E. E. CLEMENT.

TELEPHONE EXCHANGE SYSTEM.

APPLICATION FILED MAR. 20, 1908.

1,037,438.

Patented Sept. 3, 1912.

4 SHEETS—SHEET 1.

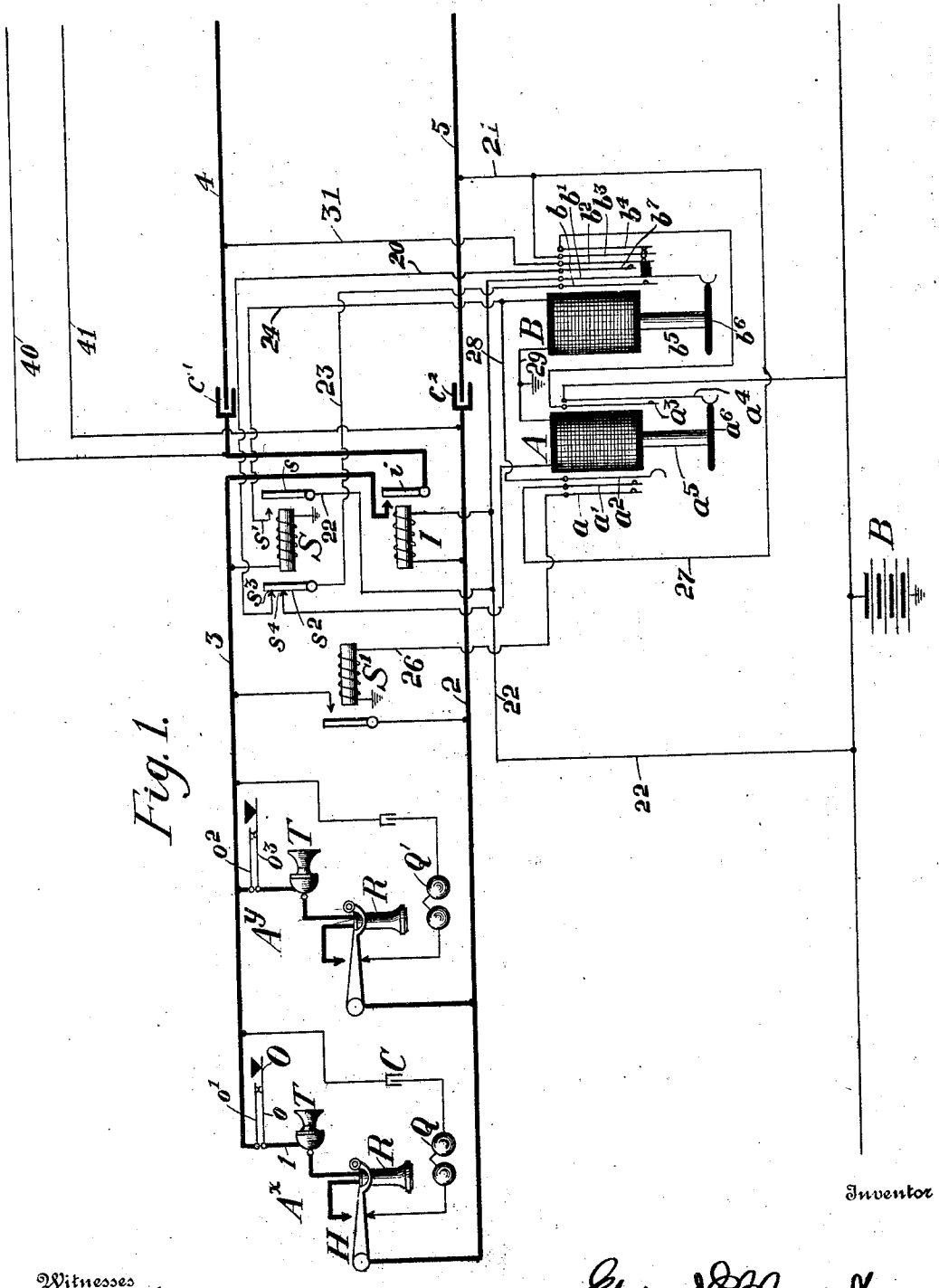

Fig. 1.

Witnesses

H. F. Lowenstein

L. A. Stanley

Inventor

Edward E. Clement

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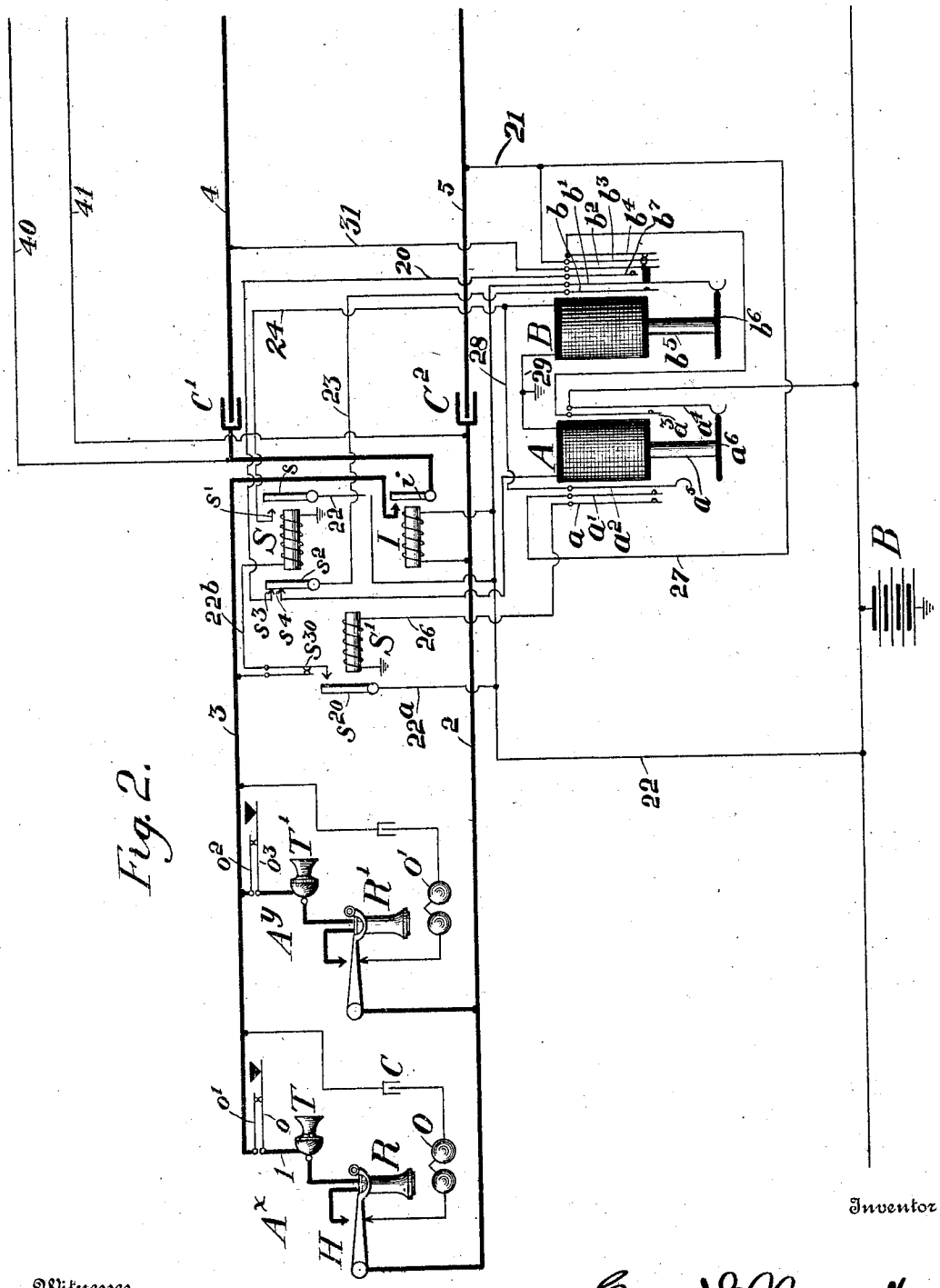

Fig. 2.

Witnesses
H. F. Lowenstein.
L. A. Stanley

Inventor
Edward E. Clement

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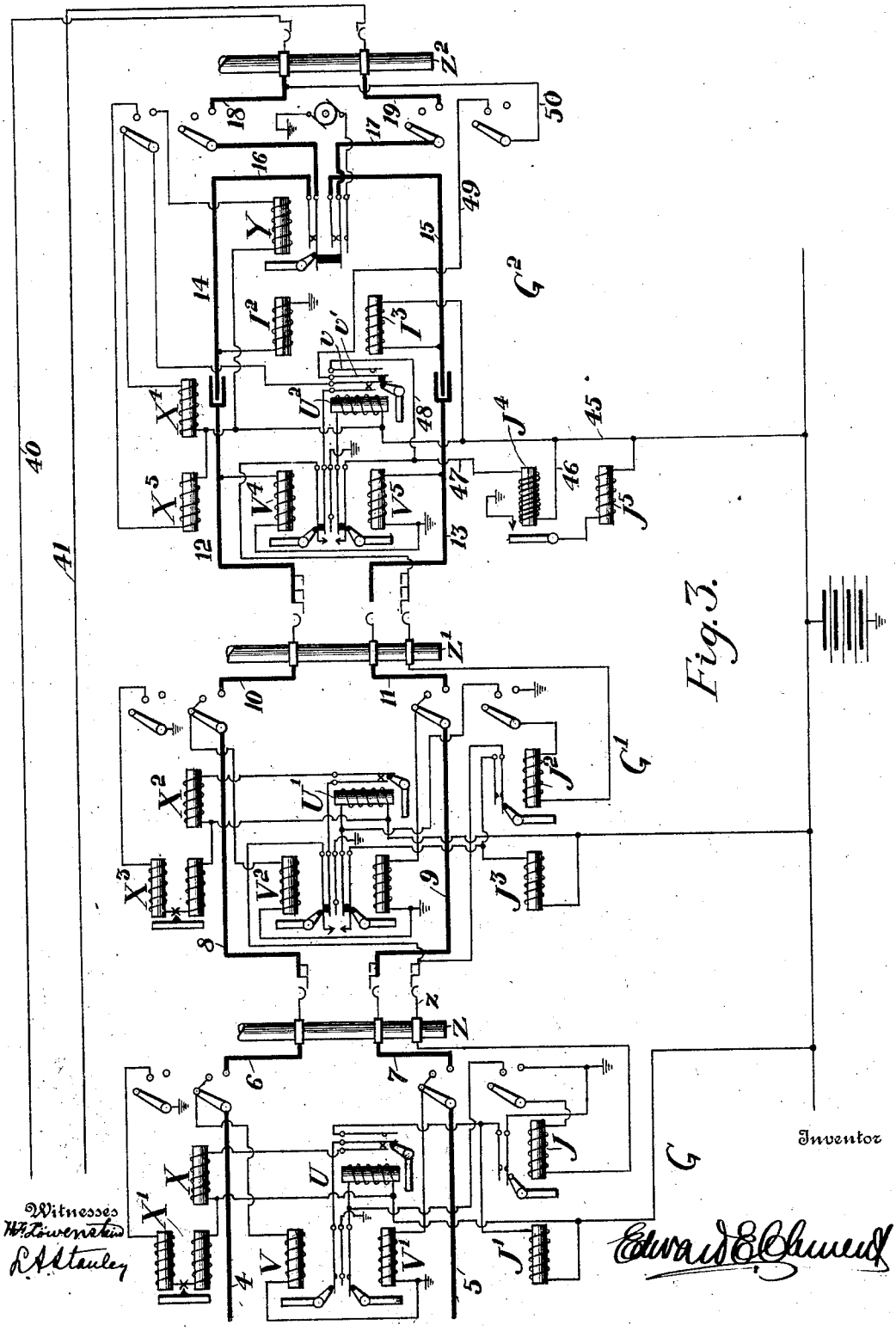

Fig. 3.

Witnesses

Inventor

E. E. CLEMENT.

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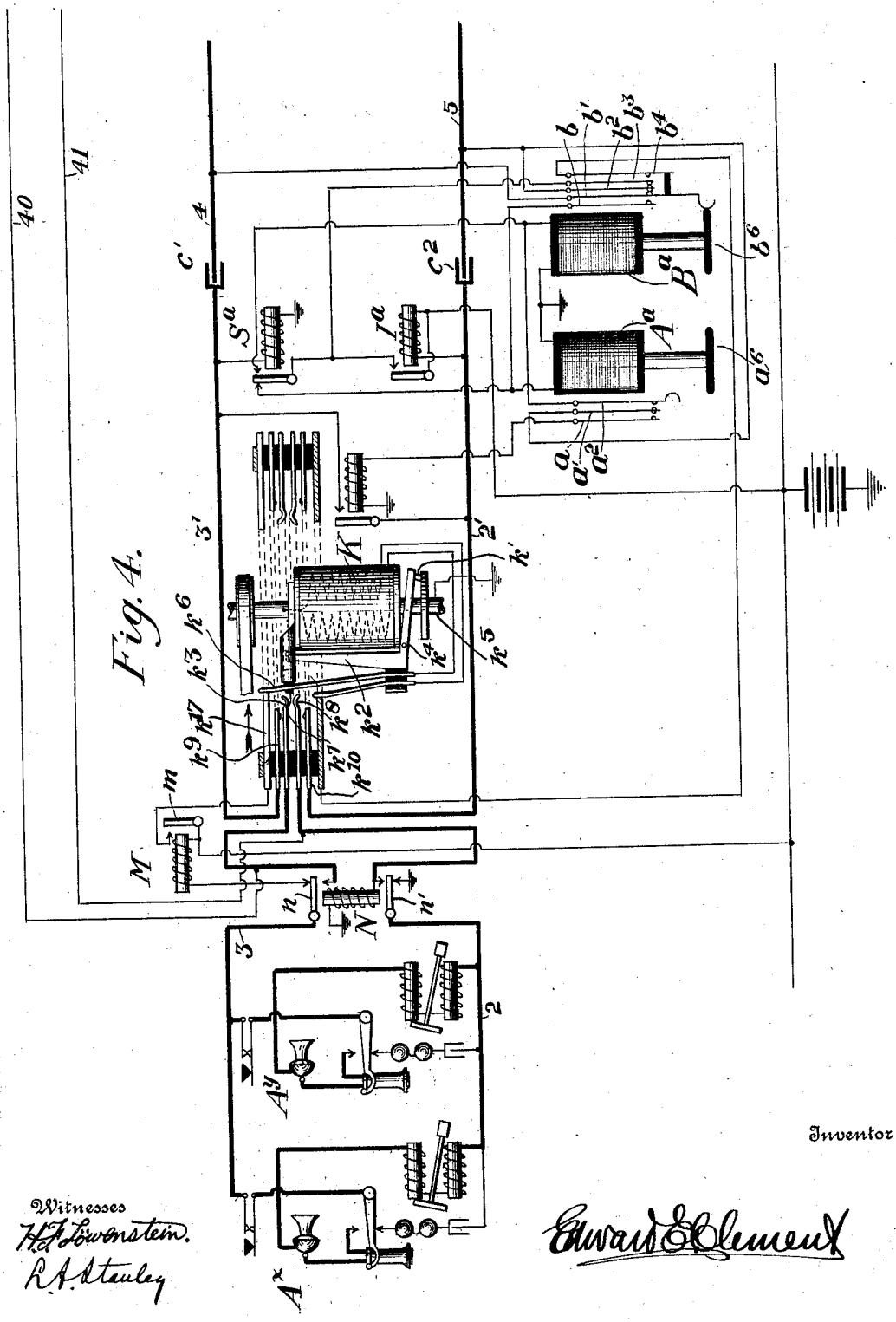

Fig. 4.

Witnesses

H. B. Löwenstein.

R. A. Stanley

Inventor

Edward E. Clement

UNITED STATES PATENT OFFICE.

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

TELEPHONE-EXCHANGE SYSTEM.

1,037,438. Specification of Letters Patent. Patented Sept. 3, 1912.

Application filed March 20, 1908. Serial No. 422,314.

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 drawing.

My invention relates to telephone exchange systems, and especially to those systems which employ automatic switching apparatus for effecting connection between subscribers.

The object of the invention is to provide means whereby a calling subscriber whose station is located on a party line, may be connected so as to converse with another party on his own line.

In all automatic systems provision is made for guarding lines already in use from interruption, some change in condition of the circuits being relied upon to affect an electromagnet in the testing connector switch, thus giving the equivalent of the operator's test in the ordinary manual system. Such a test must extend to lines which are calling as well as lines which are called, since a line calling is of course busy for the time being. From this it results that if the line calling is also the line called, then it will find itself busy and be unable to complete the connection with itself unless special provision is made for a reverting busy test. I make such provision by balancing potentials on the test relay when testing back on the calling line only.

In the present case a metallic circuit system will be illustrated and described, in which a ground is placed on the tip side of the line or the first trunk during use, and the test is made for this ground. If it is found, the line is busy, otherwise not. In testing, a relay is connected from the test terminal to battery, and in order to accomplish my present purposes I provide that when this test terminal is applied to the tip side of the calling end of the switching circuit in any particular case, a change is momentarily made on the tip side of the answering end of the same by short circuiting the line or by disconnecting one of the battery supply relays. Since this special condition only lasts an instant, the chance of thereby letting another party get in upon the same connection is infinitesimal.

It is obvious that the present invention may be applied to semi-automatic as well as to full automatic systems. The switching equipment of such systems is substantially the same in principle and arrangement and the busy test would therefore be the same. In fact, in any case in which an automatic connector switch is employed for making the final selection of the line wanted, the present invention is applicable.

My invention is illustrated in the accompanying drawings wherein:

Figures 1 and 2 show two subscribers' stations and a portion of the central office equipment; Fig. 3 shows a first and second selector switch and a connector switch of the well known Strowger type; Fig. 4 shows a modified form of part of the central station equipment.

Referring now to Fig. 1, the two subscribers' stations A^x and A^y, are equipped with apparatus usual in common battery systems. As the apparatus at each station is identical it will only be necessary to describe that of one.

Referring to station A^x, the equipment consists of the transmitter T, receiver R, hook H, ringers Q, and condenser C. In addition to these I provide a sending device which is represented diagrammatically by the push button O which contains two normally closed contact springs o and o'. The subscriber desiring to send a number, sets up his sending machine which, when running down, makes and breaks contact between the springs o and o'. The line-wires 2 and 3 from the subscribers' stations terminate in the central office on the relays S and I. The relay S controls a pair of solenoids A and B, although sluggish relays could be used instead. The relay I through its armature i closes the normally open line 3 when a subscriber at one of the stations A^x or A^y removes his receiver from the hook. The line 3 is normally open to prevent the establishment of a false busy-test-circuit through the winding of the relay S.

The solenoid B is connected to the front contact s' of the relay S by the wire 24 and to ground by the wire 29. The solenoid A is connected to the contact s^4 and to ground by the wire 29. The contacts s^4, s^2 and s^3 are normally connected and when the relay S is energized and closes the circuit of the solenoid B, battery is placed on the contact s^2 by the following path: battery B, 22, b',

b, 23, s^2. The solenoid B keeps the core b^5 drawn up when the contacts s' and s of the relay S are closed and also the relay S makes and breaks its contacts during the transmission of the impulses from the subscriber's station. In other words the core of the solenoid B will only drop down to its normal position after the contacts s and s' remain broken for quite a while, as would be the case when a subscriber hangs up his receiver at the end of a conversation. While this solenoid is active, battery is connected to the contact s^2 of the relay S and rapid makes and breaks between it and the contact s^4 will in turn keep the solenoid A active allowing the core a^5 to remain drawn up so long as impulses are being transmitted. Between every set of impulses there is a long make or pause caused by the subscriber setting up his sending device for transmitting another set of impulses. During this interval the solenoid A is deënergized and its core a^5 drops down to its normal position. At the end of the conversation the relay S becoming deënergized closes the contacts s^2 and s^4 causing the solenoid A to become active but at the same time the circuit of the solenoid B is broken at the contacts s and s' and the core b^5 thereupon drops, opening the springs b and b', disconnecting battery from the contact s^2 and deënergizing the solenoid A whose core a^5 thereupon drops.

It will be seen from the foregoing description of these two solenoids that the core of the solenoid A drops between every group or set of impulses and that the core of the solenoid B only drops at the end of a conversation. With this combination I am enabled to use the solenoid A for sending a rotary or switching impulse after each set of signals so as to work the side switches in the selector and connector switches. The solenoid B is used for releasing the various switches. When the core of this solenoid drops down, battery is placed simultaneously on the wires 4 and 5 by the closure of the springs b^2, b^3 and b^4. Battery is afterward disconnected from the wires 4 and 5 by the core a^5 of the solenoid A dropping and opening the contacts a^3 and a^4. Bridged battery is connected between the windings of the relay S and retardation coil I for supplying talking battery to the calling subscriber. The condensers c' and c^2 are inserted in the wires 3—4 and 2—5 respectively to prevent battery flowing to the various switches.

In Fig. 1 when the core of the solenoid A drops down between each group of impulses in addition to connecting battery momentarily to number 5 side of the trunk, it also connects battery to the relay S' which upon operating, short circuits or closes together the wires 2 and 3 also the wires 40 and 41 leading back to multiple contacts in the connector switches. The test relay J^4, (see Fig. 3), is high wound in comparison with the relay I connected to battery. In automatic exchanges of this type the voltage of the battery is generally high, from 50 volts up.

In Fig. 2 the operation of the relay S' disconnects the relay S from the wires 3 and 40, thereby removing grounded battery entirely from the wire 40, and at the same time keeping the relay S energized by current through wires 22^a—22^b.

Referring now to Fig. 3, I have shown circuits of first selector, second selector and connector switches as described in Letters Patent 815,321 and 815,176 granted March 13, 1906, to Keith and Erickson. I will not describe these circuits in detail. The first selector switch G has a vertical relay V, which when energized closes the circuit of the vertical magnet X, which in turn causes the spindle Z, carrying the wipers to step up vertically. The rotary relay V' when energized operates the private relay U, causing the side switches to make one step. The rotary magnet X' has its circuit closed after the side switches have made one movement and will continue to vibrate, causing the spindle Z to rotate until the test wiper z finds a contact free from ground. As soon as this happens the side switches make still another movement, disconnecting the vertical and rotary relays from the trunk wires and closing the trunk wires themselves through to the trunk wipers. The last movement of the side switches also connects the trunk release relay J to the test wiper z. The magnet J' is the release magnet and when operated restores the switch to its normal position.

The circuits of the second selector switch G' are similar to those of the first selector switch and need not be described. Referring now to the connector switch G^2, the vertical and rotary relays V^4—V^5 and vertical and rotary magnets X^4—X^5, with private magnet U^2, control the switch and the circuits are generally the same as in the Letters Patent before referred to, with the exception of using a relay J^4 to operate the reelase magnet J^5. In this case the relay J^4 is first operated as though it were the release magnet and in turn closes the circuit of the magnet J^5. Instead of testing on a third or test wiper, I do the testing directly on the vertical or tip side of the line. In place of the ordinary back release relays which are connected to the trunk wires 14 and 15 respectively I have replaced them with the retardation coils I^2 and I^3 with bridged battery between them for supplying current to the called subscriber. In this particular case I have shown the contacts in the connector switch connected directly to

the calling line as I wish to illustrate and show the method of calling back on the calling line. The change I have made in this circuit does not affect the operation of this switch in the slightest. The vertical relay V^4, rotary relay V^5, private relay U^2 and the ringing relay Y remain unchanged and the method of releasing is the same.

The operation of this system is as follows: Referring to Figs. 1 and 2 the subscriber at station A^x, desiring to be connected with station A^y, on the same line, first removes his receiver which closes the line circuit current flowing from battery B, through 22, I, 2, subscriber's telephone, o, o', 3, S and ground. Thereupon both relays I and S are energized. The pulling up of the armature i of the relay I closes the normally open line 3 while the energization of the relay S closes the circuit of the solenoid B. The core of the solenoid B now being drawn up, battery is connected to the contact s^2 of the relay S by the following path: battery B, 22, b', b, 23, s^2. The relay S at this time being energized, keeps the circuit of the solenoid A open.

The subscriber at station A^x, after removing his receiver, sets up his sending device to the desired number and this in running down makes and breaks the contacts o and o' according to the number of impulses to be sent. These makes and breaks operate the relay S at the central office which in turn makes and breaks its own contacts. The making and breaking of the contacts s^2 and s^4 causes the solenoid A to become energized and draw up the core a^5. The making and breaking of the contacts s and s' keeps the solenoid B energized, while the making and breaking of the contacts s^2 and s^3 sends impulses over the trunk wire number 4 to the first selector switch. These impulses, of course, correspond to the makes and breaks of the contacts o and o'. After this first set of impulses there is a momentary closure of the line due to the subscriber setting his sending device for another set of impulses. During this time the relay S remains energized and the core a^5 of the solenoid A drops down and in doing so momentarily closes together the contact springs a, a' and a^2. This closure places battery on the trunk wire 5 and changes the conditions on the line wire 3. Battery being thus momentarily placed on the trunk wire 5 operates the rotary relay in the first selector switch, while the change being made on line wire number 3 disables the busy test relay in the connector switch as will be described later.

Referring now to Fig. 3, the first set of impulses coming over number 4 side of the trunk operates the relay V which in turn closes the circuit of the magnet X, which causes the spindle Z to step up vertically and bring the wipers opposite a row of contacts leading to the proper group of second selector switches. After the first set of impulses the solenoid A becomes deënergized and its core dropping down places battery on number 5 side of the line of the trunk by the following path: battery B, 22, s, s', 28, a^2, a', 27, 5. This impulse operates the relay V' which in turn closes the circuit of the private relay U, causing the side switch to make one movement, cutting on the rotary magnet X', which causes the spindle to rotate until the test wiper finds the contact leading to an idle second selector switch. When such a switch is found, the side switch makes one more movement, cutting off the vertical and rotary relays and connects the trunk wires 4 and 5 to the trunk wipers which rest upon contacts leading to the second selector switch. The subscriber now being connected to the second selector switch, sends in the second set of impulses which now operate the second selector switch G' in the same manner that the first set of impulses operated the first selector switch. The subscriber now being connected to a connector switch containing multiples of the desired line, sends in the third set of impulses. This set of impulses coming in operates the relay V^4, which in turn closes the circuit of the magnet X^4, which in turn causes the spindle Z^2 to step up vertically and bring the wipers opposite a row containing the contacts leading to the desired line. The rotary impulse now coming in operates the relay V^5 causing the side switch to make one movement, disconnecting the magnet X^4 and in its place connecting the magnet X^5; it also connects the test relay J^4 to the tip side of the line through the normally open contacts u and u' of the relay U^2. The fourth set of impulses now coming in operates the relay V^4 which now closes the circuit of the magnet X^5, which in turn causes the spindle to rotate and bring the wipers to rest upon contacts leading to the desired line. In this case, the desired line happens to be the same as the calling line since the station wanted is connected to the same pair of line wires. The last rotary impulse now coming in closes the circuit of the relay V^5, which in turn closes the circuit of the relay U^2 connecting the test relay J^4 to the tip or number 18 side of the trunk. At the same time that this relay is connected to the tip side of the trunk, in Fig. 1 the wires 2 and 3 and their extensions 40 and 41 are short circuited and the coil I of relatively low resistance shunts out the test relay of relatively high resistance which is connected to battery.

In Fig. 2 the test relay fails to find ground as the relay S is removed from the extension wire 40, but is held energized by the make

before break contacts s^{20} and s^{30}. The above condition can only be brought about when trying to signal back on the line which initiates the call. If calling for another line and that line happens to be busy, ground would be connected to the tip side of the trunk through the relay S or coil I^2 and that line would test busy and the relay J^4 would become energized and close the circuit of the magnet J^5 restoring the switch to its normal position. The subscriber now being connected to his own line sets up his sending device so as to send in a set of ringing impulses. These impulses now coming in operate the relay V^4 which in turn closes the circuit of the ringing relay Y which became connected when the last rotary or test impulse was sent in, causing the side switch to make one more movement. These ringing impulses operate the relay Y, putting generator current on the called line over the following path: generator, 17, 19, 41, 2, Q', 3, and to ground through the relay S. At the end of the conversation the calling subscriber upon hanging up his telephone effects the release of the various switches in the following manner: During conversation the core of the solenoid B remains drawn up while that of the solenoid A remains down. When the calling subscriber hangs up his telephone the relay S becomes de-energized, whereupon the solenoid A at once draws up its core a^5 while the core b^5 of the solenoid B begins to drop, and as soon as it assumes its normal position battery is connected to both sides of the trunk by the following path: battery B, a^4, a^3, b^4, b^3, b^2, 21, 31. After it has assumed its normal position the contacts b and b' are broken opening circuit of the solenoid A whose core a^5 thereupon begins to drop and as soon as it assumes its normal position the contacts a^3 and a^4 are opened and battery is removed from the trunk wires 4 and 5 respectively. It will be seen from this method of operation that the joint action of these solenoids at the end of the conversation places battery momentarily on both sides of the trunk for releasing. These momentary impulses close the circuit of the relay V^4 and the relay V^5 at the same time, thus closing the circuit of the relay J^4 which in turn closes the circuit of the magnet J^5 restoring the connector switch to its normal position. The circuit of the relay J^2 in the second selector switch was closed in series with that of J^4 and upon operating closes the circuit of the magnet J^3 restoring the second selector switch to its normal position. In the first selector switch the relay J has its circuit closed in series with the magnet J^3 and becoming energized closes the circuit of the magnet J' restoring the first selector switch to its normal position. All the apparatus is now returned to its normal or starting position and ready to be used for another call.

In Fig. 4 I have shown a modified arrangement in which primary selector switches are used to complete the connections of the normally open line-circuits. From the two stations A^x and A^y extend the line-wires 2 and 3, terminating on the contacts n, n', of the cut-off relay N. The line relay M, through the pulling up of its armature m puts current through its individual bank test contact on the actuating winding of a constantly rotating test magnet K. This magnet is provided with an armature having on one end a pin k' and on the other end an upwardly extending arm k^2 adapted to actuate a plug k^3. The magnet is kept rotating by the engagement of a pin k' with a socket in a disk k^4 secured on the shaft k^5. When however, the test wiper k^6 comes onto the contact k^{17} of a calling line, the magnet is energized, the pin k' is lifted from its engagement with the disk k^4, and at the same time the plug k^3 is forced outwardly between the contacts k^7 and k^8 forcing them against the contacts k^9 and k^{10} respectively, thereby completing the connection of the line circuit with the wires 3' and 2'.

The operation of this primary selector switch has been only briefly described since the specific form is not at all essential to the present invention. This switch has been fully described in a prior application Serial No. 311,388, filed April 12, 1906. Any other primary selector switch operating substantially in the same manner may be used, such as that shown in a prior application Serial No. 383,875, filed July 15th, 1907.

The operation of the tip and sleeve relays S^a and I^a and of the solenoids A^a and B^a is similar to that of their corresponding relays S, A, I, B, in Figs. 1 and 2 and may be readily understood without going into a detailed explanation, being fully set forth in a previous application, Serial No. 279,031, filed September 18th, 1905.

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 plurality of subscribers' lines, means for automatically connecting said lines, means for testing a busy line, including a test relay, and other means for shunting said test relay when the line calling is also the line called, thereby preventing the establishment of a false test circuit.

2. In a telephone exchange system, a plurality of normally open subscribers' line circuits, means for closing said line circuits when a line is calling, automatic switches for connecting said line circuits, means for testing a busy line including a test relay,

other means operating simultaneously for shunting said test relay and rendering it inoperative thereby preventing a false busy test when a calling line is the same as the called line, and impulse sending devices at the subscribers' stations for actuating said automatic switches.

3. In a telephone exchange system, a plurality of normally open subscribers' lines, means for closing said lines when a station is calling, automatic switches for connecting said lines, a test relay adapted ordinarily to establish a test circuit on a busy line and a second relay operating simultaneously and arranged to short-circuit the test relay when the calling and the called line are the same, thereby preventing the establishment of a false test-circuit.

4. In a telephone exchange system, a plurality of normally open subscribers' lines, means actuated by a calling subscriber for automatically closing his line, automatic switches for connecting said lines, a test relay adapted under ordinary conditions to effect the disconnection of the interconnected lines when the called line is busy, a second relay arranged to short circuit said test relay when the calling and the called lines are the same, thereby preventing the breaking of the completed connection, and a third relay arranged to actuate said test and short circuiting relays simultaneously.

5. In a telephone exchange system, a plurality of normally open subscribers' lines, means actuated by a calling subscriber for automatically closing his line, automatic switches for connecting said lines, a test relay adapted under ordinary conditions to effect the disconnection of the interconnected lines when the called line is busy, a second relay arranged to disable said test relay when the calling and the called lines are the same, thereby preventing the breaking of the completed connection, and a third relay arranged to actuate said test and disabling relays simultaneously.

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

EDWARD E. CLEMENT.

Witnesses:
L. S. STANLEY,
CHARLES LOWELL HOWARD.