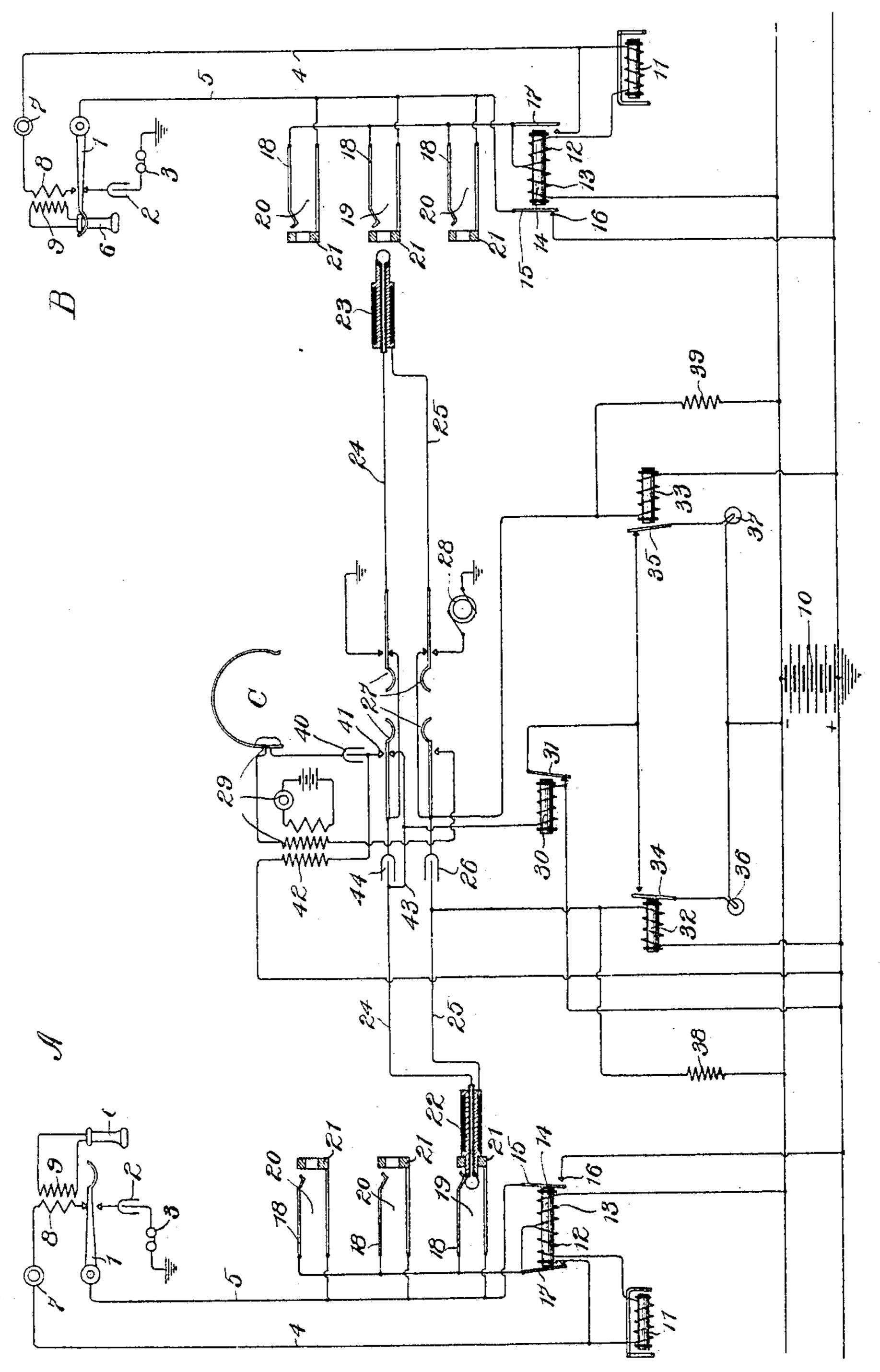
H. G. WEBSTER. TELEPHONE EXCHANGE SYSTEM.

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NO MODEL.



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TELEPHONE-EXCHANGE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 775,227, dated November 15, 1904.

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To all whom it may concern:

Be it known that I, HARRY G. WEBSTER, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Telephone-Exchange Systems, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawing, forming a part of this specification.

My invention relates to telephone-exchange systems, and more particularly to telephone-exchange systems in which the source of current for supplying signaling and talking currents is located at the central station.

My invention may further be described as relating to telephone systems in which a differential cut-off relay is employed at the central station for the purpose of destroying the substation control of a suitable line-signal.

My invention provides such a telephone system in which the contacts of the line-jacks are permanently connected with the limbs of the telephone-line. The test-thimbles of the line-jacks are normally connected to ground, whereby there is no variation of the potential of the test-thimbles due to earth-currents or inductive or static disturbances on the line.

A further advantage in my improved sys-3° tem consists in the provision of a clear ringing-circuit between the alternating-current generator at the central and the sub station.

My invention will be clearly understood by reference to the accompanying drawing, in 35 which is shown at substations A and B the customary substation apparatus, comprising in each instance a switch-hook 1, which when in its normal depressed condition connects the condenser 2 and call-bell 3 between the limbs 40 4 and 5 of the telephone-line. Upon the removal of the receiver 6 from the switch-hook 1 a circuit is closed between the line-limbs 4 and 5 through the transmitter 7 and the primary 8 of an induction-coil whose secondary 45 winding 9 is connected with the receiver 6. The line-limbs 4 and 5 lead to the central-station exchange C, where the limbs are normally connected with the terminals of a common source of current, such as the battery 10, whose positive pole is connected with the 50 ground, as shown. The line-limb 4 is connected with the negative pole of the battery 10 through a line relay or signal 11 and the two differential windings 12 and 13 of a cut-off relay 14. The line-limb 5 is normally consected through an armature 15 of the cut-off relay 14 and its back contact 16 with the positive grounded terminal of the battery 10. The second armature 17 of the cut-off relay 14 serves when in its attracted position to close 60 a low-resistance shunt-circuit about the line-relay 11 and the winding 12 of the cut-off relay 14.

The tip-contacts 18 of the answering-jack 19 and the calling-jacks 20 are connected with 65 the armature 17 and through the cut-off relay-winding 12 and line-relay 11 with the limb 4 of the telephone-line. It will be seen that the attraction of the armature 17 closes a circuit which directly connects the tip-con-70 tacts 18 of the line-jacks with the limb 4 of the telephone-line. The sleeve-contacts, which in this instance are also shown as the test-thimbles 21 of the line-jacks, are permanently connected with the limb 5 of the telephone-75 line.

The operator's cord connecting apparatus comprises an answering-plug 22 and a calling-plug 23, the tip-contacts of which are connected through a tip-strand 24 and the sleeve-80 contacts of which are connected through a sleeve-strand 25. The continuity of the sleeve-strand is interrupted by the inclusion of a condenser 26.

The usual operator's ringing and listening 85 key 27 is provided, which when actuated in one direction connects the calling-generator 28 with the cord-circuit and which when manipulated in the other direction connects the operator's telephone set 29 in bridge of the 90 cord-circuit.

A supervisory controlling-relay 30 is connected between the positive grounded side of the battery 10 and the tip-strand of the cord-circuit. This supervisory controlling-relay 95 is provided with an armature 31, which when

775,227

in its attracted position serves to connect the positive pole of the battery 10 with a supervisory lamp-circuit. The supervisory relays 32 and 33 are connected between the positive 5 pole of the battery 10 and the sleeve-strand of the cord-circuit on the opposite side of the condenser 26. These supervisory relays control armatures 34 and 35, which when in their normal unattracted condition serve to close a circuit through the associated supervisory signal-lamps 36 and 37. High resistances 38 and 39 are connected between the conductors, leading from the supervisory relays 32 and 33 to the sleeve-strand of the cord-circuit and the negative pole of the battery 10.

I find it desirable to provide a condenser 40 in the operator's telephone-circuit and to connect the contact 41, associated with the listening-key, through a test-winding 42 with the positive pole of the battery 10. The manipulation of the listening-key serves to interrupt the continuity of the tip-strand of the cord-circuit through the conductor 43, a condenser 44 being normally connected in shunt of this

25 conductor.

The operation of my improved system will

now become apparent.

A subscriber at substation A upon removing his receiver from the switch-hook 1 causes 30 the closure of a circuit from the positive pole of the battery 10 through the cut-off relayarmature 15, the line-limb 5, the primary winding 8, the transmitter 7, the line-limb 4, the line-signal 11, the two windings 12 and 35 13 of the cut-off relay to the negative pole of the battery 10. The current flowing through this circuit causes the actuation of the linesignal 11 to notify the operator that connection is desired with some other subscriber. 40 The coils 12 and 13 of the cut-off relay being differentially wound do not cause a net energization of the cut-off relay to attract the armatures 15 and 17. The operator answers the signal by the insertion of her answering-45 plug 22 within an answering-jack 19, associated with the substation A. The insertion of this answering-plug closes the following circuit of decreased resistance through the winding 13 of the cut-off relay, this circuit being 50 traced as follows: from the positive pole of the battery 10 through the supervisory controlling-relay 30, the tip-strand 24 of the cordcircuit, the tip-contact 18 of the answeringjack, the winding 13 of the cut-off relay 14 to 55 the negative pole of the battery 10. The energization due to the two windings of the cutoff relay is thereby unbalanced to cause a net energization of the cut-off relay and a consequent attraction of the armatures 15 and 17. 60 The attraction of the armature 15 breaks the direct connection between the line-limb 5 and the positive pole of the battery 10, this limb of the line being thereupon connected with the positive pole of the battery through the

65 supervisory relay 32. The attraction of the

armature 17 causes the closure of a low-resistance circuit in shunt of the winding 12 of the cut-off relay and the line-signal 11. The closure of this shunt-path of low resistance also serves to connect the contacts 18 of the 70 line-jacks directly with the limb 4 of the telephone-line. The operator manipulates her listening-key to connect her telephone set in bridge of the cord-circuit and thereupon ascertains the number of the substation to be 75 called. Learning that substation B is desired she inserts her calling-plug 23 within one of the multiple calling-jacks 20, associated with the line to substation B. The insertion of the plug 23 within a jack at once closes a cir- 80 cuit through the winding 13 of the cut-off relay associated with the called line, thus causing an attraction of its armatures 15 and 17, the armature 15 serving to break the direct connection between the test-thimbles and the 85 associated line 5 and the positive grounded terminal of the battery 10. The attraction of the armature 17 at once closes the low-resistance path in shunt of the winding 12 of the differential cut-off relay and the line-signal 90 11. The closure of this low-resistance shuntpath also connects the tip-springs of the associated line-jacks directly with the limb 4 of the line. The operator manipulates her ringing-key to send a current from the generator 95 28 through the telephone-line to the call-bell 3 at the substation B. Until the removal of the receiver at substation B from its switchhook there is no circuit formed through the supervisory relay 33, whereby this relay-ar- 100 mature is not attracted, and since the armature of the supervisory controlling-relay has already been attracted into its alternate position, as previously described, the supervisory signaling-lamp 37 continues to glow. Upon 105 the removal of the receiver at substation B a circuit is closed through the supervisory relay to cause the attraction of its armature, and therefore the extinction of the lamp 37. Upon completion of the conversation the replace- 110 ment of the receivers at either substation A or B causes an interruption of the circuit through the associated supervisory relay 32 or 33, respectively, whereby the associated armature is released to cause the associated 115 lamp to glow, thereby notifying the operator that the connected subscriber has finished his conversation. The removal of the cord-connecting plugs from the line-jacks breaks the circuit through the supervisory controlling- 120 relay 30, whose armature is released to break the connection between the battery and one terminal of the supervisory signaling-lamps. The removal of the plugs from the jacks also causes the restoration of the line apparatus 125 of the subscriber who has replaced his telephone-receiver upon its switch-hook. As is well understood by those skilled in the

As is well understood by those skilled in the art, it is desirable in a modern telephone-exchange system to provide means whereby an 13°

operator may test the condition of the line to learn whether or not the line is in use before making a connection therewith. My improved system provides means for making 5 such a busy test and may be described as follows: It will be seen that under normal conditions when a line is idle the test-thimbles of the associated line-jacks are connected through the armature 15 directly with the 10 grounded terminal of the battery 10. Furthermore, when making a test the tip-strand of the cord-circuit leading to the tip-contact of the calling-plugs is connected through the test-winding 42 with the same positive ground-15 ed terminal of the battery 10. Therefore when an idle line is tested by the application of the tip-contact of the calling-plug to a testthimble there is no current-flow, due to the fact that the test-thimble and the tip-contact 20 of the plug are at the same potential, which is, in fact, the zero potential of the ground. It will be seen that there is a complete electric circuit between the opposite poles of the battery 10 through the supervisory relays 32 25 and 33 and the high-resistance coils 38 and 39, respectively, associated therewith. The coils 38 and 39 are of such high resistance that sufficient current cannot pass through the supervisory relays to affect the operation 30 thereof. Sufficient current does flow through this circuit, however, to cause a rise in the potential of the sleeve-strand 25, each section of which is connected to a point in a circuit through a supervisory relay and a high-re-35 sistance coil. The insertion of a plug within a line-jack, therefore, causes a rise in the potential of the test-thimble to equal that of the connected sleeve-strand. The tip-contact of the calling-plug is, however, at the zero po-40 tential of the ground. Thus when the tipcontact of a calling-plug is connected with a test-thimble a momentary current is caused to flow through the test-winding 42, which, on account of the inductive relation between 45 the test-winding 42 and the operator's telephone set, causes a click in her receiver, thereby notifying her of the busy condition of the tested line.

While I have herein described one preferred 50 embodiment of my invention, it will be apparent that many modifications thereof may be employed without departing from the spirit of my invention. I do not, therefore, wish to limit myself to the precise disclosure herein 55 set forth; but,

Having described my invention, I claim as new and desire to secure by Letters Patent—

1. In a telephone-exchange system, the combination with a source of current at the ex-60 change, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line permanently connected with the other terminal of said source, a line-relay and the two differen-65 tial windings of a cut-off relay permanently serially included in circuit with said second limb, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connecting apparatus with said line 70 causes an actuation of said cut-off relay to close a low-resistance non-inductive circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb and said source of current. 75

2. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line 80 connected with the other terminal of said source, a line-relay and the two differential windings of a cut-off relay permanently serially included in circuit with said second limb, cord connecting apparatus for connecting said 85 line with another for conversation, and means whereby the connection of said cord connecting apparatus with said line causes an actuation of said cut-off relay to close a low-resistance non-inductive circuit in shunt of one 90 winding of said cut-off relay and said line-relay and to break the connection between said first limb and said source of current.

3. In a telephone-exchange system, the combination with a source of current at the ex- 95 change, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line permanently connected with the other terminal of said source, a line-relay and the two 100 differential windings of a cut-off relay serially included in circuit with said second limb, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connect- 105 ing apparatus with said line causes an actuation of said cut-off relay to close a low-resistance non-inductive circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said 110 first limb and said source of current.

4. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line normally connected with one terminal of said 115 source of current, a second limb of said line permanently connected with the other terminal of said source, a line-relay and the two differential windings of a cut-off relay included in circuit with said second limb, cord 120 connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connecting apparatus with said line causes an actuation of said cut-off relay to close a low-resist- 125 ance non-inductive circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb and said source of current.

5. In a telephone-exchange system, the com- 130

bination with a source of current at the exchange, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line 5 connected with the other terminal of said source, a line-relay and the two differential windings of a cut-off relay included in circuit with said second limb, cord connecting apparatus for connecting said line with another ro for conversation, and means whereby the connection of said cord connecting apparatus with said line causes an actuation of said cutoff relay to close a low-resistance non-inductive circuit in shunt of one winding of said 15 cut-off relay and said line-relay and to break the connection between said first limb and said source of current.

6. In a telephone-exchange system, the combination with a source of current at the ex-20 change, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line permanently connected with the other terminal of said source, a line-relay and the two differ-25 ential windings of a cut-off relay permanently serially included in circuit with said second limb, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said 30 cord connecting apparatus with said line causes an actuation of said cut-off relay to close a circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb and said

35 source of current. 7. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line normally connected with one terminal of said source of 40 current, a second limb of said line connected with the other terminal of said source, a linerelay and the two differential windings of a cut-off relay permanently serially included in circuit with said second limb, cord connecting 45 apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connecting apparatus with said line causes an actuation of said cut-off relay to close a circuit in shunt of one 50 winding of said cut-off relay and said linerelay and to break the connection between said first limb and said source of current.

8. In a telephone-exchange system, the combination with a source of current at the ex-55 change, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line permanently connected with the other terminal of said source, a line-relay and the two differ-60 ential windings of a cut-off relay serially included in circuit with said second limb, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connect-65 ing apparatus with said line causes an actua-

tion of said cut-off relay to close a circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb and said source of current.

9. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line perma- 75 nently connected with the other terminal of said source, a line-relay and the two differential windings of a cut-off relay included in circuit with said second limb, cord connecting apparatus for connecting said line with an- 80 other for conversation, and means whereby the connection of said cord connecting apparatus with said line causes an actuation of. said cut-off relay to close a circuit in shunt of one winding of said cut-off relay and said 85 line-relay and to break the connection between said first limb and said source of current.

10. In a telephone-exchange system, the combination with a source of current at the ex- 90 change, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line connected with the other terminal of said source, a linerelay and the two differential windings of a 95 cut-off relay included in circuit with said second limb, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connecting apparatus with said line 100 causes an actuation of said cut-off relay to close a circuit in shunt of one winding of said cutoff relay and said line-relay and to break the connection between said first limb and said source of current.

11. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line connected with one terminal of said source of current, a second limb of said line permanently con- 110 nected with the other terminal of said source, a line-relay and the two differential windings of a cut-off relay permanently serially included in circuit with said second limb, cord connecting apparatus for connecting said line with 115 another for conversation, and means whereby the connection of said cord connecting apparatus with said line causes an actuation of said cut-off relay to close a low-resistance noninductive circuit in shunt of one winding of 120 said cut-off relay and said line-relay and to break the connection between said first limb and said source of current.

12. In a telephone exchange system, the combination with a source of current at the ex-125 change, of a limb of a telephone-line connected with one terminal of said source of current, a second limb of said line connected with the other terminal of said source, a line-relay and the two differential windings of a cut-off re- 130

lay included in circuit with said second limb, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connect-5 ing apparatus with said line causes an actuation of said cut-off relay to close a low-resistance non-inductive circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said ro first limb and said source of current.

13. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line connected with one terminal of said source of current, 15 a second limb of said line permanently connected with the other terminal of said source, a line-relay and the two differential windings of a cut-off relay permanently serially included in circuit with said second limb, cord connect-20 ing apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connecting apparatus with said line causes an actuation of said cut-off relay to close a circuit in shunt of one 25 winding of said cut-off relay and said line-relay and to break the connection between said first limb and said source of current.

14. In a telephone-exchange system, the combination with a source of current at the ex-30 change, of a limb of a telephone-line connected with one terminal of said source of current, a second limb of said line connected with the other terminal of said source, a line-relay and the two differential windings of a cut-off relay 35 included in circuit with said second limb, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connecting apparatus with said line causes an actua-40 tion of said cut-off relay to close a circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb and said source of current.

15. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line perma-50 nently connected with the other terminal of said source, a line-relay and the two differential windings of a cut-off relay permanently serially included in circuit with said second limb, cord connecting apparatus for connect-55 ing said line with another for conversation, and means whereby the connection of said cord connecting apparatus with said line closes a circuit of decreased resistance through one winding of said cut-off relay to cause an ac-60 tuation of said cut-off relay to close a low-resistance non-inductive circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb and said source of current.

16. In a telephone-exchange system, the

65

combination with a source of current at the exchange, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line permanently connected with the other terminal of 70 said source, a line-relay and the two differential windings of a cut-off relay permanently serially included in circuit with said second limb, cord connecting apparatus for connecting said line with another for conversation, 75 and means whereby the connection of said cord connecting apparatus with said line closes a circuit of decreased resistance through one winding of said cut-off relay to cause an actuation of said cut-off relay to close a cir- 80 cuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb and said source of current.

17. In a telephone-exchange system, the 85 combination with a source of current at the exchange, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line connected with the other terminal of said source, a line- 90 relay and the two differential windings of a cut-off relay permanently serially included in circuit with said second limb, cord connecting apparatus for connecting said line with another for conversation, and means whereby 95 the connection of said cord connecting apparatus with said line closes a circuit of decreased resistance through one winding of said cut-off relay to cause an actuation of said cut-off relay to close a circuit in shunt of one winding 100 of said cut-off relay and said line-relay and to break the connection between said first limb and said source of current.

18. In a telephone-exchange system, the combination with a source of current at the ex-105 change, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line permanently connected with the other terminal of said source, a line-relay and the two differen- 110 tial windings of a cut-off relay serially included in circuit with said second limb, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connect- 115 ing apparatus with said line closes a circuit of decreased resistance through one winding of said cut-off relay to cause an actuation of said cut-off relay to close a circuit in shunt of one winding of said cut-off relay and said line-re- 120 lay and to break the connection between said first limb and said source of current.

19. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line normally 125 connected with one terminal of said source of current, a second limb of said line permanently connected with the other terminal of said source, a line-relay and the two differential windings of a cut-off relay included in cir- 130

cuit with said second limb, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connecting appara-5 tus with said line closes a circuit of decreased resistance through one winding of said cut-off relay to cause an actuation of said cut-off relay to close a circuit in shunt of one winding of said cut-off relay and said line-relay and to 10 break the connection between said first limb and said source of current.

20. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line normally 15 connected with one terminal of said source of current, a second limb of said line connected with the other terminal of said source, a linerelay and the two differential windings of a cutoff relay included in circuit with said second 20 limb, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connecting apparatus with said line closes a circuit of decreased resistance through one 25 winding of said cut-off relay to cause an actuation of said cut-off relay to close a circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb and said 30 source of current.

21. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line connected with one terminal of said source of current, a 35 second limb of said line permanently connected with the other terminal of said source, a line-relay and the two differential windings of a cut-off relay permanently serially included in circuit with said second limb, cord connecting 40 apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connecting apparatus with said line closes a circuit of decreased resistance through one winding of said cut-off 45 relay to cause an actuation of said cut-off relay to close a low-resistance non-inductive circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb and said source 50 of current.

22. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line connected with one terminal of said source of current, a 55 second limb of said line connected with the other terminal of said source, a line-relay and the two differential windings of a cut-off relay included in circuit with said second limb, cord connecting apparatus for connecting said line 60 with another for conversation, and means whereby the connection of said cord connecting apparatus with said line closes a circuit of decreased resistance through one winding of said cut-off relay to cause an actuation of said 65 cut-off relay to close a circuit in shunt of one

winding of said cut-off relay and said linerelay to break the connection between said first limb and said source of current.

23. In a telephone-exchange system, the combination with a source of current at the ex- 7° change, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line permanently connected with the other terminal of said source, a line-relay and the two differential 75 windings of a cut-off relay permanently serially included in circuit with said second limb, a spring-jack having one contact permanently connected to said first limb of said line and a second contact permanently con-80 nected to the common terminal of the two windings of said cut-off relay, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connecting appa- 85 ratus with said line causes an actuation of said cut-off relay to close a low-resistance non-inductive circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb 90 and said source of current.

24. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line normally connected with one terminal of said source of 95 current, a second limb of said line connected with the other terminal of said source, a linerelay and the two differential windings of a cut-off relay included in circuit with said second limb, a spring-jack having one contact 100 permanently connected to said first limb of said line and a second contact permanently connected to the common terminal of the two windings of said cut-off relay, cord connecting apparatus for connecting said line with 105 another for conversation, and means whereby the connection of said cord connecting apparatus with said line causes an actuation of said cut-off relay to close a low-resistance non-inductive circuit in shunt of one winding of said 110 cut-off relay and said line-relay and to break the connection between said first limb and said source of current.

25. In a telephone-exchange system, the combination with a source of current at the ex-115 change, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line permanently connected with the other terminal of said source, a line-relay and the two differen- 120 tial windings of a cut-off relay permanently serially included in circuit with said second limb, a spring-jack having one contact permanently connected to said first limb of said line and a second contact permanently connected 125 to the common terminal of the two windings of said cut-off relay, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connecting apparatus with 13°

said line causes an actuation of said cut-off relay to close a circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb and said source of current.

26. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line normally connected with one terminal of said source 10 of current, a second limb of said line connected with the other terminal of said source, a line-relay and the two differential windings of a cut-off relay permanently serially included in circuit with said second limb, a 15 spring-jack having one contact permanently connected to said first limb of said line and a second contact permanently connected to the common terminal of the two windings of said cut-off relay, cord connecting apparatus for 20 connecting said line with another for conversation, and means whereby the connection of said cord connecting apparatus with said line causes an actuation of said cut-off relay to close a circuit in shunt of one winding of said 25 cut-off relay and said line-relay and to break the connection between said first limb and said source of current.

27. In a telephone-exchange system, the combination with a source of current at the ex-30 change, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line permanently connected with the other terminal of said source, a line-relay and the two differ-35 ential windings of a cut-off relay serially included in circuit with said second limb, a spring-jack having one contact permanently connected to said first limb of said line and a second contact permanently connected to the 40 common terminal of the two windings of said cut-off relay, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connecting apparatus with said line 45 causes an actuation of said cut-off relay to close a circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb and said source of current.

28. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line perma-55 nently connected with the other terminal of said source, a line-relay and the two differential windings of a cut-off relay included in circuit with said second limb, a spring-jack having one contact permanently connected to 60 said first limb of said line and a second contact permanently connected to the common terminal of the two windings of said cut-off relay, cord connecting apparatus for connecting said line with another for conversation, 65 and means whereby the connection of said

cord connecting apparatus with said line causes an actuation of said cut-off relay to close a circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb and said 7° source of current.

29. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line normally connected with one terminal of said source of 75 current, a second limb of said line connected with the other terminal of said source, a linerelay and the two differential windings of a cut-off relay included in circuit with said second limb, a spring-jack having one contact 80 permanently connected to said first limb of said line and a second contact permanently connected to the common terminal of the two windings of said cut-off relay, cord connecting apparatus for connecting said line with 85 another for conversation, and means whereby the connection of said cord connecting apparatus with said line causes an actuation of said cut-off relay to close a circuit in shunt of one winding of said cut-off relay and said line- 90 relay and to break the connection between said first limb and said source of current.

30. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line normally 95 connected with one terminal of said source of current, a second limb of said line permanently connected with the other terminal of said source, a line-relay and the two differential windings of a cut-off relay permanently se- 100 rially included in circuit with said second limb, a spring-jack having one contact permanently connected to said first limb of said line and a second contact permanently connected to the common terminal of the two 105 windings of said cut-off relay, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connecting apparatus with said line closes a circuit of de- 110 creased resistance through one winding of said cut-off relay to cause an actuation of said cut-off relay to close a low-resistance noninductive circuit in shunt of one winding of said cut-off relay and said line-relay and to 115 break the connection between said first limb and said source of current.

31. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line normally 120 connected with one terminal of said source of current, a second limb of said line permanently connected with the other terminal of said source, a line-relay and the two differential windings of a cut-off relay permanently serially included in circuit with said second limb, a spring-jack having one contact permanently connected to said first limb of said line and a second contact permanently connected to the common terminal of the two windings of said 130

cut-off relay, cord connecting apparatus for connecting said line with another for conversation, means whereby the connection of said cord connecting apparatus with said line causes 5 an actuation of said cut-off relay to close a circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb and said source of current, and means whereby the connection of said cord connecting apparatus with said line closes a circuit of decreased resistance through one winding of said cut-off re-

lay to cause an actuation thereof. 32. In a telephone-exchange system, the 15 combination with a source of current at the exchange, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line connected with the other terminal of said source, a line-20 relay and the two differential windings of a cut-off relay permanently serially included in circuit with said second limb, a spring-jack having one contact permanently connected to said first limb of said line and a second contact 25 permanently connected to the common terminal of the two windings of said cut-off relay, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connect-30 ing apparatus with said line closes a circuit of decreased resistance through one winding of said cut-off relay to cause an actuation of said cut-off relay to close a circuit in shunt of one winding of said cut-off relay and said line-35 relay and to break the connection between said

first limb and said source of current. 33. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line normally 40 connected with one terminal of said source of current, a second limb of said line permanently connected with the other terminal of said source, a line-relay and the two differential windings of a cut-off relay serially included 45 in circuit with said second limb, a spring-jack having one contact permanently connected to said first limb of said line and a second contact permanently connected to the common terminal of the two windings of said cut-off relay, 50 cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connecting apparatus with said line closes a circuit of decreased resistance through one winding of 55 said cut-off relay to cause an actuation of said cut-off relay to close a circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb and said source of current.

34. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line permanently 65 connected with the other terminal of said

source, a line-relay and the two differential windings of a cut-off relay included in circuit with said second limb, a spring-jack having one contact permanently connected to said first limb of said line and a second contact 70 permanently connected to the common terminal of the two windings of said cut-off relay, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connect- 75 ing apparatus with said line closes a circuit of decreased resistance through one winding of said cut-off relay to cause an actuation of said cut-off relay to close a circuit in shunt of one winding of said cut-off relay and said line-re- 80 lay and to break the connection between said first limb and said source of current.

35. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line normally 85 connected with one terminal of said source of current, a second limb of said line connected with the other terminal of said source, a linerelay and the two differential windings of a cut-off relay included in circuit with said sec- 90 ond limb, a spring-jack having one contact permanently connected to said first limb of said line and a second contact permanently connected to the common terminal of the two windings of said cut-off relay, cord connect- 95 ing apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connecting apparatus with said line closes a circuit of decreased resistance through one winding of said cut-off 100 relay to cause an actuation of said cut-off relay to close a circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb and said source of current.

36. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line connected with one terminal of said source of current, a second limb of said line permanently connect- 110 ed with the other terminal of said source, a line-relay and two differential windings of a cut-off relay permanently serially included in circuit with said second limb, a spring-jack having one contact permanently connected to 115 said first limb of said line and a second contact permanently connected to the common terminal of the two windings of said cut-off relay, cord connecting apparatus for connecting said line with another for conversation, 120 and means whereby the connection of said cord connecting apparatus with said line closes a circuit of decreased resistance through one winding of said cut-off relay to cause an actuation of said cut-off relay to close a low-resist- 125 ance non-inductive circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb and said source of current.

37. In a telephone-exchange system, the 13°

combination with a source of current at the exchange, of a limb of a telephone-line connected with one terminal of said source of current, a second limb of said line connected with the 5 other terminal of said source, a line-relay and the two differential windings of a cut-off relay included in circuit with said second limb, a spring-jack having one contact permanently connected to said first limb of said line and a 10 second contact permanently connected to the common terminal of the two windings of said cut-off relay, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of 15 said cord connecting apparatus with said line closes a circuit of decreased resistance through one winding of said cut-off relay to cause an actuation of said cut-off relay to close a circuit in shunt of one winding of said cut-off 20 relay and said line-relay and to break the connection between said first limb and said source of current.

38. In a telephone-exchange system, the combination with a source of current at the ex-25 change, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line permanently connected with the other terminal of said source, a line-relay and the two differential 30 windings of a cut-off relay permanently serially included in circuit with said second limb, a spring-jack having one contact connected to said first limb of said line and a second contact and test-thimble connected to the common 35 terminal of the two windings of said cut-off relay, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connecting apparatus with said line 40 causes an actuation of said cut-off relay to close a low-resistance non-inductive circuit in shunt of one winding of said cut-off relay and said line-relay to break the connection between said first limb and said source of cur-45 rent.

39. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line normally connected with one terminal of said source of 50 current, a second limb of said line connected with the other terminal of said source, a linerelay and the two differential windings of a cut-off relay included in circuit with said second limb, a spring-jack having one contact 55 connected to said first limb of said line and a second contact and test-thimble connected to the common terminal of the two windings of said cut-off relay, cord connecting apparatus for connecting said line with another for con-60 versation, and means whereby the connection of said cord connecting apparatus with said line causes an actuation of said cut-off relay to close a low-resistance non-inductive circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb and said source of current.

40. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line normally 70 connected with one terminal of said source of current, a second limb of said line permanently connected with the other terminal of said source, a line-relay and the two differential windings of a cut-off relay permanently serially 75 included in circuit with said second limb, a spring-jack having one contact connected to said first limb of said line and a second contact and test-thimble connected to the common terminal of the two windings of said cut-off 80 relay, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connecting apparatus with said line causes an actuation of said cut-off relay to 85 close a circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb and said source of current.

41. In a telephone-exchange system, the 90 combination with a source of current at the exchange, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line connected with the other terminal of said source, a line- 95 relay and the two differential windings of a cut-off relay permanently serially included in circuit with said second limb, a spring-jack having one contact connected to said first limb of said line and a second contact and test- 100 thimble connected to the common terminal of the two windings of said cut-off relay, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connect- 105 ing apparatus with said line causes an actuation of said cut-off relay to close a circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb and said source of current. 110

42. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line permanently 115 connected with the other terminal of said source, a line-relay and the two differential windings of a cut-off relay serially included in circuit with said second limb, a spring-jack having one contact connected to said first limb 120 of said line and a second contact and testthimble connected to the common terminal of the two windings of said cut-off relay, cord connecting apparatus for connecting said line with another for conversation, and means 125 whereby the connection of said cord connecting apparatus with said line causes an actuation of said cut-off relay to close a circuit in

shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb and said source of current.

43. In a telephone-exchange system, the 5 combination with a source of current at the exchange, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line permanently connected with the other terminal of said to source, a line-relay and the two differential windings of a cut-off relay included in circuit with said second limb, a spring-jack having one contact connected to said first limb of said line and a second contact and test-thimble 15 connected to the common terminal of the two windings of said cut-off relay, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connecting appa-20 ratus with said line causes an actuation of said cut-off relay to close a circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb and said source of current.

44. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line connected 30 with the other terminal of said source, a linerelay and the two differential windings of a cut-off relay included in circuit with said second limb, a spring-jack having one contact connected to said first limb of said line and a 35 second contact and test-thimble connected to the common terminal of the two windings of said cut-off relay, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connec-40 tion of said cord connecting apparatus with said line causes an actuation of said cut-off relay to close a circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb 45 and said source of current.

45. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line normally connected with one terminal of said source of 50 current, a second limb of said line permanently connected with the other terminal of said source, a line-relay and the two differential windings of a cut-off relay permanently serially included in circuit with said second limb, 55 a spring-jack having one contact connected to said first limb of said line and a second contact and test-thimble connected to the common terminal of the two windings of said cut-off relay, cord connecting apparatus for connect-60 ing said line with another for conversation, and means whereby the connection of said cord connecting apparatus with said line closes a circuit of decreased resistance through one winding of said cut-off relay to cause an actu-65 ation of said cut-off relay to close a low-re-

sistance non-inductive circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb and said source of current.

46. In a telephone-exchange system, the 7° combination with a source of current at the exchange, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line permanently connected with the other terminal of said 75 source, a line-relay and the two differential windings of a cut-off relay permanently serially included in circuit with said second limb, a spring-jack having one contact connected to said first limb of said line and a second con-80 tact and test-thimble connected to the common terminal of the two windings of said cut-off relay, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said 85 cord connecting apparatus with said line closes a circuit of decreased resistance through one winding of said cut-off relay to cause an actuation of said cut-off relay to close a circuit in shunt of one winding of said cut-off relay and 90 said line-relay and to break the connection between said first limb and said source of current.

47. In a telephone - exchange system, the combination with a source of current at the ex- 95 change, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line connected with the other terminal of said source, a linerelay and the two differential windings of a 100 cut-off relay permanently serially included in circuit with said second limb, a spring-jack having one contact connected to said first limb of said line and a second contact and test-thimble connected to the common terminal of the 105 two windings of said cut-off relay, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connecting apparatus with said line closes a circuit of decreased 110 resistance through one winding of said cutoff relay to cause an actuation of said cut-off relay to close a circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb 115 and said source of current.

48. In a telephone - exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line permanently connected with the other terminal of said source, a line-relay and the two differential windings of a cut-off relay serially included in circuit with said second limb, a spring-jack line of said line and a second contact and test-thim-ble connected to the common terminal of the two windings of said cut-off relay, cord connecting apparatus for connecting said line with

another for conversation, and means whereby the connection of said cord connecting apparatus with said line closes a circuit of decreased resistances through one winding of said cut-off relay to cause an actuation of said cut-off relay to close a circuit in shunt of one winding of said cut-off relay and said cut-off relay and said line-relay and to break the connection between said first limb and said source of current.

49. In a telephone - exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line permanently 15 connected with the other terminal of said source, a line-relay and the two differential windings of a cut-off relay included in circuit with said second limb, a spring-jack having one contact connected to said first limb of said line 20 and a second contact and test-thimble connected to the common terminal of the two windings of said cut-off relay, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection 25 of said cord connecting apparatus with said line closes a circuit of decreased resistance through one winding of said cut-off relay to cause an actuation of said cut-off relay to close a circuit in shunt of one winding of said cut-30 off relay and said line-relay and to break the connection between said first limb and said source of current.

50. In a telephone-exchange system, the combination with a source of current at the ex-35 change, of a limb of a telephone-line normally connected with one terminal of said source of current, a second limb of said line connected with the other terminal of said source, a linerelay and the two differential windings of a 40 cut-off relay included in circuit with said second limb, a spring-jack having one contact connected to said first limb of said line and a second contact and test-thimble connected to the common terminal of the two windings of said 45 cut-off relay, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connecting apparatus with said line closes a circuit of decreased resistance through 50 one winding of said cut-off relay to cause an actuation of said cut-off relay to close a circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb and said source 55 of current.

51. In a telephone-exchange system, the combination with a source of current at the exchange, of a limb of a telephone-line connected with one terminal of said source of current, a second limb of said line permanently connected with the other terminal of said source, a line-relay and the two differential windings of a cut-off relay permanently serially included in circuit with said second limb, a spring-jack having one contact connected to said first limb

of said line and a second contact and test-thimble connected to the common terminal of the two windings of said cut-off relay, cord connecting apparatus for connecting said line with another for conversation, and means 70 whereby the connection of said cord connecting apparatus with said line closes a circuit of decreased resistance through one winding of said cut-off relay to cause an actuation of said cut-off relay to close a low-resistance non-in-75 ductive circuit in shunt of one winding of said cut-off relay and said line-relay and to break the connection between said first limb and said source of current.

52. In a telephone-exchange system, the 80 combination with a source of current at the exchange, of a limb of a telephone-line connected with one terminal of said source of current, a second limb of said line connected with the other terminal of said source, a line-relay and 85 the two differential windings of a cut-off relay included in circuit with said second limb, a spring-jack having one contact connected to said first limb of said line and a second contact and test-thimble connected to the com- 90 mon terminal of the two windings of said cutoff relay, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connecting apparatus with said line 95 closes a circuit of decreased resistance through one winding of said cut-off relay to cause an actuation of said cut-off relay to close a circuit in shunt of one winding of said cut-off relay and said line-relay and to break the con- 100 nection between said first limb and said source of current.

53. In a telephone-exchange system, the combination with a source of current at the exchange, one of whose terminals is permanently 105 connected to ground, of a limb of a telephoneline normally connected with the grounded terminal of said source of current, a second limb of said line permanently connected with the other terminal of said source of current, 110 a line-relay and the two differential windings of a cut-off relay permanently serially included in circuit with said second limb, cord connecting apparatus for connecting said line with another for conversation, a test-thimble 115 permanently connected to said first line-limb, and means whereby the connection of said cord connecting apparatus with said line causes an actuation of said cut-off relay to close a low-resistance circuit in shunt of one wind- 120 ing of said cut-off relay and to break the connection between said first limb and said source of current.

54. In a telephone-exchange system, the combination with a source of current at the exchange, of a telephone-line extending by its limbs to the central exchange, a differential cut-off relay included serially in one limb of said line, a line-relay normally included serially in said limb with said cut-off relay, two 130

armatures for said cut-off relay, the other limb of said line normally including one of said armatures, cord connecting apparatus at the central exchange, and means upon connection of said cord connecting apparatus with said line for causing attraction of said cut-off-relay armatures to open said other limb and to establish a shunt-circuit about said line-relay whereby said line-relay becomes inert.

combination with a central exchange, of a source of current at the exchange, a line leading from a substation to said exchange, a differential cut-off relay permanently serially included in one limb of said line, armatures for said cut-off relay, a line-relay normally serially included in said limb with said line-relay, one of said armatures being normally serially included in the other limb, a spring-jack concluded in the other limb, a spring-jack con-

through one of said differential windings and through the winding of said line-relay, cord connecting apparatus at the central exchange, and means upon connection of said cord connecting apparatus with said line for causing 25 attraction of said cut-off-relay armatures, one armature serving to establish a shunt-circuit about said line-relay and to connect said jack-contact directly with said line-limb, and the other armature serving to open said other 30 limb.

In witness whereof I hereunto subscribe my name this 5th day of February, A. D. 1903.

HARRY G. WEBSTER.

Witnesses:

Lynn A. Williams,

Harvey L. Hanson.