No. 854,279. PATENTED MAY 21, 1907.

W. W. DEAN.

TELEPHONE EXCHANGE SYSTEM.

APPLICATION FILED MAY 19, 1905.

2 SHEETS—SHEET 1.

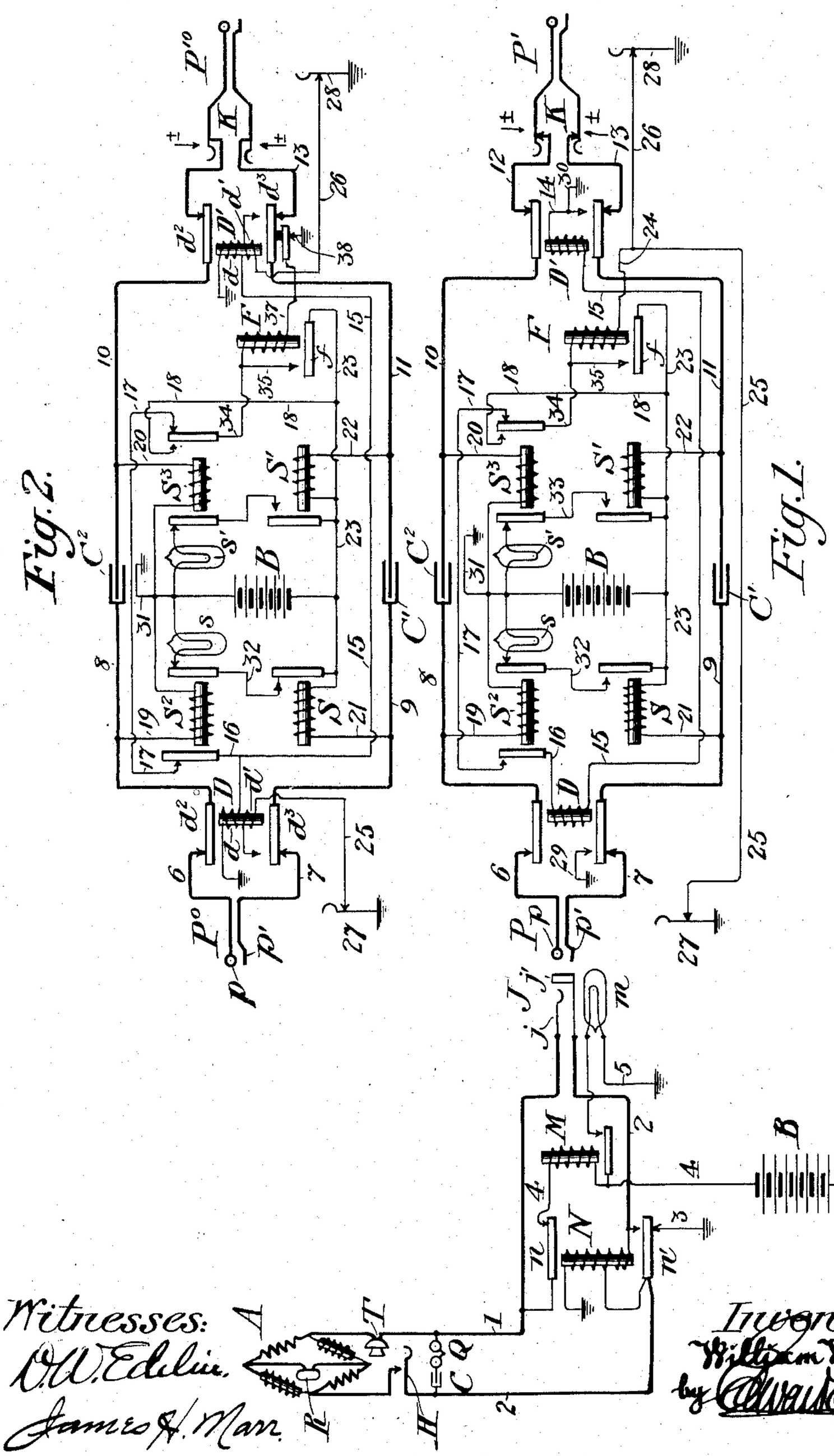

Fig. 1.

Fig. 2.

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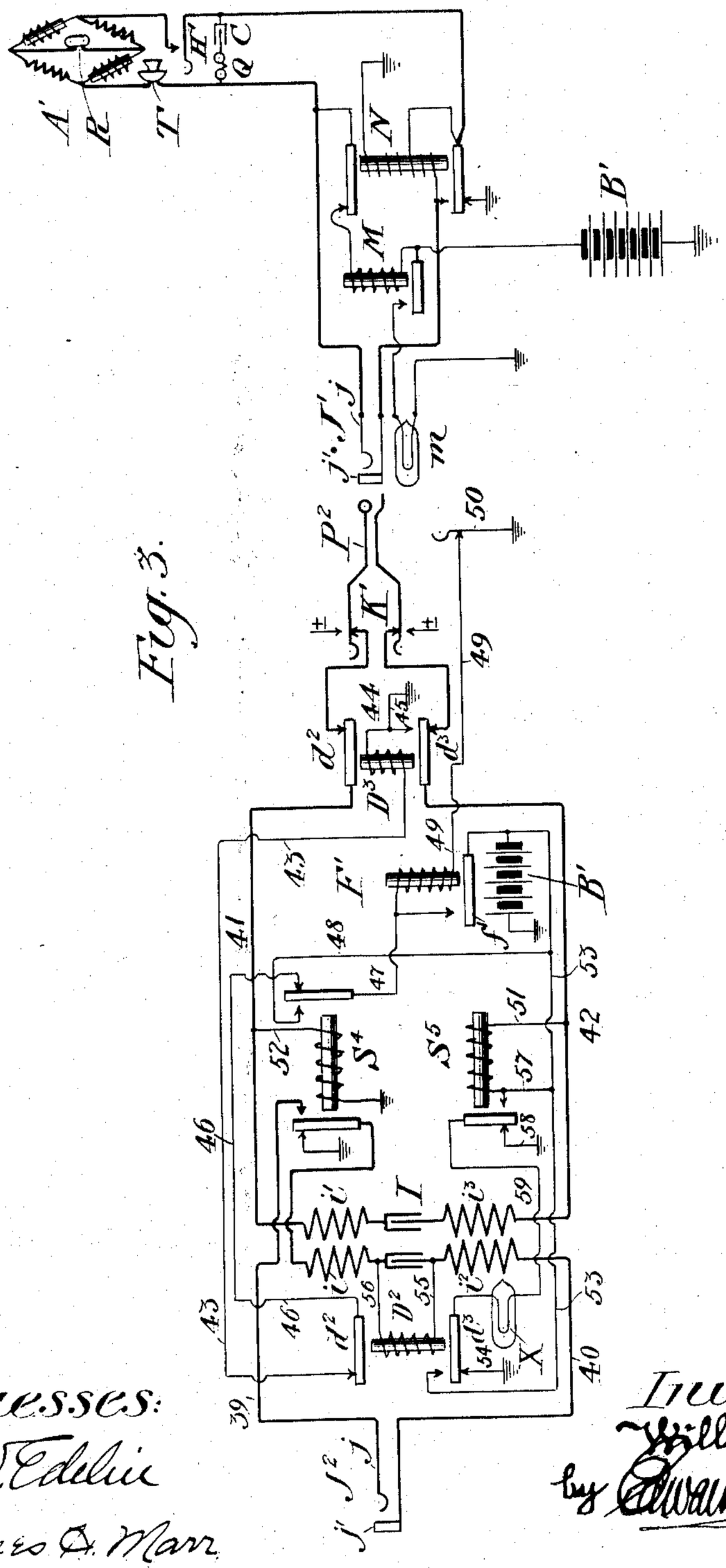
2 SHEETS—SHEET 2.

Fig. 3.



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UNITED STATES PATENT OFFICE.

WILLIAM W. DEAN, OF ELYRIA, OHIO, ASSIGNOR TO THE DEAN ELECTRIC COMPANY, OF ELYRIA, OHIO, A CORPORATION OF OHIO.

TELEPHONE-EXCHANGE SYSTEM.

No. 854,279. Specification of Letters Patent. Patented May 21, 1907.

Application filed May 19, 1905. Serial No. 261,131.

To all whom it may concern:

Be it known that I, WILLIAM W. DEAN, a citizen of the United States, residing at Elyria, in the county of Lorain and State of Ohio, have invented certain new and useful Improvements in Telephone-Exchange Systems, of which the following is a specification, reference being had therein to the accompanying drawings.

My invention relates to telephone exchange systems, and has for its object the arrangement of a system so that the subscriber may at all times absolutely control his line, and the lines cannot be "hung up" by the operators through failure to disconnect promptly after conversation.

Heretofore, even in the most improved modern common battery systems equipped with automatic signals, considerable annoyance and delay have been caused by the failure of operators to disconnect lines instantaneously upon receiving the disconnect signal. In a system having double supervisory lamps, the operator may of course be called by either subscriber flashing his lamp. In the case of the subscriber who was the caller before, this usually means that he wants a "recall," and the same operator will naturally make the second connection, so that in any case he would have to wait until this operator was at leisure to attend to this new call. Not so the called subscriber, however. Unless he should chance to come in on the same answering position as his caller, his multiple jack only would be then reached and in use; and it would be contrary to the rules of all well regulated exchanges to permit a call coming in on a multiple jack to be completed by the subscriber's operator who had previously connected that jack for a call. Such a course would inevitably lead to confusion through a lack of control by the manager, of the distribution of the lines for answering purposes among the subscribers' operators. It being impossible for the previously called subscriber to do more than idly flash his supervisory, his line is hung up in a double sense, for he is forced to wait for disconnection upon the convenience of the other man's operator, and he cannot reach his own operator to get relief.

By my present invention the foregoing difficulties and many others are obviated, without in any way changing or diminishing the efficiency of the present standard common battery circuits.

Briefly stated, my invention comprises supplementary cut-off relays inserted in the cord circuits and controlling the continuity thereof between the plugs and the ordinary supervisories. These relays are brought into service at the end of a communication when the subscribers hang up their receivers, their circuits being closed (and being locked), when the supervisories have finally responded, so that the plugs are disconnected from the intermediate cord circuit apparatus, and each subscriber's line is immediately free, the cut-off relays at once putting them back on their line signals, so that they can make calls and be answered in the ordinary way without regard to the idle and disconnected plugs sticking in their jacks.

My invention is illustrated in the accompanying drawings, wherein

Figure 1 is a diagram showing a central office connecting circuit equipped with my invention, and a subscriber's line circuit adapted to coöperate therewith; Fig. 2 is a modified cord-circuit; and Fig. 3 illustrates the adaptability of the invention to a trunk circuit. Figs. 1 and 3 are meant to be read together in order to get the proper sequences of operation.

Referring to the drawings, A in Fig. 1 and A′ in Fig. 3 are two subscribers' stations, having the same apparatus throughout, and the same line connections, so the description of Fig. 1 will suffice for both.

R is the receiver connected in the bridge wire of a Wheatstone bridge having choke coils in two of its arms and balancing non-inductive resistance in the other two, the idea being that battery currents do not affect the receiver, but voice currents are forced through it.

T is the transmitter, H is the switch-hook, Q is the ringer and C the condenser, all these being of the usual type. From the sub-station the line-wires 1 and 2 pass to the central office to the contacts *n* and *n′* of the cut-off relay N connected through its whole length from ground to the sleeve side of jack, and normally deënergized. Contact *n′* is grounded at 3 and contact *n* is connected by wire 4 through the line relay M to the main battery B. The line relay when energized, by closure of the circuit at the sub-station, lights the

lamp *m* through the wire 5. The line jack is shown at J, with sleeve and spring contacts *j'*, *j*, and with this jack coöperates the answering plug P. It will be understood that although I have only shown one jack for each line, there are supposed to be multiple jacks where required.

The plug P and the plug P' are normally connected by way of the conductors 6—8—10—12 and 7—9—11—13, broken of course by the condensers C^2, C'. Between 6 and 8, 10 and 12, 7 and 9, and 11 and 13 are inserted contacts controlled in pairs by the relay magnets D and D'. In these and their coöperating circuits my invention resides. The main battery B is bridged in the cord as usual, each end of the cord being typical, the battery connected to the sleeve side 9 through supervisory control relay S and to the tip side 8 through the supervisory relay S^3, wires 19 and 21 thus forming a bridge on one side of the condensers, and wires 20 and 22, with the corresponding relays S', S^3 forming a similar bridge on the other side. When a plug is inserted the relay S or S' pulls up at once, taking current from ground to battery and ground over the sleeve side, 9—7—2, in series with the cut-off relay N. This puts battery on the wire 32 or 33, as the case may be, and the lamp *s* or *s'* is thereafter controlled by the relay S^2 or S^3, itself controlled over the tip side of line from the subscriber's station.

From extra back contacts in series, of the relays S^2 and S^3 I derive the circuit of my control relays, D, D', which may be traced as follows: battery B, 23, *f*, 35, 34, 17, 16, D, 15, D', 14, 30 and ground. Besides the two armatures of relays S^2 and S^3, this circuit is controlled by the locking relay F. Of course the relays D, D' must be normally deënergized, and in order that they may cut off the plugs, two steps should be required; first the called subscriber should have answered, whereupon the relay S^3 would hold up, and second the subscriber should have hung up his receiver, whereupon this relay should have let go. I put in the relay F in order to respond to these two conditions. It is energized through the wire 34 by the relay S^3 when the called subscriber answers, battery then coming on the relay F, which pulls up and puts battery on itself to lock, by the circuit I have traced. In order that it shall unlock again, both the plugs P, P' must be in their seats, each seat being provided with the plug-seat switch closed to ground the wire 24 and relay F through the branches 26—28, and 25—27 when the plugs are out.

The object of the modified arrangement in Fig. 2 is to make the disconnect mechanism of the answering and calling sides of the cord independent. This is accomplished by having locking windings on the relays D and D', each winding controlled by a contact of its own relay, and a contact in its own plug-seat switch. These two relays are primarily operated by their upper windings, *d*, as already described in connection with Fig. 1. As soon as they are operated they lock by connecting the battery wires 21 and 22 to the locking winding, *d'*, and thence through their respective ground wires 25 and 26 to the plug-seat switches 27 and 28. The locking relay F in this case has its circuit 37 controlled by auxiliary contacts of relay D'.

Referring now to Fig. 3, I have here shown a trunk line supposed to interconnect two exchanges. The outgoing trunk jack J^2 and the incoming trunk plug P^2 are connected for purposes of conversation by conductors 39—41, 40—42. Interposed in the trunk is the repeating coil I, with windings *i*, *i'* i^2, i^3, between equal windings on each side of the coil, a condenser being interposed to prevent the passage of battery current. The connection 39 on the tip side of the incoming trunk line is normally broken at contacts of relay S^4 which corresponds to the supervisory relay S^3 in the cord-circuit. In series with the windings *i*, i^2, of the repeating coil, is a shunt relay D^2, connected around the condenser. This relay controls the clearing-out lamp X, and also controls the continuity of the circuit 43, 44 of the disconnect relay D^3. The relay D^2 corresponds to the supervisory relay S^2 in the cord-circuit, and the relay D^3 is controlled by the two relays D^2 and S^4 with contacts in series, battery being applied in the beginning by the locking relay F' similar to F in Figs. 1 and 2.

The arrangement and functioning of my system will be better understood from a statement of the operation, than from further detailed description.

The operation of the circuit shown in Fig. 1 is as follows: Subscriber A calls, closing hook contacts H. Line relay M takes current and lamp *m* lights. Plug P is inserted and number obtained. The line wanted is tested and plug P' inserted. When plug P is inserted the cut-off circuit is completed through the sleeve side of the cord as follows: 31, B, 23, S, 21, 7, *p'*, 2, N, ground. Relay S pulls up and puts battery on wire 32. Circuit 1—2 being closed at sub-station, current flows over the path already traced, and as relay N has pulled up, current continues through armature *n'* and by the following path: 2, H, T, 1, *j*, *p*, 6, 19, S^2, 31. Relay S^2 pulls up, extinguishes lamp *s*, and breaks the circuit of relays D, F and D'. When the called subscriber answers relay S^3 pulls up, extinguishes lamp *s'* and puts battery on relay F by the following path: 31, B, 23, 18, 34, F, 24, 26, 28 or 25, 27. Relay F pulls up and locks itself by closing *f* on to 35. This also puts battery on to the wire 34 through 35, so that when the two armatures of relays S^2 and S^3 ultimately fall back when

both subscribers have hung up their receivers, (owing to the then breaking of the line circuit,) the following circuits for relays D, D′, will be established: 31, B, 23, *f*, 35, 17, 16, D, 15, D′, 14, 30. Both relays D, D′ then pull up, cutting off the plugs from the rest of the circuit. These bare plug ends, which are harmless, may be left in the jacks without affecting the lines in any way; and in order to keep current on the wires 32, 33 so as to continue the lighting of lamps *s*, *s*′, when once they glow, I provide the grounds 29 and 30 which are put on by the respective relays D, D′ to replace the grounds of the cut-off relays, which of course are removed from the sleeve side of the cord when the latter is broken.

The cord thus being disconnected from the lines, two results are achieved: First, the subscribers who were connected are instantly free to make other calls, because their cut-off relays N put their lines back on to their line relays. Second, neither line tests "busy." This is a very important point, for as the percentage of "busy lines" in a busy exchange ranges from 10 to 17 per cent., it is safe to assume that the operator with 16 or 17 pairs of cords to attend to is responsible for a sufficient part of this percentage to make a substantial gain by my invention. According to the old system, as long as a plug is in the jack the line tests "busy." According to this system the line will not test busy after conversation has ceased.

When the operator gets ready to disconnect she takes down the plugs P, P′, and their restoration to their seats opens the switches 27 and 28, thereby breaking the circuit through the locking relay F, which lets go, and battery is at once taken off the wire 34, and hence off the relays D and D′. These relays then retract, and the cord-circuit is again complete ready for another operation.

The operation according to Fig. 2 is the same as that of Fig. 1, with the following differences: The relays D and D′ take current in parallel instead of in series, their windings *d* being in separate branches off the wires 16, 17, 34, and when the relay F is energized 35, 23, B. When these relays have pulled up, due to the deënergization of the relays S^2 and S^3, they lock themselves independently, relay D by the following path: B, S, 21, d^3, *d*′, 25, 27; and the relay D′ by the following path: B, 23, S′, 22, 11, *d*′, 26, 28. As D′ pulls up it breaks the circuit of the relay F at 38. The original or operating circuit by way of wire 35 is then broken and thenceforth each of the relays D, D′, holds up through its own armature d^3. The replacing of either plug in its seat will therefore deënergize the corresponding relay only.

The operation of the trunk circuit is as follows: Assume the call to have originated with subscriber A, in Fig. 1, and the party called for as subscriber A′ in Fig. 3: The operation is the same as already described up to the testing and insertion of plug P′. The wanted subscriber in this case being in another exchange, the subscriber's operator connects on an order wire and instructs the trunk operator in Fig. 3 as to the number desired, receiving in return her instructions to use a particular trunk, say the one shown in the figure. The subscriber's operator then immediately inserts plug P′ in the trunk jack J^3, whereupon a circuit is closed from the battery B in Fig. 1 through the relay S′ and the sleeve side of the trunk, through the winding i^2, relay D^2, wires 55 and 56, winding *i*′ to the armature of relay S^4 and ground. Relay S′ pulls up as before and puts battery on the wire 33. Relay D^2 pulls up in Fig. 3 and closes the following circuit for the guard lamp X: B′, 53, d^3, X, 59, 58 and ground. Lamp X lights, and the trunk operator tests and inserts the plug P^3 in the wanted line jack J′. Current immediately flows from battery B′ by the following path: B′, 53, 57, S^5, 51, 42, d^3, P^2, *j*′ to relay N and ground. The cut-off relay N pulls up, and the relay S^5 also pulls up, breaking the circuit of lamp X. When the subscriber A′ answers, relay S^4 pulls up, being energized by current flowing out to line over the sleeve side, and back over the tip side. This relay pulls up, and puts current on the locking relay F′ by the following path: B′, 48, 47, F′, 49, 50 and ground. F′ pulls up, and locks itself at the armature *f*′. The pulling up of relay S^4 also takes the ground off of coil *i* and completes the metallic circuit therethrough, thus performing the same function for the operation of the supervisory lamp *s*′ in Fig. 1 as if the trunk line were a subscriber's line. The relay D^2 continues to hold up as long as the plug P′ is in the trunk-jack J^2, being then bridged across the metallic circuit. When the called subscriber hangs up, the relay D^3 in Fig. 3 is energized, and the lamp X is lighted, in the following manner: (1) Relay S^4 becomes de-energized, cutting off the wire 39 from the coil *i*, and grounding the latter thereby causing the relay S^3 in Fig. 1 to become de-energized, whereupon the wires 12 and 13 are cut off as already described. The cutting off of these wires deprives the relay D^2 in Fig. 3 of current, and it lets go, whereupon the relay D^3 takes current by the following path: B′, *f*′, 47, 46, d^2, 43, D^3, 45 and ground. (It will be remembered that F′ is energized and locked.) Relay D^3 in pulling up, completes the grounded circuit: 45, d^3, 42, 51, S^5, 57, B′; whereupon the relay S^5 puts current on the lamp X through the circuit: B′, 53, 57, 59, X, d^3, 54 and ground.

When the subscribers hang up their receivers after conversation, the operation in Fig. 1 is the same as already described, at least as to the lighting of the lamp *s*. On

the trunk end, however, the following ensues: relay S^4 lets go, and relay D^3 gets current by the following path: B', f', 47, 46, d^2 (D^2 being deënergized when S^4 opened the metallic circuit 39), 43, D^3, 45 and ground. Relay D^3 pulling up disconnects the plug P^2, but puts the ground 45 on to wire 42 so as to keep relay S^5 energized over the following path: B', 53, 57, S^5, 51, 42, d^3, 45 and ground. This maintains lamp X lighted for clearing out, until the plug P^2 is withdrawn, and in its seat, when the ground is taken off at 50, relay F' lets go, battery is thereby taken off the wire 47, and everything is restored to normal.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. In a telephone exchange system subscribers' lines having switching terminals, operators' connective circuits having co-operating switching terminals, and means controlled by the subscribers through said circuits for disconnecting the same for operative purposes from the subscribers' lines, without disconnecting or dissociating the said switching terminals, substantially as described.

2. In a telephone exchange system, subscribers' lines, having switching terminals, operators' cord-circuits having co-operating terminals for interconnecting the same, switch contacts separated from said terminals normally completing said cord circuits during conversation, electromagnets connected to said circuits and controlled by the subscribers to operate said switch contacts and thereby disconnect all operative parts of the cord-circuit from the subscribers' lines at the end of a conversation, substantially as described.

3. In a telephone exchange system, subscribers' lines, and operators' plug cord-circuits for interconnecting the same, a cut-off relay for each cord-circuit, and connections therefor such that upon giving a clearing-out signal a subscriber will energize a cut-off relay to sever the cord from his line, without regard to the position of any connecting plug, substantially as described.

4. In a telephone exchange system, a subscribers' line and an operator's cord-circuit, a clearing out signal connected with said cord and adapted to be controlled by the subscriber to indicate that disconnection is desired, together with a cut-off relay controlling the continuity of the cord at the terminal or subscriber's end thereof, and means whereby said cut-off relay is operated upon the operation of the clearing out signal, substantially as described.

5. In a telephone exchange system, subscribers' lines and an operator's cord-circuit for interconnecting them, a clearing out signal associated with said cord-circuit, and controlled by the subscribers, and a cut-off relay controlling the continuity of the cord-circuit and itself controlled by the operation of the clearing out signal, substantially as described.

6. In a telephone exchange system subscribers' lines, with means at the subscribers' station for determining the flow of current in each line, a common source of current supply for all the lines, and an operator's cord-circuit for interconnecting them, a supervisory signal and a controlling relay therefor associated with the cord-circuit, a cut-off relay also associated with the cord-circuit and controlling the continuity thereof, and circuit connections for said cut-off relay controlled by the supervisory relay, whereby at the conclusion of a conversation and the cessation of the current flow through the subscribers' line, the cord-circuit will be severed, substantially as described.

7. In a telephone exchange system, a plurality of subscribers' lines and a common source of current supply therefor, an operator's cord-circuit having terminal plugs for interconnecting the line jacks, a supervisory relay associated with the cord-circuit and under the control of a subscriber when connected, a cut-off relay controlling the continuity of the cord-circuit, and a locking relay, the circuit of the cut-off relay being jointly controlled by the supervisory relay and the locking relay, and means whereby said locking relay will operate to place the cut-off relay circuit under exclusive control of the supervisory relay when a connection is completed, substantially as described.

8. In a telephone exchange system, a plurality of subscribers' lines terminating in jacks, and an operator's cord-circuit terminating in plugs for interconnecting the lines, a pair of supervisory signal magnets associated with the cord-circuits and so connected that each will respond to the control of one of a pair of connected subscribers only, a cut-off relay controlling the continuity of the cord-circuit, a locking or battery control relay initially controlled by the called subscribers' supervisory signal magnet and a circuit for the cut-off relay thereby placed under the joint control of both supervisory relays, substantially as described.

9. In a telephone exchange system, subscribers' lines and an operator's cord-circuit having terminal plugs for interconnecting the lines, a supervisory signal magnet associated with each plug and controlled during connection by the corresponding subscriber, a cut-off relay associated with each plug and adapted when operated to disconnect the plug from the cord-circuit, and circuits for said cut-off relays controlled by said supervisory signal magnets, substantially as described.

10. In a telephone exchange system, subscribers' lines and an operator's cord-circuit having terminal plugs for interconnecting

the lines, a supervisory signal magnet associated with each plug and controlled during connection by the corresponding subscriber, a cut-off relay associated with each plug and adapted when operated to disconnect the plug from the cord-circuit, a locking or battery supply relay under the control of the calling plug supervisory and adapted to be energized upon the completion of a connection to supply battery current to the cut-off relay circuits, said circuits being thereafter jointly controlled by the supervisory signal magnets, substantially as described.

11. In a telephone exchange system, subscribers' lines and an operator's cord-circuit having terminal plugs for interconnecting the lines, a supervisory signal magnet associated with each plug and controlled during connection by the corresponding subscriber, a cut-off relay associated with each plug and adapted when operated to disconnect the plug from the cord-circuit, a locking or battery supply relay under the control of the calling plug supervisory and adapted to be energized upon the completion of a connection to supply battery current to the cut-off relay circuits, said circuits being thereafter jointly controlled by the supervisory signal magnets; together with means controlled by the operator upon withdrawing the plugs, to break the cut-off relay circuit and to restore the cord to operative condition, substantially as described.

12. In a telephone exchange system, subscribers' lines and an operator's cord-circuit having terminal plugs for interconnecting the lines, a supervisory signal magnet associated with each plug and controlled during connection by the corresponding subscriber, a cut-off relay associated with each plug and adapted when operated to disconnect the plug from the cord-circuit, a locking or battery supply relay under the control of the calling plug supervisory and adapted to be energized upon the completion of a connection to supply battery current to the cutoff relay circuits, said circuits being thereafter jointly controlled by the supervisory signal magnets, together with the supplemental winding on each cut-off relay closed to battery through a locking circuit when said relays are excited, and means controlled by the operator in removing the plugs, to break said locking circuits and thereby restore the cord-circuit to normal condition, substantially as described.

13. In a telephone exchange system, subscribers' lines and an operator's cord-circuit having terminal plugs for interconnecting the lines, a supervisory signal magnet associated with each plug and controlled during connection by the corresponding subscriber, a cut-off relay associated with each plug and adapted when operated to disconnect the plug from the cord-circuit, a locking or battery supply relay under the control of the calling plug supervisory and adapted to be energized upon the completion of a connection to supply battery current to the cut-off relay circuits, said circuits being thereafter jointly controlled by the supervisory signal magnets, together with a plug seat switch included in said cut-off relay circuit and opened to restore the same when the operator withdraws the plugs, substantially as described.

14. In a telephone exchange system, subscribers' lines and an operator's cord-circuit having terminal plugs for interconnecting the lines, a supervisory signal magnet associated with each plug and controlled during connection by the corresponding subscriber, a cut-off relay associated with each plug and adapted when operated to disconnect the plug from the cord-circuit, a locking or battery supply relay under the control of the calling plug supervisory and adapted to be energized upon the completion of a connection to supply battery current to the cut-off relay circuits, said circuits being thereafter jointly controlled by the supervisory signal magnets, together with a plug seat switch associated with each plug, and controlling the cut-off relay circuits, substantially as described.

15. In a telephone exchange system, subscribers' lines and an operator's cord-circuit having terminal plugs for interconnecting the lines, a supervisory signal magnet associated with each plug and controlled during connection by the corresponding subscriber, a cut-off relay associated with each plug and adapted when operated to disconnect the plug from the cord-circuit, a locking or battery supply relay under the control of the calling plug supervisory and adapted to be energized upon the completion of a connection to supply battery current to the cut-off relay circuits, said circuits being thereafter jointly controlled by the supervisory signal magnets, together with a pair of plug seat switches controlling parallel branches to complete said cut-off relay circuit, whereby both plugs must be withdrawn and in their seats in order to restore the circuits, substantially as described.

16. In a telephone exchange system, subscribers' lines, means under the control of operators for interconnecting the lines, and means controlled by the subscribers independently of the operators for severing in two parts the operator's connecting means, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

WILLIAM W. DEAN.

Witnesses:
A. D. P. LIBBY,
SIDNEY A. BEYLAND.