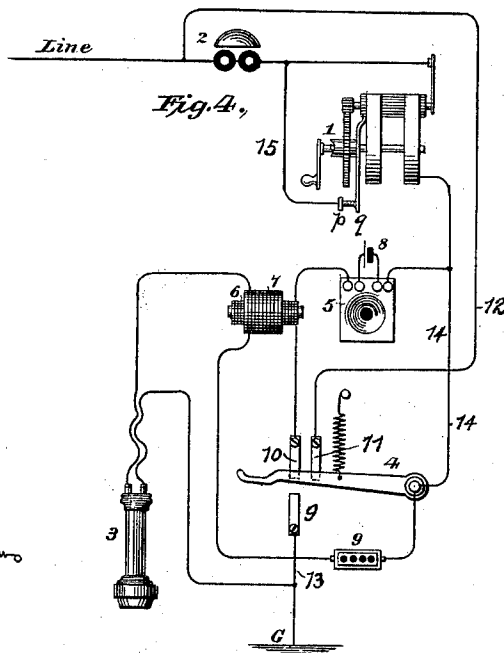
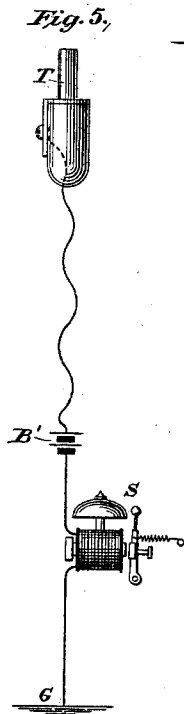
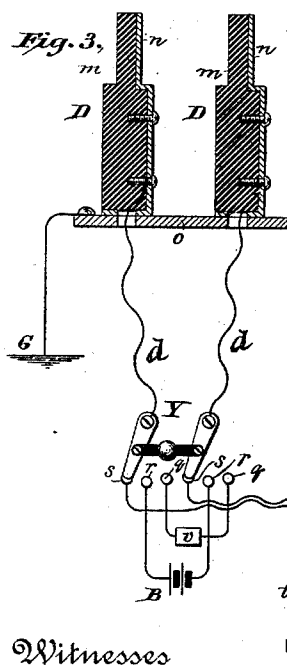
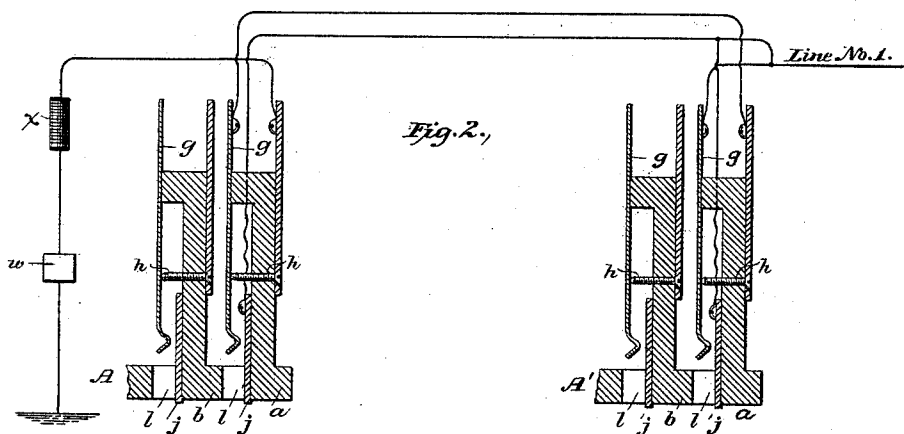
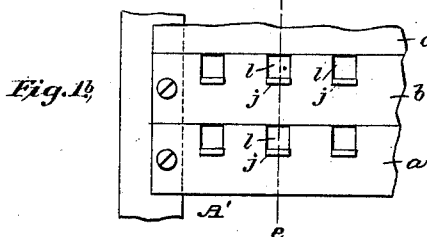
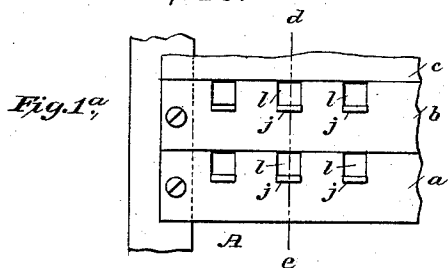


(No Model.)

M. G. KELLOGG.
MULTIPLE SWITCHBOARD.

No. 592,323.

Patented Oct. 26, 1897.



Witnesses
Geo. W. Breck.
C. C. Ashley

Inventor
Milo G. Kellogg
By his Attorneys
Baldwin, Davidson & Wright

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. 592,323, dated October 26, 1897.

Application filed November 29, 1889. Serial No. 332,026. (No model.)

To all whom it may concern:

Be it known that I, MILO G. KELLOGG, of Chicago, 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 single-circuit telephone-lines; and it consists in a system of testing such lines to determine whether they are in use.

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

In the figures like parts and apparatus are designated by the same letters and numerals of reference.

G represents the 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 board shown in Fig. 1^b, each as indicated by the line *d e*.

There are as many boards in the exchange as are necessary for the number of lines. On each board is a spring-jack or similar switch for each line. Each switch has a contact-spring which normally bears on an insulated contact-point and has a contact-piece insulated from the rest (except by the circuit connections) and is adapted to receive a switch-plug and, when a plug is inserted, to disconnect the spring from the contact-point and form connection between the spring and the contact-piece of the plug.

In Fig. 2, *g g* represent the springs of the different switches, *h h* the contact-points, and *j j* the contact-pieces. *l l* are the switch-holes. *a b* are the rubber pieces on which the metal parts are mounted and through the

fronts of which are the holes *l l*. These holes are adapted to receive the switch-plugs, (shown in Fig. 3,) and when a plug is inserted to operate the switch, as above described.

The contact-pieces *j j* should be so placed that a test-plug may be readily applied to them. Their function is to form test-pieces for their lines on the different boards, and they may be placed as shown, or in other convenient positions on the boards.

The subscriber's-line connections are shown in Fig. 2, each line passing through test-contacts *j*, thence through the pairs of contacts *g h* in the order named, thence through a resistance *x* and annunciator *w* to ground at G. The order of the resistance and annunciator is immaterial. The resistance may be in the annunciator or the annunciator may be omitted and some other equivalent method of calling be used. The resistance may be a coil or any substantial equivalent. Under these conditions a plug D may be inserted either way into a jack and make connection with either test-contact *j* or spring-contact *g*. The order of the contacts *g h* may be reversed and the plug so inserted into the jack that its contact *n* makes connection with the test-contact *j*, thus establishing a connection with the line conductor.

Fig. 3 shows an operator's cord system. Two plugs D, composed of insulating material *m*, have contacts *n* so mounted as to make connection with a test-contact *j* or spring-contact *g* when inserted in a jack and to make connection with a base-plate *o*, grounded at G when resting in their normal position. The contacts of the two plugs are connected together by a flexible cord conductor *d*, in the circuit of which is a looping-in switch Y, adapted to be placed upon either of the pairs of contacts *q q r r s s*, and thereby loop in a clearing-out annunciator *v*, a call-generator B, or an operator's telephone set *t*. When in use, the circuit of the looping-in switch Y is completed over two connected line-circuits or over one connected line-circuit and ground G through the base-plate *o*. The switch Y normally rests upon the contacts *q q*, looping in the clearing-out annunciator *v*, there being a separate annunciator individual to each

pair of plugs. The operator's telephone set is common to all the pairs of plugs at the board where the operator works. The call-generator may be common to all or only some of the pairs of plugs of the exchange, the connections being apparent to those skilled in the art.

Fig. 4 shows one of the many possible arrangements of the subscriber's outfit that may be used in my invention. The line conductor normally runs through the bells 2, the short circuit 15, and contacts *p q*, around the generator 1, thence by conductor 14 to the switch-lever 4, contact 9, short circuit 13, around the receiver set to ground at G. The resistance of the circuit being mostly in the bells 2 is ordinarily about one hundred ohms. When the telephone is off the switch and is thus switched for use, the circuit of the line conductor is continued through the short circuit 12 and contact 11, around the bells and generator, switch-lever 4, resistance 9, secondary coil 7 of the induction-coil, receiver 3 to ground at G. The resistance of this circuit in well-designed apparatus is at least four hundred ohms. The resistance 9 may add as many ohms to this circuit as desired. It may be a coil or any other substantial equivalent. While the telephone is switched for use, the circuit of the transmitter 5 and battery 8 is closed through the primary coil 6, contact 10, lever 4, and conductor 14. This lever 4 is preferably, though not necessarily, the usual automatic switch. When the telephone is on its switch and the generator is operated, it cuts itself into line-circuit by opening the pair of contacts *p q* automatically in the usual manner.

It will be noticed that normally, or when the telephone is not switched for use, the subscriber's circuit has a low resistance, and when the telephone is off the hook the subscriber's circuit has a high resistance. This difference is utilized in the test system, as will be described.

In Fig. 5 is shown an operator's test outfit comprising a test-plug T, a test receiving instrument S, and a test-battery B', all grounded at G. The order of the test receiving instrument and battery is immaterial unless one battery is used for two or more test receiving instruments and plugs, in which case they should be connected in the order named.

The instrument and battery are adjusted to each other and the other parts as follows: They are of such strength that when closed to the circuit of a line through a test-piece *j* and the line is not switched at any board and the subscriber's telephone is on its switch enough current will pass through the instrument and to ground through the office ground and the station ground of the line to operate the instrument; but when the line is switched for use at any board and the circuit to the office ground is open or when the additional resistance is placed in the line-circuit by the subscriber's telephone being taken from its

switch enough current will not pass through the instrument to operate it. The resistance in the ground-circuit of a line may without inconvenience be made several hundred ohms, as the generators are commonly made to operate the annunciators over resistances of several thousand ohms, and the resistance in the telephone-circuit at the subscriber's station may be made, as required or convenient, to produce the test operations on the test receiving instrument, as above indicated.

The necessary resistance required to be placed in the ground-circuit of each line at the central office might be included in the line annunciator-coil.

The test depends on the fact that an electromagnet with an armature and a suitable retractile spring may be made to operate or move the armature when closed in circuit with a battery of given strength through a comparatively small resistance and not to move the armature when the resistance is considerably increased. This adjustment and operation would be determined by and depend on the style of the electromagnet, the strength of the retractile spring, the size of the battery, and the resistances of the circuits. The adjustments to obtain the required test operations are easy to obtain. For instance, the resistance in the line-circuits in exchanges of ordinary character may be made about five hundred ohms for each line when the subscriber's telephone is not switched for use and, say, one thousand ohms when the telephone is switched for use, and the resistance in the circuit of each line between its test contact-pieces and the normal ground connection may be, say, three hundred ohms. The test-bell may have, say, one hundred ohms resistance and a suitable adjustable retractile spring. Ten or twelve cells of test-battery might be used. When the operator makes the test of a line by applying the test-plug to the contact-piece *j* of the line and the line is not switched with another line at the central office and its subscriber's telephone is not switched for use, the resistance of the test-circuit (exclusive of the operator's test system) would be about one hundred and eighty-seven ohms and the test receiving instrument would sound. Should, however, the subscriber's telephone be switched for use, (the line not yet being switched,) such resistance of the test-circuit would be increased to about two hundred and thirty ohms and the instrument would not sound. Should the two lines be connected together and their telephones be switched for use, the resistance of the test-circuit (exclusive of the operator's test system) would be about five hundred ohms. Should the lines be connected together and only one of the telephones be switched for use, the resistance would be about three hundred and thirty-three ohms, and should neither telephone be switched for use the resistance would be about two hundred and fifty ohms. In any of

these cases the resistance is so much greater than that when neither the line nor the telephone is switched for use that the required test operations and adjustment would be easy to obtain.

The operator's telephone set is so constructed as to have a high resistance, so that when connected on one side of the line-circuit being tested and on the other to ground through a plug D, resting on a base-plate o, the test receiving instrument of the testing operator will not respond and will thus indicate that the line is free. When an operator, therefore, makes a test of a line by placing the test-plug on the line test-piece and the line is not switched for use and the telephone is on its switch, the test receiving instrument will respond, indicating that the line is "free." If, however, either the line is switched for use, or the subscriber's telephone is off from its switch for use, the instrument will not respond, indicating that the line is not free.

In multiple-switchboard systems an operator to whom certain lines are assigned to answer frequently receives several calls at practically the same moment, and it may require some time before she can switch to a certain line and answer its call. In systems in which the test depends only on the line being switched at some board another operator may, in the meantime, test the line, and finding it to test "free" may switch it with another line and cause annoyance and confusion to the subscriber. This cannot occur in this system of testing, because as soon as the subscriber takes his telephone from its switch the line will test "busy" whether or not it is switched at the central office. Again, in systems of testing which depend only on the subscriber's telephone being on or off its switch confusion frequently arises from the fact that a subscriber places his telephone on its switch when he is through conversation without sending in a clearing-out signal, and his line tests "free" and is "connected to" when it is already switched with another line. Lines in this condition are technically called "tied up." Lines cannot become tied up in this system, because the line will test "busy" until it is disconnected at the central office, whether or not the subscriber's telephone is on its switch. The system therefore combines the advantages and obviates the disadvantages of the two general systems of testing outlined above.

It is obvious that instead of a ground connection any other common conductor may be substituted. There may be a common wire connected to all the wires shown as grounded, or each circuit may have a return metallic conductor, all said conductors being joined together at central and connected to the wires shown as grounded.

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

1. A test-circuit for a subscriber's line, from the office ground through a test receiving in-

strument and battery to a test-plug, thence to a line-contact when the test is applied, thence in one direction to the office ground through a pair of switch contact-points normally in contact but separated while the line is switched at their board and through a resistance and in the other direction to the subscriber's ground through his station apparatus and a switch having contacts and connections at the subscriber's station to switch a comparatively high resistance into the circuit of the line while the telephone is switched for use and a comparatively low resistance while the telephone is not thus switched, said test receiving instrument being so adjusted to the battery and the circuit that it will sound when on a test being made neither said telephone nor the line is switched for use, substantially as set forth.

2. A test-circuit for a subscriber's line, from the office ground through a test receiving instrument and battery to a test-plug, thence to a line-contact when the test is applied, thence in one direction to the office ground 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 and through a resistance and in the other direction to the subscriber's ground through his station apparatus, and a switch having contacts and connections at the subscriber's station to switch a comparatively high resistance into the circuit of the line while the telephone is switched for use and a comparatively low resistance while the telephone is not thus switched, said test receiving instrument being so adjusted to the battery and the circuit that it will sound when on a test being made neither said telephone nor the line is switched for use but not otherwise, substantially as set forth.

3. A test-circuit for a subscriber's line, from the office ground, through a test receiving instrument and battery to a test-plug, thence to a line-contact when the test is applied, thence, in one direction, to the office ground through a pair of switch contact-points normally in contact but separated while the line is switched at their board, and through a resistance and, in the other direction, to the subscriber's ground through his station apparatus, and a switch at the subscriber's station with contact-points which switch his telephone, secondary of induction-coil and a resistance into the circuit of the line while his telephone is switched for use and a signal-bell into the circuit while the telephone is not thus switched, said test receiving instrument being so adjusted to the battery and the circuit that it will sound when on the test being made neither said telephone nor the line is switched for use but not otherwise, substantially as set forth.

4. In a telephone-exchange system, a subscriber's line normally grounded through a pair of switch-contacts and a resistance at the central office, a test-piece for the line con-

needed to the line between the subscriber's station and the pair of switch-contacts, a call-bell normally in the normal ground connection of the line-circuit at the subscriber's station, the subscriber's telephone and switch, and contacts and connections whereby an increased resistance is included in the line-circuit when said telephone is removed from the switch, in combination with a test instrument and battery at the central office grounded on one side and connected on the other side with a test-plug adapted to be brought into connection with the test-piece of the line.

5. A test-circuit for a subscriber's line, from the office ground, through a test receiving instrument and battery to a test-plug, thence to a line-contact when the test is applied, thence, in one direction to the office ground through a series of pairs of contact-points, one pair on each of several boards, each pair normally closed but open while the line is switched at their board and a resistance, and, in the other direction, to the subscriber's ground through his station apparatus, in combination with a switch at the subscriber's station with contact-points which switch his telephone, secondary of induction-coil and a resistance into the circuit of the line while said telephone is switched for use and the signal-bell into the circuit while the telephone is not thus switched, said test receiving instrument being so adjusted to the battery and the circuit that it will sound when on the test being made neither said telephone nor the line is switched for use but not otherwise, substantially as set forth.

6. In a telephone-exchange system, a subscriber's line grounded at its outer end and having in its circuit at the subscriber's station a comparatively high resistance while his telephone is switched for use and a comparatively low resistance while the telephone is not thus switched, and at the central office a switch with a pair of contact-points normally in contact but open while the line is switched by it, a test contact-piece insulated from the rest (except by the circuit connections), and a resistance grounded on one side, said line passing through said pair of contact-points and thence to the other side of said resistance and said test contact-piece being connected to the line before the line passes to said contact-points, in combination with a test wire or circuit, containing a test receiving instrument and battery, grounded at one end and connected at its other end to a test plug or device adapted to be brought for testing into connection with said test contact-piece, said instrument being so adjusted to the battery and circuits that it will sound when on a test being made neither said telephone nor the line is switched for use but not otherwise, substantially as set forth.

7. In a telephone-exchange system, a subscriber's line grounded at its outer end and having in its circuit at the subscriber's sta-

tion a comparatively high resistance while the telephone is switched for use and a comparatively low resistance while the telephone is not thus switched, and at the central office a series of switches, one switch on each of several boards, each switch having a pair of contact-points normally closed but open while the line is switched at their board, a test contact-piece insulated from the rest (except by the circuit connections), and a resistance grounded on one side, said line passing, successively through said pairs of contact-points and thence connected to the other side of said resistance, and said contact-piece being connected to the line before the line passes to said pairs of contact-points, in combination with a test wire or circuit containing a test receiving instrument and battery, 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 said test contact-piece, said instrument being so adjusted to the battery and circuits that it will sound when on the test being made neither said telephone nor the line is switched for use but not otherwise, substantially as set forth.

8. In a telephone-exchange system, a subscriber's line normally grounded at its outer end and at the subscriber's station, a switch with contact-points to switch his telephone, secondary of induction-coil and a resistance into the circuit of the line while said telephone is switched for use and the signal-bell into the circuit while the telephone is not thus switched, and at the central office a switch with a pair of contact-points normally in contact but open while the line is switched by it, a test contact-piece insulated from the rest (except by the circuit connections) and a resistance grounded on one side, said line passing through said pair of contact-points and thence to the other side of said resistance and said contact-piece being connected to the line before the line passes to said contact-points, in combination with a test wire or circuit containing a test receiving instrument and battery, grounded on one side and connected on its other side to a test plug or device adapted to be brought on testing into connection with said test contact-piece, said instrument being so adjusted to the battery and circuits that it sounds when on a test being made neither said telephone nor the line is switched for use but not otherwise, substantially as set forth.

9. In a telephone-exchange system, a subscriber's line grounded at its outer end and having in its circuit in the subscriber's station, apparatus of comparatively high resistance while his telephone is switched for use and apparatus of comparatively low resistance while the telephone is not thus switched, in combination with a test contact-piece at the central office permanently connected to the line, a resistance normally connected on one side to the line and connected

on the other side to the ground, switch contact-points which disconnect the line from said resistance while the line is switched for use, and a test wire or circuit containing a test receiving instrument and battery, 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 said test contact-piece, said instrument being so adjusted to said battery and the circuits that it sounds when on the test being made neither said telephone nor the line is switched for use but not otherwise, substantially as set forth.

10. In a telephone-exchange system, multiple switchboards, a subscriber's line grounded at its outer end and having in its circuit at the subscriber's station, apparatus of comparatively high resistance while his telephone is switched for use and apparatus of comparatively low resistance while the telephone is not thus switched, and at the central office a series of test contact-points, one on each of the multiple boards and connected to the line, a resistance connected on one side to the ground and normally connected on its other side to the line, and switch contact-points which disconnect the line from said resistance while the line is switched for use, in combination with a test wire or circuit at each board containing a test receiving instrument and battery, grounded at one end and connected at its other end to a test plug or device adapted to be brought for testing into connection with said test contact-piece, said instrument being so adjusted to the battery and circuits that it sounds when on a test being made neither said telephone nor the

line is switched for use but not otherwise, substantially as set forth.

11. In a telephone-exchange system, multiple switchboards, a telephone-line grounded at its outer end and having at the subscriber's station, apparatus of comparatively high resistance in its circuit while his telephone is switched for use and of comparatively low resistance while it is not thus switched, test contact-pieces, one on each board and each connected to the line permanently, switches for the line one on each board and each containing a pair of contact-points normally closed but open while the line is switched at their board, and a resistance grounded on one side, said line passing, successively, through said pairs of contact-points and thence connected to the other side of said resistance, in combination with test receiving instruments, one at each board and 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 test contact-piece at its board, said instruments each having a battery in its test-circuits and being so adjusted to the battery and the circuits that it sounds when on a test of the line being made neither the telephone nor the line is switched for use but not otherwise, substantially as set forth.

In witness whereof I hereunto subscribe my name this 18th day of October, 1889.

MILO G. KELLOGG.

Witnesses:

FRANCES D. KELLOGG,
MARGARETHA RIEHL.