(No Model.)

M. G. KELLOGG.

MULTIPLE SWITCHBOARD.

No. 592,320. Patented Oct. 26, 1897.

Fig. 1a,

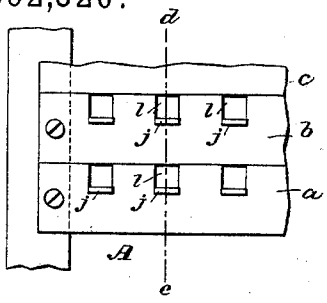


Fig. 1b,

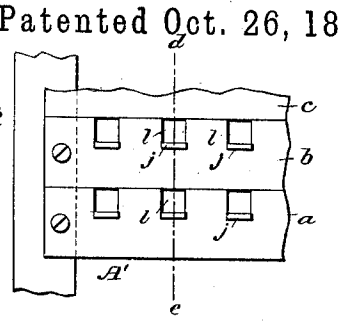


Fig. 2,

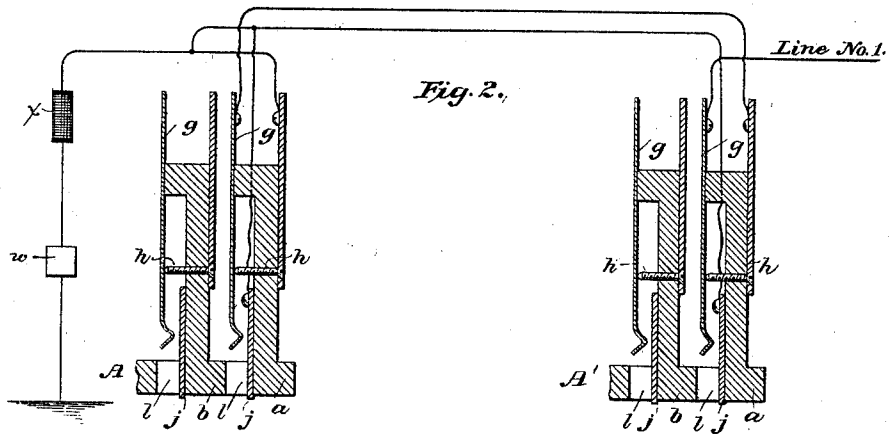


Fig. 3,

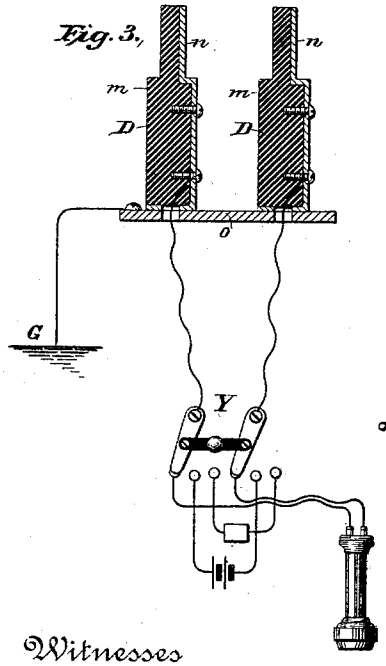


Fig. 5,

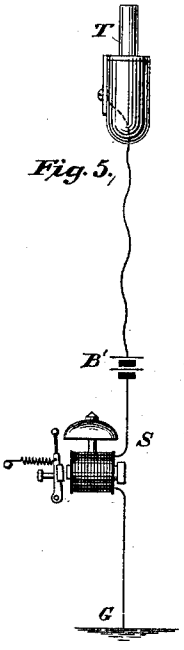
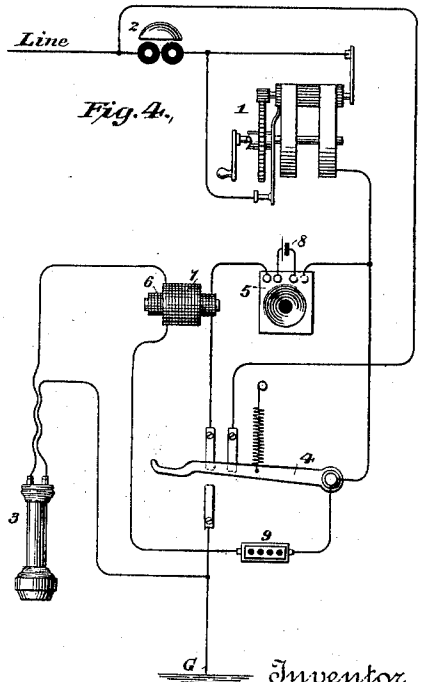


Fig. 4,



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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. 592,320, dated October 26, 1897.

Application filed November 29, 1889. Serial No. 332,023. (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 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 1ª and 1ᵇ 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 indicated by the same letters of reference.

G is a ground connection.

In Fig. 2, A is a sectional view of the switchboard shown in Fig. 1ª, and A′ is a sectional view of the switchboard shown in Fig. 1ᵇ, 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 on which the springs normally bear, and *j j* the insulated contact-pieces of the switches. *l l* are the switch-holes. *a b* are the rubber strips on which the metal parts of the switches 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 marked D D) 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 connection of the lines to the switchboard is as follows and as shown for line No. 1: The line passes successively through the pairs of contact-points of its switches on the boards, passing in each case to the spring first. It then passes through its line-annunciator and a resistance-coil to ground.

w is the annunciator, and *x* the resistance-coil.

The contact-pieces *j j* of the line are connected to the line, the connection being between the switch contact-points on the one hand and the annunciator and resistance-coil on the other hand.

Fig. 3 shows an operator's cord system with one pair of cords and their plugs, switch, annunciator, and the operator's telephone and calling generator or battery. The plugs D D are constructed substantially as shown, *m m* being the rubber insulations and *n n* the contact-pieces, and they should be inserted into the switches in such a position that the contact-piece of the plug is in connection with the spring and is not in connection with the contact-piece *j*. *o* is a metal strip on which the bases of the plugs normally rest and which then connects the contact-pieces of the plugs with the ground. The circuits are as shown.

The method of connecting other pairs of cords to the system and of operating the system in connection with the boards will be apparent to those skilled in the art. Each operator has one cord system and as many pairs of cords as she may need, and the parts are conveniently placed and mounted for her work.

In the subscriber's-station apparatus shown in Fig. 4, 1 is the calling-generator; 2, the signal-bell; 3, the hand-telephone; 4, the telephone-switch; 5, the transmitter; 6, the primary of the induction-coil; 7, its secondary

coil; 8, the transmitter-battery, and 9 is a resistance-coil of suitable magnitude for the circuits. The contact-points and circuits are as shown, or otherwise arranged, so as to perform substantially the operations hereinafter described. The calling-generator has an automatic device which shunts the armature-coil from the circuit in which the generator is placed, except when the generator is operated.

It will be seen that when the subscriber's telephone is on its switch the signal-bell magnet only is in the circuit of the line, except when the armature is in circuit by the operation of the generator in calling, and that when the telephone is taken from the switch the secondary of the induction-coil, the resistance-coil, and the telephone are in the circuit of the line. The resistance of the line will therefore be much greater when the telephone is off the switch than when it is on the switch. The resistance of the telephone and secondary of the induction-coil combined in well-designed telephone apparatus frequently comes to about four hundred ohms, while the resistance of the signal-bell magnets will be about one hundred ohms. I utilize this relation between the resistance of the parts in the testing system, as will be seen. When necessary or desirable, I also add artificial resistance to the branch circuit, in which is the telephone and coil, as shown in the drawings.

In the operator's test system shown in Fig. 5, T is the test-plug, S is the test receiving instrument, B′ is the test-battery, and G is the ground connection. They are connected as shown, and each operator has a test system suitably mounted and arranged for her work. 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 some 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 the central office and the test-circuit to the line is open, or when the additional resistance is placed in the circuit by the subscriber's telephone being taken from its switch, there will not enough current pass to operate the instrument. The resistance in the ground-circuit of a line may be well made of several hundred ohms, as the generators are generally 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 test operations on the test receiving instrument, as above indicated. When an operator, therefore, makes a test of a line by placing her test-plug on its test-piece and the line is not switched for use and the subscriber's telephone is on its switch, the instrument will respond, indicating that the line is "free." If, however, either the line is switched or the subscriber's telephone is off from its switch, the instrument will not respond, indicating that the line is not free.

The test depends on the fact that an electromagnet with an armature and a retractile spring acting on the armature may readily be made to move or attract the armature when in closed circuit with a battery and a certain resistance and not to attract the armature when in closed circuit with the battery and a considerably greater resistance. This construction and adjustment would depend on the style of the electromagnet, the strength of the retractile spring, the size of the battery, and the resistance of the circuit. With an electric bell of some ordinary construction and a suitable retractile spring and the use of about ten cells of test-battery the required adjustment and operation would be easy to produce with, say, five hundred ohms resistance in the connection to ground from the test contact-pieces and a variation in resistance of, say, five hundred ohms in the resistance of the line when the subscriber's telephone is switched for use and when it is not thus switched.

The actual resistance of the line is not of importance, so long as there is a suitable difference of resistance between the line when the telephone is on the switch and when it is off to produce the proper adjustment and operation of the test. In the illustration given above the resistance of the line when the telephone is on the switch-line may, for instance, be two hundred and fifty ohms and the resistance when it is off be seven hundred and fifty ohms. The figures of resistances and battery are illustrative and may be greatly varied from the above and yet be made to produce the described test operations.

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." This, again, cannot occur

in this system of testing, 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.

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 instrument and battery to a test contact-plug and thence to a line-contact when the test is applied, thence in one direction to the office ground through a comparatively high resistance and in the other direction to the subscriber's ground through a pair of switch-contact points in the central office and the subscriber's-station apparatus, in combination with a switch-plug which separates said pair of contact-points while it switches the line, and a switch, apparatus and circuits at the subscriber's station to switch apparatus of comparatively high resistance into the circuit of line when the telephone is switched for use and low resistance when it is not thus switched, said test receiving instrument being adjusted to respond to current of certain strength, but not to respond to current of considerably less strength, and said instrument and battery being adjusted to each other and said several resistances and the circuit to the degree that the instrument sounds when on the test being made neither the telephone nor the line is switched for use and not otherwise, 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 contact-plug and thence to a line-contact when the test is applied, thence in one direction to the office ground through a comparatively high resistance and in the other direction to the subscriber's ground through a series of pairs of switch contact-points, one on each of several boards, in combination with switch-plugs adapted to be inserted into the switches for switching and when a plug is inserted into a switch to separate its said pair of contact-points while the line is thus switched for use, and a switch, apparatus and circuits at the subscriber's station to switch apparatus of comparatively high resistance into the line-circuit while his telephone is switched for use, and of comparatively low resistance while it is not thus switched, said instrument being adjusted to respond to current of certain strength, but not to respond to current of considerably less strength, and said instrument and battery being adjusted to each other and said several resistances and the circuit to the degree that the instrument sounds when on the test being made neither the 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 to a test contact-plug and thence to a line contact-point when the test is applied, thence in one direction to the office ground through a comparatively high resistance and in the other direction to the subscriber's ground through a pair of switch contact-points in the central office and the subscriber's-station apparatus, and a battery, in combination with a switch-plug adapted to be inserted into the switch and when inserted to separate the contact-points while the line is switched for use, and a switch apparatus and circuits at the subscriber's station to switch apparatus of comparatively high resistance into the circuit of the line when the telephone is switched for use and of comparatively low resistance when it is not thus switched, said test instrument being adjusted to respond to current of certain strength, but not to respond to current of considerably less strength, and said instrument and battery being adjusted to each other and said several resistances and the circuit to the degree that the instrument sounds when on the test being made neither the telephone nor the line is switched for use but not otherwise, substantially as set forth.

4. A test-circuit for a subscriber's line, from the office ground through a test receiving instrument and battery to a test contact-plug and thence to a line contact-point when the test is applied, thence in one direction to the office ground through a comparatively high resistance and in the other direction to the subscriber's ground through a pair of switch contact-points in the central office and the subscriber's-station apparatus, in combination with a switch-plug adapted to be inserted into the switch and when inserted to separate the said contact-points while the line is switched for use and a switch at the subscriber's station with contact-points to switch his telephone, secondary of induction-coil and resistance-coil into the circuit of the line while his telephone is switched for use and the signal-bell into the circuit while the telephone is not thus switched, said test instrument being adjusted to respond to current of certain strength, but not to respond to current of considerably less strength, and said instrument and battery being adjusted to each other and said several resistances and the circuit to the degree that the instrument sounds when on the test being made neither the telephone nor the line is switched for use and not otherwise, substantially as set forth.

5. A test-circuit for a subscriber's line, from the office ground through a test receiving instrument to a test-plug, thence to a line contact-point when the test is applied, thence in one direction to the office ground through a resistance-coil, and in the other direction to the subscriber's ground through a pair of switch contact-points at the central office, and the subscriber's-station apparatus, and battery, in combination with a switch-plug adapted to be inserted into the switch and when

inserted to separate the said pair of contact-points while the line is switched for use and a switch at the subscriber's station with contact-points to switch his telephone and secondary of the induction-coil into the line-circuit while his telephone is switched for use and the signal-bell into the circuit while the telephone is not thus switched, said test instrument being adjusted to respond to current of certain strength, but not to respond to current of considerably less strength, and said instrument being adjusted to the battery and said several resistances and circuit to the degree that it sounds when on the test being made neither the subscriber's telephone nor the line is switched for use and 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, in the station apparatus, a comparatively high resistance while his telephone is switched for use and a comparatively low resistance while it is not thus switched, a switch at the central office having a pair of contact-points normally in contact but separated while the line is thereby switched for use, and a test contact-piece insulated from the rest (except by the circuit connections), said line passing through said pair of contact-points and thence to said test contact-piece, in combination with a resistance-coil grounded on one side and connected on the other side to the line-circuit between the contact-points and the test contact-piece, and a test receiving instrument with battery grounded on one side and connected on its other side to a test plug or device adapted, at the will of the operator, to be brought into connection with said test contact-piece, said instrument being adjusted to respond to current of certain strength, but not to respond to current of considerably less strength, and said instrument being adjusted to the battery and said several resistances and circuits to the degree that it sounds when on the test being made neither the subscriber's telephone nor the line is switched for use and 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 in the station apparatus, a comparatively high resistance while his telephone is switched for use and a comparatively low resistance while the telephone is not thus switched, a series of switches at the central office for said line, one switch on each of several boards, each having a pair of contact-points normally in contact but separated while the line is thereby switched, and a test contact-piece insulated from the rest (except by the circuit connections) said line passing successively through its said pair of contact-points and thence to said test contact-piece, in combination with a resistance-coil grounded on one side and connected on its other side to the line after it has passed through said pairs of contact-points, 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 at the will of the operator to be brought into connection with said test contact-piece, said instrument being adjusted to respond to current of certain strength, but not to respond to current of considerably less strength, and said instrument being adjusted to the battery and said several resistances and the circuits to the degree that it sounds when, on the test being made, neither the subscriber's 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 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 while the telephone is switched for use and the signal-bell into the circuit while it is not thus switched, in combination with a test contact-piece normally connected to the line, switch contact-points which disconnect said contact-piece from the line while the line is switched for use, a resistance-coil connected to said contact-piece on one side and grounded on the other, and a test-wire containing a test receiving instrument and battery, grounded on one side and connected on the other side to a test plug or device adapted to be brought for testing into connection with said test contact-piece, said instrument being adjusted to respond to current of certain strength, but not to respond to current of considerably less strength, and said instrument being adjusted to the battery and said several resistances and circuits to the degree that it will sound when on the test being made neither said telephone nor the line is switched for use and 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 at his station apparatus of comparatively high resistance while his telephone is switched for use and of comparatively low resistance while it is not thus switched, in combination with a series of test contact-pieces, one piece on each of several boards and normally connected to the line, switch contact-points which disconnect the line from its said contact-pieces while it is switched for use, a resistance-coil connected on one side to said contact-pieces and grounded on the other side, in combination with test receiving instruments, one at each board, each grounded on one side and connected on its other side to a test-plug adapted to be brought for testing into connection with the test contact-piece at its board, said instrument being adjusted to respond to current of certain strength, but not to respond to current of considerably less strength, and said instrument being connected in circuit with a battery and adjusted to it and said several

resistances and the circuits to the degree that it will sound when on the test being made neither said telephone nor the line is switched for use and not otherwise, substantially as set forth.

10. In a telephone-exchange system, a subscriber's line grounded at its outer end and having in its circuit at his station, apparatus of comparatively high resistance while his telephone is switched for use and of comparatively low resistance while the telephone is not thus switched, multiple switchboards, switches for the line, each having a pair of contact-points normally closed but open while the line is switched at its board, test contact-pieces, one on each board, and a resistance-coil grounded on one side, said line passing, successively, through said pairs of contact-points and thence connected to said test contact-pieces and to the other side of said resistance-coil, in combination with test receiving instruments, one at each board, 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 instrument being adjusted to respond to current of certain strength, but not to respond to current of considerably less strength, and said instrument having a battery in circuit with it and adjusted to the battery and said several resistances and the circuits to the degree that it will sound when on a test being made neither said telephone nor the line is switched for use and not otherwise, substantially as set forth.

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