

(No Model.)

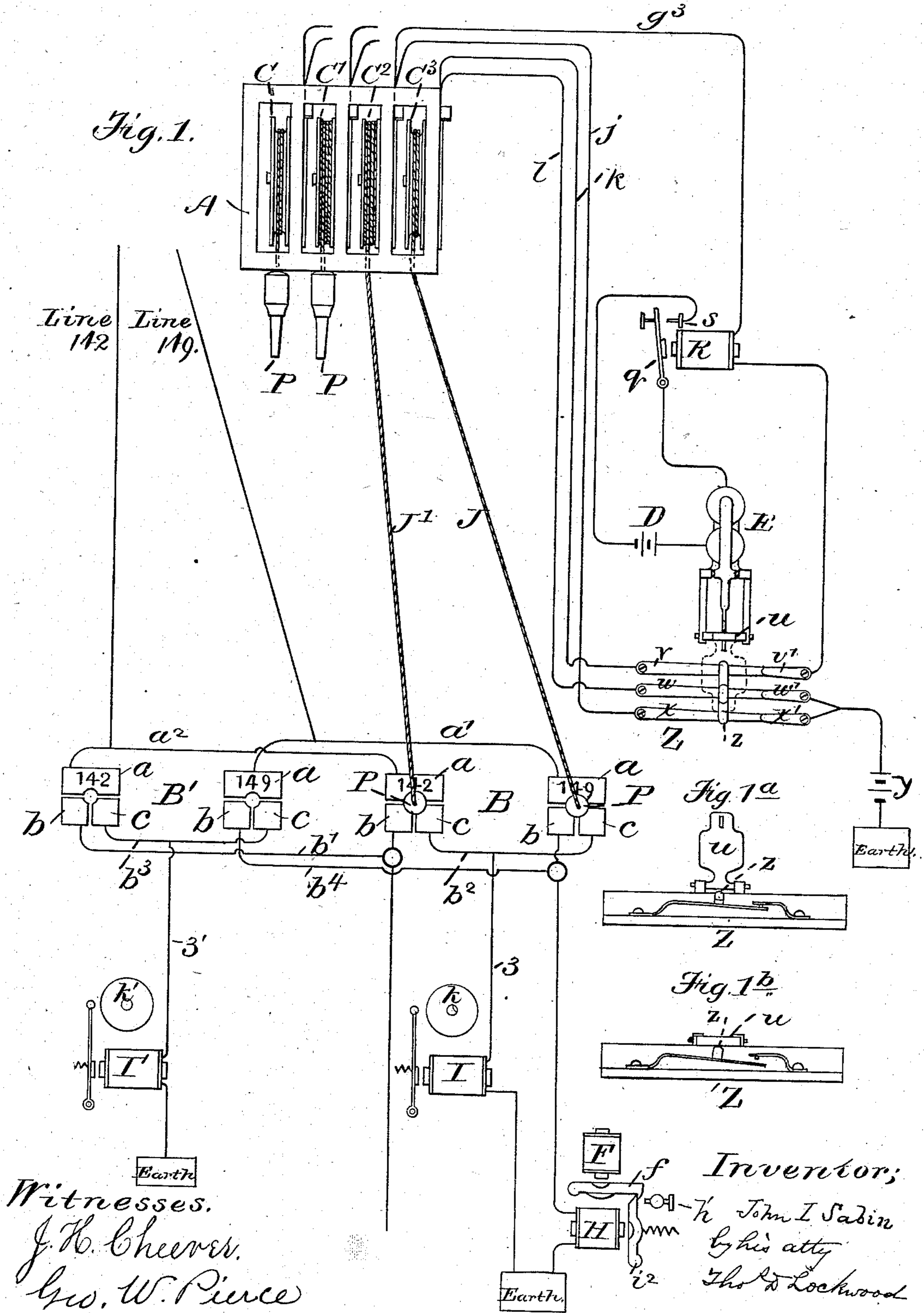
3 Sheets—Sheet 1.

J. I. SABIN.

TELEPHONE EXCHANGE CIRCUIT AND APPARATUS.

No. 255,031.

Patented Mar. 14, 1882.



(No Model.)

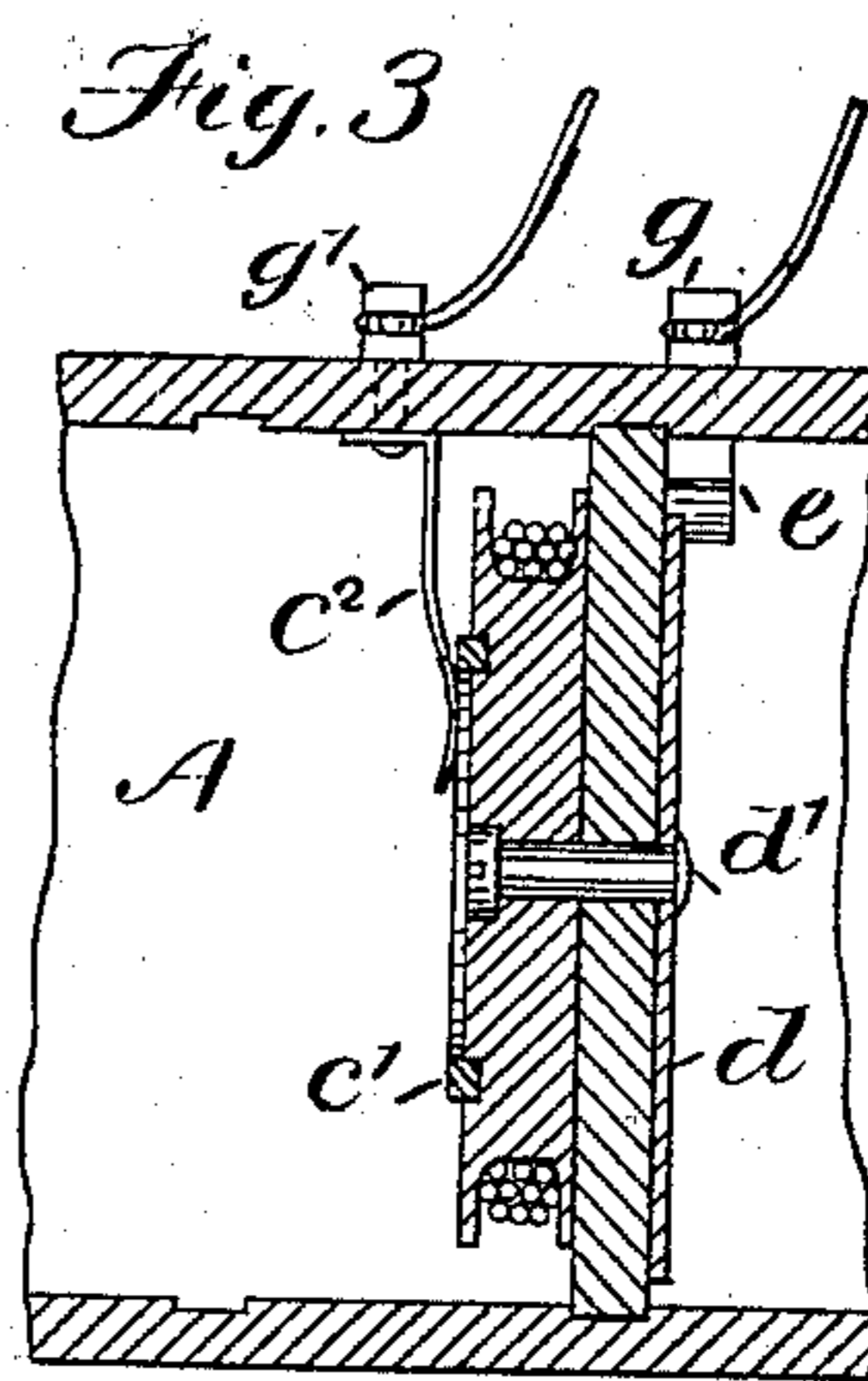
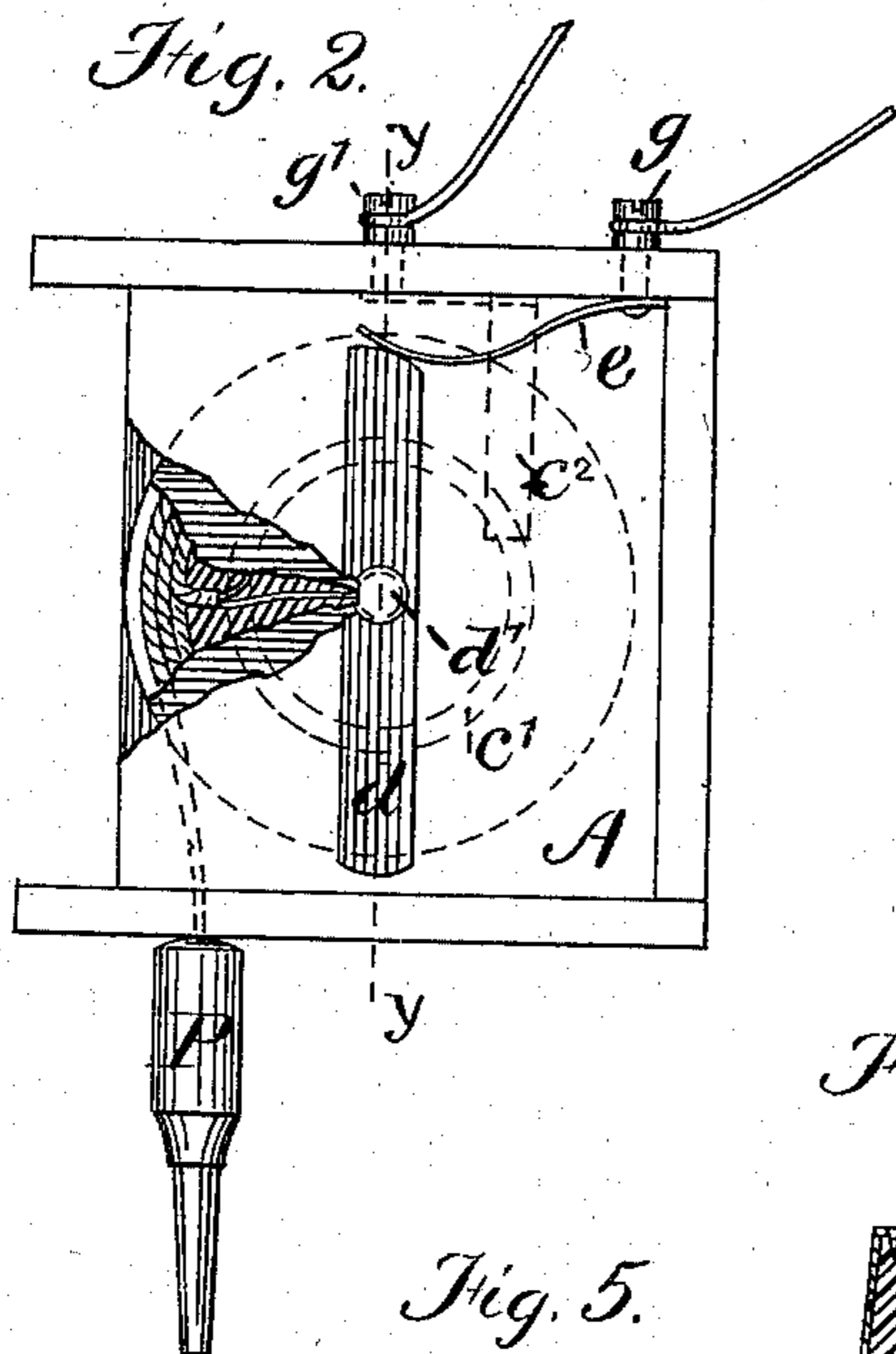
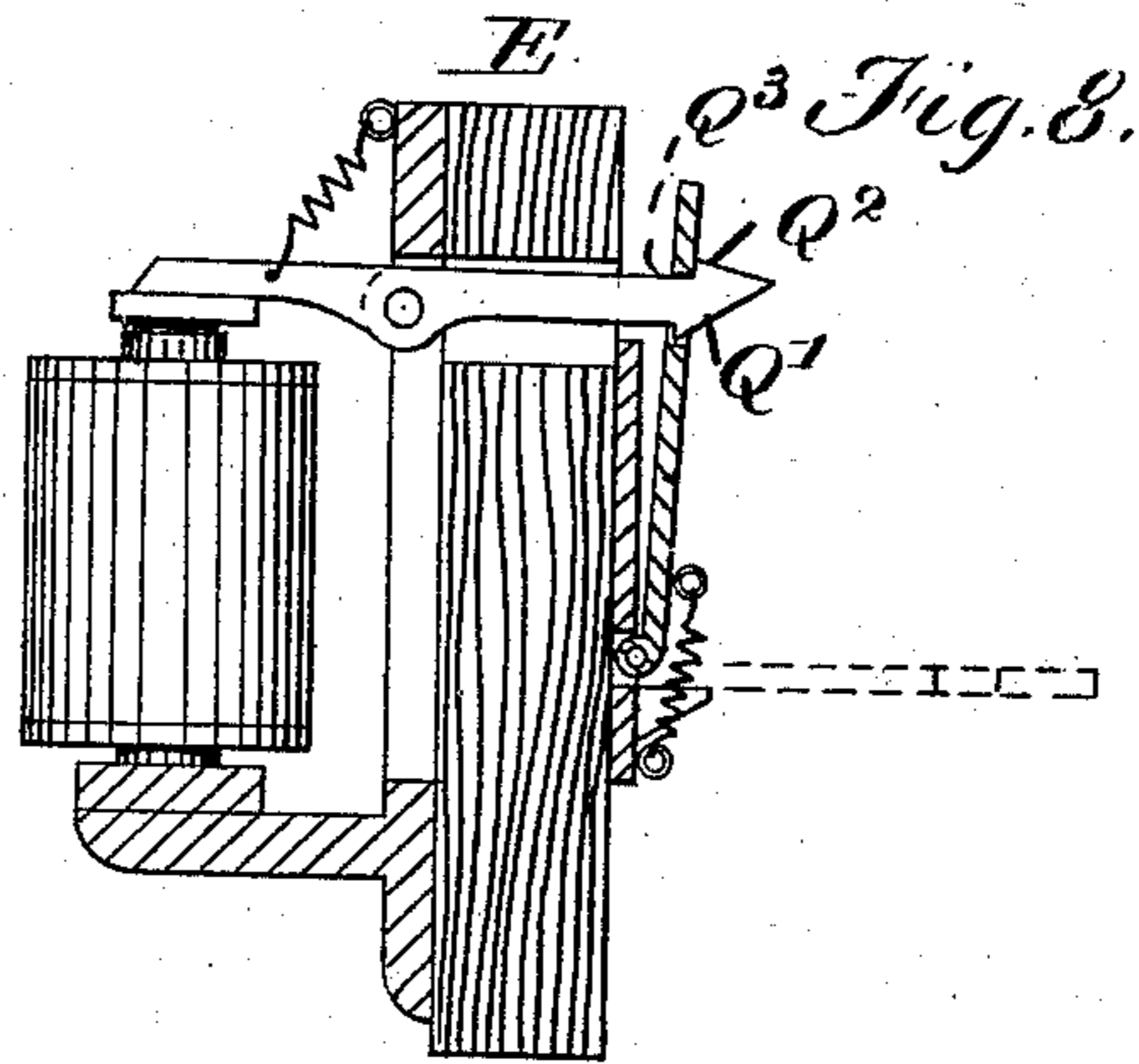
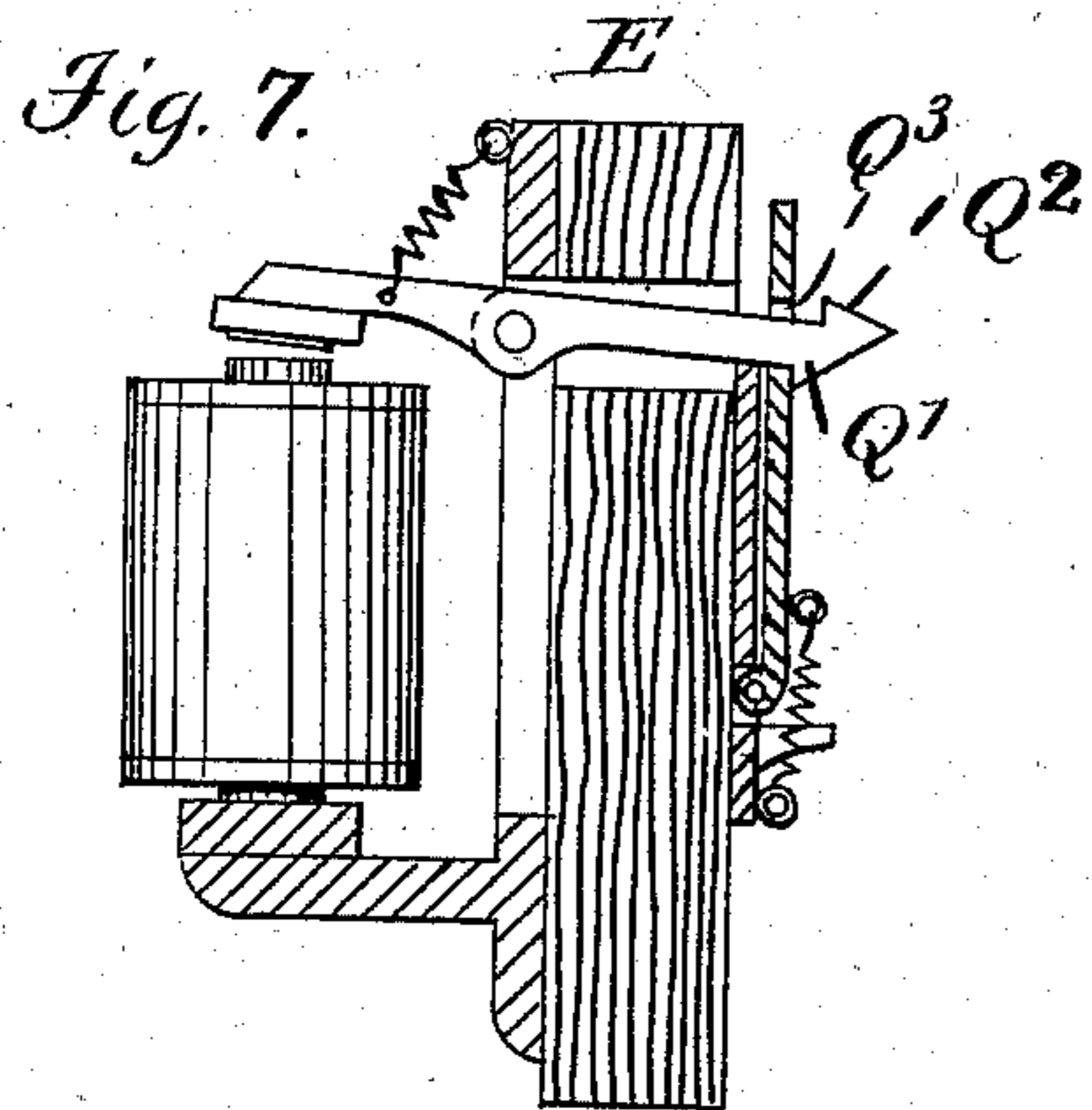
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J. I. SABIN.

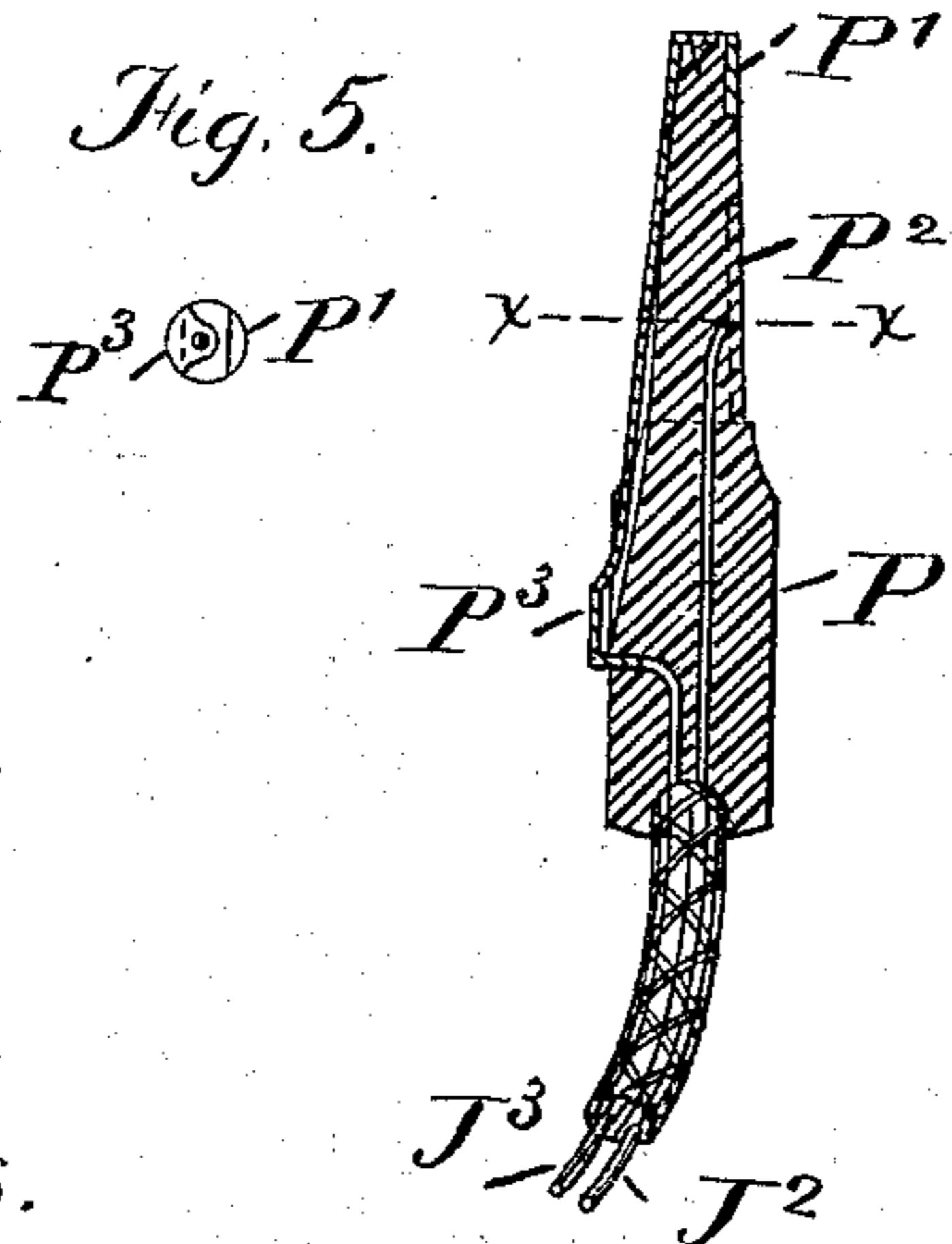
TELEPHONE EXCHANGE CIRCUIT AND APPARATUS.

No. 255,031.

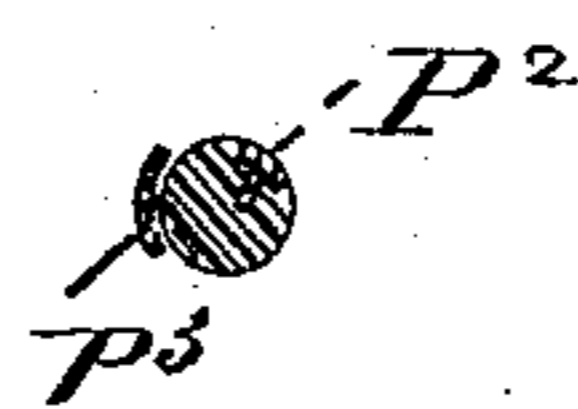
Patented Mar. 14, 1882.



*Fig. 4.*



*Fig. 6.*



Witnesses.  
J. H. Cheever.  
Geo. W. Pierce

Inventor.  
John I. Sabin  
by his atty  
Thos. D. Lockwood

(No Model.)

3 Sheets—Sheet 3.

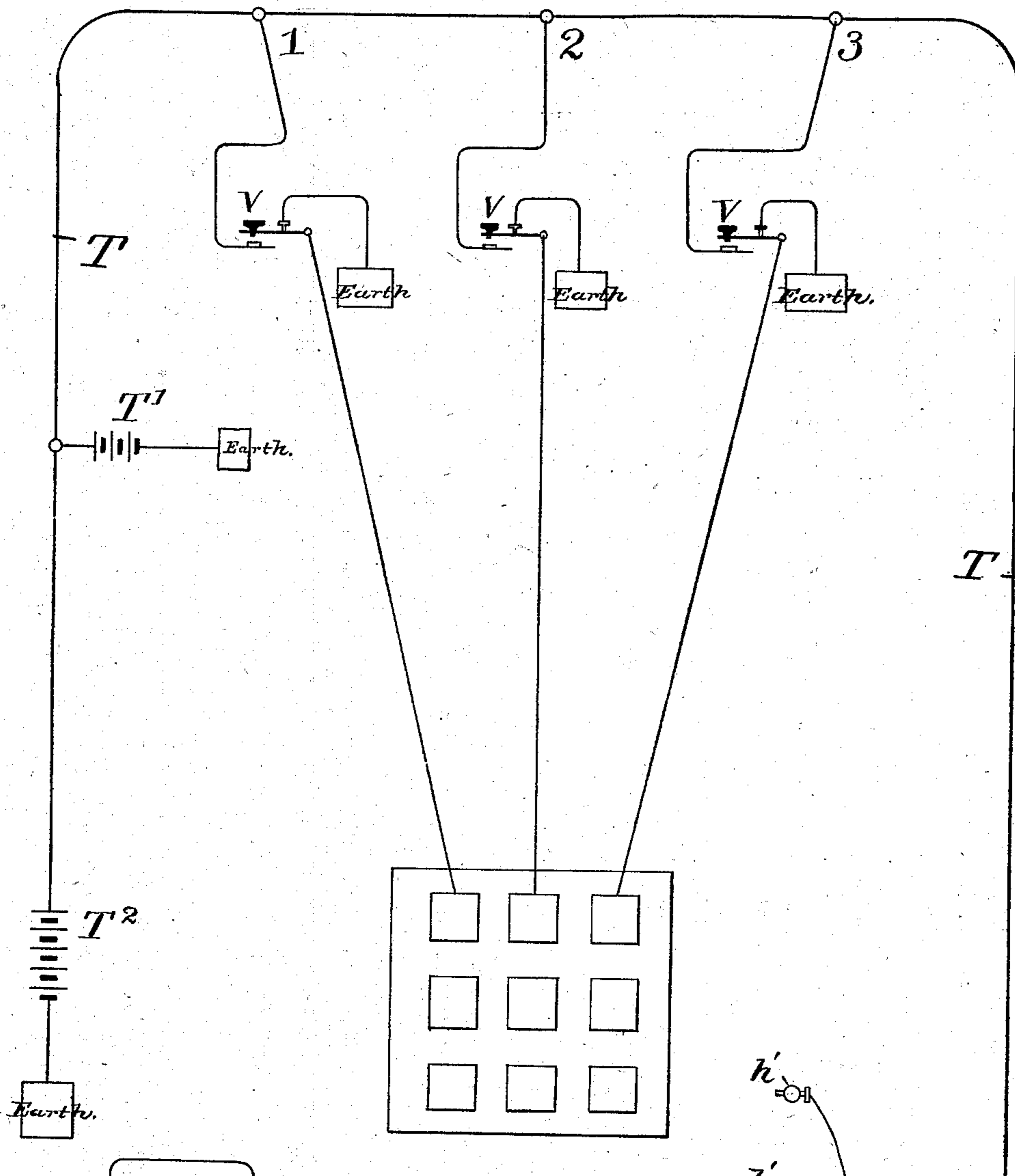
J. I. SABIN.

TELEPHONE EXCHANGE CIRCUIT AND APPARATUS.

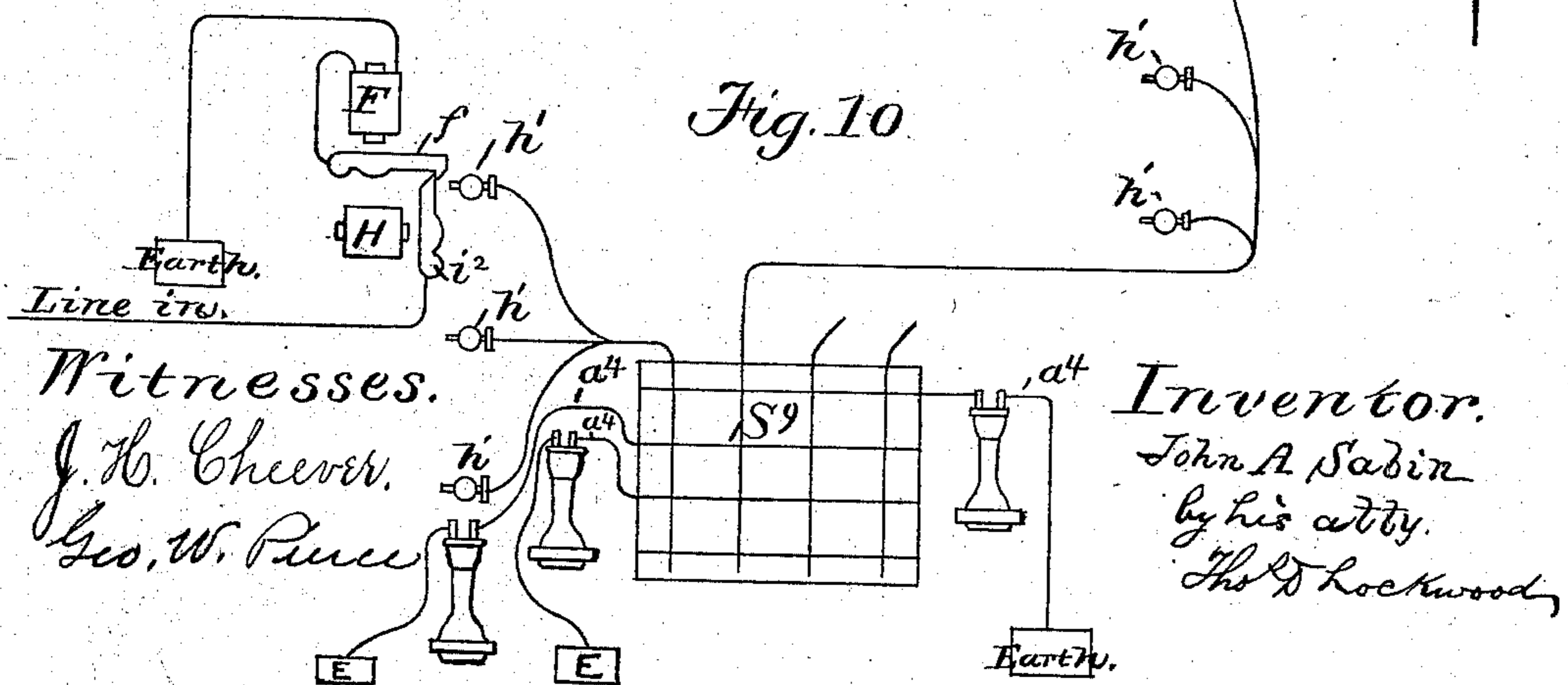
No. 255,031.

Patented Mar. 14, 1882.

*Fig. 9.*



*Fig. 10.*



Witnesses.

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# UNITED STATES PATENT OFFICE.

JOHN I. SABIN, OF SAN FRANCISCO, CALIFORNIA.

## TELEPHONE-EXCHANGE CIRCUIT AND APPARATUS.

SPECIFICATION forming part of Letters Patent No. 255,031, dated March 14, 1882.

Application filed August 6, 1881. (No model.)

*To all whom it may concern:*

Be it known that I, JOHN I. SABIN, of San Francisco, in the county of San Francisco and State of California, have invented certain Improvements in Telephone-Exchange Systems, of which the following is a specification.

My invention relates more especially to an organization of electric circuits and apparatus for direct intercommunication by means of speaking-telephones, which is known as a "telephone-exchange" or "central office," which is connected by means of telegraph or telephone lines extending in different directions, with a number of separate substations situated at various points within the geographical district which the central station is designed to serve. The organization and arrangement of the wires, switches, and instruments in the central office enable the operator or attendant, who is there constantly on duty, to place any two substations in direct electric communication with one another at a moment's notice when called to do so by a subscriber at any of the substations. This is done by means of suitable switching or connecting devices.

In Letters Patent issued to me, bearing date of July 13, 1880, and No. 230,069, are described a switch-board and system the peculiar feature of which is a reel provided with an automatic take-up for the reception of the flexible conducting-cords used for the connection of one line with another.

In my Patent No. 239,557, of March 29, 1881, are shown and described a system and apparatus for a telephone central office consisting of a switch wherein each subscriber's section is divided into three parts, each part performing a separate function, a switch-plug of peculiar character, and means for automatically throwing the subscriber's annunciator into and out of action.

In Letters Patent issued to me November 8, 1881, No. 249,262, I have shown and described improvements on the same system by combining the following features: The line-wires entering the central office are branched to each of the switch-boards; an electric switch operates by means of the incoming signal to transfer the main circuit to a normally-open branch, including a listening-telephone; means are provided to automatically restore the main-line connections to their normal position for

the reception of succeeding call-signals, and a normally-open testing circuit, including an electric testing-instrument, which, when applied to any line, enables the attendant to ascertain positively whether such line is in use or not.

The object of my present invention is primarily to diminish the work necessary at the central office to a minimum, and thus to increase the speed of making connections and give greater satisfaction to the subscribers to the system by arranging the wires and apparatus in such a manner that the subscribers may call one another, and at the conclusion of the communication may have it in their power to effect the electrical disconnection of the two lines, and consequently the restoration of the signaling devices at the central office to their normal condition, so that even if the attending operator is so pressed for time that he overlooks the lines already connected the requisite operations are automatically performed, and virtually all that is left for the operator is to insert the connecting-plugs on a call and to withdraw them at his leisure.

To this end my present invention consists mainly in certain improvements upon the systems and apparatus shown and described in the patents hereinbefore cited, and to which, if necessary, reference may be made.

It comprises certain devices whereby the signaling and disconnection of substations and lines may be effected with greater convenience and celerity than have heretofore been practicable. These are, first, a relay included in the circuit of the conducting-cord connecting any two lines for conversation, which is so adjusted as to respond only to currents of a definite character transmitted in a definite manner, and which operates to close a local circuit, dropping an annunciator, which mechanically opens the main and local circuit, thus severing the connection at the central office between the two lines and permitting them to resume their normal condition; second, the combination of the same with a double-conductor connecting-cord, an automatic take-up reel, and connecting devices between the two conductors at their inner extremities and outside connections; third, a wire common to a number of stations, running from station to station and furnishing battery-power only for

disconnection purposes; and, fourth, the combination of the battery-wire, the clearing-out relay, and the disconnecting relay or sounder and switch.

5 In the accompanying drawings, Figure 1 is a diagram illustrating the connection and disconnection devices of a central station, showing the relation of the various parts of the apparatus to each other and the method of operation. Fig. 1<sup>a</sup> is an elevation of the disconnection-switch, showing the annunciator in place and the switch closed. Fig. 1<sup>b</sup> shows the same switch with the annunciator down and the switch open. Fig. 2 is a side elevation of the reel and cord double connection, with a portion of the covering broken away to show the method of connection. Fig. 3 is a vertical section of Fig. 2, showing especially the connection of the local cord. Fig. 4 is a sectional view of the connecting-plug. Fig. 5 is an end view of the plug. Fig. 6 is a section of the plug on the line  $xx$  of Fig. 4. Fig. 7 represents the peculiar form of annunciator employed in its normal position. Fig. 8 shows the annunciator in position, with the battery on; and Fig. 9 is a diagram illustrating the battery-wire, its connections, and method of application at the various substations. Fig. 10 is a diagram representing my improved method of dividing up the annunciators and receiving-instruments of the circuits to any desired listening telephone or telephones.

10 In the central-office system of which my present invention is an improvement all the wires entering the office run to each of a series of switch-boards. One operator is capable of taking charge of any number of circuits, with complete devices for signaling and receiving calls, while at the same time every other subscriber's circuit has a branch line running to his individual board, to the end that each operator may connect the circuits in his especial care to any other circuit entering the station without leaving his board and without communication with any other operator. If, therefore, one thousand circuits enter the central station, there may be ten separate switch-boards, each of which is in charge of a separate attendant. At each of these separate boards are the terminal signaling facilities of one hundred wires, and also branches from the nine hundred other wires entering the office. Such a system, because all the wires entering the office are duplicated in each switch-board, is called the "duplicate-board system."

15 In my former patent dated November 8, 1881, No. 249,262, is shown near the terminal of each line-circuit a back stop,  $h'$ , connected by a wire to a listening-telephone, and thence to earth. When a call is received the armature of the electro-magnet  $H$  falls, owing to its release by the lever  $f$ , upon the said back stop,  $h'$ , thus connecting the main line to the listening-telephone and operator.

20 In the practical application of my present invention I provide a switch-board,  $S^9$ , of ordi-

nary construction, with metallic strips crossing each other at right angles, and, instead of connecting the wires from  $h'$  directly to the listening-telephones, I lead them, as shown in Fig. 10 of the drawings accompanying this specification, in groups of any desired number—say twenty—to the vertical series of switch-board strips, the intersecting series of strips being permanently connected to the listening-telephones  $a^4$  at the various switch-tables. By this arrangement the attendant in charge can transfer any number of line terminals to one listener or cross-connect them at his pleasure merely by changing the plugs in the switch, thus dividing the work among the operators as he may see fit. This is of great advantage, as, for example, at night all the wires may be thus connected to any desired table.

Referring now to Fig. 1,  $B B'$  represent two of these duplicate boards, which are sufficient for the purpose of illustration. I also show but two line terminals on each board connecting with the two lines 142 and 149, leading out from the office, the principle being the same with two as it would be with one hundred or more. At the distant end of each line is placed a signal apparatus, which may consist of the usual magneto-bell, together with a transmitting and receiving telephone. All these several devices and their arrangement at the substation in connection with the line are well known, and do not therefore require detailed description.

The respective lines by their branches are connected to commutators, which are constructed in three several pieces,  $a$ ,  $b$ , and  $c$ . Each line, after branching to its commutator on every board, is continued, as described in my Patent No. 249,262, to earth through lever  $i^2$ , lever  $f$ , and the circuit-changing electro-magnet  $F$ . These, being no part of the present invention, are merely shown in the drawings for lucid illustration. It will be seen that the upper section,  $a$ , of each three-part commutator is connected through its branch  $a'$  or  $a^2$  to its respective line-wire. The lower left-hand sections,  $b$ , of each number are joined together and connect by the wires  $b'$  and  $b^4$  to the earth through an electro-magnet,  $H$ , which is used to restore the normal condition of the line. The lower right-hand sections,  $c$ , of each separate switch-board are connected together, as shown, by the wires  $b^2$  and  $b^3$ , and the whole connected by the wires  $3 3'$  through the test-magnets  $I I'$ , operating the bells  $k k'$ , to earth. This arrangement differs somewhat from the arrangement shown and described in Letters Patent issued to me November 8, 1881, No. 249,262, in which I have shown and described a local battery in circuit in the wire 3 in combination with a test-magnet in a separate open circuit, and the testing has been accomplished by touching the terminal of said open circuit to any required line.

Placed over each duplicate switch-board is a reel-case,  $A$ , in which are hung reels for the

flexible connecting-cords. The reels are arranged in pairs and provided, in accordance with the subject-matter of my former patent, No. 230,069, July 13, 1880, with an automatic take-up, by which the cords, when released from the switch-boards, are drawn out of the way. The conducting-cords differ from those described in my former patent, in that they are provided with two conducting-wires, each insulated from the other, so that two totally distinct circuits pass through each cord, for a purpose which will be hereinafter set forth. Each cord is provided at its outer end with a plug-connector, P, the electrical connections of which are arranged in a manner well adapted to subserve their several functions. The upper side of each plug P is fitted with a metallic plate, P<sup>3</sup>, which is connected with one of the conductors, J<sup>3</sup>, of the cord, and which is continued to the end of the plug, as shown in Figs. 4 and 5. The second conductor, J<sup>2</sup>, of the flexible conductor connects in the plug with a second metallic plate, P<sup>2</sup>, which is placed on one side of the plug, but is not continued to the end thereof, as indicated in Figs. 4 and 6. This is so arranged that when the plug is inserted into the hole it will only make contact with the segment *b*. At the extreme end of the under side of the plug, and insulated by the material of which the plug is composed, is a third metallic plate, P'. The object of the three several plates is as follows: The plate P<sup>3</sup>, when the plug is inserted into the hole of the commutator, is to connect with the main line through the segment *a* of the switch. The plate P<sup>2</sup> on one side of the lower surface connects with segment *b* when the plug is pushed in, and by the conductor in the cord to which it is connected completes the circuit of a local battery, which operates to bring the electro-magnet H into position to bring the main connections to their normal condition when the conversation is completed, and also to remove the ground terminal of the main line by detaching the lever *i*<sup>2</sup> from the latch of the upper lever, *f*. The plate P' at the extreme end of the lower surface operates the instant a plug is entered into any of the commutator-holes to close the circuit of the test-magnet I, which will ring if by means of a connection already existing a battery is on any of the commutators connected to that particular line.

At the end of the cord which is attached to the reel the main-line conductor is connected by the metallic axis of the reel *d'*, plate *d*, and spring *e* to binding-screw *g*, from which the wire is continued out. The local or inner conductor is attached, as shown in Fig. 2, to a metallic ring, *c'*, sunk in the side of the reel. With this ring the spring *c*<sup>2</sup> makes connection by frictional contact, being itself connected to a second binding-screw, *g'*.

As hereinbefore described, the reels are in pairs, so that if reel No. 1 be used to connect with one subscriber's line, 149, reel No. 2 must necessarily be used to connect with the corre-

sponding subscriber's line—say 142. This rule holds good throughout the entire system. In Fig. 1 I have shown two of the reels as having their cords drawn down and the plugs inserted and making connection between the lines 149 and 142.

By tracing the lines of the drawing Fig. 1 it will be seen that the wire *g*<sup>3</sup>, which is the main-line wire connecting with the plate P<sup>3</sup> of the plug P, is continued from the binding-screw connection of its reel *c*<sup>2</sup> to one wire of a relay-magnet, R, the other wire of which runs to the spring circuit-breaking switch *v'*, against which normally presses up its complementary spring *v*, which is connected directly to the main-line wire *k* of the second cord and reel of the pair, thus, when the plugs of the two reels are drawn down and connected to the switch, forming a through circuit, over which conversation is maintained. The other springs, *w* *w'* and *x* *x'*, form part of the conducting-wires J J', by which the current of the local battery *y* is carried to the second or local conductor of the reels, and thence, *via* the plate P<sup>2</sup> of each plug and segments *b* *b* of the commutators of the lines 142 and 149 on the board B, to the electro-magnets H of each line, charging it and attracting its armature-lever *i*<sup>2</sup>, thus breaking the ground-connection through *f'*, and also placing the levers *i*<sup>2</sup> and *f* in such a position relatively to each other that when the local circuit is broken the normal condition of the line and annunciator connections is automatically restored, as fully described in my patent of November 8, 1881, No. 249,262.

E is the magnet of a sounder or annunciator in the circuit of the local battery D, and when the circuit is closed by the contact of the lever *q* on the screw *s* the armature of the annunciator is attracted, releasing the shutter *u*, which, being held against gravity, falls first to a second detent, and then, as shown by the dotted lines upon the stud *z*, pressing thereby the springs *v* *w* *x* from their contact with the shorter springs *v'* *w'* *x'*, and thus severing simultaneously the main circuit connection between the two lines and the continuity of the two local annunciator-circuits.

Fig. 1<sup>a</sup> shows clearly the position of the spring-switch *z* when closed with the connections made, and Fig. 1<sup>b</sup> represents the same when forced open by the weight of the shutter *u* falling upon the stud *z*. The several springs are insulated one from the other by being fixed on a base of insulating material; and the stud *z*, while attached to all the springs, is also insulated from them by a bridge-piece of some non-conductor.

The battery-power requisite to enable a subscriber at any of the substations to operate the clearing-out relay R is furnished by the arrangement delineated in Fig. 9, where a separate wire, T, is provided with a strong battery—for example, of fifteen or twenty cells—which may either be located at the central station, as at T<sup>2</sup>, or at any desired point outside,

as at T'. This battery, wherever located, is normally on open circuit, as, if the battery be at the central office, the distant end of the wire is insulated, and if the battery be located at any outside point, as T', both ends of the wire are insulated, permanent ground being at one pole of the battery. A branch line from this battery-wire is run into every substation, as 1, 2, and 3, and there terminates also open; but when the subscriber has concluded his conversation and desires disconnection, he merely presses his key V, which cuts his line from its own ground and connects it to the battery-line T, giving a circuit for the battery-current. This, being now directed through the central office to the ground at the station of the distant subscriber, passes necessarily through the relay R, causing it to close the local circuit and disconnect the two lines.

In the case of a trunk-line connection, or one wherein two lines respectively centering at different central stations are connected by a trunk line extending between such stations, there will be two disconnecting-relays in circuit, one at each central station. The subscriber is thus enabled not only to disconnect his own line from that of the sub-station with which he is connected, restoring both to their normal condition, but also performs the same office for the trunk or third line extending between and connecting the two central stations.

I construct my disconnecting sounder or enunciator E with a double catch, as shown in Figs. 7 and 8, so that when the subscriber presses his key and throws battery onto the line the drop or shutter will not immediately fall, but will drop from the catch Q' to the upper catch, Q<sup>2</sup>, as shown in Fig. 8, and there remain until the key is released and the battery taken off, when the slot Q<sup>2</sup>, being outside of Q', cannot retain it, and it falls, as shown by the dotted lines, breaking the switch-contacts. The object of this device is to prevent the disconnecting annunciator or sounder from acting until the subscriber releases his key and removes the battery; otherwise, owing to the peculiar arrangement of the signaling devices, he would disconnect himself the instant he pushed the key, and, holding his button longer, as he would naturally do, would call the central office again. This clearing-out relay R is adjusted much too high to respond to a magneto-current such as those sent by the substation when calling the central office or another subscriber, but will readily respond to the battery-currents from the extra wire, which are of much greater strength.

The operation of my improved apparatus is as follows: A person at station 149 wishes to talk with station 142. He signals the central station by transmitting an electric current thereto, which traverses the electro-magnet F, Figs. 1 and 10, of the automatic switch. This, influencing the armature *f*, permits the second armature-lever, *i*<sup>2</sup>, to fall against the pin *h*', thus breaking the continuity of the original cir-

cuit and forming a new circuit through pin *h*' and listening-telephone *a*<sup>4</sup> to ground. A receiving operator is always stationed at this telephone and receives the order of the substation operator: "Connect 149 with 142." As the apparatus for receiving calls in this manner is not herein claimed, and forms no part of my present invention, and is, moreover, fully described in my prior patent of November 8, 1881, hereinbefore cited, it is not considered essential to show the connections in the drawings. The central-office operator has only to insert the plug of any given cord and reel into the switch-section 149 and the plug of the complementary cord and reel into the switch-section of 142. Subscriber 149 can then call 142 himself with his magneto-bell. If, when the operator inserts the second plug into the section of 142, his test-bell I rings, he knows at once that line 142 is in use at some other board, the circuit of the local battery *y* at the board where 142 is in use being connected to segment *b* by the wire *b*' and completed through the bell I, causing it to ring by the action of the little plate P' on the end of the plug forming a temporary connection between the two segments *b* and *c* of the switch-section 142. After giving his order, 149 will hang up his telephone, and, expecting the connection to be made, would ring his bell to call 142. If the central-office operator ascertained that 142 was in use, he of course would not connect that line to 149, and 149, having no circuit, could not ring his bell, and would thus be made acquainted with the fact that 142 was in use. If so desired, the central office could further notify the subscriber that 142 was busy by touching the plug that he would have inserted into the commutator of 142 a certain prearranged number of times to a battery or magneto-machine, thus ringing the bell of 149 and notifying him of the fact. When the connection is made it will be evident that the main circuit through the two cords employed is from 142 through the cord J', relay R, springs *v*' and *v*, cord J, and out to station. The local circuits will correspondingly be from earth, battery *y*, springs *w* and *x*, through the respective cords and plate P<sup>2</sup> on the plugs, to the segments *b* of 149 and 142, through the magnets H, attracting the armature *i*<sup>2</sup>, and thence to earth, at the same time charging the connecting-wires *b*' and *b*<sup>4</sup>, so that if any other operator should undertake to connect a line to either 149 or 142 he would at once know by his test-bell that those lines were already in use. Now, when the conversation is concluded, either subscriber presses his key V, the heavy battery passes over the line through the relay R, the local circuit closes, and, on opening, drops the shutter on the spring-switch Z. The main and local circuits are simultaneously opened, and the plugs, though left in the holes, are rendered inoperative, and may be removed at the leisure of the operator, the two lines thus being disconnected one from the other, and each line by the removal of the lo-

cal battery *y* is restored to its annunciator or to its normal condition.

Although I have shown the disconnecting-annunciator *E* as operated by a relay and local circuit, I do not confine myself to such an arrangement, as it is obvious that I may insert the said annunciator directly in the main circuit, if I so desire.

I am aware of an existing patent in which an auxiliary wire is shown and claimed; but it differs materially from my invention in that my wire *T* is a battery-wire and does not perform the office of signaling; neither is it necessitated to take battery from or even to approach the central office for that or any purpose, as the required battery may be connected or furnished at any desired outside point or points.

Having now described my invention, I claim—

1. In a telephone-exchange system, the combination of a series of subscribers' lines, a conducting-cord inclosing a wire to connect any two of the said lines, and a second wire to complete the circuit of a local battery and electro-magnet arranged to restore the normal terminal connections of the main line, a single relay included in the main-line circuit of the cord of each pair, and a disconnecting-switch in the circuit of and controlling both main and local circuits, and adapted when operated by said relay to automatically disconnect the lines one from the other and simultaneously open the circuit of the local battery and restoring-magnet, substantially as and for the purposes described.

2. In a telephone-exchange system, the combination of a pair of subscribers' lines, a connecting-cord containing a main line and a local-circuit conductor, a relay in the main-line circuit of said cord adjusted to respond only to currents of definite character, a sounder or annunciator in an auxiliary local circuit controlled by said relay, and a disconnecting-switch or circuit-breaker included in both main and local circuits, adapted and arranged to automatically and positively disconnect the two lines and simultaneously break the circuit of the restoring-magnet and local battery, substantially as specified.

3. In a telephonic-exchange system, the battery-wire *T*, open at one end or both, connected with a grounded battery at any desired point and branching to a series of subscribers' stations, in combination with direct wires to subscribers, substantially as described, and for the purpose set forth.

4. The combination, substantially as hereinbefore set forth, of a relay in the main circuit of a cord or wire connecting any two subscribers' lines, a battery-wire common to a series of sub-

scribers' lines or substations, and means, as indicated, for connecting the battery-wire to any subscriber's line, the said relay being adapted to operate only when the battery-wire is so connected, for the purpose described.

5. The combination, substantially as hereinbefore set forth, of a telephone-switch cord inclosing two separate conductors, a reel provided with an automatic take-up, means, as indicated, for establishing connection between the said two conductors and their respective binding-screws, the clearing-out relay *R*, provided with its local circuit and annunciators, and the automatic circuit-breaking switch *Z*, acting to break simultaneously the connection between any two subscribers' lines and the local circuits.

6. In a telephone-exchange system, the combination, substantially as hereinbefore set forth, of the clearing-out relay *R*, adapted to operate the disconnecting-switch *Z*, the double conducting-cord and reel, the three-contact commutators, the subscribers' private wires, and the battery-wire *T*, all arranged as and for the purpose described.

7. The combination, substantially as hereinbefore set forth, of a commutator having three contacts, one connected to the line, one to an electro-magnetic testing device, and one to an electro-magnet acting to restore the automatic switch of said line to its normal position, with a triple-acting plug formed mainly of non-conducting material, but having a conducting contact-plate attached to the whole of its upper surface, a second conducting-plate attached to a portion of one side of its lower surface, and a third conducting-plate attached at the extreme end of its lower surface, each conducting-plate being completely insulated from the others, for the purpose specified.

8. The combination of a series of normally-open branch circuits, a series of listening-telephones included therein, an electric switch at each line terminal, actuated automatically by an electro-magnet in the main-line circuit and adapted to transfer the said main-line circuit to the listening-telephone branch, and a switch-board interposed in the branch circuits, whereby all or any number of the electric switches or circuit-changers may be connected to any desired listening telephone or telephones, substantially as and for the purpose specified.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 23d day of July, 1881.

JNO. I. SABIN.

Witnesses:

GEO. SAWYER,  
WALTER LOCKARD.