(No Model.)

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TEST CIRCUIT FOR MULTIPLE SWITCH BOARDS.

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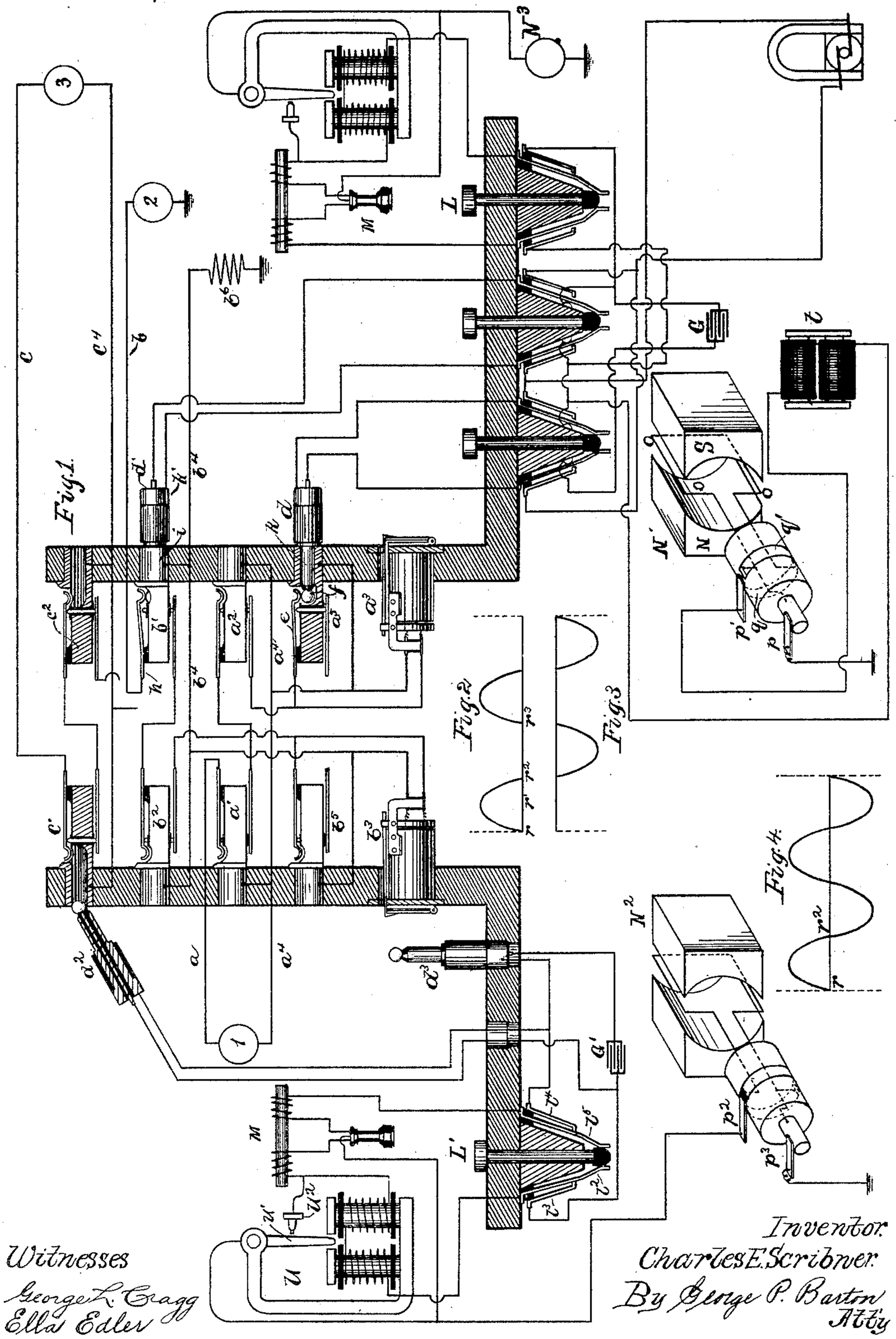

UNITED STATES PATENT OFFICE.

CHARLES E. SCRIBNER, OF CHICAGO, ILLINOIS.

TEST-CIRCUIT FOR MULTIPLE SWITCH-BOARDS.

SPECIFICATION forming part of Letters Patent No. 467,901, dated January 26, 1892.

Application filed May 29, 1891. Serial No. 394,498. (No model.)

To all whom it may concern:

Be it known that I, CHARLES E. SCRIBNER, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Testing Systems for Multiple Switch-Boards, (Case No. 259,) 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 testing apparatus for multiple switch-boards of telephone-exchange systems. Its object is to provide an audible test-signal of a character distinct and different from any sound which may be produced by extraneous and accidental causes.

In the system of multiple switch-boards in most general use the operation of testing at one multiple switch-board to determine whether any line is in use at some other board is accomplished in the following manner: When a connection is made to any line at any board, an earth connection is completed through a battery to the "test-ring" or frame of the spring-jack at which the connection is made. The frames of all the spring-jacks belonging to one line are in electrical connection and in the metallic-circuit system are connected to one side of the line. If now a connection be made from the test-ring of a spring-jack at another board through a telephone to earth, the battery-circuit will be completed, and at each test a click will be heard in the telephone. The circuit directly involved in this process of testing—those portions of the switch-board connections which are necessary to complete the circuit of the test-current in a busy line—is commonly designated as the "test-circuit." When, however, the telephone-lines extend parallel or in proximity to electric-railway lines or other conductors carrying heavy and varying currents, currents and electrostatic charges varying in character according to their causes are induced upon the telephone-lines, and when an earth connection is made to the line, as through a testing-telephone, a false signal is produced in the telephone, leaving it uncertain whether the line tested is in use or not, and thus causing confusion.

My invention herein described is designed to obviate this difficulty. The test-signal is so produced that it could not be counterfeited by any static discharge or induced current through the telephone. I include in the connection between the test-ring and earth a dynamo giving a pulsating current of constant direction and of such period as to produce no sound in a telephone included in its circuit, each pulsation having a duration equal to one-half of the period, and included in the circuit from the telephone to earth is a second dynamo, giving pulsations whose period and duration are the same as those of the first dynamo, but whose direction is opposite with reference to the test-circuit, and which lag one hundred and eighty degrees behind the pulsations of the first dynamo, and a polarized device adapted to make an audible signal when its armature vibrates. When a pulsating or continuous current of constant direction traverses the polarized device, it gives no sound; but when it is traversed by the composite current from the two dynamos, which is, in fact, an alternating current, it is thrown into vibration, which may be rendered audible. Thus when the line tested is not in use no test-signal is given; but when the line is in use a signal which is reliable and certain is produced. I shall have occasion to refer to the action of these two currents hereinafter, and I find it convenient to designate those pulsations or intermittent currents from one dynamo which are in a phase lagging one hundred and eighty degrees or one-half period behind those of the other dynamo, so as to occupy in the resultant or composite current the intervals between the currents from the first dynamo as "complementary" currents.

I have devised several forms of polarized responsive devices adapted to my invention, whereby the passage of an alternating current may be detected. Thus I have sometimes placed a polarized bell in circuit with the testing-plug. I have also included the coils of a polarized relay in the circuit of the testing-plug, with its relay-contacts in a shunt-circuit of the operator's telephone, so that when an alternating current passes through the testing-circuit a shunt-circuit around the

telephone is rapidly made and broken, and a succession of clicks is heard in the telephone. This method I find preferable.

My invention will be more readily understood by reference to the accompanying drawings, Figures 1, 2, 3, and 4, which are illustrative thereof.

In Fig. 1 I have shown three subscriber's stations connected, as usual, to their respective spring-jacks and calling apparatus on two sections of multiple switch-board. I have shown at each of the switch-boards an operator's listening-key, telephone-set, connecting-plugs, and testing apparatus, and at the second board the operator's calling-keys. These calling-keys and their operation are too well known to need description. Fig. 2 is a graphic representation of the character of the current from one of the dynamos in a manner well understood by those skilled in the art to which my invention pertains. Fig. 3 is a similar representation of the character of the current from the other dynamo. Fig. 4 represents in the same manner the composite current of both dynamos in series.

Having thus generally described my invention, I will now proceed to describe it and its operation in greater detail.

Parts in the drawings will be indicated by letters and figures of reference, similar parts being designated by similar letters and figures of reference.

Reverting to Fig. 1, 1, 2, and 3 are three subscribers' stations connected to the exchange. Line from station 1, for example, may be traced by line a through the line-spring and back contact of spring-jack a' at the first board at the left of the drawing, thence similarly through spring-jack a^2 at the second board, thence the circuit would be normally through annunciator a^3, and thence returning by line a^4 to station 1. The return-wire a^4 is connected to the frames of the spring-jacks a' a^2, and an answering-jack a^5 is bridged in between the lines a and a^4. Circuit from station 2, which is represented as a grounded line, may likewise be traced through line b, jacks b' b^2, annunciator b^3, answering-jack b^5, and return-line b^4, resistance b^6, and earth to station 2. Circuit from station 3 may be traced through jacks c' c^2. The answering-jack and calling annunciator are not shown.

I have shown stations 1 and 2 connected together for conversation at the second board by means of the flexible cord and terminal plugs d d'. The circuit from station 1 is thus extended from line-spring e of jack a^5, through the tip f of plug d, through the condenser G, through the tip f' of plug d', thence through line-spring h of jack b' and returning to test ring or frame i of jack b' through sleeve k' of plug d', cord, sleeve k of plug d, test-ring of jack a^5, and returning to station 1. The operator at the second board is provided with a listening-key L, adapted to bridge her telephone M in between the two sides of the connected lines; but this key is shown in its open position, whereby the telephone is disconnected from the lines. Connected to the sleeve-strand of the cord joining the connecting-plugs d d' I have shown one of the dynamos described N'. Two pole-pieces N S furnish an approximately uniform magnetic field, in which revolves armature O, shown in the drawings as of one turn of wire. One end of the armature is connected to a contact bearing against a brush p, which is grounded. The other terminal is connected to a commutator-segment q, which during one-half of each revolution bears against brush p', which is connected to the sleeve-strand of the connecting-cords. An idle segment is provided upon the commutator in such position that it short-circuits the brushes during that half of the revolution in which the brush p' is not in contact with segment q.

The character of the current is graphically represented in Fig. 2. Beginning with the point r a current flows which gradually increases from 0 at r to a maximum at r' after a quarter of a revolution or ninety degrees. In the next quarter-revolution the current falls again to 0 at r^2. During the whole of the succeeding half-revolution to r^3 no current flows. The armature-circuit is open and the brushes are short-circuited. Thus a pulsatory current, or, if no test-circuit is completed, an intermittent electro-motive force, is closed to the sleeves of the connecting-plugs d d', and hence to the test-rings of the lines between which a connection is made by means of them. I have shown a retardation-coil t included in circuit between the sleeve-strand and the brush p' of the dynamo, in order that another or several more connections may be extended from the same dynamo to other pairs of plugs at the same or at other boards without appreciably crossing the lines together. The operator's outfit at the first board is similar to that at the second. At this board I have shown the operator's outfit as in the act of testing the spring-jack c' of line 3. The listening-key L' is in position to connect the telephone-set M' to the connecting-strands of the plugs d^2 d^3. The telephone-circuit may be traced from the tip of plug d^2 through the corresponding cord-strand, through spring l^3, contact l^2, through telephone-set M', returning to contact l^5, spring l^4, through the other strand of the cord to the sleeve of plug d^2. The circuit may also be traced from tip of plug d^3, through its connecting-cord, through condenser G' to spring l^2, and through the telephone back to spring l^5, and thence to the sleeve of plug d^3. Hence it is evident that the telephone-set M' is in a shunt or bridge connection between the sleeves and tips of the two plugs.

The two terminals of the telephone-coil are connected, as traced, to the springs l^2 l^5; but to the center of the coil a connection is made which extends through another dynamo N^2 similar to that just described. The period or

rate of the pulsations of this dynamo is exactly the same as that of the other; but the commutator is so disposed that the pulsations of this dynamo lag one hundred and eighty degrees behind those of N′, and are of opposite phase or direction. The character of the current from this dynamo is shown in Fig. 3. It will be seen that the periods of activity of N′ coincide with the periods of idleness of N^2 and the periods of idleness of N′ with those of N^2's activity. At the second board at the right I have represented a dynamo N^3 by a circle similar to dynamo N^2 at the first board.

Included in the telephone-circuit between the tip of test-plug d^2 and the telephone is the coil of a polarized relay u, whose contacts u' u^2, when closed, complete a short circuit around one-half of telephone M′.

I will now proceed to describe the operation of the telephone system shown and of my invention in connection therewith. Suppose that a call is sent from station 1, the shutter of annunciator a^3 falls. The operator at the second board seeing this signal thrusts plug d into answering-jack a^5 and places listening-key L in its alternate position, whereby she is placed in communication with station 1. Having ascertained with what line a connection was desired—say with station No. 2—her next operation would be to test that line to determine whether it was in use at some other board or not; but this test I will for the present ignore, and will consider it at length later. The operator thrusts her second connecting-plug d' into jack b' of line to station 2. The circuit from station 1 is now extended from the line-spring a^2, through the tip of plug d, condenser G, tip of plug d', line-spring b' to station 2, thence returning by the path previously traced to frame of jack b', sleeve of plug d', sleeve of plug d to frame of jack a^2. Having thus made the desired connection, the operator sends a call-signal to station 2 by means of the calling-keys, and a calling-generator throws listening-key L into the position shown and leaves stations 1 and 2 in communication. Dynamo N′ is now impressing an intermittent electro-motive force, as represented in Fig. 2, upon the test-rings of both lines a^4 and b^4, which results in the case of the latter line in a slight current through drop a^3 over line b, through subscriber's station 2 to earth; but the strength of the current is so slight as not to operate drop a^3. Since its direction is constant, it will not ring the bell at station 2. Moreover, the period of pulsation is so slow that the separate pulsations do not blend into a musical tone. I find that fifteen pulsations per second may be sent through a telephone without producing a tone, and when the fluctuation of the current is gradual, as represented in Fig. 4, as is the case with an armature revolving in a uniform magnetic field, the attraction and release of the diaphragm of a telephone in circuit is so gradual as to produce no sound whatever. Care must be taken, however, to insure that the brush p' reaches and leaves the commutator-segment when the electro-motive force of the armature is at exactly zero, as at points r r^2 in Fig. 4, else there would be an abrupt starting or cessation of a current through the circuit, which would produce a click in the telephone. Suppose, now, that the operator at the first board has occasion to test jack a' of line from station 1 to determine whether or not the line is already in use at another board. She places the tip of her testing-plug d^2 against the frame or test-ring of jack a'. The circuit from brush p' of dynamo N′ will now be completed through the retardation-coil, through the strand of cord to sleeve of plug d, to test-ring of jack a^2, thence to test-ring of jack a', to tip of plug d^2, cord, spring l^3, and contact l^2 of her listening-key L′, through the coil of the polarized relay u, through one-half of the coil of telephone M′, through the brushes p^2 p^3 of dynamo N^2 to ground, thence returning to dynamo N′. Let the commutator-segments of dynamo N′ be in position to allow a current to flow from the armature, then the commutator of dynamo N^2 is at the same instant in a position to short-circuit its brushes p^2 p^3, and a current flows from dynamo N′ through the circuit traced in one direction, throwing the armature of polarized relay u to one side and closing the shunt around the telephone, and so producing a click in the telephone. One half-revolution later the commutator of dynamo N′ has short-circuited brushes p p', while that of dynamo N^2 is allowing a current to flow in the opposite direction through the same circut. The polarized armature of relay u is thrown to the other side, opening the shunt around telephone M′ and producing another click. Thus a composite alternating current, (represented in Fig. 4,) made up of the pulsatory currents of the two dynamos, will flow in the test-circuit, and through the agency of the polarized relay will produce a rapid succession of sharp clicks in the testing-operator's telephone, which will be indicative to her that the line tested is busy. Suppose, however, that the operator test the jack c' of the line from station 3, which is at present not in use. The line connecting station 3 with the telephone-exchange is shown as metallic and is nowhere connected to ground; but if it were a grounded line, as that from station 2, a slight pulsating current would obviously find circuit through the various grounds of the line; but this current, being constant in direction, would produce only one click in the telephone, or, if the relay were in the corresponding position, no click, since the tendency of the current through the relay-coils would be to retain the armature in one position.

It will be noted here that it is necessary to have the polarized relay so arranged with reference to the direction of this current from dynamo N^2 that it shall separate its contacts,

and thus open the shunt around the telephone.

It will be understood that the brushes p^2 p^3 of dynamo N^2 are to be adjusted in the same manner as those of dynamo N′, in order not to disturb the proper working of telephone M′.

I have sometimes placed a switch in circuit with telephone M′ so arranged that the dynamo N^2 could be included in circuit only when a test was about to be made; but with a proper adjustment of the various apparatus I do not find this necessary.

It is obvious that my invention might be applied with little or no alteration to any of the well-known forms of test-circuit for multiple switch-board. Hence I do not limit myself to the precise arrangement of circuits shown.

Having thus fully described my invention, I claim as new and desire to secure by Letters Patent—

1. The combination, in a circuit open at two points, of contacts whereby the circuit may be closed at either point or at both of two sources of intermittent currents, one source giving currents of opposite direction to and complementary to those from the other source, and a polarized device adapted to respond to composite currents from the two sources, in the manner and for the purpose specified.

2. In a testing-circuit for multiple switch-boards, the combination of spring-jacks having test-rings electrically connected together, an earth connection including a retardation-coil and a source of intermittent currents of electricity, a testing-plug adapted to be brought into contact with one of the test-rings and having included between it and the earth a second source of intermittent currents opposite in direction and complementary to those from the first source, and a polarized device adapted to respond audibly to the composite current from the two sources, in the manner and for the purpose specified.

3. The combination, with telephone-lines extending through spring-jacks having test-rings electrically connected together, of a connection extending from a test-ring through a source of intermittent currents of electricity to earth, a testing-plug adapted to be brought into connection with another test-ring of the series and connected through a telephone, a polarized relay adapted when its armature is in one of its positions to close a shunt-circuit around the telephone, and a second source of intermittent currents of electricity opposite in direction and complementary to those of the first, in the manner and for the purpose specified.

4. In combination, in an electric circuit, a source of intermittent current, a second source of intermittent current whose pulsations are of the same frequency as those of the first source, but opposite in direction in the circuit to and complementary to those from the first source, a polarized responsive device included in the circuit adapted not to respond to currents of constant direction, but to respond to the composite current from both sources, and a conductor or conductors adapted to complete the electric circuit, in the manner and for the purpose specified.

5. In combination, in an electric circuit, a source of intermittent current, a second source of intermittent current whose pulsations are of the same frequency as those of the first source, but opposite in direction in the circuit to and complementary to those from the first source, a polarized relay having its magnet-coil included in the circuit and its relay-contacts adapted when closed to close a shunt-circuit around a telephone-coil normally included in the circuit, and a conductor or conductors adapted to complete the electrical circuit, as and for the purpose described.

In witness whereof I hereunto subscribe my name this 27th day of April, A. D. 1891.

CHARLES E. SCRIBNER.

Witnesses:
ELLA EDLER,
FRANK R. MCBERTY.