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W. W. DEAN.

TELEPHONE SYSTEM.

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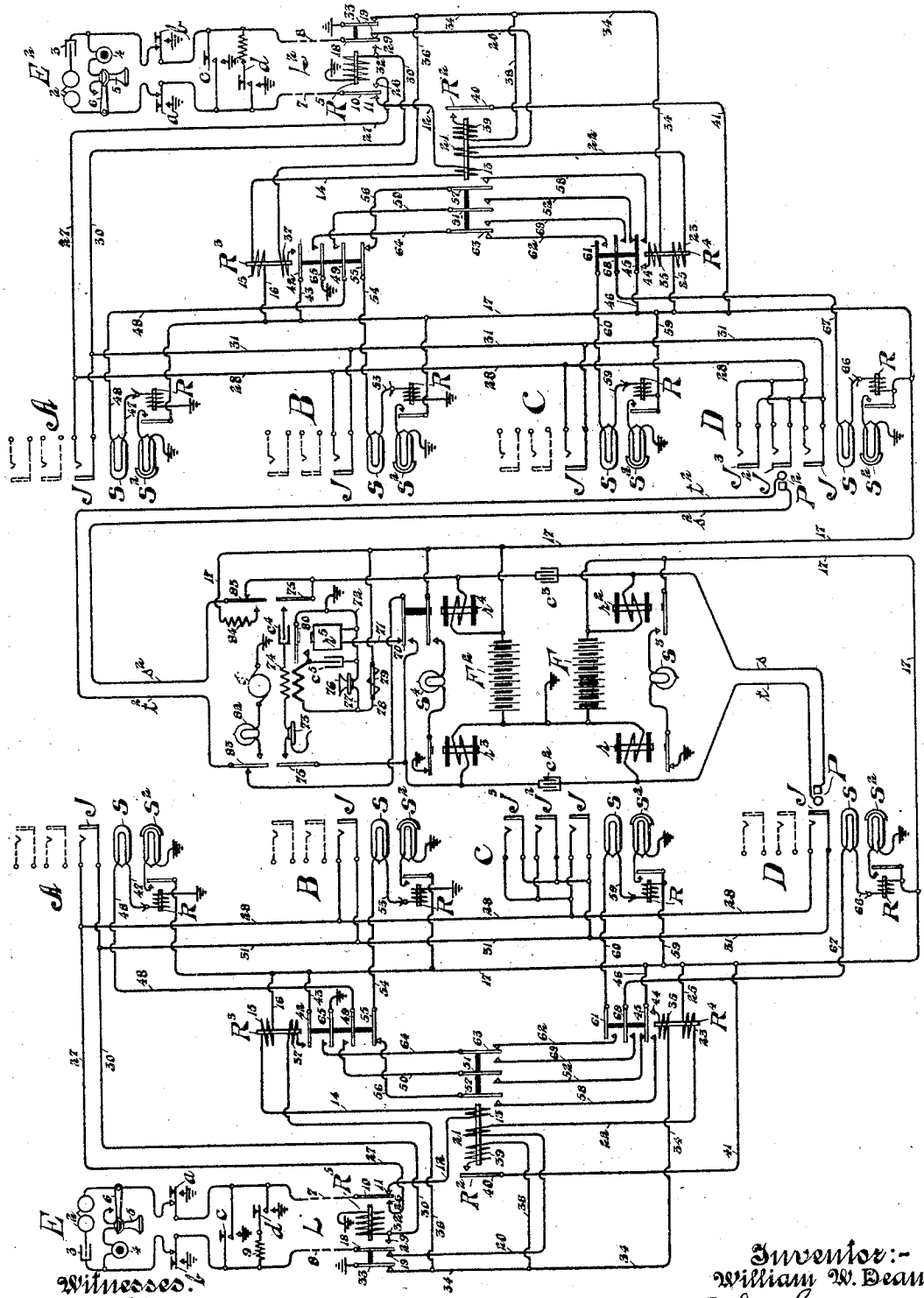

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UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

No. 796,568. Specification of Letters Patent. Patented Aug. 8, 1905.

Application filed October 27, 1902. Serial No. 128,882.

To all whom it may concern:

Be it known that I, WILLIAM W. DEAN, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented new and useful Improvements in Telephone Systems, of which the following is a specification.

My invention relates to telephone systems, and particularly to those of the four-division type. In this type of telephone systems it is now well understood the subscribers' lines are provided with a calling-signal and an answering-jack upon each division of the switchboard, together with suitable calling apparatus at the subscriber's station for selectively actuating any of the said signals. Upon one of the divisions of the switchboard each line is provided also with a plurality of multiple jacks.

The system of my invention includes common batteries or other common sources of current at the central office for the actuation of all signals and apparatus, so that the subscribers' stations are equipped only with the necessary mechanical and electrical devices for suitably completing the circuits of said central sources.

Although the lines of my invention are provided with a calling-signal upon each of the four divisions of the switchboard, only four relays are required for each line, one of said relays being a cut-off relay, which is actuated when a connection is established with a line at any of its connection terminals or spring-jacks to render the line-signals inoperative. This cut-off relay serves the further function of placing the line in condition for conversation by connecting the normally disconnected jacks or connection terminals with the external line-circuit.

My invention is illustrated in the accompanying drawing, in which the same reference characters are used to designate like parts, and in which the figure is a diagram of a system, showing two subscribers' lines and the central-office apparatus at one division of the switchboard.

Two subscribers' lines L and L^2 are shown extending from their respective substations E and E^2 to the central office. The apparatus at the substations is the same throughout the system, so that only that, say, at station E will be specifically described. This apparatus includes an ordinary polarized signaling-bell 2 and a condenser 3, permanently connected between the line conductors of the telephone-line and a transmitter 4, and receiver 5 in a normally open bridge of the said conductors, but which is adapted to be closed by the switch-hook 6 during conversation. A set of calling-keys is also provided for each substation, the key *a* being adapted to ground the tip line conductor 7 when actuated, the key *b* to ground the sleeve line conductor 8, the key *c* to directly ground both conductors 7 and 8, and the key *d* to ground both conductors, but with a resistance 9 between the sleeve conductor and the ground branch. These keys at the substation are adapted to operate the line-signals located upon the corresponding divisions A, B, C, and D of the switchboard. The line is also provided with an answering-jack J upon each of the divisions and with multiple jacks upon one of the divisions. The multiple jacks for the line L are shown at J^2 and J^3 upon division C. Pilot-signals S^2, common to all of the lines upon each operator's position, are provided for each of the divisions, the circuits of these pilot-signals being controlled by the pilot-relays R. Three line-relays R^2, R^3, and R^4 are provided for each line, and a cut-off relay R^5 is also furnished for the line. The tip line conductor 7 terminates in the spring 10 of the cut-off relay R^5, the normal contact 11 of which is connected, by means of conductor 12, with one differential winding 13 of the line-relay R^2, the opposite terminal of which is connected by conductor 14 with actuating-winding 15 of the line-relay R^3 and thence by conductor 16 with the battery-lead 17, extending to the live pole of the battery F, the opposite pole of which is grounded. The other line conductor 8 is connected with the spring 18 of the cut-off relay R^5, the normal contact 19 of which is connected by conductor 20 with the other differential winding 21 of line-relay R^2 and thence by conductor 22 with the actuating-winding 23 of line-relay R^4 and thence over branch 25 to the battery-lead 17. The forward contact 26 of spring 10 of the cut-off relay is joined by conductors 27 and 28 with the tip-springs of all of the jacks or connection terminals of the line, while the forward contact 29 of spring 18 of the cut-off relay is electrically connected

by conductors 30 and 31 with the sleeve rings or contacts of the said jacks or connection terminals belonging to the line. The winding of the cut-off relay R^5 is connected in a ground branch from the point 32 on the sleeve conductor 30, leading to the said jacks. The cut-off relay is provided with an additional spring 33, which is grounded and the normal contact of which is joined by conductor 34 with the locking-winding 35 of the line-relay R^4. A branch conductor 36 extends from said conductor 34 to the locking-winding 37 of line-relay R^3, and a similar branch 38 leads to locking-winding 39 of relay R^2. The locking-winding of line-relay R^2 has its circuit completed through the normal contact and spring 40 of said relay and conductor 41 to the battery-lead 17, while line-relay R^3 has the circuit of its locking-winding completed through the forward contact and spring 42 and conductor 43 to the said battery-lead 17, and the circuit of the locking-winding of relay R^4 is likewise completed through the forward contact 44 and spring 45 and conductor 46 to the said battery-lead. The circuit of the signal-lamp S in division A of the switchboard is completed from ground by conductor 47, which includes the pilot-relay R, thence by conductor 48, spring 49, and forward contact of line-relay R^3, conductor 50, spring 51, and forward contact of relay R^2, conductor 52, normal contact, and spring 45 of relay R^4, and thence by conductor 46 to the battery-lead 17. The corresponding lamp in division B has its circuit completed from ground by conductor 53, including the pilot-relay R, conductor 54, spring 55, and normal contact of relay R^3, conductor 56, spring 57, and forward contact of relay R^2, conductor 58, the forward contact and spring 45 of relay R^4, and conductor 46 to the battery-lead 17. The lamp in division C has its circuit completed from the battery-lead 17 by means of conductor 59, including the pilot-relay R, the lamp, conductor 60, spring 61, and forward contact of relay R^4, conductor 62, normal contact, and spring 63 of line-relay R^2, conductor 64, forward contact and spring 65 of relay R^3, and thence to ground. The lamp in division D has its circuit likewise completed from the battery-lead 17 by means of conductor 66, including the winding of the pilot-relay R, the lamp, conductor 67, spring 68, and forward contact of line-relay R^4, conductor 69, forward contact, and spring 63 of line-relay R^2, conductor 64, forward contact, and spring 65 of relay R^3, and thence to ground. The pilot-signals in each of these divisions, preferably in the form of small incandescent lamps, are fed from the battery-lead 17, as shown.

The central-office apparatus at the division D is intended to be shown by the diagram of the cord-circuit and associated apparatus. It will be understood that all of the divisions and all of the operator's positions are provided with a plurality of said cord-circuits and apparatus. The cord-circuit shown comprises the answering-plug P and the calling-plug P^2, having tip and sleeve contact-surfaces adapted to register with the like surfaces in the jacks of the lines. The tip-contacts of the two plugs are connected together by the strands t and t^2 with an interposed condenser c^2, while the sleeves of the plugs are joined by the strands s and s^2 and the condenser c^3. The battery F is bridged across between the strands t and s and includes upon either side the supervisory relays r and r^2, which control the local circuit of the supervisory signal S^3, associated with the answering-plug, the relay r serving to normally close said local circuit and the relay r^2 to normally open the same. The battery F^2 is bridged across the calling end of the cord-circuit and includes upon either side the similar supervisory relays r^3 and r^4, controlling the former through its normally closed contacts and the latter to its normally open contacts the local circuit of the supervisory signal S^4, associated with the calling-plug. The tip-strand t^2 of the called circuit is normally open at spring 70 of supervisory relay R^4, the normal contact of which is joined by conductor 71 with the high-resistance and high-impedance test-relay r^5, the opposite terminal of which is grounded through conductor 72. The forward contact of said spring 70 is connected with the remainder of the tip-strand, whereby when said supervisory relay is actuated the test-relay is cut off and the tip-strand of the cord-circuit is completed for conversation. The operator's receiver 73, the secondary of her induction 74, and the condenser c^4 are adapted to be connected in a bridge of the cord-circuit by the springs 75 of the listening-key. Her transmitter 76 is connected on one side to ground by conductor 72 and on the other side by conductors 77 and 78 with the battery-lead 17, extending from the live pole of the battery F^2, the conductor 78 including an impedance-coil 79. The primary of her induction-coil 74 together with the condenser c^5 are connected in shunt of the transmitter 76. The spring 80 of the test-relay r^5 is grounded and the forward contact of said spring is connected with the shunt containing the primary of the operator's induction-coil. A ringing-generator 81 is adapted to be connected together with a resistance-lamp 82 between ground and the tip-spring of the ringing-key 83 83 of the cord-circuit, while the sleeve-spring of said key when actuated connects with said battery-lead 17 and includes the resistance 84.

The operation is as follows: By pressing the key a at the substation the signal in the A division of the switchboard is actuated over the following path: from ground at said key over the tip line conductor 7, contacts 10 and 11 of the cut-off relay R^5, conductor 12, winding 13 of the differential line-relay R^2, con-

ductor 14, winding 15 of relay R^3, conductor 16, and the battery-lead 17 to the live pole of battery F, and thence to ground. The completion of this path actuates both relays R^2 and R^3, the circuit of the locking-winding of relay R^2 being completed from the battery-lead 17 over conductor 41, spring 40, and front contact of relay R^2, locking-winding 39, conductors 38 and 34, normal contact and spring 33 of cut-off relay R^5 to ground, while the circuit for the locking-winding of relay R^3 is completed from the battery-lead 17, conductor 43, spring 42, its forward contact, winding 37 of relay R^3, conductors 36 and 34, and spring 33 to ground. These relays are therefore locked in actuated condition, even though the calling-key *a* be released. The actuation of these two relays effects the closing of the circuit of the signal-lamp S, said circuit being traced from ground at said signal, the pilot-relay R, signal S, conductor 48, spring 49 of relay R^3, its forward contact, the conductor 50, spring 51 of relay R^2, its forward contact, conductor 52, and the normal contact of spring 45 of relay R^4, which is not actuated, and thence by conductor 46 and battery-lead 17 to the battery F. This lamp is therefore lighted and the pilot-relay is energized to close the circuit of the pilot-lamp S^2 from the battery-lead 17. It will be noticed that the actuation of the relay R^3 opens the circuit of the signal-lamp in the B division of the switchboard through its spring 55, that the circuit of the lamp in the C division of the switchboard is open at spring 61 of relay R^4, and that the lamp-circuit of the D division is open at spring 68 of the relay R^4, for which reasons only the lamp A operates.

In case it be desired to operate the signal upon the B division of the switchboard the key *b* is actuated at the substation and a path for current is completed over a circuit similar to that before described for the key *a*, except that the relays R^2 and R^4 are now operated and the relay R^3 does not respond. This results in closing an actuating-circuit for the signal-lamp upon the B division from ground at said signal through the pilot-relay R, lamp S, conductor 54, spring 55 of relay R^3 and its normal contact, conductor 56, spring 57, and the forward contact of the line-relay R^2, conductor 58, the forward contact, and spring 45 of relay R^4, and thence by conductor 46 to battery-lead 17. The locking-circuits are completed, as before described, through the ground spring 33 of the cut-off relay, whereby when a connection is established in response to the signal, as hereinafter described, and the cut-off relay R^5 is actuated the said locking-circuits are opened at said spring 33. The circuit of the lamp upon the A division is now open at spring 45 of relay R^4. The circuit of the lamp upon the C division is open at spring 63 of relay R^2, while the similar lamp upon the D division remains open at spring 65 of relay R^3.

The lamp at the C division of the switchboard may be selectively operated from the substation by key *c*, which serves to ground both conductors 7 and 8 of the line-circuit, thus permitting current to flow from the live pole of the battery F over the two paths singly traced for the keys *a* and *b*, but with the result that the equal currents flowing through the differential windings of the relay R^2 are neutralized, thus preventing the operation of said relay, while the two relays r^3 and r^4 respond to these currents and are therefore actuated and locked up. The operation of these two relays effects the closing of the signal-lamp at the C division from the battery-lead 17 over conductor 59, through the pilot-relay R, the signal-lamp S, conductor 60, spring 61 of relay R^4, its forward contact, conductor 62, the normal contact and spring 63 of relay R^2, conductor 64, the forward contact and spring 65 of relay R^3 to ground. This signal as well as its pilot-signal are therefore actuated to indicate the call of the subscriber. Although the relays R^3 and R^4 are now operated, the fact that the springs of relay R^2 are in normal position serves to open the circuits of the other three lamps of the line, which are therefore inert. Assuming, however, that the subscriber wishes a connection with another subscriber having his multiple jacks upon the D division of the switchboard, he operates the key *d* with the result, as just described, that both line-wires are grounded, but the conductor 8 has its circuit to ground completed through the five-hundred-ohm resistance-coil 9. This results in unbalancing the magnetic effects of the currents flowing through the two differential windings of the relay R^2, which is thus actuated in addition to the other two relays R^3 and R^4. The simultaneous operation of these three relays results in closing only one of the signal-circuits—namely, that of the lamp located upon the division D, which is completed from the battery-lead 17 over conductor 66, through the lamp, conductor 67, spring 68 of relay R^4 and its forward contact, conductor 69, forward contact and spring 63 of relay R^2, conductor 64, forward contact and spring 65 of relay R^3 to ground. The circuit of the A-division lamp is now open at spring 45 of relay R^4, that of the B lamp is open at spring 55 of relay R^3, while the circuit of the C lamp is open at spring 65 of relay R^2. The lighting of this signal is answered by the insertion of the answering-plug of the operator's cord-circuit, which completes a path for current from the live pole of the battery F, through the sleeve supervisory relay r^2, sleeve-strand *s* of the cord-circuit, sleeve conductors 31 and 30 of the jacks, and through the cut-off relay R^5 to ground. The actuation of this cut-off relay serves to disconnect the line conductors

7 and 8 from the three line-relays and to connect them with the conductors 27 and 30, leading to the jacks. At the same time the spring 33 serves to open the circuits of the locking-windings of said line-relays, which are therefore deënergized and return to normal position. The signal-lamps are thus rendered inert and prevented from again operating during the connection. The subscriber having taken up his receiver, a complete path over the metallic line is provided for current from the battery F, whereby both supervisory relays r and r^2 are operated, the former serving to open the local circuit of the supervisory signal S^3, which therefore remains dark. In order to converse with the subscriber, the operator actuates her listening-key, thus bridging her instrument across the cord-circuit, and upon receiving the order tests the condition of the wanted line by means of the tip of the calling-plug. Under normal conditions the test rings or sleeves of the lines are disconnected from any current source; but upon the connection of the cord-circuit, as just described with reference to the answering-plug P, the live pole of a battery is connected with the sleeve conductors of the jacks. It therefore follows that the sleeve-rings of all jacks of the line are raised to a potential above that of the earth and are in condition to test busy upon the completion of a path for current therefrom to ground or to the other pole of the battery. Touching the tip of the calling-plug completes such a testing-path from the tip of said plug over strand t^2, spring 70 of sleeve supervisory relay r^4, its normal contact, conductor 71, through test-relay r^5, and conductor 72 to ground. If the line is idle, the test-relay will not respond and no click will be received by the operator; but if the line is busy the test-relay will respond and close, through its armature and forward contact, a path for current from the battery-lead 17, through impedance-coil 79, and the primary of the inductance-coil to ground. This causes a click in the operator's receiver. The high resistance of the test-relay prevents a large variation of current upon the tested line in case it is connected for conversation, and the high impedance prevents a sudden variation. Upon finding the line idle the calling-plug P^2 is inserted in one of the multiple jacks of the wanted-subscriber's line, and the calling-key 83 83 is operated. The insertion of the plug P^2 completes a path over the sleeve-strand of the cord-circuit from the live pole of the battery F^2 through the cut-off relay R^5 for the line, which is thus actuated to render all of the line-signals for the line inert. The operation of the ringing-key does not destroy this condition, for the reason that the sleeve-spring 83 completes a path for current over said battery through the resistance-coil 84 and the battery-lead 17, so that the cut-off relay remains actuated during ringing. Ringing-current is sent out over the tip side of the line from the generator 81 to the substation and back over the sleeve side of the line and through the said resistance 84, the battery-lead 17, and battery F^2 to ground. As soon as the ringing-key is released the supervisory relay r^4 of the cord-circuit is actuated to disconnect the test-relay and complete the tip-strand of the cord-circuit for conversation. At the same time the local circuit of the supervisory signal S^4 is closed, and since the tip-relay r^3 is not yet actuated said signal is lighted to indicate the fact of the non-response of the subscriber. Upon the response of the called subscriber a complete path for current from the battery F^2 is established over the metallic line and over both sides of the cord-circuit, whereby said tip supervisory relay r^3 responds, thus opening the circuit of the supervisory signal S^4 and rendering the same inert. The operator is thus apprised of the fact that the subscribers are in communication. At this time the batteries F and F^2 are furnishing current for the operation of the several relays associated with the connected lines and the transmitters at the substation. At the termination of the conversation the subscribers return their receivers to the hooks, with the result that the metallic lines are opened at the substation and the tip supervisory relays r and r^3 are deënergized to close the local circuits of the corresponding supervisory relays S^3 and S^4, which are thus lighted. Upon observing these signals the operator takes down the connection and all parts are restored to normal position.

The substation apparatus is intended to indicate any desired common battery set, and the ringing and listening keys are only diagrammatically shown and are intended to designate any ordinary key, preferably the kind in which the actuation of a single lever in one direction will simultaneously actuate both the tip and sleeve springs. The several grounds referred to may be and in practice usually are one and the same or the common office-ground or common return. Several sets of batteries may be employed, although it is preferable to use a single set for the exchange.

Various other modifications may be made in my invention without departing from the scope or principle of the same.

I claim—

1. In a telephone system, the combination with a telephone-line, of a relay at the central office in each line conductor and actuated thereover, a differential relay having a winding in each line conductor, and telephonic apparatus affected by said relays when operated, substantially as described.

2. In a telephone system, the combination with a telephone-line, of a relay at the central office in each line conductor and actuated thereover, a differential relay having a winding in each line conductor, a locking-circuit for each of said relays to maintain the same

actuated, and telephonic apparatus affected by said relays when operated, substantially as described.

3. In a telephone system, the combination with a telephone-line having a signal upon each of the four divisions of a switchboard, of three line-relays for the line controlling through their contacts the circuits of said signals; one of said relays having its actuating-winding in one conductor, another having its winding in the other line conductor, and the other relay having a winding in each line conductor differentially disposed with reference to current over the two sides of the line in parallel; a central source of current having its live pole connected with both of said line conductors, four switches located at the substation and corresponding to the four line-signals, two of said switches being adapted to ground their respective line conductors to simultaneously actuate the differential relay and the corresponding relay, another of said switches being adapted to ground both line conductors whereby the differential relay remains neutral while the other two are actuated, and the fourth key serving to ground both line conductors but including a resistance in one of said conductors, whereby the magnetic effects of the current in the two coils of the differential relay are unbalanced and all relays are actuated, substantially as described.

4. In a telephone system, the combination with a telephone-line, of normally disconnected jacks therefor located upon the several divisions of a divided central switchboard, a signal for the line in each of the divisions, a plurality of relays for the line less than the number of signals, a central common source of current to operate said relays, said relays serving to control the circuits of the signals, a cut-off relay for the line actuated over a portion of the talking-circuit when a connection is established with the line at any of the divisions, said cut-off relay serving when actuated to disconnect said relays and signals from the line and to connect the spring-jacks therewith, substantially as described.

5. In a divided central system, the combination with a telephone-line, of a plurality of signals therefor located upon the different divisions of a switchboard, a plurality of relays controlled from the substation to cause the desired operation of said signals, one of said relays being operated by current over one line conductor, another by current over the other line conductor, and still another by current over both conductors of the telephone-line, a central common source of current to furnish current for the operation of said relays, and means to render said signals inoperative when a connection is established with the line for conversation at any of the divisions of the switchboard, substantially as described.

6. In a divided central system, the combination with a telephone-line, of a plurality of signals therefor located upon the different divisions of the switchboard, a plurality of relays controlled from the substation to cause the desired operation of said signals, a common source of current connected with the line at the central office, one of said relays being operated by current from said source over one line conductor, another by current from said source over the other line conductor, and still another by current from said source over both line conductors, and means to render said signals inoperative when a connection is established with the line for conversation at any of the divisions of the switchboard, substantially as described.

7. In a divided central system, the combination with a telephone-line, of a plurality of signals therefor located upon the different divisions of the switchboard, a plurality of relays associated with the line and controlled from a substation to cause the desired operation of said signals, a common source of current connected with the line at the central office, one of said relays being operated by current from said source over both sides of the telephone-line in parallel, and means to render said signals inoperative when a connection is established with the line for conversation at any of the divisions of the switchboard, substantially as described.

8. In a divided central system, the combination with a telephone-line, of a plurality of signals therefor located upon the different divisions of the switchboard, a plurality of relays controlled from the substation to cause the desired operation of said signals, a common source of current connected with the line at the central office, one of said relays being operated by current from said source over one line conductor, a second from said source over the other line conductor and a third from said source over both line conductors in parallel, and means to render said signals inoperative when connection is established with the line for conversation at any of the divisions of the switchboard, substantially as described.

9. In a divided central system, the combination with a telephone-line, of a plurality of signals therefor located upon the different divisions of the switchboard, a plurality of relays associated with the line and controlled from the substation to cause the desired operation of said signals, a common source of current to which the line is connected at the central office, one of said relays being differential and operated by current from said source over both sides of the telephone-line, and means to render said signals inoperative when a connection is established with the line for conversation at any of the divisions of the switchboard, substantially as described.

10. In a divided central system, the combination with a telephone-line, of a plurality of signals therefor located upon the different divisions of the switchboard, a plurality of re-

lays at the central office associated with the line and controlled from the substation to cause the desired operation of said signals, one of said relays being placed in each line conductor and actuated thereover, and a differential relay having a winding in each line conductor, and means to render the said signals inoperative when a connection is established with the line for conversation at any of the divisions of the switchboard, substantially as described.

11. In a divided central system, the combination with a metallic telephone-line, of a plurality of signals therefor located upon the different divisions of the switchboard, a plurality of relays for the line controlled from the substation to selectively cause the operation of said signals, one of said relays having a winding in each side of the line whereby it may be operated by current over either line conductor, and means to render said signals inoperative during connections for conversation with the line at any division of the switchboard, substantially as described.

12. In a divided central system, the combination with a metallic telephone-line, of a plurality of signals therefor located upon the different divisions of the switchboard, a plurality of relays for the line controlled from the substation to selectively cause the operation of said signals, one of said relays being in one line conductor and a second relay having a winding in each conductor, whereby both relays may be simultaneously operated by current over one side of the line and the second relay may be operated independently of said first relay by current over the other side of the line, and means to render said signals inoperative during connections for conversation with the line at any division of the switchboard, substantially as described.

13. In a divided central system, the combination with a metallic telephone-line, of a plurality of signals therefor located upon the different divisions of the switchboard, a plurality of relays for the line controlled from the substation to selectively cause the operation of said signals, one of said relays being located in each line conductor and a third relay having a winding in each line conductor, whereby said third relay may be operated simultaneously with either of the other relays by current over the corresponding conductor of the telephone-line, and means to render said signals inoperative during connections for conversation with the line at any division of the switchboard, substantially as described.

14. In a divided central system, the combination with a metallic telephone-line, of a plurality of signals therefor located upon the different divisions of the switchboard, a plurality of relays for the line controlled from the substation to selectively cause the operation of said signals, one of said relays having a winding in each side of the line and being differential to current over both sides of the line in parallel, and means to render said signals inoperative during connections for conversation with the line at any division of the switchboard, substantially as described.

15. In a telephone system, the combination with a telephone-line, of telephonic apparatus associated with the line, three relays adapted to be operated in different groups to suitably control said apparatus, one of said relays having a winding in each side of the line differentially disposed with reference to current over both sides of the line in parallel whereby the said relay may be operated by current over either line conductor and remain inoperative by current over both sides of the line in parallel, substantially as described.

16. In a divided central system, the combination with a metallic telephone-line, of a plurality of signals therefor located upon the different divisions of the switchboard, a plurality of relays for the line controlled from the substation to selectively cause the operation of said signals, one of said relays being in each line conductor and a third having a winding in each line conductor and being differential to currents over the two sides of the line in parallel whereby said third relay and one of the other relays may be operated together by current over the appropriate line conductor and said first two relays may be operated together without operating said third relay by current over the two sides of the line in parallel, and means to render said signals inoperative during connections for conversation with the line at any division of the switchboard, substantially as described.

17. In a telephone system, the combination with a telephone-line, of telephonic apparatus associated with the line, three relays for the line, one of said relays being placed in each line conductor, and the other relay having a winding in each side of the line differentially disposed with reference to current over the line conductors in parallel, means to cause current flowing over both sides of the line in parallel to produce equal and opposite effects in the differential windings of said relay and unequal effects in said relays, whereby said differential relay may be operated simultaneously with said other relays or said other relays may be operated simultaneously without operating said differential relays to affect said telephonic apparatus, substantially as described.

18. In a telephone system, the combination with a telephone-line, of telephonic apparatus associated with the line, three relays for the line, one of said relays being placed in each line conductor and the other relay having a winding in each line conductor differentially disposed with reference to current over both sides of the lines, means to cause current to flow over either line conductor alone to thereby operate the corresponding relay and the

differential relay, means to cause current to flow over the telephone-line to produce equal and opposite effects in the differential relay whereby the other two relays may be simultaneously operated without operating the differential relay, and means to cause current over both sides of the line to produce unequal effects in said differential coils whereby all of the relays may be simultaneously operated to affect said telephonic apparatus, substantially as described.

19. In a divided central telephone system, the combination with a metallic telephone-line, of four signals therefor located upon different divisions of the switchboard, three relays for the line at the central office, one in each line conductor and the third relay having a winding in each side of the line differentially disposed with reference to current over the two sides of the line in parallel, switches at the substation for grounding either of the line conductors singly, for directly grounding both line conductors simultaneously, and for grounding both line conductors simultaneously and at the same time including a suitable resistance in the path of current over one line conductor, a common source of current at the central office connected between ground and the two sides of the telephone-line, the circuits of said signals being suitably controlled through the contacts of said relays whereby the subscriber may cause the simultaneous operation of the differential relay, and either of the other relays by current over the proper line conductor, the simultaneous operation of the two first-mentioned relays without operating the differential relay by current over both line conductors and the simultaneous operation of all three relays by current over both line conductors and through said resistance to thereby cause the desired operation of any of said signals, substantially as described.

Signed by me at Chicago, county of Cook, State of Illinois, this 23d day of October, 1902.

WILLIAM W. DEAN.

Witnesses:
ROBERT LEWIS AMES,
GAZELLE BEDER.