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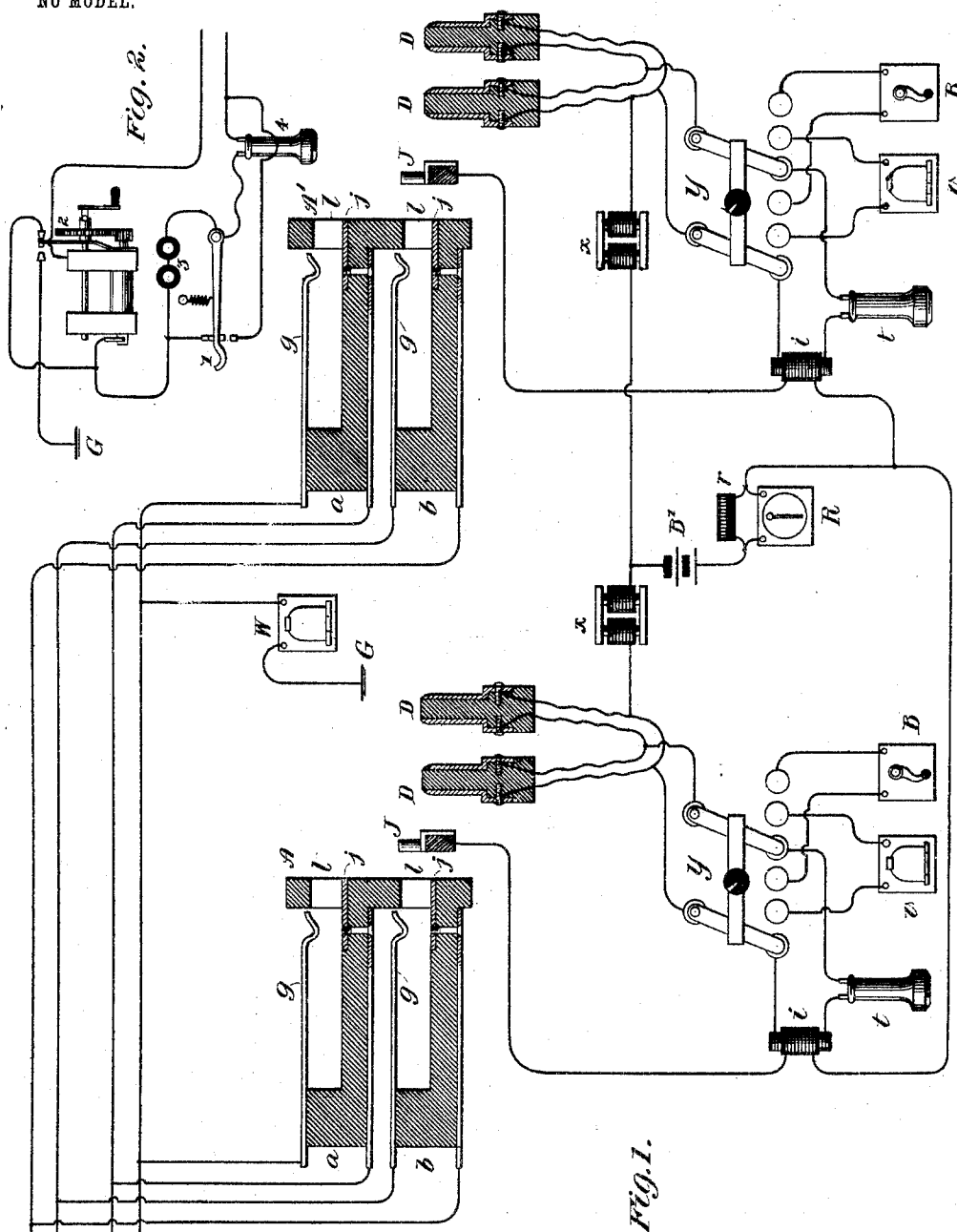
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MULTIPLE SWITCHBOARD FOR TELEPHONE EXCHANGES.

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NO MODEL.



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MULTIPLE SWITCHBOARD FOR TELEPHONE-EXCHANGES.

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To all whom it may concern:

Be it known that I, MILO G. KELLOGG, of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful
 5 Improvements in Multiple Switchboards for Telephone-Exchanges, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

10 My invention relates especially to a telephone-exchange system in which metallic-circuit lines are used.

It consists in a system of calling, switching, testing, and clearing-out signals which I shall
 15 describe and claim in detail.

In the accompanying drawings, Figure 1 illustrates the central-office apparatus, and Fig. 2 the subscriber's-station apparatus of my invention.

20 In Fig. 1, A A' are two multiple switchboards, to each of which all the lines of the exchange are connected. As many boards or sections may be used as are necessary for the exchange in which the system is used. Each
 25 switchboard or section has a switch for each line of the exchange. Each switch has two contact-pieces, marked *g j*, with which, respectively, the two contact-pieces of a loop-switch plug are connected when a plug is
 30 placed into the switch for switching. These loop-switch plugs are marked DD in the drawings. *ll* are the switch-holes into which the plugs are placed, and *a b* the rubber strips on which the metal parts of the switches are
 35 mounted. *ww* are the line-annunciators, of which there is one for each line. These annunciators are distributed among the several boards or sections of the exchange, and each is placed at a section where its subscriber's
 40 calls are to be answered. Each operator has as many pairs of loop-switch plugs DD as she may need in order to properly attend to the lines which are allotted to her. Y Y are
 45 switches, one for each pair of plugs. Each switch Y has two switch-levers and three pairs of contact-bolts on which, respectively, the two levers may be alternately placed. *tt* are

the operators' telephones, of which there is one for each operator. B B are calling-generators, of which there may be one for each
 50 operator, or one generator may answer for several or all of the operators. J J are test-plugs, and *ii* are induction-coils, one of each for each operator. The contact-piece of each
 55 test-plug is adapted to be placed for testing into connection with each contact-piece *j j* at its switchboard. *vv* are clearing-out annunciators, and *xx* are retardation-coils, of which there is one of each for each pair of plugs. B' is a test-battery, R is a rheotome, and *r* a
 60 resistance-coil, of which there may be one of each for the exchange. One side of each metallic-circuit line is connected to one of the contact-pieces—say *g*—of each switch of the
 65 line. The other side of the line is connected to the other contact-piece—say *j*—of each switch of the line. One side of each line—say that side which is connected to the
 70 contact-pieces *g g* of its switches—is grounded through the annunciator *w* of the line.

The two contact-pieces of each switch-plug are connected with the two contact-pieces of the plug which is its mate by two flexible switch-conductors. One of these switch-conductors is connected to one of the levers of
 75 the switch Y of the pair of plugs, and the other conductor is connected to the other lever. The two contact-bolts of each switch Y which form one pair are connected together through the operator's telephone and one coil
 80 of her induction-coil *i*. The bolts of the next pair are connected together through the clearing-out annunciator of the pair of plugs, and the bolts of the third pair are connected together through the operator's generator.
 85 The rheotome R and the resistance-coil *r* are placed in derived or parallel circuit with each other. One of the flexible conductors of each pair of cords is connected through the retardation-coil of the pair of plugs to one side of a
 90 circuit connection which contains the battery B' and the rheotome R and resistance-coil *r* in derived or parallel circuit. The other side of this circuit connection, which contains the

battery, rheotome, and resistance-coil, as described, is connected to the test-plug J of each operator through the other coil of her induction-coil *i*. The rheotome R should preferably be such as to give some defined musical tone in its vibrations.

The annunciators, both line and clearing-out, should be such as to offer high retardation to telephone and alternate currents, and other currents which rapidly change in character and for the purpose which will hereinafter be described the respective resistance of the line-annunciators should be much higher than that of the clearing-out annunciator.

In the subscriber's-station apparatus (shown in Fig. 2) 1 is the telephone-switch; 2, the calling-generator; 3, the signal-receiving bell, and 4 the subscriber's telephone. The switch 1 has two pairs of contacts and circuit connections, substantially as shown, by which when the telephone is on the switch it is shunted or short-circuited from the circuit of the line and the signal-receiving bell is in the circuit of the line, and when the telephone is off the switch the signal-receiving bell is shunted or short-circuited from the circuit of the line and the telephone is in the circuit of the line. The calling-generator 2 is preferably an alternate-current generator of the usual kind, and has an automatic device of the usual kind with contacts by which the generator-armature is shunted or short-circuited, while the generator is not operated, and the shunt is automatically opened by the operation of the generator. It has also another pair of contacts by which the line-circuit is automatically grounded during the operation of the generator.

The subscriber's-station apparatus should be connected in the line-circuit in such a direction that when the generator is operated it and the line-annunciator are in a closed ground-circuit which contains one side or branch only of the line-circuit.

The operation of the system is as follows: When a subscriber operates his generator to send a call, he automatically establishes a ground connection by which his generator and line-annunciator are included in a closed circuit. The annunciator therefore indicates a call. The operator then places one of her switch-plugs into the switch of the line and moving the switch Y connected with the plug used connects her telephone into a complete circuit with the line and by conversation finds out what line is wanted. This complete circuit is established by the connection of the two contacts of the plug (which are connected with the two sides of the operator's telephone) to the two contacts of the switch, which are connected to the two sides of the line, respectively. When the operator finds out what line is wanted, she tests that line, as will hereafter be indicated, and if she finds it free or unswitched she places the other plug of the

pair of plugs into the switch of the line wanted and moves the levers of the switch Y of the pair of plugs so that they are connected with the two sides of the operator's calling-generator. The generator then bridges the two sides of the circuit of the two lines established by the placing of the plugs in the respective line-switches, and calling-current passes over both line-circuits and rings the bell of the subscriber wanted. The operator then moves the levers of the switch Y so that they are connected to the two sides, respectively, of the clearing-out annunciator of the pair of plugs, and the lines are then in a complete circuit for conversation with the circuit bridged by the clearing-out annunciator of the pair of plugs.

The clearing-out system is as follows: When either subscriber after conversation is finished operates his generator to send the clearing-out signal, he automatically grounds his circuit by the operation of the automatic device of his generator. The current generated will then divide into four parts, passing through four branch or derived circuits. Two of these circuits are a circuit from the subscriber's ground through his generator and one side of his line and thence through the two line-annunciators in derived circuit to ground at the central office. Another of these circuits is through the complete metallic circuit of the two lines. The other circuit is through the complete circuit of the line of the subscriber who sends the clearing-out signal and the clearing-out annunciator which is used for the connection.

As the resistances of the line-annunciators are much higher than the resistance of the clearing-out annunciator, very little of the current generated in sending the clearing-out signal will pass through the line-annunciators and considerable of such current will pass through the clearing-out annunciator. The line-annunciators may, moreover, if considered necessary or desirable, be of such construction and adjustment as not to be operated by the same strength of current passing through them as will operate the clearing-out annunciator, and in the latter case there will not be the necessity of as great a difference of resistance between the clearing-out and line annunciators as would otherwise be necessary to make the system operative.

The subscriber's calling-generator should be of such power and adjustment to the other apparatus and circuits and the other apparatus and circuits should be so adjusted to each other as to resistance and sensitiveness of operation and to the calling-generator that when a call is sent from any station and the line is not switched for conversation the line-annunciator will invariably be operated; but when two lines are connected together, as above described, and their circuit is bridged through a clearing-out annunciator the operation of the calling-generator of either subscriber will invariably operate the clearing-out annunciator.

tor and invariably fail to operate either line-annunciator.

When two lines are connected together for conversation as above described, their combined circuit is grounded through the line-annunciators of high resistance and retardation of the two lines. The description heretofore made contemplates that the plugs are placed in the line-switches in such a direction that the two ground connections of the combined circuit through the annunciators shall be on the same side of the circuit. The operation might, however, be varied in such a way that the ground connections shall be from the two sides of the combined circuit. In that case part of the calling-current from the operator's generator will pass through a circuit which contains the two line-annunciators. The resistance of this circuit should in such a case be sufficiently high so that enough of such current will not pass through the line-annunciators to operate them. In that case also the resistances of the annunciators and their construction and adaptation to the subscribers' calling-generators should be such that when a generator is operated to send a clearing-out current the clearing-out annunciator through which part of the generated current passes will invariably be operated, and the two line-annunciators through which part of the generated current will also pass will invariably not be operated.

The test system is as follows: The rheotome R should preferably be such as to give a defined musical indication. When an operator tests a line to find out whether or not it is in use, she places the contact-piece of her test-plugs J into connection with the contact-piece j of the switch of the line, her telephone being then in closed circuit with one coil of her induction-coil $\dot{z}$. If the line is then switched for use at any board by the insertion of a plug into a switch of the line at another board, a complete circuit is established which contains the other coil of the operator's induction-coil, the test battery B', and the rheotome R, and resistance-coil r in derived or parallel circuit, and the current of the battery B' being varied by the operation of the rheotome the telephone will sound or respond with a tone of the kind to correspond to the makes and breaks of the rheotome. The operator will therefore know that the line is in use and will proceed accordingly. The complete circuit thus established may be traced as follows: say from the contact-piece of the test-plug used in testing, through one coil of the induction-coil, thence through the circuit connection which contains the battery B' and the rheotome and resistance-coil in parallel circuit, thence through the retardation-coil connected with the plug by which the line is switched, to the line, and thence through the connection of the line to the contact-piece of the line to which the contact-piece of operator's plug is applied

for testing. If the line is not switched for use when the test is made, no such complete circuit is established and the operator's telephone will not sound.

The system which includes the operator's telephone in closed circuit and her induction-coil $\dot{z}$ as used for the test-signal may be called the "test-receiving" instrument. Other forms of apparatus may be used for the operator's test-receiving instrument, to one side of which her test-plug is connected and to the other side of which is connected the circuit connection which contains the rheotome and test-battery.

The advantage of using a rheotome which gives a certain defined or musical tone is that the operator on making the test cannot be misled by any inductive effect or electric discharge from the line to think that the line is switched when it is not switched. She can always distinguish the certain defined musical tone from any accidental inductive or other electrical effect which may exist on the line and affect her telephone. The use of the resistance-coil is that the test-circuit is not broken, but is only varied as to its resistance by the operation of the rheotome. The system would, however, be operative and effective without the use of the resistance-coil. Among the various forms of rheotome which may be used as described to produce a defined or musical tone when a test-circuit is completed through a test-receiving instrument and battery may be mentioned the electroharmonic transmitter of Elisha Gray, shown in his Patent No. 165,728, of July 20, 1875.

Instead of the rheotome and resistance-coil in multiple or parallel circuit or the rheotome alone, as heretofore described, other forms of supplemental apparatus may be used which when closed with the test-battery and a test-receiving instrument when the test of a busy-line is made will produce a defined or musical tone in the test-receiving instrument which the operator will readily recognize as distinct from any inductive, static, or cross effect which may be indicated in her test-receiving instrument when the test is made of a line which is not in use. It is also evident that the calling system I have described could be operated without any apparatus (as a rheotome) to vary the test-circuit, and in that case the operator would get a simple click in her telephone when she tested a line which was already switched for conversation, or other forms of test apparatus might be used.

It is evident that the system herein described could be operated with other means of grounding each line at the subscriber's station when his generator is operated—as, for instance, by suitable contacts on the telephone-switch or by a key manipulated by the subscriber for the purpose.

I claim as my invention—

1. In a telephone-exchange system, metal-

lic-circuit lines, and annunciators, one for each line, and a permanent ground connection from one side of each line containing the line-annunciator, in combination with switching apparatus to connect together any two of said lines for conversation into a complete metallic circuit which does not contain either line-annunciator, and a clearing-out annunciator bridged across between the two sides of said complete metallic circuit, the resistances of said line-annunciators being high as compared with the resistance of said clearing-out annunciator.

2. In a telephone-exchange system, metallic - circuit lines, multiple switchboards, switches, one for each line on each board, each switch having two contact-pieces to which respectively the two sides of its lines are permanently connected, and annunciators one for each line, and a permanent ground connection from one side of each line containing the line-annunciator, in combination with switching apparatus at each board to connect together any two of said lines for conversation into a complete metallic circuit by connecting together their respective contact-pieces at that board, and a clearing-out annunciator bridged across between the two sides of any such complete metallic circuit, the resistances of said line-annunciators being high as compared with the resistance of said clearing-out annunciator.

3. In a telephone-exchange system, metallic-circuit lines and annunciators, one for each line, one side of each line being permanently grounded through the annunciator of its line, in combination with switching apparatus to connect together any two of said lines for conversation into a complete metallic circuit which does not contain either line-annunciator, and a clearing-out annunciator bridged across between the two sides of said complete metallic circuit.

4. In a telephone-exchange system, metallic - circuit lines, multiple switchboards, switches, one for each line on each board, each switch having two contact-pieces to which respectively the two sides of its lines are permanently connected, and annunciators one for each line, one side of each line being permanently grounded through the annunciator of its line, in combination with switching apparatus at each board to connect together any two of said lines for conversation into a complete metallic circuit by connecting together their respective contact-pieces at that board, and a clearing-out annunciator bridged across between the two sides of any such complete circuit.

5. In a telephone-exchange system, metallic-circuit lines, and annunciators, one for each line, one side of each line being permanently grounded through the annunciator of its line, in combination with switching apparatus to connect together any two of said lines for conversation into a complete metallic circuit which

does not contain either line-annunciator, a calling-generator at each subscriber's station located in the main or closed metallic circuit of its line whenever operated to send a signal either the primary or clearing-out signal, a ground connection to the line when the generator is thus operated, with the generator and the annunciator of the line in the complete ground-circuit thereby existing, and a clearing-out annunciator bridged across between the two sides of said complete metallic circuit.

6. In a telephone-exchange system, metallic - circuit lines, multiple switchboards, switches, one for each line on each board, each switch having two contact-pieces to which respectively the two sides of its line are permanently connected, and annunciators one for each line, one side of each line being permanently grounded through the annunciator of its line, in combination with switching apparatus at each board to connect together any two of said lines for conversation into a complete metallic circuit by connecting together their respective contact-pieces at that board, a calling-generator at each subscriber's station located in the main or closed metallic circuit of its line whenever operated to send a signal either the primary or clearing-out signal, a ground connection to the line when the generator is thus operated, with the generator and the annunciator of the line in the complete ground-circuit thereby existing, and a clearing-out annunciator bridged across between two sides of any such complete circuit.

7. In a telephone-exchange system, metallic-circuit lines, and annunciators, one for each line, one side of each line being permanently grounded through the annunciator of its line, in combination with switching apparatus to connect together any two of said lines for conversation into a complete metallic circuit which does not contain either line-annunciator, a calling-generator at each subscriber's station located in the main or closed metallic circuit of its line whenever operated to send a signal either the primary or clearing-out signal, a ground connection to the line when the generator is thus operated, with the generator and the annunciator of the line in the complete ground-circuit thereby existing, and a clearing-out annunciator, bridged across between the two sides of said complete metallic circuit, each line-annunciator being operated or responding when its subscriber's generator is operated and the line is not switched for conversation, but when two lines are connected together into a metallic circuit for conversation, neither of the line-annunciators being operated, but the clearing-out annunciator bridged across between the two sides of the metallic circuit being operated when the calling-generator of either line is operated to send the clearing-out signal.

8. In a telephone-exchange system, metallic - circuit lines, multiple switchboards,

switches, one for each line on each board, each switch having two contact-pieces to which respectively the two sides of its line are permanently connected, and annunciators one for each line, one side of each line being permanently grounded through the annunciator of its line, in combination with switching apparatus at each board to connect together any two of said lines for conversation into a complete metallic circuit by connecting together their respective contact-pieces at that board, a calling-generator at each subscriber's station located in the main or closed metallic circuit of its line whenever operated to send a signal either the primary or clearing-out signal, a ground connection to the line when the generator is thus operated, with the generator and the annunciator of the line in the complete ground-circuit thereby existing, and a clearing-out annunciator bridged across between the two sides of any such complete circuit, each line-annunciator being operated or responding when its subscriber's generator is operated and the line is not switched for conversation but when two lines are connected together into a metallic circuit for conversation, neither of the line-annunciators being operated but the clearing-out annunciator bridged across between the two sides of the metallic circuit being operated when the calling-generator of either line is operated to send the clearing-out signal.

9. In a telephone-exchange system, metallic-circuit lines, and annunciators, one for each line, one side of each line being permanently grounded through the annunciator of its line, in combination with switching apparatus to connect together any two of said lines for conversation into a complete metallic circuit which does not contain either line-annunciator, a calling-generator at each subscriber's station located in the main or closed metallic circuit of its line whenever operated to send a signal either the primary or clearing-out signal, a ground connection to the line when the generator is thus operated, with the generator and the annunciator of the line in the complete ground-circuit thereby existing, and a clearing-out annunciator bridged across between the two sides of said complete metallic circuit, said generators and annunciators being so related to each other and the circuits that each line-annunciator responds when its subscriber's generator is operated and the line is not switched for conversation, but neither of the line-annunciators is operated but the clearing-out annunciator bridged across between the two sides of the complete metallic circuit is operated, when two lines are connected together into a complete metallic circuit for conversation, and the calling-generator of either line is operated to send the clearing-out signal.

10. In a telephone-exchange system, metallic-circuit lines, multiple switchboards,

switches, one for each line on each board, each switch having two contact-pieces to which respectively the two sides of its line are permanently connected, and annunciators one for each line, one side of each line being permanently grounded through the annunciator of its line, in combination with switching apparatus at each board to connect together any two of said lines for conversation into a complete metallic circuit by connecting together their respective contact-pieces at that board, a calling-generator at each subscriber's station located in the main or closed metallic circuit of its line whenever operated to send a signal either the primary or clearing-out signal, a ground connection to the line when the generator is thus operated, with the generator and the annunciator of the line in the complete ground-circuit thereby existing, and a clearing-out annunciator bridged across between the two sides of any such complete circuit, said generators and annunciators being so related to each other and the circuits that each line-annunciator responds when its subscriber's generator is operated and the line is not switched for conversation, but neither of the line-annunciators is operated but the clearing-out annunciator bridged across between the two sides of the complete metallic circuit is operated, when two lines are connected together into a complete metallic circuit for conversation, and the calling-generator of either line is operated to send the clearing-out signal.

11. In a telephone-exchange system, metallic-circuit lines, multiple switchboards, switches, one for each line on each board, each switch having two contact-pieces to which respectively the two sides of its line are permanently connected, and annunciators one for each line, one side of each line being permanently grounded through the annunciator of its line, in combination with switching apparatus at each board to connect together any two of said lines for conversation into a complete metallic circuit by connecting together their respective contact-pieces at that board, and a clearing-out annunciator in circuit with the two lines of any such complete circuit.

12. In a telephone-exchange system, metallic-circuit lines, multiple switchboards, switches, one switch on each board for each line, each switch having two contact-pieces or terminals to which the two sides or branches of the line are respectively connected, two of said lines being temporarily connected together at a board into a combined circuit for conversation, by connecting together their respective contact pieces or terminals at that board, in combination with two ground connections to one side of said combined circuit, the line-annunciators of the two lines thus connected together, one in each of said ground connections, a calling-generator at one of the subscriber's stations of the two lines when they are thus connected operated in the circuit of

the line to send a clearing-out signal, and a ground connection to said subscriber's line at his station when the clearing-out signal is sent, said ground connection at the subscriber's station being on that side of the generator that the generator and the two line-annunciators are in closed circuit through one side of the subscriber's line only, said annunciators being so constructed or related that they are not operated by the current passing through them when the clearing-out signal is sent.

13. In a telephone-exchange system, metallic-circuit lines, multiple switchboards, switches, one switch on each board for each line, each switch having two contact pieces or terminals to which the two sides or branches of the line are respectively connected, two of said lines being temporarily connected together at a board into a combined circuit for conversation by connecting together their respective contact pieces or terminals at that board, in combination with two ground connections to one side of said combined circuit, the line-annunciators of the two lines thus connected together, one in each of said ground connections, a calling-generator at one of the subscriber's stations of the two lines when they are thus connected, operated in the circuit of the line to send a clearing-out signal, a ground connection to said subscriber's line at his station when the clearing-out signal is sent, and a clearing-out annunciator in circuit with said generator, said ground connection at the subscriber's station being on that side of the generator that the generator and the two line-annunciators are in closed circuit through one side of the subscriber's line only, said annunciators being so constructed or related that the line-annunciators are not operated, but the clearing-out annunciator is operated by the current passing through them when the clearing-out signal is sent.

14. In a telephone-exchange system, multiple switchboards, metallic-circuit lines, each line connected to each board, and means at each board to connect any two of said lines into a closed metallic circuit for conversation, in combination with a battery and a rheotome connected in series in a circuit connection, to one side of which circuit connection each line is connected whenever and as long as it is switched at a board for conversation and only then, and test-receiving instruments, one at another board, each connected on one side to the other side of said circuit connection and on its other side to a plug adapted to be placed for testing into connection with either of said lines.

15. In a telephone-exchange system, multiple switchboards, telephone-lines, each line connected to each board, and means at each board to connect any two of said lines into a closed circuit for conversation, in combination with a battery and a rheotome connected in series in a circuit connection, to one side of

which circuit connection each line is connected whenever and as long as it is switched at a board for conversation and only then, and test-receiving instruments, one at another board, each connected on one side to the other side of said circuit connection and on its other side to a plug adapted to be placed for testing into connection with either of said lines.

16. In a telephone-exchange system, multiple switchboards, metallic-circuit lines, each line connected to each board, and means at each board to connect to any two of said lines into a closed metallic circuit for conversation, in combination with a battery and a rheotome connected in series in an ungrounded circuit connection, to one side of which circuit connection each line is connected whenever and as long as it is switched at a board for conversation and only then, and test-receiving instruments, one at another board, each connected on one side to the other side of said circuit connection and on its other side to a plug adapted to be placed for testing into connection with either of said lines.

17. In a telephone-exchange system, multiple switchboards, telephone-lines, each line connected to each board, and means at each board to connect any two of said lines into a closed circuit for conversation, in combination with a battery and a rheotome connected in series in an ungrounded circuit connection, to one side of which circuit connection each line is connected whenever and as long as it is switched at a board for conversation and only then, and test-receiving instruments, one at another board, each connected on one side to the other side of said circuit connection and on its other side to a plug adapted to be placed for testing into connection with either of said lines.

18. In a telephone-exchange system, multiple switchboards, metallic-circuit lines, each line connected to each board, and means at each board to connect any two of said lines into a closed metallic circuit for conversation, in combination with a battery and a supplemental apparatus connected in series in a circuit connection, to one side of which circuit connection each line is connected whenever and as long as it is switched at a board for conversation and only then, and test-receiving instruments, one at another board, each connected on one side to the other side of said circuit connection and on its other side to a plug adapted to be placed for testing into connection with either of said lines.

19. In a telephone-exchange system, multiple switchboards, metallic-circuit lines, each line connected to each board, and means at each board to connect any two of said lines into a closed metallic circuit for conversation, in combination with a battery and a supplemental apparatus connected in series in an ungrounded circuit connection, to one side of which circuit connection each line is con-

5 nected whenever and as long as it is switched
at a board for conversation and only then,
and test-receiving instruments, one at another
board, each connected on one side to the other
side of said circuit connection and on its other
side to a plug adapted to be placed for test-
ing into connection with either of said lines.

In testimony whereof I have hereunto sub-
scribed my name.

MILO G. KELLOGG.

Witnesses:

ANNA M. BROWN,
L. D. KELLOGG.