

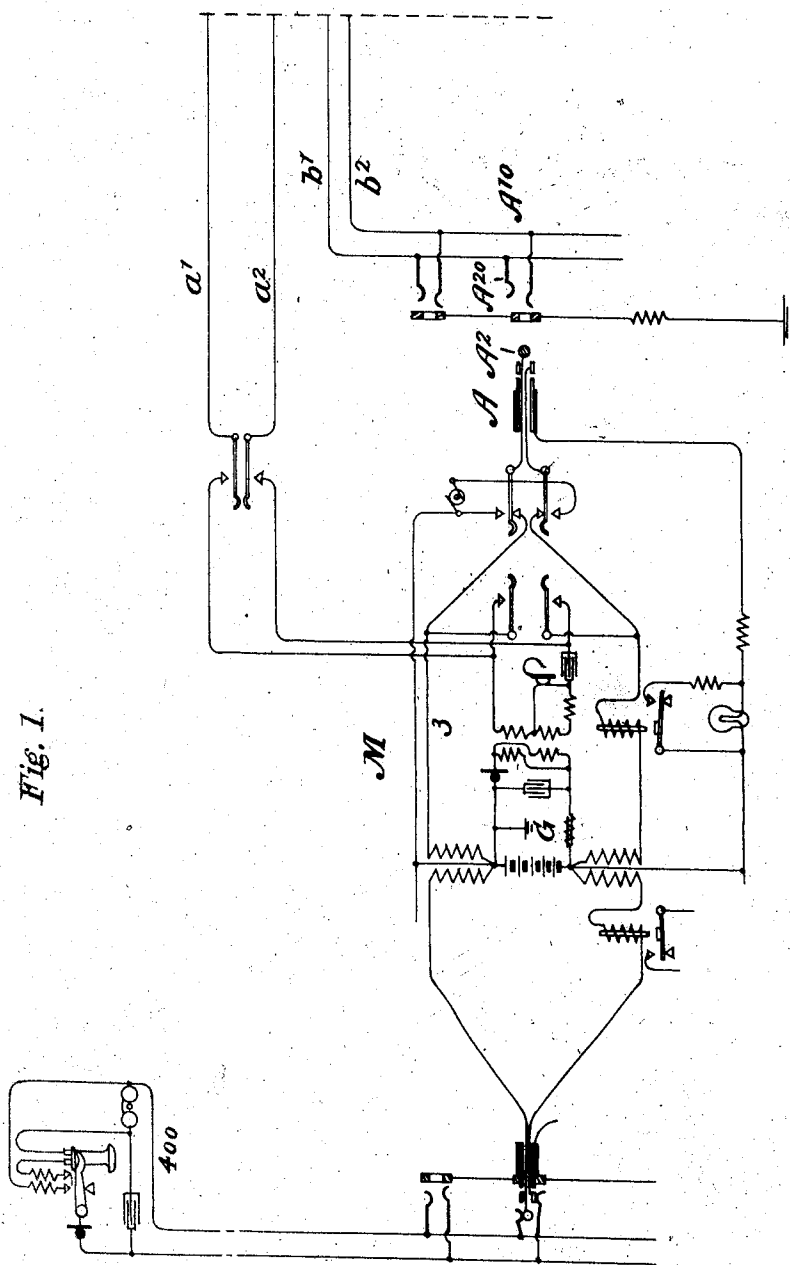
No. 833,816.

PATENTED OCT. 23, 1906.

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

APPLICATION FILED JULY 3, 1905.

3 SHEETS—SHEET 1.



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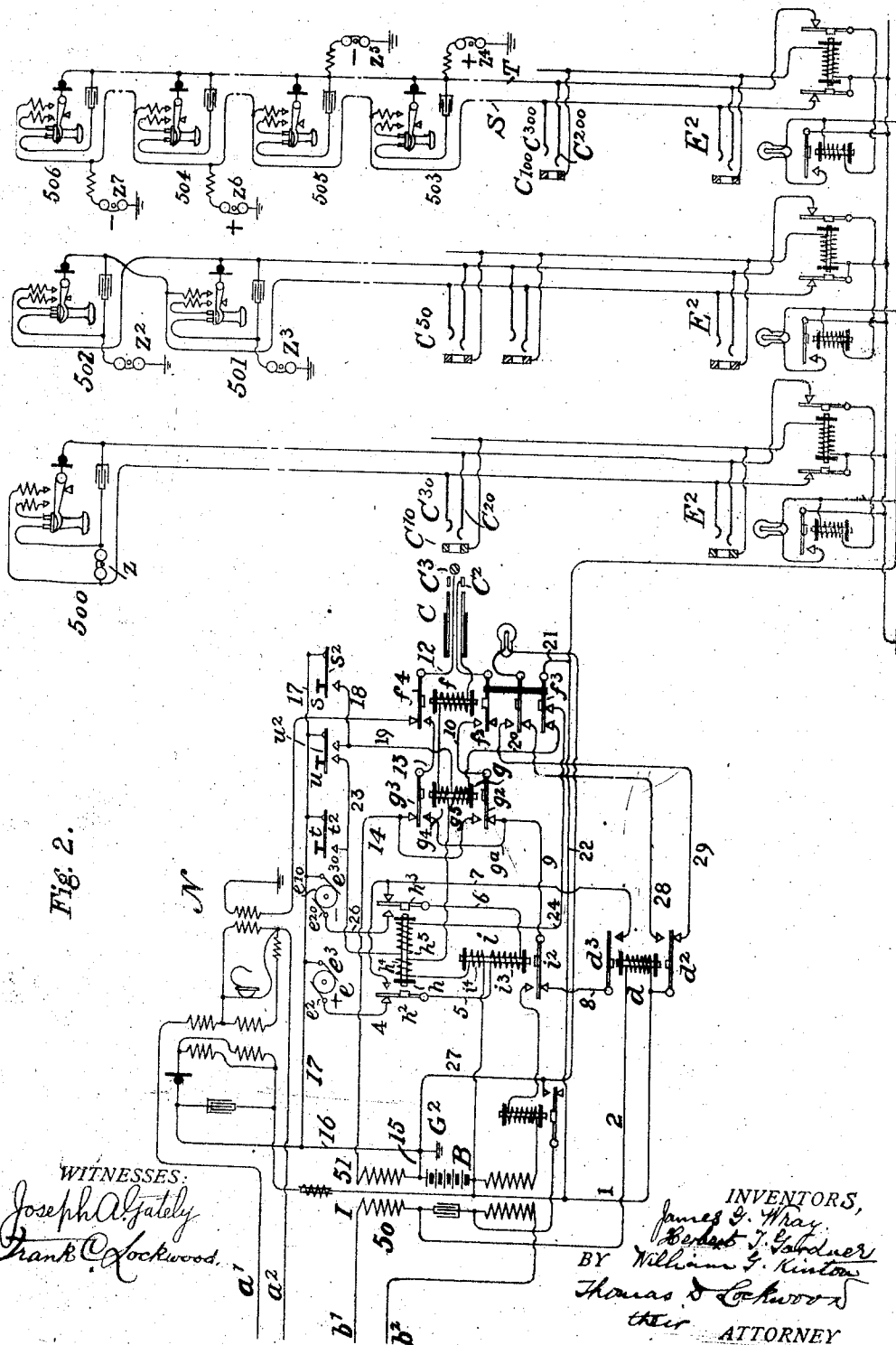


Fig. 2.

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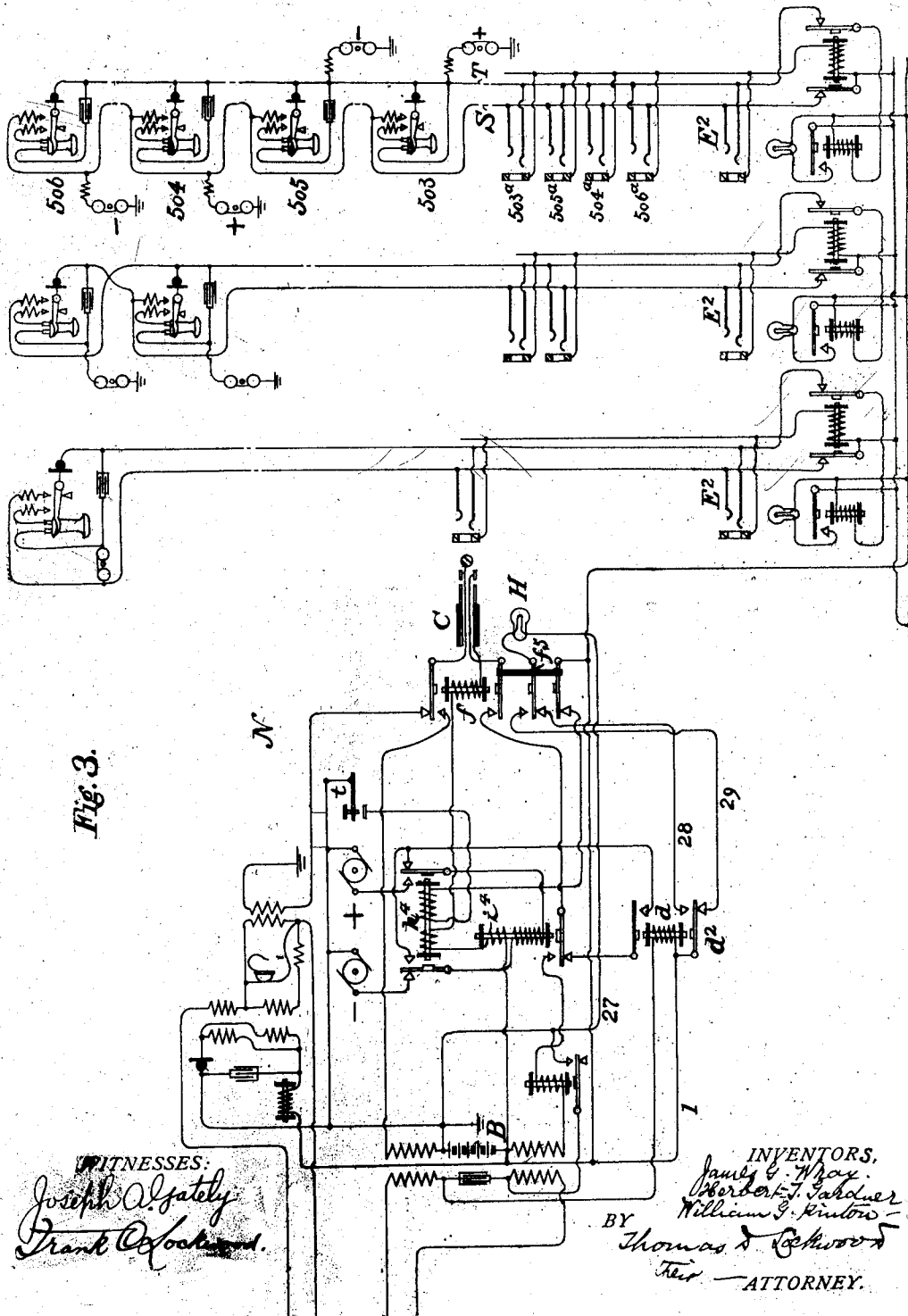


Fig. 3.

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TELEPHONE-CIRCUIT SIGNALING APPARATUS.

No. 833,816.

Specification of Letters Patent.

Patented Oct. 23, 1906.

Application filed July 3, 1905. Serial No. 268,215.

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 and State of Illinois, have invented certain Improvements in Telephone-Circuit Signaling Apparatus, of which the following is a specification.

The present invention relates to a telephone-exchange system, and is mainly embodied in novel means for selectively signaling four-party lines, the arrangement being such that one and two party lines can be properly signaled by the same apparatus, there being no ringing-key employed in any case.

The invention is shown as embodied in a trunk-line system in which a trunk-line cord-circuit is employed in signaling a subscriber who has been called for by another central office, the system being such that the use of a ringing-key is obviated, the insertion of the plug causing the signal to operate, while the operator at the central office is protected from accidental shock, since the current from the ringing-generator cannot enter the plug until the latter has been fully inserted in the jack. The arrangement is such, furthermore, that it is impossible to signal a wanted subscriber unless the connection has been made, so that false or premature signals cannot be given, it being impossible, for example, to signal a subscriber if a mistake has been made in the selection of the trunk connection. In the case of a four-party line the control of the signals at the several substations depends upon the operation of three keys, which may be termed "master-keys," since each key may be associated with, and thereby rendered capable of controlling, the operation of all the trunk cord-circuits under the control of the operator at the called central station. A single-party line may be signaled without the operation of the keys, and one of the substations on a four-party line may also be called without the operation of a key, the signals at the other three stations on the same line being controlled by the three keys mentioned. A two-party line can be controlled by the use of a single master-key,

if desired, or the system may be employed in connection with two or four party lines having multiple jacks corresponding to the substations on the line, in which case no manipulation of the keys is necessary, except in connection with the stations on a four-party line, in which case one master-key only is required. The four-party lines are provided in the usual way with two signals in circuits branched to ground from one side of the line and adapted to respond, respectively, to currents flowing in opposite directions and two signals branched from the opposite side of the line also having this characteristic difference.

In accordance with the invention the side of the line to which the generator is connected and the direction in which the current flows from the generator are selected by the action of relays, the operation of which is influenced by the master-keys above mentioned, the arrangement being such that the key used must be manipulated prior to the insertion of the plug in the jack in order to insure the giving of the proper signal.

Figure 1 is a diagram of the circuits at a calling central office—that is to say, a central office where the calling-subscriber's line is connected. Fig. 2 is a diagram of circuits at the called central office—that is to say, a central office connected by a trunk-line with the calling central office, Fig. 2 also showing diagrams of one, two, and four party lines to which connection can be made; and Fig. 3 is a diagram similar to Fig. 2, but showing a modification.

The salient features of the invention are mainly illustrated in Figs. 2 and 3; but some of the circuits which require mention extend through both central stations, and in tracing such circuits it is to be understood that the conductors illustrated by the reference characters a' 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' and b^2 .

The apparatus at the calling central station is substantially the same as that usually employed, it being understood, therefore, that if a subscriber—for example; at station

400—has notified the operator at central station M, Fig. 1, that he desires, for example, station 500, which is connected with central station N, the operator at station M, calling over the line $a' a^2$, notifies the operator at station N that station 500 is wanted and asks to have a trunk-line assigned to make the necessary connections. Assuming, then, that the trunk-line assigned is the line $b' b^2$, the operator at station M inserts the plug A into the jack A^{10} , thereby completing a circuit which energizes a relay d at station N, the operation of said relay being essential to the signaling of the called party, so that it is impossible to send a signal to the substation wanted unless the right trunk has already been connected. The circuit through the relay d starts from the battery B at station N, passing through conductors 1 and 2 and winding 50 of induction-coil I to conductor b' , which leads to the tip-terminal A^{20} of the jack A^{10} , thence to the tip A^2 of the plug A, conductor 3 at station M to ground G, and thence back to ground G^2 at station N, completing the circuit. This causes the attraction of the armatures d^2 and d^3 of the relay d , and it may be assumed, therefore, that these armatures are in engagement with their forward contacts in tracing the signaling-circuits to be hereinafter described.

In signaling a substation on a one-party line—for example, the substation 500—there is no novelty involved; but the operation of sending the signal may be briefly described in order to facilitate the understanding of the novel features of the invention, which relate mainly to the selective signaling of the four-party lines. The insertion of the plug C into the jack C^{10} of the line which leads to substation 500 completes a signaling-circuit from the generator e , which may be traced as follows: The generator e is arranged to produce a pulsating current. Starting with the brush e^2 current flows through conductor 4 to armature h^2 of relay h , conductor 5, main coil i^3 of relay i , conductor 6, armature h^3 of relay h , back contact of said armature to conductor 7, armature d^3 , conductor 8, armature i^2 of relay i , conductor 9, armature g^2 of relay g , conductor 10, armature f^2 of relay f , to the ring contact-piece C^2 of plug C, long spring C^{20} of the jack C^{10} , and thus out over the line through the condenser and bell z and back to the short spring C^{30} and tip C^3 , conductor 12, armature f^4 of relay f , conductor 13, armature g^4 of relay g , conductor 14, winding 51 of induction-coil I, conductors 15, 16, and 17 to the brush e^3 of the generator e . The completion of this circuit depends upon the energization of the relays d and f , the former being controlled, as previously stated, from the central station M, while the latter is controlled from the central station N, the closure of the usual local grounded frame-circuit of

the plug C and jack C^{10} permitting current to flow from the battery B through the relay f and the supplemental windings g^4 , h^4 , and i^4 of the relays g , h , and i , these windings being so adjusted as to develop only sufficient magnetism to maintain in their forward positions the armatures of the relays when thus attracted, but not sufficient to cause said armatures to be attracted, so that upon the first insertion of the plug C the relay f alone operates. Assuming, therefore, that the bell at station 500 is arranged to operate in response to pulsating currents traveling in the direction traced the bell will be rung upon the insertion of the plug C in the jack C^{10} if the other end of the trunk-line has been properly connected at station M. The signal is stopped by the operation of the relay i , the main coil i^3 of which is in the generator-circuit and so adjusted as to create sufficient magnetism to attract the armature i^2 when the receiver at the called station has been taken down, thereby closing the circuit conductively and shunting the condenser and bell.

In the construction herein shown the two-party line, which is indicated as having the stations 501 and 502 located thereon, is provided with multiple jacks, the long and short springs of which are reversed, so that the two bells z^2 z^3 , branched to ground from opposite sides of the line, can be selectively rung by current flowing in the same direction from the generator, one terminal of said generator being grounded at G^2 , Fig. 2, it being deemed unnecessary to trace the circuits, since this arrangement possesses no features of novelty so far as relates to the present invention. The construction under consideration, moreover, is fully set forth and described in another application filed by us of even date herewith, Serial No. 268,216.

In the case of a four-party line one jack only is employed for each line in the construction shown in Fig. 2, the selection of the stations depending upon the use of three master-keys s , t , and u , there being one station on the line, (shown as station No. 503,) which has its jack arranged like that of station No. 500 on a one-party line and also like the jack C^{10} of station 501 of the two-party line, and which, therefore, can be signaled without the use of any key—that is to say, merely by the insertion of the plug C into the jack C^{10} . The bell at station No. 503 is branched to ground from the same side of the line as the bell at station 501 and the jack C^{10} is arranged to correspond to the jack for station 501, so that the operation is the same in connection with both of these substations. The other three substations, however—504, 505, and 506—are under the control of keys s , t , and u , these keys influencing the operation of the relays g and h , the latter constituting substantially an electromagnetic pole-

changing switch to control the direction of current, while the former constitutes means for changing the connections between the brushes of the generator and the conductors of the line, so that it is possible by the operation of these relays to shift the line connections and the direction of the current, and thereby select the desired signal out of the three signals at the stations 504, 505, and 506. It may be stated at this point that while the two-party line has been shown as equipped with jacks corresponding in number to the substations on the line a single jack may be employed, as in the case of the four-party line, and the signaling controlled by the master-key *s* or the master-key *t*, as will readily appear from the following description of the means for signaling on the four-party line shown.

It is to be understood that the keys *s*, *t*, and *u* are connected in multiple to all the trunk-line cord sets under the control of the operator at central station N or to all of a group of any preferred number and that they control only local circuits which influence the relays *g* and *h*, it being necessary, therefore, that the right key be manipulated prior to the insertion of the plug in the jack. The manipulation of the key causes the member of the relay controlled thereby to be attracted, the said armature being maintained in its attracted position after the key has been released by the supplemental coil with which each relay is provided, these supplemental coils being supplied with current in response to the insertion of the plug.

Assuming that station 504 is to be called, this station having a bell which is adapted to respond to positive currents and which is branched to ground from the conductor S, which is connected with the short spring C³⁰⁰ of the jack C¹⁰⁰, the operator before inserting the plug in the jack manipulates the key *s*, thereby closing a circuit, which may be traced as follows: Starting from the battery B the current flows through conductors 15 16 17, key member *s*², conductors 18, 19, and 20, the main coil *g*² of relay *g* being between conductors 19 and 20, armature *f*³ of relay *f* and conductors 21, 22, and 1 back to the battery B. By manipulating the key *s*, therefore, the relay *g* becomes energized to a sufficient extent to attract its armatures *g*² and *g*³ prior to the insertion of the plug C, these armatures being maintained attracted by current flowing through the supplemental coil *g*¹, which is in series with the coil of the relay *f* after the plug has been inserted. The key *s* may then be released—i. e., after the plug has been inserted—the necessary arrangement of the signaling-circuit having thus been provided for. In this case the signaling-circuit may be traced, as before, from the positive brush *e*² of the generator *e* through the conductor 4, armature *h*², con-

ductor 5, coil *i*³ of relay *i*, conductor 6, armature *h*³, conductor 7, armature *d*³, conductor 8, armature *i*², conductor 9, conductor 9^a, armature *g*³, conductor 13, armature *f*⁴ of relay *f*, and conductor 12 to the plug-tip C³, which is in connection through the short spring C³⁰⁰ with the conductor S, from which the signal *z*⁶ at station 504 is branched to ground, the connection being completed through ground G² and conductors 16 and 17 to the brush *e*³ of the generator *e*. The signal at substation 504 will therefore be operated by positive current pulsations without the operation of any of the other signals upon this line or substation circuit.

The signal at substation 505 is branched to ground from the conductor T, which is connected with the long spring C²⁰⁰ of the spring-jack C¹⁰⁰, so as to be connected when the plug C is in the jack with the ring-terminal C² thereof. This signal is arranged to respond to currents flowing in the direction opposite to that of those previously described and is controlled by the key *t*, which in turn controls a local circuit containing a relay which constitutes an electromagnetic pole-changing device for the call-current generator *e*. The local circuit controlled by the key *t* may be traced as follows: Battery B, conductors 15, 16, and 17, to the key member *t*², conductors 23 and 24, between which is located the main coil *h*² of relay *h*, armature *f*³ and conductors 21, 22, and 1, to the opposite terminal of the battery B. This causes the armatures *h*² and *h*³ of the relay *h* to be attracted, it being understood, of course, since the key *s* is not manipulated, that the armatures *g*² and *g*³ of the relay *g* remain in engagement with their back contacts. The signaling-circuit may then be traced as follows: Starting with the negative brush *e*²⁰ of the generator *e*¹⁰, the current will travel by way of conductor 26, armature *h*³ of relay *h*, conductor 6, the main coil *i*³ of relay *i*, conductor 5, armature *h*² of relay *h*, conductor 7, armature *d*³ of relay *d*, conductor 8, armature *i*², conductor 9, armature *g*², conductor 10, and armature *f*² of the relay *f* to the ring-contact C² of the plug C, and thus to the long jack-spring C²⁰⁰, which is attached to line-conductor T and at station 505 through the bell *z*⁵ to ground, returning through the earth to the grounded pole of the central-station call-generator. It will be seen, therefore, that the negative current pulsations from the generator *e*¹⁰ will flow through the signal at station 505 in the proper direction to cause the said signal to operate.

In order to operate the signal at substation 506, which is arranged to operate also in response to a negative current—that is, a current flowing in the same direction as that required to operate the signal at station 505, the signal, however, being branched to ground from the opposite side of the line—it

is necessary only to shift the generator-terminals from one side of the line to the other, which may be accomplished as previously described, in addition to the reversal in the direction of the current through the agency of the pole-changing device. This can be done by the manipulation of the key *u*, which is arranged to close local circuits through both of the relays *g* and *h*, so that the direction of the current is shifted by the operation of the relay *h*, and the line connections are shifted by the relay *g*, as previously described, so that negative-current pulsations will flow through the signal at station 506 to operate said signal to the exclusion of the others. For this purpose, the movable key member *u*² of the switch *u* is arranged to connect the conductor 17 with the conductors 19 and 23, thus completing the two local circuits through the relay-coils *g*² and *h*², as previously traced. In this case the armatures *h*² and *h*³ and the armatures *g*² and *g*³ are attracted prior to the insertion of the plug in the jack and maintained in such attracted position after the insertion of the plug. It is deemed unnecessary to trace the signaling-circuit in this case, it being sufficient to note that the negative current starting from the brush *e*²⁰ of the generator *e*¹⁰ passes through the line conductor *S* and the signal *z*⁷ at station 506 to earth, reaching the said line conductor by the short jack-spring *C*¹⁰⁰ and the plug-tip terminal *C*², this terminal being connected, through the circuit controlled by the armature *g*² and the armatures *h*² and *h*³, with the said brush *e*²⁰, the return-circuit from substation 506 being through the earth to the central-station ground connection *G*² to the generator-brush *e*²⁰.

As shown in Fig. 3, a four-party line may also be provided with multiple jacks like those shown in connection with the two-party line, in which case the shifting of the terminals of the generator from one line to the other is provided for by the arrangement of the jack-springs, there being a jack for each substation. As shown in Fig. 3, the substations 503 and 504, at which the signals are branched from opposite sides of the line, are controlled by the spring-jacks 503^a and 504^a, the tip-terminal of spring-jack 503^a being connected to the line *S*, while the tip-terminal of spring-jack 504^a is connected to the line *T*. The signals at the said substations respond to current flowing in the same direction, so that either station may be selectively signaled by the insertion of the plug in the proper jack, as is the case with the signals previously described in connection with the two-party line. The jacks which control the stations 505 and 506 are similarly and correspondingly arranged, and since the signals at the said stations are arranged to respond to current flowing in the opposite direction it is necessary only after the plug has

been inserted in the proper jack to change the direction of flow of current through the generator, which is done through the operation of the electromagnetic pole-changing device *h*. This is accomplished through the operation of the key *t*, as previously described, the keys *u* and *s* and the reversing-switch controlled by the relay *g* being dispensed with. In this case the key *t* is used in signaling two of the stations on a four-party line, the signaling of the other two stations being automatic.

The cord set is shown provided with a guard-lamp *H*, the purpose of which is to inform the operator at station *N* of the insertion or removal of the plug at station *M*, this lamp being controlled by the armature *d*² of the relay *d*, in conjunction with the armature *f*³ of the relay *f*. Upon the energization of the relay *d* in response to the insertion of the plug *A* in the proper jack at station *M* current flows through the lamp *H* from the battery *B* through conductor 27, armature *f*³, conductor 28, armature *d*², and conductor 1, the lamp thus lighting. Upon the insertion of the plug *C* at station *N* this circuit is broken by the attraction of the armature *f*³, thus extinguishing the lamp, but closing a circuit through conductor 29, the circuit of which, however, at this time is broken on account of the previous attraction of the armature *d*². The release of the armature *d*², however, in response to the removal of the plug *A* at station *M* closes this circuit, and the lamp *H* lights, thus informing the operator at station *N* that the line has been disconnected. On the removal of the plug *C* the lamp is again extinguished, owing to the release of the armature *f*³.

It is to be understood, of course, that the drawings are 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 since no novelty is involved, the jacks being shown simply to complete the illustration of the system in general. The signaling-current-generating device is also conventionally shown, the description being facilitated by indicating separate generators for positive and negative currents. This duplication of generators is obviously not essential, and it is to be understood that other means for producing currents flowing in opposite directions might be equally well employed.

What we claim is—

1. In a telephone-exchange system provided with a plug and jack to close a circuit for current from a signaling-current generator, and with relays controlled respectively by the operators at the calling and called central stations to actuate circuit-closers in said circuit; an electromagnetic pole-changing switch in said circuit; and a manually-operated device for causing the operation of said pole-changing switch.

2. In a telephone system, a line leading to a plurality of substations having signals branched from opposite sides of the line to a separate return-conductor, such as a ground-circuit; a generator for signaling-currents; a jack for the line; a plug to be associated with said jack; an electromagnetic switch for reversing the connections between the terminals of said generator and the line-terminals of said jack; and means located at the central station for controlling said switch.

3. In a telephone system, a line leading to a plurality of substations having signals branched from opposite sides of the line to a separate return-conductor, such as a ground-circuit; a generator for signaling-currents; a jack for the line; a plug cooperating with said jack; a switch for connecting either terminal of said generator with either of the line-terminals of said jack and the opposite terminal of the generator to said separate conductor; a relay to control said switch; a local circuit for energizing said relay and means for closing said circuit; and a supplemental winding on said relay supplied with current through the local sleeve and frame-circuit of the plug and jack, substantially as described.

4. In a telephone system in which four substations are located on a single line, two of said substations having signals branched to ground from one side of the line, and two having signals branched to ground on the opposite side of the line, the two signals branched to each side of the line being responsive to currents flowing in opposite directions; a single jack for said line; a plug to be associated with said line; a generator for signaling-currents; an electromagnetic pole-changing switch for reversing the direction of current from said generator, the generator-circuit being completed through the ground and one side of the line when the plug is in the jack; a manually-controlled local circuit for supplying said pole-changing switch

with current; an electromagnetic device supplied with current through the sleeve and frame circuit for maintaining said switch after it has been operated; a reversing-switch for reversing the connection between the terminals of the generator and the ring and tip members of the plug; a relay to operate said reversing-switch; a local circuit for supplying said switch with current; a manually-operated device for controlling said circuit; and a supplemental winding supplied with current through the sleeve and frame-circuit for maintaining said switch after it has been operated, substantially as described.

5. In a telephone system for selectively signaling the substations on a four-party line of the kind described, a jack and plug controlling the connections with said line; a generator for signaling-currents; a pole-changing switch; a switch for reversing the circuit connections of said generator; separate local circuits controlling said switches respectively; a circuit-controller for each of said local circuits; and a third circuit-controller common to both of said local circuits, substantially as described.

6. In a telephone system for selectively signaling the substations on a four-party line, a generator for signaling-currents; an electromagnetic pole-changing device; a key for operating and controlling the movement of said device; and an electromagnetic switch for reversing the circuit connections of said generator with the line conductors.

7. In a selective signaling system for four-party lines terminating at a called central station; a source of signaling-current; a pole-changing device therefor under the control of the operator at said called central station; a circuit for said current controlled at one point by said pole-changing device; a separate circuit-controller for said circuit; a relay to operate said circuit-controller; and means located at a calling central station for controlling the flow of current through said relay.

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

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HERBERT T. GARDNER.
WILLIAM G. KINTON.

Witnesses:

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