No. 652,928. Patented July 3, 1900.

W. SMITH.

TELEPHONE EXCHANGE SYSTEM.

(No Model.) (Application filed Mar. 28, 1899.)

3 Sheets—Sheet 1.

Fig. 2.

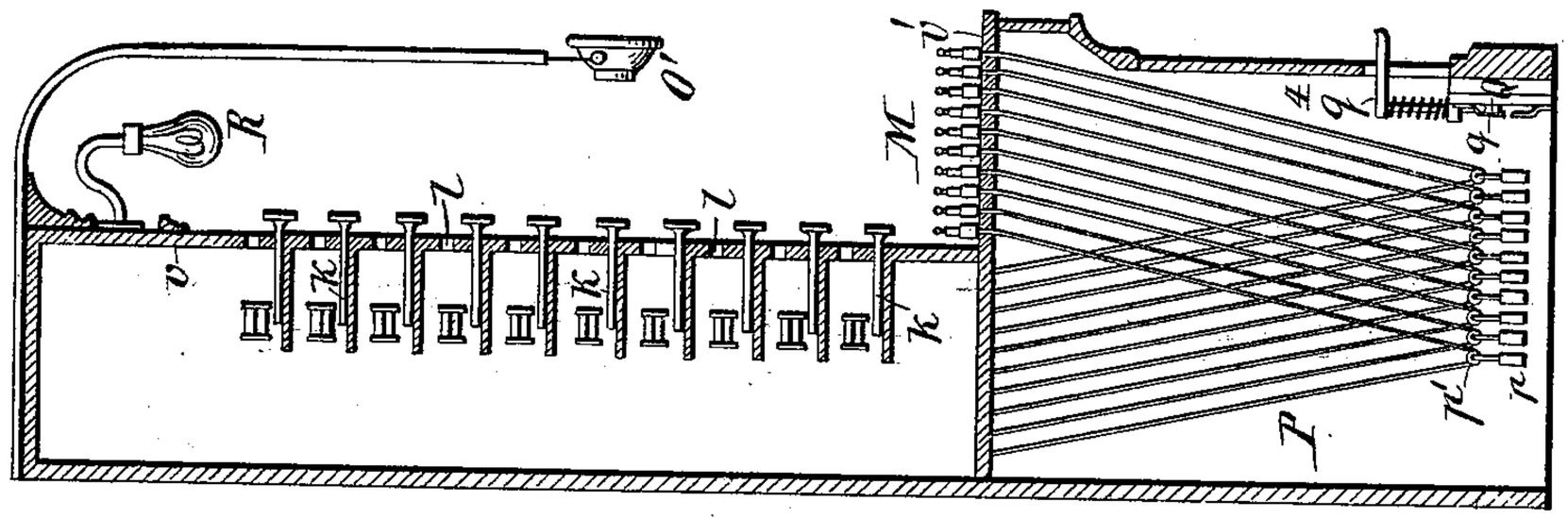
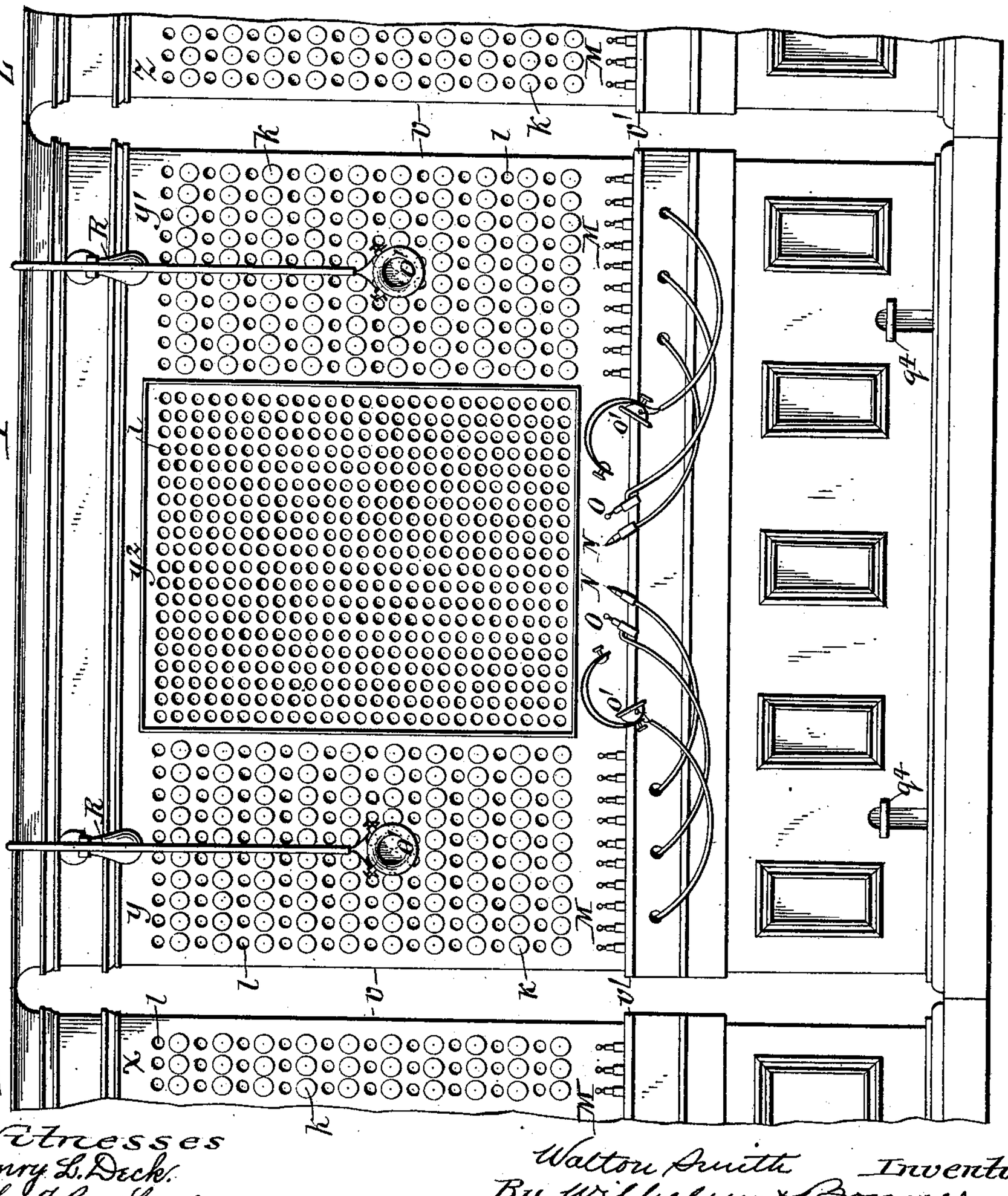


Fig. 1.



Witnesses
Henry L. Deck.
Chas. F. Burkhart.

Walton Smith Inventor.
By Williamson & Bonner.
Attorneys

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(No Model.) 3 Sheets—Sheet 2.

Fig. 3.

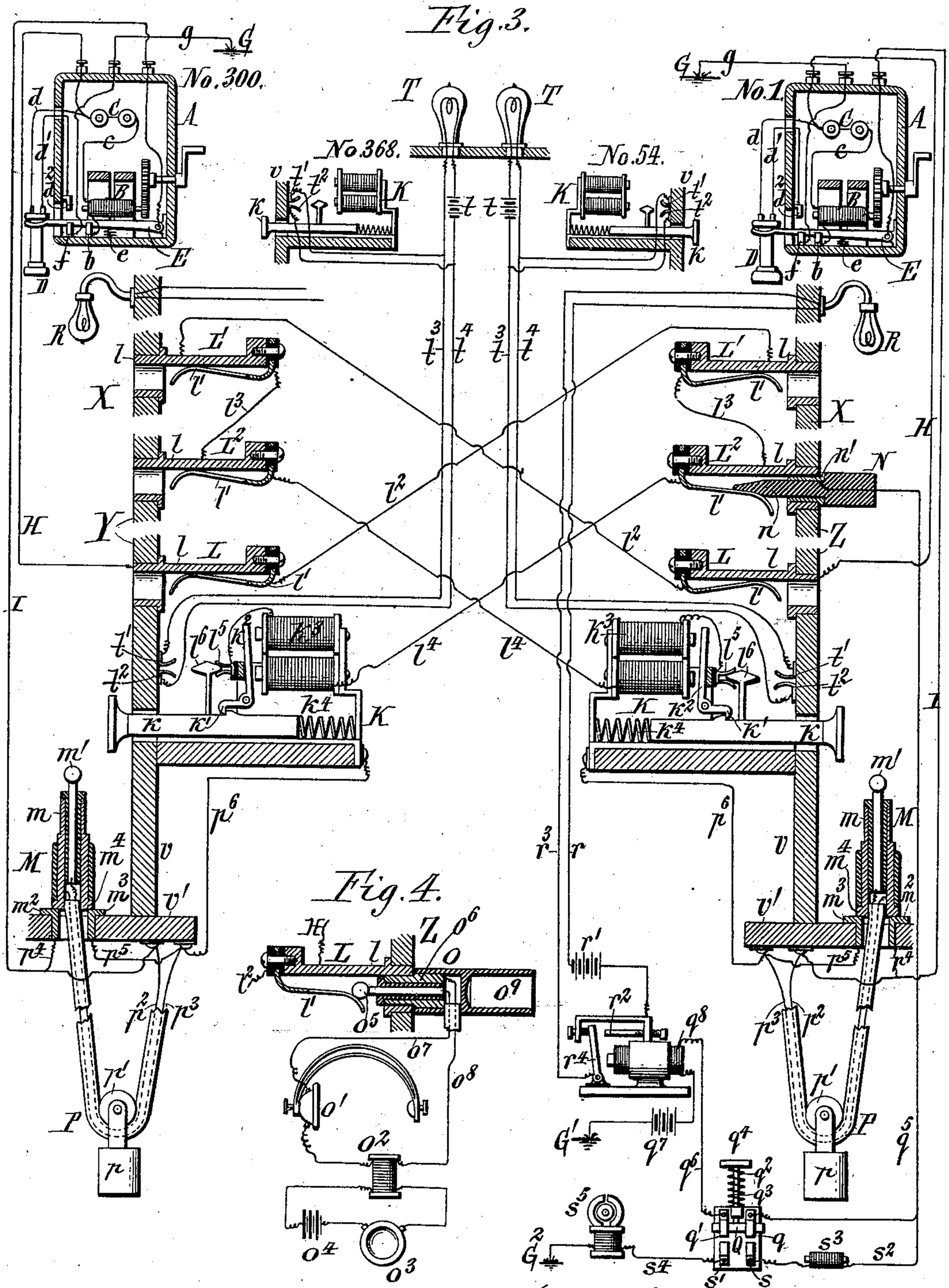

Fig. 4.

Witnesses.
Henry L. Dicke.
Chas. F. Burkhart.

Inventor.
Walton Smith,
By Wilkinson & Bonner
Attorneys.

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W. SMITH.

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(No Model.) 3 Sheets—Sheet 3.

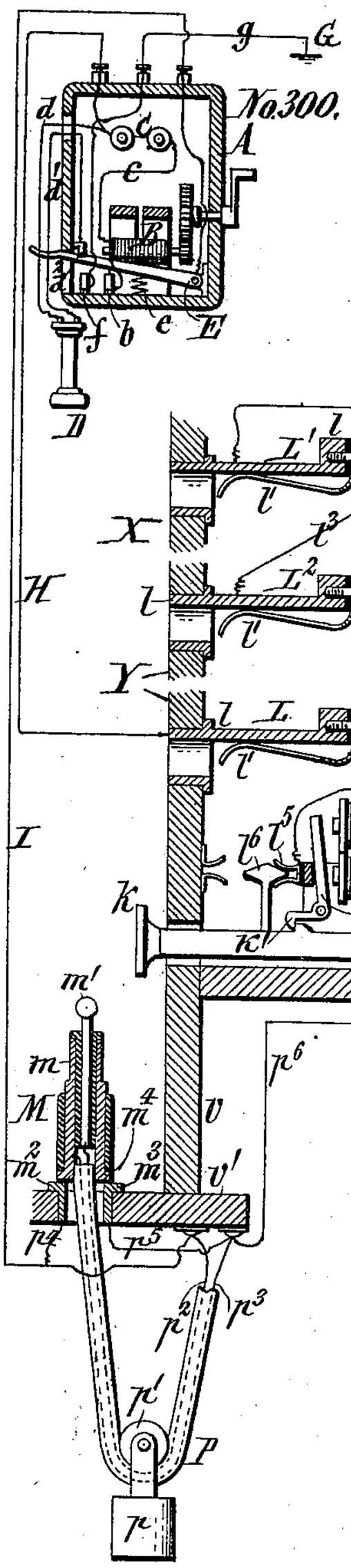

Fig. 5.

Fig. 6.

Witnesses:
Henry L. Decke.
Chas. F. Burkhart.

Walton Smith Inventor
By Wilhelm & Bonner
Attorneys

UNITED STATES PATENT OFFICE.

WALTON SMITH, OF RIDLEY PARK, PENNSYLVANIA, ASSIGNOR TO JAMES S. THOMPSON, OF NORTH TONAWANDA, NEW YORK.

TELEPHONE-EXCHANGE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 652,928, dated July 3, 1900.

Application filed March 28, 1899. Serial No. 710,757. (No model.)

To all whom it may concern:

Be it known that I, WALTON SMITH, a citizen of the United States, residing at Ridley Park, in the county of Delaware and State of Pennsylvania, have invented new and useful Improvements in Telephone-Exchange Systems, of which the following is a specification.

This invention has for its principal object to provide a telephone-exchange system in which a metallic circuit and a ground-circuit are so combined that the testing and calling of a subscriber from the central office and the ringing off between two subscribers are effected over a ground-circuit, while the subscribers talk with each other and with the central office over a metallic circuit, the circuits being so arranged that when an operator calls up a subscriber the annunciator of the latter is not affected and when the subscribers ring off only the annunciator of the calling subscriber is effected, thereby reducing the amount of work required of the operator and increasing the efficiency and rapidity of the service.

My invention has for a further object to improve the telephone-exchange in several other respects.

In the accompanying drawings, consisting of three sheets, Figure 1 is a front elevation showing one complete station and fragments of two adjoining stations which are equipped with my improved system. Fig. 2 is a vertical transverse section of the same through a subscriber's local section of one of the stations. Fig. 3 is a sectional diagrammatic view showing two subscribers having their terminals on different stations, the line of one subscriber being in its normal condition, while the line of the other subscriber is being tested. Fig. 4 is a fragmentary view showing the operator's talking set looped into one of the subscriber's lines. Fig. 5 is a diagrammatic sectional view showing two subscribers which have their terminals on different stations connected so as to be able to converse with each other. Fig. 6 is a fragmentary sectional view showing a modification of my improved telephone-exchange system.

Like letters of reference refer to like parts in the several figures.

X, Y, and Z in Fig. 1 represent the switchboard-stations at the central office of the telephone-exchange system, the station Y being shown complete, while the stations X and Z, arranged on opposite sides of the station Y, are shown fragmentary. As shown in Figs. 1 and 2, each of these stations is provided with an upright board or support v, on which the annunciators and the coupling-jacks of the station are mounted, and a horizontal table v', which projects forwardly from the lower portion of the upright board and supports the coupling-plug of the station. Each station is provided at opposite ends with two local sections or groups of annunciators, coupling-jacks, and coupling-plugs, each local section constituting the terminals of one group of subscribers and being in charge of one operator. Between the two sections or groups of subscribers on each station a multiple jack board or section is arranged which contains a coupling-jack for every subscriber connected with the central office, excepting the subscribers whose terminals are on the adjacent local sections of the same station.

As shown in Figs. 3 and 5, the subscribers are not provided with a multiple coupling-jack on the multiple board adjacent to the local section on which the terminals of the subscriber are located, as the cords of the coupling-plugs are usually long enough to couple the subscribers in the local sections on opposite sides of the multiple board without plugging into the latter; but, if desired, each subscriber may be provided with a coupling-jack on the multiple board of its own station. Each subscriber is provided with a local coupling-jack adjacent to its annunciator and a similar coupling-jack on the multiple board of every other station in the central office, by which arrangement a subscriber on one local section can be coupled by its plug directly with another subscriber on the same section, or a subscriber on one local section can be coupled by its plug to a subscriber on another local section through a jack on the adjacent multiple board.

As shown in Fig. 1, the local sections y y' of station Y are arranged on opposite sides of the multiple section y^2 of this station. The stations are preferably arranged sufficiently close so that subscribers on one local

section of a station can be coupled by their plugs with the jacks of subscribers on the adjacent station without going through a multiple board. For instance, as shown in Fig. 1, the subscribers on local section y of station Y can be coupled directly with the subscribers on local section x of station X and the subscribers on local section y' of station Y can be coupled directly with the subscribers on local section z of station Z.

Fig. 3 shows the normal circuit between the central office and the station of subscriber No. 1, the annunciator, coupling-plug, and local coupling-jack of which are located on section z of switchboard of station Z, and the operator is testing the circuit of subscriber's station No. 300, the annunciator, coupling-plug, and local coupling-jack of which are located on local section y of switchboard of station Y. Fig. 5 shows subscribers' stations No. 1 and No. 300 connected so as to permit of conversing between these stations.

Each of the subscribers' apparatus is so organized that the same may be connected with the telephone-exchange or central office either by a metallic circuit or by a ground-circuit, the essential parts of each subscriber's apparatus for producing these circuits being constructed and wired as follows:

A represents the inclosing case of the subscriber's apparatus; B, the generator; C, the bell-coils; D, the telephone or receiver, and E the vertically-movable switch-lever, which is depressed when the telephone is hung upon the same and raised by a spring e when the telephone is removed therefrom.

Any suitable or well-known form of transmitter may be used at the subscriber's station in connection with the telephone; but for the purpose of simplifying the drawings only the telephone is shown, which in this instance may be used both for talking and listening, and thus serve the purpose of indicating a speaking apparatus.

f is a ground-contact, which is adapted to be engaged by the switch-lever when the latter is in a depressed position and which is connected by a ground line or wire g with a ground G. One end of the coil of the generator-armature is connected with a generator-contact b, which is adapted to be engaged by the switch-lever when the latter is in a depressed position. The other end of the armature-coil is connected by a wire c with one side of the bell-coils. One end of the coil in the telephone is connected by a wire d with the opposite side of the bell-coil, and the other end of the telephone-coil is connected by a wire d' with a contact d^2, which is adapted to be engaged by the switch-lever when the latter is in an elevated position.

H and I represent a pair of main lines or wires whereby the subscriber's apparatus is connected with the central office. The wire H is connected with the bell-coils on the side opposite to that with which the generator is connected and it is also connected with the telephone d, so that the current from the wire H can pass either through the bell-coils and generator, which constitute the signaling apparatus, or through the telephone. The wire I is connected only with the switch-lever E. When the telephone is hung up, as represented in Fig. 3, the switch-lever is depressed, in which position the lever is disengaged from the telephone-contact d^2 and engaged with the ground-contact f and generator-contact b, and the circuit is as follows: The current, entering through wire H, passes successively through the bell-coils C, wire c, generator-coil, generator-contact b, switch-lever E, ground-contact f, and wire g to ground G, the ground-circuit being completed by crossing over to its companion ground at the central office or at another subscriber's station. The current takes this course when the central office calls up a subscriber or when one of two subscribers rings off after the conversation is finished, in both of which cases the signaling apparatus is operated over a ground-circuit. When the ground and signaling apparatus are connected by the switch-lever E with the metallic circuit, the speaking apparatus is wholly disconnected or cut off from the metallic circuit, thereby preventing the same from being injured by powerful electric currents passing over the main lines, such as lightning, electric-light currents, or other violent electrical disturbances. When the telephone is removed from the switch-lever and the latter is elevated by the spring e into engagement with the telephone-contact d^2 and out of engagement with the ground-contact f and generator-contact b, the circuit through the subscriber's apparatus is as follows: The current, entering through wire H, passes successively through wire d, telephone D, wire d', contact d^2, switch-lever E, and wire I, thereby forming a metallic circuit together with the switching apparatus at the central office, with which the opposite ends of the wires H I are connected or with similar wires of another subscriber when coupled with the same for conversation.

K represents the annunciators of the subscribers, which are mounted on the upright switchboard v at the central office. The preferred form of annunciator (shown in Figs. 3 and 5) is so organized that when the subscriber rings up the central office the operator receives a visual signal and the circuit is automatically opened or broken, thereby stopping the ringing of the subscriber's bell and informing the subscriber that his call has been received at the central office. The essential parts of this annunciator are as follows:

k represents a plunger projecting through an opening in the switchboard v and provided at its front end with an indicator head or button; k', a catch pivoted to the annunciator-frame and adapted to engage with a shoulder on the plunger for holding the latter in a retracted position; k^2, an armature

connected with said catch; k^3, a pair of coils which when energized attract the armature and disengage the catch from the plunger, and k^4 a spring whereby the plunger is projected when released by the catch. Each subscriber is provided with one of these annunciators on one of the local sections.

L L' L² represent a number of coupling-jacks, which are arranged in each subscriber's line and which receive the coupling-plugs M of other subscribers and the testing and signaling plug N and the listening and talking plug O of the operator. Each subscriber is provided with a local coupling-jack L adjacent to its annunciator and with a multiple jack, such as L' L², on the multiple board or section of every other station in the central office, so that the operator who has charge of the section or group of subscribers on which the particular subscriber's annunciator and local jack are located can couple directly with the subscriber, and the operators of all the other local sections can likewise couple directly with the same subscriber through the multiple jacks without disturbing the operator who has charge of the local section on which the terminals of said subscriber are located. Each of these jacks consists of two contact members $l\ l'$, which are adapted to be engaged or disengaged for making or breaking the circuit through the same. The contact l consists, preferably, of a metallic socket or support secured to the upright board v and provided with a rearward extension on its upper side, and the other contact l' consists of a spring which is secured by an insulated connection to the rear end of the contact l and bears normally with its downwardly-curved front end against the under side of the extension, so as to make contact therewith.

The wire H of each subscriber runs directly to the local coupling-jack L adjacent to its annunciator and is preferably connected to the socket l or to its extension. The other member l' of the local jack is connected by a wire l^2 to the socket l of the multiple jack L' on the multiple board of another station. The spring l' of the coupling-jack L' is connected by a wire l^3 with the socket l of its companion coupling-jack L² on the multiple board of another station. The multiple jacks of each subscriber are connected in this manner from one multiple board to another, and the final multiple jack is connected with the annunciator of the subscriber, so that all of the coupling-jacks are arranged in one line between the subscriber and his annunciator and are connected in series. As shown in the drawings, coupling-jack L² is assumed to be the last multiple jack of the subscriber, and the spring-contact l' of this jack is connected by wire l^4 with one end of the subscriber's annunciator-coils k^3. The opposite end of the annunciator-coils is connected with an insulated contact l^5, which is mounted on the annunciator-frame and which is adapted to be engaged by a contact l^6 on the plunger k of this annunciator. When the plunger is projected, its contact l^6 moves away from the contact l^5, and the circuit is thereby broken at this point, and upon moving the plunger inwardly until it is held by the catch of the armature the plunger-contact l^6 engages with the contact l^5 of the annunciator-coils, and thereby reëstablishes the circuit at this point.

The coupling-plug M of each subscriber is provided with two contacts $m\ m'$, which are adapted to engage, respectively, with the two members $l\ l'$ of any coupling-jack of another subscriber. This plug preferably consists of a central metallic stem, which constitutes the contact m', and a cylindrical sleeve, which surrounds the stem and constitutes the contact m. The contact stem and sleeve are separated by an intervening sleeve of insulating material, and the contact-sleeve m is partly surrounded by an insulating jacket or sleeve in the usual manner for convenience in handling the same. The coupling-plug is so constructed that when the same is shoved into the jack of a subscriber the central contact m' of the plug will engage with the spring l' of the jack and separate the spring from the socket, and the sleeve of the plug will engage with the socket of the jack, so that the circuit will pass through the plug instead of passing across the jack.

$m^2\ m^3$ represent the two members of a divided contact-seat, which are adapted to support the plug of the subscriber when not in use and which are electrically connected by a bridge m^4, formed by the metallic base or lower end of the contact-sleeve m or by a separate metallic part on the plug or its cord. When the coupling-plug is not in use, the same is returned to and held against its seat, so that the bridge m^4 on its base crosses the contacts $m^2\ m^3$ by a cord P, which is connected with its ends to the plug and to the adjacent stationary part of the switchboard and a take-up weight p, which is provided with a roller p', engaging with the bight of the cord. The cord P contains two wires $p^2\ p^3$. The wire p^2 is connected at one end with the contact m' of the plug, and its other end is connected with the main-line wire I and with the socket contact member m^2 by a branch wire p^4. The other wire p^3 of the cord is connected at one end with the contact-sleeve m of the plug and at its other end with the socket contact member m^3 by a branch wire p^5, and also with the frame of the companion annunciator of the subscriber by a wire p^6. The plunger k, carrying the contact l^6, is in metallic contact with the annunciator-frame to which the wire p^6 is secured, so that the frame and plunger form part of the circuit and serve as a conductor for carrying the current from the wire p^6 to the contact l^6.

If subscriber No. 1, whose line is in normal condition, desires to call up the central office, the signaling-circuit, as represented in Fig. 3, is wholly metallic and is as follows: Begin-

ning at the generator-contact *b* of subscriber No. 1, the current generated passes successively through the switch-lever E, wire I, branch wire p^1, seat-contact m^2, bridge m^4, seat-contact m^3, branch wire p^5, wire p^6, frame and plunger of annunciator, contacts l^6 l^5, annunciator-coils k^3, and wire l^4 to and through the members of multiple coupling-jack L^2 on the multiple board of station Y, thence by wire l^3 to and through coupling-jack L′ on multiple board of station X, thence by wire l^2 to and through local coupling-jack L on local section of subscriber's station Z, thence through wire H to and through bell-coil C and wire *c* and to the opposite end of the generator-coil. This current energizes the annunciator-coils of subscriber No. 1 at the central office, thereby releasing its plunger and permitting the latter to be projected by its spring, so as to inform the operator that subscriber No. 1 has called up, and at the same time this metallic signaling-circuit of the subscriber is broken by reason of the separation of the contacts l^5 and l^6, thereby informing subscriber No. 1 that his call has been received at the central office. During this operation the ground-wire *g* at the station of subscriber No. 1 is connected with the switch-lever E; but since there is no ground elsewhere in this circuit to coöperate with the ground of the subscriber the subscriber's ground at this time has no effect upon the metallic ringing-circuit. The operator now shoves in the plunger of subscriber No. 1, so as to reëstablish a metallic circuit, and at the same time loops in the operator's listening and talking apparatus to find out what the calling subscriber desires. The operator's listening and talking apparatus is wholly distinct from the remaining portion of the switchboard, and consists, essentially, as shown in Fig. 4, of a listening-telephone *o′*, which is in circuit with an induction-coil o^2, and a speaking-microphone o^3, which is in circuit with a battery o^4 and the induction-coil o^2. The listening and talking plug O of the operator's listening and talking apparatus is provided with a central contact-spindle o^5 and a surrounding insulated contact-sleeve o^6, and these contacts are connected, respectively, with the telephone-wires o^7 o^8, which are arranged in a cord in the usual manner. The operator pushes this plug O into the local coupling-jack L of the calling subscriber, and in doing so the center contact o^5 of the plug engages with the spring l' of this jack and moves the same away from the socket extension, so as to break the connection between the spring and socket, and the sleeve-contact o^6 of the plug engages with the socket *l*, thereby looping the operator's listening and talking set into the metallic circuit between the operator and subscriber No. 1. The subscriber No. 1 upon now removing his telephone from the switch-lever permits the latter to be raised, thereby throwing out his signaling apparatus and the ground-wire and looping in his telephone, so that conversation can now be carried on between the subscriber and the operator over a metallic circuit, during which the current passes as follows: Beginning at wire *d* on one side of the subscriber's telephone, the current passes successively through wire H, socket *l* of local coupling-jack L, contact o^6 of operator's listening and talking plug, wire o^8, induction-coil o^2, telephone *o′*, wire o^7, central contact o^5 of operator's plug O, spring l' of jack L, wire l^2 to and through the members of multiple coupling-jack L′ on station X, wire l^3 to and through multiple coupling-jack L^2 on station Y, wire l^4, coils k^3, contacts l^5 l^6, plunger *k*, and frame of subscriber No. 1's annunciator, wires p^6 p^5, contact m^3, bridge m^4, contact m^2, wire p^4, main line I, switch-lever E, telephone-contact d^2, and wire *d′* to the opposite side of telephone D of subscriber No. 1. The listening and talking plug O is provided at its rear end with a thimble or socket o^9, as shown in Fig. 4, so that the same can be slipped on the finger of the operator, thereby enabling the operator to conveniently shove in the plunger of the calling subscriber and looping the listening and talking set into the circuit of the subscriber by a single movement of one hand, whereby the other hand of the operator is left free to ring up the called subscriber and effect a connection between the calling and called subscribers.

Having ascertained that subscriber No. 1 wishes to talk to subscriber No. 300, whose annunciator is located on station Y, the operator proceeds to test the line of subscriber No. 300 to see if his line is in use, and then calls this subscriber, if he is not busy, by means of the operator's testing and calling set, which is constructed as follows:

Plug N is provided with a central insulating-stem *n* and with a metallic contact-sleeve *n′*, surrounding the insulating-stem.

q *q′* represent two upper members of a switch, which are adapted to be connected or disconnected by a vertically-movable switch-bar Q. This switch-bar is yieldingly held in an elevated position, so as to connect the contacts *q* *q′* by a spring q^2, which surrounds a vertical shifting rod q^3, connected with the switch-bar. The upper end of this rod is provided with a treadle q^4, so that the operator can depress the switch-bar by means of the foot and move the switch-bar downwardly out of engagement with the contacts *q* *q′*, and thereby break the connection between these contacts. The contact *q* is connected by wire q^5 with the contact *n′* of the plug N, and the other contact *q′* is connected by a wire q^6 with a ground G′ at the central office. This wire q^6 includes a constant-current electric generator q^7 and the coil q^8 of a relay.

R represents a testing-lamp which is arranged adjacent to the group of subscribers which the operator has in charge and which is lighted whenever the operator shoves the plug N into a coupling-jack of a subscriber whose

line is not in use, thereby informing the operator that he can call up this subscriber and connect him with the subscriber who wishes to speak to him. This light is arranged in a circuit, one wire r of which includes an electric generator r' and terminates in a contact r^2 on the relay, and the other wire r^3 of which circuit is connected with the armature r^4 of the relay. When the operator shoves the plug N into the coupling-jack of a subscriber, the insulating-stem thereof engages with the spring of the coupling-jack and disengages the same from the socket, so as to break the circuit at this point, and the sleeve-contact n' of the plug N engages with the socket l of said jack. If the subscriber's line into one of whose coupling-jacks the operator has shoved the plug N is not in use, a ground-circuit is established between the operator's ground G′ at the central office and the ground at subscriber's station. If the operator has shoved the plug N into the multiple coupling-jack L^2 of subscriber No. 300 and the line of the latter is not in use, as shown in Fig. 3, the ground-circuit is as follows: Beginning at the ground G′ at the central office the current passes successively through the generator q^7 and relay-coil q^8, arranged in wire q^6, thence through contact q', switch-bar Q, contact q, wire q^5, plug-contact n', socket l, wire l^3 to multiple jack L′, wire l^3, local jack L of subscriber No. 300, wire H, coils C, wire c, generator B, generator-contact b, switch-lever E, ground-contact f, and wire g to ground at subscriber No. 300. When the ground-circuit from the operator to subscriber No. 300 is thus completed, the relay-magnet coil is energized and attracts its armature, so that the latter bears against the contact r^2, thereby completing the circuit, which includes the lamp R and the generator r', and lighting this lamp, whereby the operator is informed that the line is not in use. If subscriber No. 300 has removed his telephone from the switch-lever E and is talking over his line to another subscriber, his ground is open, and if at this time the operator shoves the plug N into a coupling-jack in the line of subscriber No. 300 no companion ground will be found at this subscriber's apparatus to work in conjunction with the operator's ground G′, and consequently the circuit cannot be completed through the generator q^7 and the relay-coil q^8, whereby the circuit including the lamp R is left open and does not light the lamp, thereby informing the operator that the line of subscriber No. 300 is busy. If the operator finds upon testing a subscriber's line that the same is busy, which is indicated by the failure of the lamp R to light instantly, the operator immediately withdraws the plug N, so as not to interrupt the conversation of the subscribers.

s s' represent two lower contacts which are arranged opposite the contacts q q' and which are adapted to be connected or disconnected by the switch-bar Q. The contact s is connected with the main wire q^5 of the plug N by a branch wire s^2, which includes a buzzer s^3 or other signaling device. The other contact s' is connected with a ground G^2 at the central office by a wire s^4, including an alternating-current electric generator s^5. If the operator finds upon introducing the plug N into a coupling-jack of a subscriber that the latter is not busy, which fact is indicated by the lighting of the lamp R, the operator depresses the switch-bar Q by means of the foot, so that it clears the testing-contacts q q' and engages with the signaling-contacts s s'. Assuming that the operator is calling up subscriber No. 300, the current passes from the central office over a ground-circuit to the signaling apparatus of subscriber No. 300, as follows: Beginning at ground G^2 the current passes successively through wire s^4, including generator s^5, contact s', switch-bar Q, contact s, wire s^2, including the buzzer s^3, wire q^5, plug-contact n', socket l of multiple jack L^2, wire l^3, to and through the members of multiple jack L′, wire l^2, to and through the members of local jack L of subscriber No. 300, main wire H, bell-coils C, wire c, generator-coil B, generator-contact b, switch-lever E, ground-contact f, and wire g to the ground of subscriber No. 300. When the ground-circuit is thus completed, the bells of subscriber No. 300 are sounded and operator's buzzer s^3 is sounded, thereby informing the operator that her calling apparatus is in working condition. If an operator tests a subscriber's line and the test-lamp lights without getting a reply from the subscriber, the line is accidentally grounded between the subscriber and the central office, and if the operator's test-lamp after repeated tests does not light the line is broken or the subscriber has failed to hang up the telephone to apply the ground.

The several coupling-jacks of each subscriber are connected in series, as shown in the drawings, and the operator's testing and signaling plug N is so constructed that when the plug is shoved into any one of the coupling-jacks of the subscriber the operator's ground-line is connected with that side or contact of the jack which leads directly to the signaling mechanism of the subscriber's station, and the opposite side or contact of the same jack is deflected, so as to break the metallic circuit at this point, and cuts out the subscriber's annunciator, which is connected with the cut-out side of the jack. By this means the current from the operator's generator does not go through the subscriber's annunciator, but passes around the same, thereby avoiding operating the line at the annunciator of the called subscriber when the latter is called up, which otherwise would require the operator at the called-subscriber's station to close the line again at the annunciator before a metallic talking-circuit could be subsequently established. In order to avoid operating the annunciator of a subscriber when the latter is called up by an op-

erator, the insulating-stem n of the plug N is made sufficiently long, so that it will disengage the spring l' from the socket l of the jack before the sleeve-contact n' of this plug engages with the socket l; otherwise the current from the generator s^5 might reach the ground of a subscriber through the annunciator-coil of the same and open the line at that point by projecting the plunger. After the operator has called up subscriber No. 300 he withdraws the coupling-plug N from the coupling-jack L^2 of this subscriber and then moves the plug M of subscriber No. 1, so as to disconnect the contacts m^2 m^3, and shoves it into the multiple jack L^2 of subscriber No. 300, as shown in Fig. 5, whereby a metallic talking-circuit is established between subscriber No. 1 and subscriber No. 300, which runs as follows: Beginning at wire d, on one side of the telephone D of subscriber No 1, the current passes successively through wire H, to and through the members of the local jack L, wire l^2, to and through jack L' on the multiple board of station X, wire l^3, to and through jack L^2 on the multiple board of station Y, wire l^4, coils k^3, contacts l^5 and l^6, plunger k, and annunciator-frame of subscriber No. 1, wire p^6, wire p^3 in cord P, socket l of multiple jack L^2 on station Z, wire l^3, to and through jack L' of subscriber No. 300 on multiple board of station X, wire l^2, to and through local jack L of subscriber No. 300, main wire H, wire d, telephone D of subscriber No. 300, wire d', contact d^2, switch-lever E, main wire I, branch wire p^4, contact m^2, bridge m^4, contact m^3, wires p^5 p^6, frame-plunger k, contacts l^6 l^5, and coils k^3 of subscriber's annunciator No. 300, wire l^4, contact l' of multiple jack L^2 of subscriber No. 300 on station Z, center contact m' of plug M of subscriber No. 1, wire p^2, main wire I, switch-lever E, contact d^2, and wire d' to the opposite side of the telephone D of subscriber No. 1. It will be seen that the conversation of the two subscribers is carried on through the annunciator-coils of both subscribers. After the subscribers have finished their conversation and both have hung up their telephones, so as to ground both of their stations, either one of the subscribers upon operating his generator can give the ring-off signal to the central office over a ground-circuit which extends from one subscriber to the other as follows: Beginning at the ground of subscriber No. 1 the current passes successively through ground-wire g, ground-contact f, switch-lever E, generator-contact b, armature-coil of generator B, wire c, bell-coils C, wire H, local jack L of subscriber No. 1, wire l^2, multiple jack L' on station X, wire l^3, multiple jack L^2 on station Y, wire l^4, coils k^3, contacts l^5 l^6, plunger k, and frame of annunciator of subscriber No. 1, wire p^6, wire p^3, contact m of subscriber's plug No. 1, socket l of subscriber No. 300, multiple jack L^2 on station Z, wire l^3, to and through multiple jack L' of subscriber No. 300 on station X, wire l^2, to and through local jack L of subscriber No. 300, wire H, bell-coils C, wire c, coils of generator-armature B, generator-contact b, switch-lever E, ground-contact f, and ground-line g to ground at subscriber No. 300. It will be seen that the ringing-off ground-circuit includes only the annunciator-coils of the calling subscriber, whereby only the latter's annunciator-plunger is projected and utilized as a "clearing-out drop" to notify the operator who made the connection between the subscribers that the subscribers have finished talking, thereby avoiding signaling the operator on whose local section the called-subscriber's annunciator is located, which would otherwise require the operator on the called-subscriber's local section to restore the latter's annunciator to its normal retracted position. When the plunger of the calling subscriber is projected, the operator on the local section of the calling subscriber upon receiving the signal that the subscribers have finished talking pulls the coupling-plug M of subscriber No. 1 out of the multiple jack L^2 of subscriber No. 300 and replaces the same upon the socket-contacts m^2 m^3, so as to connect the same and restore the lines of both subscribers to their normal condition. By this arrangement of the circuits it is possible for an operator at one station to connect a calling subscriber at this station with a called subscriber on another station and effect a disconnection between these subscribers without the aid of the operator on whose station the called subscriber is located. If one subscriber after conversing with another subscriber should neglect to hang up his telephone, so that the line would not be grounded at his station, and the other subscriber operates his generator for the purpose of ringing off, the current will pass over the same metallic circuit over which the subscribers have been carrying on their conversation, excepting that the signaling apparatus of the subscriber whose telephone is hung up will be in circuit, and as this circuit includes the annunciator-coils of both subscribers the signal-plungers of both subscribers will be projected, thereby informing both the operators having charge of the terminal of the calling and the called subscribers that the conversation is finished. The operator at the calling-subscriber's station upon receiving this signal will disconnect the subscribers and reestablish the lines to their normal condition, while the operator at the called-subscriber's station, presuming that a call has been received from the called subscriber, will loop her telephone into the called-subscriber's local jack, and receiving no reply will restore the called-subscriber's annunciator to its normal position.

In order to enable the superintendent of the central office to determine whether any one operator is negligent in responding to the calls of the subscribers on her local section, an indicator-lamp T for each section is arranged at the superintendent's quarters, and

each of these lamps is connected with a generator t and provided with a pair of contacts $t' t^2$, adjacent to the plungers of every annunciator on its companion local section. Each pair of contacts is adapted to be closed for lighting the superintendent's lamp T by the outward movement of the plunger and is effected by engaging the contact l^6 of the plunger with the adjacent lamp-contacts $t' t^2$. The contacts $t' t^2$ of each annunciator are connected in multiple with the main wires $t^3 t^4$ of the indicator-lamp T, as shown in Fig. 3, in which subscribers No. 1 and No. 54, arranged on the same local section, have their annunciator-contacts $t' t^2$ connected with the same lamp-circuit and subscribers No. 300 and No. 368, arranged on the same local section, have their annunciator-contacts $t' t^2$ connected with another indicator-lamp. When any one of the annunciators of a section is projected, the superintendent's lamp lights and remains lighted until all of the annunciators of the respective section have been replaced.

In the modification of my improved telephone-exchange system shown in Fig. 6 an annunciator U, with a drop-indicator apron u, is employed. The coil of this annunciator is connected with the main line, so that when the subscriber sends in a call only the indicator-apron is dropped, but the line is not opened, so as to inform the subscriber that his call was received at the central office, as in the construction of the annunciator shown in Figs. 3 and 5. Fig. 6 also shows a modified construction of the coupling plug and jack, the plug having its contacts $l^7 l^8$ arranged on opposite sides of an insulating-stem and the jack having both of its contact members $m^5 m^6$ made in the form of springs.

The operation, briefly stated, of my improved telephone-exchange system is as follows: A subscriber when turning his generator for calling up the central office operates his annunciator so as to project his plunger, thereby informing the operator that a call has been sent in, and the line is at the same time opened, thereby informing the subscriber that his call has been received. The operator now shoves in the plunger of the subscriber, so as to reëstablish the circuit, and by the same movement of the hand loops the listening and talking plug into the local jack of the calling subscriber's line for the purpose of learning the desire of the subscriber. Having been informed with whom the calling subscriber wishes to be connected, the operator next shoves the plug of his testing and ringing set into a coupling-jack of the called subscriber, and if his lamp does not light he immediately withdraws the testing and ringing plug and informs the calling subscriber with whom he is still connected that the party desired is busy. If the lamp lights upon shoving the testing and ringing plug into the jack of the called subscriber, the latter is not busy, and while the testing and ringing plug is still in this coupling-jack the operator depresses the treadle, thereby cutting out the operator's testing-circuit and cutting in the the operator's ringing-circuit, whereby the subscriber wanted is called up. The operator now removes her talking-plug from the calling-subscriber's local jack and then removes her testing and ringing plug from the coupling-jack of the called subscribed, and in the place of the testing and ringing plug inserts the plug of the calling subscriber, thereby connecting the subscribers. When the latter have finished their conversation and ring off, the plunger of the calling subscriber is projected, and upon receipt of this visual signal the operator pulls out the coupling-plug of the calling subscriber and returns the same to its normal position and also shoves the calling-subscriber's plunger inwardly, so as to restore the line. The various operations attending the connection and disconnection of two subscribers are obtained by the fewest number of movements, which can be made with great rapidity and certainty, thereby increasing the efficiency of the telephone system.

I claim as my invention—

1. In a telephone-exchange system, the combination with a metallic circuit which connects a subscriber's station with a central office and which is normally grounded at the subscriber's station and normally ungrounded at the central office, of a number of coupling-jacks each of which consists of only two coöperating contacts connected in series in the metallic circuit at the central office so that all of the coupling-jack contacts are in circuit when a subscriber is connected with another subscriber, an annunciator arranged at the central office in one side of said circuit, a speaking apparatus and a signaling apparatus arranged at the subscriber's station in the opposite side of said circuit, a ground arranged at the subscriber's station, a switch whereby the ground and signaling apparatus or the speaking apparatus may be connected with the metallic circuit, a coupling-plug connected by branch wires with the metallic circuit on the same side which includes the annunciator, and a switch which is operated by the coupling-plug and which cuts out the coupling-plug from the circuit when the same is retracted and which cuts in the coupling-plug when the same is withdrawn, substantially as set forth.

2. The combination with a metallic circuit connecting a subscriber's station with a central-office switchboard, of a ground-line connected with the metallic circuit at the subscriber's station, a plug which is adapted to be connected with the metallic circuit at the central office and which is connected with a line having two grounded branches, one branch including a constant-current generator and a relay-coil, while the other branch includes an alternating-current generator and an indicator, a local circuit including an indicator and a generator and controlled by the relay, and a switch whereby either one or the

other of said branches is connected with the line of the plug, substantially as set forth.

3. In a telephone-exchange system, the combination with a metallic circuit which connects a subscriber's station with a central office and which is normally grounded at the subscriber's station and normally ungrounded at the central office, of a number of coupling-jacks each of which consists of only two co-operating contacts connected in series in the metallic circuit at the central office so that all of the coupling-jack contacts are in circuit when a subscriber is connected with another subscriber, an annunciator arranged at the central office in one side of said circuit, a speaking apparatus and a signaling apparatus arranged at the subscriber's station in the opposite side of said circuit, a ground arranged at the subscriber's station, a switch whereby the ground and signaling apparatus or the speaking apparatus may be connected with the metallic circuit, a coupling-plug connected by branch wires with the metallic circuit on the same side which includes the annunciator, a switch which is operated by the coupling-plug and which cuts out the coupling-plug from the circuit when the same is retracted and which cuts in the coupling-plug when the same is withdrawn, a ground-line arranged at the central office and including an indicator, and an operator's plug connected with the ground-line at the central office and provided with a single contact and with an insulating member, said operator's plug being adapted, when inserted in a coupling-jack, to pass with its insulating member between the contacts of the coupling-jack and separate the same so as to break the circuit on the side containing the annunciator, while the contact thereof is adapted to engage the contact of the coupling-jack which is included in the side of the metallic circuit containing the signaling and speaking apparatus of the subscriber's station, whereby the annunciator is not affected when the operator tests a line or calls up a subscriber's station, substantially as set forth.

Witness my hand this 25th day of March, 1899.

WALTON SMITH.

Witnesses:
JAMES W. SCRIBNER,
THEO. L. POPP.