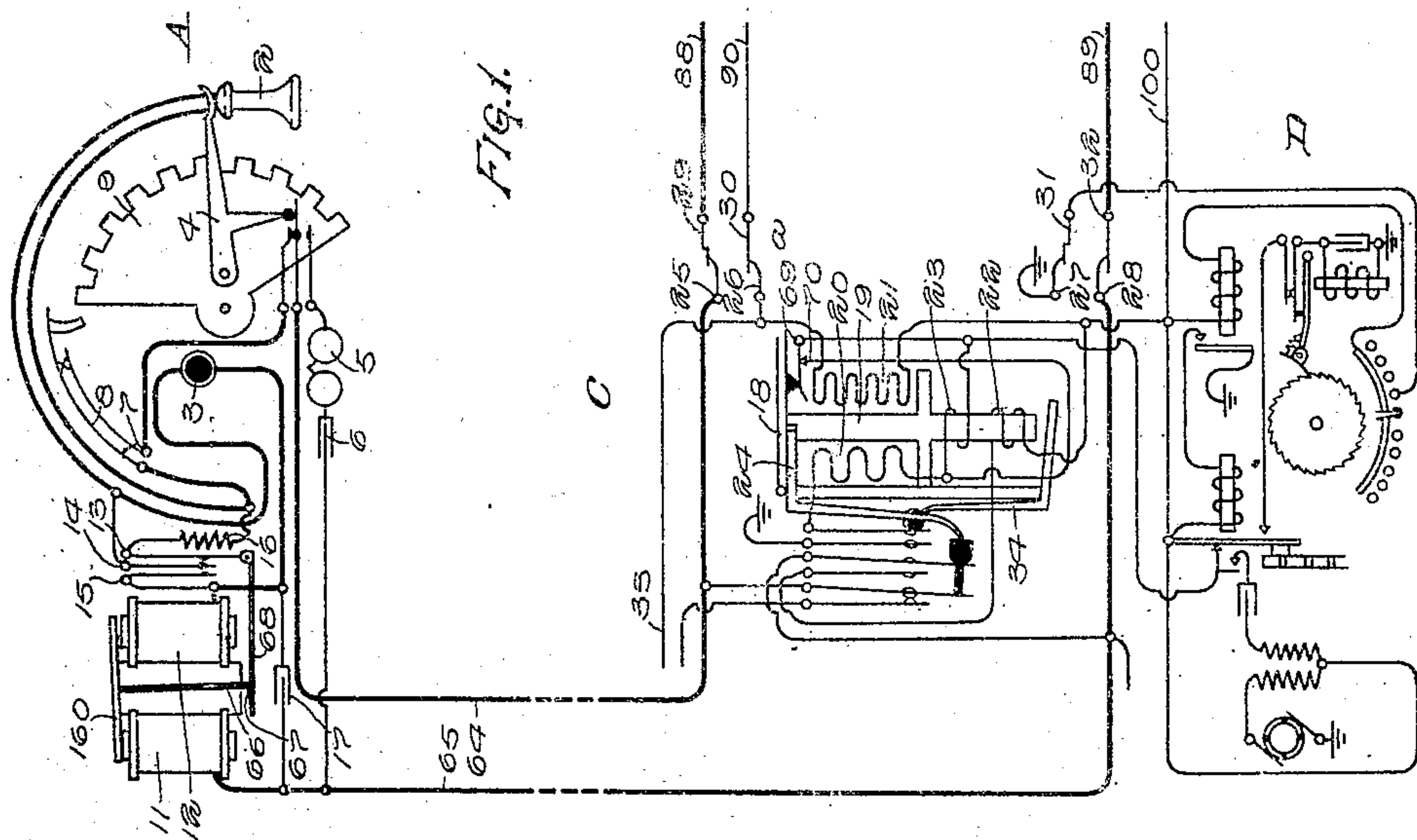


T. G. MARTIN.
AUTOMATIC TELEPHONE SYSTEM.
APPLICATION FILED FEB. 5, 1916.

1,288,098.

Patented Dec. 17, 1918.

4 SHEETS—SHEET 1.



WITNESSES

Herkko Hakala

Louis M. Landa

INVENTOR
TALBOT G. MARTIN

By Charles C. Bullock

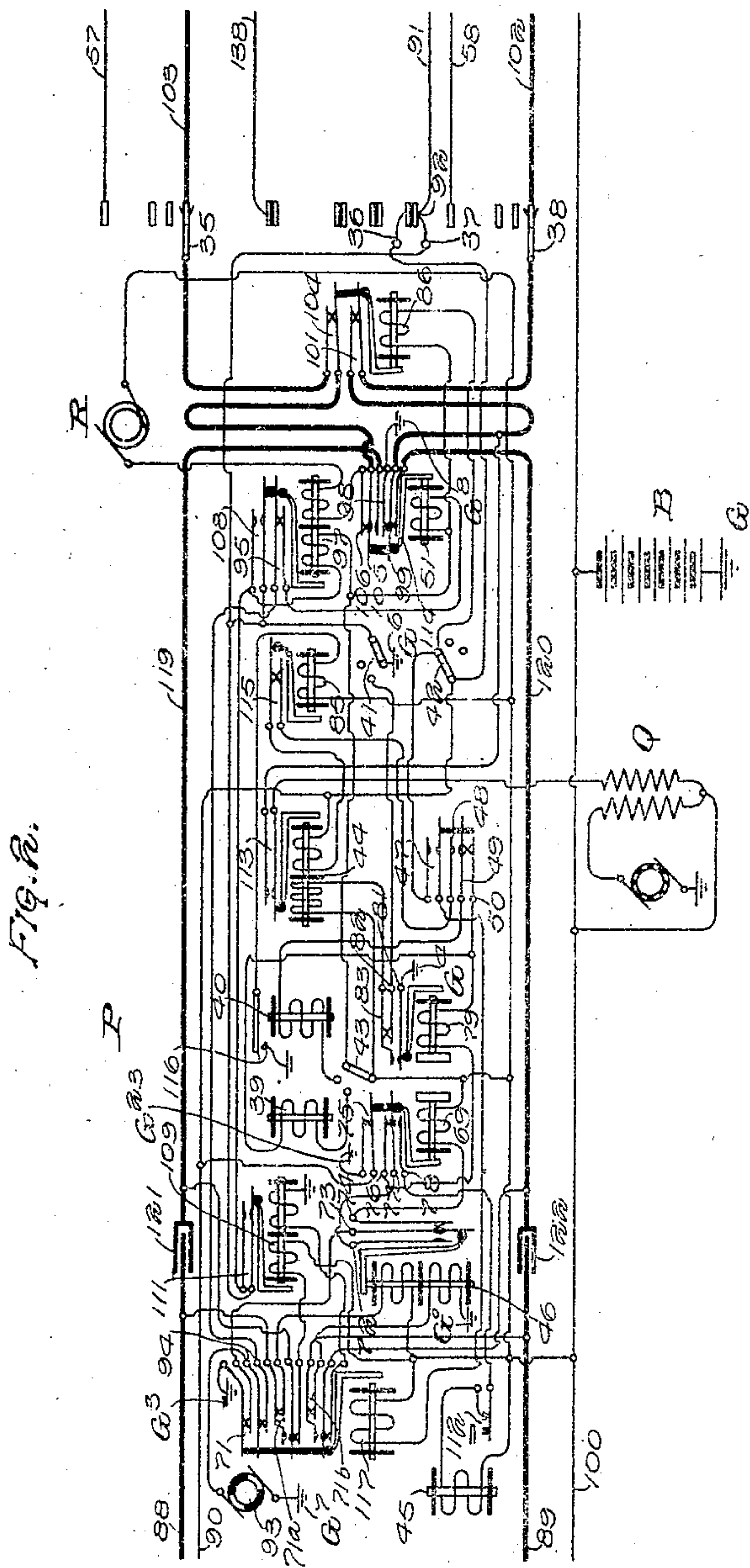
ATTORNEY

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4 SHEETS—SHEET 2.



WITNESSES

H. H. W. K. K.
Louis M. Landa

INVENTOR:
TALBOT G. MARTIN,

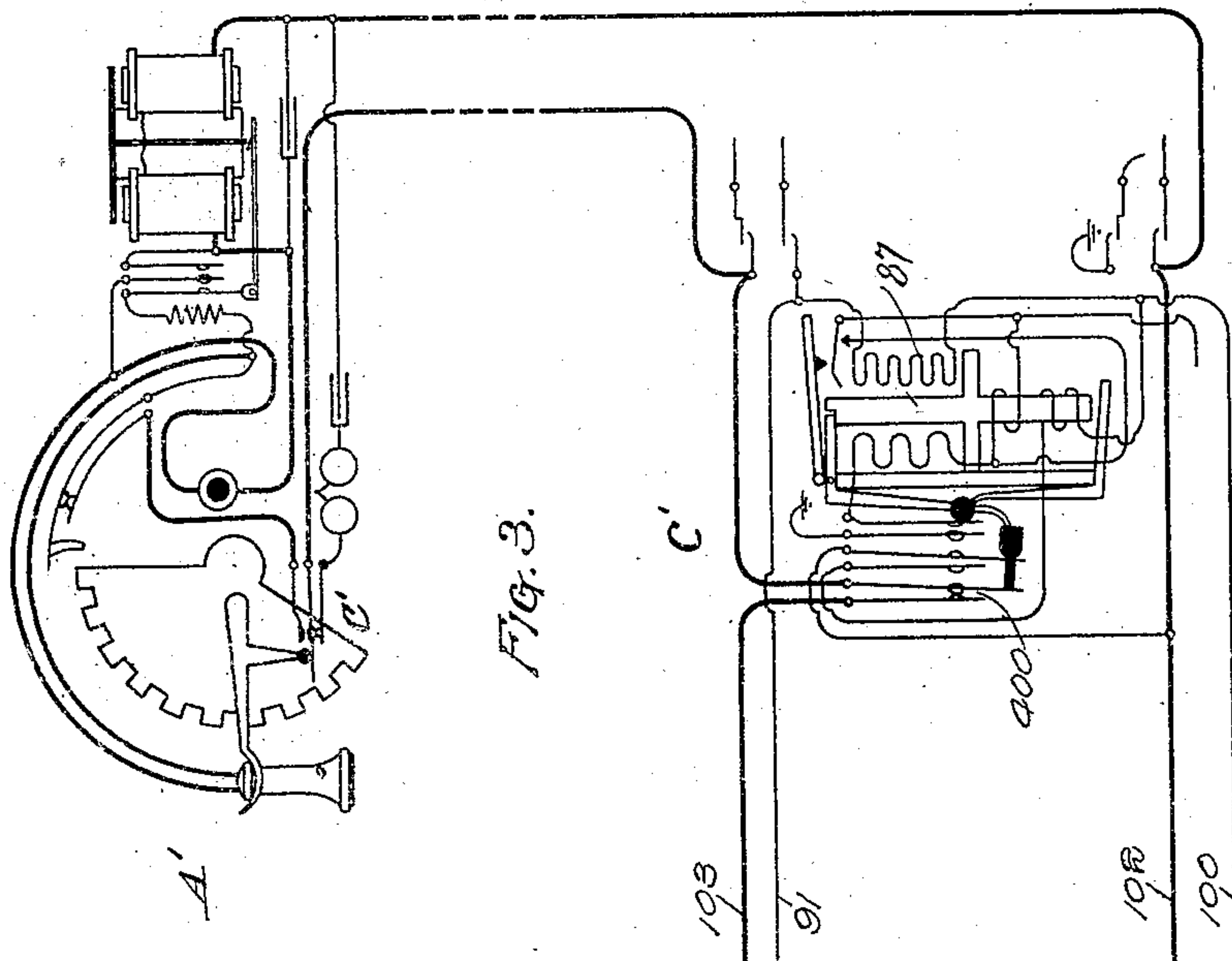
By Charles C. Bulkeley

ATTORNEY

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4 SHEETS—SHEET 3.



WITNESSES

Hertie W. Kack

Louis M. Landa

INVENTOR:

TALBOT G. MARTIN

By Charles C. Bulkeley

ATTORNEY,

T. G. MARTIN.
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4 SHEETS—SHEET 4.

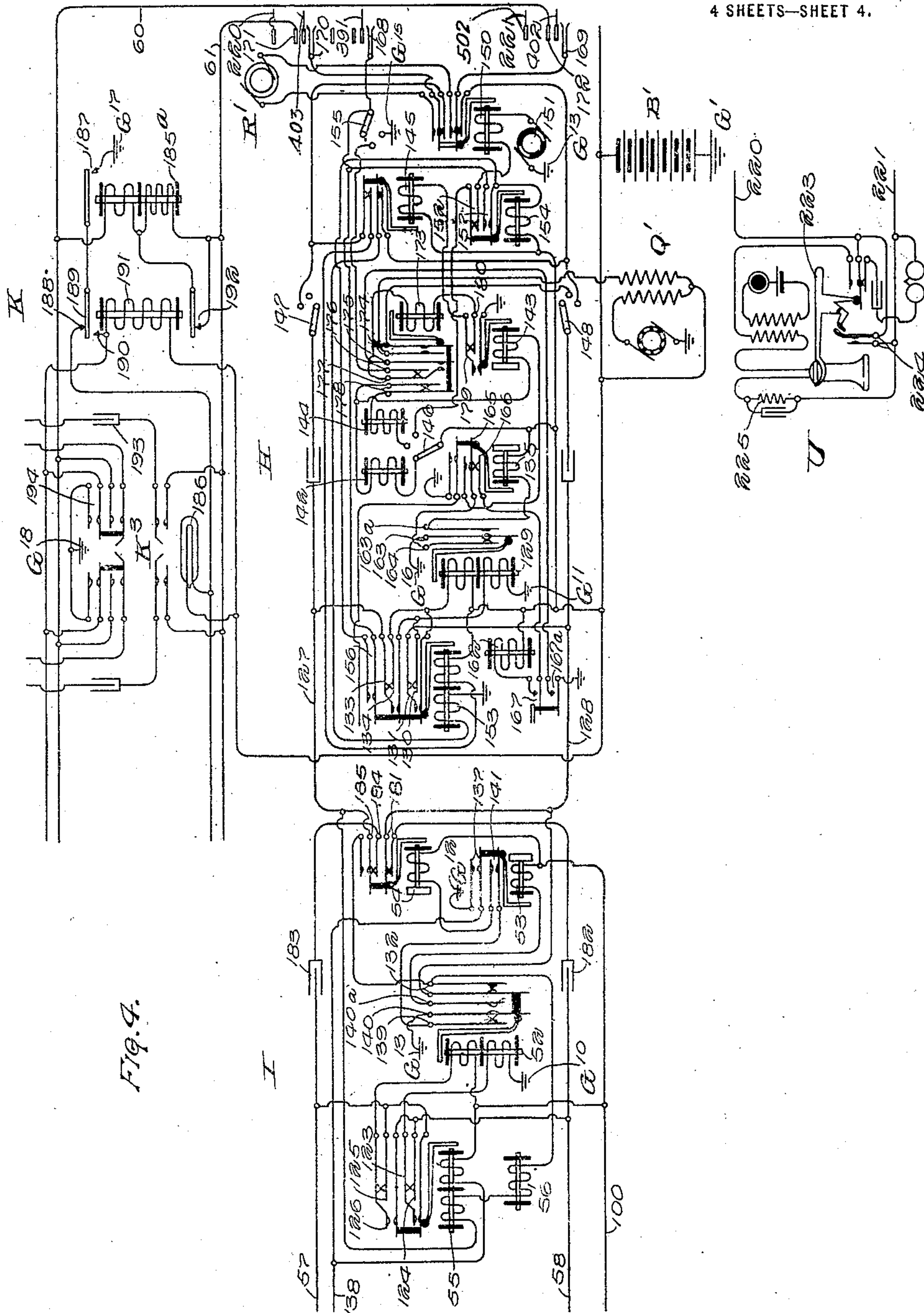


Fig. 4.

WITNESSES

Herbert W. Kacker

Louis M. Landa

INVENTOR:
TALBOT G. MARTIN,
By Charles C. Bulkley
ATTORNEY

UNITED STATES PATENT OFFICE.

TALBOT G. MARTIN, OF CHICAGO, ILLINOIS, ASSIGNOR TO AUTOMATIC ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

AUTOMATIC TELEPHONE SYSTEM.

1,288,098.

Specification of Letters Patent.

Patented Dec. 17, 1918.

Application filed February 5, 1916. Serial No. 76,309.

To all whom it may concern:

Be it known that I, TALBOT G. MARTIN, a citizen of the United States of America, and resident of Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Automatic Telephone Systems, of which the following is a specification.

My invention relates to automatic telephone systems and in certain of its features has particular reference to those systems which include automatic private branch exchanges.

In these exchanges it has been customary to provide so called connector and selector switches, the former for completing local connections and the latter for selecting an idle one of the connectors or for selecting an idle trunk line to the main exchange.

One of the objects of my invention is the provision of a switch which can perform the functions of both a selector and a connector. My improved type of switch operates as a connector on the first nine levels, these levels containing contacts which are terminals of local lines; but on the tenth level it operates as a selector to pick out contacts which are terminals of an idle trunk line.

A further object is to provide in a switch of the above character an improved ringing method by virtue of which a called subscriber is enabled to instantly stop the ring by removing his receiver from the hook.

In a system of the general character described above the subscriber's station equipment may include a coin collecting device by means of which a coin or other token may be collected for each successful originating call. A coin collecting device in common use depends for its action upon a polarized relay in series with the line. When making a call the relay is energized, but with no effect other than to place certain of its parts in operative position. When the called party answers, however, the connector reverses the direction of current flow in the calling line whereupon the polarized relay operates to close a shunt around the transmitter. The calling subscriber can hear his party answer but cannot talk until he has dropped a suitable coin in the coin collecting device whereby his transmitter is again made operative for talking purposes.

However, at each main exchange there usually are certain telephones to which it is

desirable to give all the subscribers free access. Furthermore, certain departments of the telephone company should be accessible to the subscribers without charge. In the past it has been customary to provide a separate section of the switchboard for handling the above class of service, the connectors in this special switchboard being arranged so as not to reverse battery to the calling line. But the use of a special switchboard provides no means by which one of the regular switchboard numbers may be made temporarily accessible without charge and, furthermore, the special equipment is a source of considerable extra expense.

In addition to these features already mentioned, my invention provides simple and efficient means whereby a connector of the regular type, which ordinarily reverses battery to the calling line, is prevented from so doing when the called line is one to which it is desired to give free access. I make no change in the connector switches or in the general trunking scheme, but rather employ individual apparatus in connection with each free substation whereby a connector, upon completing a connection with that substation, is prevented from performing certain of its functions, thereby enabling the calling subscriber to converse without depositing the usual coin.

Trunk lines accessible to the regular connectors and extending to operators' positions may be equipped in accordance with these specifications whereupon they will also be made accessible to all the subscribers without charge.

These and other valuable features of my invention are provided for by means which will be hereinafter fully explained, reference being had to the accompanying drawings.

The telephone system illustrated therein comprises an automatic private branch exchange and an automatic main exchange.

Figures 1, 2 and 3 represent a complete circuit connection between a calling substation A and a called substation A' whose lines terminate in the said private branch exchange. The said connection is established through the medium of the subscriber's individual switch C, connector switch P and the called subscriber's individual switch C'.

Fig. 4 represents apparatus at the main exchange which may be used for completing

a connection between a calling substation A, whose line terminates in the said private branch exchange, and a called substation, which may be similar to the substation A', but whose line terminates in the main exchange. The said connection is established by means of the subscriber's individual switch C, connector switch P, (which acts as a selector switch on the top level, as will be hereinafter more fully explained,) repeater I, connector switch H (located in the main exchange) and the called subscriber's individual switch.

In the circuit connections referred to above, the central office equipment, as shown, comprises only the so called line switches, connector switches, and repeater, but it will be clearly understood by those versed in the art, that so-called selector switches may be inserted before the connector switches, thereby increasing the capacity of the system, without departing from the principles of my invention. Selector switches which may be used are of the type disclosed in British patent to T. G. Martin, No. 1419 of 1910.

The automatic telephone or substation A, as herein represented, comprises the usual receiver 2, transmitter 3, switch hook 4, ringer 5, and condenser 6. Being an automatic substation, it is also provided with an automatic calling device. This calling device may be of the same type as that shown in British patent to S. G. S. Dicker, No. 29,654 of 1910. The calling device is shown diagrammatically by a pair of impulse springs 7 and 8 and a toothed impulse wheel 9, which latter is controlled by the subscriber through the medium of a dial (not shown) provided with finger holes for convenience in turning. The coin collecting device is also shown diagrammatically; it consists essentially of a polarized electromagnet, the coils 11 and 12 of which are connected in series with the telephone, and bridged by a condenser 17. The springs 13, 14 and 15 are so arranged that when their contacts are closed, the transmitter 3 is short circuited and the receiver 2 is shunted by the resistance coil 16. The coin connecting device is similar to that described in British patent specification No. 587 of 1912.

The subscriber's individual switch C is of the general type of subscriber's switch shown in British patent to R. W. James, No. 26,301 of 1906, being however, of the particular type disclosed in British patent to T. G. Martin No. 1419 of 1910. This line switch comprises among other details, a plunger (not shown) attached to the end of a so-called plunger arm 18 which is controlled by the magnet 19. The magnet 19 comprises four windings, namely a pull down winding 20, cut-off or holding winding 21, line winding 22 and an auxiliary winding 23. The core of the magnet 19 is

so constructed that the magnetic circuit of the windings 20 and 21 is separate from that of the windings 22 and 23. The winding 20 operates both the plunger arm 18 and the cut-off armature 24, while the winding 21 is strong enough only to operate the cut-off armature 24 and to hold the plunger arm 18 in its operated position. When the plunger arm 18 is operated, the plunger is forced into a bank of contact springs, forcing the springs 25, 26, 27 and 28 into engagement with the contacts 29, 30, 31 and 32, respectively. Although only one set of springs and contacts (25 and 32 inclusive) is shown, each line switch is provided with a plurality of such sets, each set forming the terminals of a trunk line leading to a connector P. Each trunk line is connected in multiple with the corresponding springs of all the line switches of the group which is controlled by the master switch D. The switch C is controlled by the subscriber, through the medium of the line winding 22, as will be hereinafter more fully explained.

The master switch D is of the general type disclosed in British Patent No. 26,301 of 1906, referred to above, being, however, of the particular type disclosed in said British Patent No. 1419 of 1910. The function of the master switch, as is well known, is to maintain the plungers of all the idle line switches in position to engage the terminal of an idle trunk line.

The connector switch P is of the same general type of connector switch disclosed in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson, the circuits, however, being modified to enable the switch to operate in a system in which the central office apparatus is controlled by impulses delivered over the two sides of the line in series. The connector is provided with a shaft (not shown) carrying the wipers 35, 36, 37 and 38 and controlled by the vertical magnet 39 and the rotary magnet 40. The connector switch is also provided with banks of contacts, which are divided into rows or levels, generally ten in number. The bank contacts in the first nine rows or levels are used for local connections, while the bank contacts in the tenth level are connected to trunk lines leading to the main exchange. The springs 47, 48, 49 and 50 are controlled by the switch shaft—that is, they are operated whenever the switch shaft is raised to the tenth row or level of bank contacts. The function of the said springs is to change the operation of the connector switch from that of a connector to that of a selector. The bank contacts accessible to the wipers 37, 38 and 35 are multiplied between the banks of the switches on all ten levels while the bank contacts accessible to the wiper 36 are only multiplied between banks on the tenth level

and are left disconnected on all other levels. The usual side switch comprising the switch wipers 41, 42 and 43 is controlled by the private magnet 44 in the well known manner. The magnet 45 is the usual release magnet. The line relay 46 is the means for controlling the various operations of the connector switch. The ringing relay 51 is the means by which ringing current is applied to the called line from the ringing current generator R. At Q there is shown a busy signaling machine which provides a busy signal, said busy signal being applied to the calling line when the called line is in use.

The substation A' and the individual switch C' are similar in all respects to the substation A, and the line switch C.

The repeater I comprises a line relay 52, slow acting relays 53 and 54, battery reversing relay 55 and an impedance coil 56. The line relay 52 is normally bridged across the trunk conductors 57 and 58 in series with the battery, through the reversing springs of the battery reversing relay 55, and is arranged so that when its armature operates in accordance with the impulses from the subscriber's substation A, it opens and closes the bridge across the trunk extending to the connector H a corresponding number of times. Another function of the repeater I is to supply talking current to the calling line and maintain a holding circuit for the connector P and line switch C, thus obviating the necessity of having three conductor trunks between exchanges.

The connector H is of the same general type as connector P, but is provided with only three shaft wipers and operates as a straight connector on all levels. By means of wipers 168, 169 and 170, connector H has access to the group of relays K, to the special substation U, and to a number of substations similar to the substation A' in Fig. 3.

The group of relays K may be located in a manual board and is for the purpose of allowing an operator to answer an information call or the like without necessitating the calling subscriber dropping a coin in his coin collecting device. In the event that a subscriber has had his telephone removed or taken out of service for any reason, his line is disconnected from the central office apparatus, and the connector bank normals are connected to what is known as a traffic trunk, as shown at K, said trunk being designated by the reference numerals 60 and 61. Therefore, when the subscriber at substation A attempts to call a subscriber whose telephone has been disconnected (and the connector bank normals connected to said traffic trunk) he will signal an operator who will immediately give him the required information. It is desirable (as hereinbefore stated) that the calling subscriber should not have to pay for such a call, therefore, arrange-

ments are provided in the group of relays K for obviating the necessity of the calling subscriber dropping a coin to render his substation operative for talking purposes. The substation U is equipped with apparatus to accomplish the same result as is accomplished by the group of relays K.

For the purpose of supplying battery current for operating the central office apparatus and for talking purposes, there is shown throughout the drawings, a plurality of batteries B and B', each having one of its terminals grounded at G and G' respectively. In practice there need be only one such battery, or preferably one battery for each exchange.

A general description of the apparatus having been given, it will now be explained how a connection is extended from a calling substation A to a called substation A', whose lines terminate in the same private branch exchange. We will assume the number of the called substation to be 20. Since part of the automatic switching apparatus disclosed herein is in general well known in the art, and is described in the publications hereinabove referred to, its operation will be explained in a more or less general manner. Upon the removal of the receiver from the switch hook at the substation A, preparatory to making a call, the substation receiver 2, transmitter 3, and polarized relays 11 and 12 are bridged across the line conductors 64 and 65 causing an energizing circuit to be closed through the line winding 22 of the individual switch C, thereby attracting the line armature 34. At this time the current flowing through the coils 11 and 12 is in such a direction as to attract the armature to the coil 11, thereby moving the arm 66 behind the lug 67 on the arm 68. The armature 34, when attracted, closes a circuit through the pull down coil 20, in series with the auxiliary winding 23. The pull-down coil, upon energizing, attracts the plunger arm 18 to force the plunger into the bank of springs thereby forcing springs 25 to 28 into engagement with contacts 29 to 32, respectively. The cut-off armature 24 is also attracted, thereby disconnecting the two sides of the line from ground and from the line winding 22. The armature 34 does not fall back immediately, however, being held by the winding 23 which is still in series with the pull down winding 20. As the plunger enters the bank, the springs 69 and 70 are brought together to short-circuit the auxiliary winding 23, making the line relay slightly slow acting. The armature 34 being slow to fall back, sufficient time is provided for a holding circuit to be closed in the switch ahead for the cut-off or holding winding 21. The engagement of the springs 25 and 28 with the contacts 29 and 32, respectively, extends the subscriber's line to the

line relay 46 of the connector P. The circuit thus established extends from ground G^0 through lower winding of line relay 46, contact springs 71^b, conductor 89, bank contact 32, spring 28, conductor 65, to and through substation A, conductor 64, spring 25, bank contact 29, conductor 88, contact springs 71^a and upper winding of line relay 46 to the battery B. The line relay 46 of the connector switch P is thereupon energized, closing a circuit extending from ground G^3 through contact springs 71, springs 73 and 74 and the relay 69 to battery B. The relay 69, upon energizing, closes the above-mentioned holding circuit through the cut-off winding 21 of the line switch C. This circuit extends from ground G^{23} through the contact springs 75, conductor 90, bank contact 30, spring 26, and cut-off winding 21 to the battery B. The winding 21, upon energizing, holds the armature 24 and the plunger arm 18 in their operated positions after the circuit of the pull down winding is broken by the falling back of the line armature 34. A guarding ground potential is supplied to the connector private bank contacts of the calling line as soon as the relay 69 is energized. This circuit extends over the circuit just traced to the bank spring 26, thence over the conductor 33 to said private bank contacts. The energization of the relay 69 also prepares a circuit for the vertical magnet by bringing into engagement the springs 76 and 77 and opens the circuit of the release magnet 45 at the springs 77 and 78.

The calling subscriber now operates his calling device for the first digit 2 of the desired number, whereby the substation impulse springs 7 and 8 are separated twice momentarily, each time breaking the circuit of the connector line relay 46. The relay 69 of the connector being slow acting, it does not deenergize during the momentary interruptions of its circuits by the line relay 46 and, consequently, each time the latter relay deenergizes, an impulse is transmitted over the circuit extending from ground G^3 through the contact springs 71, springs 73 and 72, springs 77 and 76, relay 79, vertical magnet 39, and side switch wiper 43 (in first position) to battery B. The vertical magnet 39 receives two impulses over this circuit and operates to raise the switch wipers 35, 36, 37 and 38 to a position opposite the second level of bank contacts. The relay 79, which is included in series with the vertical magnet, is slow acting and remains in its energized position during the entire time that impulses are being transmitted through it and operates to close the circuit of the private magnet 44. This circuit extends from ground G^4 through contact springs 81 and 83 and the left hand winding of relay 44 to battery B. After

the last impulse is delivered, the relay 79 opens the circuit of the private magnet 44, which, upon deenergizing, permits the side switch to advance from first to second position. The movement of the side switch wiper 43 from first to second position transfers the battery connections from the vertical magnet 39 to the rotary magnet 40. The calling subscriber now operates his calling device for the last digit 0, in response to which the connector line relay 46 operates to transmit ten impulses through the rotary magnet 40 in series with the relay 79, whereby the shaft wipers are rotated onto the contacts of the desired line. The circuit for the rotary magnet extends from ground G^3 through contact springs 71, springs 73 and 72, springs 77 and 76, relay 79, springs 50 and 49, rotary magnet 40, and the side switch wiper 43 (in second position) to battery B. Each time the rotary magnet energizes, a circuit is closed through the relay 85, however, the operation of said relay is functionless at this time. The relay 79 operates in response to this digit in the same manner as for the previous digit to cause the private magnet 44 to advance the side switch one more step, that is, from second to third position—after the last impulse for the digit has been transmitted. By the energization of the relay 86 and the bridge cut-off winding 87 of the called subscriber's individual switch C' the line connection is completed with the called substation, as shown by the heavy conductors. The energizing circuit for the said bridge cut-off coil extends from ground G^6 through the side switch wiper 41 (in third position) wiper 37, conductor 91 and the said bridge cut-off winding 87 to battery B. The connection of ground G^6 with the connector private bank contact 92 of the called line prevents the called line from being seized by some other connector switch. The energizing circuit for said relay 86 extends from ground G^{23} by way of contact springs 75, conductor 90, side switch wiper 42 in third position, winding of relay 86 and side switch wiper 43 in third position to battery.

A further result of the engagement of side switch wiper 43 with its third position contact point is the closure of a circuit through the ringing relay 51. This circuit extends from ground G^7 through the interrupter 93, springs 94, springs 95, ringing relay 51 and the side switch wiper 43 (in third position) to battery B. The ringing relay is energized intermittently through the medium of the interrupter 93. The path of the ringing current extends from ground G^8 through the contact of springs 98 and 99, springs 101 of relay 86, wiper 38, conductor 102, ringer at substation A', contact springs 400 of line switch C', return conductor 103, wiper 35, springs 104, springs 105 and 106, the right

hand winding of relay 97, generator R, to and through the battery B to ground G. The relay 97 is so constructed and so adjusted that it will not respond to ringing current from the generator R when the substation bells and condenser are bridged across the line, but the instant that the receiver is removed at the called substation, thereby bridging the transmitter and receiver across the line, sufficient current is permitted to flow from the battery B, through the generator R, and through the said relay 97, for it to become operatively energized. Should the called subscriber answer during the ringing period—that is during the time the ringing relay 51 is energized, the relay 97 will immediately energize and upon energizing, opens the circuit of the ringing relay 51 at the springs 95 and closes a locking circuit for itself through the springs 108. The said locking circuit extends from ground G⁶ through the side switch wiper 41 (in third position), springs 108, the left hand winding of relay 97 and the side switch wiper 43 (in third position) to battery B. The called subscriber is provided with talking battery through the windings of the back bridge relay 109. If the calling subscriber should answer during the time that the ringing relay 51 is deenergized, the back bridge relay 109, being bridged across the called line in series with battery B, will immediately energize. The relay 109, upon energizing, closes a circuit through the ring cut-off relay 97. The said circuit extends from ground G⁶ through the said side switch wiper 41 (in third position), contact of springs 111, the said relay 97, and the side switch wiper 43 (in third position) to battery B. The relay 97, upon energizing, forms a locking circuit for itself over a hereinbefore traced circuit. The subscribers may now carry on an interrupted conversation over the heavy conductors shown.

After the conversation is completed, the connection is released in the following manner: When the receiver at the substation A is restored to the switch hook, the separation of the hook switch springs opens the energizing circuit of the connector line relay 46. The relay 46 is deenergized, and opens the circuit of the relay 69. The relay 69, upon deenergizing, opens the holding circuit of the hold-in winding 21 of the line switch C and closes the circuit of the connector release magnet 45. This latter circuit extends from ground G³ through the springs 71, springs 73 and 72, springs 77 and 78, off normal springs 112, and the release magnet 45 to battery B. The release magnet, upon energizing, restores the switch shaft and side switch wipers to normal position and its own circuit is broken at the springs 112 when the shaft reaches its low-

est position. The winding 21 of the line switch C, upon deenergizing, allows the plunger arm 18 to return to normal position.

It now having been explained how one subscriber establishes a connection and releases the same, it will be explained how a connection is prevented from being made with a busy line, and how the calling subscriber receives a busy signal when calling a busy number. If the called number is busy, there will be a guarding potential upon the connector private bank contact, just as explained in connection with the line switch C. The connector private wiper 37, upon engaging this contact before the private magnet 44 has deenergized to allow the side switch to pass to third position, completes a locking circuit through the said private magnet, thus retaining the side switch in second position. This circuit extends from ground upon the private bank contact 92, through the wiper 37, side switch wiper 41 (in second position), contact springs 82 and 83 (when relay 79 deenergizes), and the left hand winding of said private magnet 44 to battery B. The private magnet thus locks the side switch in second position, and transmits a busy signal to the calling subscriber over the following path: battery B, secondary winding of the induction-coil, contact springs 113, springs 99 and 114, heavy conductor 89, to and through the substation A, return conductor 88, springs 71^a of relay 117, and through the upper winding of relay 46 to battery B. A tone induced in the secondary winding of the induction coil is perceived by the calling subscriber who, upon replacing his receiver, releases the apparatus in a hereinbefore mentioned manner.

It having been explained how a local connection is established and released, it will now be explained how a connection may be extended from the calling substation A to a called substation in the main exchange, whose number, we will assume to be 020. The calling subscriber upon removing his receiver preparatory to making a call, operates his individual switch C in the same manner as hereinbefore described to effect connection with the connector switch P. The calling subscriber now operates his calling device for the first digit 0 in response to which the switch shaft and wipers of the connector P are raised opposite the tenth row or level of bank contacts. The switch shaft, upon being raised to the tenth level, operates to switch the springs 47, 48, 49 and 50 in a hereinbefore mentioned manner. The private magnet 44, operates in the same manner as hereinbefore described to step the side switch from first to second position. The side switch wiper 43, upon passing to second position operates to close a circuit through the rotary magnet 40 and the pri-

vate magnet 44. The said circuit extends from ground G^{23} through contact springs 75, right hand winding of magnet 44, springs 115, springs 48 and 49, rotary magnet 40, and the side switch 43 (in second position) to battery B. The rotary magnet 40, upon energizing, operates to rotate the shaft and wipers one step and to close a circuit through the relay 85 (previously referred to) which, upon energizing, interrupts the circuit of the rotary magnet and private magnet at the springs 115. If the first trunk line of the O level is idle, the private magnet 44 deenergizes and permits the side switch to step to third position. If this trunk line is busy, however, the private wiper 37, finds the contact with which it engages provided with a guarding potential which is transmitted to the private magnet 44 over the following path: ground on test contact, wiper 37, side switch wiper 41 (in second position), springs 82 and 83, and the left hand winding of the magnet 44 to battery B. The rotary magnet, however, deenergizes when the springs 115 disengage, regardless of whether the magnet 44 remains energized or not. The rotary magnet, upon deenergizing opens the circuit of the relay 85 at the springs 116, and the relay 85, upon deenergizing, again closes a circuit through the rotary magnet 40 at the springs 115. The rotary magnet will, therefore, operate in the manner of a buzzer to advance the wipers step by step over the contacts until a non-grounded contact of an idle trunk line is reached by the wiper 37, whereupon the private magnet 44 deenergizes and permits the side switch to advance one more step, or from second to third position. The side switch wiper 42, upon engaging its third position contact point, closes a circuit through the relays 117 and 86. The circuit for relay 86 extends from ground G^{23} by way of springs 75, conductor 90, side switch wiper 42 (in third position), relay 86, and the side switch wiper 43 (in third position) to battery B. The relay 86, upon energizing, connects the line wipers 35 and 38 to the conductors 119 and 120 respectively. The energizing circuit for relay 117 extends from ground G^{23} over the above traced circuit to side switch wiper 42 (in third position), thence through the springs 47 and the said relay 117 to battery B. The relay 117, upon energizing, disconnects the line relay 46 from the conductors 88 and 89 and also disconnects the back-bridge relay 109 from the conductors 119 and 120. At the same time it short circuits the condensers 121 and 122 and cuts the calling line through to the line relay 52 of the repeater I. This circuit extends from ground G^{10} through the lower winding of relay 52, springs 123 and 124, conductor 58, wiper 38 (now resting on bank contact of "O" level), conductor 120, to and through the calling substation A, re-

turn conductor 119, wiper 35 (now resting on bank contact of "O" level), conductor 57, springs 125 and 126, and the upper winding of relay 52 to battery B. The relay 52, upon energizing, closes a circuit through the relay 53, which upon energizing, closes a holding circuit for the relays 86 and 117 of connector P and holding winding 21 of line switch C', the former holding circuit being broken an instant later when relay 69 deenergizes. The circuit energizing relay 53 extends from ground G^{13} , through contact springs 140 and 140^a and said relay 53 to battery B. The said holding circuits for relays 86 and 117 extend from ground G^{12} through the springs 137 by way of conductor 138, wiper 36 (now resting on bank contact "O" level), side switch wiper 42 (in third position), and over the hereinbefore traced circuits through the said relays to battery B. The holding circuit for holding winding 21 of line switch C may be traced as a branch of the above circuit from wiper 42 (in third position), over conductor 90 and through the said holding winding to battery B. Another branch of the above holding circuit extends from conductor 138 through the right hand winding of relay 55 to battery. The right hand winding of relay 55 is a polarizing winding only, being made of German silver wire, and does not energize the core of relay 55 sufficient to enable it to attract its armature.

A further result of the energization of line relay 52 of repeater I is the closure of a circuit across the conductors 127 and 128 leading to the connector H in the main exchange, thus energizing the relay 129 of said connector. The energizing circuit for said relay extends from ground G^{11} , through the lower winding of relay 129, springs 130 and 131, trunk conductor 128, springs 132, impedance coil 56, left hand winding of relay 55, conductor 127, springs 133 and 134, and the upper winding of relay 129 to battery B'. The relay 129, upon energizing, closes a circuit through the slow acting relay 135. This circuit extends from ground G^{16} through springs 163 and 163^a, relay 135, to battery B'. Although both windings of the relay 55 are carrying current at this time, the said relay is not operatively energized as the windings are working in opposition to each other.

The central office apparatus is now in condition for the transmission of the second series of impulses, whereupon the dial is operated in the usual manner, opening the circuit of the line relay 52 in the repeater I twice momentarily. The slow relay 53 does not deenergize during the transmission of the impulses. Therefore the holding ground G^{12} is not removed from the conductor 138. Each time the line relay 52 deenergizes, a circuit is closed extending from ground G^{13} through contact springs 140 and

139, springs 141, and the relay 54 to battery B. The result is that the first time the relay 52 deenergizes, the relay 54 closes a direct bridge across the trunk conductors 127 and 128; and, since the said relay 54 is slow acting, it remains energized during the interruptions of its circuit by the line relay 52. A further result of the deenergization of line relay 52 is the opening of the bridge across the trunk conductors 127 and 128, therefore each time the said relay deenergizes, an impulse is repeated to the line relay 129 of connector H. The line relay 129, responding to the impulses transmitted to it by the repeater I, operates to transmit two impulses through the vertical magnet 142 in series with the relay 143. The vertical magnet operates to raise the switch shaft and wipers to a position opposite the second row or level of bank contacts. The slow relay 143 which is included in series with the vertical magnet, remains in its energized position while impulses are being transmitted through it and operates to close the circuit of the private magnet 145. After the last impulse is delivered, the relay 143 deenergizes and opens the circuit of the private magnet 145, which upon deenergizing, permits the side switch to advance from first to second position. The movement of the side switch wiper 146 from first to second position, transfers the battery connection from the vertical magnet 142 to the rotary magnet 144. The calling subscriber now operates his calling device for the last digit 0 in response to which the repeater relay 52 repeats 10 impulses to the connector line relay 129, whereupon the said connector line relay transmits ten impulses through the rotary magnet 144 in series with the relay 143, whereby the shaft wipers are rotated onto the contact of the desired line. The relay 143, operates in response to this digit in the same manner as for the previous digit to cause the private magnet 145 to advance the side switch one more step, that is, from second to third position. By the engagement of side switch wipers 147 and 148 with their third position contact points, the line connection is completed with the conductors 403 and 402 which, with the conductor 391, are connected with the individual line switch of the desired substation which is similar to the one shown in Fig. 3, it being assumed that the wires 403, 391 and 402 are joined to the wires 103, 91 and 102, respectively, for this purpose. A guarding ground potential is supplied to the connector private bank contacts of the called line, which prevents the called line from being seized by some other connector switch, and also serves to energize the cut-off relay of the called substation's line switch. By the engagement of the side switch wiper 146 with its third position contact point, the circuit of

the ringing relay 150 is closed. This circuit extends from ground G^{15} , through the interrupter 151, ringing relay 150, springs 152, and the side switch wiper 146 (in third position) to battery B'. The ringing relay, upon energizing, disconnects the calling line from the called line and bridges the ringing current generator R' across the called line to signal the called subscriber. The ringing relay is energized intermittently through the medium of the interrupter 151. Upon the response of the called subscriber his line is provided with talking current, through the windings of the back bridge relay 153, which relay, upon energizing, closes the circuit of the ring cut-off relay 154. The said circuit extends from ground G^{15} through the side switch wiper 155 (in third position), by way of contact springs 156 and the said relay 154 to battery B'. The relay 154, upon energizing, opens the circuit of the ringing relay 150 at the springs 152 and closes a locking circuit for itself through the springs 157 independent of the springs 156. The circuit thus formed extends from ground G^{15} through side switch wiper 155 (in third position), springs 157, and the said relay 154 to battery B'. A further result of the energization of the back bridge relay 153 upon the response of the called subscriber is the transposition of the battery connections of the windings of the line relay 129 with regard to the battery B', whereby the direction of the current in the trunk lines 127 and 128 is reversed. The reversing of the current over the trunk conductors 127 and 128 reverses the direction of the current flow in the left hand winding of relay 55 of repeater I, whereupon the said relay energizes. The relay 55, upon energizing, reverses the flow of current over the calling line, whereupon the change of direction of current through the coils 11 and 12 of the substation A causes the armature 160 to be tilted in the opposite direction. The lever 66, by its engagement with the lug 67 of the arm 68, operates to carry said arm into the slot of the coin chute (not shown) and to close the contacts of springs 13, 14 and 15, which, as has been stated previously, short circuit the transmitter 3 and shunt the receiver 2, thereby rendering the substation A inoperative for talking purposes. This condition is maintained until the calling party drops a coin into the chute, the weight of which coin will knock the lug 67 out of engagement with the lever 66 and restore the transmitter and receiver to their normal condition.

After the conversation is completed, the connection is released in the following manner: When the receiver at the substation A is restored to the switch hook, the separation of the hook springs opens the energizing circuit of the line relay 52 of repeater

I, which, upon deenergizing, opens the circuit of the line relay 129 of connector H and relay 53 of repeater I. The line relay or connector H, upon deenergizing, opens the circuit of relay 135, which upon deenergizing, closes the circuit of the release magnet 162. The said circuit extends from ground G^{16} through contact springs 163 and 164, springs 165 and 166, off normal springs 167 and release magnet 162 to battery B' . The magnet 162, upon energizing, restores the switch shaft and side switch wipers to normal position after which its own circuit is broken at the springs 167 when the shaft reaches its lowest position. The relay 53, of repeater I, upon deenergizing, removes the ground G^{12} from the conductor 138 allowing the connector P and the line switch C to release in the hereinbefore described manner.

If the number called is busy, there will be a guarding potential upon the connector private bank contact, just as explained in connection with the line switch C. When the slow-acting relay 143 deenergizes at the end of the last series of impulses, the connector private wiper 168, by its engagement with this guarding contact, completes an energizing circuit through the busy relay 173. This circuit extends from the ground at the private bank contact, private wiper, side switch wiper 155, (in second position), springs 176 and 177, relay 173, springs 179 and 180, and the private magnet 145 to battery B' . The private magnet thus holds the side switch in second position and holds the line circuit open to the called line. The relay 173, upon energizing, opens the circuit of the rotary magnet at the springs 178 and forms a locking circuit for itself and private magnet 145 through springs 175 and 177 and off normal springs 167^a independent of the ground upon the said private bank contact. Also, by closing contact springs 174, the busy relay connects a tone from the busy machine Q' with one side of the calling line (side switch lever 148 being in its second position) whereby the calling subscriber is informed that the called line is busy. The calling subscriber upon receiving the busy signal, hangs the receiver upon the hook, thereby releasing the connection in the manner above described.

Whenever a telephone is removed from service, or temporarily disconnected for any reason, the lines leading to the central exchange are disconnected and the connector bank contacts are connected to the conductors 61 and 60 (as the connector bank contacts 171 and 172 are shown connected in Fig. 4). The conductors 61 and 60 terminate in a key K^3 situated at an information desk or manual operator's board. It will now be explained how the subscriber at substation A, in attempting to call a substation

whose telephone has been disconnected, will effect connection with the operator at the said manual board and receive the necessary information, without having to deposit a coin in the coin collecting device.

The calling subscriber operates the connector H to cause the line wipers 170 and 169 to make connection with the bank contacts 171 and 172. The upper winding of relay 185^a is normally bridged across the conductors 61 and 60, therefore as soon as the connector wipers land on the contacts 171 and 172 the said relay energizes in series with the back bridge relay 153. The relay 153 reverses the battery upon the calling line in the same manner as hereinbefore described but the calling subscriber does not deposit his coin because he has not yet heard the called subscriber answer by giving his name or number. The relay 185^a, upon energizing, closes a circuit through the signal lamp 186. This circuit extends from ground G^{17} , through contact 187, contact 188 and armature 189 and the said lamp to battery B' . The operator immediately answers by throwing key K^3 which bridges her head set (not shown) across the conductors 61 and 60 in series with the condenser 193 and closes a circuit through the relay 191. This latter circuit extends from ground G^{18} through the springs 194 and the said relay to battery B' . The relay 191 upon energizing, closes a locking circuit for itself and removes the shunt from around the lower winding of relay 185^a at the springs 192. The two windings of relay 185^a are now connected in series across the trunk conductors 61 and 60. The lower winding of relay 185^a is of sufficiently high resistance to cause the back bridge relay 153 to deenergize and reverse the battery upon the calling line back to normal, whereby the substation A is again rendered operative for talking purposes without the necessity of depositing a coin. The operator now gives the calling subscriber the necessary information, whereupon the connection is released as hereinbefore described by the calling subscriber replacing his receiver upon his receiver hook.

If the calling substation A desired to call the individual substation U, which substation is intended to be accessible without charge to all subscribers, the apparatus is operated in the same manner as hereinbefore explained. The connector H, upon completing connection to the substation U through the medium of bank contacts 501 and 502 and conductors 220 and 221, signals the subscriber at substation U, who upon answering, causes the switch hook 223 to close springs 224 for a long enough period of time to cause the back-bridge relay 153 to pull up and energize the ring cut-off relay 154. The said springs then separate and the resistance 225 is cut in series with the back-

bridge relay 153, thereby causing it to fall back and reverse the flow of current back to normal on the calling line. It follows that the subscribers at substation A and substation U may now converse without requiring the subscriber at substation A to deposit a coin.

While I have shown and explained in the foregoing a certain specific embodiment of the various features of my invention, I do not wish to be held strictly to the exact forms shown herein, for different adaptations will no doubt present themselves to persons skilled in the art. I desire, therefore, to include and have protected by Letters Patent all modifications of my invention which may come within the scope of the appended claims.

What I claim as my invention is:

1. In a telephone system, a subscriber's station and a line therefor, a device for rendering said station inoperative for talking purposes, a trunk line, means for connecting said line and said trunk line, means included in said connecting means for operating said device, means included in said trunk line whereby said operating means is rendered effective, means for completing a talking connection over said trunk line, and means included in said trunk line whereby said operating means is rendered ineffective without destroying said talking connection.

2. In a telephone system, a subscriber's station and a line therefor, a device for rendering said station inoperative for talking purposes, an automatic switch accessible to said line, means included in said switch for operating said device, a trunk line accessible to said switch, means whereby said operating means is rendered effective upon the connection of said switch with said trunk line, means for completing a talking connection over said trunk line, and means whereby said operating means is rendered ineffective without destroying said talking connection.

3. In a telephone system, a subscriber's station and a line therefor, a device for rendering said station inoperative for talking purposes, a trunk line extending to an operator's position, means for connecting said line and said trunk line, means included in said connecting means for operating said device, means included in said trunk line whereby said operating means is rendered effective, means for completing a talking connection over said trunk line, and manually controlled means included in said trunk line whereby said operating means is rendered ineffective without destroying said talking connection.

4. In a telephone system, a subscriber's station and a line therefor, a device for rendering said station inoperative for talking purposes, an automatic switch accessible to said line, means included in said switch for operating said device, a trunk line accessible

to said switch and extending to an operator's position, means whereby said operating means is rendered effective upon the connection of said switch with said trunk line, means for completing a talking connection over said trunk line, and manually controlled means whereby said operating means is rendered ineffective without destroying said talking connection.

5. In a telephone system, a subscriber's station and a line therefor, a reverse current controlled device for rendering said station inoperative for talking purposes, an automatic switch accessible to said line, a source of current for said line controlled by said switch, means included in said switch for reversing the direction of current flow in said line, a trunk line accessible to said switch, means whereby said reversing means is rendered effective upon the connection of said switch with said trunk line, means for completing a talking connection over said trunk line, and means whereby said reversing means is rendered ineffective without destroying said talking connection.

6. In a telephone system, a subscriber's station and a line therefor, a reverse current controlled device for rendering said station inoperative for talking purposes, an automatic switch accessible to said line, a source of current for said line controlled by said switch, means included in said switch for reversing the direction of current flow in said line, a trunk line accessible to said switch extending to an operator's position, means whereby said reversing means is rendered effective upon the connection of said switch with said trunk line, means for completing a talking connection over said trunk line, and manually controlled means whereby said reversing means is rendered ineffective without destroying said talking connection.

7. In a telephone system, a subscriber's station and a line therefor, a reverse current controlled device for rendering said station inoperative for talking purposes, an automatic switch accessible to said line, a source of current for said line controlled by said switch, a back bridge relay in said switch for reversing the direction of current flow in said line, a trunk line accessible to said switch, means whereby upon the connection of said switch with said trunk line, a circuit including said trunk line is established for said relay, and means associated with said trunk line for increasing the resistance of said trunk line to make said relay inoperative.

8. In a telephone system, a subscriber's station and a line therefor, a reverse current controlled device for rendering said station inoperative for talking purposes, an automatic switch accessible to said line and

extending to an operator's position, a source of current for said line controlled by said switch, a back bridge relay in said switch for reversing the direction of current flow in said line, a trunk line accessible to said switch, means whereby, upon the connection of said switch with said trunk line, a circuit including said trunk line is established for said relay, and manually controlled means associated with said trunk line for increasing the resistance of said trunk line to make said relay inoperative.

9. In a telephone system a subscriber's station and a line therefor, a device for rendering said station inoperative for talking purposes, a second subscriber's station and a line therefor, means for completing a connection between said lines, means included in said connecting means for operating said device, means associated with said second station whereby said operating means is made effective, means for completing a talking circuit through said second station, and means included in said talking circuit whereby said operating means is rendered ineffective without destroying said circuit.

10. In a telephone system, a subscriber's station and a line therefor, a device for rendering said station inoperative for talking purposes, a second station and a line therefor, an automatic switch for connecting said lines, means included in said switch for operating said device, means associated with said second station whereby said operating means is made effective, means for completing a talking circuit through said second station, and means included in said talking circuit whereby said operating means is rendered ineffective without destroying said circuit.

11. In a telephone system, a subscriber's station and a line therefor, a reverse current controlled device for rendering said station inoperative for talking purposes, a second subscriber's station and a line therefor, a source of current for said lines, means for completing a connection between said lines, means included in said connecting means for reversing the direction of current flow in said first line, means associated with said second station whereby said reversing means is made effective, means for completing a talking circuit through said second station, and means included in said talking circuit whereby said reversing means is rendered ineffective without destroying said circuit.

12. In a telephone system, a subscriber's station and a line therefor, a reverse current controlled device for rendering said station inoperative for talking purposes, a second station and a line therefor, a source of current for said lines, an automatic switch for connecting said lines, means included in said switch for reversing the direction of cur-

rent flow in said first line; means associated with said second station whereby said reversing means is made effective, means for completing a talking circuit through said second station and means included in said talking circuit whereby said reversing means is rendered ineffective without destroying said circuit.

13. In a telephone system, a subscriber's station and a line therefor, a reverse current controlled device for rendering said station inoperative for talking purposes, a second station and a line therefor, a source of current for said lines, an automatic switch for connecting said lines, a back-bridge relay in said switch for reversing the direction of current flow in said first line, means associated with said second station whereby, after the completion of said connection, an operating circuit may be momentarily established for said relay, and means included in said second station for completing a talking circuit therethrough without operating said relay.

14. In a telephone system, a subscriber's station and a line therefor, a reverse current controlled device for rendering said station inoperative for talking purposes, an automatic switch accessible to said line, a source of current for said line controlled by said switch, a back bridge relay in said switch for reversing the direction of current flow in said line, signaling apparatus in said switch controlled by said relay, a trunk line accessible to said switch, means whereby upon the connection of said switch with said trunk line, a circuit including said trunk line is established for said relay to disconnect said signaling apparatus, and means associated with said trunk line for increasing the resistance of said trunk line to make said relay inoperative.

15. In a telephone system, the combination of a first circuit, a source of current therefor, a device electrically related to said circuit, a first switch, a first magnet in said first circuit for controlling said first switch, a second switch, a second circuit, a second magnet in said second circuit for controlling said second switch, a third switch for closing said second circuit for energizing said second magnet to operate said second switch to change the character of the current in the first circuit to operate said first switch through the medium of its controlling magnet to change the electrical relation of said device to said first circuit, and means for controlling said second circuit without interrupting the same to restore the current in the first circuit to its original character thereafter, whereby the first magnet is operated to restore the original electrical relation of said device to said first circuit.

16. In a telephone system, the combination of a first circuit, a source of current

therefor, a device electrically related to said circuit, a first switch, a first magnet in said first circuit for controlling said first switch, a second switch, a second circuit, a second magnet in said second circuit for controlling said second switch, a third switch for closing said second circuit for energizing said second magnet to operate said second switch to change the character of the current in the first circuit to operate said first switch through the medium of its controlling magnet to change the electrical relation of said device to said first circuit, a device electrically related to said second circuit and means for controlling said second circuit without interrupting the same to restore the current in the first circuit to its original character thereafter, whereby the first magnet is operated to restore the original electrical relation of said device to said first circuit whereby communication may be had between the two devices.

17. In a telephone system, the combination with a first circuit, a telephone instrument electrically related thereto; and a magnet in said first circuit for changing said electrical relation, of a second circuit, a source of current for said circuits, a second magnet in said second circuit for altering the character of current flow in said first circuit to operate the magnet included therein, means for closing said second circuit to operate the said second magnet, and means for controlling said second circuit without interrupting the same to render the said second magnet inoperative, whereby the electrical relation between the first circuit and said telephone instrument is first changed and then restored to its original condition.

18. In a telephone system, the combination with a first circuit, a telephone instrument electrically related thereto, and a magnet

in said first circuit for changing said electrical relation, of a second circuit inductively related to said first circuit, a source of current for said circuits, a second magnet in said second circuit for altering the character of current flow in said first circuit to operate the magnet included therein, means for closing said second circuit to operate the said second magnet, a second telephone instrument and means for associating said instrument with said second circuit, and means for controlling said second circuit without interrupting the same to render the said second magnet inoperative, whereby the electrical relation between the first circuit and said telephone instrument is first changed and then restored to its original condition to enable conversation to be held between said telephone instruments.

19. In a telephone system, a pair of subscribers' stations and lines therefor, means for connecting said lines, condensers normally in series with said stations, a source of signaling current, a source of direct current, means for intermittently completing a signaling circuit including said current sources and the called one of said lines all in series, a controlling relay for said last means included in said circuit, said relay being irresponsive to said signaling current, a second relay for initially controlling said controlling relay, said second relay being in series with the called one of said lines and said direct current source between signals, and means for completing a path for direct current through said called substation for operating said controlling relay during signals and for operating said second relay between signals.

Signed by me at Chicago, Cook county, Illinois, this 31st day of January, 1915.
TALBOT G. MARTIN.