E. E. CLEMENT.

TELEPHONE EXCHANGE SYSTEM.

APPLICATION FILED NOV. 13, 1907.

1,024,487.

Patented Apr. 23, 1912.

3 SHEETS—SHEET 1.

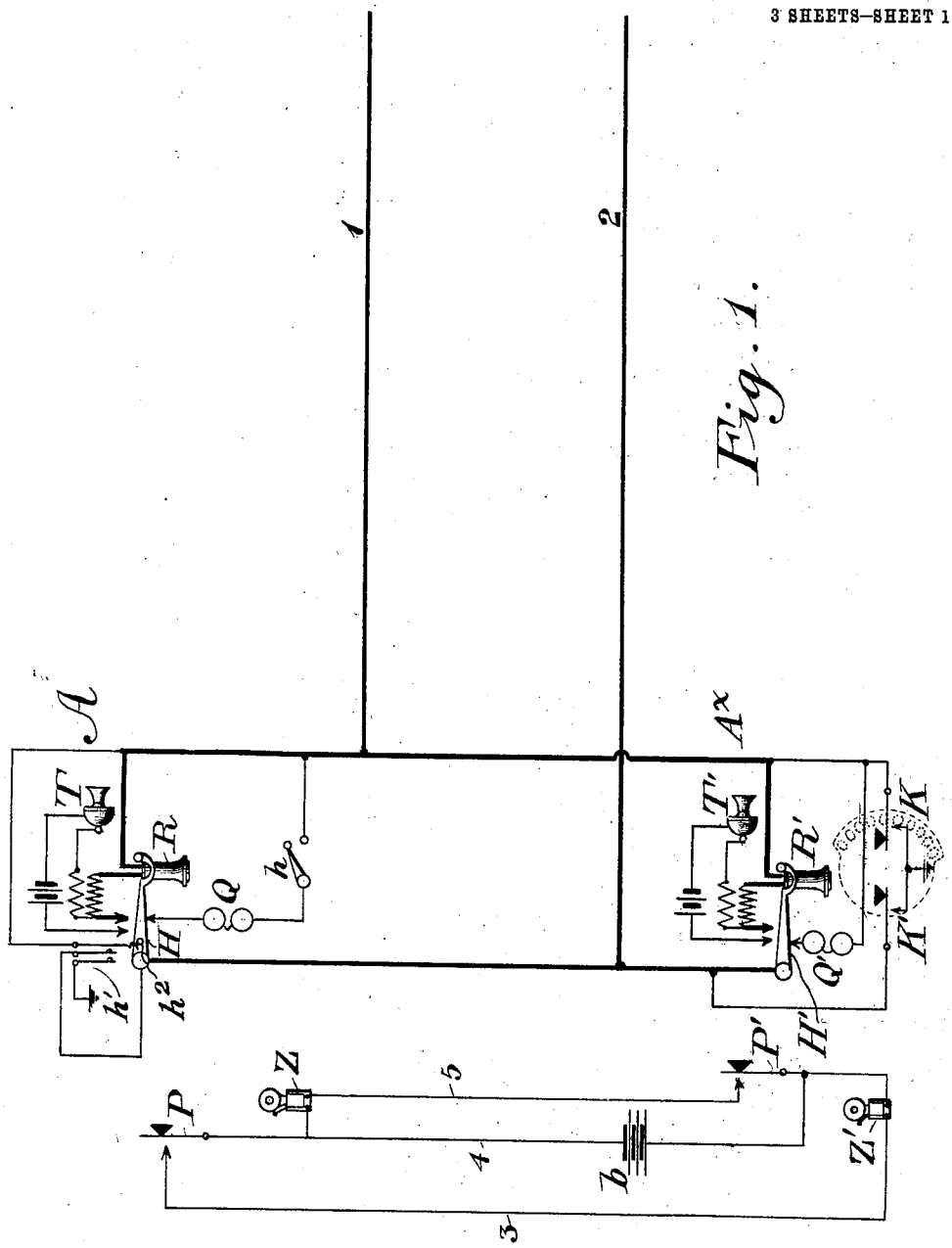

Fig. 1.

Witnesses

H. E. Whiting

James H. Marr

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Edward E. Clement

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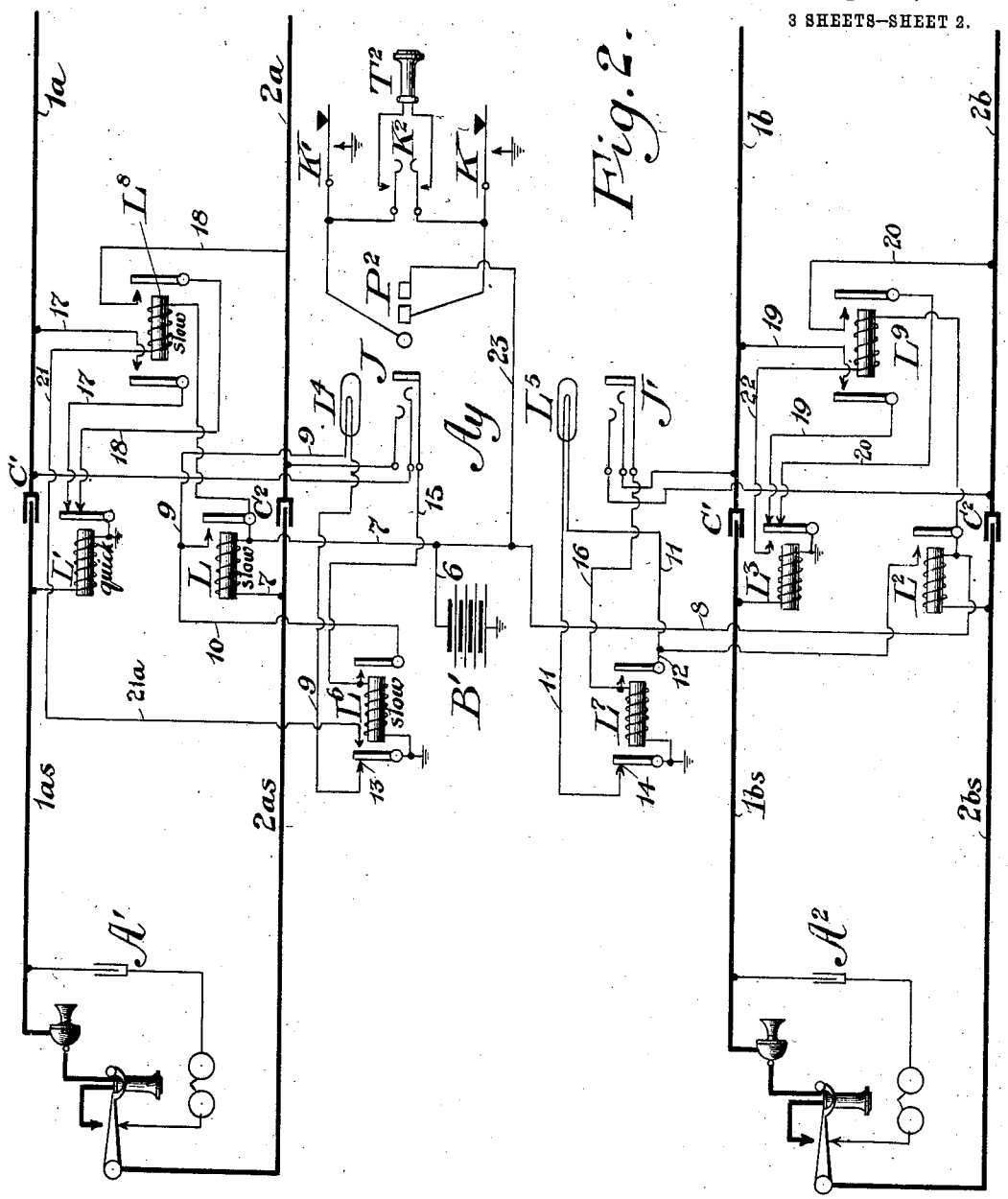

Fig. 2.

Witnesses

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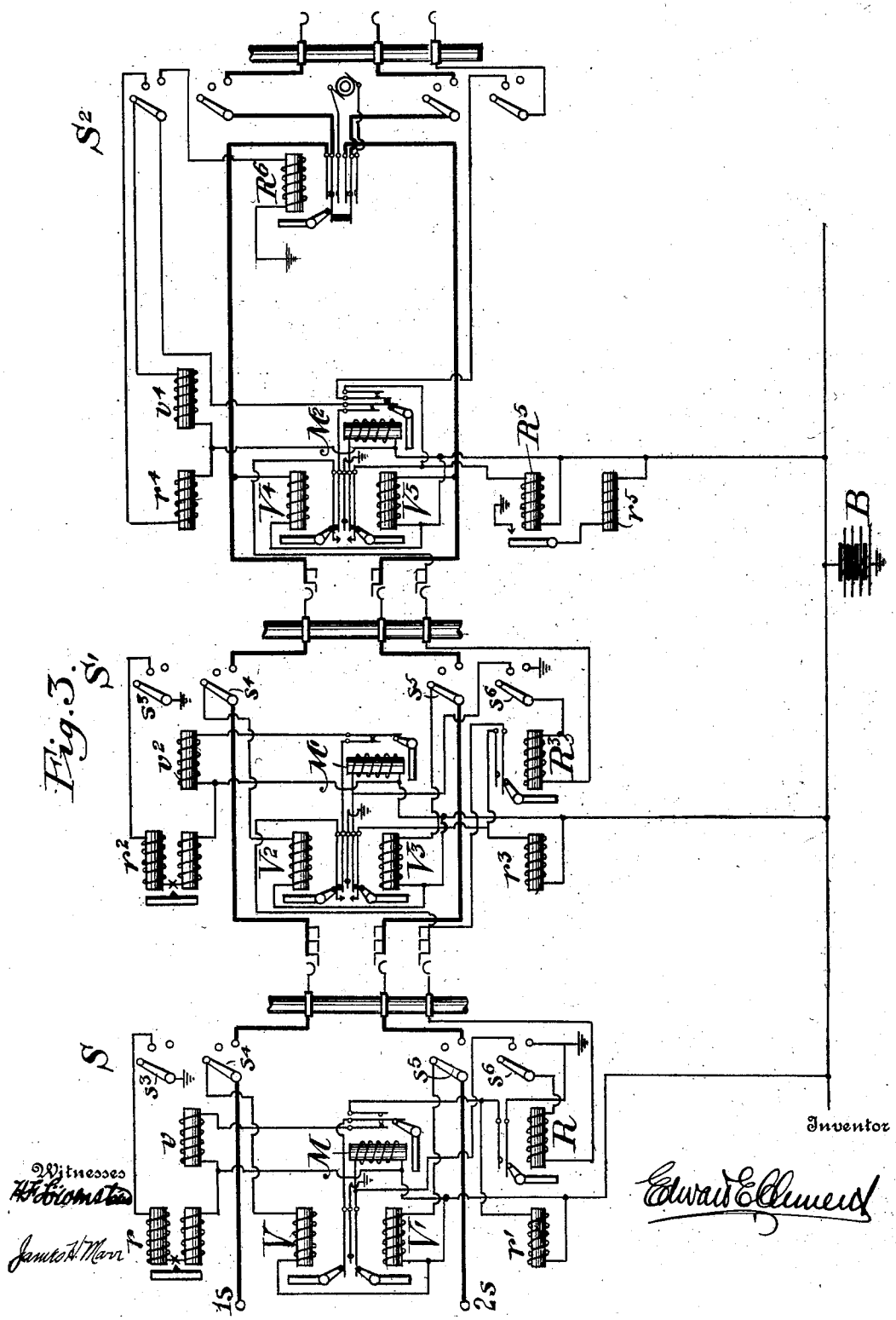

Fig. 3.

UNITED STATES PATENT OFFICE.

EDWARD E. CLEMENT, OF WASHINGTON, DISTRICT OF COLUMBIA.

TELEPHONE-EXCHANGE SYSTEM.

1,024,487. Specification of Letters Patent. Patented Apr. 23, 1912.

Application filed November 13, 1907. Serial No. 402,028.

To all whom it may concern:

Be it known that I, EDWARD E. CLEMENT, a citizen of the United States, residing at Washington, in the District of Columbia, have invented certain new and useful Improvements in Telephone-Exchange Systems, of which the following is a specification, reference being had therein to the accompanying drawings.

My invention relates to telephone exchange systems and has for its object the simplification of such systems in certain particulars hereinafter pointed out, and also their improvement in point of efficiency.

Broadly stated, my invention comprises automatic switching apparatus at a central office, adapted to interconnect subscribers' and other lines, with controlling means for the switches located at other points than the actual subscribers' stations.

More specifically stated, the system which will be described herein as an embodiment of my invention, has subscribers' stations equipped with ordinary telephone instruments, but without any sending devices or other means for controlling the central office switches, an auxiliary station or stations being supplied for each line or group of lines, with sending devices and signals so arranged that when a subscriber wishes to obtain a connection he can notify the operator at the auxiliary station, and the said operator can manipulate the switches at the central office to connect the lines as desired. In its simplest form the auxiliary station is in the same building as the subscriber's station, and may be in the same apartment, being arranged like an extension set on the same line. A more elaborate auxiliary station is arranged like a branch exchange, with a number of subscribers' lines passing through it on their way to the central office. Each line has connections to the auxiliary operator's outfit, so that the subscribers can signal to the operator, and she can in turn send signaling current over the respective lines to the central office so as to actuate the switches.

My invention is illustrated in the accompanying drawings in which—

Figure 1 shows a subscriber's station and an auxiliary station of the simplest type. Fig. 2 shows an auxiliary station with a plurality of subscribers' stations connected thereto, and Fig. 3 is a diagram of the central office switching circuits.

Referring to the drawings, in Figs. 1 and 2 I have shown subscribers' line wires 1—2, 1^a—2^a, and 1^b—2^b, terminating at the substations A, A′ and A^2 respectively. Each of these lines is supposed to terminate at the central office in a first selector switch, which is typified at S in Fig. 3, and whose line terminals are represented at 1^s and 2^s. In practice there may be one of these switches for each of the lines, or any suitable or desired type of primary switching apparatus may be employed to connect a line when calling with an idle switch S. Such primary switching apparatus is shown for example in my prior applications, Serial Numbers 274,765, August 18, 1905; 277,524, September 8, 1905; 279,031, September 18, 1905; 296,853, January 19, 1906; 306,292, March 15, 1906; 323,096, June 23, 1906; 328,723, August 1, 1906; but as these form no direct part of the present invention, and as the simplest form of illustration is that of the line passing direct to the switch, they are not illustrated herein.

The switching circuits in Fig. 3 are shown as of the well known Strowger automatic type, and will be briefly described before passing to the other figures. The switches employed at S, S′ and S^2 with the circuit shown in Fig. 3 are of the type described and claimed in Letters Patent numbered 815,176 and 815,321, to Keith and Erickson, dated March 13, 1906. In these switches the distinguishing characteristic is a movable spindle carrying wipers to which the trunk contacts are connected, the spindle itself having what are called vertical and rotary ratchets, whereby it is both raised and turned. Coöperating with the wipers on the spindle are fixed or bank contacts arranged in a hollow figure constituting a portion of the surface of a cylinder, the axis of the cylinder coinciding with the axis of the spindle. The bank contacts, usually one hundred in number, are arranged in horizontal rows of ten, and where separate test contacts are shown they are similarly arranged in duplicate banks, with a separate wiper or wipers on the spindle coöperating therewith. The vertical ratchet takes a pawl worked by a so-called vertical magnet, and the rotary ratchet takes a pawl worked by a so-called rotary magnet. A stop pawl or detent has toes engaging both ratchets, so that when the spindle has been stepped up and stepped around it will remain in that

position until it is released by the disengagement of the stop pawl, which is effected through the agency of a so-called release magnet. In the connector switch S^2 this release magnet acts upon the direct impulse of current in the release circuit, but in the selector switches S and S′ the release magnet does not trip the detent and restore the switch until it becomes deënergized after full energization. All of these operations and the aforesaid points of construction are fully illustrated and described in the Keith and Erickson patents to which reference is hereby made.

In the selector switches S and S′ of Fig. 3 herein, s^3, s^4, s^5 and s^6 are side-switch arms mounted to move together over their respective contacts, and controlled by the magnet M in switch S and M′ in switch S′. The operation and functions of these side switches and their controlling magnets are the same in both switches. In switch S, r is the rotary magnet, v is the vertical magnet, r' is the release magnet, V is the so-called vertical relay, V′ the so-called rotary relay, and R is the release relay. In switch S′, r^2 is the rotary magnet, v^2 is the vertical magnet, r^3 is the release magnet, V^2 is the vertical relay, V^3 is the rotary relay, and R^3 is the release relay. In the connector switch S^2, r^4 is the rotary magnet, v^4 is the vertical magnet, r^5 is the release magnet, V^4 is the vertical relay, V^5 is the rotary relay, M^2 is the test relay, R^5 is the release relay, and R^6 is the ringing relay. G is the ringing generator and B is the main battery.

In operating the switches of Fig. 3, so-called "vertical" actuating impulses are sent over the wire 1^s passing through the side switch arm s^4 to the vertical relay V. The so-called "rotary" or intermediate single impulses which affect the side switches and so determine the successive steps in operation, come over the wire 2^s and through the side switch arm s^5 to the rotary relay V′. Taking a concrete number for example, we will assume the call to be for line Number 2673. Two impulses come over wire 1^s, the relay V pulls up twice and in so doing closes the circuit of the magnet v twice, thereby stepping up the spindle and its wipers to the second row of contacts from the bottom. In this row are found the terminals of trunks leading to the group numbered 2000. A single rotary impulse now comes over wire 2^s, pulls up the relay V′, which pulls up the relay M, and this in turn works the escapement which mechanically releases all the side switch arms s^3, s^4, s^5 and s^6 upon a complete up-and-down vibration. These arms, therefore, all pass to the second contact points in their respective sets. The vertical relay V is thereby disconnected from wire 1^s, as is the rotary relay from the wire 2^s. The circuit of the rotary magnet r is completed to ground, and this magnet being a self-controlling vibrator, proceeds to step around the spindle continuously until its circuit is broken. The relay R is connected to a circuit leading to the magnet M on one side and to the test wiper of the switch on the other. All the busy trunks have their test contacts grounded, and it will be observed that the relay R is connected to ground when the side switch is in its last position. In testing, however, the ground will be found and will remain on the wiper and so through relay R onto the magnet M, so long as the wiper is passing over busy contacts. As soon as one is found that is not busy, the magnet M lets go, the side switch takes its last step, the rotary magnet r is cut-off, the talking circuit is completed by arms s^4 and s^5, and the release relay R is grounded so as to be ready for clearing out. The operation of the switch S′ is precisely the same as that stated, except that six vertical impulses come over the vertical side 1^s of the trunks, the spindle is stepped up by the magnet v^2 to the sixth row, and then after the rotary impulse comes, it is turned by the magnet r^2 around the row until it finds an idle trunk leading to the 600 group of connectors S^2. To pick out line No. 73 in this group, seven impulses come over the wire 1^s to the relay V^4, which by means of the magnet v^4 steps the spindle up to the seventh row, and then three impulses over the wire 2^s to the relay V^5 turn the spindle until the wipers rest on the third contact in the row, using the magnet r^4 for that purpose. The last rotary impulse tests the line, energizing the magnet M^2, and causing the relay R^5 to be momentarily connected through the contacts M^2 to the test wiper. If the line is busy, the relay R^5 becomes energized since the test wiper finds ground, whereupon the magnet r^5 is grounded and becomes energized to release. If the line is not busy, the last motion of the magnet M^2 throws the side switch arms all the way over, connects the contacts of the vertical relay V^4 with the ringing relay R^6, completes the talking circuit, and breaks its circuit. Further impulses over the vertical side of line 1^s work the relay V^4 to energize the relay R^6 and thereby connect the generator G to ring the wanted subscriber. In clearing out, the subscribers hang up, and the relays V^4 and V^5 are pulled up together by simultaneous impulses over both sides of the line, closing the circuit of the release relays R^5, R^3 and R in succession.

It will be understood that the diagram in Fig. 3 and the foregoing description thereof are mere skeleton outlines of the circuits and apparatus used in practice: They are given here to complete the circuits and illustrate one form of switch equipment which may be used in conjunction with my novel ar-

rangement of subscriber's lines and auxiliary stations. Additions to and subtractions from the circuits and apparatus of Fig. 3 may therefore be made as may be necessary or desired, without affecting the invention.

Having thus shown the central office portion of the equipment, we pass to the subscribers' lines and will refer first to the form shown in Fig. 1. Here A is a subscriber's station having the usual transmitter T, receiver R, ringer Q, switch-hook H, and local battery. A supplemental switch h is provided to cut off the ringer when desired, and a set of grounding springs h' cooperate with a stud h^2 on the switch-hook for clearing-out purposes. As the hook goes up or down, it puts a momentary ground on both sides of the line. Connected in parallel with the station A is an auxiliary station A^x, having a transmitter T', receiver R', ringer Q', and switch-hook H'. This station also has an automatic sending device typified in its simplest form by a pair of grounding keys K and K' connected respectively to the line wires 1 and 2. In dotted lines I have shown an outline of a Strowger dial to suggest that these keys may be replaced by the ordinary Strowger sending device. The station A^x is supposed to be at the desk of an office boy, a stenographer, or some other person whose duties include attending to the telephone for both incoming and outgoing calls. The station A by closing the switch h may receive the incoming calls from the central office, or by opening the switch h may cause them to be received at the station A^x only. In order to permit station A to be called from station A^x, I provide local signal wires 3—4—5 with a battery b, push buttons P and P', controlling bells or buzzers Z and Z'. The operation of the stations thus described is as follows: Assuming the line wire 1—2 to be connected to the terminals 1^s and 2^s in Fig. 3: if station A wishes to call a number, the push button P is pressed, whereupon the buzzer Z' will sound and the parties at stations A^x and A taking down their receivers are in direct communication with each other. A gives the number to A^x, and may then hang up his receiver until the connection is completed. A^x proceeds to work the keys K—K' to send the proper number of impulses over line wires 1—2 so as to move the switches S, S' and S^2 to select and ring the party wanted. When that party answers, A^x presses the button P' and the buzzer Z sounds, thereby notifying station A that the wanted subscriber is ready to converse. Station A^x can then hang up the receiver, or if desired may keep it off the hook. After station A and the called party have finished the conversation, they hang up their receivers and the switches clear out in the manner heretofore described. It should be noted that if the subscriber A is to be enabled to hang up his receiver while waiting for a connection, then his grounding springs h' and the stud h^2 must be so arranged with suitable coöperating means, that the ground impulses will be sent only when the hook is moving down. Otherwise the connection would be cleared out when station A took down the receiver to respond. Of course this construction can be simplified by having the receiver left off the hook, but as either method is perfectly practicable, this arrangement in practice may be left to the wishes and necessities of those who employ it.

Turning now to Fig. 2, as already stated, I have illustrated therein a species of branch exchange or group auxiliary station, A^y, wherein a single station with one or more operators serves a plurality of subscribers' lines. In this arrangement each substation A' and A^2 is arranged on the common battery plan, with the usual transmitter, receiver, ringer, condenser and switch-hook. The local circuits may be of any desired and suitable type, and are shown as of the simplest for convenience of illustration. The line wires 1^a—2^a and 1^b—2^b, pass from the auxiliary station A^y to the central office in Fig. 3 are supposed to be connected to the terminals 1^s and 2^s of the first selector switch thereat. Each line contains a pair of condensers C' and C^2 and I have indicated the subscribers' ends of the lines as 1^{as}—2^{as} and 1^{bs}—2^{bs}. A source of current B' is provided for the auxiliary station, and this may be either a storage battery kept charged in any suitable manner, or it may be a heavy battery supply wire brought from the central office, and tapped off the main battery B therein. From the live side of this source B' the bus wire 6 branches to the several lines served by the station. It is connected to the line wire 2^{as} through branch 7 containing a relay L. Similarly it is connected to the wire 2^{bs} through branch 8 containing the relay L^2. These relays constitute the line signal relays and are controlled by the subscribers. Each has a mate relay L' or L^3, which responds to the acts of the subscriber and produces the clearing out impulses to the central office as will presently appear. Each line is represented by a spring jack J or J', in the auxiliary station, and the operator thereat has one or more plugs P^2, adapted to coöperate with the jacks. Each plug has a tip, ring and sleeve, each tip and ring being connected to the grounding keys K—K' or to the contacts of the equivalent sending device as already stated in connection with Fig. 1. Of course any kind of a sending device may be employed in this connection, the only requirement being that

it shall send impulses suitable to the type of switch circuits which may be employed at the central office. A change in the circuits of Fig. 3 would of course produce a corresponding change in the operating circuits of Figs. 1 and 2. The relay L controls a local circuit 9 of a lamp L^4 associated with a jack J, and similarly a relay L^2 controls a local circuit 11 of a lamp L^5 associated with a jack J'. These relays also control respectively the locking circuits 10 and 12 of two auxiliary relays L^6 and L^7, whose function it is to cut off the lamps when the operator has answered the calls, and to maintain the same cut off until the lines have cleared out. To enable them to perform this function, each lamp circuit 9 or 11 is carried through a pair of contacts 13—14 controlled by one of the relays L^6 or L^7. For talking purposes as well as signaling, the short and long springs of each jack are connected to the two sides of the corresponding line, and the operators listening key K^2 is arranged to bridge a telephone set T^2 across the cord circuit of plug P^2. The sleeve of this plug is connected to battery B', so that when the plug is inserted, the wire 15 or 16 of the jack in use will take battery current to energize the corresponding relay L^6 or L^7. For the purpose of clearing out, that is restoring the switches at the central office after conversation, I provide the relays L' and L^8, each of which has its armature connected to ground, and adapted when the relay is de-energized to put ground on the two sides of its line simultaneously through the branches 17 and 18 or 19 and 20. In order that the line wires may not remain permanently grounded, I preferably provide cut-off relays L^8 and L^9, pulled up by current in the wires 21 and 22 which are grounded when the relays L^6 and L^3 become energized. These relays L^8 and L^9 as well as relays L and L^6, if used as shown must be very sluggish, and in order to make them so I may employ dash-pots, or I may make them solenoids with slow moving cores, or may resort to any other well known or desirable expedient. As a matter of fact the relays L^8 and L^9 may be dispensed with, provided the relays L and L^2 are made sluggish enough to handle the circuits.

The operation of the parts shown in Fig. 2 is as follows: Suppose subscriber A' to be calling. He takes down the receiver, and his switch hook rises so as to close the line circuit. Current then flows from the source B' through the wires 6 and 7 and relay L to the line wire 2^{as}, out to the substation A' and back through the line wire 1^{as}, through relay L' and back to the source. Both relays L and L' become energized. The former closes the lamp circuit 9 and the lamp L^4 thereupon glows. The operator perceiving this signal, immediately inserts the plug P^2 in the corresponding jack J, and by using the listening key K^2 obtains the number wanted. At the same time current flows through wires 23 and 15 to the relay L^6 which pulls up and breaks the contact 13 to extinguish the lamp L^4, the relay locking itself on the wire 10, which is kept in connection with the battery bus 6 by the relay L until the subscriber A' finally hangs up his receiver. Having ascertained the number wanted, the operator manipulates the keys K—K', or the equivalent sending machine, to send the various impulses to the switches in Fig. 3. These impulses pass through the tip and ring of the plug, the corresponding springs of the jack and to the line wires 1^a—2^a. The operator then rings and she may supervise the connection to the extent of listening in until the wanted subscriber answers, although this is not at all necessary. As soon as she has sent the number and started the ringing, she is at liberty to take another call. When, after finishing the conversation, subscriber A' hangs up the receiver and thereby opens his line, the relays L and L' let go. Relay L' being quick, and relay L^8 being very sluggish, this results in a ground being placed through 17—18 onto the line wires 1^a—2^a which will pull up the relays V^4 and V^5 in Fig. 3 so as to restore all the switches as hereinbefore described.

Sundry changes in and additions to the circuits and apparatus here described may of course be made. Instead of having a plug and cord for connecting the operator and her sending machine to the different lines, I may provide automatic switching means of suitable character. The operator may also use sending machines and keyboards instead of the grounding keys or Strowger dial. All these changes and any others which do not destroy the characteristic and typical features of the present invention are contemplated by me and I do not wish to confine myself to the specific construction shown.

Having thus described my invention what I claim and desire to secure by Letters Patent is—

1. In a telephone exchange system, the combination with a central office automatic switching equipment, of a plurality of subscribers' lines connected thereto, a subscriber's station equipped with a common battery telephone set on each line, an auxiliary station or branch exchange common to said subscribers' lines, a source of current, an individual signal for each line, and switching means for each line in the auxiliary station, together with means whereby the auxiliary operator may effect connection through its switching means with a calling line, and may transmit suitable current impulses over

the line to the central office, to effect the desired connection.

2. In a telephone exchange system, the combination with a central office switching equipment, of a plurality of lines connected thereto, a subscriber's station equipped with a common battery telephone set on each line, an auxiliary station or operator's position common to said lines and equipped with a telephone set and means for controlling the automatic switches, signaling means at the operator's position responsive to the acts of the several subscribers in calling, a source of current for the operator's position and a common source of current for the lines, and means to connect the operator's telephone and controlling device to any line when calling, all connections from the operator's position to the lines being made outside of the line terminals in the automatic switching equipment, whereby each line is afforded direct access to the operator, who may thereafter transmit suitable current impulses over the lines to the automatic switches to effect any desired connection therethrough.

3. In a telephone exchange system, the combination with a central office automatic switching equipment, of a plurality of subscribers' lines terminating therein and connected thereto, an auxiliary station or operating position common to said lines, a common source of current for the lines adapted to supply the subscribers with both signaling and talking current, a bridged relay connected to each line entering the auxiliary station, signaling means controlled by said relays, switching terminals for the several lines in the auxiliary station, coöperating switching means for the operator, and a telephone set and number transmitting apparatus connected to said coöperating switching means, the connections from the auxiliary station to the several lines being directly effected outside of the line terminals in the automatic switching equipment, whereby incoming calls over the lines will pass to the operator's station without affecting the central office equipment.

4. In a telephone exchange system, the combination with a plurality of lines to be connected, of centralized automatic switching apparatus containing permanently connected terminals of the lines for incoming as well as outgoing calls thereover, a substation on each line equipped with a telephone, an auxiliary station with means for controlling the automatic switching apparatus, and a switch adapted to connect said auxiliary station equipment directly with the line in response to calls thereover, without initial actuation of the centralized automatic switching apparatus.

5. In a telephone exchange system, the combination with a line circuit, of automatic switching apparatus permanently connected thereto and containing terminals of other lines, a substation telephone connected to said line, an auxiliary station equipped with a telephone set and also with means for controlling the automatic switching apparatus, and a switch adapted to connect the auxiliary station equipment directly with the line outside of its connection with the automatic switching apparatus.

6. In a telephone exchange system, the combination with a line circuit, of automatic switching apparatus permanently connected thereto and containing terminals of other lines, a substation telephone without switch controlling means connected to said line, an auxiliary station equipped with a telephone set and also with means for controlling the automatic switching apparatus, and a switch adapted to connect the auxiliary station equipment directly with the line outside of its connection with the automatic switching apparatus, together with a call signal at the auxiliary station, and means at the substation for actuating the same to indicate that a connection is desired.

7. In a telephone exchange system, the combination with a central office automatic switching equipment, of a plurality of subscribers' lines permanently and individually connected thereto, a telephone talking and signal receiving set associated with each line, an auxiliary or operating station common to the lines, signal receiving means at said auxiliary station controllable over said lines, a telephone and a central office switch operating device also at the auxiliary station, and a selective switch having contacts connected to the lines outside of the central office switches, and coöperating contacts connected to said telephone and switch controlling device, whereby incoming calls over the lines will be directly received by the operator at the auxiliary station, and the desired connections effected thereafter through the lines and the central office switches.

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

EDWARD E. CLEMENT.

Witnesses:
E. EDMONSTON, Jr.,
JAMES H. MARR.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."