(No Model.) 2 Sheets—Sheet 1.

F. A. PICKERNELL.

MULTIPLE SWITCH BOARD BUSY TEST CIRCUIT AND APPARATUS.

No. 466,702. Patented Jan. 5, 1892.

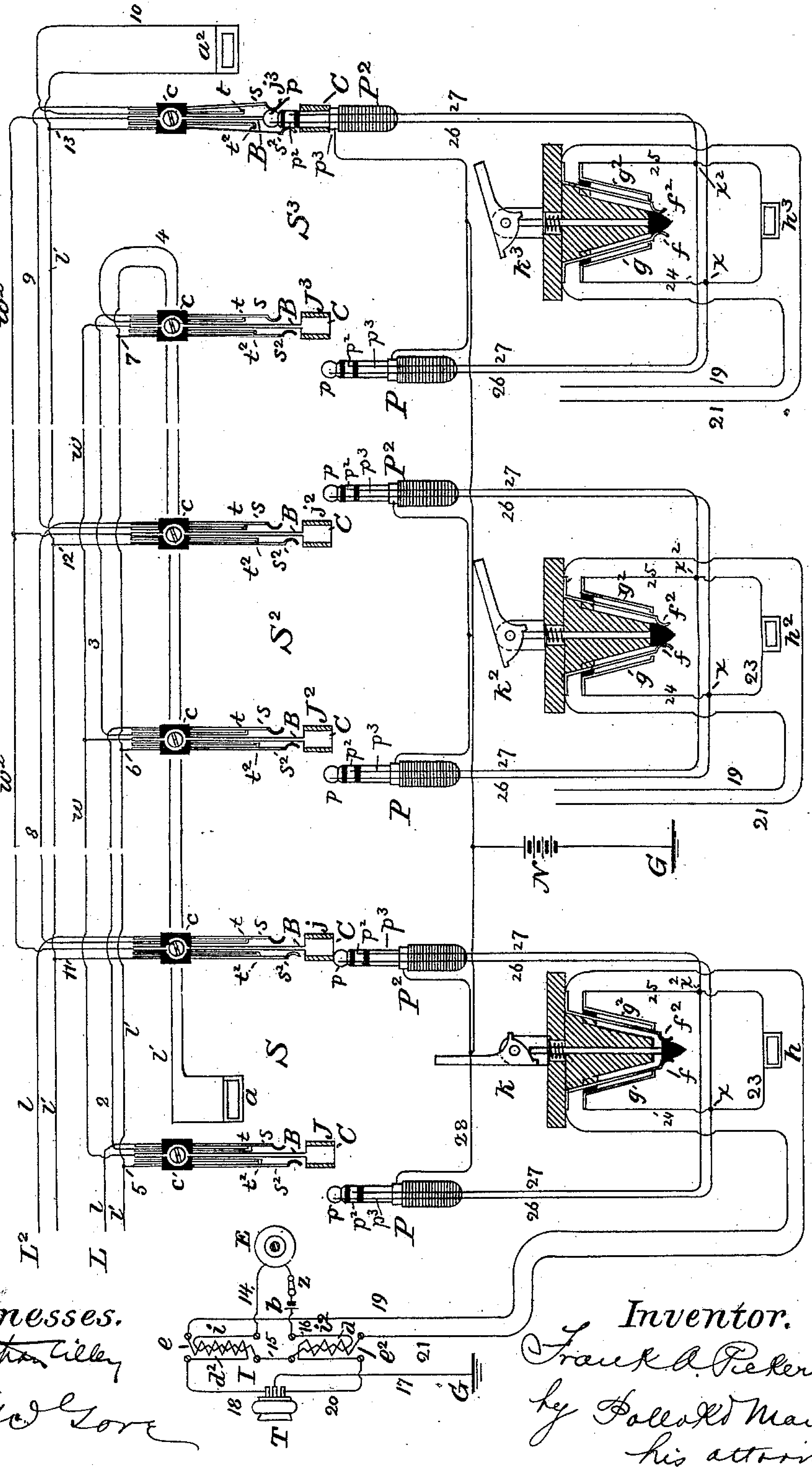

Fig. 1.

Witnesses.
Jonathan Tilley
H. W. Gore

Inventor.
Frank A. Pickernell,
by Pollok & Mauro,
his attorneys.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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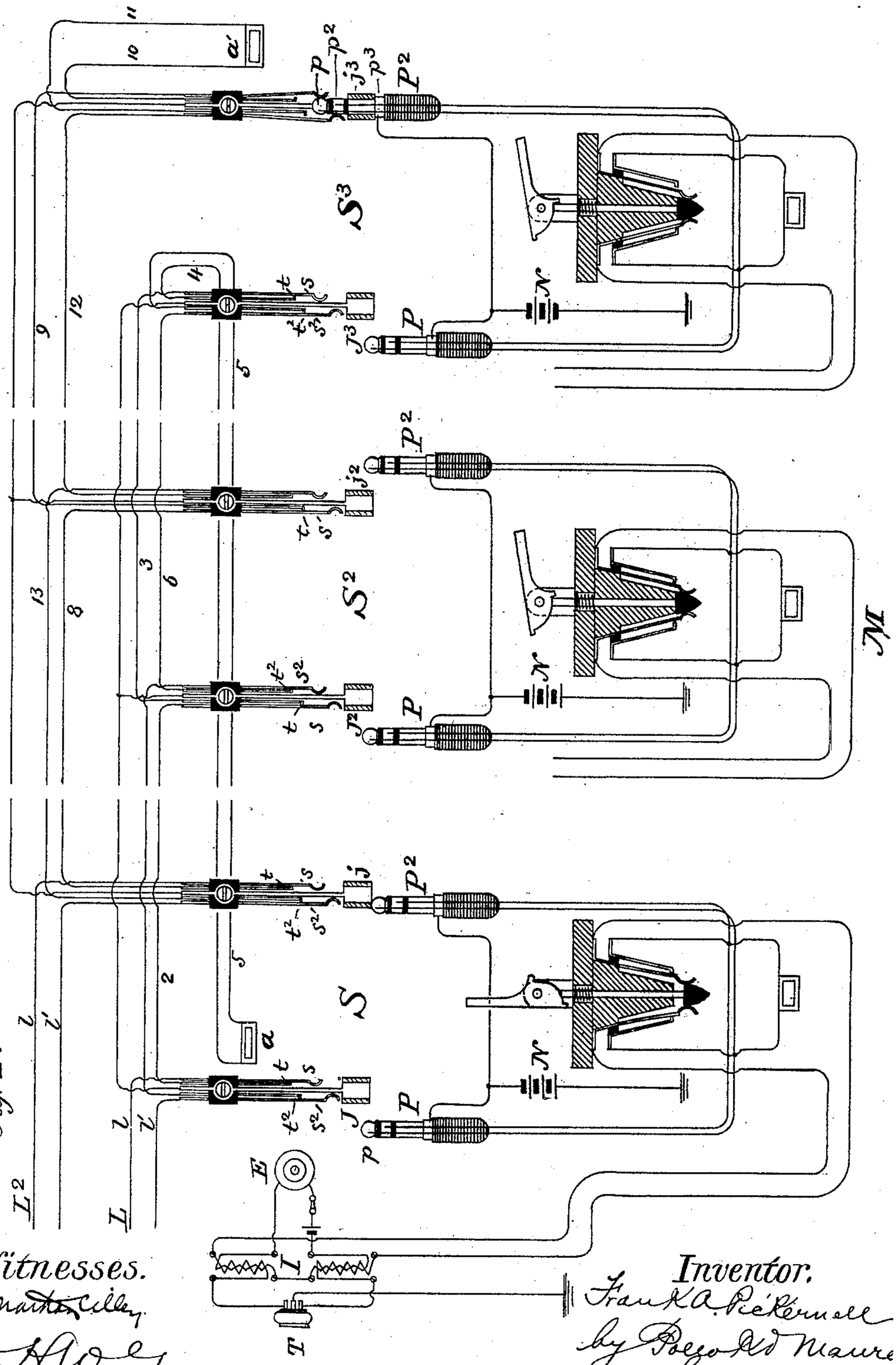

UNITED STATES PATENT OFFICE.

FRANK A. PICKERNELL, OF NEWARK, NEW JERSEY.

MULTIPLE SWITCH-BOARD BUSY-TEST CIRCUIT AND APPARATUS.

SPECIFICATION forming part of Letters Patent No. 466,702, dated January 5, 1892.

Application filed August 17, 1891. Serial No. 402,901. (No model.)

To all whom it may concern:

Be it known that I, FRANK A. PICKERNELL, residing at Newark, in the county of Essex and State of New Jersey, have invented certain Improvements in Multiple Switch-Board Busy-Test Circuits and Apparatus, of which the following is a specification.

This invention relates to multiple telephone switch-boards, and especially to busy-tests adapted for use in connection therewith. Multiple switch-boards are now almost universally employed in central telephone-exchanges even of moderate size, and wherever employed it is obvious that for each section some form of busy-test appliance must be provided whereby an operator at such section may at any time be enabled to ascertain whether a given line called for is or is not already in use at another section of the switch-board. As long as earth-completed circuits only were in use it was not difficult to provide an efficient test; but the use of metallic circuits has made the problem a complex one.

The object of my invention is to provide a test arrangement which shall be simple in construction and operation, reliable in result, and which shall be completely localized—that is to say, that the test-circuit shall be entirely insulated from the line-circuit.

It has been found, also, in multiple switch-boards as ordinarily constructed that when a connection is made between any two lines at any section of the switch-board (the jack-frames of the several spring-jacks of each line being permanently connected to serve as one side of the circuit through the switch-board) a long discontinuous branch remains attached at one end to each of the united circuits, and this being laid up behind the switch-board, with similar branches of other circuits, produces cross-talk due to electrostatic induction. Another object of my invention is to avoid this disadvantage by so arranging the circuits that when a connection is made at any spring-jack the extensions of the line concerned, through the switch-board inwardly, shall be totally cut off.

In the accomplishment of the objects stated above my invention consists in a busy-test circuit and apparatus comprising a third wire for each metallic circuit through the switch-board uniting the several spring-jack frames of each line, and a corresponding additional test-wire leading to a battery and earth, provided, in connection with each connecting-plug and flexible conductor, combined with an operator's telephone whose electro-magnetic helix has an earth-wire branched from its center.

It also consists in combining the above instrumentalities with a double separable contact spring-jack for each line at each switch-section, so that whenever a connection is made by inserting a plug in a spring-jack the extensions of both sides of the line concerned through the switch-board are totally disconnected.

In the drawings which illustrate this invention, Figure 1 is a diagram showing the test-circuit and apparatus in its simplest form, and Fig. 2 is a similar diagram in which the compound contact spring-jacks are employed to disconnect the inwardly-directed line-extensions of the switch-board.

The drawing Fig. 1 indicates a multiple switch-board M in three sections S, S^2, and S^3, to each of which are allotted a certain portion of the incoming circuits, so that calls of the said circuits so apportioned are attended to at such section only, while each of the said sections are also provided with spring-jacks or connecting devices for all the lines entering the central station, so that in a manner well understood a call coming in on any line is responded to at its own terminal section only and can there be connected with any line of the system, including those terminating at or responded to at other sections. Each line is represented by a suitable connection device (in this case a spring-jack) at each section and has an annunciator at its own answering section only.

At each switch-section a suitable key-board is in practice placed with a number of connecting-conductors having at their two ends connecting-plugs, which, when placed in two spring-jacks representing any two lines, act to unite such lines. By means of suitable key devices the operators' telephones at each section can be introduced into the circuit of any plug and cord connector, or alternatively a disconnecting-annunciator can be in like manner introduced. In practice there are also ringing keys associated with each con-

necting-cord, whereby call-signals can be sent over any line to which said cord is attached. In the drawings, for the purpose of avoiding unnecessary complication, the latter instrumentalities are omitted. I have for the same reason shown but a single double-plug-connecting conductor and the operators' telephones at section S only. Two metallic circuits L and L^2 are shown as entering the central station and are supposed to extend outwardly to exchange-stations. The two wires 1 1′ of each pass through the several switch-board sections S S^2 S^3, &c., it being of course understood that as the number of entering lines increases the number of sections must also be increased and include in their circuit at the sections where they are respectively terminated their call-annunciators *a* and a^2.

At each section one of the wires 1 loops and the other wire 1′ branches into a spring-jack, the construction of which I will now explain. The spring-jacks of line L are marked, respectively, J, J^2, and J^3, while those of line L^2 are marked *j*, j^2, and j^3. Each jack is provided with a metal frame or stem B, which supports, but is insulated from, the other working parts, and of which the plug socket or sleeve C for the reception of the plug-connector is either an integral part or electrically connected thereto. This frame by means of an insulating-block *c* supports the jack-springs or movable contacts *s* and s^2 and the anvil or resting contacts *t* and t^2, and each jack thus comprises a frame terminating outwardly in a plug-socket supporting but insulated from two spring or movable contacts, which, when at rest, bear upon two fixed or resting contacts, from which they are separated upon the insertion into the socket of a suitable plug-connector. It is, however, to be noted that while the resting contact *t* is an electrical contact, whereby the circuit entering the jack is continued in the direction of the jack next in succession, its counterpart t^2 is non-electrical, and in this case is merely a mechanical stop for the spring s^2.

Considering first the circuit L, we may trace it through the switch-board as follows: by wire 1 to contact-spring *s* and point *t* at spring-jack J, wire 2, spring *s* and point *t* at the second spring-jack J^2, wire 3, spring-jack J^3, wire 4, call-annunciator *a*, and then out by wire 1′; but from wire 1′ branches 5, 6, and 7, normally discontinuous, extend to the respective springs s^2 of the several jacks J, J^2, and J^3 for the purpose of enabling any double conductor-plug inserted in the said jacks to connect with this side of the metallic circuit as well as the other. In the same way the other circuit L^2 passes successively through its series of spring-jacks *j*, j^2, and j^3, its side *l* looping first through jack *j*, then passing on to wire 8, jack j^2, wire 9, jack j^3, wire 10, annunciator a^2, after which it continues out as wire 1′, which, as in the first case, has branches 11, 12, and 13 to the second spring t^2 of each of its spring-jacks, and the same mode of connection is carried out irrespective of the number of circuits entering the switch-board.

Each metallic circuit has a third wire *w*, which traverses the switch-board and which unites electrically the frames or stems of its several spring-jacks, and which has no other connection whatsoever, and thus the jack-frames B of circuit L are all united by wire *w*, while those of circuit L^2 are all united by wire w^2. This third wire is a part of the busy-test appliance and forms a part of the test-circuit, which, when operated, is capable of being completed by the means I am now about to describe.

At each section is an operator's telephone outfit, which can be looped to any connecting-cord circuit by means of a suitable loop-key *k* for each of the said connecting-circuits.

In the drawings the telephone-loop ends in two contact-springs *f* and f^2, and in practice may be of course branched to any number of such contact-springs to serve other pairs of plugs and their cords.

T is the operator's receiving-telephone, E the transmitter, and I the transmitter induction-coil, which to maintain a balance is divided, the telephone T being interposed between its two portions *i* and i^2. The transmitter E is, as usual, placed in circuit with a local battery *b* and with the primary helices of the induction-coil, and for convenience, if desired, a small circuit-opening switch may be added to the circuit. The primary circuit leading from one pole of the battery passes by wire 16 to the primary helix *d* of one part of the coil i^2, to wire 15, to the primary helix d^2 of the second half of said coil by wire 14, to the transmitter E, and thence by way of the switch *z* to the opposite pole of the battery. From one terminal of the receiving-telephone T a conductor leads by wire 18, secondary helix *e* of one-half *i* of the induction-coil wire 19 to contact-spring *f* of the loop-key *k*, where it is ended, and is when at rest discontinuous. From the other terminal of the said telephone the other conductor of the telephone-loop leads by wire 20 through the helix e^2 of the second half i^2 of the induction-coil and by wire 21 to the opposite contact-spring f^2 of the loop-key *k*. From a point at the center of the telephone-helix, or, if it should have two helices, from a point between them, is extended a wire 17, leading to earth at G.

P and P^2 at each switch-section are plug-connectors, forming the terminals of two flexible conductors 26 and 27. They are adapted to be thrust into the plug-sockets constituting the spring-jack frames, and, as is well understood in the art, when so placed in the spring-jacks of any two lines they serve in conjunction with their connecting-conductors to electrically interconnect the said lines. The plugs P and P^2 have a special construction and have three contact-surfaces all insulated from one another, which respectively make contact with complementary contacts within any spring-jacks into which they may be

thrust. The main-line plug-contacts are the tip-contact p, which is adapted to connect with the back springs s, and thereby with one side of the metallic line-circuit the first stem-contact p^2, which is adapted to connect with the jack-spring s^2, and thereby with the other side of the metallic line-circuit, and upon the insertion of the plug not only are these connections made, but the said springs are, moreover, at the same time lifted from their resting-contacts t and t^2.

I will hereinafter refer to the third plug-contact and its electrical connections. From the tip-contact of plug P the conductor 26 (usually in a flexible cord) extends to the corresponding tip-contact of the other plug P^2 of the pair. From the outermost stem-contact p^2 of plug P the conductor 27 extends to the corresponding stem-contact p^2 of plug P^2. The annunciator h is bridged by wire 23 between these plug-uniting conductors, connecting therewith at the points x and x^2, and it serves to receive signals to disconnect transmitted from exchange-stations. Spring-contacts g and g^2 are suitably mounted within the cam-loop key k in such proximity to the telephone-loop contact-springs f that when the cam is turned down their terminals are just out of connection with each other, but that when the cam is turned into a vertical position they are forced together. These contact-springs g and g^2 are also bridged by wires 24 and 25 between the plug-uniting conductors 26 and 27, so that when the cam is turned up the telephone-loop and telephones are connected across and are brought into communication with the plugs and through them with the spring-jacks and circuits. The third conducting-surface p^3 is also on the plug-stem just behind the surface p^2, and on the insertion of the plug in a jack it connects electrically with the socket C, and thereby with the frame B, and the third wire w uniting the said frame with the frames of the other jacks of the said line. From this conducting-surface p^3 a wire 28 leads to a testing-battery or other electrical source N, the other pole of which connects with the earth.

One testing-battery by suitable connections, as shown, can be made to supply all of the sections, and so far as the test is concerned the wire leading from the center of the telephone-helix of each operator's telephone and that leading from the earth-pole of the testing-battery N, (common to the entire system,) instead of being grounded, may be united to each other.

The operation of the test-circuit is as follows: Line L^2 is in use, the plug P^2 at switch-board section S^3 being inserted in its jack j^3. Suppose it to be called for by some subscriber who is connected with another switch-section, the operator at such section must ascertain first whether line L^2 be at liberty. This is done by first elevating the cam-key k so as to connect the telephone to a particular cord, and then by listening at the said telephone while the plug-socket or jack-frame of the line desired is touched by the tip of one of the plugs with which the telephone is now connected. If the line required be already busy, a click is heard. If it be at liberty, there is silence, for if a plug be in another socket of the desired line at another section, as shown, a local circuit is partly formed for the battery N by way of the earth, battery N, wire 28, plug-contact p^3 on plug P^2 at section S^3, socket and frame B of jack j^3, wire w^2, to socket-frame B of the same line at all other sections, including of course section S. The touching of the socket-frame B of jack j' at section S by the tip of plug P^2, which thus serves as a contact-maker for the local test-circuit, (the telephone being introduced,) completes the said local-battery test-circuit through the telephone-helix or a part thereof by way of plug-tip p, conductor 26, junction-point x, wire 24, key-contacts g and f, wire 19, helix e, wire 18, telephone T, and earth-wire 17 to earth at G, and the establishment of the current of battery N through the telephone necessarily produces a sharp click, which cannot of course appear if the tip of a plug be applied to a jack-frame of a line not in use, and therefore having no connection with battery N. It is evident that this test is equally applicable to central-station switch-boards where mixed circuits—that is to say, both metallic and earth-completed circuits—are operated, and although the test-circuit is perfectly localized and is insulated from the line-circuit at all points, and can therefore be depended upon to give an absolutely trustworthy test, no extra appliances—such as condensers or retardation-coils—are required, and consequently there is no increased complication. It is evident that this busy test can be applied with equal facility to multiple switch-boards in which both sides are branched instead of one or both being looped into the plug-sockets. In the arrangement of Fig. 1, however, there is still one defective feature. Suppose that in a multiple switch-board having a considerable number of sections a connection be made with a given line L by inserting a plug into the spring-jack of said line at some section where there are still a number of spring-jacks beyond. For illustration, we may instance section S of Fig. 1; but the side l' of L does not loop. It branches into the spring-jacks. It is evident that, though the insertion of a plug into a jack—say J—actually breaks the circuit on one side l between s and t, it cannot break the circuit on the other side l', and we then find this condition, that the metallic circuit L, by its two conductors 1 and 1′, is united through the two plug-conductors with some other similar line, but that one side of it 1′ has a single-wire extension projecting from it at the point 5 and extending from the said point by wire 1′ through all remaining sections and annunciator a and then back through all the jack-contacts of its own line, finally ending discontinuously at the point t of the jack in which the plug is in-

serted. As this extension lies closely packed among the wires of other circuits, its electrostatic capacity is high and it introduces inductive disturbance to its own circuit, adjacent circuits acting inductively thereon. To remedy this I arrange the spring-jacks, as shown in Fig. 2, to cut off both inwardly-direct extensions when a connection is made by a plug. The loop-key and testing-circuit, including the third wire *w*, uniting the spring-jack frames, remains unchanged. The elements also of the several spring-jacks remain unchanged; but the mode in which the connections of the jack are arranged with respect to the two wires of the metallic circuit main line is made to differ, and both wires now lead through separable electric contacts in each jack. The circuit L, for example, leads by its wire 1 through each jack J of its series, passing in each from the contact-spring *s* to the fixed contact *t*, and after reaching the final section of the board and passing through its annunciator *a* its wire 1′ is retraced in reverse order through the jacks, passing in each from the fixed contact *t′* to the spring-contact *s′*, so that its route is from 1 to *s*, jack J to the fixed contact *t*, then by wire 2 to jack J^2, through spring *s*, fixed contact *t*, wire 3, jack J^3, through spring *s*, and fixed contact *t*, then to wire 4, annunciator *a*, wire 5, fixed contact t^2, and spring s^2 at jack J^3, wire 6, fixed contact t^2, and spring s^2 at jack J^2, wire 7, fixed contact t^2, and spring s^2 of jack J, and thus to wire 1′. The other circuits are similarly connected. It will be observed that returning through the switch-board the circuit passes in every case from the fixed to the movable contact. With this construction whenever a connecting-plug is introduced into the circuit its tip-conductor *p* makes contact with the inner spring-contact *s* or s^2, while the first stem contact-piece p^2 connects with the longer spring *s* or s^2, both spring-contacts being simultaneously disconnected from their resting contacts *t*, whereby the jacks of all sections in an inward direction through the switch-board are cut off or entirely disconnected on both sides of the circuit, the line out connecting by both conductors to the plug-conductors and having both of its conductors open immediately beyond, so that any disturbance which may tend to be set up in the cut-off portion by static induction is in any event prevented from reaching the main-line talking-circuit and is therefore harmless. Switch-board cross-talk is in this way totally prevented.

I claim as my invention—

1. A busy-test system for metallic-circuit multiple switch-boards, consisting in a series of metal spring-jack frames or plug-sockets for each circuit, supporting but insulated from spring contacts or terminals representing the conductors of said circuit, an independent conductor for each circuit extending between the several spring-jacks of said circuit and uniting electrically the insulated metal frames thereof, plug-connectors adapted to be inserted in the said plug-sockets and each provided with independent insulated contact-pieces at its tip and stem arranged to connect with the circuit-terminals, a third contact-piece arranged to connect with the plug-socket frames, a testing-battery having one of its poles in permanent connection with the said third contact-piece, and a telephone or similar testing-instrument detachably connected in circuit with the said tip contact-piece and with the return-conductor of said battery, substantially as described.

2. In a metallic-circuit multiple-switch-board busy-test apparatus, the combination of a series of triple-contact connection devices for each main metallic circuit, one at each section of the said switch-board, two of the said contacts being terminals, respectively, of the two conductors of the said metallic circuit, and the third of all of the said series being electrically united to form together part of a local test-circuit normally open at two points, the said three contacts being in each device insulated from one another, a test-battery included in said normally-open local circuit, conducting devices in pairs, substantially as indicated herein, for uniting at any switch-board section the two main-conductor terminal contacts of one of the said connection devices with those of any other and for simultaneously closing the said local test-circuit at one point, and a telephone at each switch-section connected by one of its terminals with the said local circuit and provided at its other terminal with a contact-maker whereby the local test-circuit may be closed at its second normally-open point through the said telephone and be enabled to give a busy-test signal therein at a switch-section differing from that where it was first closed, for the purposes specified.

3. In a metallic-circuit multiple switch-board, two conductors extending from section to section of said board to constitute the direct and return conductors of a metallic main circuit and both provided at each section with connection terminals whereby they may be united to other circuits, a third conductor for each metallic circuit extending also between the sections of said switch-board and uniting a series of independent terminals insulated from but closely associated with the said pairs of line-terminals, metallic-circuit plug and cord conductors at each switch-board section for connecting the terminals of any two circuits, a contact-surface on each plug adapted to connect with the independent switch-board terminals when the said plug is employed to effect a line connection, a third conductor in each plug-cord connecting the same with one pole of a test-battery, and a telephone bridged between the two main conductors connecting any two plugs and connected also with the return-conductor of said battery, substantially as described.

4. The combination of a multiple switch-

board, terminal contacts at the sections of said switch-board for the incoming metallic line-circuits, connectors or plugs in pairs having contacts and conducting-wires for uniting two line-circuits, a separate wire for each metalllic circuit connecting the several sections of the switch-board, and a corresponding test-circuit having terminal contacts at said connectors or plugs, substantially as and for the purpose described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 8th day of August, A. D. 1891.

FRANK A. PICKERNELL.

Witnesses:
T. W. DUNBAR,
C. J. PICKERNELL.