(No Model.)

M. G. KELLOGG.

MULTIPLE SWITCHBOARD.

No. 592,384. Patented Oct. 26, 1897.

Fig. 2.

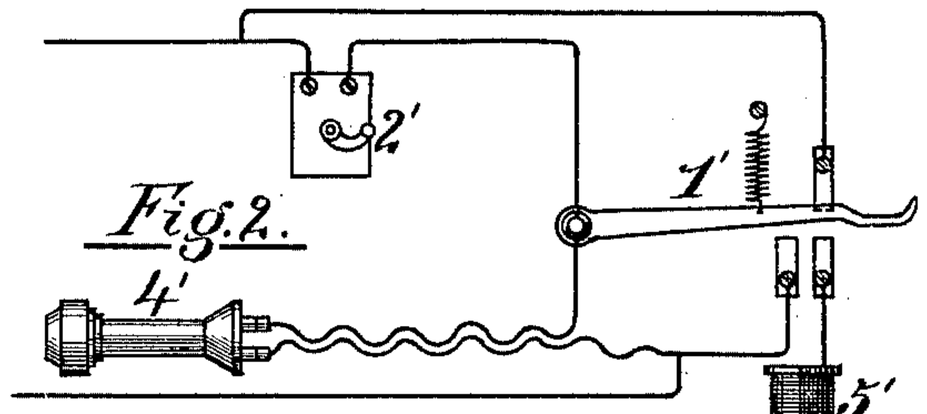

Fig. 1.

Witnesses:

G. Chas. Dietz.

Gustav Gross.

Inventor:

Milo G. Kellogg

UNITED STATES PATENT OFFICE.

MILO G. KELLOGG, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF SAME PLACE.

MULTIPLE SWITCHBOARD.

SPECIFICATION forming part of Letters Patent No. 592,384, dated October 26, 1897.

Application filed August 5, 1890. Serial No. 361,111. (No model.)

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, temporarily residing at Stuttgart, in the Empire of Germany, have invented certain new and useful 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.

My invention relates to a metallic-circuit telephone-exchange system in which there is a plug and a cord attached for each line of the exchange. Such a system is called a "single-cord" system. Said plug normally rests in a switching device, and when it is desired to connect the line with another line the plug is taken from its normal position and is placed in the switch of the other line.

My invention consists in a system of testing and an organization of apparatus, circuits, and connections for each line, whereby the operator may expeditiously and with few motions connect her telephone to a line when its call is indicated, may test the line wanted, may connect the two lines together and send a calling-current to the line wanted, may leave the lines connected together for conversation and connect her telephone into their circuit to determine whether they are through conversation, and may receive and attend to any clearing-out signal. Said organization is more simple and the operations required are less than in other systems devised to accomplish similar purposes.

In the accompanying drawings, illustrating my invention, Figure 1 represents the central-office apparatus and connections, and Fig. 2 the subscriber's-station apparatus necessary to illustrate my invention.

In the central office are as many switchboards as are found necessary or desirable in order to properly operate the exchange.

In Fig. 1, A A′ represent sectional views of sections of two switchboards to which the same lines connect. On each board of the exchange is a spring-jack or similar switch for each line. Each switch has a contact-spring which is normally in contact with a contact-point and is separated and insulated from the point when a switch-plug is inserted into the switch, and has a third contact-piece which is normally insulated from the other parts except by the circuit connections. This contact-piece is adapted to have a test-plug applied to it for testing. The switches shown in the figure are of well-known construction. For each line there is also a compound answering switch or device located at the board where the cord and plug of the line are located and where its calls are to be answered. This answering switch or device is operated on in part by the switch-plug when placed in its normal position and in part by the operator who answers the calls of the line. The construction, operation, and manipulation of these answering switches or devices will hereinafter be explained in detail.

Two lines and their switches on the boards, their plugs and cords, their compound answering-switches, and their annunciators are shown in Fig. 1. The answering apparatus of one line is shown as located at one board and that of the other line at the other board.

B B′ represent the two compound answering-switches of the lines, and D D their switch-plugs, to which the double insulated flexible conductors are attached. These plugs are adapted to be placed in any switch at their boards, and are each adapted to be placed normally or when not in use in the answering-switch of its line and to operate the switch, as will be described. One plug is shown in its answering-switch and the other plug is shown out of its switch. In the said switches B B′, *a a* are cylinders, preferably of metal, adapted to receive the movable commutator and plug-supporting pieces *b b*. These pieces *b b* may be of rubber and of the shape substantially as shown, or of other shapes, to correspond with variations in the construction of the other parts. 1, 2, 3, 4, 5, and 6 are contact-pieces which are insulated from each other. 2, 4, and 5 are spring-contacts. The others may be rigid.

Pieces 1 and 2 are mounted parallel to each other and in close juxtaposition, so that contact between them will be made and broken by the operation of the switch-plug, as hereinafter indicated. The pairs of contacts 3 4 and 5 6 are mounted parallel to each other

and in close juxtaposition, so that the contact of each pair is made and broken, as hereinafter described, by the operation of the plug. Spring 4 is connected near its upper end to spring 5 by means of an insulation-piece fastened to both. It therefore moves back and forth as spring 5 moves. Springs 2 and 5 are constructed and adjusted to press toward the center of piece *b* and will press against and be acted upon by the plug, as will be described.

The piece *b* has a hole or socket on its top, adapted to receive the plug-handle. It has also two chambers at its side, adapted to receive the bent portions of pieces 2 and 5, as shown, and has also a shoulder adapted to rest on the piece *a* when the piece *b* is moved to its lower portion. In the chamber adapted to receive the bent part of 5 is a shoulder *c*, on which the spring 5 bears when piece *b* is moved to its upper position and which then causes the contacts to change, as will be indicated. These pieces *b b* are adapted to occupy two positions—the upper, as shown in B′, and the lower, as shown in B.

When the switch-plug is in its socket in the movable piece *b*, this piece should occupy its lower position, and the handle of the plug presses on the springs 2 and 5, so that spring 2 is brought into contact with piece 1 and spring 5 is pressed out of contact with piece 6, while spring 4, which is attached to but insulated from 6, is pressed out of contact with piece 3. When the plug is withdrawn from the socket by the operator, the springs 2 and 5 are released from the pressure of the plug-handle, and (the movable piece *b* being still in its lower position) the contact between 2 and 1 is broken and that between 3 and 4 and that between 5 and 6, respectively, are established. When the plug is removed from the socket and the operator manipulates piece *b* and places it in its upper position, the contact between 1 and 2 still remains broken, and the shoulder *c* in the chamber of the piece *b* presses spring 5 out of contact with piece 6, and at the same time spring 5 carries spring 4 out of contact with piece 3. When, therefore, the plug is in its socket and piece *b* is in its lower position, 1 and 2 are in contact with each other, and the other contacts of the answering device are out of contact. When the plug is out of the socket and the piece *b* still remains in its lower position, 1 and 2 are out of contact and 3 and 4 and 5 and 6, respectively, are in contact, and when the plug is out of the socket and the piece *b* is raised to its outer position all of the three pairs of contacts are out of contact.

The switch-plugs D D are of a usual construction of loop-switch plugs adapted to be used with the spring-jack switches. The outsides of the handles have a rubber insulation. Each plug has two switch-contact pieces insulated from each other, one of them, *s*, being at the end of the plug and the other, *s′*, being an insulated cylinder placed along the surface of the tip. When a plug is inserted into a switch, the piece *s* presses against the spring of the switch and forces it away from the contact-point and makes connection with it, and the other piece of the plug *s′* forms connection with the third or insulated contact-piece of the switch.

t t are operators' telephones; R R, operators' calling-generators; R′ R′, operators' test-batteries; *r r*, resistance-coils, and K K calling-keys. Each operator has one of each of said parts, and they are connected to each other and to her answering-switches substantially as shown and as will be described.

C is a rheotome placed in the common ground connection of the lines, as will be described. The rheotome shown contains a clock-movement actuated by a spring and has a pair of insulated contact-points, the contact between which is alternately made and broken by the movement of the verge or shaft. The contact-points are connected in the circuit indicated for the rheotome.

w and *x* are calling-annunciators, one for each line shown.

G G are ground connections. The connections are substantially as follows: One side or branch of each line passes normally successively through the pairs of contact-points of the line-switches, passing in each case to the spring first. It then passes through the line-annunciator, and is then connected through one of the insulated conductors of the switch-cord to the contact-piece *s* of the switch-plug. The other side or branch of the line is connected to all of said third insulated contact-pieces of the switches of the line and is connected through the other conductor of the switch-cord to the other contact-piece *s′* of the switch-plug of the line. The first-mentioned side or branch of the line is also connected, after it passes through the line-annunciator, to contact-pieces 1 and 5 of the compound answering switch of the line, and the other side or branch of the line is connected to piece 3. One side of the operator's telephone is connected to the upper contact-point of the calling-key, and the other side of the telephone is connected through the resistance-coil to contact-piece 6. The lower contact-point of the key is connected through the calling-generator to the circuit-wire, which connects the telephone and the resistance-coil. Contact-piece 2 is connected through the rheotome C to the ground. The lever of the key is also connected to contact-piece 4. The side of the telephone which is connected to the upper part of the key-lever 6 is grounded through the test-battery R′.

Each compound answering-switch is connected to its line and to the operator's special apparatus substantially as described. It is also connected to the common rheotome as described. One rheotome will answer for all the lines of the exchange.

The calling-key K is a three-point key having a lever and two points, on one, the upper

point, of which the lever normally bears, and on the lower point of which it is in contact when it is pressed down by the operator.

Weights or other suitable devices may be used to bring the switch-plugs into their normal position in the sockets of the answering-switches, and they may be such as will press the movable pieces of their respective switches to their normal lower or inner positions.

In the subscriber's-station apparatus shown in Fig. 2, 1′ is the telephone-switch. 2′ is the calling-generator. 3′ is the signal-receiving bell. 4′ is the subscriber's telephone, and 5′ is a resistance-coil. G is a ground connection. The signal-receiving bell and the resistance-coil are placed in a ground-wire which is connected to a contact-point of the switch. This contact-point is in contact with the switch-lever when the telephone is on the switch, and the line-circuit is grounded through the bell and resistance-coil when the telephone is on the switch, and said ground connection is open when the telephone is off the switch. Other arrangements of contacts and points may be used which will produce the same result. The calling-generator is connected into the line-circuit, so that it is between the normal ground connection at the subscriber's station and the normal ground connection of the line at the central office.

The operation of the system is as follows: When the plug of a line is in its normal position in the socket of its compound answering-switch and the line is not switched at any board of the exchange, the line is grounded at the central office through the rheotome. When the line is switched at any board by the insertion of a switch-plug into its switch or its plug is withdrawn from its normal position in the socket, the ground connection through the rheotome is broken. In the latter case the interruption is at the pair of contacts 1 2 and in the former case in the pair of contact-points of the switch. When the plug is withdrawn from its normal position in the answering-switch, the two sides of the line are automatically brought into a closed circuit, with the operator's telephone in the circuit. This connection is made by the closing of the two pairs of contacts 3 4 and 5 6, respectively. Such circuit is from contact-spring 5 (which is connected to one side of the line) to contact-piece 6 and thence through the resistance-coil *r*, operator's telephone *t*, and the two normally closed contact-points of the key K to the contact-piece 4 and thence to contact-piece 3, which is connected to the other side or branch of the line. The operator then by conversation finds out what line is wanted by the subscriber. She then tests the line wanted, as will hereinafter be described, and if she finds it to be "free" she places the switch-plug in its switch. The two lines are then disconnected from their ground connection through the rheotome and are connected together into a metallic circuit, and the circuit is cross-connected or bridged by a circuit which contains the resistance-coil and telephone. The operator will now press on the calling-key, and by so doing disconnect the upper contact-points and connect the lower points, and a calling-current will pass to the line wanted. The connection of the generator is to the ground at the central office and to the normal ground connection of the line at the subscriber's station, and his bell will ring, indicating the call. The telephone of the other subscriber will then generally be off its switch for conversation, and the bell will not be in a closed circuit with the generator and will not ring. The operator now pulls the movable piece *b* of the answering-switch to its upper position, and the cross or bridge connection is interrupted by the opening of the pairs of contact-points 3 4 and 5 6.

When the operator desires to listen into the circuit to learn whether the subscribers are through conversation, she presses the piece *b* to its lower position and the bridge or cross connection is again established, and enough telephone-current, if the line is in use, will pass through her telephone to enable her to determine that they are not through conversation. When the operator desires to clear out the connection, she takes the switch-plug from the switch and places it in its normal position in the socket of piece *b* and presses piece *b* into its lower or inner position. The line apparatus is then ready to receive and answer a new call on the line by the mere act of withdrawing the plug and making the other operations which I have described.

The special use and function of the resistance-coil *r* is to prevent an undue amount of telephone-current from being diverted to the operator's telephone when she listens into the circuit to the detriment of the conversation passing through it. This resistance may be made great or small, as is found most desirable for the general conduct of the business.

It will be observed that in this system the signal-bell of the subscriber who is wanted will be rung when the signal-current is directed to the circuit as described, and that the bell of the subscriber who originated the call will generally not be rung, as his telephone will be generally off its switch and the ground connection of his line with his bell broken.

The operation of the test system is as follows: When the operator tests any line, she places the tip *s* of the plug of the line whose call she is answering on the metal socket or third contact-piece of the switch at her board of the line wanted. If, then, the line tested is not switched, a complete test-circuit will be established, in which is the operator's telephone, the rheotome, and the test-battery. This circuit is from the ground through the rheotome, the contact-points 1 2 of the answering-switch of the line, and the normally closed contact-points of its spring-jack switches to the line, through the circuit of the line to contact-piece *s* of the plug, and

thence through contacts 5 and 6, resistance *r*, and operator's telephone *t* and test-battery to the ground. This circuit is tapped or grounded at the subscriber's station through the resistance-coil 5′ and the signal-bell 3′. Part of the current from the test-battery when the test of a line is made and the subscriber's telephone is on its switch seeks ground through this tap ground connection, and only part of the current through the test receiving instrument will therefore be interrupted by the make and break of the rheotome. The current through the test receiving instrument when the test of a line is made and the line is not switched and the subscriber's telephone is not switched for use will therefore be pulsatory and not intermittent. This regular variation in the strength of the current will, however, be sufficient to be heard in the test receiving instrument, which should preferably be a receiving-telephone. The operator will then, on making the test, hear in her telephone the click when the circuit is alternately established and broken at the rheotome and will know that the line is "free" or unswitched. When the line tested is switched at any board, its connection to the rheotome is broken, and the operator not hearing the click in the telephone will know that the line is switched.

The resistance of the coil 5′ and the signal-bell 3′ should be such that enough current from the test-battery will pass through the rheotome to make its makes and breaks audible in the test receiving instrument. Instead of the resistance-coil in the circuit connection with the bell, the bell itself may have sufficient resistance to answer the purpose.

With the system and mechanism above described for the operation of a single-cord metallic-circuit system there are fewer parts and their arrangement is more simple than is the case with other systems which have been devised for similar use, and the operations required of the operator in making a connection are reduced to the minimum.

By the use of the subscriber's-station apparatus constructed substantially as indicated in connection with the central-office apparatus constructed substantially as indicated I am enabled to signal on the bell of the subscriber wanted without ringing the bell of the calling subscriber, and at the same time employ a test which indicates whether or not the line tested has been disconnected from the ground at the central office. In some telephone-exchanges it is thought very desirable that when a subscriber is called his own bell shall be rung without ringing the calling-subscriber's bell. My system accomplishes this.

I use the terms "bridge" and "cross-connect" in connection with a complete metallic circuit to describe a connection between one side or branch of the circuit and its other side or branch, and an instrument in a bridge or cross-connecting circuit to a metallic circuit is not in the direct circuit, but is in a circuit connection across the two sides or branches of the circuit.

I claim as my invention and desire to secure by Letters Patent—

1. In a telephone-exchange system, metallic-circuit lines normally grounded at the central office through a rheotome but disconnected from such ground connection while switched for conversation, in combination with an operator's-telephone coil grounded on one side, a loop-switch plug for each line, one of whose contact-pieces is adapted to be brought into contact with the test contact-pieces of the other lines and to the two contact-pieces of which, respectively, are connected through flexible conductors the two sides or branches of the line, a plug switching device into which the plug is normally placed, two pairs of contact-points in said switching device normally open but closed when the plug is withdrawn from the switching device, one of said contact-points being connected to the side of the telephone-coil which is not grounded and its mate with said contact-piece of the plug which is adapted to be brought into contact with said test contact-pieces, while the two other points are connected with the other contact-piece of the plug and the other side of the telephone-coil, respectively, and a test-battery in the test-circuit thereby established, substantially as set forth.

2. In a telephone-exchange system, metallic-circuit lines normally grounded at the central office through a rheotome but disconnected from such ground connection while switched for conversation, in combination with an operator's-telephone coil grounded on one side through a test-battery, a loop-switch plug for each line one of whose contact-pieces is adapted to be brought into contact with the test contact-piece of the other lines and to the two contact-pieces of which, respectively, are connected through flexible conductors the two sides or branches of the line, a plug switching device into which the plug is normally placed, two pairs of contact-points in said switching device normally open but closed when the plug is withdrawn from the switching device, one of said contact-points being connected to the side of the telephone-coil which is not grounded and its mate with said contact-piece of the plug which is adapted to be brought into contact with the said test contact-pieces, while the two other points are connected with the other contact-piece of the plug and the other side of the telephone-coil, respectively, substantially as set forth.

3. In a telephone-exchange system, metallic-circuit lines normally grounded at the central office through a rheotome but disconnected from such ground connection while switched for conversation, in combination with an operator's-telephone coil, a loop-switch plug for each line, one of whose con-

tact-pieces is adapted to be brought into contact with the test contact-pieces which, respectively, are connected through flexible conductors the two sides or branches of the line, a plug switching device into which the plug is normally placed, two pairs of contact-points in said switching device normally open but closed when the plug is withdrawn from the switching device, one of said contact-points being connected to the side of the telephone-coil which is not grounded and its mate with said contact-piece of the plug which is adapted to be brought into contact with said test contact-pieces, while the two other points are connected with the other contact-piece of the plug and the other side of the telephone-coil, respectively, and a test-battery in the test-circuit thereby established, substantially as set forth.

4. In a telephone-exchange system, metallic-circuit lines normally connected at the central office to a common ground wire or connection but disconnected from said common ground-wire while switched for conversation and a rheotome in said common ground-wire, in combination with an operator's-telephone coil grounded on one side, a loop-switch plug for each line, one of whose contact-pieces is adapted to be brought into contact with the test contact-pieces of the other lines and to the two contact-pieces of which plug, respectively, are connected through flexible conductors the two sides or branches of the line, a plug switching device into which the plug is normally placed, two pairs of contact-points in said switching device normally open but closed when the plug is withdrawn from the switching device, one of said contact-points being connected to the side of the telephone-coil which is not grounded and its mate with said contact-piece of the plug which is adapted to be brought into contact with said test contact-pieces, while the two other points are connected with the other contact-piece of the plug and the other side of the telephone-coil, respectively, and a test-battery in the test-circuit thereby established, substantially as set forth.

5. In a telephone-exchange system, a metallic-circuit line normally connected with the ground at the subscriber's station but disconnected from the ground there while it is in use for conversation, one branch of which is normally or while and as long as the line is not switched for conversation connected to a ground wire or connection at the central office and a rheotome in said ground wire or connection and the other branch of which is normally open at the central office, in combination with a switching device at the central office to disconnect said line from such ground connection through the rheotome when the line is switched for conversation, a test receiving instrument grounded on one side and connected on its other side to a test plug or device adapted to be brought for testing into connection with the normally open end of the line, and a battery in the test-circuit thereby established, substantially as set forth.

6. In a telephone-exchange system, a metallic-circuit line normally connected with the ground at the subscriber's station but disconnected from the ground there while it is switched for conversation, one branch of which is normally or while and as long as the line is not switched for conversation, connected to one side of a rheotome at the central office and the other branch of which is normally open at the central office and said rheotome, in combination with a switching device at the central office to disconnect the line from such connection with the rheotome, while or during the time the line is switched for conversation a test receiving instrument connected on one side to the other side of the rheotome and on its other side to a test plug or device adapted to be brought into connection with the open end of the line, and a battery in the test-circuit thereby established, substantially as set forth.

7. In a telephone-exchange system, a metallic-circuit line normally connected with the ground at the subscriber's station, one branch of which is normally or while and as long as the line is not switched for conversation, connected with a ground wire or connection at the central office and a rheotome in said ground wire or connection and the other branch of which is normally open at the central office, in combination with switching devices at the central office which disconnect said line from such ground connection through the rheotome when or during the time the line is switched for conversation, a test receiving instrument grounded on one side and connected on its other side to a switch plug or device adapted to be brought into connection with such normally open branch of the line, and a battery in the test-circuit thereby established, substantially as set forth.

8. In a telephone-exchange system, a metallic-circuit line normally connected with the ground at the subscriber's station, one branch of which is normally or while and as long as the line is not switched for conversation, connected with one side of a rheotome at the central office and the other branch of which is normally open at the central office and said rheotome, in combination with switching devices at the central office which disconnect the line from such normal connection with the rheotome when or during the time the line is switched for conversation, a test receiving instrument connected on one side to the other side of the rheotome and on its other side to a test plug or device adapted to be brought for testing into connection with such normally open end of the line, and a battery in the test-circuit thereby established, substantially as set forth.

9. In a telephone-exchange system, a metal-

lic-circuit line normally connected through a resistance to the ground at the subscriber's station but disconnected from the ground there while it is in use for conversation, one branch of which is normally or while and as long as the line is not switched for conversation connected to a ground wire or connection in the central office, a rheotome in said ground wire or connection and the other branch of which is normally open at the central office and said resistance, in combination with switching devices in the central office with contact-points which disconnect said line from said ground connection through the rheotome while or during the time the line is switched for conversation, a test receiving instrument grounded on one side and connected on its other side to a test plug or device adapted to be brought for testing into connection with the normally open end of the line, and a battery in the test-circuit thereby established, substantially as set forth.

10. In a telephone-exchange system, a metallic-circuit line normally connected through a resistance to the ground at the subscriber's station, one branch of which is normally or while and as long as the line is not switched for conversation, connected to a ground wire or connection at the central office a rheotome in said ground wire or connection, and the other branch of which is normally open at the central office and said resistance, in combination with switching devices in the central office with contact-points which disconnect said line from said ground connection through the rheotome while or during the time the line is switched for conversation, a test receiving instrument grounded on one side and connected on its other side to a test plug or device adapted to be brought for testing into connection with the normally open end of the line and a battery in the test-circuit thereby established, substantially as set forth.

11. In a telephone-exchange system, a metallic-circuit line normally connected through a signal-receiving bell to the ground at the subscriber's station, one branch of which is normally or while and as long as the line is not switched for conversation connected to a ground wire or connection at the central office a rheotome in said ground wire or connection and the other branch of which is normally open at the central office, and said bell, in combination with switching devices in the central office with contact-points which disconnect said line from said ground connection through the rheotome while or during the time the line is switched for conversation, a test receiving instrument grounded on one side and connected on its other side to a test-plug adapted to be brought for testing into connection with the normally open end of the line and a battery in the test-circuit thereby established, substantially as set forth.

12. In a telephone-exchange system, a metallic-circuit line normally connected through a signal-receiving bell to the ground at the subscriber's station while the line is not in use for conversation, one branch of which is normally or while and as long as the line is not switched for conversation connected to a ground wire or connection at the central office in which is a rheotome and the other branch of which is normally open at the central office, said rheotome and said signal-receiving bell, in combination with switching devices at the central office with contact-points which disconnect the line from said ground connection through the rheotome while or during the time it is switched for use, a test receiving instrument grounded on one side and adapted to be brought for testing into connection with the normally open end of the line and a battery in the test-circuit thereby established, substantially as set forth.

13. In a telephone-exchange system, a metallic-circuit line, one branch of which is normally or while and as long as the line is not switched for conversation connected to a ground wire or connection at the central office in which is a rheotome and the other branch of which is normally open at the central office and said rheotome, in combination with switching devices at the central office with contact-points which disconnect the line from said ground connection through the rheotome while or during the time said line is switched for use, a resistance at the subscriber's station, a switch operated by the subscriber's telephone to ground the circuit of the line through said resistance while the telephone is not switched for use but not otherwise, a test receiving instrument grounded at one side and connected on its other side to a test plug or device adapted to be brought for testing into connection with the normally open end of the line, at the central office and a battery in the test-circuit thereby established, substantially as set forth.

14. In a telephone-exchange system, a metallic-circuit line, one branch of which is normally or while and as long as the line is not switched for conversation connected to a ground wire or connection at the central office, in which is a rheotome and the other branch of which is normally open at the central office, and said rheotome, in combination with switching devices at the central office with contact-points which disconnect the line from said ground connection through the rheotome while or during the time said line is switched for use, a signal-receiving bell at the subscriber's station, a switch operated by the subscriber's telephone, with contact-points which ground the circuit of the line through said bell when the subscriber's telephone is not switched for use but not otherwise, a test receiving instrument grounded on one side and connected on its other side to a test plug or device adapted to be brought for testing into connection with the normally

open end of the line, at the central office, and a battery in the test-circuit thereby established, substantially as set forth.

15. In a telephone-exchange system, a metallic-circuit line, one branch of which is normally or while and as long as the line is not switched for conversation, connected to a ground wire or connection at the central office in which is a rheotome and the other branch of which is normally open at the central office, in combination with switching devices at the central office with contact-points which disconnect the line from said ground connection through the rheotome while or during the time said line is switched for conversation, a signal-receiving bell and a resistance-coil at the subscriber's station, a switch operated by the subscriber's telephone with contact-points which ground the circuit of the line through said bell and resistance-coil while the subscriber's telephone is not switched for use but not otherwise, a test receiving instrument grounded on one side and connected on its other side to a test plug or device adapted to be brought for testing into connection with the normally open end of the line and a battery in the test-circuit thereby established, substantially as set forth.

16. In a telephone-exchange system, a metallic-circuit line, one branch of which is normally or while and as long as the line is not switched for conversation connected at the central office to one side of a rheotome and the other branch of which is normally open at the central office to said rheotome, in combination with switching devices at the central office with contact-points which disconnect the line from said connection with the rheotome while or during the time said line is switched for use, a resistance at the subscriber's station, a switch operated by the subscriber's telephone, which connects the circuit of the line to the ground through said resistance while the subscriber's telephone is not switched for use but not otherwise, a test receiving instrument connected on one side to the other side of said rheotome and on its other side to a test plug or device adapted to be brought for testing into connection with said open branch of the line, and a battery in the test-circuit thereby established, substantially as set forth.

17. In a telephone-exchange system, a metallic-circuit line, one branch of which is normally or while and as long as the line is not switched for conversation, connected at the central office to one side of a rheotome and the other branch of which is normally open at the central office to said rheotome, in combination with switching devices at the central office with contact-points which disconnect the line from said connection with the rheotome while or during the time said line is switched for use, a signal-receiving bell at the subscriber's station, a switch operated by the subscriber's telephone, with contact-points which connect the circuit of the line to the ground through said bell while the subscriber's telephone is not used but not otherwise, a test receiving instrument connected on one side to the other side of said test-battery and on its other side to a test plug or device adapted to be brought for testing into connection with said open branch of the line and a battery in the test-circuit thereby established, substantially as set forth.

18. In a telephone-exchange system, a metallic-circuit line normally or while and as long as the line is not switched for conversation connected with the ground at the subscriber's station through a resistance but disconnected from the ground there when the line is in use for conversation, one branch of said line being normally connected at the central office with one side of a rheotome and the other branch being open to the rheotome, in combination with switching devices at the central office with contact-points which disconnect the line from said rheotome when or during the time said line is switched for use and a test receiving instrument connected on one side to the other side of said rheotome and on its other side to a test plug or device adapted to be brought for testing into connection with said normally open end of the line and a battery in the test-circuit thereby established, substantially as set forth.

19. In a telephone-exchange system, a metallic-circuit line, one branch of which is normally connected with the ground wire or connection at the central office in which is a rheotome and the other branch of which is normally open at the central office, and at the subscriber's station a normal ground connection of the line and a signal-bell in said ground connection, in combination with switching devices at the central office which disconnect said line from such ground connection through the rheotome when the line is switched for conversation, a test receiving instrument grounded on one side and connected on its other side to a switch plug or device adapted to be brought into connection with such normally open branch of the line, and a battery in the circuit with the test receiving instrument between its ground connection and its test plug or device, substantially as set forth.

20. In a telephone-exchange system, a metallic-circuit line, one branch of which is normally connected to a ground wire or connection at the central office in which is a rheotome and the other branch of which is normally open at the central office, and at the subscriber's station a normal ground connection of the line of some resistance, in combination with switching devices in the central office with contact-points which disconnect said line from said ground connection through the rheotome while the line is switched for conversation, a test receiving instrument grounded on one side and connected on its

other side to a test plug or device adapted to be brought for testing into connection with the normally open end of the line and a battery in the circuit with the test receiving instrument between its ground connection and its test plug or device, substantially as set forth.

In witness whereof I hereunto subscribe my name this 23d day of June, 1890.

MILO G. KELLOGG.

Witnesses:
EMIL ABENHEIM,
ABBOTT L. MILLS.