

No. 768,039.

PATENTED AUG. 23, 1904.

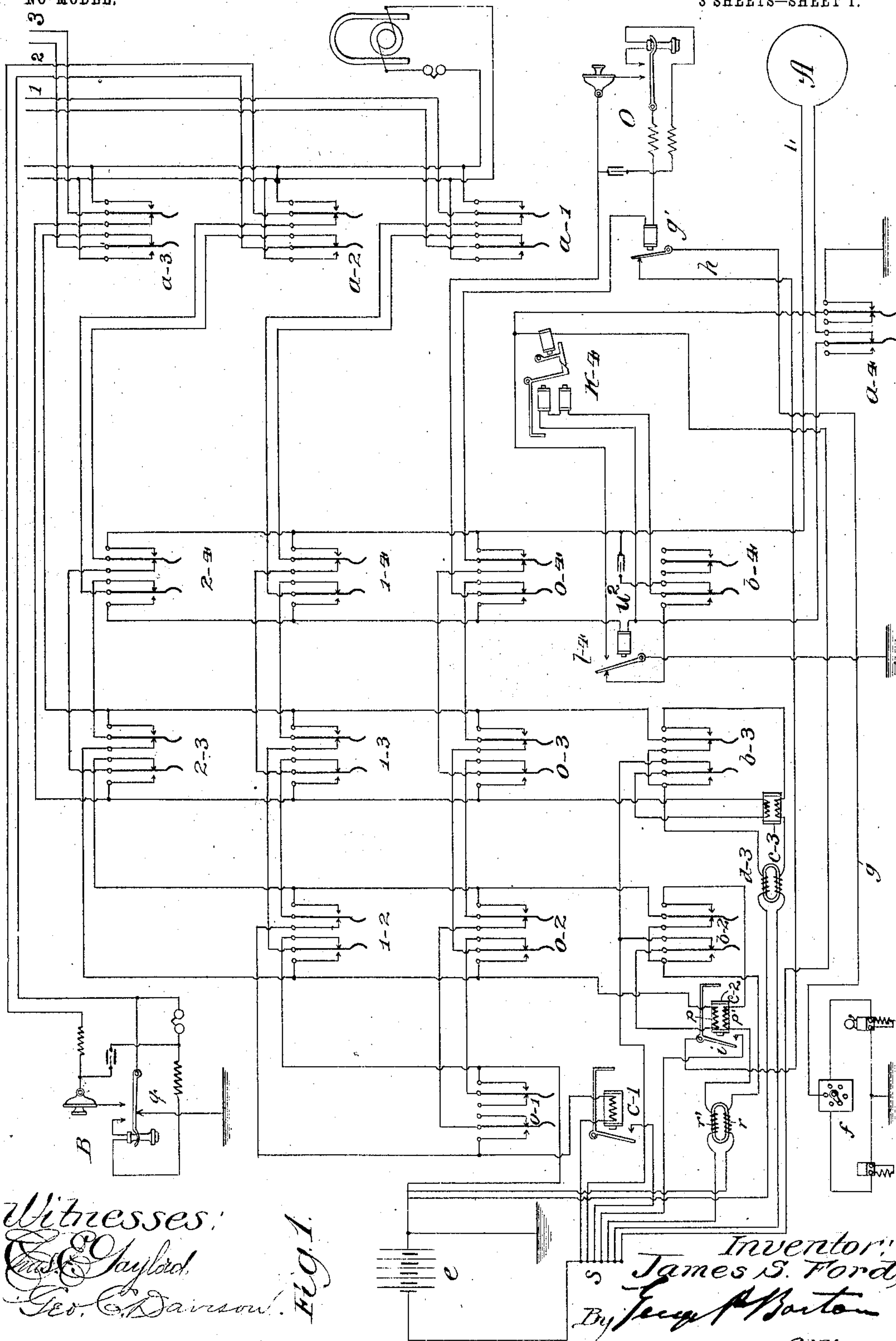
J. S. FORD.

TELEPHONE EXCHANGE APPARATUS.

APPLICATION FILED APR. 9, 1902.

NO MODEL.

3 SHEETS—SHEET 1.



Witnesses:
Geo. E. Taylor,
Geo. E. Davison.

FIG. 1.

Inventor:
James S. Ford,
By *James A. Barton*
Att'y

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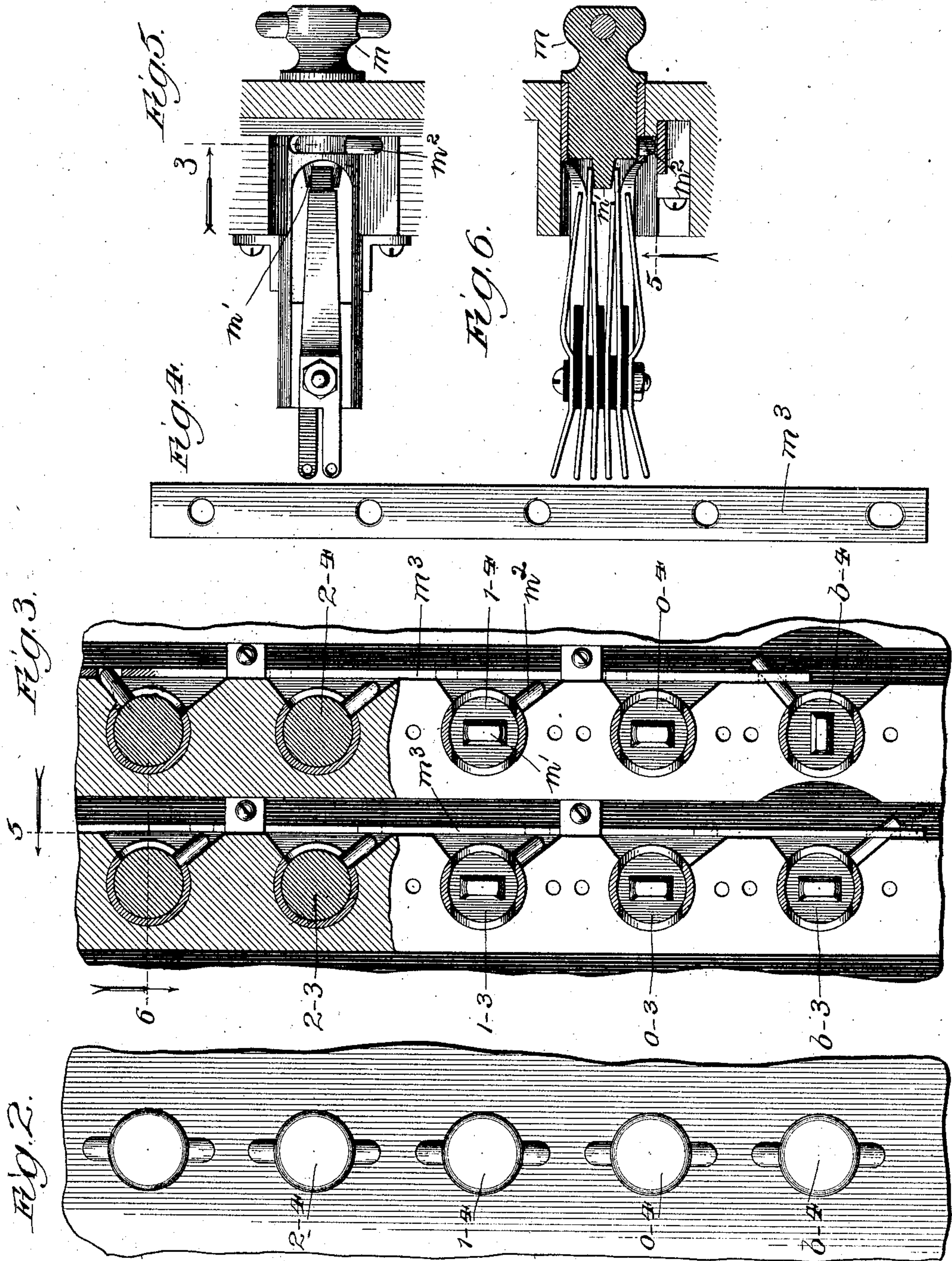
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NO MODEL.

3 SHEETS—SHEET 2.



Witnesses:
Geo. C. Gaylord,
Geo. C. Davidson.

Inventor:
James S. Ford,
By George P. Barton
Att'y

No. 768,039.

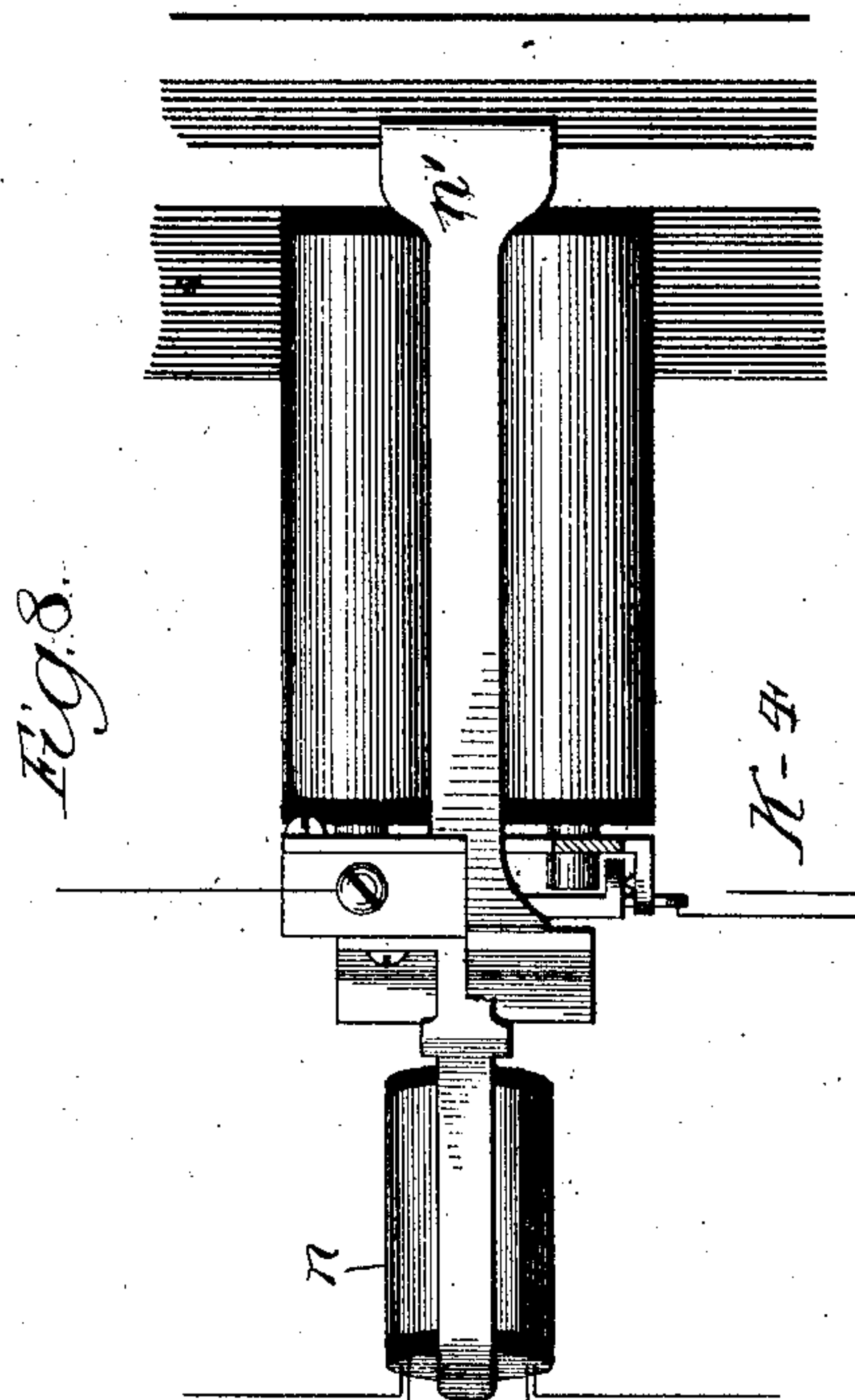
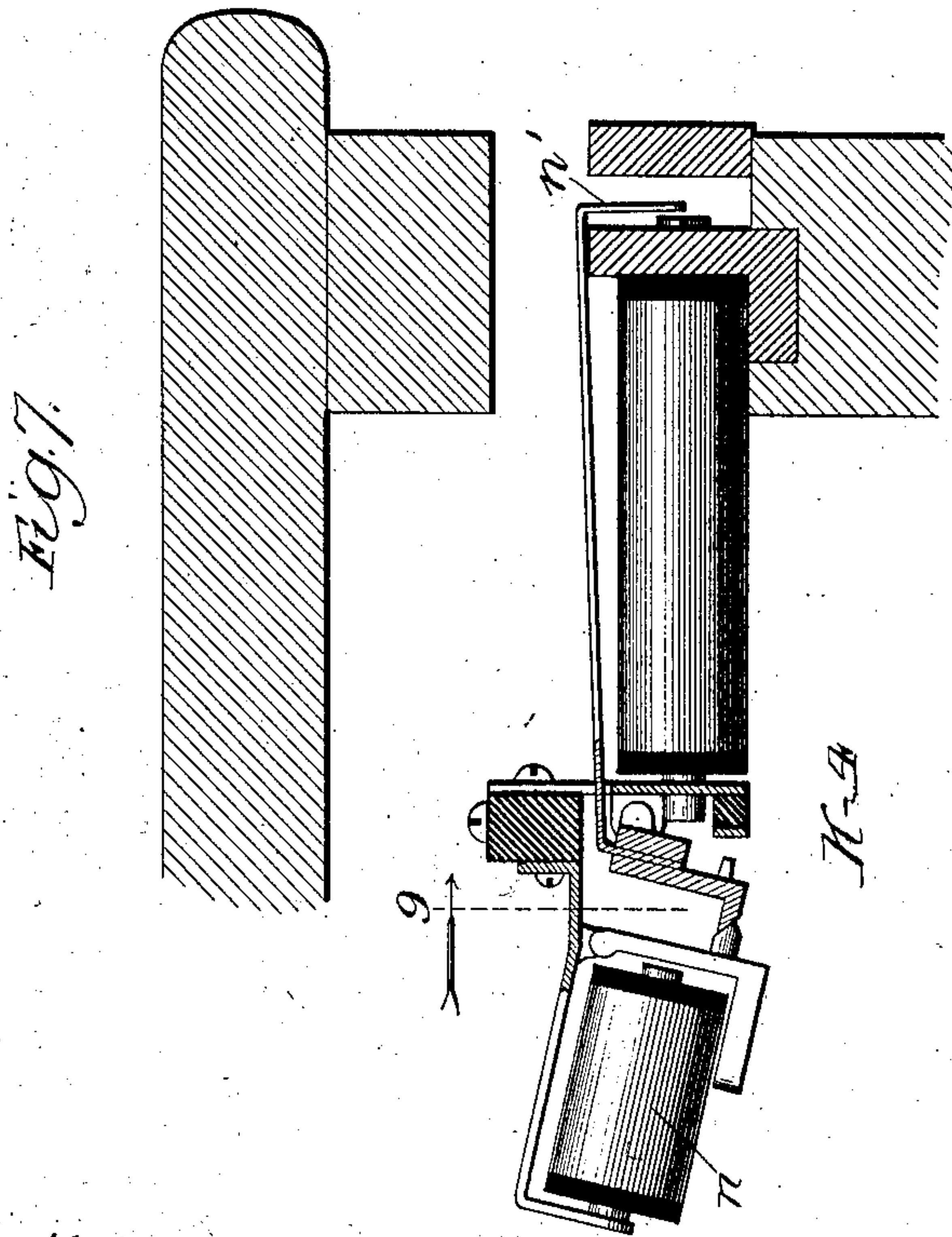
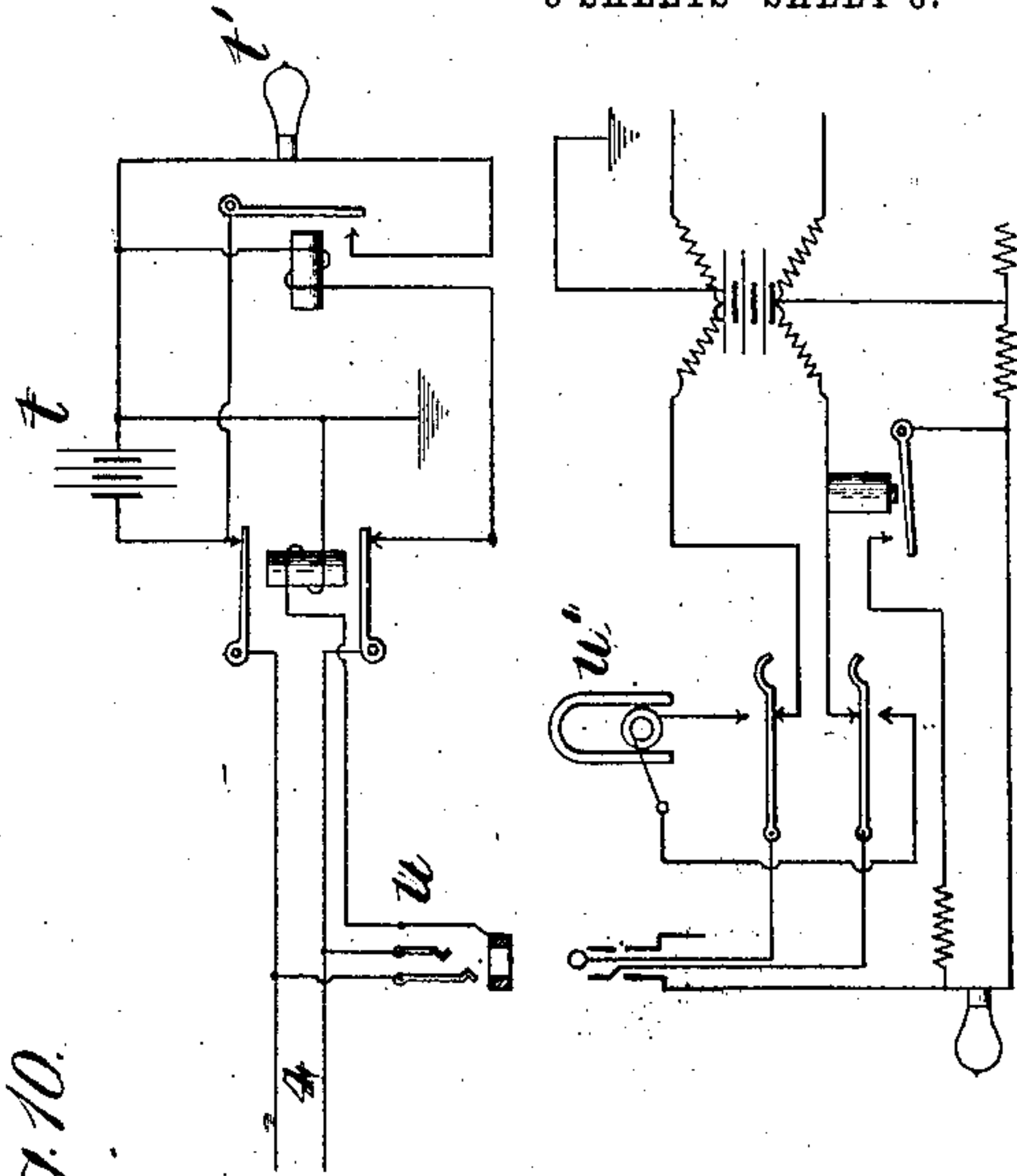
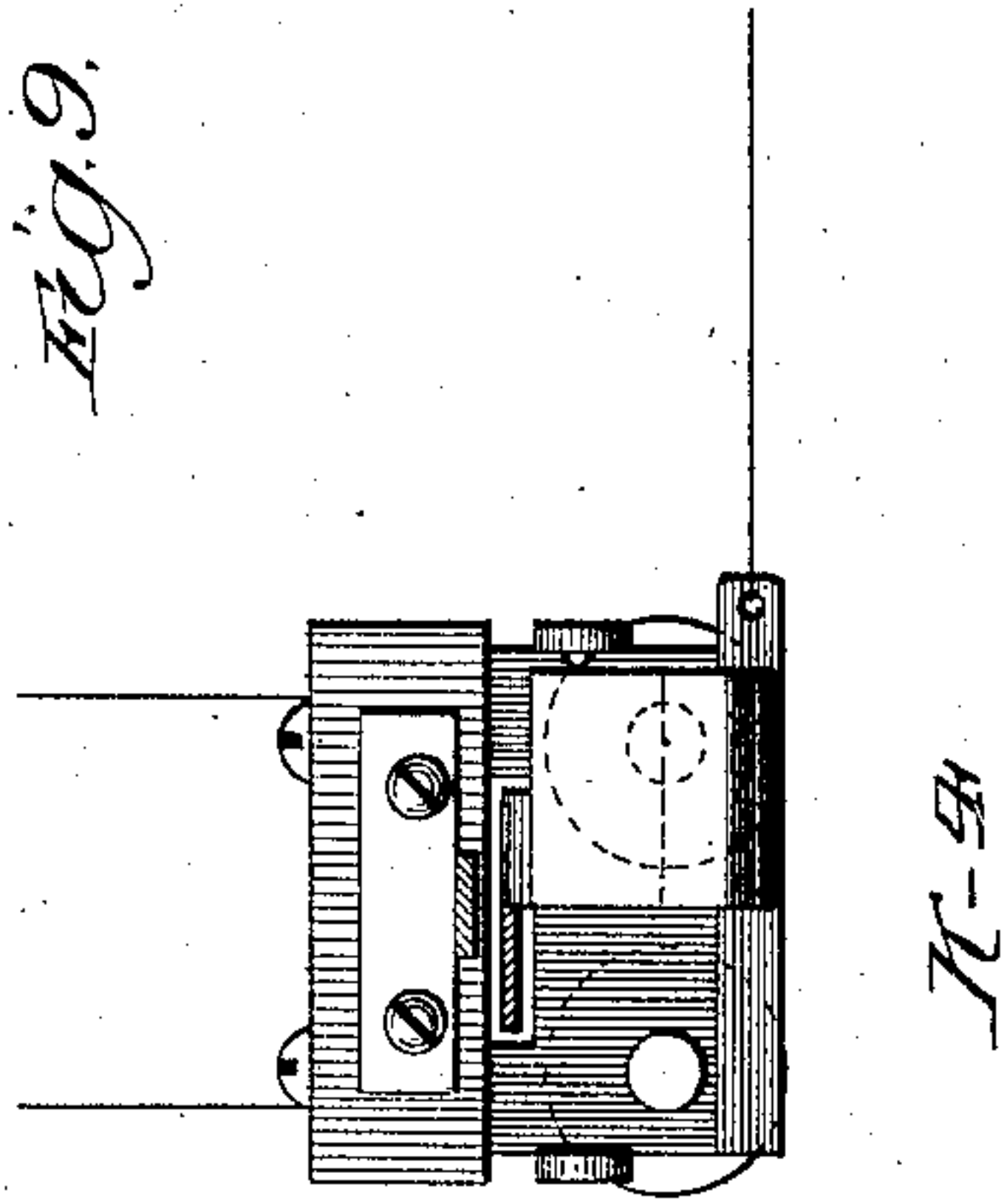
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J. S. FORD.
TELEPHONE EXCHANGE APPARATUS.

APPLICATION FILED APR. 9, 1902.

NO MODEL.

3 SHEETS—SHEET 3.



Witnesses:
Ed. Chyford,
Geo. C. Dawson.

Inventor:
James S. Ford,
By *James P. Barton*
Att'y.

UNITED STATES PATENT OFFICE.

JAMES S. FORD, OF CHICAGO, ILLINOIS, ASSIGNOR TO WESTERN ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TELEPHONE-EXCHANGE APPARATUS.

SPECIFICATION forming part of Letters Patent No. 768,039, dated August 23, 1904.

Application filed April 9, 1902. Serial No. 101,977. (No model.)

To all whom it may concern:

Be it known that I, JAMES S. FORD, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have
5 invented a certain new and useful Improvement in Telephone-Exchange Apparatus, of which the following is a full, clear, concise, and exact description.

My invention relates to telephone-exchange
10 switchboard apparatus, and more particularly to such apparatus as is used upon the switchboard of a moderate-sized branch exchange—that is to say, a switchboard intended for the switching between ten or a dozen lines. Some
15 of these lines would run to private offices, and one or more would ordinarily be a main telephone-line of a general exchange.

My invention is of special utility in the equipment of such small branch-exchange
20 switchboards in which the work of connecting and disconnecting the lines is done by means of keys as distinguished from those which employ switching apparatus consisting of jacks and cords with terminal plugs.

25 My invention comprises, first, the combination, with certain sets of the keys, of connecting-bars in order that when a particular key of a set is thrown a corresponding key will also be thrown through the medium of
30 the common connecting-bar, the other keys of the set being blocked; second, the combination, with a line-annunciator, of a locking device and a releasing-magnet so arranged that when a momentary impulse of current is sent
35 over the line the signal will be displayed and locked in position and subsequently when connection is made with the line by operating a key current will be directed through the releasing-magnet to unlock the signal and cause
40 it to be withdrawn; third, the combination, with a general signal, as the bell or buzzer, or both, and the circuit thereof, of a relay associated with the operator's set, whereby when the operator's set is in use the general signal
45 is disconnected, so that it cannot be sounded; fourth, a line-signal provided with two windings adapted to act differentially in combination with a special key associated with a con-

necting-key, whereby when connection is made with the line at the connecting-key the special
50 key is operated, and thereby the second of the windings is brought into circuit, thus making the magnet of the signal inert to cause the withdrawal of the indication, the signal being again displayed when current is shut
55 off from either of the windings; fifth, the combination, with a line-signal, of a special key and circuit, including a condenser and a relay, whereby when the line—as, for example, the
60 line to the general exchange—is united with another line, as one belonging to the branch exchange, the circuit containing the line-signal is held open by the relay during the conversation, but restored when the local sub-
65 scriber hangs up his telephone on completion of the conversation, and, sixth, my invention also comprises the special combination of keys with circuits whereby on connecting two lines together by the connecting-key belonging to
70 said two lines the circuit to one of the line-signals will be opened, the signal of the other line remaining connected to act as a clearing-out indicator.

My invention will be more readily understood by reference to the accompanying drawings, in which—

Figure 1, Sheet 1, illustrates diagrammatically the circuits and apparatus embodying my system of branch telephone-exchange. Fig. 2,
80 Sheet 2, is a front elevation showing a vertical row of keys upon the branch switchboard. Fig. 3 is a rear view of two such rows of keys, the rear portion of the several keys being removed, as indicated by section-line 3 of Fig. 5. Fig. 4 is a side view of one of the con-
85 necting and locking bars. Figs. 5 and 6 are detailed views illustrative of the keys. Fig. 7, Sheet 3, is a side elevation of a line-annunciator with its locking device and releasing-magnet. Fig. 8 is a plan of the same. Fig. 9
90 is a view thereof with the releasing-magnet removed, taken on line 9 of Fig. 7; and Fig. 10 illustrates the operator's apparatus at the general exchange with a line of the branch exchange of Fig. 1 connected there-
95 with.

Like parts are indicated by similar characters of reference throughout the different figures.

I will first give a brief outline of the system with reference to Fig. 1, in which are shown three lines belonging, primarily, to the branch exchange and one line coming from the distant central exchange. Lines 1, 2, and 3 are the lines to the local or private branch exchange and line 4 the trunk-line or circuit extending to the distant general exchange. The distant apparatus of the exchange operator is of well-known construction and is indicated diagrammatically in Fig. 10. Lines 1, 2, and 3 may be connected with one another at the switches 1 2, 1 3, 2 3 upon the switchboard. Lines 1 and 2 may be connected, respectively, with the exchange-line 4 at switches 1 4, 2 4. Line 3 is designed for use only in connection with other lines of the branch exchange and is therefore not provided with any means of connection with the general exchange.

The operator's apparatus O of the branch exchange is of usual construction, and the circuit thereof extends through switches $o' o^2 o^3 o^4$, by means of which the operator may make connection with any one of the lines 1, 2, 3, and 4, as occasion may require. I have shown the local-station apparatus of line 2 at B, which is of usual construction. Similar apparatus (not shown) will be provided for lines 1 and 3. Calling-keys $a' a^2 a^3$ are provided for the different branch-exchange lines, and a key a^4 , which may be termed a "flash-key," is provided for the exchange-line 4. This flash-key is designed for use only at such times as when the exchange-line 4 shall be joined with some one of the branch-exchange lines, as 1 or 2. At such times key a^4 may be used to attract the operator at A by flashing her signal. Keys $b^2 b^3 b^4$ are provided for lines 2, 3, and 4, as indicated, for controlling the differential signals and are operated, respectively, by the connecting-keys belonging to the lines through the medium of connecting-bars to be described in detail later. In passing I will say that the key b^3 is mechanically associated with the connecting-keys 2 3, 1 3 of line 3 by means of a bar, so that when either of the keys 2 3, 1 3 is operated to make a connection the key b^3 is operated at the same time to change the circuit leading therefrom through the differential signaling apparatus c^3 , the retardation-coils d^3 , and the battery e . The keys b^2 and b^4 are in a similar manner connected with the connecting-keys of their respective lines. The general signal apparatus f , consisting of a buzzer and bell, which may be switched into the circuit alternatively, as desired, is connected by wire g with the relay g' of the local operator's set O and from the back contact of the relay by wire h through the contact i , provided upon the line-signal c^2 of line 2, and thence through the battery e to ground. The

local operator on seeing the signal c^2 disclosed and hearing the audible signal immediately turns key o^2 and takes down her telephone. Current is then directed over her line from battery e to operate the relay g' , thus opening the circuit of the signaling apparatus f . In connection with the exchange-line 4 is a signal h^4 , which is primarily worked by an alternating current sent by the exchange operator at A. When thus operated, this signal is locked in its disclosed position, and so remains until current is directed through the releasing-magnet of said signal. The relay h is also associated with this line 4 to change or control the circuit of the signal device h^4 .

After describing somewhat in detail the construction of the keys and line-signals illustrated in Figs. 2 to 9 I will come back to the description of the general system and its mode of operation.

Referring to Figs. 5 and 6, it will be seen that each of the keys is provided with a knob m , carrying a cam or wedge m' , which when in the position shown permits the contact-springs of the key to assume their normal or "not-in-use" position. This knob carries a pin or finger m^2 , which is adapted to engage with a corresponding opening in the bar m^3 when the bar is in its normal position. If, however, the bar has been moved by another key of its set, there will be no opening opposite the finger m^2 , and hence the knob cannot be turned—that is, the key will be locked in position. The keys $b^4, o^4, 1 4, 2 4$ of Fig. 2 may be considered as corresponding to the keys similarly designated in Fig. 1. These same keys are indicated in Fig. 3, together with another set $b^3, o^3, 1 3, 2 3$, which may be considered as corresponding to the keys of Fig. 1 thus designated. Keys $o^3 o^4$, it will be observed, are independent—that is, they have no special mechanical association with the bars, as bar m^3 . The upper keys of Figs. 2 and 3 are not specially lettered, as they are not represented in Fig. 1.

The signal device h^4 is so clearly illustrated in Figs. 7, 8, and 9 as to require but little description. When energized, its armature is attracted, and the weighted armature of the restoring-magnet n follows its movement and serves to lock it in position to hold the signal h^4 disclosed. When current is sent through restoring-magnet n , the force or weight of its armature will be withdrawn from the armature of the signal device, and the signal h^4 will then resume its normal undisclosed position.

I will first describe how two lines of the local or branch exchange are connected and disconnected. Assume that the station B of line 2 wishes connection with line 1. On taking down the telephone at station B current is directed in metallic circuit from battery e through upper winding p of signal c^2 . This discloses the signal and at the same time closes the relay-contact i of said signal, and current

is thereby completed to operate the audible signal f . The operator, as previously stated, thereupon makes connection with line 2 at listening-key o^2 and at once takes down her telephone. The operator's line O is now connected in metallic circuit with the battery e , and current is thus supplied to her transmitter, and at the same time the magnet of relay g' is excited, thus causing said magnet to attract its armature to open the signal-circuit $g h$, and thus cut off the audible signal f . By turning the key o^2 the operator has not only made connection with the battery e , but also with the line 2 of the user at station B. She accordingly on taking down her telephone is in communication with station B and receiving the order, as we assume, for connection with line 1 will at once operate the key 1 2. By means of calling-key a' the operator will throw generator-current onto line 1, that being the line asked for, thus signaling to the person desired at the station of line 1. The operation of this key 1 2, as we have explained in connection with Figs. 2, 3, also serves to operate the corresponding key b^2 —that is to say, the contact springs or levers of said key b^2 are separated from their normal contacts and thrown upon the outer contacts. This changes the circuits of the line-signal c^2 to bring the lower winding p' into circuit, thus neutralizing the magnet, since the windings $p p'$ are wound differentially, and the signal c^2 thereupon assumes its retired or non-disclosed position. The magnet being thus made inert, the relay-contact i will be opened, and thus the circuit of the audible signal f will be held open during the conversation carried on over lines 1 2—that is to say, when the operator takes down her telephone this circuit of the audible signal is opened at relay g' ; but as this relay will close when the operator hangs up her telephone the relay-contact i is provided in order that the audible signal may be cut off during the entire time of the conversation between the connected users. This signal c^2 serves not only as a line-signal, but also as a signal for disconnection—that is to say, when either user hangs up his telephone the circuit through winding p of the differential signal will be broken and a ground-circuit will be formed from the battery through the winding p' to the ground at the user's station. Assuming that it was the user at station B who hung up his telephone, the circuit would be traced from ground g at station B to the switch-lever, thence over one limb of the line 2, through coil p' and the upper winding r of the retardation-coil, and thence to the bus-bar s , and thence from battery e to ground. The signal to disconnect is thus disclosed, as in the first instance, and the contact i being closed the audible signal f will be operated. The operator thereupon makes the disconnection by turning the knob of connecting-key 1 2 back to its normal position.

It will be observed that the battery-current when directed through the differential windings p or p' must pass first through one or the other of the windings $r r'$ of the retardation-coil—that is to say, retardation-coil winding r is in series with the winding p and retardation-winding r' is in series with the winding p' of the differentially-wound signal c^2 . The use of a retardation-coil in connection with a centralized battery used in telephone systems is well understood. It is for the purpose of preventing loss of telephonic or voice currents.

When any two lines are connected together—as, for example, at switch 2 3—the line-signal of only one of the connected lines will be left in circuit to serve as a clearing-out signal.

I will now assume that the station B wishes connection with a line of the main exchange at A. The user at station B will proceed in the same way heretofore described, taking down his telephone, disclosing his line-signal c^2 , and causing the audible signal f to respond. The operator at O will answer and make the connection at o^2 . The order being given for connection with the distant exchange, the operator will make connection between line 2 and the exchange or trunk line 4 at the key 2 4. The operator of key 2 4 in making connection with the line 4 closes the battery t through the lamp or signal t' of the apparatus at the exchange-office A. (See Fig. 10.) The operator at A responds in the usual way by plugging into the jack of the line 4. Either the operator at O or the user at station B will then communicate the order to the operator at the distant exchange-station A, who will proceed to make the connection with the line of the exchange that is desired in the usual way.

The battery in the cord-circuit at A, it will be understood, will furnish current for the transmitter at station B.

When the conversation is completed and the operator at exchange A withdraws the plug from the jack u of line 4 (see Fig. 10) or when the user at station B hangs up his telephone, the disconnecting-signal will be disclosed at k^4 .

I will now describe how a call is sent from the exchange A to the branch exchange by means of line 4, and in connection therewith I will give a more detailed description of the signal k^4 , the relay l^4 , and the circuit connections thereof. The operator at A on inserting the plug into the jack u of line 4 throws alternating current on the line from her generator w' by bridging the same across the cords, thus operating the line-signal k^4 —that is to say, the alternating current of generator w' traversing the metallic circuit, including the condenser w^2 , will excite the main magnet of signal k^4 to display the signal. The operator at O makes connection at o^4 , takes down her telephone, and answers. If the call be for line 2, she will then operate key 2 4,

which, as previously described, is connected with the key b^4 to operate the same, thus making signal z^4 available as a disconnecting device. Whenever current is sent over the line from the distant exchange A, the magnet of relay l^4 will be energized, closing the front contact thereof. When this action takes place, a ground-circuit from battery e is directed through the restoring-magnet of the signal z^4 , and the signal resumes its undisclosed position. The operator at O by means of key a^2 will call up station B, and thus the two users will be put into communication. The operator O may then disconnect her telephone at key o^4 . When the conversation has been completed and the user at station B hangs up his telephone and the current being interrupted, the armature-lever of relay l^4 falls on its back contact and current is thus directed through the magnet of signals z^4 from the battery in the cord-circuit at exchange A, thus operating the annunciator z^4 , which is the signal to disconnect line 2 from line 4.

My invention as thus described provides ready means for connecting and disconnecting any lines of the local exchange with one another, also means whereby these lines or some of them may be connected with lines of a distant or main exchange. The trunk-line signal z^4 and its associated relay l^4 and the signal-controlling key b^4 are brought into service in making connection and disconnection between local lines of the branch exchange, as line 2, and trunk-lines, as line 4, extending to the general or city exchange.

Having thus described my invention, I claim as new, and desire to secure by Letters Patent, the following:

1. The combination with the line-signal z^4 including the locking device and releasing-magnet thereof, of the relay l^4 and the signal-controlling key b^4 , with operator's apparatus including sources of current, whereby a momentary impulse of current displays the signal which is locked in position, and subsequently on making connection with the line, current is directed through the releasing-magnet to unlock the signal and cause the same to be withdrawn.

2. The combination with the general signal and the circuit g h thereof, of a relay g' whereby when the operator's set is in use such gen-

eral signal is disconnected, a telephone-line with a switch at the substation thereof for uniting the two lines in metallic circuit, the signal thereof provided with differential windings, as p p' , adapted to act differentially, in combination with a special key, as key b^2 , associated with a connecting-key, whereby on connecting the limbs in metallic circuit at the subscriber's station, current is directed through one of the windings of the signal device, and subsequently on connecting the line with another line current is directed also through the other winding thereof.

3. In combination with the metallic circuit 4, of the generator u' adapted to be bridged across the line, the condenser u^2 and the coils of the main magnet z^4 included in the circuit, the armature of said magnets and the locking device thereof with the releasing-magnet and means for operating the same, substantially as described.

4. The combination with the branch-exchange telephone-lines 1, 2, 3, &c., the battery e and the telephone-switches at the stations thereof, of connecting-keys at the intersections of said lines and line-signals having differential windings, special keys for changing the circuits of said signals, said special keys being controlled by the connecting-keys of their different lines respectively, whereby on connecting two lines together the signals thereof are maintained undisclosed during the conversation, one of the windings of one of the signals, however, being left connected with the battery to cause the said signal to act as a clearing-out device when either subscriber by hanging up his telephone directs current through said winding.

5. The combination with local telephone-lines of a branch exchange, of a trunk-line, as line 4, extending to the general exchange, a trunk-line signal z^4 , its associated relay l^4 , and controlling-key b^4 with operator's apparatus at the distant exchange, and local operator's apparatus of the branch exchange, substantially as and for the purpose specified.

In witness whereof I hereunto subscribe my name this 3d day of January, A. D. 1902.

JAMES S. FORD.

Witnesses:

GEORGE P. BARTON,
DE WITT C. TANNER.