(No Model.)

M. G. KELLOGG.

MULTIPLE SWITCHBOARD.

No. 592,347. Patented Oct. 26, 1897.

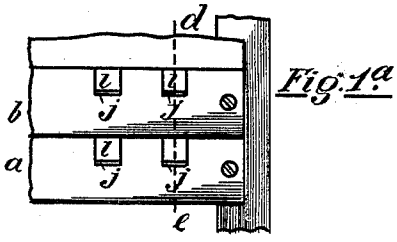


Fig. 1a.

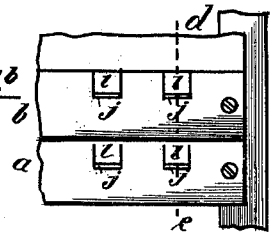


Fig. 1b.

Line No 2.

Fig. 2.

Line No 1.

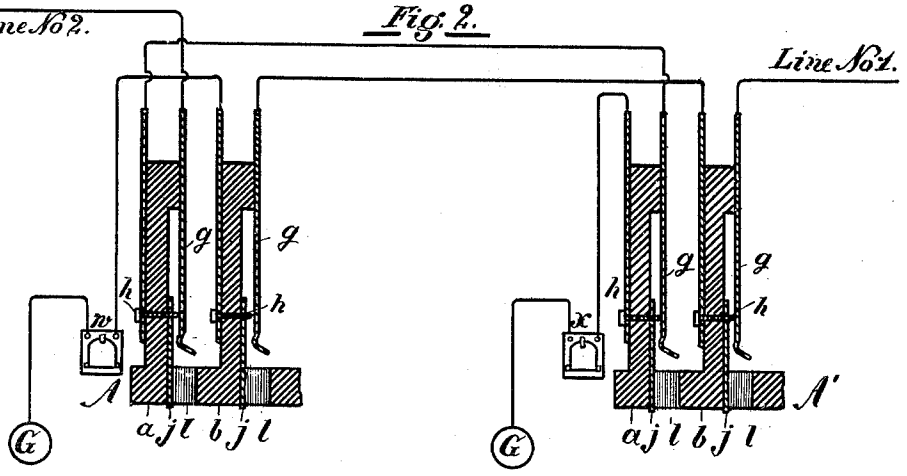


Fig. 3.

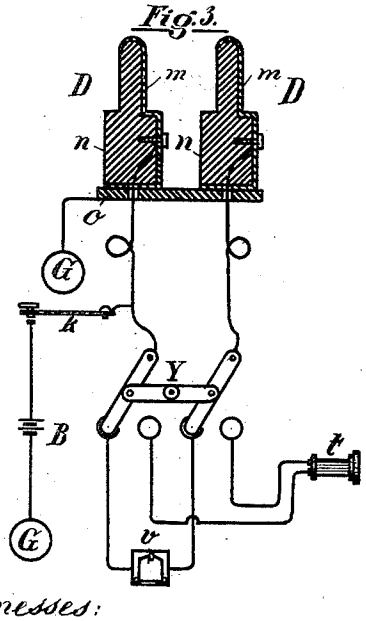


Fig. 4.

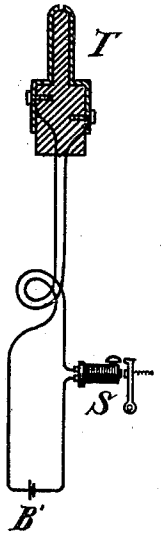
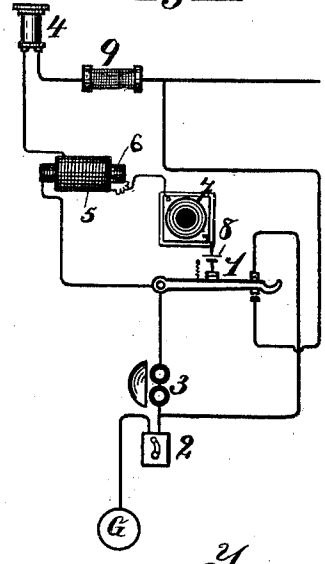


Fig. 5.



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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. 592,347, dated October 26, 1897.

Application filed January 2, 1890. Serial No. 335,696. (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 telephone-exchange system in which the lines are lines grounded at their outer ends; and it consists of apparatus for switching such lines of the exchange in the operation of the exchange system and a system of testing the lines to determine whether they are in use.

In the drawings illustrating my invention, Figures 1^a and 1^b represent sections of two multiple switchboards of the exchange to which the same lines are connected. Fig. 2 shows a diagram of the boards with the main-line apparatus and connections necessary to illustrate my invention. Fig. 3 shows a diagram of an operator's cord system to be used in connection with the boards. Fig. 4 shows an operator's test system to be used at the boards. Fig. 5 shows a subscriber's-station apparatus.

G represents in each case a ground connection.

In Fig. 2, A is a sectional view of the switchboard shown in Fig. 1^a, and A′ is a sectional view of the switchboard shown in Fig. 1^b, each as indicated by the line *d e*.

I place as many boards in the central office as are found necessary or desirable in order to properly operate the exchange. On each board is a spring-jack or other suitable switch for each line. Each switch has a contact-spring which normally connects with an insulated contact-piece and is adapted to receive a loop-plug and, when a plug is inserted, to disconnect the spring from the contact-piece and connect the two contact-pieces of the plug with the spring and said insulated contact-piece, respectively. The switch is also adapted to receive a single-contact switch-plug and, when a plug is inserted, to disconnect the spring from the contact-piece and connect the spring with the contact-piece of the plug.

In the construction of the switches as shown and as will hereinafter be described I prefer to have a contact-point electrically connected with the contact-piece and on which the spring normally bears, as there is less chance of poor connection when the spring bears on a point than when it bears on a surface adapted to be brought into connection with the plug-contacts.

In Fig. 2, *g g* represent the springs of the different switches, *h h* the contact-points on which the springs normally bear, and *j j* the contact-pieces of the switches connected with the points *h h*. *l l* are the switch-holes. *a b* are the rubber strips on which the metal parts of the switches are mounted, as shown, and through the fronts of which are the switch-holes *l l*. The contact-pieces *j j* are so placed along one of the surfaces of the plug-holes as readily to form connection with one of the contact-pieces of the loop-plugs.

The holes *l l* are adapted to receive the switch-plugs shown in Fig. 3 and marked D D, and when a plug is inserted into a switch it raises the spring *g* from the contact-point *h*, and the spring *g* and contact-piece of the plug are in contact. These holes are also adapted to receive the loop-plug shown in Fig. 4, and when a plug is inserted into a hole it raises the spring of the switch from the contact-point *h*, and the spring *g* and the contact-piece *j* of the switch are in contact with the two contact-pieces of the plug, respectively.

w and *x* are calling-annunciators, one for each of the lines shown.

Two lines are shown in the drawings, one marked line No. 1 and the other line No. 2. These lines are ordinary single-circuit lines, grounded at their outer ends and having at the subscribers' stations any usual and appropriate subscriber's-station apparatus. Each line passes, successively, through the pairs of contacts of its switches on the several boards, passing in each case to the spring first. It then passes through its line-annunciator to the ground. The circuit of each line shown may thus be traced in Fig. 2.

In the operator's cord system shown in Fig.

3, D D are the switch-plugs of a pair of cords, *n n* are the rubber insulations of the plugs, and *m m* are their contact-pieces. These contact-pieces pass each to the bottom of its plug and are adapted to rest normally, or when the plug is not in use, on the metal piece *o*, which then connects it with the ground. Weights, as is usual, or similar devices may be used to bring the contact-pieces of the plugs into contact with the piece *o* and secure a good connection. These plugs are adapted to be inserted into any of the switches at their board, and when a plug is inserted it operates the switch, as above described. The plugs should be inserted so that the contact-piece *m* is in contact with the spring *g*. The connections of the lines might have been reversed, so that the lines pass first to the contact-piece *j* of each of their switches, and in that case the plugs should be inserted in such a position that their contact-pieces form connection with the pieces *j* of the switches. Y is the looping-in switch for the pair of cords shown. K is the calling-key, and *v* is a clearing-out annunciator. *t* is the operator's telephone, and B is her calling generator or battery. The circuits are substantially as shown.

The two levers of the looping-in switch are connected by means of flexible conductors to the two contact-pieces of the switch-plugs. The contact-bolts of one of the pair of contact-bolts of the switch are connected together through the clearing-out annunciator, and the two other bolts are connected together through the operator's telephone. The lever of the calling-key is connected with one cord, and the contact-point of the key is grounded through the calling generator or battery. The piece *o* on which the plugs normally rest is connected with the ground.

The operation of the system in connection with the switchboards will be apparent to those skilled in the art. It will readily be apparent that when a line is switched by the insertion of a plug into its switch the line is disconnected from its normal ground at the central office and is connected into a circuit with the pair of cords. Only one pair of cords is shown, but the connection of such other pairs with their accompanying apparatus as the operator may need will be apparent to those skilled in the art. To each pair of cords, with its plugs, belong a looping-in switch, a clearing-out annunciator, and a calling-key. One telephone and one calling-generator will answer for her system of cords.

In the operator's test system shown in Fig. 4, T is a loop test-plug adapted to be inserted into any of the switches and when inserted to operate them as heretofore described. B′ is a test-battery, and S is a test receiving instrument. The battery and instrument are connected in a loop which terminates in the two contact-pieces of the plug.

Each operator has one cord system and one test system and they are conveniently mounted and arranged for her work.

In the subscriber's-station apparatus shown in Fig. 5, 1 is the telephone-switch, 2 is the calling-generator, 3 is the signal-receiving bell, 4 is the subscriber's telephone, 5 is the secondary and 6 is the primary of the induction-coil, 7 is the transmitter, 8 is the transmitter-battery, 9 is a resistance-coil of suitable resistance to operate as hereinafter described. These parts may be of usual forms of apparatus and are connected, as shown or in other ways, so as to perform practically the operations required and the operations hereinafter described.

The circuit of a line is through the resistance-coil 9, the telephone 4, and the secondary of the induction-coil 5 to the lever of the switch 1, and from the lever of the switch through the signal-bell 3 and calling-generator 2 to ground. From a point of the circuit before the line passes to the resistance-coil a circuit-wire of small resistance passes to the lever contact-point of the switch with which the lever is in contact when the telephone is on the switch, and from a point of the circuit after the line passes through the signal-bell another wire of small resistance passes to the upper contact-point of the switch with which the lever comes in contact when the telephone is taken from the switch.

When the subscriber's telephone is on its switch, the signal-receiving bell is in the circuit of the line, and the telephone, the secondary of the induction-coil, and the resistance-coil are shunted by a wire of small resistance, so as to be practically out of the circuit. When the telephone is off the switch, the telephone, the secondary of the induction-coil, and the resistance-coil are in the circuit and the signal-bell is practically out of the circuit. The resistance of the telephone and secondary of the induction-coil combined aggregate in well-constructed apparatus about four hundred ohms and the resistance of the signal-bell amounts to about one hundred ohms. The resistance switched into the circuit when the telephone is off its switch for use is therefore much greater than is the resistance in the circuit when the telephone is in its normal position on the switch. I utilize this difference in resistance in the operation of the test system, as will hereinafter appear. If the difference in the resistance when the telephone is off its switch for use and when it is in its normal position on the switch is not sufficient to secure an easy adjustment of the test apparatus to the circuits, such additional resistance as is required may be placed in the resistance-coil 9. Whether this artificial resistance is used and its amount, if used, will depend on the apparatus and circuits to which the system may be applied. The test receiving instruments and test-batteries are then so adjusted to each other and the circuits that the instrument will sound or respond when it and its battery are looped into the closed circuit of any single line and the subscriber's telephone is not off its switch for use, but will

not respond if the circuit is open at any point by switching or if the subscriber's telephone is off its switch and the additional resistance at the subscriber's station is included in the circuit, or the line is in circuit with another line and thereby additional resistance is in the circuit with the line. This adjustment can be regulated as required by the addition of artificial resistances in the circuits. This construction and adjustment depend on the fact that an electromagnet may be readily made so as to operate when a battery and a certain resistance is in circuit with it and not to operate when the resistance is considerably greater. This operation can be obtained in different ways, dependent on the style of the electromagnet, the number of convolutions of its coil, the size of the battery, and the adjustment of the retractile spring. These parts should be such and so adjusted that the electromagnet will be actuated when the test system is looped into the simple circuit of any line of the exchange when its subscriber's telephone is not switched for use, but will not be actuated when much additional resistance is introduced into circuit with it. The resistances of the coils may be made such as is necessary or desirable in order to obtain this marginal adjustment of the parts of the exchange system.

The operation of the test system is as follows: When an operator desires to test a line, she places her test-plug into the switch of the line, and by so doing disconnects the points *g* and *j* of the switch and connects them with the contact-pieces of the plug. If, then, the line is not switched at any board and the subscriber's telephone is on its switch, the test receiving instrument will sound or respond, indicating that the line is free to be switched to, for in that case the test receiving instrument and battery are looped into a closed circuit of the line which extends from the subscriber's ground through his station apparatus and line and through the normally closed contacts of the line-switches at the other boards and to ground at the central office, and the resistance of this circuit is so small that sufficient current from the battery will pass through the magnet of the test receiving instrument to cause the force of the retractile spring of its armature to be overcome and the armature to move and strike the gong of the test receiving instrument. If, however, the subscriber has sent in a call and has taken his telephone from the switch for use, the instrument will not sound, as the additional resistance in the circuit will prevent it from doing so. In that case the additional resistance in the line-circuit caused by the switching of the telephone for use is so great that although current from the battery passes through the instrument and continually causes the armature to be attracted the current is not strong enough to overcome the adjusted retractile force of the armature-spring and the armature will not move to strike the gong. If, again, the line is switched at some board and the test is made in the cut-off portion of the line—that is, that portion which is between the switch used for switching and the office ground—the instrument will not sound, because the test-circuit is open at the pair of contact-points of the switch used for switching. In that case no current at all is passing through the test receiving instrument and no attraction is produced in its magnet. If, again, the line is switched at any board with another line, the instrument will not sound on account of the increased resistance of the circuit. If in that case either or both the subscribers' telephones are switched for use, the resistance of their station apparatus will be so great that enough current will not be allowed to pass through the test receiving instrument to cause its armature to move. The instruments and battery may be also so adjusted to the line-circuits and apparatus, so that in that case the armature will not be sufficiently attracted to move even if both subscribers' telephones are on their switches.

When, as described above, the test receiving instrument and battery are placed for testing in closed circuit with the subscriber's additional resistance included in the circuit, continuous current from the battery will pass through the instrument, attracting its armature and tending to move it. On account of the increased resistance sufficient current does not, however, then pass to overcome the retractile force of the adjustment-spring and the armature will not be moved. When, however, the line is not switched and the subscriber's telephone is not switched and the test instrument and battery are included in its circuit, the resistance of the circuit is so small in relation to the strength of the battery and the character and adjustment of the test receiving instrument that sufficient current will pass through the instrument to cause its armature to move and the sound to be given. This system therefore depends on a marginal adjustment of these parts to each other and to the resistances to secure the sound of the test receiving instrument when neither the line nor the subscriber's telephone is switched for use and to insure that it does not sound when either are switched for use.

The resistance-coil furnishes the additional resistance required in the circuit when the subscriber's telephone is switched for use to provide for the operation of the test system, as described. It is well known that mere resistance-coils wound in the usual manner and without the use of iron cores do not offer much retardation to telephone-currents, even though these coils be of comparatively high resistance.

The resistance-coil, moreover, provides an all-metallic circuit through the subscriber's line for the passage of the clearing-out currents, especially when one subscriber sends the clearing-out signal while the other sub-

scriber has not yet placed his telephone on his switch, as may often be the case. With the forms of apparatus used in telephone-exchanges the clearing-out signals will be readily operated over the resistances necessary to produce the marginal adjustment of the test system which has been described.

When a test of a line is made and the test receiving instrument sounds, the operator knows that neither the line is switched for use nor the subscriber's telephone is switched for use, and when the instrument does not sound she knows that either the subscriber's telephone is switched for use or the line is switched for use, or both, and she will not connect the line with any other line.

By this system a subscriber's line is reserved to himself from the time he sends in his call and takes his telephone down for use.

In this system only two switch-contacts are required for each line on each board instead of three or more, as in other systems with ground-circuit lines, and there are only two leading-in wires to each switch instead of three or more, as in other systems. There is also but one wire required for each line for the connection between two boards instead of two or more, as in other systems. The annunciators will be so related to the test-batteries that they will not be made to indicate when closed with each other on a test being made. They may for this purpose be polarized annunciators so connected with reference to the batteries that the batteries will not operate, or they may not be of sufficiently sensitive construction to be operated by the test-batteries.

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

1. In a multiple-exchange system, a telephone-line normally passing successively through several pairs of switch contact-points, in series, one pair on each of several boards, each pair normally closed but open while the line is switched at their board, in combination with switching devices at each board to disconnect said pair of contact-points at the board and switch the line for conversation, apparatus at the subscriber's station normally in the direct circuit of the line, other apparatus of greater resistance normally out of the direct circuit of the line, and switching devices and circuit connections at the subscriber's station to switch the apparatus of greater resistance into the direct circuit of the line while the telephone is switched for use, and a loop test-plug at one of the boards in the two contact-pieces of which terminate the two sides of a loop which contains a test receiving instrument and battery, said plug being adapted to be inserted into the line-switch at the board and when inserted to disconnect said pair of contact-points of the switch and connect them with the contact-pieces of the plug, said test receiving instrument being so adjusted to the battery and to the resistances that the instrument sounds when it is thus looped into the normal closed circuit of the line but will not sound when the circuit is then open or the line is in circuit with another line or the subscriber's telephone is switched for use and the additional resistance is thereby included in the circuit, whereby the differentiation of the various multiple-test signals is obtained by the marginal adjustment of the apparatus, substantially as set forth.

2. In a multiple telephone-exchange system, a telephone-line normally on closed circuit and passing successively through a series of pairs of switch contact-points, one pair on each of several boards, each pair normally closed but open while the line is switched at their board, in combination with switching devices at each board to disconnect said pair of contact-points at the board and switch the line for conversation, apparatus at the subscriber's station normally in the direct circuit of the line, other apparatus of greater resistance normally out of the direct circuit of the line, and switching devices and circuit connections at the subscriber's station to switch the apparatus of greater resistance into the circuit of the line, while the subscriber's telephone is switched for use, and a loop test-plug at one of the boards, in the two contact-pieces of which terminate the two sides of a loop which contains a test receiving instrument, said plug being adapted to be inserted into the switch of the line at that board, and when inserted to disconnect the contact-points of the switch which are normally in contact and connect them with the contact-pieces of the plug, and battery in the test-circuit normally established on testing, said test receiving instrument being so adjusted to the battery and to the resistances that the instrument sounds when it is looped into the normal closed circuit of the line but will not sound when the circuit is open or the line is in circuit with another line or the subscriber's telephone is switched for use and the additional resistance is thereby switched into the circuit, whereby the differentiation of the several multiple-test signals is obtained by a marginal adjustment of the apparatus, substantially as set forth.

3. In a multiple telephone-exchange system, a telephone-line normally on closed circuit and passing successively through a series of pairs of contact-points, one pair on each of several boards, each pair normally in contact but open while the line is switched at their board, in combination with switching devices at each board to disconnect said pair of contact-points at the board and switch the line with another line for conversation, apparatus at the subscriber's station normally in the direct circuit of the line, other apparatus of greater resistance normally out of the direct circuit of the line, and switching devices and circuit connections at the subscriber's station to include the apparatus of greater resistance in the direct circuit of the

line while his telephone is switched for use, and loop test-plugs, one at each board, each plug having a pair of contact-pieces in which terminate the two sides of a loop which contains a test receiving instrument and battery, each loop-plug being adapted to be inserted into the switch at its board and when inserted to disconnect said pair of contact-points of the switch and connect them with the two contact-pieces of the plug, each test receiving instrument being so adjusted to its battery and to the resistances that the instrument sounds when it is looped into the normal closed circuit of the line but will not sound when the circuit is open or the line is in circuit with another line or the subscriber's telephone is switched for use and the additional resistance is thereby included in the circuit, whereby the differentiation of the several multiple-test signals is obtained by a marginal adjustment of the apparatus, substantially as set forth.

4. In a multiple telephone-exchange system, a telephone-line normally on closed circuit and passing through a series of pairs of contacts at the several boards, one pair at each of the boards, in combination with a test receiving instrument and battery at each board and testing device connected therewith adapted at the will of the operator to open said contacts at the board and loop said instrument and battery into the circuit of the line when thus normally on closed circuit, apparatus at the subscriber's station normally in the direct circuit of the line, other apparatus at the subscriber's station of greater resistance and of continuity to battery-currents normally out of the direct circuit of the line, and switching devices and circuit connections at the subscriber's station to include the apparatus of greater resistance in the direct circuit of the line, while his telephone is switched for use, each test receiving instrument being so adjusted to the battery and the resistances that when thus looped into the circuit of the unswitched line and the subscriber's telephone is not switched for use the instrument will sound, but when the telephone is switched for use and the additional resistance is included in the circuit the instrument will not sound, whereby by the differentiation of the multiple-test signals obtained by a marginal adjustment of the apparatus, the line is prevented from being switched to at either of the boards from the time the subscriber switches his telephone for use.

5. In a multiple telephone-exchange system, a telephone-line normally on closed circuit and passing through a series of pairs of contacts at the several boards, one pair at each of the boards, in combination with a test receiving instrument at each board, and testing device connected therewith adapted at the will of the operator to open said contacts at the board and loop said instrument into the circuit of the line when thus normally on closed circuit, apparatus at the subscriber's station normally in the direct circuit of the line, other apparatus at the subscriber's station of greater resistance and of continuity to battery-currents normally out of the direct circuit of the line and switching devices and circuit connections at the subscriber's station to include the apparatus of greater resistance in the direct circuit of the line while his telephone is switched for use, and battery in any closed circuit thus established on testing, each test receiving instrument being so adjusted to the battery and the resistances that when thus looped into the circuit of the unswitched line and the subscriber's telephone is not switched for use the instrument will sound, but when the telephone is switched for use and the additional resistance is included in the circuit the instrument will not sound, whereby by the differentiation of the multiple-test signals obtained by a marginal adjustment of the apparatus, the line is prevented from being switched to at either of the boards from the time the subscriber switches his telephone for use.

6. In a multiple telephone-exchange system, telephone-lines, each normally on closed circuit, and passing through a series of pairs of contacts at the several boards, one pair at each of the boards, in combination with switching apparatus at each board to at the will of the operator connect any two lines into a closed circuit for conversation, a clearing-out-annunciator circuit with the two lines when thus connected, a test receiving instrument and battery at each board, and testing device connected therewith, adapted at the will of the operator to open said contacts at the board and loop said instrument and battery into the normal line-circuit, apparatus at the subscriber's station of metallic continuity normally in the direct circuit of the line, other apparatus at the subscriber's station of greater resistance and also of metallic continuity normally out of the direct circuit of the line, and switching devices and circuit connections at the subscriber's station to include the apparatus of greater resistance in the direct circuit of his line, while his telephone is switched for use, each test receiving instrument being so adjusted to the battery and the resistances that when thus looped into the circuit of an unswitched line and the subscriber's telephone is not switched for use, the instrument will sound, but when the telephone is switched for use and the additional resistance is included in the circuit, the instrument will not sound, whereby a circuit of metallic continuity is obtained for the clearing-out current, and by the differentiation of the multiple-test signals obtained by a marginal adjustment of the apparatus, the line is prevented from being switched to at either of the boards from the time the subscriber switches his telephone for use.

7. In a multiple telephone-exchange system, telephone-lines each normally on closed circuit and passing through a series of pairs

of contacts at the several boards, one pair at each of the boards, in combination with switching apparatus at each board to at the will of the operator connect any two lines into a closed circuit for conversation, a clearing-out-annunciator circuit with the two lines when thus connected, a test receiving instrument at each board, and testing device connected therewith adapted at the will of the operator to open said contacts at the board, and loop said instrument into the normal line-circuit, apparatus at the subscriber's station of metallic continuity, normally in the direct circuit of the line, other apparatus at the subscriber's station of greater resistance and also of metallic continuity, normally out of the direct circuit of the line, switching devices and circuit connections at the subscriber's station to include the apparatus of greater resistance in the direct circuit of his line, while his telephone is switched for use, and battery in any closed circuit thus established on testing, each test receiving instrument being so adjusted to the battery and the resistances that when thus looped into the circuit of an unswitched line and the subscriber's telephone is not switched for use, the instrument will sound, but when the telephone is switched for use and the additional resistance is included in the circuit the instrument will not sound, whereby a circuit of metallic continuity is obtained for the clearing-out current, and by the differentiation of the multiple-test signals obtained by a marginal adjustment of the apparatus, the line is prevented from being switched to at either of the boards from the time the subscriber switches his telephone for use.

In witness whereof I hereunto subscribe my name this 13th day of December, 1889.

MILO G. KELLOGG.

Witnesses:
EMIL ABENHEIM,
MARGARETHA RIEHL.