(No Model.)

5 Sheets—Sheet 1.

P. MINNIS.

SWITCHBOARD FOR TELEPHONE SYSTEMS.

No. 561,419. Patented June 2, 1896.

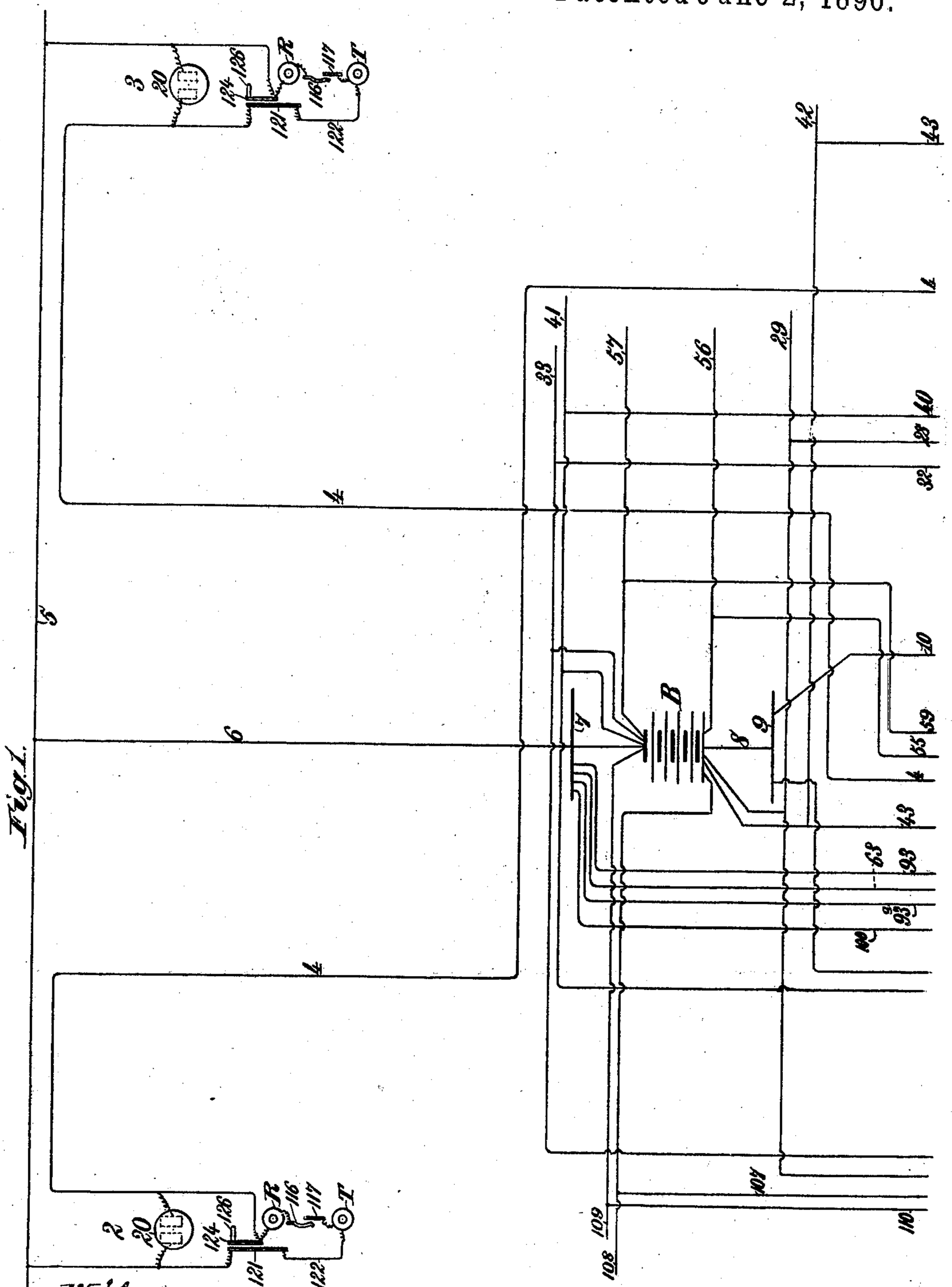

Fig. 1.

Witnesses.
Robt Everett.
Geo. H. Rea.

Inventor.
Paul Minnis
By James L. Norris.
Atty.

(No Model.) 5 Sheets—Sheet 2.

P. MINNIS.

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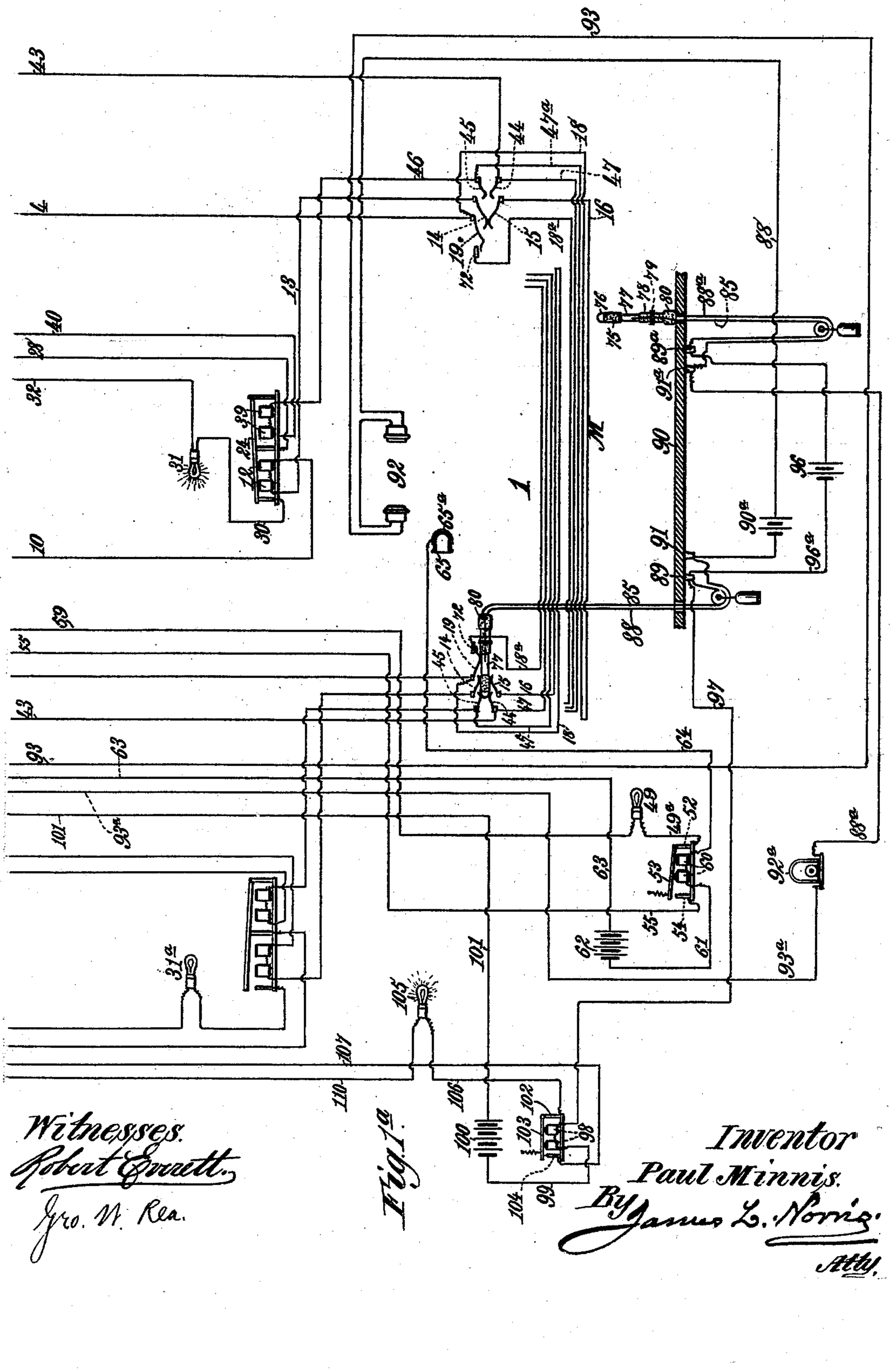

Witnesses.
Robert Ewett.
Jno. N. Rea.

Fig. 1a.

Inventor
Paul Minnis.
By James L. Norris.
Atty.

(No Model.)

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P. MINNIS.

SWITCHBOARD FOR TELEPHONE SYSTEMS.

No. 561,419. Patented June 2, 1896.

Fig. 3.

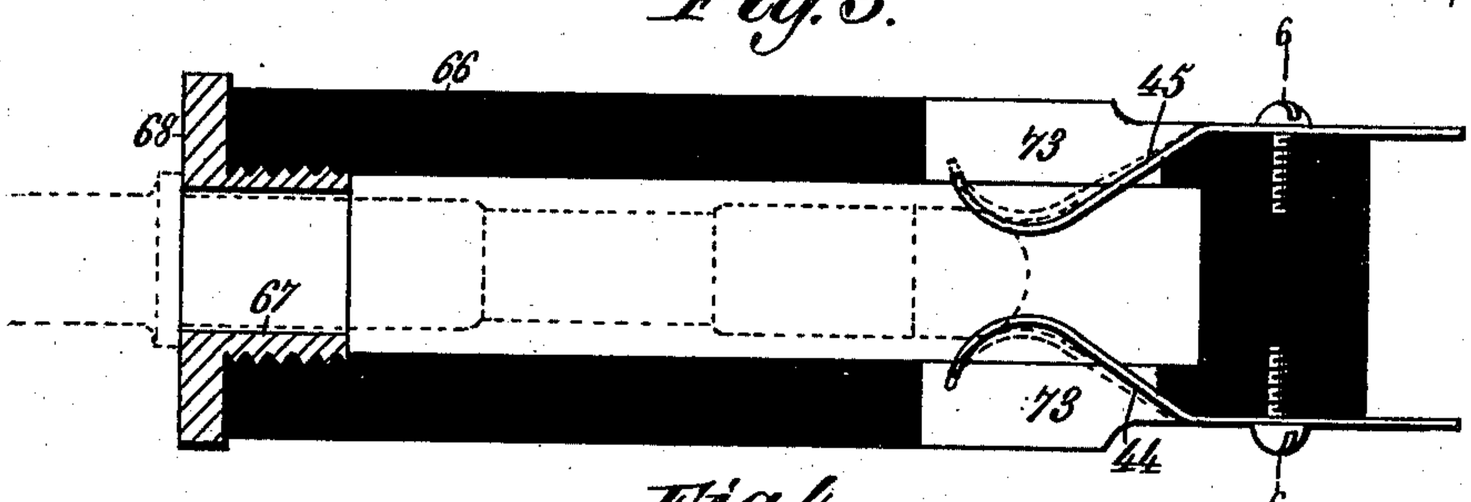


Fig. 4.

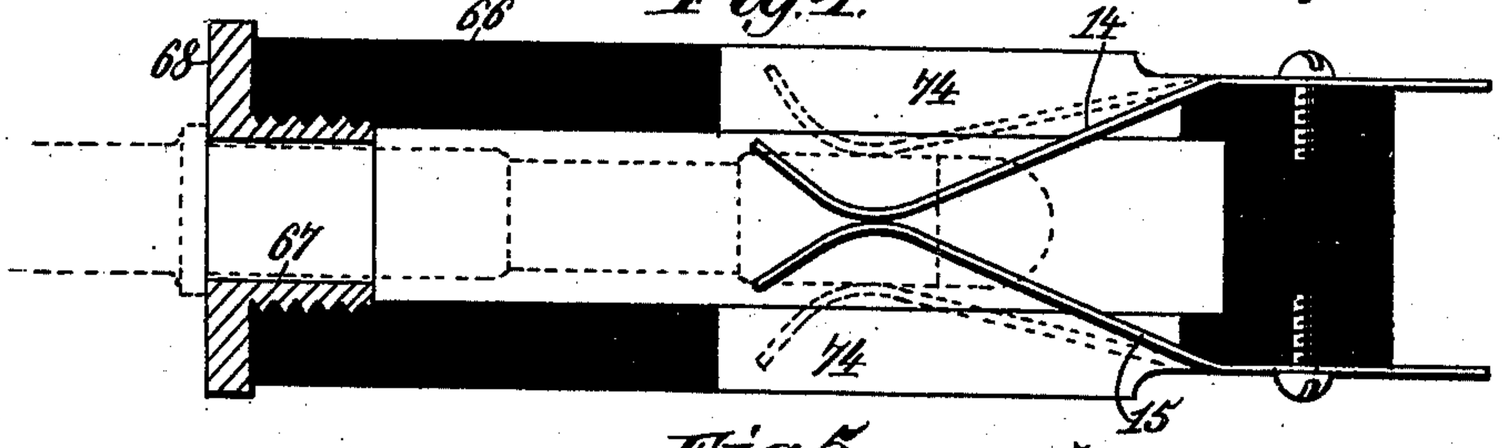


Fig. 5.

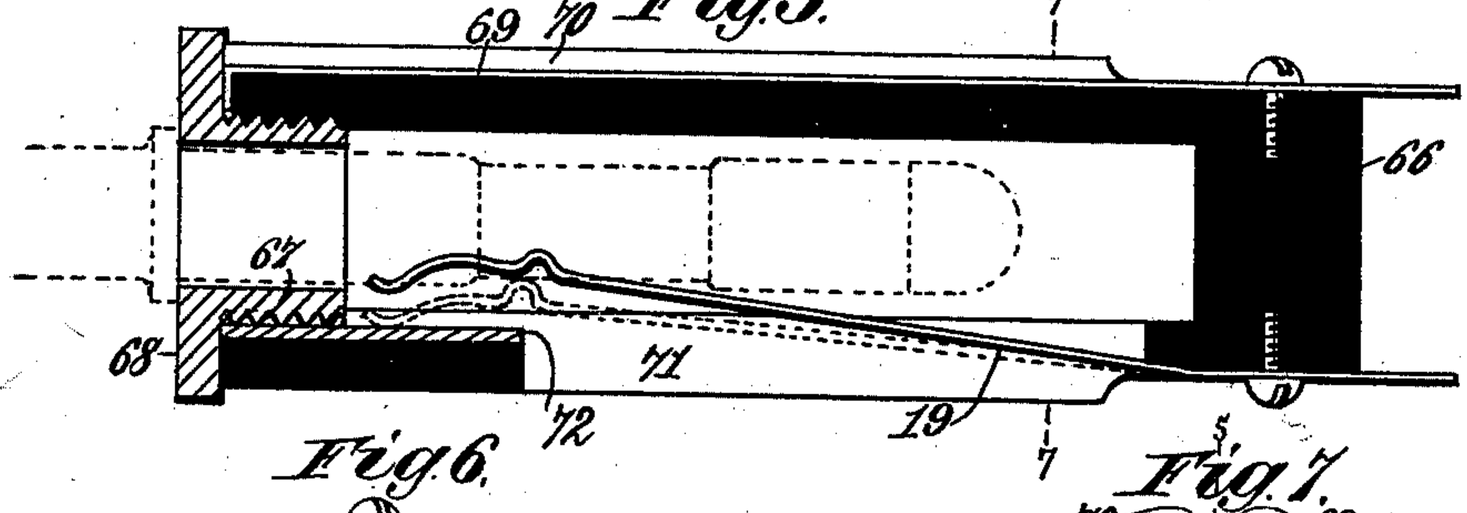
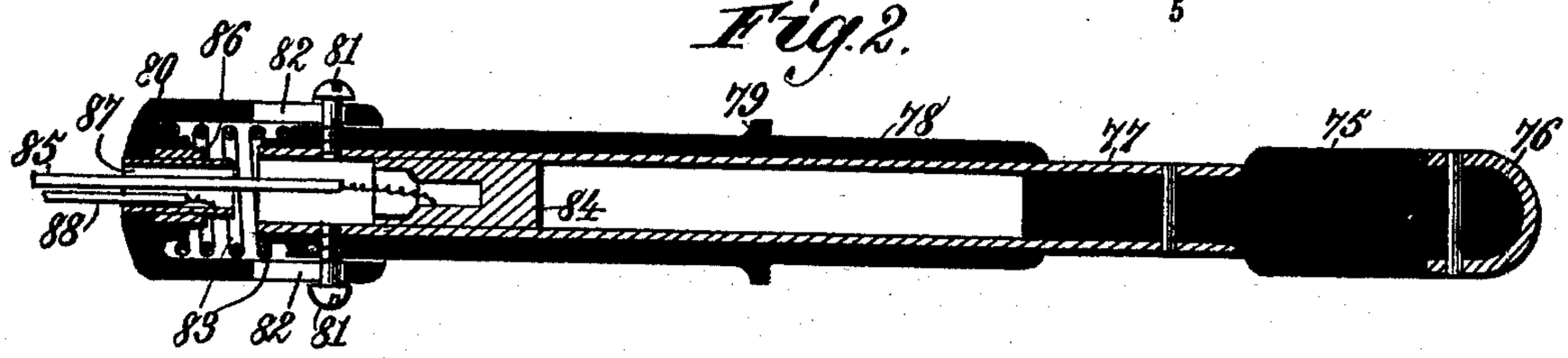


Fig. 6.

Fig. 7.

Fig. 2.



Witnesses.
Robt Everett.
Geo. W. Rea.

Inventor.
Paul Minnis.
By James L. Norris.
Atty.

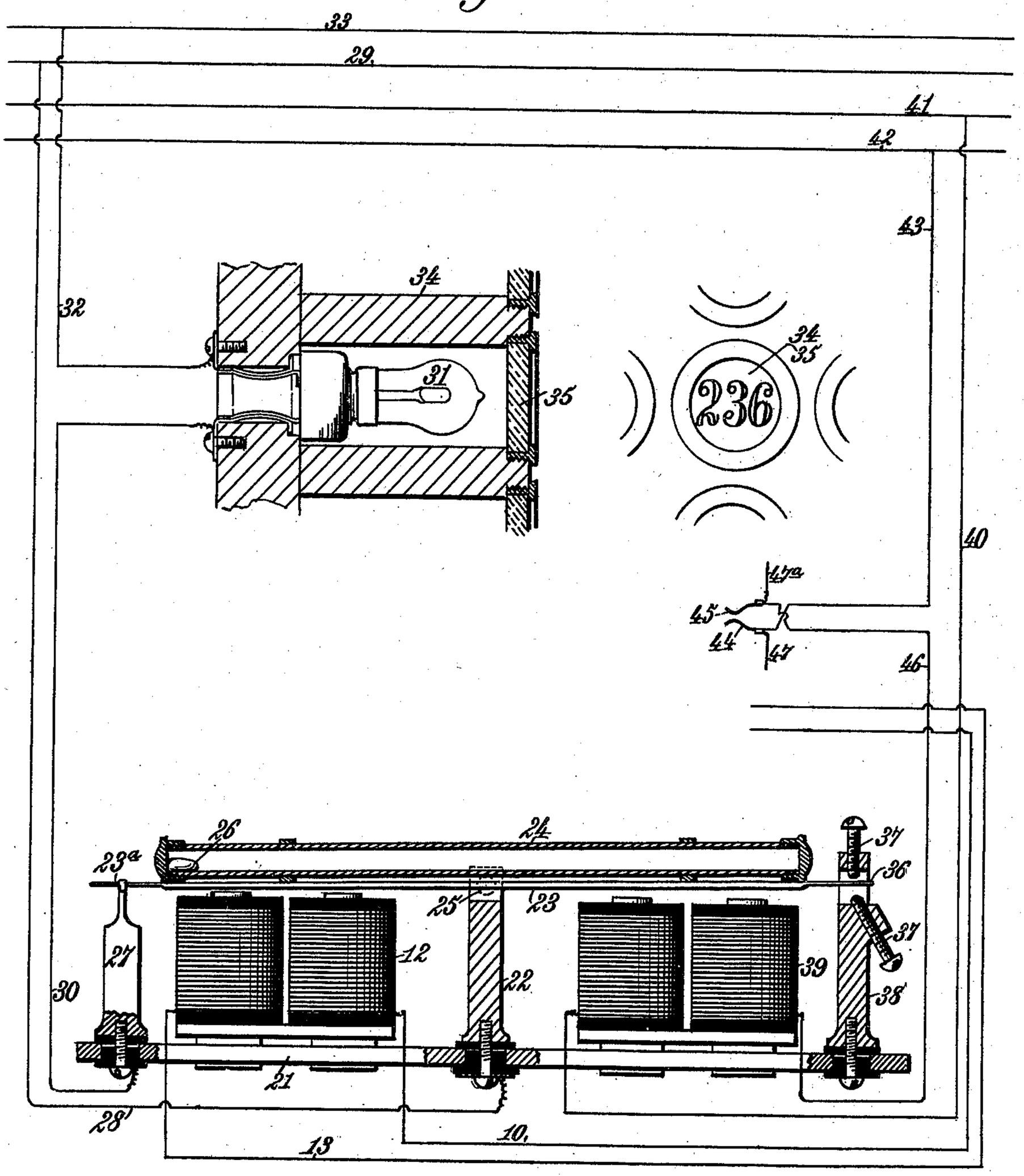
(No Model.) 5 Sheets—Sheet 4.

P. MINNIS.

SWITCHBOARD FOR TELEPHONE SYSTEMS.

No. 561,419. Patented June 2, 1896.

Fig. 8.



Witnesses.
Robert Everett.
Geo. W. Rea.

Inventor.
Paul Minnis.
By James L. Norris.
Atty.

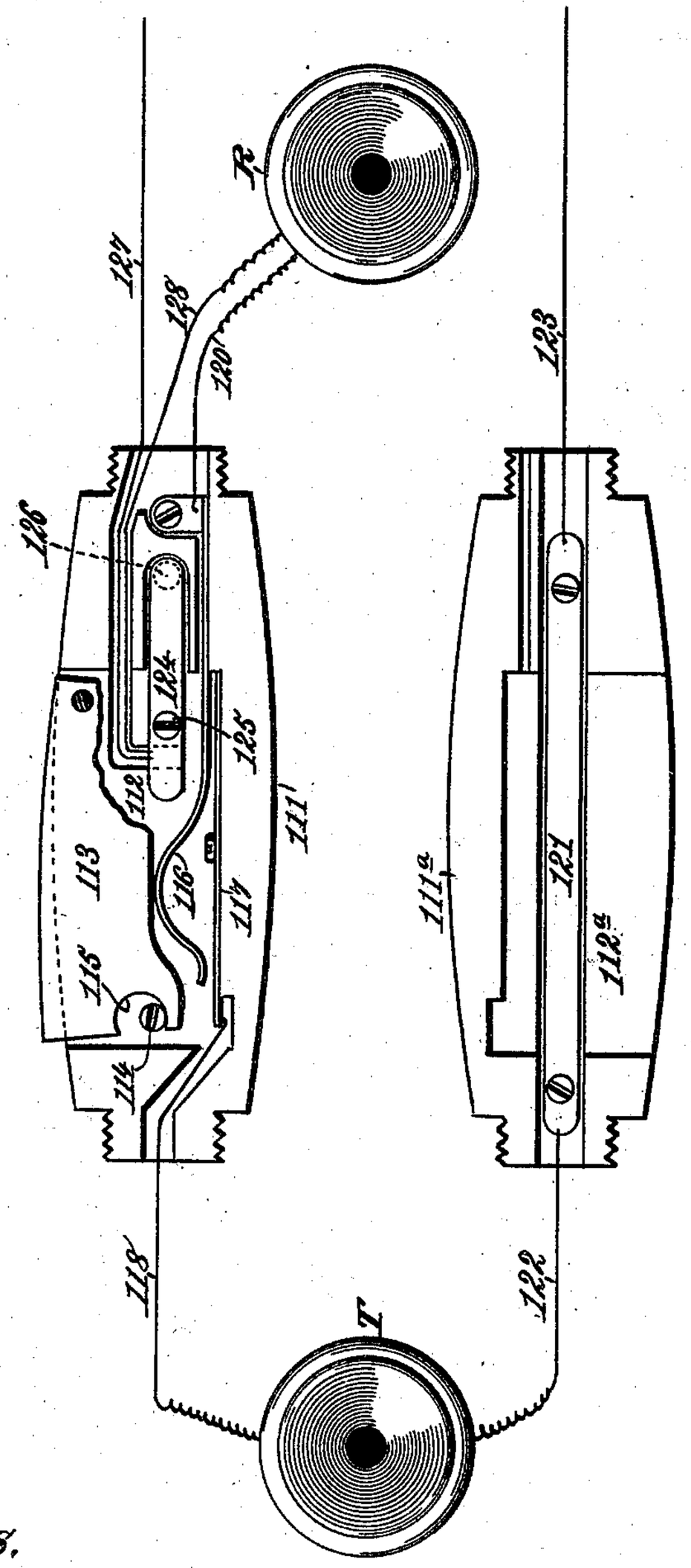
(No Model.) 5 Sheets—Sheet 5.

P. MINNIS.

SWITCHBOARD FOR TELEPHONE SYSTEMS.

No. 561,419. Patented June 2, 1896.

Fig. 9.



Witnesses.
Robt Ewett.
Geo. W. Rea.

Inventor
Paul Minnis.
By James L. Norris.
Atty.

UNITED STATES PATENT OFFICE.

PAUL MINNIS, OF MOBILE, ALABAMA, ASSIGNOR OF ONE-HALF TO THE HOME TELEPHONE COMPANY, OF SAME PLACE.

SWITCHBOARD FOR TELEPHONE SYSTEMS.

SPECIFICATION forming part of Letters Patent No. 561,419, dated June 2, 1896.

Application filed February 17, 1896. Serial No. 579,647. (No model.)

To all whom it may concern:

Be it known that I, PAUL MINNIS, a citizen of the United States, residing at Mobile, in the county of Mobile and State of Alabama, have invented new and useful Improvements in Switchboards for Telephone Systems, of which the following is a specification.

My invention relates to switchboards for telephone systems, my purpose being as follows: First, to so arrange and improve the apparatus and the circuits that the work of a central telephone-station shall be materially abridged, more rapidly and easily performed, greater accuracy secured, and confusion and uncertainty removed in a marked degree; second, to provide a system of call-circuits, electric-lamp circuits, and switch-operating devices to cut the lamp-circuits in and out, each lamp being placed in a call-box having a numeral or other character denoting one of the line-stations, the station thus indicated being comprised in a call-circuit which is completed through the switch-operating device which cuts the lamp in the call-box into circuit and through a switch at the line-station which is normally open, whereby a subscriber can call the central station by merely closing the open switch, without resorting to a magneto call-generator, the ignition of the lamp giving notice to the central station by illuminating a numeral or character on a transparent wall of the call-box; third, it is one purpose of my said invention to provide automatic means for giving notice to the central station of the cessation of communication between any two line-stations, such notice being the equivalent of the "ring-off" now practiced in other systems, but differing therefrom in being automatically accomplished by merely releasing the hand-telephone, which permits the switch to open the lamp-circuit and extinguish the lamp in the call-box, thus rendering it unnecessary for the person using the telephone to ring-off or perform any other act except to remove the hand from the instrument; fourth, it is my object to provide means whereby any operator at a central station can ascertain in an instant whether a wire over which communication is desired is in use.

My invention also comprises other novel features, all of which will be fully explained hereinafter, and then particularly pointed out and defined in the claims which terminate this specification.

To enable those skilled in the art to which my said invention relates to clearly understand and to practice the same, I will proceed to describe said invention in detail, reference being had for this purpose to the accompanying drawings, in which—

Figures 1 and 1ª constitute a diagram showing the arrangement of circuits at a central station and between the latter and two line-stations. Fig. 2 is a central longitudinal section of one of the plugs used in connecting the service-wires of two line-stations through the line-jacks of the switchboard. Fig. 3 is a view in longitudinal section of one of the line-jacks of the switchboard. Fig. 4 is a sectional view of the same, the section plane being indicated by the dotted line 4 4 in Fig. 7. Fig. 5 is a further sectional view of the same, the section plane being denoted by the line 5 5, Fig. 7. Fig. 6 is a transverse section upon the line 6 6 in Fig. 3. Fig. 7 is a cross-section upon the line 7 7 in Fig. 5. Fig. 8 is a sectional view showing the electrically-operated switch for closing and opening one of the lamp-circuits, this view also including a diagram of the two circuits for lighting and extinguishing the lamp and a circuit for the latter. Fig. 9 is a sectional view of the telephone used at the line-stations, showing the switch which completes the call-circuit, the figure being in two parts.

The reference-numeral 1 in said drawings indicates generally the central station of a telephone system, and the numerals 2 and 3 denote two of the line-stations, the station apparatus, comprising the station-call and the parts of the telephone, being shown conventionally in Fig. 1. It should be stated that the system of circuits in which each line-station is connected by an independent service-wire to the central station and to a return-wire common to all the stations and to a single main battery or source of electric generation is the same, substantially, as that set forth in an application filed by me of even date for a system of telephonic communication, said case bearing Serial No. 579,647. The line-station apparatus also, as

well as the switch-operating device, the plug, and the line-jack and plug combined, are all subjects of separate applications of even date, and I make no claim in this case to any of these parts separately. Being essential to my present invention, they are described in connection with it, but are claimed only in those combinations in which the present invention is included.

Each line-station is connected by a service-wire 4 to the central-station switchboard in the manner described hereinafter. The same wire also makes connection with a single return-wire 5 of such diameter as to equalize the aggregate resistance of the service-wires. This return-wire forms part of the path traversed by the currents from all the service-wires. It is not connected to earth at any point, and there is no "ground" upon any service-wire, so that I provide a complete metallic circuit for every line-station which is without earth connection.

The return-wire 5 is connected by a tap-wire 6 to one pole of a single main battery or source of electric energy B. This tap-wire also connects electrically with a spread terminal 7, which lies between the return-wire and the main battery. The other pole of said battery B is connected by a wire 8 to a second spread terminal 9. From this spread terminal a wire 10 is carried to the first terminal of the helices of a pair of electromagnets 12, and from the second terminal a wire 13 is led to one of the line-jacks of the switchboard at the central station, which has two closed spring-contacts 14 and 15, to the former of which said wire 13 is connected. From the other spring-contact, 15, a wire 16 goes to the multiples M of the switchboard, and from these multiples a wire 18 is carried to a single spring-contact 19, which is in the same line-jack with the closed contacts 14 and 15. From the single contact 19 the service-wire 4 is led to line-station 2, where it forms a loop having two branches between which the bell-coils 20 are placed in bridging connection. Beyond these coils the transmitter T and receiver R are connected in series, and from these parts of the telephone one branch of the loop is led to the return-wire 5. The circuit, which includes the service-wire 4, single contact 19, wire 18, multiples M, wire 16, closed contacts 14 and 15, wire 13, electromagnets 12, wire 10, spread terminal 9, wire 8, battery B, tap-wire 6, and common return-wire 5, is normally complete at every point except at the line-station, where a switch (shown conventionally in Fig. 1) is placed in the handle supporting the receiver and transmitter, as shown in Figs. 9 and 10 and explained in detail hereinafter. This switch is normally open, and by closing it the person using the telephone is able to send a current from the battery B over the circuit last described. The action of this current is as follows:

The electromagnets 12 are arranged at the central station in convenient proximity to the switchboard and in full sight of the operators. There are a pair of these magnets for each line-station, the circuit in each being similar to that already described. By reference to Fig. 8 it will be seen that the pair of electromagnets 12 are mounted upon a base 21, from which they are insulated. Rising from this base is a post 22 of conducting material, on which is accurately balanced an armature 23. Upon this armature is mounted a small glass tube 24, which is also in equilibrium so far as regards an equal apportionment of its weight upon both sides of the fulcrum 25, on which the armature is balanced. Within the tube, which is closed at both ends, is placed a globule of mercury 26, which is free to run from end to end of the tube when the latter is inclined even slightly. Mercury is the only substance suitable for this purpose, as it will move on a very slight inclination and with great swiftness, so that an instantaneous tip of the armature will be sufficient to enable the mercury to travel past the center and depress the end toward which it moves. The armature 23 forms part of the derived circuit, the extremity which is adjacent to the magnets 12 being prolonged to form a contact 23^a, which rests upon the end of a second post 27. The wires 10 and 13 go, as already stated, to the terminals of the magnets 12. From the post 22 a wire 28 is led to a feeder 29 and from the post 27 a wire 30 is led to one terminal of a small incandescent lamp 31. From the second terminal of the lamp a wire 32 goes to a second feeder 33. These feeders are connected, respectively, to the opposite poles of the main battery B and are open or without circuit, except through the multiple-arc connections to the lamp 31 and through similar connections to a lamp 31^a, identified with line-station 3. Each of these lamps is inclosed in a small box or housing 34, having a transparent wall 35, on which is displayed a number or character denoting the line-station identified with that lamp. Thus by merely closing the switch at the line-station the lamp-circuit is established and maintained after the switch is released by the armature 23, overbalanced on one side by the mercury globule 26. The means for cutting out the lamp-circuit will be explained in due course.

The end of the armature 23 opposite that forming the contact 23^a has a prolongation 36, which lies between two stops 37, both of which are adjustable in a post 38 upon the base 21. This post is insulated and forms no part of any electrical circuit. Beneath the adjacent end of the armature 23 is a pair of electromagnets 39, insulated on the base and similar in all respects to the magnets 12. The first terminal of the magnets 39 is connected by a wire 40 to a wire 41, which is led to one pole of the main battery B. From the other pole of said battery the circuit of the magnets 39 is by way of a wire 42 to a wire 43, and by the latter to a spring-contact 44, one

of a pair arranged in the same line-jack with the contacts 14 and 15. The second contact of the pair, denoted by the numeral 45, is arranged over the contact 44, but not in touch with it. From this second spring-contact a wire 46 goes to the second terminal of the magnets 39. When the operator at the central station answers a call and inserts the plug on one end of the flexible cord in the line-jack in the manner shown in Figs. 3, 4, and 5, the conducting-cap upon the end of the plug engages the two contacts 44 and 45 and closes the circuit, which includes the helices of the electromagnets 39. This attracts the corresponding end of the armature 23, drawing it down and causing the mercury globule to run to that end of the glass tube 24, thus maintaining the armature in the position it is caused to assume by the attraction of the magnets 39. The rise of the terminal-contact 23^a breaks the circuit of the lamp 31 and extinguishes it, its ignition being the call-signal by which the central station was notified that line-station No. 2 desired to communicate with another station. Wires 47 go from the contact 44 to the multiples of the switchboard, as shown conventionally in Fig. 1, these connections being so familiar as to require no description.

It is well known that in every central station of a telephone system comprising an average number of subscribers' or line stations, or in systems serving even less than an average number, the switchboard is divided into parts, each containing as many separate connections as can be served by a single attendant, and containing, moreover, multiples or duplicates of all the remaining connections. I may mention, though it may be unnecessary, that one purpose of these duplicate connections in each of the divisions or panels of the switchboard is to enable any one of the operators to connect a line-station served by that operator with any one of the line-stations served by an operator having charge of another division or panel, and to be able, moreover, to ascertain easily, accurately, and instantaneously whether the line-station with which communication is desired is already using the service-wire which connects that station to the switchboard. It is one of the special purposes of my present invention to provide means for accomplishing this with absolute certainty with the minimum expenditure of time, care, and effort or manual action on the part of the operators at the switchboard, and without the necessity of addressing a question to either line-station and awaiting a reply. The means I provide for this purpose are as follows: At the central station, in convenient proximity to the switchboard, so that the attendants can readily see the same without changing their position, I arrange a series of small lamps 49, each identified with one of the panels of the switchboard. Each lamp has its own independent circuit, which is closed and opened in the manner I am about to describe. One lamp-terminal is connected by a wire 49^a to a post 52, which forms a support for the armature 53 of a pair of electromagnets, which are arranged, when energized, to attract the armature, which is normally raised by a spring or any other means suitable for the purpose. When attracted, the prolonged end of the armature is brought into contact with the post 54, and from said post 54 a wire 55 is led to a feeder 56. This feeder goes to one pole of the main battery B and the other pole of said battery is connected to a second feeder 57. From the latter a wire 59 is led to the second terminal of the lamp.

The magnets acting upon the armature 53 are denoted in Fig. 1^a by the numeral 60. The circuit by means of which they are energized is as follows: From one terminal of the helices of said magnets 60 a wire 61 goes directly to one pole of a battery 62. From the other pole a wire 63 goes to the spread terminal 7, from which point the circuit is by the tap-wire 6, return-wire 5, to the line-station. Here if the line is closed the current passes through the telephone and over the service-wire 4 to the single contact 19 in the line-jack. Thence, a plug being inserted in the jack, the path of the current is through contact-piece 72, bushing 67, face-plate 68, conducting-strip 69 of the jack, and thence on by a wire 18^a to the corresponding multiples M and to their respective face-plates 68 through their respective contact-strips 69. The circuit is completed by a wire 64 from the second terminal of the electromagnets 60 to a test-thimble 65. This thimble is in form a device corresponding with its name, being worn by the operator upon one finger. It is made of some insulating material and has a metal tip 65^a, to which wire 64 is attached. The pressure of this metal tip 65^a against the face-plate 68 of any line or multiple jack that is in use closes the test-circuit, energizes the electromagnet 60, attracting the armature 53, and drawing it into contact with the post 54, thus closing the circuit of the lamp 49, by the ignition of which the operator is notified that the service-wire thus tested is in use. Should the line be idle, the test-circuit will be open between single contact 19 and contact-piece 72 in the line-jack and all of its multiples, and it being therefore impossibe for the operator to close the test-circuit by establishing the contact between the metal tip 65^a of the test-thimble 65 and the face-plate 68 of the corresponding jack in front of the operator the failure of the lamp 49 to burn indicates that the line tested is free for use. To make the use of this testing device clear, I will now refer to the construction of the line-jacks and the plugs used therein.

Figs. 3 to 7 show one of the line-jacks, and Fig. 2 one of the plugs. Each of the line-jacks has a non-conducting body 66, containing the opening for the insertion of the plug. At its mouth this opening has a bushing 67 and face-plate 68 of conducting metal. A conducting-

strip 69 connects at one end with the face-plate and extends to or a little beyond the rearward end of the non-conducting body 66, lying for the greater portion of its length in a channel 70, formed in the non-conducting material. Diametrically opposite this strip 66 the single spring-contact 19 is arranged, secured near one end to the outside rearward part of the jack, its forwardly-projecting portion lying in a longitudinally-formed slot 71, its free extremity extending beyond the slot and lying inside the end of the bushing 67, and normally separated from a contact-piece 72, which connects electrically with the bushing 67 and face-plate 68.

Upon the rearward end of the line-jack are mounted the two spring-contacts 44 and 45, diametrically opposite each other. Their free ends approach each other, but do not meet, their points projecting forward or toward the mouth of the jack and being curved to diverge, as shown in Fig. 3. These contacts are attached to the exterior faces of the non-conducting body 66, and their forwardly-projecting portions pass into slots 73, in order to enter the opening for the plug. Upon the same part of the non-conducting body are mounted in a similar manner the contacts 14 and 15, which pass into and through slots 74, their forwardly-projecting ends meeting in the center of the opening. The points of the contacts are bent away from each other or diverged to enable the end or the plug to enter between and separate them. For convenience in mounting these contacts the rear end of the jack may be hexagonal, as shown in Fig. 6, and the opposite contacts are separated from adjacent contacts by arcs measuring about sixty degrees upon the cylindrical surface of the jack.

The wires 43 and 46 are connected to the contacts 44 and 45, respectively. From contacts 44 and 45 are carried wires 47 and 47^a, respectively, to the corresponding contacts of the corresponding multiple jacks of the switchboard. Wire 13 is connected to contact 14, and from opposing contact 15 is carried wire 16 through the contacts of the corresponding multiple jacks of the switchboard corresponding to the contacts 14 and 15 of the corresponding line-jacks. Wire 4 is connected to contact 19, from which is carried wire 18 to the corresponding contacts of the coresponding multiple jacks of the switchboard. From contact-strip 69 is carried wire 18^a to the corresponding contact-strips of the corresponding multiple jacks of the switchboard. Beyond the last corresponding multiple jack of the switchboard wires 16 and 18 are connected together, while the ends of wires 47, 47^a, and 18^a are left free and are tapped or otherwise insulated to prevent any short circuit with other wires or parts of the switchboard. Wires 16, 18, 18^a, 47, and 47^a are designated and known as the "multiple" wires of the switchboard, wire 16 being the "annunciator-multiple," wire 18 the "line-multiple," wire 18^a the "test-multiple," and wires 47 and 47^a the "first" and "second" restoring-multiples.

The plug shown in Fig. 2 has a point 75 of non-conducting material, its tip being covered by a cap 76 of conducting material. The reduced portion of the point enters a tubular body 77, between the end of which and the thimble 76 the enlarged non-conducting portion of the point is exposed. A non-conducting sleeve 78 incloses most of the tubular body, and between the end of said sleeve and the exposed part of the non-conducting point a portion of the conducting body 77 is exposed. A collar 79 is formed on the exterior of the sleeve 78 to limit the insertion in the line-jack, this collar being placed at such a point that when it abuts on the face-plate 68 the conducting-cap 76 will engage the ends of contacts 44 and 45, while the contacts 14 and 15 will be separated and will rest upon the exposed non-conducting portion of the point 75, as seen in Figs. 3 and 4. The single contact 19 will at the same time rest against the exposed portion of the conducting tubular body 77, the point of said contact being forced against the contact-strip 72, as shown in Fig. 5 in dotted lines.

Upon the open end of the sleeve is placed a cap 80, formed of insulating material and connected by screws 81, which pass through slots 82 in the cap and are tapped into the sleeve 78 and tubular body 77. A spring 83, coiled between the end of the sleeve and the closed end of the cap, holds the latter normally in the position shown in Fig. 2, permitting the cap, however, to be moved toward the open end of the sleeve by pressure.

In the tubular conducting-body 77 is a core 84 of conducting material, which is connected to a wire 96^a. In the center of the cap 80 is inserted a ring 86 of conducting metal, having a diameter equal to that of the tubular body, with which it is substantially concentric. Within this ring lies a cylindrical bushing 87, which projects a little inside the cap and enters the tubular body 77 when the cap 80 is pushed up. The wire 85 enters through this bushing, and a second wire 88 is connected to the ring 86. These two wires are contained in one part of the divided flexible cord shown in Fig. 1. From binding-post 89 wire 96^a goes to one pole of battery 96 and from the other pole of this battery onto binding-post 89^a, and thence on through the other part of the divided cord to core 84 of the other plug of the pair. In said figure the wire 85 goes to a binding-post 89 on the apron 90. In the first plug of the pair wire 88 goes to a binding-post 91, and thence to the head-phone 92 of the operator at the central station. From the head-phone a wire 93 returns and goes to the spread terminal 7. In the other plug of the pair the wire 88^a goes to binding-post 91^a, and thence to one pole of a magneto-generator 92^a, from the other pole of which wire 93^a goes to the spread terminal 7.

If station 2 is talking, and if a call comes

to another panel of the switchboard to connect said station 2 with the person calling, the operator, who knows nothing about station 2 except through the multiples of the board, must first ascertain if the service-wire from station 2 is in use. To do this, the metal tip 65ª of thimble 65 is pressed against the face-plate 68 of the jack corresponding to line-station 2. A circuit is thus completed over the following path: beginning at face-plate 68, through contact-strip 69, test-multiple 18ª, to the contact-strip 69 of the corresponding jack in use at the time by line-station 2, through the face-plate 68, bushing 67, contact-piece 72, and line-contact 19 of that jack, and thence on over service-wire 4 to line-station 2, through the two branches of the loop in service-wire 4 at that station, over return-wire 5, tap-wire 6, to spread terminal 7, thence on by wire 63 to one pole of battery 62, from the other pole of battery 62 to one terminal of electromagnet 60, and from the other terminal of electromagnet 60, over wire 64, back to metal tip 65ª of thimble 65. The circuit of the electromagnet 60 being thus completed, armature 53 is drawn by it into contact with post 54, thus closing the circuit of lamp 49, the ignition of this lamp notifying the testing operator that the wire is in use at the line-station 2.

The two parts of each flexible cord at the central station are connected, respectively, to the opposite poles of a battery 96, which I term a "talking-battery." The poles of this battery are connected to the wires 85 and 85ª, respectively, in the two parts of the cord, so that when the plugs are inserted to put the line-stations in communication the circuit beginning at one pole of battery 96 will be by way of a wire 96ª to binding-post 89, wire 85 to binding-post 89, thence on to the first plug of the pair, thence through its conducting-body 77, line-contact 19 of the jacks, service-wire 4, to the line-station corresponding to that service-wire and through the two portions of the loop of the service-wire 4 and the telephone therein to the return-wire 5, thence along return-wire 5 to the line-station of the service-wire corresponding to the jack into which the plug of the other part of the flexible cord is inserted, over the two portions of the loop of this second service-wire and the telephone therein, and on over this second service-wire to its corresponding jack in the switchboard at the central station, over contact 19 of said jack to conducting-body 77 of the inserted plug, and thence by wire 85ª to binding-post 89ª, and on to the other pole of battery 96.

The operator's head-phone 92 is connected by wire 88 in one part of the flexible cord and wire 93 between the cylindrical bushing 87 of the cap 80 of one of the plugs and spread terminal 7. The magneto-generator 92ª is similarly connected between cylindrical bushing 87 of the cap 80 of the other of the plugs and spread terminal 7 by wires 88ª and 93ª, respectively.

I have the two plugs made in two colors, all those to which the head-phone circuit is connected being of one color and commonly designated as the "first plug" of the pair, and all the plugs to which the magneto-generator circuit is connected being of another color and commonly designated as the "second plug" of the pair. The circuits for the head-phone and the magneto-generator, respectively, are normally open in the caps of their respective plugs between the cylindrical bushing 87 in the cap 80 and the conducting-body 77 of the plug. When a subscriber calls the central office, the force necessary to insert the plug in that subscriber's jack telescopes the cap 80 on the body 78 of the plug, closing the contact between the cylindrical bushing 87 of the cap and the conducting-body 77 of the plug, thus completing the circuit of the operator's head-phone 92 over the conducting-body 77 of the plug, contact 19 of the jack, the service-wire to the line-station, over the two portions of the loop in the service-wire at the line-station, return-wire 5, tap-wire 6, spread terminal 7, wire 93, to the head-phone, thence on by wire 88 to one pole of battery 90ª, and on from the other pole of battery 90ª to binding-post 91, and from binding-post 91 back to cylindrical bushing 87 of the cap 80. The talking-battery for the operator's head-phone (designated as 90ª) is placed in series with the wire 88 after it leaves the binding-post 91, all of the binding-posts 91 on each panel of the switchboard being connected by a common strip for that panel and being conducted on from that strip by a single wire 88, the same being common to all the independent wires 88, one in each of the portions of the flexible cords connected to the first plugs of that panel of the switchboard. By the term "operator's head-phone" I mean both the receiver and transmitter, as shown in Fig. 1. The operator's head-phone being brought into connection with the calling-subscriber's station automatically, as just described, the operator can promptly ascertain the wants of that subscriber. Should the calling subscriber request connection with some other line-station, the operator inserts into the jack of the called-subscriber's line the second plug of the pair, the force required to insert the plug automatically telescoping the cap on the body of the plug, setting up a contact between the cylindrical bushing 87 of the cap and the conducting-body 77 of the plug, thus completing and establishing a circuit carrying in series therewith magneto-generator 92ª, by which the electromagnet of the bridging-bells at the called-subscriber's station are energized and the bells rung, notifying that subsubscriber that he is wanted at his telephone. The path of this ringing-circuit is substantially similar to that of the head-phone circuit already described, with the substitution

of wires 88ª and 93ª for wires 88 and 93, respectively.

In the ringing-circuit wire 88ª corresponds to wire 88 in the head-phone circuit, there being an independent wire 88ª from the second plug of each pair to each of the binding-posts 89ª, all of these binding-posts on each panel of the switchboard being connected together by a common strip for that panel and being conducted on from that strip by a single wire 88ª to the magneto-generator 92ª. The release of the plug by the operator cuts out the head-phone circuit of the ringing-circuit, as the case may be, by means of the spring 83, which forces the cap 80 back to its normal position, thus breaking the contact between cylindrical bushing 87 of the cap 80 and conducting-body 77 of the plug. Either of these circuits can, however, be instantly reëstablished by a pressure of the operator's finger upon the cap of either plug; but should it become necessary to ring the calling subscriber or speak to the called subscriber the plugs must be reversed. In other words, all talking or listening must be done by the operator by means of the first plug of the pair and all ringing by means of the second plug of the pair. The simplicity, speed, and certainty secured by this arrangement will be readily appreciated.

From each of the binding-posts 89 on apron 90 is led a wire 97 to one terminal of the electromagnets 98, and from the other terminal of electromagnets 98 a wire 99 goes to one pole of an independent battery 100, from the other pole of which wire 101 is led to the spread terminal 7. Electromagnet 98 is provided with a post 102, which carries an armature 103, normally held out of contact with a second post 104 by a spring or other contrivance. From post 102 a wire 106 is led to one terminal of lamp 105, from the other terminal of which wire 110 goes to wire 109, wire 109 going to one pole of main battery B, and being one of a pair of common open-circuit feed-wires with which all the lamp-circuits of the switchboard corresponding to the circuit of lamp 105, now being described, are in multiple arc. Wire 108 is the other of this pair of common feed-wires and goes to the other pole of main battery B. From wire 108 a wire 107 is led back to post 104.

The above-described circuit, with all its appurtenances, provides what I term an "automatic ring-off," as it accomplishes the work at present done by the arrangements and appliances known as "ring-off devices." The operation of this ring-off, briefly described, is as follows: Its circuit is over the following path: from one terminal of electromagnet 98 over wire 97 to binding-post 89, thence by wire 85 to conducting-core 84 of the plug, through conducting-body 77, containing core 84, to contact 19 of the jack, from contact 19 over service-wire 4 to the line-station, over both portions of the loop of the service-wire, and through the telephone and its connections at the line-station to return-wire 5, thence on over tap-wire 6 to spread terminal 7, from spread terminal 7 over wire 101 to one pole of battery 100, and from the other pole of battery 100 by wire 99 to the other terminal of electromagnets 98. This circuit is normally open in the switch in the handle of the telephone at the line-station. When the subscriber closes this switch, in order to cut his transmitter and receiver into circuit, the ring-off circuit is established, the electromagnets 98 energize, armature 103, attracted into contact with post 104, closing the lamp-circuit and igniting lamp 105.

It is obvious that as long as the subscriber has his telephone in use the ring-off circuit will remain intact and the lamp 105 will continue to burn and that as soon as he releases the handle of his telephone the spring-switch in the handle will open, disestablish the ring-off circuit, and by the consequent release of armature 103 open the lamp-circuit and extinguish the lamp 105, thus notifying the operator that the two line-stations connected together by the corresponding pair of cords and plugs have completed their conversation and that these two service-wires are ready to be disconnected. It will be observed that I run the ring-off circuit through binding-post 89 and to the first plug of the pair, so that the calling subscriber always controls the circuit. This arrangement also enables the calling subscriber to recall the operator at any time by manipulating the switch in the handle of his telephone, which manipulation will result in the flashing or intermittent ignition and extinguishment of lamp 105. Each first plug of the switchboard is provided with one of these automatic ring-off circuits.

In order to prevent the batteries 90ª, 96, and 100 or any two thereof from short-circuiting through each other when brought in contact, by means of a plug and jack, with any service-wire, they are placed with their similar poles toward the plug connection. Thus, although all three or any two of these batteries may be connected to one service-wire at the same time, establishing two or three similar circuits whose currents all travel over a partially common path, there can be no commingling, as they will be either all negative or all positive at the point where they enter upon the common path.

Although the connections of the telephone at the line-station are only conventionally related to the subject-matter of this case, and as they are covered with separate applications of even date herewith in order that the manner in and the means by which the subscriber controls that portion of the appliances of the switchboard representing his line-station may be fully understood, I have shown in Figs. 9 and 10 the detail arrangements of the telephone and its connections, particularly the switches in the handle of the telephone. These appliances may be described, briefly, as follows: In Fig. 9 the numeral 111 denotes

one half of the handle of the telephone, and in the figure the numeral 111ª denotes the other half of the handle. In the two figures the numerals 112 and 112ª denote a chamber formed by the juncture of 111 and 111ª, in which chamber plate 113 is partially buried. Plate 113 is pivotally mounted at one end and projected at the other end a little distance outside the handle, the degree of projection being controlled by screw 114, lying in notch 115 in the end of the plate. An elastic conducting-strip 116 bears against the interior edge of plate 113, normally pushing it out as far as permitted by screw 114. When the handle is grasped, the pressure upon the projected edge of plate 113 forces it inward and presses the end of elastic strip 116 into contact with strip 117, which is secured by a screw to the bottom of the chamber. This contact closes the circuit of the line-station over the following path: over strip 117, by wire 118, to one terminal of transmitter T, from the other terminal of the transmitter, over wire 122, strip 121, and terminal wire 123, to one branch of the loop in the service-wire, over the service-wire to the central station, by the path in the switchboard and central-office connections, previously described, to return-wire 5, and back to the other branch of the loop in the service-wire, thence on over that loop, terminal wire 127 to elastic contact-strip 124, thence over wire 128 to one terminal of the receiver R, and from the other terminal of the receiver over wire 120 back to elastic contact 116. The path just described is the one taken by the circuit set up by the contact between elastic strip 116 and strip 117 when the subscriber is not connected with any other line-station at the switchboard. When such a connection has been established, the path is through the spring-jacks, plugs, cord, and talking-battery at the central station, thence on over the service-wire to the line-station with which the subscriber is connected, through the loops in the service-wire and the telephone and its connections therein at that line-station to return-wire 5, and thence back to the original line-station and over the path already described, the paths through the telephone and its connections at both line-stations thus connected being similar. Elastic contact-strip 124 is secured by screw 125 at one end, its other end being free. Numeral 126 denotes a pusher lying behind the free end of strip 124. The other end of this pusher protrudes above the surface of the handle, and by pressure upon it with the thumb or finger the strip 124 can be brought into contact with strip 121, thus completing a short circuit between terminal wires 123 and 127 through strip 124 without incorporating the other contact strips and wires and the receiver and transmitter in its path. This short circuit goes through the corresponding annunciator at the switchboard over the path already described and is used for controlling that annunciator, although the longer circuit closed by pressure upon plate 113 will accomplish and can be used for this purpose. The legitimate use of plate 113 is to complete the circuit through the transmitter and receiver for purposes of conversation, and also for calling the operator after the operator has once answered the annunciator-call and cut the annunciator-circuit out by the insertion of the first one of the pairs of plugs of the switchboard, as already described. The two halves 111 and 111ª of the handle, plate 113, and pusher 126 are of non-conducting material, all the contact-strips and connections being of conducting material.

It will be observed that the insertion of the plugs in the line-jacks not only breaks the call-circuits, which include the contacts 14 and 15, but it also completes the circuit of the magnets 39, which restore the armature 23 to its original position, thus cutting out the circuit of the lamp 31. The circuit of the magnets 39 is completed through the contacts 44 and 45 and the metallic cap 76 on the tip of the plug.

The purpose of opening the call-circuit by the insertion of the plug in the line-jack is not merely for the prevention of short circuiting or leakage of the talking-current, but is for the very essential purpose of disestablishing the connection between the line and the main battery B. The heavy current from this battery must be removed from the talking-circuit, because if it be present conversation would be practically impossible. In this connection I will remark that the substitution of lamps for bells as means for calling the central station gives me a silent switchboard, the quiet of which is only interrupted by the low tones of the operators in speaking to calling subscribers. The substitution of this tranquility in place of the indescribable clamor and interminable clanging of a large central station using the bell-calls removes one of the severest and most injurious strains upon the nervous system of women that modern civilization has developed. Such a board, moreover, secures not only silence but speed to a degree far superior to anything heretofore used, and adds greatly to the convenience of both the subscriber and operator. For example, if the former desires to speak to the operator, instead of hanging up his hand-telephone on a gravity-switch or operating said switch with one hand and the magneto in his box with the other hand he simply presses the switch in his telephone-handle several times in quick succession, thereby producing a series of flashes from the lamp which the operator instantly sees and answers, and, in other respects as set forth in the specification at various points, the changes effected by my invention simplify and reduce the labor of the operator, enable the switchboard to be accurately, promptly, and rapidly served by a

much smaller force than has been required under other systems, and in all respects improve the service.

What I claim is—

1. In a telephone system, a switchboard having each of its flexible cords divided in two parts, one wire in each part connected to the poles of a talking-battery, and the other wires to the head-phone and to one pole of a call-generator, respectively, the ends of said cords having plugs in which one wire is connected to a conducting-body and the other to a contact carried by a non-conducting spring-projected cap movable on the end of the said plug to couple the wires electrically, a visual call-signal corresponding to each line-station, a circuit for said signal comprising a balanced armature, and a contact for one end of said armature, electromagnets to attract each end of the armature and independent circuits for said magnets, one circuit including a normally-open switch at a line-station, and the other circuit comprising separated contacts in the line-jack of the switchboard, which are coupled electrically by a conducting-cap on the tip of the plug, substantially as described.

2. In a telephone system a visual call-signal for each line-station, such as an electrically-illuminated call-box, a circuit for the same comprising a balanced armature and a contact for one end of said armature, electromagnets to attract both ends of said armature, independent circuits for said magnets, one circuit including a normally open switch at a line-station and normally-closed elastic contacts in the line-jack which corresponds to said station, and the other circuit including rigid separated contacts in the line-jack, a plug having a conducting-cap on its tip to couple said contacts electrically when the plug is inserted and thereby complete the circuit of the electromagnets by which the armature is attracted to break the signal-circuit said plug being also provided with a non-conducting point behind its tip to separate the closed elastic contacts in the line-jack a divided flexible cord one part attached to each plug, one wire in each part being connected to one pole of a talking-battery, the second wire in one part to the head-phone and the second wire in the other part to one pole of a call-generator, a non-conducting spring-projected cap carrying a contact to which one wire in each part is connected, a conducting-body part of the plug to which the other wire in each part is connected, and a spring-contact connected to a service-wire and arranged in the line-jack to electrically engage the conducting-body of the plug when the latter is inserted, substantially as described.

3. In a telephone system, a switchboard having the two parts of each divided flexible cord connected to the opposite poles of a primary battery, one wire in each part being connected from the battery to the conducting-body of the plug, and the other wire in one part to the head-phone and in the other part to a call-generator, each of the last-named wires being connected to a contact-ring in a movable cap on the plug, and a line-jack for the plug having a single spring-contact to bear on the tubular conducting-body of the plug, a contact-piece, bushing, face-plate and contact-strip, into contact with which the single spring-contact is brought by the insertion of the plug, for the closing and establishment of a test-circuit to the face-plates of the corresponding multiple jacks of the switchboard two contacts normally closed to complete a call-circuit and separated by an insulating portion of the plug, and two normally-separated contacts to engage a conducting-tip on the plug and complete a circuit by which the call-signal is restored to position, substantially as described.

4. In a telephone-switchboard, the combination with the line-jacks and plugs of contacts which complete a circuit for communication between two line-stations over service-wires and a common return-wire, spring-contacts arranged in the line-jack and normally closed to form part of a call-circuit, and having their ends adapted to be separated by the insertion of the plug, a visual call-signal operated by said circuit which includes a normally open switch at the line-station corresponding to said jack, and contacts normally separated but electrically connected by the plug, to complete a circuit by which the visual signal is restored to its original condition, substantially as described.

5. In a telephone system, the combination with a central station and a series of line-stations of a single wire common to all the line-stations, a series of service-wires connecting the line-stations to the switchboard at the central station and to said single wire, a test-signal consisting of a lamp for each multiple switchboard, a circuit for each lamp including a switch-armature and a suitable generator of electricity, and a testing-circuit comprising a separate test-battery for each multiple switchboard, electromagnets in the circuit of the test-battery, to attract the switch-armature, a test-thimble, the multiples of the switchboard, a conducting face-plate and bushing in each line-jack, and the service and return wires, over which communication is in progress, whereby the test may be made without interrupting, or interfering with the communication between connected line-stations, substantially as described.

6. The combination with a switchboard of a telephone system of a call-signal such as a lamp, a main battery, service-wires connecting the line-stations to the switchboard and to a common return-wire open circuit-feeders connected to the poles of the main battery, lamp-circuits from said feeders, a balanced armature forming part of each lamp-circuit, a glass tube mounted on each armature and containing a globule of mercury, a group of electromagnets under one end of the

armature, a circuit for said magnets including the service-wires and return-wire and a normally open switch in each telephone, a group of magnets under the other end of said armature and a circuit for the latter magnets including separated contacts in the line-jack and a conducting-tip on the plug, substantially as described.

7. The combination with a switchboard of a telephone system, of a series of automatic ring-off circuits, each of such circuits operated by an independent primary battery, one of such circuits connected to the first of each pair of plugs of the switchboard through one of the conductors of its portion of the flexible cord, each of said ring-off circuits comprising a small independent battery, and an electromagnet controlling an armature-switch by which a local circuit is opened and closed, each of said local circuits being provided with an independent visual signal such as a lamp and all of such local lamp-circuits being supplied with current from a common pair of feed-wires from the two poles of the single main battery, each of said ring-off circuits including, when in use, one of the ring-off batteries, one of the electromagnets, the return-wire, one of the service-wires, one of the plugs and one of the conductors in its corresponding portion of the flexible cord of the switchboard by which connection is made with the service-wire through the spring-jacks or their multiples, the line spring-contact of one of the spring-jacks of the switchboard, the loop and telephone at one of the line-stations and the switch in the handle of the telephone normally open when the telephone is not in use and closed by the grasp on the handle of the telephone by the person using it, substantially as described.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

PAUL MINNIS.

Witnesses:
CLAYTON B. CLARK,
WILLIAM H. SULLIVAN.