C. L. ZAHM.

TELEPHONE EXCHANGE SYSTEM.

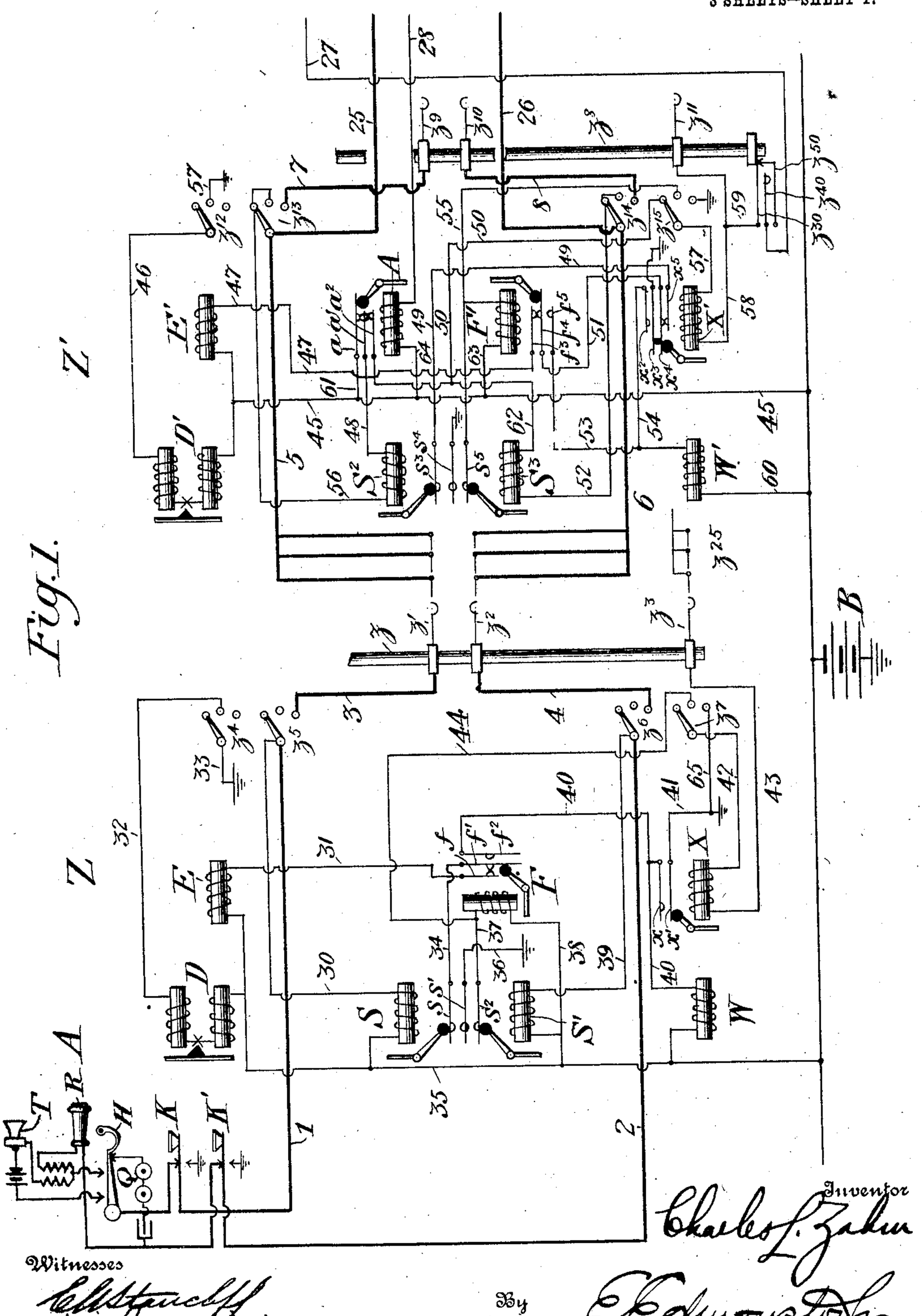
APPLICATION FILED SEPT. 19, 1905.

938,541.

Patented Nov. 2, 1909.

3 SHEETS—SHEET 1.

Fig. 1.



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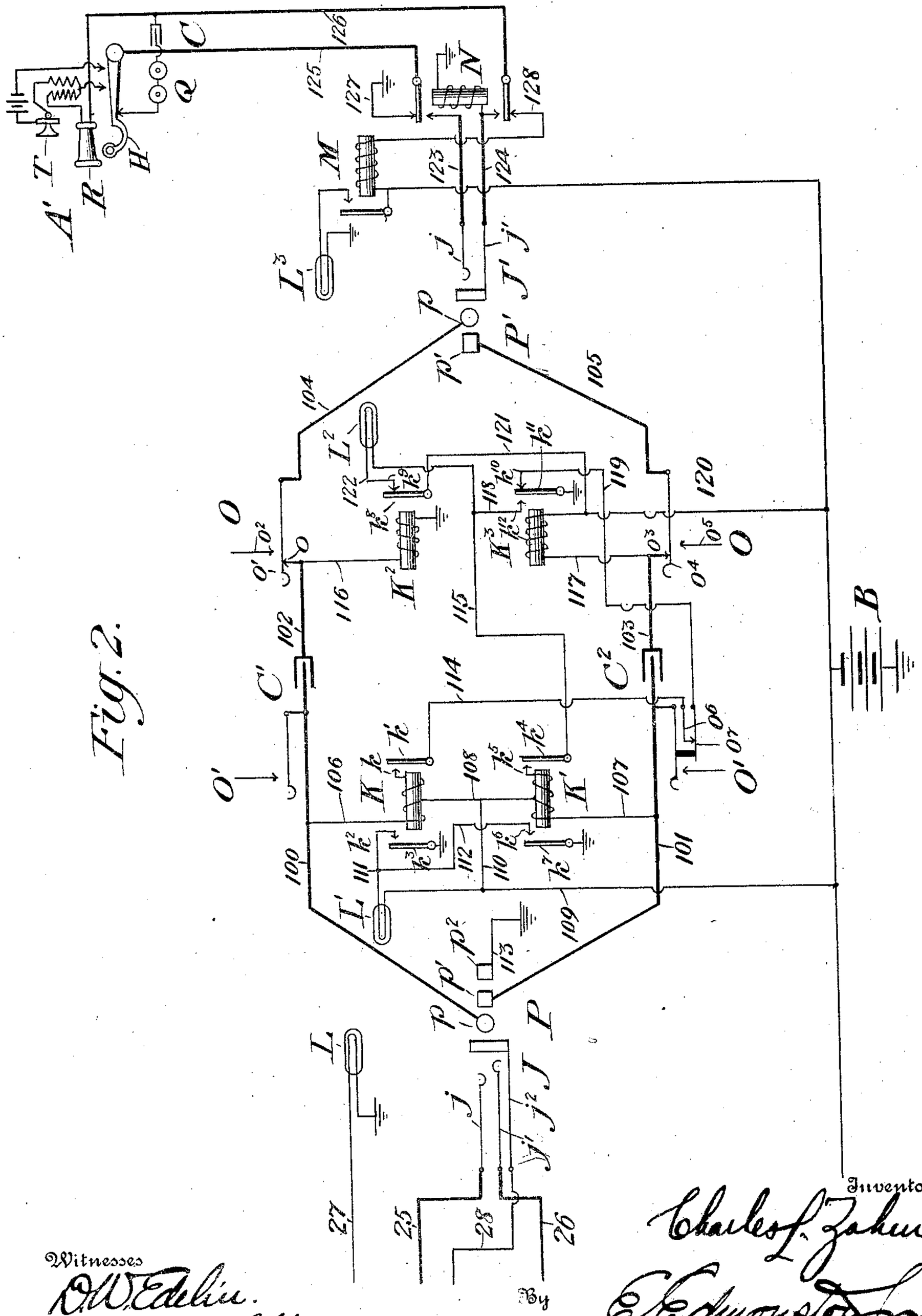
3 SHEETS—SHEET 2.

Fig. 2.



Witnesses

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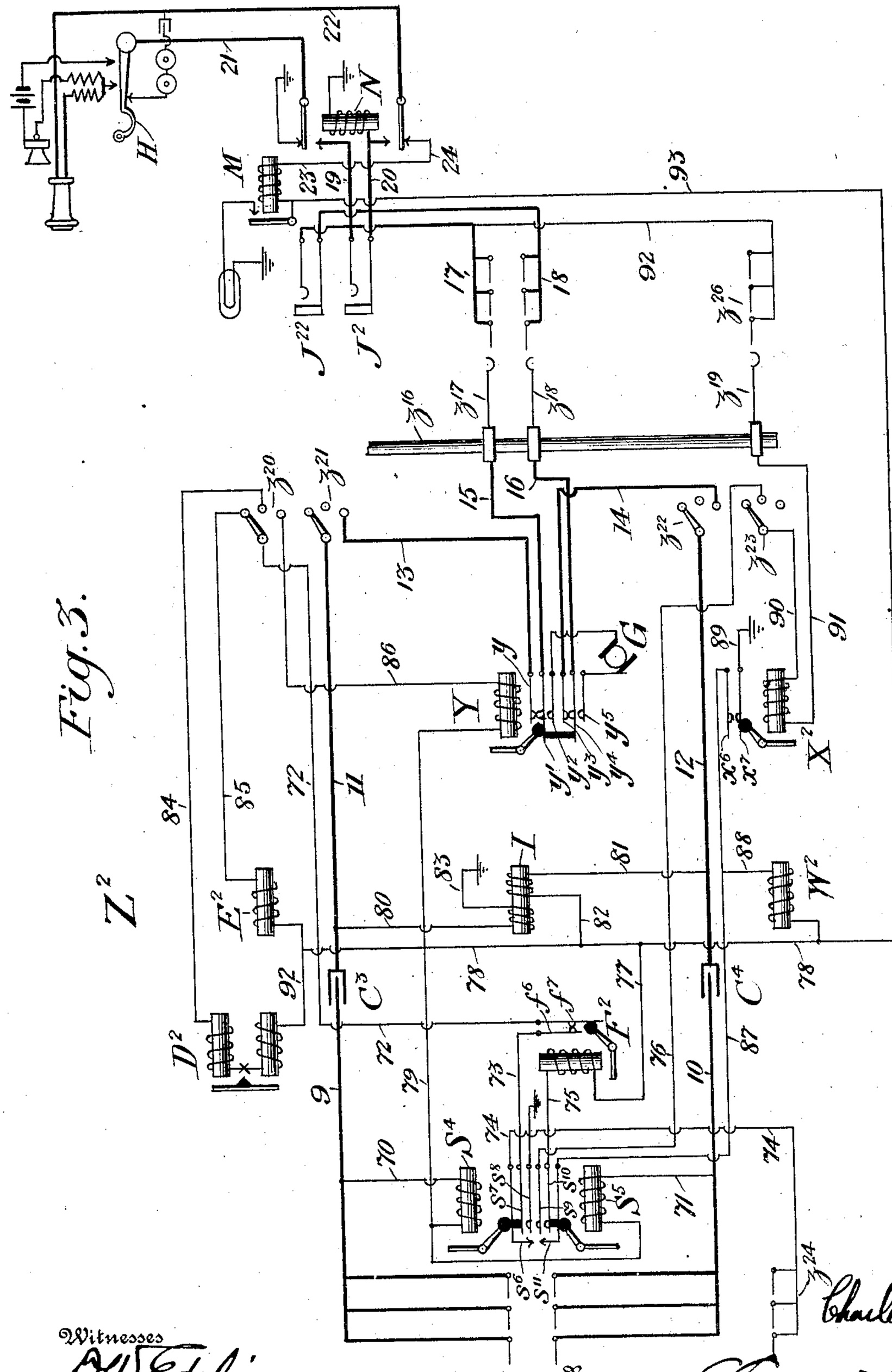
3 SHEETS—SHEET 3.

Fig. 3.



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CHARLES L. ZAHM, OF LOS ANGELES, CALIFORNIA, ASSIGNOR OF ONE-FOURTH TO EDWARD E. CLEMENT, OF WASHINGTON, DISTRICT OF COLUMBIA.

TELEPHONE-EXCHANGE SYSTEM.

938,541. Specification of Letters Patent. **Patented Nov. 2, 1909.**

Application filed September 19, 1905. Serial No. 279,123.

To all whom it may concern:

Be it known that I, CHARLES L. ZAHM, a citizen of the United States, residing at Los Angeles, in the county of Los Angeles and State of California, have invented new and useful Improvements in Telephone-Exchange Systems, of which the following is a specification.

My invention relates to telephone exchange systems, and has for its object to produce means whereby subscribers working on an automatic system may trunk directly into the manual system, without making any substantial change in either the automatic or manual equipment, but retaining all the advantages of both.

According to one arrangement I cause a subscriber who comes in on a first selector of the well known Strowger type, to select an idle second selector switch through which connection may be had directly to a manual switch board through a trunk line, or, if desired, any of the ordinary connector switches may be reached and through any of them the call may also be made to a subscriber who may also have manual switch board connections. With this arrangement it must be obvious that I obtain a very great degree of flexibility in my system. It is possible through the second selector to get onto a toll board, information apparatus, etc., with expedition and certainty; while if the subscriber wanted happens to have an automatic connection, the calling subscriber can proceed in his usual manner and make the call direct instead of going through the tool or other manual switch board.

My invention is illustrated in the accompanying drawings, wherein,

Figure 1 shows in diagram a subscriber's station, a standard first selector switch of Strowger type, and a second selector switch of the same type wherein I have made certain changes so as to be able to trunk directly to a manual switchboard. Fig. 2 is a similar diagram showing a trunk jack on the manual switchboard with the connective cord circuit and also a common battery subscriber's station with its line terminating on a manual switchboard. Fig. 3 is a similar diagram showing a Strowger connector switch with certain changes, which allow me, in connection with the apparatus shown in Fig. 1, to call automatically a subscriber whose line terminates in a common battery exchange system.

Referring now to Fig. 1, the subscriber's station A is equipped with apparatus usually found in local battery systems, consisting of the transmitter T, receiver R, hook H, and ringer Q. In addition to the foregoing talking set there is added the sending apparatus for transmitting impulses to operate the switches at central. I have for simplicity represented the sending apparatus by the two push buttons K, K'. The button K when depressed grounds number 1 side of the line, and sends impulses which operate vertical relays in the various switches, while the button K' when depressed sends in an impulse over number 2 side of the line which operates the rotary relays. At the end of the conversation, both buttons are depressed sending in an impulse over both sides of the line simultaneously, affecting both the vertical and rotary relays and releasing the various switches. Button K, when depressed, after sending in the last set of impulses, operates the ringing relay in the connector switch.

The switches I employ at the central office are preferably of the "Strowger" type shown in Letters Patent Nos. 815,176 and 815,321 to Keith and Erickson, dated March 13, 1906, although I do not limit myself thereto, reserving the right to employ others where desired, with the necessary non-essential changes in circuits and connections.

The first selector switch Z being the regular Strowger type without change, need not be described in detail. The vertical relay S responds to impulses over one side of the line, and operates the vertical magnet E whose armature *c* controls a pawl which engages a ratchet on the spindle *z* causing it to step up in a vertical position. This spindle carries the trunk wipers z', z^2, and the test wiper z^3, which are insulated from the spindle. The rotary relay S' responds to the impulses over the rotary side of the line, and in turn operates the private relay F which causes the mechanically operated side switches z^4, z^5, z^6 and z^7 to turn one point, cutting on the rotary magnet D which in turn moves the side switches another point connecting the line wires to the trunk wipers. The release relay X is connected to the test wiper z^3 and controls the circuit of the re-

lease magnet W which, when operated, restores the switch to its normal position.

In the second selector switch Z′ wherein part of my invention lies, I have inserted additional apparatus and wiring which enables me to signal and be connected to a manual exchange without the necessity of using the ordinary connector switch. I will point out the additions and changes as I proceed with the description. The vertical relay S^2 which responds to impulses over the vertical side of the line, operates the magnet E′ which steps up the spindle z^8 vertically, in the same manner as described for switch Z. The rotary relay S^3, which responds to impulses over the rotary side of the line, operates the private relay F′ which causes the mechanically operated side switches z^{12}, z^{13}, z^{14}, z^{15} to move one point, cutting in the rotary magnet D′, which in turn causes the switches to move another point connecting the line wires to the trunk wipers. One terminal of each relay S^2 S^3, instead of being connected permanently to battery, as in the ordinary Strowger switch, is connected indirectly through the contacts a, a', a^2 of the cut-off relay A, which I have inserted. One terminal of this relay is connected directly to battery, while the other terminal is connected to the ring of a trunk jack on a manual switch-board. The trunk wires 25 and 26 are continued through to the tip and sleeve springs of the same jack. I have also added the two normally closed contact springs x^4 and x^5 to the release relay X′, so that instead of the spring s^3 of the relay S^2 being connected directly to the spring f^4 of the relay F′, it is connected indirectly through these two additional contacts. In addition to the foregoing, I have added the three contact springs z^{30}, z^{40}, and z^{50}, which are operated mechanically by the spindle z^8. To the contact z^{30} I have connected the terminal of the release relay X′ which leads to the private wiper z^{11}. The normally open contact z^{40} is connected to one terminal of the lamp L on the manual switchboard Fig. 2. I have connected the first contact in the side-switch z^{15} to battery through the contacts of the relay A, the reason for which will be explained later.

Referring now to Fig. 2, I have shown the manual switchboard end of the trunk which consists of the lamp L and jack J having the tip spring j, sleeve spring j', and ring j^2. The cord circuit which forms the connecting link between the second selector switch and the subscriber whose station is equipped with common battery apparatus, consists of the following: the answering plug P, the tip p of which is connected to the tip p of the calling plug P′ by the following path: strand 100, condenser C′, 102, contacts o and o', 104, to p. The sleeve p' of the answering plug P is connected to the sleeve p' of the calling plug P′ by the following path: 101, condenser C^2, 103, contacts o^3, o^4, 105, to p'. The ring p^2 of the plug is connected to ground by the wire 113. The relays K and K′ are connected to the tip and sleeve respectively, of the plug P, and are connected permanently to battery at their middle points, while the other terminals are connected to normally open contacts. Both of these relays are of the locking type, and each one controls the circuit of the lamp L′. The relay K after becoming locked, is released manually by the operator throwing forward her listening key which opens the circuit of the relay. The relays K^2, K^3 are connected to the tip and sleeve of the calling plug P′, respectively, one terminal of the relay K^2 being connected to grounded battery, and one terminal of the relay K^3 being connected to the free side of battery, thus supplying current for talking to the called subscriber. These two relays jointly control the circuit of the lamp L^2. The relay K′ cannot become locked unless the calling plug P′ is inserted in the jack of a called line which energizes the relay K^3, closing the locking circuit of the relay K′, so it follows that after this relay becomes locked it cannot be released until the calling plug is withdrawn from the jack, deënergizing the relay K^3. The subscriber's station A′ is equipped with apparatus usual in common battery systems, which consists of the transmitter T, receiver R, hook H, ringer Q, and condenser C. The wires from this station terminate in a central office on a line relay M through the normally closed contacts of the cut-off relay N. This relay when energized upon the insertion of the plug P′, attracts its armatures, disconnects the line relay and connects the line wires to the springs j, j' of the jack J′.

Referring now to Fig. 3 I have shown a connector switch Z^2 wherein I have added apparatus and wiring which in connection with the equipment already described in Fig. 2 enables me to call automatically a subscriber in a common battery exchange. I will point out as we go along the additions and changes I have made. The vertical relay S^4 responds to impulses over the vertical side of the line, operates the vertical magnet E^2, causing the spindle z^{16} to step up vertically The rotary relay S^5 responds to impulses over the rotary side of the line which operates the private relay F^2, which causes the side switches z^{20}, z^{21}, z^{22}, z^{23} to move one point, which in the switch z^{20} disconnects the vertical magnet E^2 and connects in its place the rotary magnet D^2, which is operated when the second set of impulses are sent in over the vertical side of the line affecting the relay S^4. In the rotary relay S^5 I have added a contact s^9 which is connected to the second point in the switch z^{23}. This second

point in the Strowger system is connected to a normally open contact in the private relay F^2, and the contact which engages it is connected to battery with the release magnet W^2 in series. In the private relay F^2 I have omitted these two springs, as I have no further use for them. In place of the release relays which in the Strowger system have one terminal of each relay connected to the trunk wires 11 and 12, respectively, the other terminals being connected to one side of the battery, I have added the retardation coil 1. This coil has two windings, the terminal of one winding being connected to trunk wire 11, the other terminal being grounded. The second winding has one terminal connected to the trunk wire 12, the other terminal being connected to the free side of the battery. Battery being thus bridged between the two windings supplies talking current to the subscriber in the manual system, and also furnishes means for pulling up the cut-off relay, disconnecting the line signal, and providing a "busy" test as will be explained later.

In the Strowger system, the arm of the side-switch z^{23} is connected directly to the private wiper z^{19}, but between these two points I have inserted the release relay X^2 having the contact x^7 grounded, and the contact x^6 connected to one terminal of the release magnet W^2, and to the contact s^{11} of the relay S^5. It will be seen that instead of having the magnet W^2 act as the test as in the Strowger system, I have placed it in the local circuit of the relay X^2 which responds to, or becomes energized, by a small amount of current such as would be received in testing a busy line in a manual system. The test in such cases is generally produced by the difference in potential between two relays or coils. The magnet W^2 will not respond to such currents as it is simply built for working purposes, and requires a certain amount of current to operate. I have not changed the circuits of the ringing relay Y in the slightest, which when becoming energized opens the calling end of the trunk and connects generator current to the calling end. I have connected the test contacts z^{26}, which in the Strowger system are normally free from any connection, to the tip contacts of the lines in the manual exchange which are in parallel with the multiple and answering jacks of the manual switchboard. The tip and sleeve contacts in the switch are connected in parallel with the tip and sleeve springs respectively in the same answering and multiple jacks.

In the operation of that part of my system where a calling subscriber wishes for a connection in a common battery manual exchange where the conditions are such that he cannot call the subscriber automatically, the procedure is as follows: He is first connected to a second selector switch and from there directly to a manual switchboard where an operator completes the connection through her cord circuit to the wanted subscriber. The calling subscriber first depresses the button K sending impulses, the number of which will correspond to the exchange wanted. The impulses coming in over number 1 side of the line operate the relay S, which attracting its armature closes the circuit of the magnet E by the following path: ground, 36, s', s, 34, f, f', 31, E, 35, to battery B. The operation of this magnet causes the spindle z carrying the trunk wipers z', z^2, and the test wiper z^3 to step up vertically and come opposite a row of contacts leading to a group of second selector switches of my changed type which have access directly to a manual switchboard. The subscriber now depresses a button K', sending an impulse over number 2 side of the line, operating the relay S', which in turn closes the circuit of the private relay F by the following path: ground, 36, s', s^2, 37, F, 38, to battery B. This relay operating opens the contacts f, f', disconnecting the vertical magnet E and preventing the spindle z from making a vertical movement. The operation of the relay F also causes the side-switches z^4, z^5, z^6, z^7, to move one point, and in the switch z^4, closing the circuit of the rotary magnet D. The circuit of this magnet being closed causes its armature to vibrate, which in turn rotates the spindle z until the wiper z^3 finds a contact in the row not busy, that is to say, free from grounds. As soon as such a contact is found the relay F becomes deënergized and causes the side switches to take the third position cutting off the rotary magnet I and causing the spindle to come to rest with the wipers on contacts leading to an idle second selector switch. The relay F is kept energized while the switch is rotating and the wiper z^3 is passing over the grounded contacts by the following path: z^3, 43, X, 42, z^7, 44, 37, F, 38, 35 to battery B. The relay X does not become energized on account of its winding being of a very low resistance and in series of the winding of the relay F which is of comparatively high resistance. The side switches in taking the third position connect the line wires 1, 2 to the wires 3 and 4 respectively leading to the wipers z' and z^2, and ground the test contact z^{25} by the following path: ground, 65, z^7, 42, X, 43, z^3 to z^{25}. The calling subscriber is now connected to a second selector switch which leads directly to a manual switchboard. Instead of sending in additional set of impulses he now simply depresses the button K which in the Strowger system would be the ringing button. The pushing of this button sends an impulse over No. 1 side of the line operating the vertical relay S^2 which closes the circuit of the vertical magnet E' by the following path: ground, s^4, s^3, 49, x^5, x^4, 51,

f^4, f^3, 47, E′, 45 to battery B. The energizing of this magnet causes the spindle z^8 to step up vertically to the first row of contacts, closing the contacts z^{40} and z^{50} which completes the circuit of the line lamp on the switchboard by the following path: battery B, 45, 61, a, a', a^2, 62, 50, z^{15}, 57, X′, 58, 59, z^{30}, z^{50}, z^{40}, 27, lamp L to ground. The release of the different switches is effected by the release magnet first becoming energized and then deënergized thus constituting a two-step escapement. As the back release relay X′ is in series with the lamp L it becomes energized and, attracting its armature, closes the circuit of the release magnet W′ by the following path: ground, x^3, x^2, 54, W′, 60, to battery B. This magnet becoming energized takes the first step toward releasing the switch Z′. The contacts x^4 and x^5 of the magnet X′ are broken, disconnecting the vertical magnet E′, thus preventing the spindle z^8 from taking a second step in case the subscriber should depress the button K the second time. The calling subscriber has now signaled and is connected to the manual switchboard over No. 1 side of the line by the following path: 1, z^5, 3, z', 5, 25 j of the jack J and over No. 2 side of the line by the following path: 2, z^6, 4, z^2, 6, 26, to j' of the jack J.

Referring now to Fig. 2, the operator at the manual exchange perceiving the lamp L glowing inserts the plug P into the jack J, throws forward her listening key O′ in the ordinary manner, and asks for the number wanted. The insertion of this plug closes the circuit of the cut-off relay A in the second selector switch Z′ by the following path: ground, 113, p^2, j^2, 28, A, 64, 45 to battery B. This relay becoming energized attracts its armature opening the contacts a, a', a^2, disconnecting the vertical and rotary relays S^2 and S^3 and opening the circuit of the back release relay X′ whose armature now assumes its normal position and opens the circuit of the release magnet W′ restoring the switch Z′ to its normal position. The spindle z^8 in returning to its normal position opens the contacts z^{40} and z^{50} extinguishing the signal lamp L.

Referring again to Fig. 2, the operator upon finding the number wanted inserts the calling plug P′ into the jack J′ of the desired line. This insertion closes the circuit of the relay K^3 and the cut-off relay N by the following path: battery B, 120, K^3, 117, o^3, o^4, 105, p', j', 124, N to ground. The relay N becoming energized attracts its armatures and disconnects the line relay M and connects the line wires 125, 126 to the spring j and j' of the jack J′. The operator throws forward her key O whose contacts o^2 and o^5 are connected to generator current, and rings in the ordinary manner. The relay K^3 in becoming energized attracts its armature and closes the circuit of the supervisory lamp L^2 and places a ground on the contact k^4 of the relay K′ by the following path: ground, k^{11}, k^{12}, 115, k^4. The subscriber at station A′ upon answering closes his line circuit energizing the relay K^2, extinguishing the lamp L^2, thus notifying the operator that he has answered. At the end of the conversation the subscriber at station A′ hanging up opens his line circuit, deënergizing the relay K^2 causing the lamp L^2 to again glow. The subscriber at the automatic station A in hanging up depresses both buttons K and K′ sending impulses simultaneously over both sides of the line. In the first selector switch Z, Fig. 1, these impulses operating the relays S and S′ at the same time close the circuit of the relay F which attracting its armature closes the circuit of the release magnet W by the following path: ground, s', s, 34, f', f^2, 40, W to battery B, thus restoring the switch Z to its normal position. These same impulses operate the relays K and K′ in Fig. 2 in a similar manner. The relay K′ attracting its armature closes the circuit of the lamp L′ by the following path: ground, k^7, k^6, 112, 111, L′, 109, to battery B and locks itself by the following path: battery B 109, 110, 108, K′, k^5, k^4, 115, 118, k^{12}, k^{11} to ground. The operator upon perceiving both lamps glowing takes down the connection, that is withdraws both plugs P, P′ from the jacks J, J′ respectively. The relay K^3 now becomes deënergized extinguishing the lamp L^2 and releases the relay K′ which in turn extinguishes the lamp L′. If the calling subscriber wishes to signal the operator while the plugs are in their respective jacks, he depresses the ringing button which sends in an impulse over the vertical side of the line operating the relay K which, attracting its armatures, closes the contacts k^2 and k^3 causing the lamp L′ to flash. This relay K cannot lock itself at this time because the contacts k^{11} and k^{10} of the relay K^3 are broken. Suppose the calling subscriber hangs up before the operator has placed the calling plug P′ into the jack J′ of the wanted line. Impulses coming in over both sides of the line simultaneously operate both the relays K and K′ but locking only the relay K by the following path: battery B, 109, 110, 108, K, k, k', 114, o^6, o^7, 119, k^{10}, k^{11} to ground. The circuit of the lamp L′ is also closed and the operator noticing the lamp glowing throws her key O′ into the listening position breaking the contacts o^6 and o^7 releasing the relay K which in turn extinguishes the lamp L′.

It will be seen from the foregoing description that I have provided for any contingency which might arise while the sub-

scriber in an automatic exchange is connected to a subscriber in a common battery exchange through a manual switchboard.

I will now describe the operation of that part of my invention wherein a subscriber in an automatic exchange is enabled to call a subscriber in a common battery exchange without the necessity of having an operator on the manual switchboard complete the connection. This is done by calling through to a connector switch of my type which I have described. This connector switch coöperates with the selector switches already described in Fig. 1. While I have made certain changes in the second selector switch Z′ enabling me to be connected directly to a manual switchboard it also can perform the ordinary function as in the regular Strowger system by picking out the connector switch of the desired hundred.

I have already described the operation of the first selector switch Z in connection with the first part of my invention and it will not be necessary to repeat it. We will take it for granted that the calling subscriber is connected through the first selector switch to a second selector switch of my type. Depressing the button K he sends in impulses over No. 1 side of the line operating the relay S^2 in the switch Z′ which in turn closes the circuit of the vertical magnet E′ by the following path: ground, s^4, s^3, 49, a^5, a^4, 51, f^4, f^3, 47. E′ 45 to battery B. This magnet in operating causes the spindle z^8 to step up vertically bringing the wipers opposite a row of contacts leading to a connector switch of the desired hundred. The subscriber now depresses the button K′ sending an impulse over No. 2 side of the line operating the relay S^3 which in turn closes the circuit of the private magnet F′ by the following path: ground, s^4, s^5, 55, F′, 63, 45, to battery B. The magnet F′ becoming energized opens the contacts f^3, f^4, disconnecting the vertical magnet E′ preventing the spindle from making a vertical movement. The operating of this relay causes the side switches z^{12}, z^{13}, z^{14}, z^{15} to move one point closing the circuit of the rotary magnet D′ which causes the spindle to rotate and continue to rotate until the wiper z^{11} finds a contact free from ground. As soon as this happens the relay F′ becomes deënergized and the side switches move another point disconnecting the rotary magnet causing the wipers to rest on contacts leading to an idle connector switch. The side switches in taking this final step disconnect the relays S^2 and S^3 and ground the contact of the connector switch upon which the private wiper rests by the following path: z^{11}, 58, X′, 57, z^{15} to ground. The calling subscriber is now connected to the connector switch containing the contacts of the desired line.

The operation of the spindle z^8 in stepping up vertically is much too rapid to cause the lamp L on the manual switchboard to glow and as soon as the switch makes a second vertical movement its circuit is broken at springs z^{30}—z^{50}, that is the relay X′ is no longer connected to the wire 27. This rapid movement of the spindle in the first step is also too rapid to operatively energize the magnet W′, hence the release mechanism is not set in the vertical movement for any step beyond the first. The subscriber now being connected to a connector switch of the desired hundred, depresses the button K sending in impulses over No. 1 side of the line operating the vertical relay S^4 which in turn closes the circuit of the vertical magnet E^2 by the following path: ground, S^8, S^7, 73, f^6, f^7, 72, z^{20}, 85, E^2, 92, 78 to battery B. The operation of this magnet causes the spindle z^{16} to move up vertically bringing the wipers z^{17}, z^{18} and z^{19} opposite the row containing the contacts of the desired line. The subscriber now depresses the bottom K′ sending an impulse over No. 2 side of line operating the relay S^5 which in turn closes the circuit of the relay F^2 by the following path: ground, s^8, s^9, s^{10}, 75, F^2, 77, 78 to battery B. This relay opens the contacts f^6, f^7 disconnecting the vertical magnet E^2 and causing the side switches z^{20}, z^{21}, z^{22} and z^{23} to move one point. In the side switch z^{20} the rotary magnet I^2 is now connected in place of the vertical magnet E^2. The subscriber now depresses the button K sending impulses over No. 1 side of the line operating the relay S^4 the second time which now in turn closes the circuit of the rotary magnet I^2 by the following path: ground, s^8, s^7, 73, f^6, f^7, 72, z^{20}, 84, I^2, 92, 78 to battery B. This magnet in operating causes the spindle to rotate bringing the wipers to rest on the contacts of the desired line. The subscriber now depresses the button K′ sending an impulse over No. 2 side of the line operating the relay S^5 which in turn closes the circuit of the relay F^2 as before and at the same time placing the relay X^2 in a test position by the following path: ground, s^8, s^9, 76, z^{23}, 90, X^2, 91, to wiper z^{19} and the contact z^{26} upon which it rests. Normally this contact as will be seen by referring to the diagram is open being multipled to the tip spring of the multiple jacks J^2, J^{22} and from there to the normally open contact of the cut-off relay N. If this line was busy the battery would be connected to it through the supervisory relays of the operator's cord circuit on the manual switchboard. If on the other hand the line was engaged by another connector switch the tip side of line would be supplied with battery through the talking or retardation coil which furnishes the battery supply for talking purposes. If in this case the line was engaged the relay X^2 would become energized and close the circuit of the

release magnet W^2 restoring the switch to its normal position. We will take it for granted that the line is not busy. The operation of the private magnet F^2 the second time causes the side switches to move another point. In the side switch z^{20} the rotary magnet I^2 is disconnected and the ringing relay Y connected in its place. The trunk wires 11 and 12 are connected respectively to the trunk wipers z^{17} and z^{18} through the normally closed contacts of the ringing relay Y. In the side switch z^{23} the circuit of the relay X^2 is opened. As soon as the trunk wires of the switch are connected to the wipers resting on the contacts of the desired line the circuit of the cut-off relay N is closed by the following path: battery B, 78, 82, one winding of the coil I, 81, 12, z^{22}, 14, y^3, y^4, 16, z^{18}, 18, 20, N to ground. This relay becoming energized attracts its armature, disconnects the relay M and connects the line wires 21 and 22 respectively to the trunk contacts 17 and 18. The calling subscriber is now connected to the desired party and depressing the button K which now acts as the ringing button, he operates the vertical relay S^4 which in turn closes the circuit of the ringing relay Y by the following path: ground, s^8, s^7, 73, f^6, f^7, 72, z^{20}, 86, Y, 79, 78 to battery B. This relay becoming energized attracts its armature, disconnects the calling end of the trunk and connects generator current to the wipers leading to the desired line. The subscriber in the common battery exchange removing his telephone is supplied with battery for talking purposes through the windings of the retardation coil I. The condensers C^3 and C^4 being inserted between the wires 9, 11 and 10, 12 prevent battery from flowing back over the trunk operating the vertical and rotary relays.

At the end of the conversation the calling subscriber in hanging up depresses the buttons K and K′ grounding both sides of the line simultaneously which in the switch Z^2 operate the relays S^4 and S^5. These two relays becoming energized at the same time close the circuits of the release magnets in the connector switch Z^2 and in the second selector switch Z′ in the following manner: First the circuit of the release magnet W^2 is closed in series through the back release relay X′ by the following path: battery B, 78, W^2, 87, s^{11}, s^6, 74, z^{24}, z^{11}, 58, X′, 57, z^{15}, to ground. The magnet W^2 becoming energized restores the switch Z^2 to its normal position. The relay X′ becoming energized attracts its armature and closes the circuit of the release magnet W′ by the following path: ground, x^3, x^2, 54, 53, W′, 60 to battery B. This magnet becoming energized restores the switch Z′ to its normal position. In the first selector switch Z, the vertical and rotary relays S and S′ are connected permanently to the trunk and the impulses coming in over both sides of the line simultaneously energize these relays which close the circuit of the release magnet W by the following path: ground, 36, s', s, 34, f', f^2, of the relay F as it is energized at this time, 40, W, 35, to battery B. The energizing of this relay restores the switch Z to its normal position.

It will be readily seen from the foregoing description that the second selector switch Z′ is a combination switch, and performs two functions, first in connection with a first selector switch it connects the subscriber directly to a manual switchboard where he can be connected to any subscriber in the manual common battery exchange. The operator at the manual switchboard can also act in the capacity of an information operator in case the subscriber desires some information relating to new subscribers or changes of numbers, etc. Second, this switch can be used as the ordinary second selector switch and connect the calling subscriber directly to a connector switch which is operated in the ordinary manner and enables him to call a subscriber in an automatic exchange or in picking out a group of selectors of my type he can call a subscriber in the manual full common battery exchange in the same manner as calling a party in the automatic exchange.

Having thus described my invention, what I claim and desire to secure by Letters Patent of the United States is:

1. In a telephone exchange system, a subscriber's line, a selector switch controlled thereby having means to connect the line by successive motions with other lines, a manually operated switchboard having trunk line connective terminals and signals associated therewith, connections from said selector switch to said switchboard, and means actuated in the first motion of the selector switch to display a signal and indicate that a connection is desired on the manual switchboard, substantially as described.

2. In a telephone exchange system, a subscriber's line, a substation having sending apparatus and a central station having selector switches for interconecting the line with other lines as determined by the subscriber, one of said switches permanently associated with and controlled by said subscriber's line, a manually operated switchboard having trunk terminals and signals therefor, a trunk line permanently connected to one of said selector switches accessible by a single selective operation from the subscriber's switch, and to one of said trunk terminals on the manual board, with means whereby the said signal may be set and connection obtained through the manual switchboard by a single operation of the subscriber's switching apparatus, and further

means whereby continued or repeated operations may connect the line directly to other lines without operating the trunk signal, substantially as described.

3. In a telephone exchange system, a plurality of subscribers' lines and a plurality of automatic switches for interconnecting them as determined by repeated current changes caused by the calling subscribers, one of said switches associated with each line and used as a first digit selector, a plurality of said switches accessible from the first selectors and used as second digit selectors, with other switches accessible from said second selectors and used to connect through to the subscribers' lines; a manually operated switchboard having connective terminals and signals, a trunk line permanently connected to a second selector switch circuit and to one of said connective terminals, with means actuated in the first step in operation of the said second selector to display the trunk signal on the switchboard, said means requiring an appreciable time to set the signal, substantially as described.

4. In a telephone exchange system, a subscriber's line, a first selector switch controlled thereby and having means to pick out and connect with a trunk to a second selector switch, thence to further switching means and to subscribers' lines automatically, a permanent extension of the trunk from the second selector to a manually operated switchboard, a connective terminal and a signal on said board for said trunk extension, and means whereby the second selector switch may be advanced one step to display the switchboard signal without changing the connection of the trunk, substantially as described.

5. In a telephone exchange system, a subscriber's line, a first selector switch controlled thereby, and having means to pick out and connect with a trunk to a second selector switch, thence to further switching means and to subscribers' lines automatically, a permanent extension of the second selector trunk to a manually operated switchboard, a connective terminal and a signal on said board for said trunk extension, means operated in one step of the second selector switch to set said signal to attract the attention of the operator, and means controlled by the operator to release and restore the switch and thereby restore the signal. substantially as described.

6. In a telephone exchange system, a selector switch having a release magnet operating to release the switch mechanism, means to control the switch as determined by a calling subscriber, and means to select other switches and subscribers' lines automatically thereby, a permanent connection of the talking circuit of the selector switch to a manually operated switchboard and a signal thereon for the same, whereby the talking circuit is complete when a line has selected the said switch without moving its operating parts, means for displaying said signal on actuating the switch, and means controlled by the operator in answering the call on the manual switchboard to cut off and deënergize said release magnet, whereby the switch will be restored and the signal reset, substantially as described.

7. In an automatic telephone exchange system, a second selector switch, means controlled by a subscriber to connect his line therewith and thence with other subscribers' lines automatically, a back release relay for said switch, and a release magnet controlled thereby, an extension of the talking circuit of the switch to a manually operated switchboard, a signal on said board associated therewith, a circuit for said signal closed in the first movement of the switch and including the said back release relay to cause the initiation of the release movement when the signal is displayed, a cut-off relay for the signal and release relay circuit, and means actuated by an operator in answering a call on the manual switchboard to energize said cut-off relay, substantially as described.

8. In an automatic telephone exchange system, a selector switch, means controlled by a subscriber to select other subscribers through said switch, an extension of the circuit of said switch to a manually controlled switchboard, whereby a calling subscriber can connect his talking circuit to said manual switchboard without operating the switch, a signal associated with the extension on the manual switchboard, a circuit for said signal closed in the first movement of the selector switch without affecting the talking circuit, and a cut-off relay associated with the selector switch controlled by the operator in answering a call on the switchboard, and acting to cut off the signal and restore the switch, substantially as described.

9. In an automatic telephone exchange system, a selector switch having a trunk, means controlled by a subscriber to connect his line with said trunk and through the selector switch with other subscribers' lines, an extension of said trunk to a manual switchboard, a spring jack thereon and a signal associated with the trunk extension, a circuit closer for said signal actuated in the selector switch by the subscriber, and a cut-off relay in the selector switch connected to a contact in the springjack closed by the operator in answering a call and acting to disconnect the controlling means in the switch to leave a clear talking circuit and also to cut off the signal, substantially as described.

10. In a telephone system, a second selector switch having bridged controlling

magnets, a trunk accessible to a calling subscriber and connected to give control of said magnets and the switch, an extension of said trunk to a manually operated switchboard with a signal associated therewith, a springjack for the trunk extension, operator's plugs and cords coöperating therewith, a circuit closer for the signal operated in the first step up of the selector switch, a release magnet therefor, and a cut-off relay in a circuit closed in the jack when a plug is inserted by the operator, whereby the controlling magnets are cut off, the release is operated, and the signal is restored substantially as described.

11. In a telephone exchange system, a selector switch, controlling magnets therefor and means whereby a subscriber may thereby select further switches and other subscribers' lines, a connection from the circuit of the switch to a manual board and a signal circuit associated therewith with a signal on said board, a circuit closer for said signal circuit closed by the switch upon the first actuation by the controlling magnet, and means in the signal circuit for disabling the said controlling magnet circuit so that after the first impulse repeated impulses by the subscriber will produce no effect, substantially as described.

12. In an automatic telephone exchange system, selector switches and means controlled thereby to directly interconnect subscribers' lines, an extension from a selector switch circuit to a manual switchboard and a signal therefor, a circuit closer for said signal actuated by the first movement of the switch, means at a subscriber's station for sending a rapid succession of impulses to set up the switch, and means also to send a single impulse to close the manual switchboard signal circuit, the succession of impulses being too rapid in every case to set the switchboard signal, substantially as described.

13. A combined automatic and manual switchboard system of the type described, comprising a pair of connective terminals and cord conductors, with three bridged relays on opposite ends thereof and responding to current in opposite directions to the connected stations, two of said relays bridged across one end of the cord with a battery connection from a point between them, the first relay having a circuit whereby upon attraction of its armature it will be self-locking through the listening key of the cord and a normally closed contact of the third relay, the second relay being similarly self-locking through contacts normally open in the third relay but closed when a connection is completed, substantially as described.

14. In an automatic telephone exchange system, a plurality of selector switches and connector switches working therewith to select and connect with subscribers' line terminals therein, vertical and rotary relays therein, manual switchboard connections and relays for said subscribers' lines, a sensitive test relay, and means controlled by the rotary relay in a connector switch in completing a connection with a called line, to connect said test relay to the test wiper of the said connector switch, whereby differences of potential on the manually connected lines may be detected in testing, substantially as described.

15. In a telephone exchange system, a subscriber's line, a selector switch controlled thereby having means to connect the line by successive motions with other lines, a manually operated switchboard having trunk line connective terminals and signals associated therewith, connections from said selector switch to said switchboard, means actuated in the first motion of the selector switch to display a signal and indicate that a connection is desired on the manual switchboard, and means actuated on the second motion or step thereof to cut off the same, substantially as described.

16. In a telephone exchange system, a selector switch having a release magnet operating to release the switch mechanism, means to control the switch as determined by a calling subscriber, and means to select other switches and subscribers' lines automatically thereby, a permanent connection of the talking circuit of the selector switch to a manually operated switchboard and a signal thereon for the same, whereby the talking circuit is complete when a line has selected the said switch without moving its operating parts, means for setting the signal and closing circuit to the release magnet on the first step of the switch, means controlled by an operator in answering a call to cut off and deënergize the release magnet, and other means controlled in a subsequent step of the switch when making a selection other than that of the manual operator, to cut off the release magnet without effectively energizing the same, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

CHARLES L. ZAHM.

Witnesses:
GEO. E. HIGGINS,
REX GARRETT.