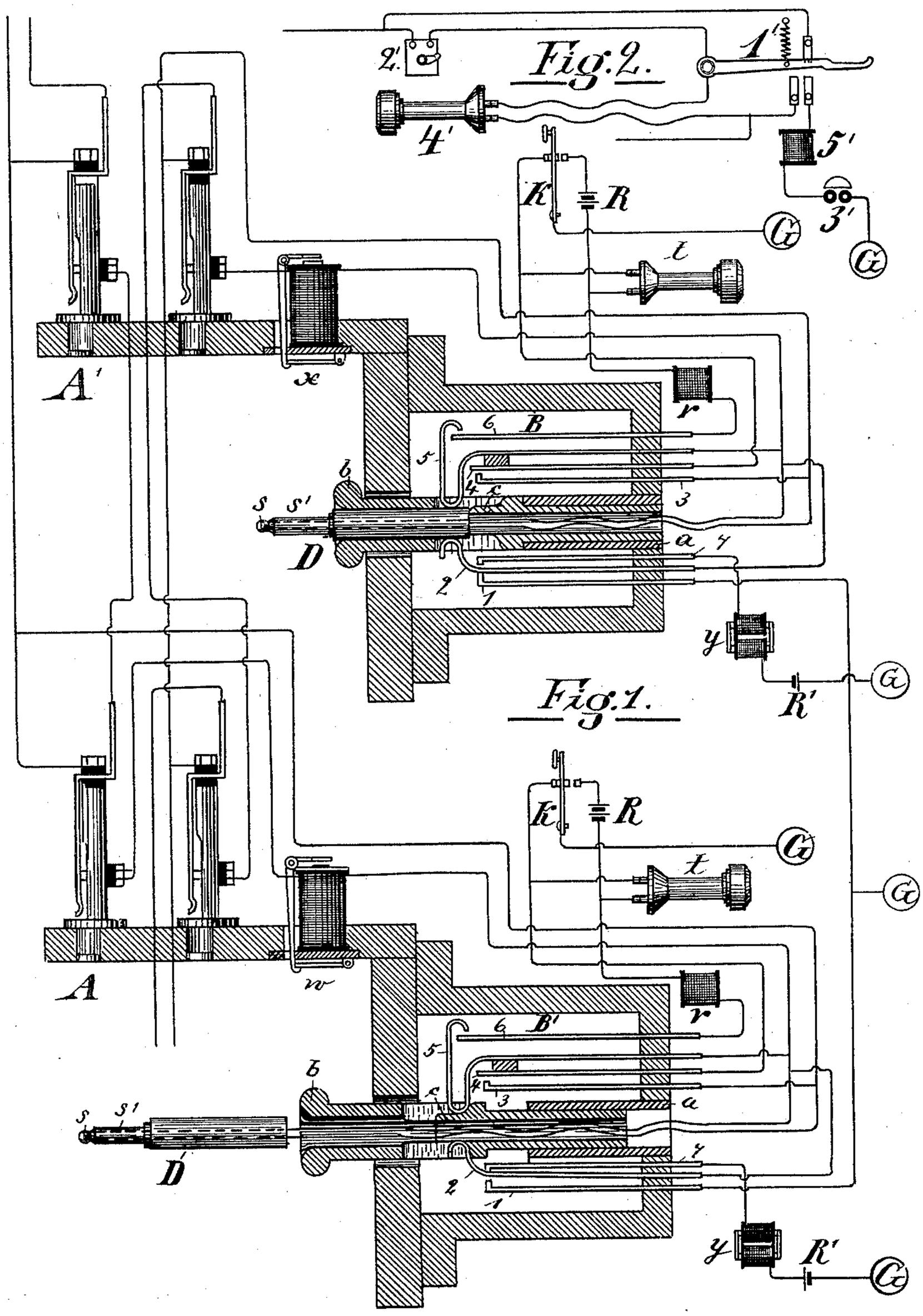
(No Model.)

M. G. KELLOGG.

MULTIPLE SWITCHBOARD.

No. 592,388. Patented Oct. 26, 1897.



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MULTIPLE SWITCHBOARD.

SPECIFICATION forming part of Letters Patent No. 592,388, dated October 26, 1897.

Application filed August 5, 1890. Serial No. 361,115. (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 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 is shown out of its switch. In the said switches, B B′ *a a* are cylinders, preferably of metal, adapted to receive and guide the commutator and plug-supporting pieces *b b*. These pieces *b b* (one for each switch) may be of rubber and of the shape substantially as shown or of other shapes to correspond with variations in the shape and arrangement of the other parts of the switches. 1, 2, 3, 4, 5, 6, and 7 are contact-pieces insulated from each other. 2, 4, and 5 are spring contact-pieces. The other pieces 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 in its top adapted to receive the plug-handle. It has also two chambers at its sides adapted to receive the bent portions of springs 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 position. In the chamber adapted to receive the bent part of spring 5 is a shoulder or projection *c*, on which the spring 5 bears when piece *b* is moved to its upper position, and which then causes contacts to change, as will hereinafter be indicated. These pieces *b b* are adapted and intended to occupy two positions in the operation of the system—the upper or outer position, as shown in B′, and the lower or inner position 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 is not in contact with piece 7, and spring 5 is pressed out of contact with piece 6, while spring 4, which is attached to but insulated from 5, 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 contacts between 2 and 7, between 3 and 4, and 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 2 and 7 still remains 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 2 and 7, 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 7 and 2 are in contact and all of the other 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-tip 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 a 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-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.

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

G G are ground connections.

y y are retardation-coils, one for each line of the exchange.

R′ is a test-battery.

The calling-keys K K are three-point keys having each a lever and two points, on one of which the lever normally bears and on the other of which it is in contact when it is pressed down by the operator away from the first-mentioned point.

Each of the retardation-coils contains two spools or helices of insulated wire, each helix surrounding an iron core. The two cores are connected at their two ends by cross-bars of iron. The coils of a retardation-coil are connected together in such a direction as to magnetize in the same direction the closed magnetic circuit made by the iron pieces of the coil.

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 2 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 contact-piece 4 of the answering-switch, and the other side of the telephone is connected, through the resistance-coil, to contact-piece 6.

The circuit-wire connecting the telephone and contact-piece 4 is connected to the upper contact-point of the calling-key. The lower

contact-point of the key is connected, through the operator's calling-generator, to the circuit-wire which connects the telephone and contact-piece 6, and the lever-key is connected to the ground. Piece 7 of each switch is connected, through the retardation-coil of its line and thence through the common test-battery to the ground. Piece 1 is grounded.

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

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 operator'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 bell could, if desired, be removed from said ground-wire and be placed in the line-circuit.

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. 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 said ground connection 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 line is grounded through its retardation-coil and the test-battery by the closing of contacts 2 and 7 and 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 *b*, and thence through the resistance-coil *r* and operator's telephone *t* 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 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 thereupon presses down on the lever of her calling-key and thereby connects her calling-generator in a circuit from the ground to the line-circuit and to ground at the station of the subscriber wanted, and his signal-bell will be rung. The telephone of the calling subscriber will generally be switched for use during this operation, and his bell will not ring. The operator then moves the piece *b* of the answering-switch to its upper or outer position, and the bridge circuit or connection of the circuit is opened by the opening of the pairs of contact-points 3 4 and 5 6.

When the operator desires to listen into the circuit to determine whether the subscribers are through conversation, she presses the movable piece *b* in and thereby establishes again the bridge to the circuit which contains her telephone and resistance-coil. The resistance-coil prevents an undue amount of the telephone-current from going through her telephone.

The test system is as follows: When any line is unswitched at any board, it is disconnected from the ground connection through the test-battery. When it is switched at any board, either by its own switch-plug being used for switching or the switch-plug of another line being inserted into one of its line-switches, its circuit is connected to the ground through the test-battery. The connection is made by the closing of the pair of contact-points 7 2 of the answering-switch used in switching. When the line is not switched, it is not grounded through a battery. When the operator desires to test any line to find out whether it is switched, she places the tip of the switch-plug of the calling-line on the insulated contact-piece of the switch at her board of the line to be tested. If the line is switched at any board, there is a complete circuit then established through the test-battery and the operator's telephone will sound or respond. This circuit is from the ground at the central office of the line tested through its test-battery and retardation-coil and the pair of contacts 2 7 of the line whose plug has been used in switching the line tested, thence to contact *s* of said plug, thence through the circuit of the line by way of the subscriber's station to the switch-contact to which the test is applied, and thence through the contact-piece *s* of the plug used in testing and contacts 5 6 of its switching device, the resistance-coil *r*, the operator's telephone *t*, and the normally closed contacts of the key K to ground. If the line is not switched, there is no such circuit estab-

lished and the telephone will not respond. She can therefore tell whether or not the line is switched at any board.

It will be noticed that when two lines are connected for conversation their circuit is grounded at the central office through a retardation-coil and the test-battery. The retardation-coil prevents or minimizes the effect on the circuit which might arise from other metallic circuits connected in like manner to the ground.

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, a metallic-circuit line one side or branch of which is normally grounded at the central office, in combination with a switch-plug with cord for said line, a test-wire grounded on one side, a test-battery, in said test-wire, a switching device into which the plug is normally placed, a pair of contacts in said switching device normally open but closed on the withdrawal of the plug, to one of which said line is connected and to the other of which the other side of said test-wire is connected and a pair of contacts through which said line normally passes, normally closed but open on the withdrawal of the plug, by which when the plug is withdrawn from the switching device the said normal ground connection of the line is broken and the line is grounded through the test-battery, substantially as set forth.

2. In a telephone-exchange system, a metallic-circuit line one side or branch of which is normally grounded at the central office, in combination with a switch-plug with cord for said line, a circuit-wire grounded at one end, a retardation-coil in said circuit-wire, and a switching device into which the plug is normally placed, a pair of contacts in said switching device normally open but closed on the withdrawal of the plug, to one of which said line is connected and to the other of which the other end of said circuit-wire is connected and a pair of contacts through which said line normally passes, normally closed but open on the withdrawal of the plug, by which when the plug is withdrawn from the switching device the said normal connection of the line is broken and the line is grounded through the retardation-coil, substantially as set forth.

3. In a telephone-exchange system, a metallic-circuit line one side or branch of which is normally grounded at the central office, in combination with a switch-plug with cord for said line, a circuit-wire grounded at one end, a test-battery and retardation-coil in said circuit-wire and a switching device into which the plug is normally placed, a pair of contacts in said switching device normally open but closed on the withdrawal of the plug to one of which said line is connected and to the other of which the other end of said circuit-wire is connected and a pair of contacts through which said line normally passes, normally closed but open on the withdrawal of the plug, by which when the plug is withdrawn from the switching device the line is grounded through the test-battery and retardation-coil, substantially as set forth.

4. In a telephone-exchange system, a metallic-circuit line one side or branch of which is normally grounded at the central office, in combination with a switch-plug with cord for said line, a circuit-wire grounded at one end, a test-battery in said circuit-wire, a switching device into which the plug is normally placed, a pair of contacts in said switching device normally open but closed on the withdrawal of the plug, to one of which said line is connected and to the other of which the other end of said circuit-wire is connected and a pair of contacts through which said line normally passes, normally closed but open on the withdrawal of the plug, by which when the plug is withdrawn from the switching device such normal connection of the line is broken and the line is grounded through a test-battery, and a test receiving instrument grounded on one side and connected on its other side to a plug or device adapted at the will of the operator to be brought into connection with the line, substantially as set forth.

5. In a telephone-exchange system, a metallic-circuit line one side or branch of which is normally grounded at the central office, in combination with a switch-plug with cord for said line, a circuit-wire grounded at one end, a test-battery and retardation-coil in said circuit-wire, a switching device into which the plug is normally placed, a pair of contacts in said switching device normally open but closed on the withdrawal of the plug, to one of which said line is connected and to the other of which the other end of said circuit-wire is connected, and a pair of contacts through which said line normally passes, normally closed but open on the withdrawal of the plug by which when the plug is withdrawn from the switching device such normal connection of the line is broken and the line is grounded through a test-battery, and a test receiving instrument grounded on one side and connected on its other side to a plug or device adapted at the will of the operator to be brought into connection with the line, substantially as set forth.

6. In a telephone-exchange system, a metallic-circuit line one side or branch of which is normally grounded at the central office, in combination with a switch-plug with cord for said line, a circuit-wire connected at one end to one side of a test receiving instrument, a test-battery in said circuit-wire and a switching device, a pair of contacts in said switch-

ing device normally open but closed on the withdrawal of the plug, to one of which said line is connected and to the other of which the other end of said circuit-wire is connected and a pair of contacts through which said line normally passes, normally closed but open on the withdrawal of the plug by which when the plug is withdrawn from its normal position in the switching device the normal ground connection of the line is broken and the line is connected to one side of said test-battery, substantially as set forth.

7. In a telephone-exchange system, a metallic-circuit line one side or branch of which is normally grounded at the central office, in combination with a switch-plug with cord for said line, a circuit-wire connected at one end to one side of a test receiving instrument, a retardation-coil in said circuit-wire, and a switching device, a pair of contacts in said switching device normally open but closed on the withdrawal of the plug, to one of which said line is connected and to the other of which the other end of said circuit-wire is connected and a pair of contacts through which said line normally passes normally closed but open on the withdrawal of the plug by which when the plug is withdrawn from its normal position in the switching device the normal ground connection of the line is broken and the line is connected to one side of said test-battery, substantially as set forth.

8. In a telephone-exchange system, a metallic-circuit line one side or branch of which is normally grounded at the central office, in combination with a switch-plug with cord for said line, a circuit-wire connected at one end to one side of a test receiving instrument, a test-battery and retardation-coil in said circuit-wire, and a switching device, a pair of contacts in said switching device normally open but closed on the withdrawal of the plug, to one of which said line is connected and to the other of which the other end of said circuit-wire is connected and a pair of contacts through which said line normally passes normally closed but open on the withdrawal of the plug by which when the plug is withdrawn from its normal position in the switching device the normal ground connection of the line is broken and the line is connected to one side of said test-battery, and retardation-coil, substantially as set forth.

9. In a telephone-exchange system, a metallic-circuit line one side or branch of which is normally grounded at the central office, in combination with a switch-plug with cord for said line, a circuit-wire, a test-battery in said circuit-wire, a switching device into which the plug is normally placed, a pair of contacts in said switching device normally open but closed on the withdrawal of the plug, to one of which said line is connected and to one of which the other end of said circuit-wire is connected and a pair of contacts through which said line normally passes normally closed but open on the withdrawal of the plug, by which when the plug is withdrawn from the device the normal ground connection of the line is broken and the line is connected to one end of said circuit-wire, and a test receiving instrument connected on one to the other end of said circuit-wire and on its other side to plug or device adapted to be brought into connection with the line, substantially as set forth.

10. In a telephone-exchange system, a metallic-circuit line one side or branch of which is normally grounded at the central office, in combination with a switch-plug with cord for said line, a test-battery and retardation-coil, a switching device into which the plug is normally placed, with contacts and connections by which when the plug is withdrawn from the device the normal ground connection of the line is broken and the line is connected to one side of said test-battery and retardation-coil, and a test receiving instrument connected on one side to the other side of said test-battery and retardation-coil and on its other side to a plug or device adapted to be brought into connection with the line, substantially as set forth.

11. In a telephone-exchange system, a metallic-circuit line, one side or branch of which is normally grounded at the central office, in combination with a switch-plug with cord for said line, a circuit-wire, a retardation-coil in said circuit-wire, a switching device into which the plug is normally placed, a pair of contacts in said switching device normally open but closed on the withdrawal of the plug, to one of which said line is connected and to one of which the other end of said circuit-wire is connected and a pair of contacts through which said line normally passes normally closed but open on the withdrawal of the plug, by which when the plug is withdrawn from the device the normal ground connection of the line is broken and the line is connected to one end of said circuit-wire, and a test receiving instrument connected on one side to the other end of said circuit-wire, and on its other side to a plug or device adapted to be brought into connection with the line, substantially as set forth.

12. In a telephone-exchange system, a metallic-circuit line which is normally grounded at the subscriber's station, one side or branch of which is normally grounded and the other side or branch of which is normally open at the central office, in combination with a switch-plug with cord for said line, a test-battery, a switching device into which the plug is normally placed, with contacts and connections by which when the plug is withdrawn from the device the normal ground connection of the line at the central office is broken and the line is grounded through the test-battery, and a test receiving instrument grounded on one side and connected on its other side to a plug or device adapted to be brought into connection with said normally

open side or branch of the line, substantially as set forth.

13. In a telephone-exchange system, a metallic-circuit line which is normally grounded at the subscriber's station through a resistance, one side or branch of the line being normally grounded and the other side or branch normally open at the central office in combination with a switch with contacts and connections by which such normal ground connection at the subscriber's station is broken while the subscriber's telephone is switched for use, a switch-plug with cord for the line, a test-battery a switching device into which the plug is normally placed, with contacts and connections by which when the plug is withdrawn from the switching device the normal ground connection of the line at the central office is broken and the line is grounded through the test-battery, and a test receiving instrument grounded on one side and connected on its other side to a plug or device adapted to be brought into connection with the normally open side or branch of the line, substantially as set forth.

14. In a telephone-exchange system, a metallic-circuit line which is normally grounded at the subscriber's station, one side or branch of which is normally grounded and the other side or branch normally open at the central office, in combination with a switch with contacts and connections by which such normal ground connection at the subscriber's station is broken while the subscriber's telephone is switched for conversation, a switch-plug with cord for the line, a switching device into which the plug is normally placed, with contacts and connections by which when the plug is withdrawn from the switching device the normal ground connection of the line at the central office is broken and the line is grounded through a circuit connection which contains a test-battery and retardation-coil, and a test receiving instrument grounded on one side and connected on its other side to a plug or device adapted to be brought into connection with the normally open side or branch of the line, substantially as set forth.

15. In a telephone-exchange system, a metallic-circuit line one side or branch of which is normally grounded at the central office, in combination with a switch-plug with cord for the line, a test-battery and retardation-coil, a switching device into which the plug is normally placed, with contacts and connections by which when the plug is withdrawn from the device the normal ground connection of the line is broken and the line is connected to one side of a circuit connection containing the test-battery and retardation-coil, and a test receiving instrument connected on one side to the other side of such circuit connection and on its other side to a plug or device adapted to be brought into connection with the line, substantially as set forth.

16. In a telephone-exchange system, a metallic-circuit line normally grounded at the subscriber's station and one side or branch of which is normally grounded at the central office, in combination with a switch at the subscriber's station with contacts to open the ground connection there while the subscriber's telephone is switched for use, a switch-plug with cord for said line, a test-battery, and a switching device into which the plug is normally placed, with contacts and connections by which when the plug is withdrawn from the switching device the said normal ground connection of the line is broken and the line is grounded through the test-battery, substantially as set forth.

17. In a telephone-exchange system, a metallic-circuit line normally grounded at the subscriber's station and one side or branch of which is normally grounded at the central office, in combination with a switch at the subscriber's station with contacts to open the ground connection there while the subscriber's telephone is switched for use, a switch-plug with cord for said line, a retardation-coil and a switching device into which the plug is normally placed, with contacts and connections by which when the plug is withdrawn from the switching device the said normal connection of the line is broken and the line is grounded through the retardation-coil, substantially as set forth.

18. In a telephone-exchange system, a metallic-circuit line normally grounded at the subscriber's station and one side or branch of which is normally grounded at the central office, in combination with a switch at the subscriber's station with contacts to open the ground connection there while the subscriber's telephone is switched for use, a switch-plug with cord for said line, a test-battery and retardation-coil, and a switching device into which the plug is normally placed, with contacts and connections by which when the plug is withdrawn from the switching device such normal ground connection of the line is broken and the line is grounded through the test-battery and retardation-coil, substantially as set forth.

19. In a telephone-exchange system, a metallic-circuit line normally grounded at the subscriber's station and one side or branch of which is normally grounded at the central office, in combination with a switch at the subscriber's station with contacts to open the ground connection there while the subscriber's telephone is switched for use, a switch-plug with cord for said line, a test-battery, a switching device into which the plug is normally placed, with contacts and connections by which when the plug is withdrawn from the switching device such normal connection of the line is broken and the line is grounded through a test-battery, and a test receiving instrument grounded on one side and connected on its other side to a plug or device adapted at the will of the operator to be brought into connection with the line, substantially as set forth.

20. In a telephone-exchange system, a metallic-circuit line normally grounded at the subscriber's station and one side or branch of which is normally grounded at the central office, in combination with a switch at the subscriber's station with contacts to open the ground connection there while the subscriber's telephone is switched for use, a switch-plug with cord for said line, a test-battery and retardation-coil, a switching device into which the plug is normally placed, with contacts and connections by which when the plug is withdrawn from the switching device such normal connection of the line is broken and the line is grounded through said test-battery and retardation-coil, and a test receiving instrument grounded on one side and connected on its other side to a test plug or device adapted to be brought into connection with the line, substantially as set forth.

21. In a telephone-exchange system, a metallic-circuit line, normally grounded at the subscriber's station and one side or branch of which is normally grounded at the central office, in combination with a switch at the subscriber's station with contacts to open the ground connection there while the subscriber's telephone is switched for use, a switch-plug with cord for said line, a test-battery, and a switching device with contacts and connections by which when the plug is withdrawn from its normal position in the switching device the normal ground connection of the line is broken and the line is connected to one side of said test-battery, substantially as set forth.

22. In a telephone-exchange system, a metallic-circuit line normally grounded at the subscriber's station and one side or branch of which is normally grounded at the central office, in combination with a switch at the subscriber's station with contacts to open the ground connection there while the subscriber's telephone is switched for use, a switch-plug with cord for said line, a retardation-coil and a switching device into which the plug is normally placed, with contacts and connections by which when the plug is withdrawn from the device the normal ground connection of the line is broken and the line connected to one side of said retardation-coil, substantially as set forth.

23. In a telephone-exchange system, a metallic-circuit line normally grounded at the subscriber's station and one side or branch of which is normally grounded at the central office, in combination with a switch at the subscriber's station with contacts to open the ground connection there while the subscriber's telephone is switched for use, a switch-plug with cord for said line, a test-battery and retardation-coil, and a switching device into which the plug is normally placed, with contacts and connections by which when the plug is withdrawn from its normal position in the device, the normal ground connection of the line is broken and the line is connected to a circuit which contains the test-battery and retardation-coil, substantially as set forth.

24. In a telephone-exchange system, a metallic-circuit line normally grounded at the subscriber's station and one side or branch of which is normally grounded at the central office, in combination with a switch at the subscriber's station with contacts to open the ground connection there while the subscriber's telephone is switched for use, a switch-plug with cord for said line, a test-battery, a switching device into which the plug is normally placed, with contacts and connections by which when the plug is withdrawn from the device the normal ground connection of the line is broken and the line is connected to one side of said test-battery, and a test receiving instrument connected on one side to the other side of said test-battery and on its other side to a plug or device adapted to be brought into connection with the line, substantially as set forth.

25. In a telephone-exchange system, a metallic-circuit line, normally grounded at the subscriber's station, and one side or branch, of which is normally grounded at the central office, in combination with a switch at the subscriber's station with contacts to open the ground connection there while the subscriber's telephone is switched for use, a switch-plug with cord for said line, a test-battery and retardation-coil, a switching device into which the plug is normally placed, with contacts and connections by which when the plug is withdrawn from the device the normal ground connection of the line is broken and the line is connected to one side of a circuit which contains the test-battery and retardation-coil, and a test receiving instrument connected on one side to the other side of said circuit and on its other side to a plug or device adapted to be brought into connection with the line 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.