No. 833,906. PATENTED OCT. 23, 1906.

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

TELEPHONE SWITCHING AND BUSY TEST APPARATUS.

APPLICATION FILED JULY 3, 1905.

2 SHEETS—SHEET 1.

Fig. 1.

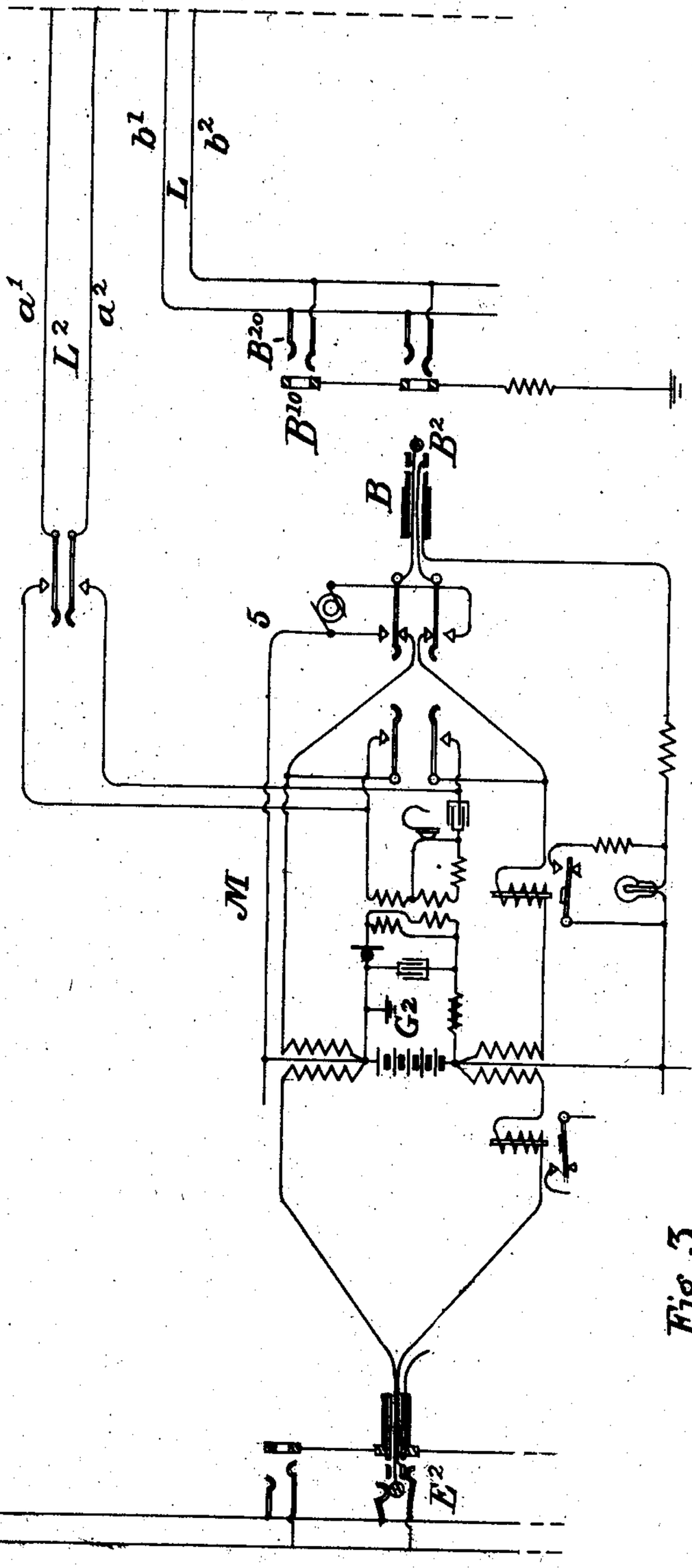
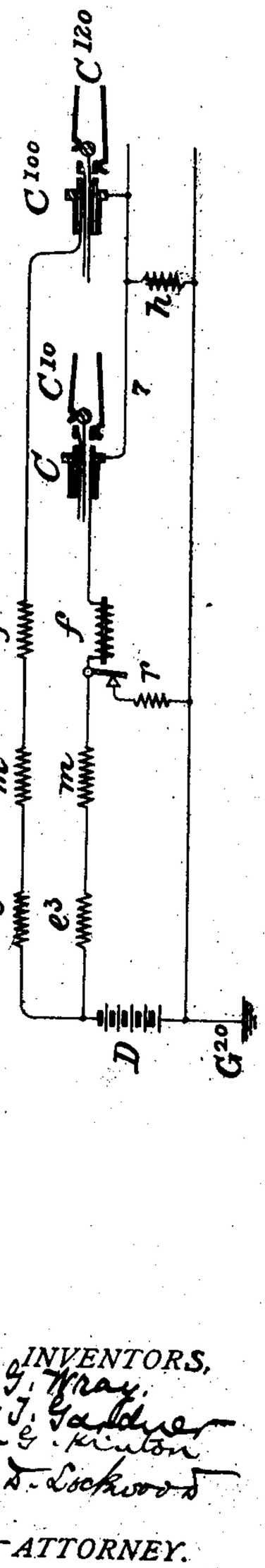


Fig. 3.



WITNESSES:

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Frank C. Lockwood.

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2 SHEETS—SHEET 2.

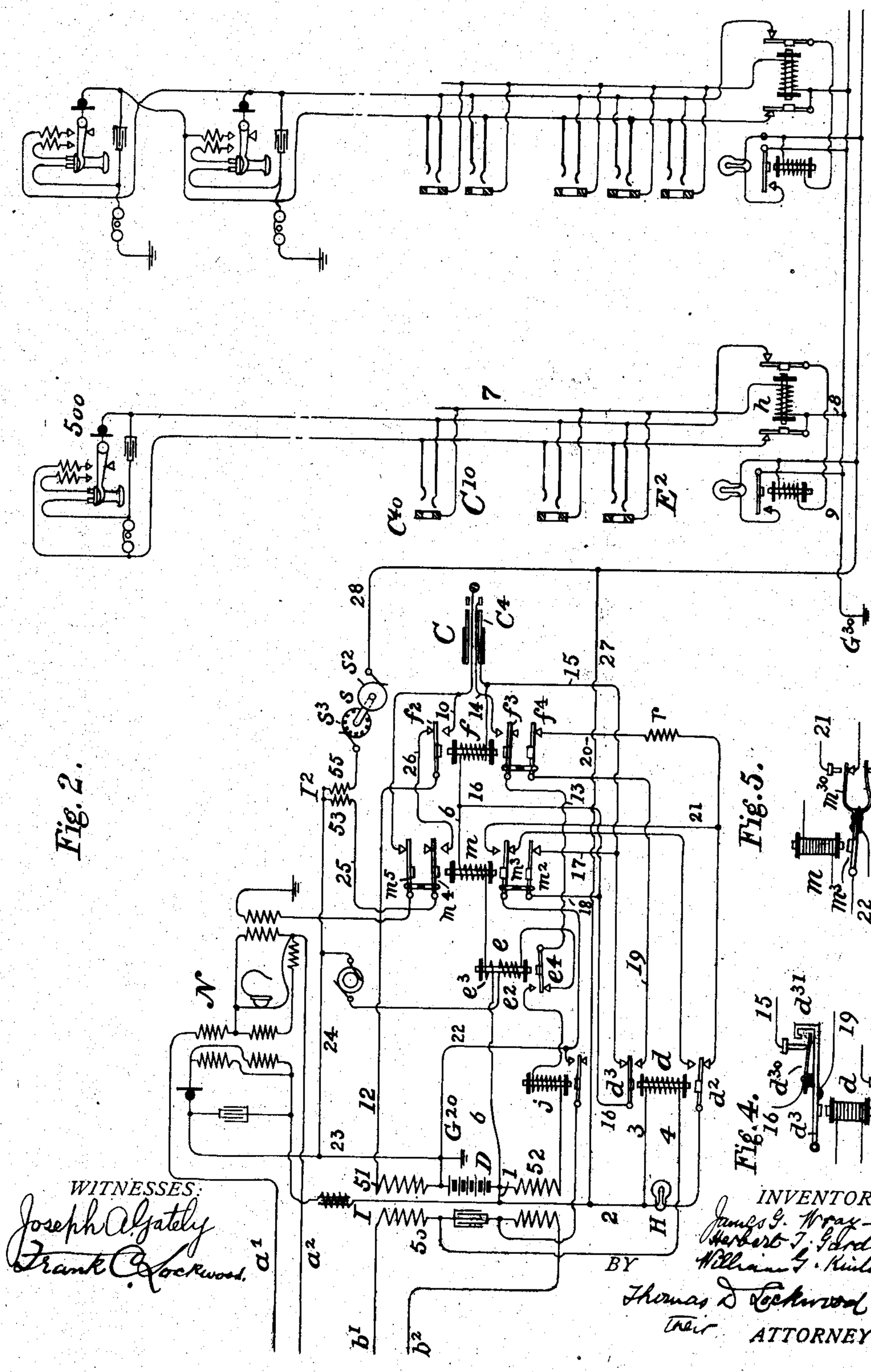

Fig. 2.

Fig. 5.

Fig. 4.

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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 BUSY-TEST APPARATUS.

No. 833,906. Specification of Letters Patent. Patented Oct. 23, 1906.

Application filed July 3, 1905. Serial No. 268,214.

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 Busy-Test Apparatus, of which the following is a specification.

The present invention relates to telephone-exchange systems, and is shown as comprised in a trunk-line switchboard apparatus for connecting one central station with another or substation-lines converging to one central station with those centering at another, the principal feature of the invention consisting in an automatically-operating busy-test system and appliances for the multiple part of said trunk-line switchboard apparatus in association with an automatic signaling system for the wanted substation, the operator at the calling central station being, moreover, notified if the line wanted is busy by the automatic operation of a "busy-back" signal.

The system is further so arranged that single-party lines or selective two-party lines may be signaled, the lines of both classes being equipped with multiple jacks or jacks at each section of the multiple switchboard and the two-party lines being also provided with two jacks—that is, one for each of its stations at the several multiple-switchboard sections. The calling system is automatic, so that it is only necessary for the operator at the called central station to insert the plug in the proper jack in order (provided the line of such jack be not already engaged) to signal the desired subscriber. The system is so arranged that it is impossible to signal any subscriber until the proper connection has been actually made at both central stations, the final connection and giving of the signal depending upon the operation of a main relay at the called central station, such operation, however, being dependent upon such conditions as to insure the proper connections before the signal has been given. The busy-back-signal to the call-originating station also depends for its ultimate operation upon this relay, the back contact of an armature controlled by said relay maintaining a circuit which previously had been closed by another relay and upon which the aforesaid signal depends, while the conditions are such that the relay cannot attract its armature if the line is busy. The operation of the main relay is controlled by shunt-circuits of sufficiently low resistance to short-circuit the relay and prevent the operation thereof, one of said shunt-circuits being controlled by a relay which depends for its operation upon the insertion of the plug at the calling central station, while the other depends upon the action of a relay controlled by the insertion of the plug at the called central station, so that one or the other, or both, of said shunts will be closed around the main relay pending the insertion of both plugs in the jacks. The giving of the signal further depends upon the operation of the main relay at the called central station, and the said relay cannot operate until both shunts have been opened, so that it is impossible to give a premature signal or to give a signal at all in the case of an error in the assignment of the trunk-line. The main relay, furthermore, is influenced by a special circuit which is so arranged as to prevent the operation of the relay if the line called for is busy, this circuit being so arranged that if the potential of the battery is on the line both terminals of the relay will be connected to the same terminal of the battery and both terminals of the relay connected also with the opposite terminal of the battery through substantially or approximately equal resistances, whereby the magnetizing effect is substantially balanced, so that sufficient magnetism cannot be developed to attract the armature. The giving of the signal on the line wanted is under these conditions thus prevented, while the busy-back signal is placed in operation, and the calling subscriber and the calling operator thereby notified that the line is busy.

Figure 1 is a diagram of the circuits at the calling central station. Fig. 2 is a diagram of the circuits at the called central station, said figure also showing the answering and calling jacks and multiple representatives of the latter for a one-party line and a two-party line. Fig. 3 is a diagram illustrating the battery connections when a plug has been inserted into a jack belonging to a busy line, and Figs. 4 and 5 are details showing

mechanical expedients for operating the circuit-controllers in a manner necessary to insure the necessary operations.

The salient features of the invention are mainly illustrated in Fig. 2; but certain of the circuits extend through both central stations, and in tracing such circuits it is to be understood that the conductors indicated 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.

In describing the invention the successive operations performed by the operator at the calling subscriber's central station and the operator at the called subscriber's central station will be followed, and the results of each operation traced out with reference to the drawings.

After the operator at the calling subscriber's central station (which will be hereinafter designated as "station M") has been signaled in the usual way and has ascertained the desires of the calling subscriber the said operator inserts the plug B in the jack B^{10}, which corresponds to the trunk-line L having main conductors b' b^2, which has been assigned, the operator having previously by means of the circuit L^2 having conductors a' and a^2 asked the operator at the called central station (hereinafter designated as "station N") to assign the trunk to be used, and stated to the latter operator the number of the station wanted.

Assuming that station No. 500, Fig. 2, on a single-station line is the station wanted, the operator at the central station N inserts the plug C into the jack C^{10}, and if conditions are normal—that is to say, if the operator at the station M has placed the plug B in the jack B^{10} and the line leading to station 500 is not busy—a signal will be given at the said station, which signal will be stopped upon the taking down of the receiver.

The operations of producing the signal and stopping the same form no part of the present invention, and it is sufficient to state that under the conditions hereinbefore outlined a circuit is closed from the generator through the condenser and bell at the station, the said circuit including the main coil e^2 of relay e and winding 51 of the induction-coil I, so that the bell is rung and an audible signal repeated back to the calling-stations, the said signal being stopped upon taking down the receiver at station 500, which by shunting the bell and condenser causes an increased flow of current through the relay e, so that the armature of said relay will be attracted, thereby breaking the signaling-circuit. The completion of the signaling-circuit, however, depends upon the operation of the relay f, which relay is subjected to control, so that it will fail to operate unless the plugs at both central stations M and N have been placed in their appropriate jacks, and if the called or wanted line is busy. For this purpose the main relay f, which is in a circuit primarily closed by the connection of the sleeve C^4 of plug C with the frame or socket C^{40} of the jack C^{10}, is provided with shunt-circuits of sufficiently low resistance to prevent the operation of the relay so long as the said shunts remain closed, two of these circuits depending, respectively, upon the operation of relays controlled, respectively, by the plugs at the opposite ends of the trunk-line, there being also a third circuit, which is capable of influencing the relay f and preventing the operation thereof when the wanted line is busy. Under normal conditions if the wanted line is not busy and both plugs have been inserted in their respective jacks the relay d, Fig. 2, will have been energized by current in a circuit which may be traced as follows: battery D, conductor 1, conductor 2, conductor 3, the winding of said relay d, conductor 4, winding 50 of the induction-coil I, conductor b', jack-spring B^{20}, tip B^2 of plug B, conductor 5, to ground G^2, thence returning to ground G^{20}, Fig. 2, and thus to the other terminal of the battery. The armatures d^2 and d^3 of the relay d will therefore be attracted or moved to a position the reverse of that shown in Fig. 2. A circuit will also be closed through the relays f and m and the coil e^3 of relay e, which may be traced as follows: Starting from the battery D, the circuit passes through the conductor 6, coil e^3, winding of relay m, winding of relay f, sleeve C^4, jack-frame C^{40}, conductor 7, cut-off relay h, conductors 8 and 9 to ground G^{30}, and thence back through ground G^{20} to the other side of the battery D. Under normal conditions the relays f and m will attract their armatures, so that the said armatures will be in the position opposite that shown in Fig. 2 of the drawings, while the coil e^3 of the relay e will magnetize the core of said relay sufficiently to retain the armature e^4 thereof attracted after the exalted action of the main coil e^2, due to the taking down of the receiver at the called substation. The talking-circuit is then closed from the tip of the plug to its ring through conductor 10, armature f^2, conductor 12, induction-coil winding 51, to the battery and from the other terminal of the battery through induction-coil winding 52, supervisory relay j, armature e^4, conductor 13, armature f^3, and conductor 14. The final completion of this circuit, however, depends upon the energization of the coil e^2 of the relay e, which, as previously stated, takes place upon the removal of the receiver at the called substation, this feature requiring no further explanation, since it does not enter into the present invention.

In order to prevent the operation of the re-

lay *f* and the consequent completion of the signaling-circuit and subsequently of the talking-circuit in case the conditions are not suitable for connection, the operation of the said relay is controlled in accordance with the present invention by means of shunt-circuits, which circuits in turn are controlled by the relays *m* and *d*, there being, first, a closed shunt around the relay *f* up to the time that both the plugs B and C have been inserted in the jacks, and, second, a closed circuit through a suitable resistance which is capable of influencing the relay *f* if the line wanted is busy.

For convenience in description these circuits will be hereinafter referred to as "shunt X, shunt Y, and special circuit Z," these reference characters, however, not being placed upon the drawings, since they are merely used for the purpose of distinguishing the circuits in the description.

The shunt X, which is controlled by the relay *d*, extends through conductor 15, back contact of relay *d*, armature d^3, and conductor 16 to the conductor 6, which leads to the battery and forms part of the usual circuit controlled by the sleeve and frame, the main circuit including the relays *f m* and coil e^3 of relay *e*. The shunt X thus affords a low-resistance path around the relay *f*, through which prior to the operation of the relay *d* the relay *f* is short-circuited, the result being that the said relay *f* is thus far not energized and does not attract the armatures f^2 and f^3. Since, therefore, the relay *d* is controlled by the operator at the station M, the signaling and talking circuits, which are finally controlled by the relay *f*, cannot be closed prior to the insertion of the plug B in the proper trunk-jack B^{10} at station M.

The shunt Y extends through the conductor 15, conductor 17, armature m^2 of relay *m*, and conductors 18 and 16 to the conductor 6, thus making a second short circuit around the relay *f* in addition to that of the shunt X. This circuit is controlled by the armature m^2 of the relay *m*, which relay being included in the main sleeve and frame-circuit becomes energized upon insertion of the plug C in the jack C^{10}, it being obvious, therefore, that the relay *f* will not operate until the plug C has been placed in position.

So far as relates to the prevention of a premature signal or false signal in case of a wrong trunk assignment the shunts X and Y afford the necessary protection; but these shunts by themselves will not operate to prevent the giving of the signal and the final connection of the two substations if the wanted line is busy.

To prevent the operation of the relay *f* in case the wanted line is busy, the special circuit Z is employed, and before tracing this circuit in Fig. 2 reference may be had to Fig. 3, which shows in a simple diagram the conditions existing if the plug C is placed in the jack C^{10} of a line which is already connected elsewhere, as by the plug C^{100} inserted in jack C^{120} of said line at another section of the multiple switchboard. In this case it will be seen that one terminal of the battery D will be connected through the coils of the relays *e* and *m* to one end of the relay *f*, while the same terminal of the battery is connected through the corresponding relays e^{10}, m^{10}, and f^{10} of the busy line associated with the cord-circuit of plug C^{100} to the opposite terminal of the relay *f* through the conductor 7, which unites the several jack-frames of the same line. At the same time the opposite terminal of the battery is connected to both ends of the relay *f* through the cut-off relay *h* at one end and at the other through a special resistance *r*, which is included in the special circuit Z under consideration, this special circuit being controlled by the operation of the relay *f* itself if the said relay is free to operate. The resistances of the relay-coils e^3, *m*, and *f* of the cord-circuit terminating in switch-plug C, through which it is sought to establish connection with a wanted line, are of course the same as those of the corresponding relay-coils e^{10}, m^{10}, and f^{10} of the cord-circuit of plug C^{100}, through which a connection has previously been made with such wanted line, establishing the busy condition of the same, and are so proportioned to the special resistance *r* and the resistance of the cut-off relay that if the line called for is busy a similar potential is established at both terminals of the relay *f*, which accordingly will not operate and the signal will not be given nor the line connection completed.

Starting with the conductor 6, Fig. 2, which is connected with one terminal of the relay *f*, the special circuit may be traced through conductor 16, armature d^3, the forward contact of said armature, conductor 19, armature f^4 of relay *f*, conductor 20, which includes the resistance *r*, conductor 21, armature m^3 of relay *m*, and conductor 22 to the ground at G^{20}, thus connecting one terminal of relay *f* with the ground, the same terminal being connected with the other pole of the battery through the coil e^3 of the relay *e* and the coil of relay *m*. The opposite terminal of relay *f* is grounded in the usual way through the plug-sleeve, jack-frame, conductor 7, and cut-off relay *h* and if the line is busy is also connected with the other terminal of the battery through the jack, plug, and associate relays e^{10}, m^{10}, and f^{10} at the section of the multiple switch where a previous connection has been established with the wanted line. Under these conditions, therefore, there is a balance of potentials, so that the magnetizing effect is substantially negligible, thus preventing the operation of the relay *f*. It will be noted however, that the circuit Z above traced is nor-

mally open at m^3 and also at d^3, becoming closed at m^3 upon the insertion of the plug C into its jack and at d^3 upon the insertion of the plug B. The operations of these relays, however, as previously described, cut out the shunts X and Y, and in order to prevent the operation of the relay *f* if the line is busy the armature m^3, which controls the special circuit Z, is arranged to reach its back contact before the armature m^2, which controls the shunt Y, has opened the said shunt, the armature d^3, which controls the shunt X, operating in the same way, so that one or the other of said shunts is momentarily closed at the same time that the special circuit is closed, thereby insuring the short-circuiting of the relay *f* if the line wanted is busy.

The failure of the relay *f* to operate leaves the armature f^2 in circuit with its back contact, thereby completing a circuit including a winding 53 of the inducton-coil I^2 of the busy-back signal and the winding 51 of induction-coil I, the said circuit including the conductors 12 23 24 25 and armature m^4 of relay *m*, which is then in engagement with its forward contact, and thereby connected with conductor 26. The busy-back-signal-producing apparatus, which is indicated as a rotating member *s*, having a ring s^2 and a commutator or rotary circuit-interrupter s^3, is supplied with current through conductors 27 and 28 and conductors 24 and 23, the induction-coil winding 55 being in this circuit. The removal of the plug C breaks the busy-back circuit by releasing the armature m^4. As herein shown, the relay *m* may be further provided with an armature m^5, which controls the ordinary busy-test circuit and mode of operation, which may be utilized, if desired, in case there are several lines leading to one substation, making it desirable for the operator at station N to test independently of the operator at station M. Otherwise the operator at N, being warned by the lighting of the usual lamp-signal H that the operator at M has, in view of the busy condition of the wanted line, withdrawn the plug B, disconnects by withdrawing the plug C.

Figs. 4 and 5 illustrate details showing practicable devices for controlling the circuits X, Y, and Z in the manner described to close one circuit before another is broken. In Fig. 4 the armature d^3 of the relay *d* is shown as provided with a spring d^{30}, connected with conductor 16 and having sufficient play to remain in contact with the conductor 15 until the end of the said spring is engaged by the overhanging arm d^{31} of the armature, which constitutes a conductor to connect conductor 16 with conductor 19, after which the final movement of the armature separates the spring d^{30} from conductor 15.

In Fig. 5 the armature of the relay *m* is shown as provided with two spring-contacts m^{30} and m^{30}, corresponding, respectively, to the separate armatures m^2 and m^3, (shown in Fig. 2,) one of said springs m^{20} having sufficient play to remain in engagement with the conductor 17 until after the other spring m^{30} has made engagement with the conductor 21, thus obtaining substantially the same result.

As illustrated in Fig. 2, the system hereinbefore described is applicable to use with a selective two-party line, the control of the signaling being provided for by the engagement of the springs in multiple spring-jacks, there being one signal-bell branched to ground from one side of the line and another signal-bell branched to ground from the other side of the line, this system requiring no further detailed description, since it forms no part of the present invention.

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, 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 system for connecting two central stations, a relay controlled by the plug and jack at the calling central station; a relay controlled by the plug and jack at the called central station; a third relay to control the main connecting-circuit from one central station to the other; and shunt-circuits around said third relay controlled respectively by the other two relays.

2. In a telephone signaling system, a signaling-circuit; a relay to control said circuit; a source of current; a conductor which connects one terminal of said source of current to one terminal of said relay; multiple jacks; a conductor or ground connection to connect said jacks with the other terminal of said source of current; means for connecting the opposite terminal of said relay with any one of said jacks; a conductor to connect the first-named terminal of the relay with the second-named terminal of the source of current; means controlled by said relay for controlling a circuit including said conductor; and one or more separately-controlled shunt-circuits around said relay.

3. In a telephone signaling system, a signaling-circuit; a relay to control said circuit; a source of current; a conductor which connects one terminal of said source of current

to one terminal of said relay; multiple jacks; a conductor or ground connection to connect said jacks with the other terminal of said source of current; means for connecting the opposite terminal of said relay with any one of said jacks; a conductor to connect the first-named terminal of the relay with the second-named terminal of the source of current; means controlled by said relay for controlling a circuit including said conductor; one or more separately-controlled shunt-circuits around said relay; one or more circuit-controllers in a circuit including said conductor, the said shunt-circuits around said relay being also under control of the said circuit-controllers; and means whereby the said circuit-controllers operate to close said circuit including said conductor before opening said shunt-circuits.

4. In a telephone signaling system for trunk-lines, a main relay to control the signaling and talking circuits; a shunt-circuit around said relay adapted to be opened by the insertion of the plug in the jack at the calling central station; a second shunt-circuit adapted to be opened by the insertion of the plug at the called central station; a special circuit arranged to prevent the operation of said relay if the line wanted is busy; and means for closing said special circuit prior to the opening of one or the other of said shunt-circuits.

5. In a telephone trunking system, a line-jack; a switch-plug to be inserted in said jack; a relay associated with said plug controlling the continuity of the main circuit thereof, and adapted to operate and to close said circuit when, the said plug being inserted in said jack, the line connected with said jack is disengaged; and means for establishing substantially similar potentials at both terminals of said relay, and for thereby preventing its operation on the insertion of the plug, when the line connected with said jack is already occupied; substantially as set forth.

6. An automatic busy-test system and apparatus comprising a multiple switchboard; a switch-plug and main and local conductors associated therewith; a test-circuit uniting the frame-pieces of the several jacks of a line and adapted to be completed through the local-circuit conductor of said plug; a relay connected with said local-circuit conductor and controlling the said main-circuit conductors; and means for either establishing an operative current through said relay, or establishing substantially similar potentials at both of the terminals thereof, when the said switch-plug is placed in a spring-jack of any line, according as said line is at liberty or already busy; substantially as set forth.

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.
HERBERT T. GARDNER.
WILLIAM G. KINTON.

Witnesses:
MARION A. REEVE,
GEORGE E. CHIPMAN.