

**No. 613,036.**

**Patented Oct. 25, 1898.**

**C. S. HEILMAN.**  
**TELEPHONE EXCHANGE SYSTEM.**

(Application filed Nov. 21, 1896.)

(No Model.)

**3 Sheets—Sheet 1.**

Fig. 1.

Fig. 3.

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Fig. 4.

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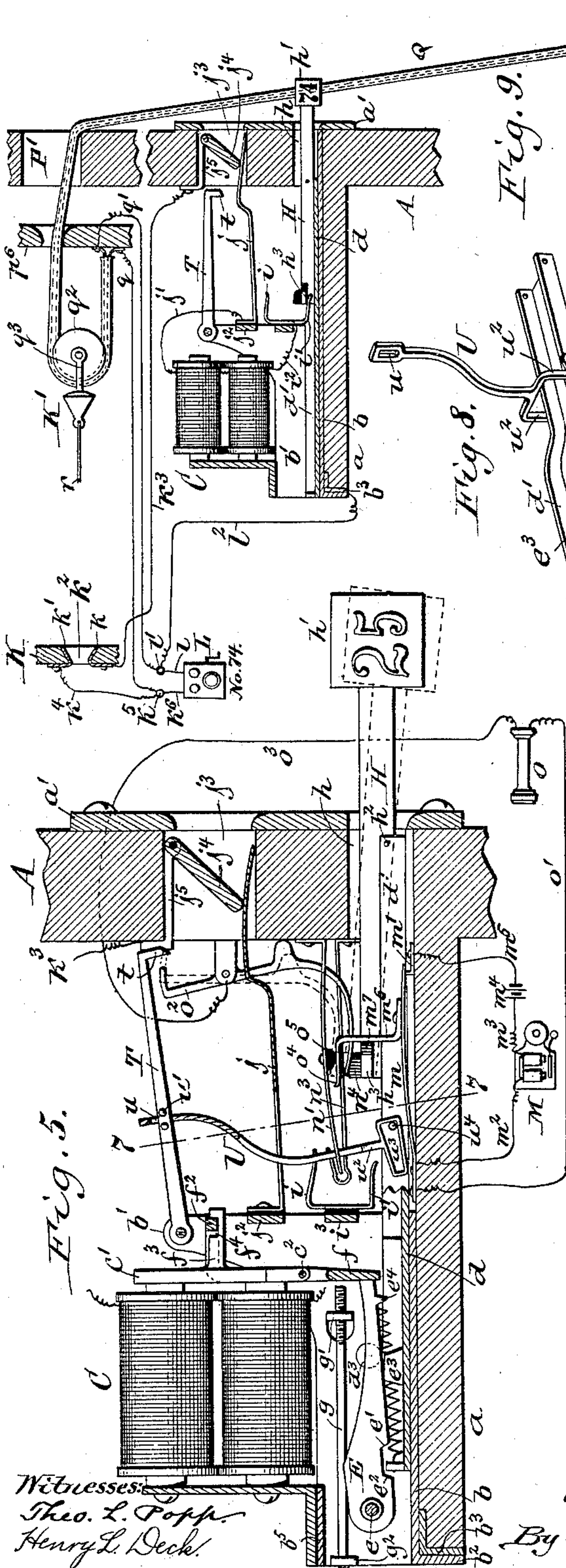
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3 Sheets—Sheet 2.



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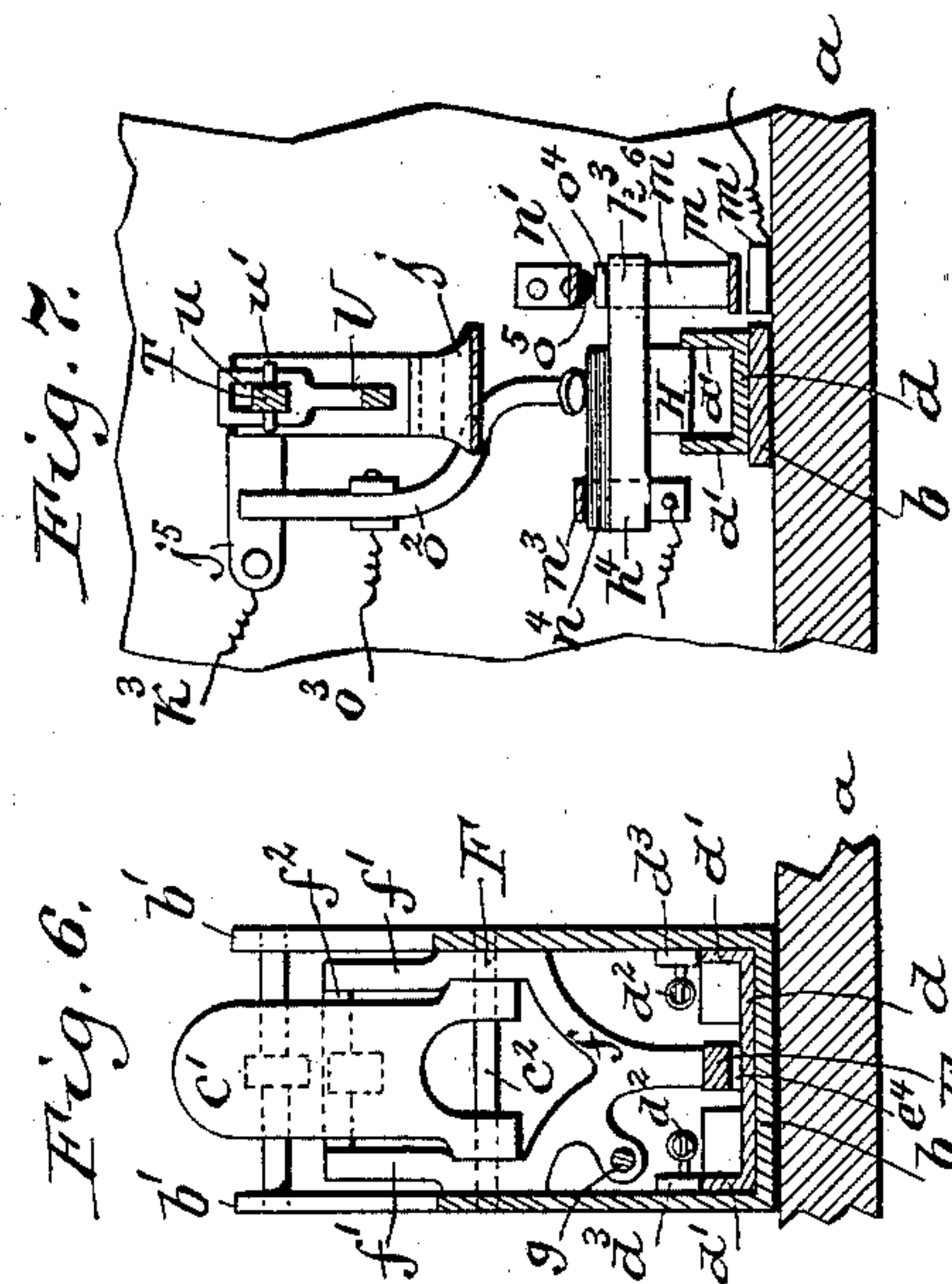
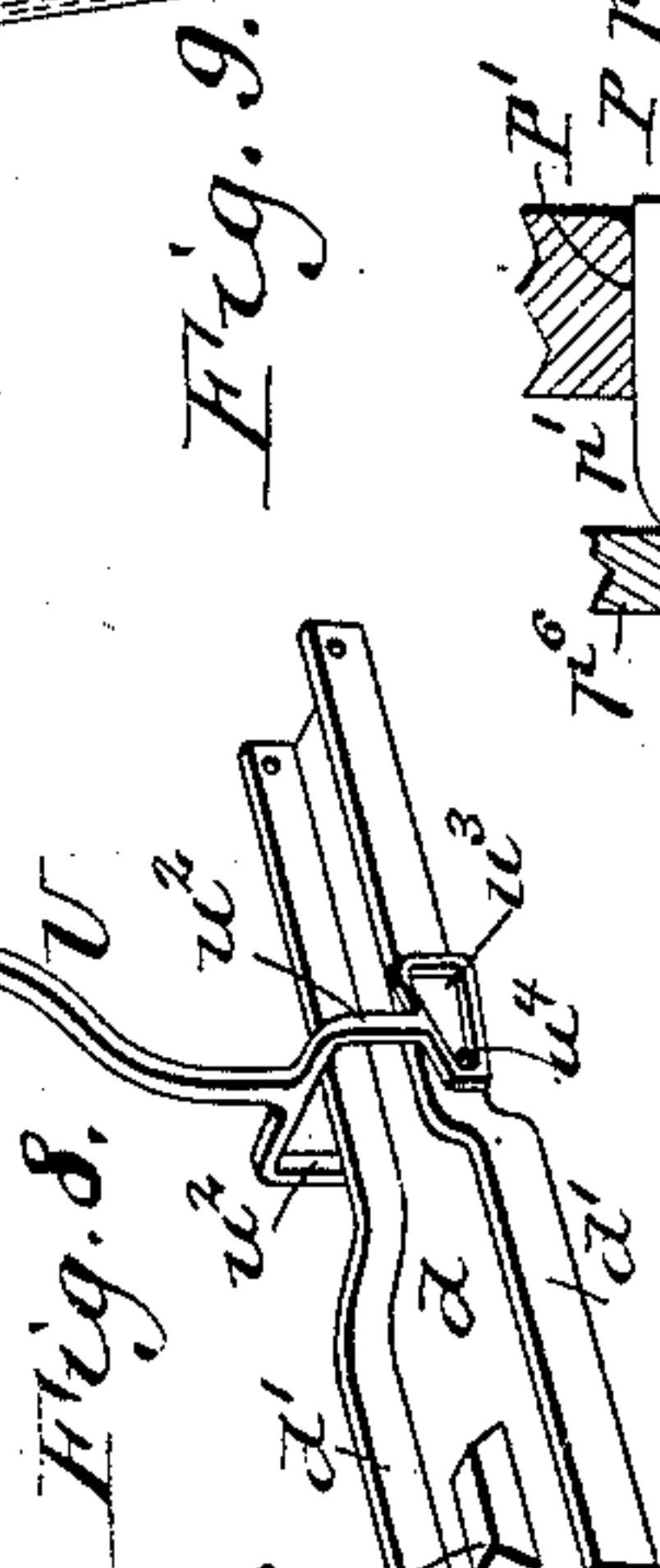


Fig. 7.

Fig. 6.

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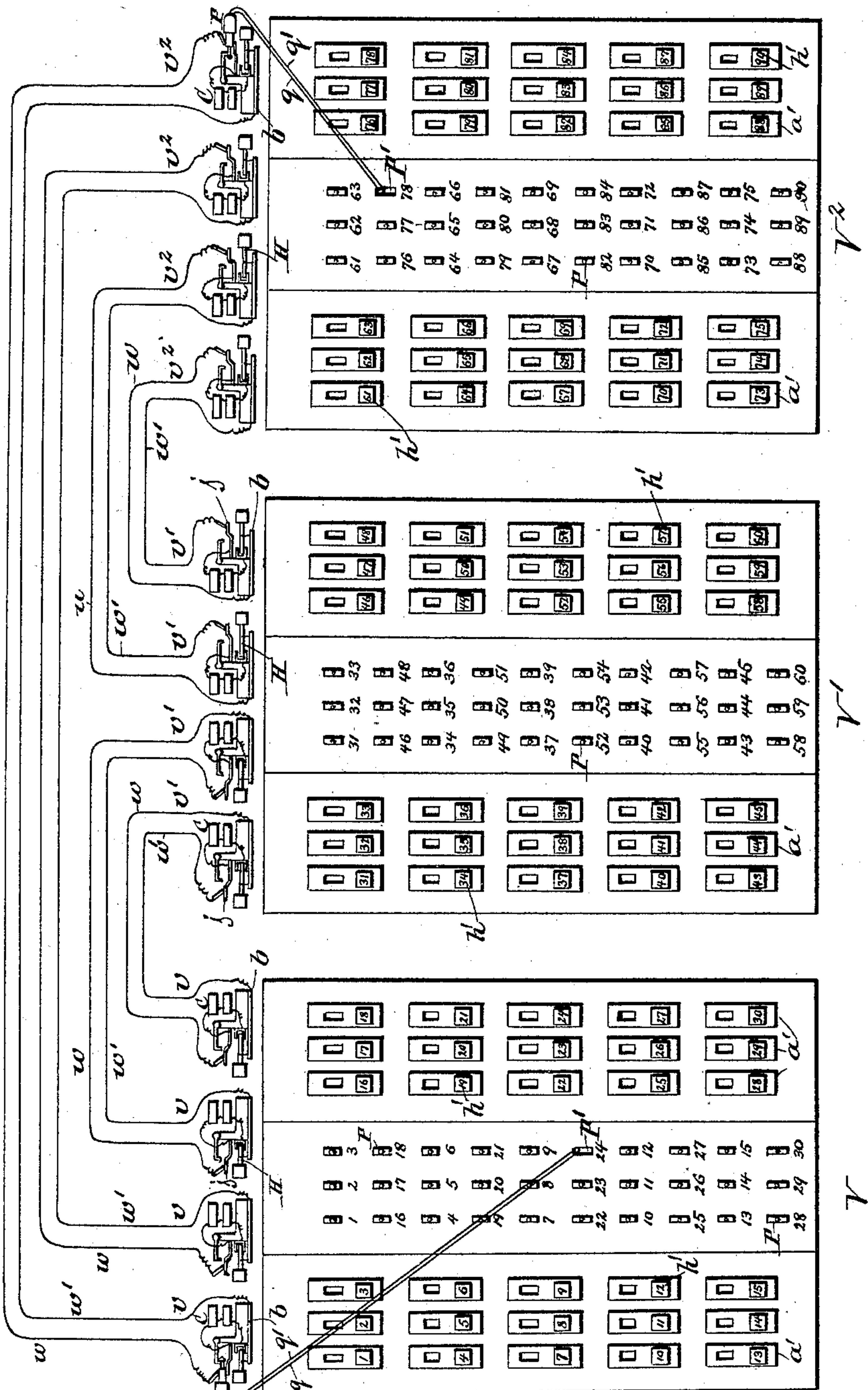
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(No Model.)

3 Sheets—Sheet 3.

Fig. 10.



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# UNITED STATES PATENT OFFICE.

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## TELEPHONE-EXCHANGE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 613,036, dated October 25, 1898.

Application filed November 21, 1896. Serial No. 612,946. (No model.)

*To all whom it may concern:*

Be it known that I, CHARLES S. HEILMAN, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented new and useful Improvements in Telephone-Exchange Systems, of which the following is a specification.

This invention relates to a telephone system, and has the object to improve the construction of the annunciator, the coupling-plug, the means for returning the coupling-plug to its normal position, to prevent looping in the talking-circuit when the subscriber of one board is connected with a subscriber on another board, and to improve the system in other respects.

In the accompanying drawings, consisting of three sheets, Figure 1 is a fragmentary longitudinal sectional elevation of the switchboard, showing one of the subscribers' lines and connecting parts in their normal position. Figs. 2 and 3 are horizontal sections in lines 2-2 and 3-3, Fig. 1, respectively. Fig. 4 is a front end view of one of the subscribers' coupling-plugs. Fig. 5 is a sectional elevation similar to Fig. 1, showing the position of the parts when the subscriber calls up the central office. Fig. 6 is a vertical transverse section in line 6-6, Fig. 1. Fig. 7 is a similar section in line 7-7, Fig. 5, showing the key shifted for switching in the operator's talking apparatus. Fig. 8 is a perspective view of one of the switch-plungers and the plug-releasing link. Fig. 9 is a sectional view, on a reduced scale, showing the position of the parts when the lines of two subscribers are coupled. Fig. 10 is a front elevation, on a reduced scale, showing the means whereby the subscribers on one operator's or terminal board may be connected with a subscriber on another operator's board.

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

A represents the upright front portion of the switchboard, and  $a$  one of the horizontal shelves which project from the rear side of the front board.

The frames which support the annunciators are arranged in a row on each shelf in rear

of the front board, and each frame consists, essentially, of a base  $b$ , which is fastened to the top of the shelf, two uprights or standards  $b'$ , arranged lengthwise on opposite sides of the rear portion of the base, a lip  $b^2$  depending from the rear end of the base and secured to an angle-plate  $b^3$  on the rear edge of the shelf by a screw  $b^4$ , and a cross-bar  $b^5$ , connecting the upper rear portions of the standards.

C represents the electromagnet, having its coils arranged one above the other and secured with their rear ends to the cross-bar  $b^5$  of the frame.

$c'$  is the armature, which is arranged vertically in front of the poles of the electromagnet end, which is pivoted with its lower portion on a horizontal pin  $c^2$ , connecting the standards.

Between the base of the annunciator-frame and the electromagnet a longitudinally-movable plunger is arranged, which consists, essentially, of a bottom plate  $d$ , having a wide rear portion and a narrow front portion, and two flanges  $d'$ , arranged lengthwise on opposite sides of the wide and narrow portions of the base. The bottom of the plunger slides on top of the base of the annunciator-frame and the flanges on its rear portion bear against the inner side of the standards, as represented in Figs. 1, 2, 5, 6, and 7. The forward movement of the plunger is effected by springs  $d^2$ , arranged lengthwise over the side portions of the plunger and secured with their rear ends to the rear end of the plunger and with their front ends to the standards. The plunger is held down on the base of the annunciator-frame by rollers  $d^3$ , pivoted on the inner side of the standards and bearing upon the rear portions of the flanges of the plunger, as represented in Figs. 1, 2, and 6.

E represents a locking-lever whereby the plunger is held in its retracted position and which is arranged lengthwise above the rear portion of the plunger. This locking-lever is pivoted with its rear end by a transverse pivot  $e$  to the standards, so as to swing vertically with its front end, and its under side is provided near its pivot with a notch, forming front and rear shoulders  $e'$   $e^2$ , respectively.



This notch is adapted to engage with a lug  $e^3$ , arranged on the rear portion of the bottom of the plunger when the latter is retracted and the locking-lever is depressed, thereby holding the plunger in its retracted position against the forward pull of the springs  $d^2$ . The downward movement of the front portion of the locking-lever is limited by means of a stop lug or teat  $e^4$ , which is formed on the under side of the locking-lever and which bears against the plunger-bottom when the locking-lever is in its operative position. This lug is preferably V-shaped, so that it can penetrate any dust or clear away any other slight obstruction on the plunger, thereby enabling the locking-lever to always descend into its lowermost or operative position.

F represents an intermediate or releasing lever whereby the locking-lever is held in its depressed position when the plunger is retracted and which is pivoted on the same pin  $c^2$  on which the armature is pivoted. The releasing-lever is arranged vertically, with its lower arm  $f$  adjacent to the front end of the locking-lever, and its upper portion is divided, forming two upper arms  $f'$   $f'$ , which are arranged on opposite sides of the armature. The upper ends of the upper arms  $f'$  of the releasing-lever are bent forwardly and are connected in front of the armature by a cross-bar  $f^2$ .

$f^3$  is a forwardly-projecting lug formed on the front side of the armature and provided with a notch  $f^4$ , which receives the cross-bar  $f^2$  of the releasing-lever.

During the last portion of the inward or rearward movement of the plunger the rear side of its locking-lug engages with the rear side of the notch in the locking-lever, and thereby aids gravity in producing a quick downward movement of the locking-lever. The instant the latter reaches its lowermost position the lower end of the releasing-lever is swung rearwardly over the free end of the locking-lever, whereby the latter is prevented from rising by the forward pressure of the locking-lug of the plunger against the front side of the notch in the locking-lever. The backward or locking movement of the lower arm of the releasing-lever is produced by the forwardly-overhanging weight of the upper arms thereof. When the armature is attracted by the electromagnet, its hook, which embraces the cross-bar of the releasing-lever, pulls the upper arms of the latter backwardly and its lower arm forwardly until it clears the locking-lever, whereby the latter is raised and the plunger is projected forwardly or outwardly by the springs  $d^2$ . The notch in the lug of the armature is of such length so as to produce a loose fit and permit of some play between the armature and the releasing-lever. When the armature is retracted, it rests by gravity with the rear side of the notch in its lug  $f^3$  against the cross-bar of the releasing-lever, while the front side of said notch is removed from said cross-bar. When the

armature is attracted, it moves idly toward the electromagnet until the front side of the notch in the armature-lug strikes the cross-bar of the releasing-lever, after which the upper end of the latter is moved backwardly with the armature and its lower end is moved forwardly out of engagement with the locking-lever, thereby releasing the latter and the plunger. By allowing the armature to move independent of the releasing-lever during the first portion of its movement toward the electromagnet the armature acquires a momentum and strikes the releasing-lever with a blow of considerable force, thereby insuring the release of the locking-lever and permitting a comparatively light or low wound electromagnet to be employed. The throw of the releasing and locking levers is regulated by a horizontal adjusting-screw  $g$ , arranged lengthwise between the standards and engaging with its inner screw-threaded portion in an internally-screw-threaded eye  $g'$  on the inner side of one of the standards and supported loosely with its outer portion in an eye  $g^2$  on the same standard. The inner end of the adjusting-screw bears against a projection on the lower arm of the releasing-lever, and its outer end is provided beyond the annunciator-frame with a thumb-piece for turning the same conveniently.

H represents a switch or key lever whereby the various circuit changes in the subscriber's line are effected during the operation of connecting one subscriber with another and which also serves as a visual signal to the operator when a subscriber calls up the central office. This key-lever extends horizontally through an opening  $h$  in the front board and is provided at its outer end with a knob or handle  $h'$ , having the form of a cube, which bears the number of the respective subscriber. The inner portion of the key-lever is arranged between the front portions of the flanges of the plunger and is pivoted thereto near its middle by a horizontal pin  $h^2$ , which connects these flanges. The inner arm of the key-lever is provided with two lugs  $h^3$   $h^4$ , projecting laterally in opposite directions and forming a cross-head, and this lever is normally held in a horizontal position by making the inner arm thereof somewhat heavier than the outer arm, although the same effect can be produced by the aid of springs.

$i$   $i'$  represent upper and lower insulated contacts which are connected by a wire  $i^2$  with one end of the coils of the electromagnet and which are supported on a cross-bar  $i^3$ , connecting the lower front portions of the standards. The lower contact  $i'$  is adapted to bear against the under side of the lug  $h^3$  on one side of the key-lever and the upper contact  $i$  overhangs the lug  $h^4$  on the opposite side of the key-lever when the latter is in its retracted position.

$j$  is a lower insulated coupling-contact arranged lengthwise over the key-lever and connected by wire  $j'$  with the opposite end of



the coils of the electromagnet. This contact is secured with its rear end to a cross-bar  $j^2$ , which connects the upper front portions of the standards, while its front end rests on the bottom of a coupling socket or opening  $j^3$ , which is formed in the front board above the key-lever opening  $h$ .

$j^4$  is an upper insulated coupling-contact arranged in the upper portion of the coupling-socket and adapted to bear upon the lower contact  $j$  by gravity. This upper contact is pivoted with its upper end to a bracket  $j^5$ , which is secured to the rear side of the front board and inclines from its upper end rearwardly to its lower free end.

$k$   $k'$  are two contacts secured to opposite sides of an opening  $k^2$ , which is formed in a rear supporting-board K, arranged vertically in rear of the front board, and  $K'$  is a movable contact-plug adapted to bear against the front sides of both contacts and establish electrical communication between the same when the contact-plug is fully retracted.

$k^3$  is a wire leading from the contact  $k$  to the bracket  $j^5$ , supporting the coupling-contact  $j^4$ , and  $K^4$  is a wire leading from the other contact  $k'$  to a binding-post  $k^5$  on the cross connecting-board at the central office, to which post one side of the subscriber's apparatus L is connected by a wire  $k^6$ . The opposite side of the subscriber's apparatus is connected by a wire  $l$  with another binding-post  $l'$  on the cross connecting-board, and this post is connected by a wire  $l^2$  with the angle-plate  $b^3$  on the supporting-shelf. The metallic frame connected with the angle-plate  $b^3$ , the plunger resting on the frame, and the key-lever pivoted on the plunger form parts of the electrical conductor in different positions of these parts. When the parts are in the normal position, (shown in Figs. 1, 2, and 6,) the subscriber's signaling or calling circuit is established from one side of his apparatus L, through wire  $l$ , binding-post  $l'$ , wire  $l^2$ , angle-plate  $b^3$ , annunciator-frame, plunger, key-lever, contact  $i'$ , wire  $i^2$ , coils C, wire  $j'$ , lower coupling-contact  $j$ , upper coupling-contact  $j^4$ , bracket  $j^5$ , wire  $k^3$ , contact  $k$ , plug  $K'$ , contact  $k'$ , wire  $k^4$ , binding-post  $k^5$ , and wire  $k^6$  back to the opposite side of the subscriber's apparatus. Upon calling up the central office in this condition of the line the electromagnet is energized, the armature is attracted, and the plunger is released, thereby permitting the springs to project the plunger into the position shown in Fig. 5, whereby the subscriber's circuit is broken by the lug  $h^3$  of the key-lever leaving the contact  $i'$ .

In projecting the plunger and key-lever to their outer position the operator's night-bell or signal M is looped in by the following mechanism:

$m$  represents a movable upper contact which is arranged lengthwise on one side of the plunger and secured with its rear end to the supporting-shelf, while its front end overhangs a lower stationary contact  $m'$ , secured

to the shelf. One end of the bell-coils is connected by a wire  $m^2$  with the upper contact  $m$ , while the other end of the coils is connected by wire  $m^3$  with one pole of an electric generator  $m^4$ , the opposite pole of which is connected by wire  $m^5$  with the lower contact  $m'$ .

$m^6$  is an upwardly-projecting arm formed on the movable contact  $m$  in front of the lug  $h^3$  of the key-lever. During the last portion of the forward movement of the key-lever with the plunger an insulating-block  $m^7$  on the front side of the lug  $h^3$  of the key-lever bears against the arm  $m^6$ , whereby the upper movable contact is depressed into engagement with the lower contact  $m'$ , as represented in Fig. 5, and the circuit for ringing the night-bell is established through the wire  $m^3$  leaving one side of the bell M, generator  $m^4$ , wire  $m^5$ , lower contact  $m'$ , upper contact  $m$ , and wire  $m^2$  back to opposite side of the bell.

The mechanism and circuits which enable the operator to signal or call up a subscriber are constructed and arranged as follows:

N represents an electric generator having one of its poles connected by a wire  $n$  with a contact  $n'$ , which is secured with one end to the rear side of the front board and is arranged with its free end over the lug  $h^3$  of the key-lever when the latter is retracted with the plunger. The opposite pole of the generator N is connected by a wire  $n^2$  with a contact  $n^3$ , which is secured with one end to the rear side of the front board and is arranged with its free end over an insulating-block  $n^4$  on the lug  $h^4$  of the key-lever when the latter is retracted. Upon depressing the outer or front arm of the key-lever when the latter is retracted, as shown by dotted lines, Fig. 1, the lug  $h^3$  on the inner arm thereof is lifted out of engagement with the contact  $i'$  and into engagement with the contact  $n'$ , while the insulating-block  $n^4$  on the opposite key-lever lug  $h^4$  lifts the contact  $n^3$  into engagement with the contact  $i$ , whereby the circuit for calling up the subscriber is established through wire  $n$  from one pole of operator's generator N, contact  $n'$ , lug  $h^3$ , key-lever, frame, angle-plate  $b^3$ , wire  $l^2$ , binding-post  $l'$ , wire  $l$ , subscriber's apparatus L, wire  $k^6$ , binding-post  $k^5$ , wire  $k^4$ , contact  $k'$ , plug  $K'$ , contact  $k$ , wire  $k^3$ , bracket  $j^5$ , contact  $j^4$ , contact  $j$ , wire  $j'$ , coils C, wire  $i^2$ , contact  $i$ , contact  $n^3$ , and wire  $n^2$  back to the opposite pole of the operator's generator N.

The operator's listening and speaking apparatus is looped into the subscriber's line by the following means:

O represents the operator's listening-telephone, and  $o'$  a wire leading from one side of this telephone to the contact  $m$ .

$o^2$  is a rock-lever pivoted on the rear side of the front board so as to swing in a vertical plane and connected by a wire  $o^3$  with the opposite side of the operator's listening-telephone. The lower arm of this rock-lever extends rearwardly over the key-lever, while its upper arm stands in rear of the bracket



$j^5$ , which supports the upper coupling-contact  $j^4$ .

$o^4$  is a rearwardly-projecting finger formed on the upper end of the arm  $m^6$  on the contact  $m$  and adapted to overhang the lug  $h^3$  of the key-lever when the latter is in its projected position. Upon depressing the outer arm of the key-lever when the latter is in its projected position, as represented in dotted lines, Fig. 5, the lug  $h^3$  of the key-lever engages against the under side of the finger  $o^4$  and lifts the upper contact  $m$  from the lower contact  $m'$ , thereby opening the night-bell circuit at this point, and at the same time the insulating-block  $n^4$  on the lug  $h^4$  of the key-lever engages against the under side of the lower arm of the rock-lever  $o^2$  and turns the same until its upper arm bears against the bracket  $j^5$ , whereby the talking-circuit between the operator's telephone O and the subscriber's telephone is established through wire  $o'$ , leading from one side of the operator's telephone, contact  $m$ , arm  $m^6$ , finger  $o^4$ , lug  $h^3$ , key-lever, plunger, angle-plate  $b^3$ , wire  $l^2$ , binding-post  $l'$ , wire  $l$ , subscriber's telephone apparatus L, wire  $k^6$ , binding-post  $k^5$ , wire  $k^4$ , contact  $k'$ , plug K', contact  $k$ , wire  $k^3$ , bracket  $j^5$ , rock-lever  $o^2$ , and wire  $o^3$  back to the opposite side of the operator's telephone. While the inner arm of the key-lever is raised for looping in the operator's telephone, the finger  $o^4$ , which is arranged under the contact  $n'$ , is prevented from touching the latter by an insulating-block  $o^5$ , secured to the under side of the contact  $n'$ , thereby preventing the generator N from being looped into the main line during the operation of looping in the operator's telephone.

It will be observed that when the operator talks to a subscriber the talking-circuit does not include the annunciator-coils of the respective subscriber.

P, Figs. 1, 4, and 9, represents the coupling-plug, whereby one subscriber is coupled with another and which is seated, when not in use, in a socket P', formed in the front board of the switch adjacent to the terminal of the respective subscriber. The body of the plug consists of vulcanite or other insulating material, and its front portion  $p$  is smaller than its rear portion  $p'$ , so as to form a shoulder  $p^2$  on the body.

$p^3 p^4$  are two terminals, which extend lengthwise through the rear portion of the plug-body and along opposite sides of the front portion of the body.

$p^5$  is a casing which incloses the rear portion of the body of the plug and which is adapted to abut against a stop or board  $p^6$ , arranged in rear of the front board, for limiting the inward movement of the plug into its normal or home socket.

$q q'$  represent two conducting-wires, which connect the terminals  $p^3 p^4$ , respectively, with the subscribers' binding-posts  $k^5 l'$  on the cross connecting-board. A portion of these plug-wires  $q q'$  are arranged in a cord Q, which ex-

tends through openings in the rear of the plug-casing and the adjacent portion of the stop-board, thence rearwardly and downwardly around a take-up pulley  $q^2$ , and thence forwardly to the stop-board, to which it is secured, thereby forming a loop or bight, which is paid out when the plug is withdrawn from its socket in making connection with another subscriber. The take-up pulley  $q^2$  is mounted in a pulley-frame  $q^3$ , which is constantly pulled backwardly by any suitable contrivance, so as to take up the slack in the cord and pull the plug back into its normal socket when the plug is uncoupled from another subscriber. The preferred means for accomplishing this result consists of a cord  $r$ , secured at one end to the pulley-frame and wound with its opposite end around a spring-drum R, which is mounted on a supporting-board  $r'$ , arranged in rear of the supporting-board K. Upon withdrawing the plug-cord the drum-cord in unwinding from the drum strains its spring until the pulley strikes the rear side of the stop-board, when the further outward movement of the cord and the unwinding movement of the drum are arrested, thereby preventing undue straining of the spring.

In order to divert the circuit from the annunciator-coils and connecting parts to the terminals of the coupling-plug upon withdrawing the latter the main-line circuit is opened or broken beyond the coils by removing the plug K' from the contacts  $k k'$ , thereby cutting out the coils when the coupling-plug is withdrawn. For the purpose of accomplishing this automatically by the withdrawal of the coupling-plug the contact-plug K' is connected with or formed integrally with the frame of the take-up pulley, whereby the first portion of the outward movement the coupling-plug removes the plug K' from the contacts  $k k'$  and opens the main line. If desired, the wires  $k^3 k^4$  may be connected with contacts  $k^7 k^8$ , arranged on the front side of the stop-board, as shown in dotted lines, Fig. 1, in which case the metallic case  $p^5$  of the coupling-plug can be utilized as a means for bridging the contacts  $k^7 k^8$  for restoring the line to its normal condition.

Upon withdrawing the coupling-plug of one subscriber and inserting the same into the coupling-socket  $j^3$  of another subscriber the contacts  $j j^4$  in the coupling-socket are separated and the terminals of the coupling-plug are engaged, respectively, with the coupling-contacts  $j j^4$ , and when the plungers and key-levers of the subscribers so connected are retracted into their normal position the talking-circuit between these subscribers is established as follows and as shown in Fig. 9, in which subscribers Nos. 25 and 74 are connected: Beginning on one side of the subscriber's apparatus No. 25, the current passes through wire  $l$ , binding-post  $l'$ , wire  $l^2$ , angle-plate  $b^3$ , annunciator-frame, key-lever and its lug  $h^3$ , contact  $i'$ , wire  $i^2$ , coils C, wire  $j$ , lower coupling-contact  $j$ , terminal contact  $p^3$  of



coupling-plug, wire  $q$ , binding-post  $k^5$ , wire  $k^6$ , subscriber's apparatus No. 74, wire  $l$ , binding-post  $l'$ , wire  $q'$ , plug-terminal  $p^4$ , upper coupling-contact  $j^4$ , bracket  $j^5$ , wire  $k^3$ , contact  $k$ , plug  $K'$ , contact  $k'$ , wire  $k^4$ , binding-post  $k^5$ , and wire  $k^6$  back to the opposite side of subscriber's apparatus No. 25.

The coupling-plug is inserted into the coupling-socket  $j^3$  until its shoulder  $p^2$  engages with the front board or the escutcheon  $a'$ , surrounding the outer end of the socket, and the plug is confined in said socket by the following mechanism, so that it cannot be withdrawn without operating the generator of either subscriber or that of the operator:

$S$  represents a stem projecting forwardly from the front end of the plug-body and provided with a coupling-head  $s$ , having a conical or inclined front side and an abrupt rear side.

$T$  represents a vertically-movable locking-pawl whereby the coupling-plug is confined in the coupling-socket and which is pivoted with its rear end to the upper ends of the standards  $b'$ . The front end of the pawl is provided with a hook  $t$ , which is normally arranged in the path of the coupling-head and which has a beveled front side and an abrupt rear side. Upon inserting the coupling-plug in the coupling-socket  $j^3$  the conical front side of the coupling-head engages with the beveled front side of the hook on the coupling-pawl, whereby the latter is lifted out of the path of the head, and after the head has passed the pawl-hook the latter drops, so as to stand in rear of the coupling-head, thereby preventing the coupling-plug from being withdrawn unless the locking-pawl is raised.

$U$  represents a lifting rod or link which connects the plunger with the locking-pawl and whereby the latter is lifted for releasing the coupling-plug when the plunger is projected. This link is provided at its upper end with a vertical slot  $u$ , through which the locking-pawl passes, and the latter is provided on opposite sides of the link with pins or stops  $u'$ , which prevent the link from being displaced on the locking-pawl. The lower end of the link is bifurcated or divided into two arms  $u^2$ , which straddle the plunger and rest on the base of the annunciator-frame, and the locking-pawl rests on the lower end of the slot in the upper end of the link. Each of the link-arms is provided with a transverse slot  $u^3$ , which extends in the longitudinal direction of the plunger and which receives a pin  $u^4$ , secured to the plunger. In the retracted position of the plunger its pins  $u^4$  engage with the rear ends of the slots in the lower arms of the link and the latter is shifted rearwardly at such an angle as to permit the locking-pawl to descend and stand with its hook in the path of the head on the coupling-plug, as represented in Fig. 1. During the first portion of the outward movement of the plunger it moves idly without affecting the link; but during the last portion of its out-

ward movement the pins  $u^4$  of the plunger engage with the front ends of the lower slots  $u^3$  in the link and carry the lower end of the same forward on the base, thereby straightening the link or bringing its lower end more nearly vertically in line with its upper end, whereby the locking-pawl is lifted, as represented in Fig. 5, and its hook is raised out of the path of the head of the coupling-plug. The object in slotting the lower end of the link is to secure a certain amount of dead forward movement of the plunger before the locking-pawl is affected, thereby avoiding an excessive movement of the latter, which otherwise would take place if the lower end of the link were pivoted to the plunger. Upon inserting the coupling-plug into the coupling-socket when the plunger is retracted the head of the coupling-plug while engaging with the locking-pawl moves the latter upwardly in the upper slot of the link without affecting the latter.

The operation of my improved telephone system is as follows: When the subscriber calls up the central office, the plunger is released and projected together with the key-lever, whereby the main line is opened between the contact  $i'$  and lug  $h^3$  of the key-lever and the subscriber's bell stops ringing, thereby indicating to the subscriber that his call has been received at the central office. At the same time the projected key-lever or the sounding of the night-bell, the circuit of which has been closed, serves as a signal to the operator. The operator now loops his listening-telephone into the main line by depressing the outer end of the key-lever while the latter is in its projected position and ascertains with which subscriber the calling subscriber wishes to communicate, when the operator pushes the key-lever inwardly to its normal locked position, thereby cutting out his listening-telephone. The operator next depresses the outer end of the key-lever of the called subscriber while the lever is retracted, thereby looping in the operator's generator  $N$  and ringing up the called subscriber. In thus signaling the called subscriber the plunger and key-lever are not projected when released by the electromagnet, because the operator retains hold of the key-lever until the generator has been cut out again. Having called up the desired subscriber, the coupling-plug of the calling subscriber is pulled out of its socket and inserted in the coupling-socket of the called subscriber, thereby establishing the talking-circuit between the two subscribers. If desired, the talking-circuit can be produced by inserting the coupling-plug of the called subscriber into the coupling-socket of the calling subscriber. When the talking-circuit is established between two subscribers, the particular subscriber whose coupling-plug has been withdrawn has his coils cut out by opening the line between the contacts  $k$   $k'$  in the act of withdrawing his coupling-plug, so that conversation is carried



on through only one set of coils, whereby the efficiency of the service is increased on account of the reduction in resistance. As the coupling-plug of one subscriber is locked in the coupling-socket of the other subscriber the operator cannot project the key-lever into the position where he can loop in his listening-telephone without first looping in his generator. It is therefore impossible for the operator to attempt to listen to the conversation of the subscribers without being detected. When the subscribers have finished talking and either one of them rings off, the coils of the subscriber which are in circuit are energized, whereby the respective plunger and key-lever are released and projected, indicating to the operator that the conversation has terminated. The operator now pulls out the coupling-plug of the calling subscriber from the coupling-socket of the called subscriber and at the same time pushes in the key-lever and plunger of the called subscriber and then returns the coupling-plug of the calling subscriber to its respective socket, whereby the ringing-circuits are again restored to their normal condition ready for another call.

If the subscribers fail to ring off, the operator can release the locked coupling-plug by depressing the outer end of the respective key-lever when the latter is retracted, thereby looping in the operator's generator and projecting the key-lever, together with the plunger, after which the parts can be restored to their normal position, as before described.

For the purpose of enabling the subscribers on one of the operator's boards to be connected with the subscribers on the board of another operator without the possibility of any operator looping in on the circuit without detection the following means are provided:

$V V' V^2$  represent three switchboards upon which the annunciators or terminals and the coupling-plugs of three groups of subscribers are respectively arranged.

$v v' v^2$  represent a number of terminals or annunciators which are arranged adjacent to each switchboard and each of which is constructed substantially the same as the annunciator heretofore described, and shown in Figs. 1, 2, 6, and 7. Each annunciator of one board is connected by individual wires  $w w'$  with an annunciator on one of the other boards, the two annunciators so connected forming a pair which are exclusively connected with the ends of the respective wires  $w w'$ , no provision being made for looping into these wires at a point intermediate of the pair of annunciators. The wires  $w w'$  of each pair are connected at their ends with the brackets  $j^5$ , which carry the upper coupling-contacts  $j^4$ , and with the metallic supporting-frames of both annunciators of each pair.

As represented in Fig. 10, each of the switchboards is connected with every other switchboard by two pairs of annunciators, the number being determined by the demand. Assuming that subscriber No. 24 on board V

wishes to be connected with subscriber No. 78 on board  $V^2$ , the connection between the same would be made, as shown in Fig. 10, in the following manner: Having ascertained from the calling subscriber No. 24 in the manner heretofore described with which subscriber he wishes to communicate, the operator depresses the key-lever of one of the annunciators  $v$  and loops in his generator in the circuit which includes this annunciator and the companion annunciator  $v^2$  on switch  $V^2$ , whereby the plunger and the key-lever of the last-mentioned annunciator are projected and the operator of board  $V^2$  is notified that a subscriber on his board is wanted. The operator of board V immediately upon calling up operator of board  $V^2$  pulls out the coupling-plug belonging to subscriber No. 24 and inserts it into the coupling-socket of the annunciator  $v$  in circuit with the annunciator  $v^2$ , which has just been rung up. The operator of board  $V^2$  now loops in his listening-telephone and asks the calling subscriber with which subscriber he wishes to be connected, and having ascertained that he wants No. 78 he rings up the called subscriber No. 78, then pulls out the latter's coupling-plug and inserts the same into the coupling-socket of the rung-up annunciator  $v^2$ , whereby the subscribers Nos. 24 and 78 are placed in communication with each other. If desired, the operator of board V can loop his listening-telephone into annunciator  $v$  and himself inform operator of board  $V^2$  that subscriber No. 24 wishes to speak to subscriber No. 78, which would avoid the necessity of asking subscriber No. 24 twice with whom he wishes to communicate. When a subscriber rings off, the annunciator having the highest resistance will be operated and project its plunger and key-lever, thereby signaling the respective operator to disconnect the lines. Assuming that operator of board V has been so signaled, he pulls the coupling-plug out of the socket of annunciator  $v$  and returns the plug to its normal position and at the same time loops in his generator in the circuit, which includes this pair of annunciators, so that the plunger and key-lever of the companion annunciator  $v^2$  on board  $V^2$  will be projected and signal the operator of board  $V^2$ , in response to which the latter pulls the coupling-plug of subscriber No. 78 out of the annunciator-socket  $v^2$  and returns it to its normal position. Inasmuch as it is necessary for the operator who first receives the ring-off signal from the subscribers to signal the operator of the other board to the same effect, more work devolves upon the first-mentioned operator, and for the purpose of equalizing this work when each board is connected by a number of annunciator-circuits with every other board one-half of the coils of the annunciators of each board are wound with a high resistance and the other one-half with a low resistance, so that the work devolving upon each operator by reason of receiving



the first ring-off signal is approximately uniformly divided. In order to enable the operators to distinguish whether the ring-off is the primary signal from the subscribers or the secondary signal from another operator, the high and low resistance annunciators are distinguished in some way. For instance, the escutcheon or key-lever knob of the high-resistance annunciators may be colored red and those of the low-resistance annunciators black. By this means an operator can readily determine whether the ring-off is the primary signal of the subscribers, which demands a restoration of the plug to its normal position and a ring-off to the other operator as a secondary signal to also restore his plug to the normal position, or whether the ring-off is the secondary signal from the other operator and only requires the restoration of the plug to its normal position.

I claim as my invention—

1. The combination with the electromagnet and its armature, of a horizontally-movable switch-plunger provided with a shoulder, a horizontal locking-lever provided with a shoulder adapted to engage with the shoulder of the plunger for holding the latter in its retracted position, an upright releasing-lever adapted to engage its lower arm with the locking-lever for holding the latter in its operative position, and means whereby the plunger is projected when released by the locking-lever, substantially as set forth.

2. The combination with the electromagnet and its armature, of a switch-plunger provided with a shoulder, a locking-lever controlled by said armature and provided with a shoulder which is adapted to engage with the shoulder of the plunger, and a wedge-shaped teat or projection arranged on the locking-lever and adapted to rest on the plunger and limit the locking movement of said lever, substantially as set forth.

3. The combination with the electromagnet and its armature, of a horizontally-movable switch-plunger provided with a shoulder, a horizontal locking-lever provided with a shoulder adapted to engage with the shoulder of the plunger for holding the latter in its retracted position, an upright releasing-lever adapted to engage its lower arm with the locking-lever for holding the latter in its operative position and having its upper arm loosely connected with the armature, and means whereby the plunger is projected when released by the locking-lever, substantially as set forth.

4. The combination with the electromagnet having an armature, of a switch-plunger provided with a shoulder, a locking-lever provided with a shoulder adapted to engage with the shoulder of the plunger for holding the latter in its retracted position, a releasing-lever pivoted concentric with the armature, loosely connected with the armature and adapted to hold the locking-lever in its operative position, and means whereby the plunger is projected when released, substantially as set forth.

5. The combination with the supporting-frame and the electromagnet provided with an armature, of a horizontally-movable switch-plunger guided in said frame and provided with a shoulder, a horizontal locking-lever pivoted with its rear end on said frame and provided with a shoulder adapted to engage with the shoulder of the plunger for holding the latter in its retracted position, an upright releasing-lever pivoted on the supporting-frame and adapted to engage its lower arm with the front end of the locking-lever for holding the latter in its operative position, a cross-bar arranged on the upper arm of the releasing-lever, a lug arranged on said armature and provided with a notch which receives the cross-bar of the releasing-lever, and means whereby the plunger is projected when released by the locking-lever, substantially as set forth.

6. The combination with the supporting-frame and the electromagnet provided with an armature, of a horizontally-movable switch-plunger guided in said frame and provided with a shoulder, a horizontal locking-lever pivoted with its rear end on said frame and provided with a shoulder adapted to engage with the shoulder of the plunger for holding the latter in its retracted position, a releasing-lever pivoted on the front portion of the supporting-frame and having its upper arm connected with the armature while its lower arm is adapted to control the locking-lever, and an adjusting-screw mounted on the supporting-frame and having its front end bearing against the releasing-lever while its rear end is arranged adjacent to the rear end of the supporting-frame, substantially as set forth.

7. The combination with an electromagnet, of a switch-plunger controlled by said electromagnet, a key-lever fulcrumed on said plunger and carried bodily back and forth with the plunger, and a circuit which may be opened and closed by turning the key-lever on its fulcrum, substantially as set forth.

8. The combination with the main-line circuit and the electromagnet arranged in said circuit, of a switch-plunger, controlled by the electromagnet, a key-lever fulcrumed on the plunger and carried bodily back and forth with the plunger, and a break which is arranged in the main-line circuit and which is opened and closed by the back-and-forth movement of the key-lever, substantially as set forth.

9. The combination with the electromagnet having a terminal contact, of a switch-plunger controlled by the electromagnet and a key-lever adapted to bear against said contact and fulcrumed on said plunger so as to be carried bodily back and forth with the plunger, substantially as set forth.

10. The combination with the electromagnet arranged in the main line, and the gen-



erator-circuit, of a switch-plunger, and a key-lever fulcrumed on said plunger so as to be carried back and forth with said plunger and adapted to cut the generator-circuit into or  
5 out of the main line, substantially as set forth.

11. The combination with the electromagnet and the switch-plunger controlled by the electromagnet, of a local signal-circuit and a  
10 key-lever fulcrumed on the plunger so as to be carried bodily back and forth with the plunger and adapted to open and close the local signal-circuit, substantially as set forth.

12. The combination with the electromagnet and the switch-plunger controlled by the electromagnet, of a local signal-circuit, a contact arranged in the signal-circuit and provided with an arm, and a key-lever fulcrumed on said plunger so as to be carried bodily  
20 back and forth with said plunger and provided with a lug adapted to engage with said arm and close the signal-circuit, substantially as set forth.

13. The combination with the electromagnet and the switch-plunger controlled by the electromagnet, of a speaking-circuit, and a key-lever adapted to open and close the speaking-circuit and fulcrumed on the plunger so as to be carried bodily back and forth with the  
30 plunger, substantially as set forth.

14. The combination with the electromagnet and the switch-plunger controlled by the electromagnet, of a speaking-circuit, a rock-lever adapted to open and close the speaking-circuit and a key-lever pivoted on the plunger and adapted to operate the rock-lever, substantially as set forth.

15. The combination with the electromagnet and the switch-plunger controlled by the electromagnet, of a contact arranged in a signal-circuit and in a speaking-circuit and provided with an arm having a finger, a rock-lever adapted to open and close the speaking-circuit, and a key-lever pivoted on the plunger and adapted to bear against said arm for closing the signal-circuit or against said finger and rock-lever for closing the speaking-circuit, substantially as set forth.

16. The combination with the electromagnet and the switch-plunger controlled by the electromagnet, of a contact arranged adjacent to said upper contact, a contact arranged in both a signal-circuit and a speaking-circuit, and a key-lever pivoted on the plunger and adapted when in its retracted position to open and close the main-line and the generator circuits and when in its projected position to open and close the  
60 speaking and signaling circuits, substantially as set forth.

17. The combination with the electromagnet and the coupling-plug, of a switch-plunger controlled by the electromagnet, and a locking-pawl adapted to hold the coupling-plug in its coupled position and controlled by the plunger, substantially as set forth.

18. The combination with the electromagnet and the coupling-plug provided with a shoulder, of a switch-plunger controlled by  
70 the electromagnet, and a pawl connected with said plunger and provided with a hook adapted to engage with the shoulder of the coupling-plug, substantially as set forth.

19. The combination with the electromagnet and the coupling-plug, of a switch-plunger controlled by the electromagnet, a locking-pawl adapted to hold the coupling-plug in its coupled position, and a link connecting the switch-plunger and locking-pawl, substantially as set forth.

20. The combination with the electromagnet and the coupling-plug, of a switch-plunger controlled by the electromagnet, a locking-pawl adapted to hold the coupling-plug in its coupled position, and a link connected at one end with the switch-plunger and connected loosely at its opposite end with the locking-pawl, substantially as set forth.

21. The combination with the electromagnet and the coupling-plug, of a switch-plunger controlled by the electromagnet, a locking-pawl adapted to hold the coupling-plug in its coupled position, and a link connected at one end with the locking-pawl and loosely connected at its opposite end with the switch-plunger, substantially as set forth.

22. The combination with the electromagnet and the coupling-plug, of a switch-plunger controlled by the electromagnet, a locking-pawl adapted to hold the coupling-plug in its coupled position, and a link provided at one end with a slot through which the locking-pawl passes and at its opposite end with a slot which receives a projection on the switch-plunger, substantially as set forth.

23. The combination with the non-conducting body of the plug having a contracted front portion, of two conducting-terminals extending through the rear portion of the body and along opposite sides of the front portion of the body, and a head arranged on the front end of the body and provided with an inclined front side and an abrupt rear side which is adapted to be engaged by a locking-pawl, substantially as set forth.

24. The combination with the main line, of a signal mechanism arranged in a branch of the main line, a movable coupling-plug arranged in another branch of the main line, and a switch which is arranged in the signal-mechanism branch but which is not electrically connected with said plug, said switch being operated to open the signal-mechanism branch upon withdrawing the plug and to close the signal-mechanism branch upon returning the plug, substantially as set forth.

Witness my hand this 7th day of November, 1896.

CHARLES S. HEILMAN.

Witnesses:

JNO. J. BONNER,  
KATHRYN ELMORE.