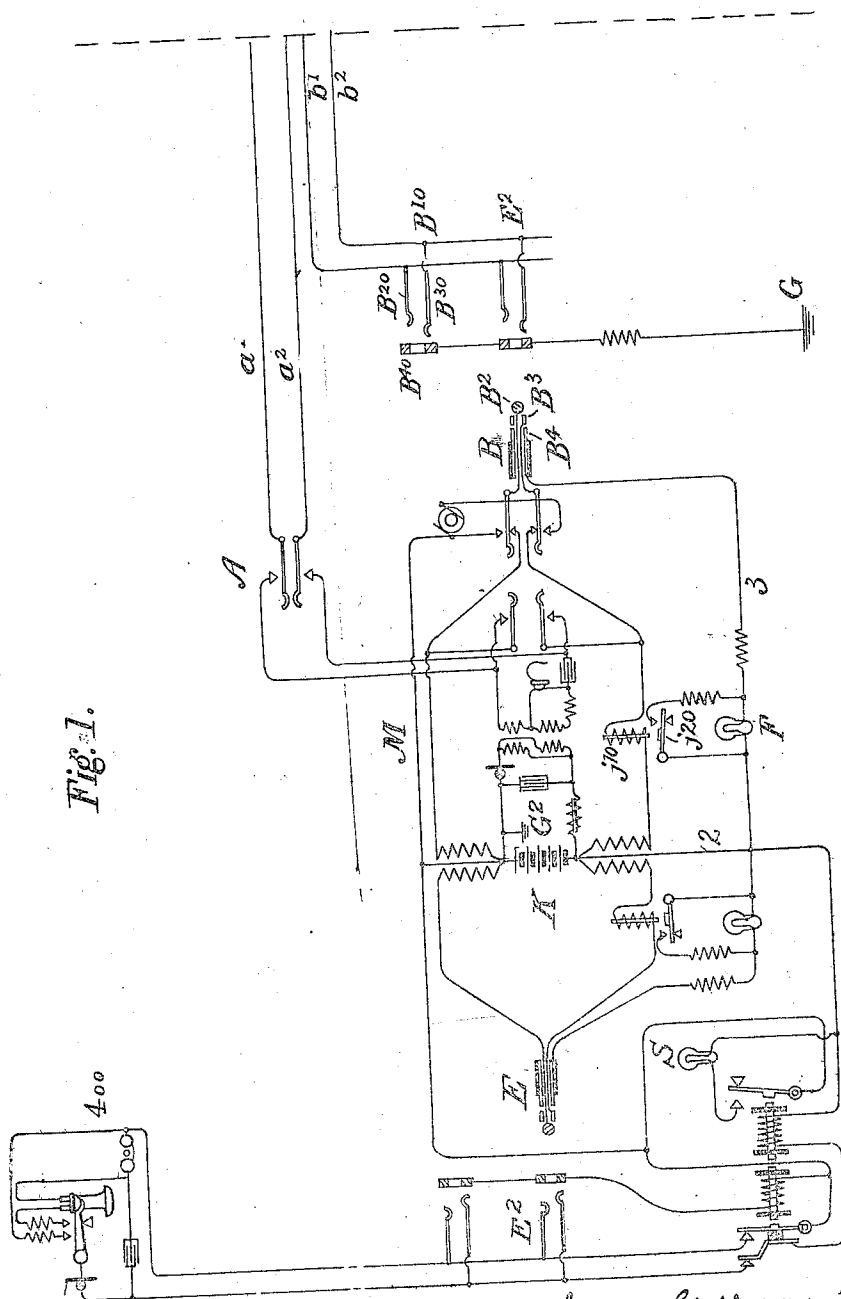


Fig. 1.

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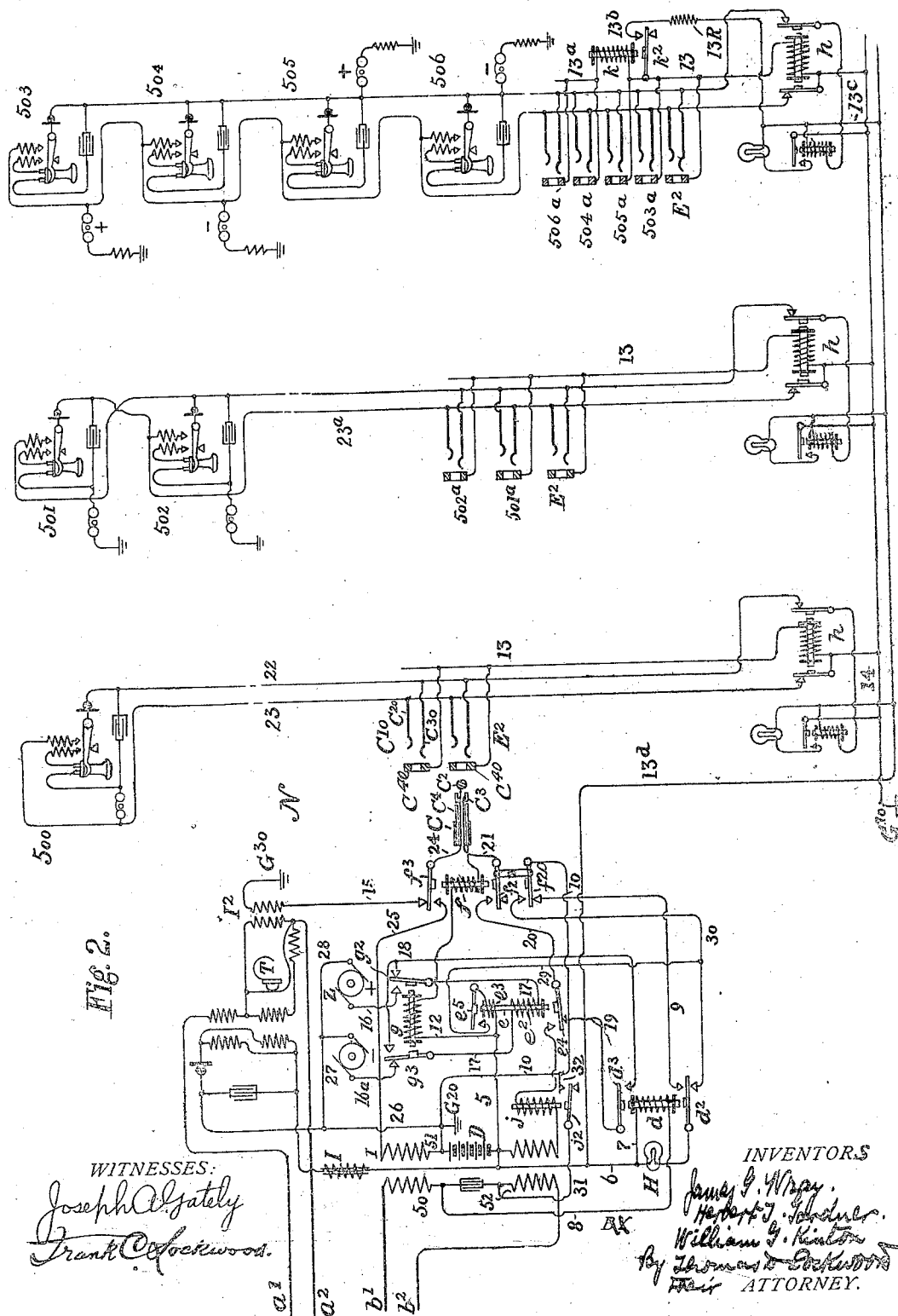
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2 SHEETS—SHEET 2.



UNITED STATES PATENT OFFICE.

JAMES G. WRAY, OF CHICAGO, HERBERT T. GARDNER, OF MAYWOOD, AND WILLIAM G. KINTON, OF CHICAGO, ILLINOIS, ASSIGNORS TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

TELEPHONE SWITCHING AND SIGNALING APPARATUS.

No. 893,414.

Specification of Letters Patent.

Patented July 14, 1908.

Application filed July 3, 1905. Serial No. 268,213.

To all whom it may concern:

Be it known that we, JAMES G. WRAY, HERBERT T. GARDNER, and WILLIAM G. KINTON, residing at Chicago, Maywood, and Chicago, respectively, in the county of Cook and 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 is embodied 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 may be employed in connection with a cord circuit for connecting substations at the same central station. The main advantages of the invention, however, are found in connection with trunk lines for connecting a substation at one central station with a substation at another central station; and the invention will be described as embodied in a system of this kind, with the understanding that it is not necessarily limited in all its features to this specific use.

In an apparatus embodying the invention, the ringing key at the central station is dispensed with, and in the case of a trunk line connection between a central station connected with a calling substation and another central station connected with a called substation, the ringing key is eliminated at both central stations, and the operator at the central station to which the called substation is connected, is incidentally protected from accidental shock through the plug, due to the generator current at the central station to which the calling substation is connected when a ringing key is employed at that central station, and operated prematurely. The time of the operators at both central stations is also economized; the operator at the calling central station having merely to place her cord-circuit plug in the jack of the trunk assigned to her, while the operator at the called central station has merely to place the proper plug in the jack of the called substation, the signaling and the stopping of the signal being dependent, respectively, upon the placing of the plug in the jack at the cen-

tral station with which the wanted substation line is connected, and upon the removal of the receiver at the called substation. The supervisory signals, moreover, are so arranged that the replacement of the receiver at the called substation operates the supervisory signal at the central station of the calling substation, while the supervisory signal at the called central station operates in response to the removal of the plug at the calling central station, so that the supervision is entirely under the control of the operator at the central station where the call has originated, thus avoiding any chance of confusion or premature cutting out of the connected subscribers. The arrangement is such, moreover, that no signal will be given at the called substation until the operators at both of the connected central stations have completed their connections to the trunk, so that, in case of error or misunderstanding on the part of the calling operator in the assignment of the trunk, it is impossible to signal a called substation, as might be the case if the signal were given from a ringing key at the central station to which the wanted substation is connected. During the operation of the signal at the substation called, moreover, a circuit is closed, which causes an induced current to be sent back over the line, giving audible notice both at the calling central station and at the calling substation that the signal is in operation.

A further feature of the invention in connection with the automatic signaling 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 on the same line 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.

The subject-matter herein disclosed relating to a telephone signaling system for selectively signaling substations on four-party lines, involving the arrangement of jack springs and resistances to effect or prevent the operation of the relay, constitutes the subject-matter of our co-pending application Serial No. 305,658, filed Feb. 21, 1906, and is not herein specifically claimed.

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.

The salient features of the invention are completely illustrated in Fig. 2; but certain of the circuits, mainly the circuits controlling the supervisory signals, extend through both central stations, and it is to be understood, therefore, in tracing such circuits that the conductors indicated by the reference characters a^1 and a^2 in Fig. 2 are continuations of the conductors designated by the same reference characters in Fig. 1, the same being true in both figures of the conductors designated by the characters b^1 and b^2 .

In describing the invention, the successive operations performed by the calling subscriber, the calling subscriber's central station, the operator at the called subscriber's central station, and the called subscriber himself, will be followed, and the results of each operation traced out with reference to the drawings, the operations being first described in connection with the one and two party lines, since the operation of a four-party line involves merely the function of one relay at the called subscriber's exchange, the operation of which will be more easily understood after the other features of the invention have been described. Assuming, therefore, that the subscriber at substation

400, Fig. 1, desires to be connected with the subscriber at substation 500, Fig. 2, which is indicated as the only station on the line which leads to it, the subscriber at substation 400 takes down his receiver, thus causing the signal lamp S to light in the usual way, there being no need of tracing the circuits in this connection, since they are the well known circuits 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. With the understanding that the invention is herein shown as embodied in a trunk line circuit, 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^1 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 into 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^1 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 d 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^1 , said conductor b^1 , 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.

5 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 now 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 conditions above described, the signal is given at substation 500, as will now be described.

Omitting, for the present, the means for selectively signaling the substations on two and four party lines, and assuming that the bell at substation 500 is arranged to respond to plus current from the generator, the circuits controlling the signal 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^{30} , 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^{20} which are shown as being connected together, and the armature f^3 which detaches the ordinary busy test circuit consisting of the conductor 15, induction coil I^2 , 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: Start-

ing 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) to 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 M, through conductor 31, arma-

ture 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 round the condenser, consequently opening the main metallic circuit, the relay j at the central station N will become deenergized, 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 deenergized, 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^3 , 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.

It is to be noted that, in the two and four party lines, the signaling current does not pass through the induction coil I, but a current is induced by the ringing current, in the other side of the line which passes through the tip terminal of the switch plug, and the conductors 24 and 25 through winding 51 of the said induction coil to ground, so that the signal back is received by the calling subscriber and the operator at the calling central station, as in the case of the one party line.

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 electro-magnetic pole changing switch, herein shown as embodied in the relay g in connection with a resistance medium 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 cutoff 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.

It is desirable, though not essential, to provide means for maintaining an additional flow of current through the coils of the cutoff 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^a, conductors 13^c, 13^d, and 6, the current then passing from the battery D over the conductors 6, 13^d, Ec., and the armature *k*² to the conductor 13, relay *h* and conductor 14 to the ground G¹⁰ and ground G²⁰ to the opposite terminal of the battery. Under these conditions, the cutoff relay *h* receives current through the plug circuit and special relay *K*, and also by way of conductor 13^b.

The bells, as shown in connection with the four-party line in Fig 2, are connected directly from the line to the ground through a resistance, instead of being connected through the condensers, as shown in connection with the other lines. In this case, 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 E² of each set of jacks shown in the drawing 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 trunk lines, a signaling circuit; a relay having an armature included in said circuit; a circuit for said relay including the trunk lines; means at the call-originating central station for operating said relay; a second circuit closer to close said circuit at another point; means located at the central station of the called substation for operating said second circuit closer; a circuit breaker for said circuit; and means located at the called substation for causing the operation of said circuit breaker, substantially as described.

2. In a telephone signaling system, a generator circuit including the signal at the called substation; a circuit closing relay included in a trunk line and controlled by the operator at the call-originating central station, said relay having an armature to close said generator circuit at one point; a circuit closing relay controlled by the operator at the central station of the called substation for closing said generator circuit at another point; and a circuit-breaking relay controlled by the receiver hook at the called substation, whereby the generator circuit is broken when the receiver is taken down.

3. In a telephone signaling system, a generator circuit; a plug and jack at the central station to close said generator circuit at one point; a relay controlled by said plug and jack to close said generator circuit at another point; a relay included in a trunk line and controlled by the plug and jack at another central station, said relay having an armature to close said generator circuit at a third point; a relay in circuit with said generator; a resistance in said circuit sufficient to prevent the operation of said relay; means located at the called subscriber's station for short circuiting said resistance to permit the operation of said relay; and a supplementary or retaining coil on said relay in a circuit closed by the armature of said relay, substantially as described.

4. In a telephone signaling system for trunk lines; a calling central station; a called central station; a trunk line connect-

ing said stations; a called substation; a signaling circuit connecting said called central station and substation; a relay in said trunk line, provided with an armature in said signaling circuit; a supervisory signal circuit having a transposed section; a plurality of armatures in said signal circuit having front and back contacts for controlling display of the signal; relays for operating the said armatures; and means at the two stations for controlling said relays.

In testimony whereof, we have signed our names to this specification in the presence of two subscribing witnesses, this 28th day of June, 1905.

JAMES G. WRAY.
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WILLIAM G. KINTON.

Witnesses:

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