

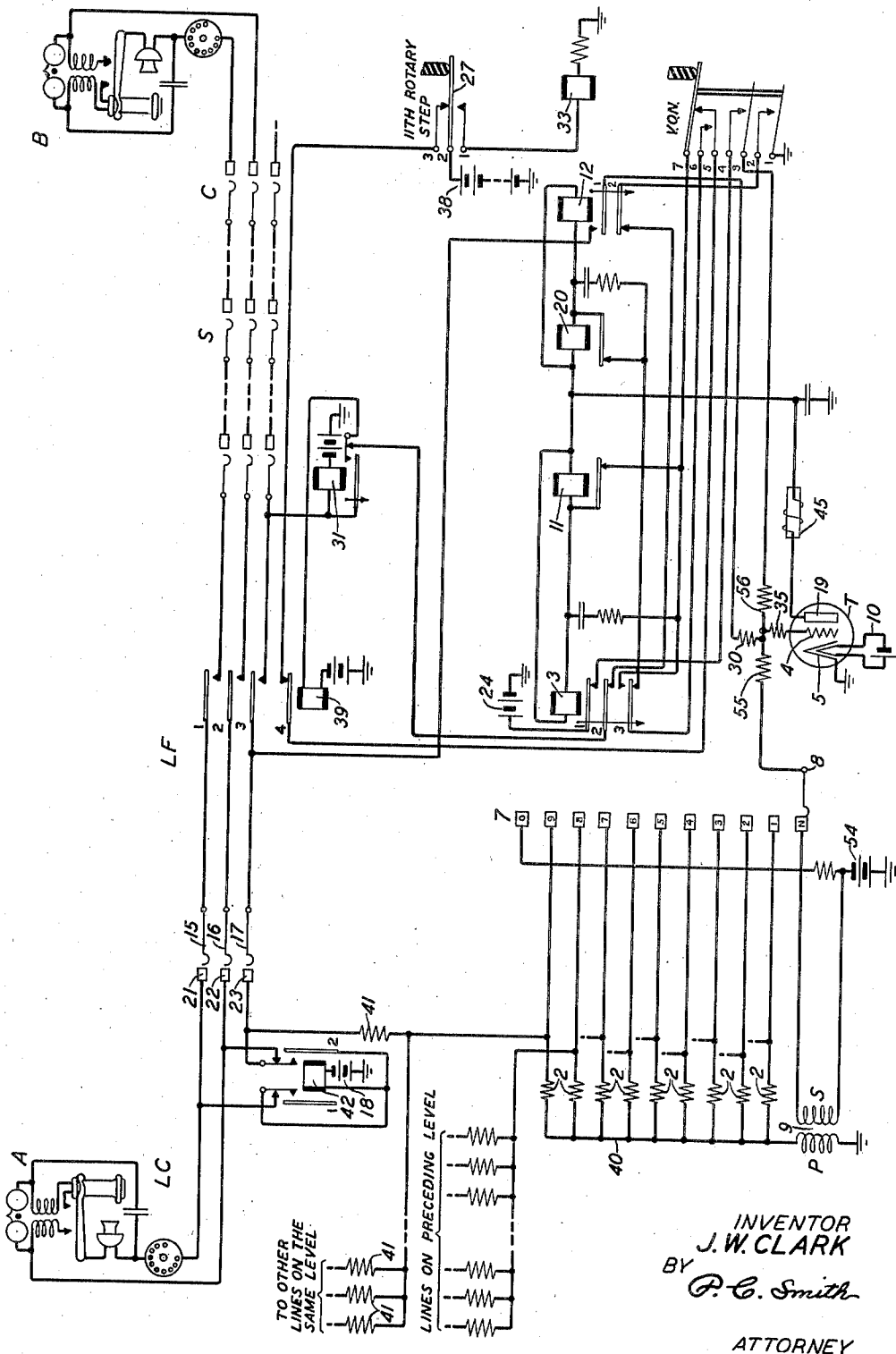
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TELEPHONE SYSTEM

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## TELEPHONE SYSTEM

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This invention relates to telephone systems and particularly to those systems in which automatic switches are used for establishing connections.

The object of the invention is to eliminate some of the individual equipment usually provided for subscribers' lines, especially the line relays.

It has been proposed heretofore to eliminate the individual line relays and to replace them by a relay mechanism common to a group of lines. To accomplish this, however, it has been necessary to provide an auxiliary switching mechanism for associating the common relay mechanism with any one of the lines when calling.

It has also been proposed to use a vacuum tube in common to a group of lines the control element of which is connected through individual resistances to the respective subscribers' lines, thus doing away with the individual line relays, and to utilize the vacuum tube as the signaling means for starting the line-finder switch that is to be used for connecting with the terminals of the calling line. An arrangement of this kind, however, is subject to false operation due to the combined effect of several line leaks, and further does not lend itself readily to a line terminal test which is sufficiently positive and reliable to enable the line finder to distinguish and seize the particular calling line in the group that is calling.

According to one feature of the present invention these difficulties are overcome by the use of a gaseous conductor tube device having a single control electrode which is inductively coupled to the groups of lines and to each of the individual lines through a resistance network connecting all groups and all lines whereby the initiation of a call by a line produces an impulse that momentarily alters the normally negative bias of the control electrode so as to render the tube conducting to establish an anode-cathode circuit there-through which will supply driving battery for one of the driving magnets of the switch.

Another feature of the present invention is a resistance network comprising a resistor for each group of lines and a resistor for each line. The group resistor is connected to the terminal which marks the line group level in which the individual lines of the group terminate and the individual resistor is connected to one of the terminals of the set reserved for a line. The function of this network, when a line in any group initiates a call, is to maintain each of the group marking terminals below the level containing the calling line and each of the line terminals preceding the terminal of the calling line, at a positive potential and the terminal of the wanted level and that of

the calling line in the level at a negative potential. Since the control electrode of the tube is arranged for connection with each level terminal and each line terminal traversed by the connecting elements of a hunting switch adapted for hunting over said terminals, and since the cathode-anode circuit of the tube, when conducting, supplies current in succession to each of the driving magnets of the switch it is obvious that the terminals at positive potential will render the tube continuously conducting until a terminal at negative potential is encountered whereupon the tube is extinguished to halt further driving operations.

Another feature of the invention is a novel circuit arrangement for supplying the control element of the tube with positive potential to render it once more conducting after it has been rendered non-conducting by the negative potential at the wanted group level, whereby switch driving operations are then resumed to cause the connecting element of the switch to selectively step over the normal or busy line terminals in the wanted level maintained at positive potential, in quest once more of a negative potential which, in this case, marks the calling line.

The foregoing and other features of the invention will be described in detail in the following specification, which should be read in conjunction with the attached drawing and accompanying claims.

The drawing represents, schematically, a telephone system in which the features of the invention are embodied in a circuit structure that makes use of automatic switches of the well-known two-motion step-by-step type. It is understood, however, that the embodiment of the invention as herein set forth is given by way of illustration only, and that the invention may be readily applied to other types of automatic or semi-automatic telephone systems.

Referring to the drawing, there are shown two subscriber stations, namely, a calling station A and a called station B, a line circuit LC associated with station A, a line-finder switch LF, a selector switch S and a connector switch C.

The subscribers' stations A and B are each provided with the usual subscriber's set which is equipped with a dial for controlling the establishment of the desired connections. The selector switch S and the connector switch C are of the well-known step-by-step or Strowger type. Inasmuch as the construction and operation of these switches form no part of the present invention they are but schematically shown, and reference may be had to pages 53 to 67, inclusive, of

the second edition of "Automatic Telephony" by Smith and Campbell for a detailed description of the operation of the circuits associated with these switches.

The line circuit LC and the line-finder switch LF are shown in detail since the features of the invention apply specifically to these circuits. The heater type gaseous discharge tube T is a part of the line-finder switch equipment, and is of the type which breaks down and becomes conducting when the potential of its control electrode becomes more positive than a critical value with respect to the potential of its associated cathode, and can be extinguished when the potential of the control electrode becomes sufficiently negative with respect to the anode potential or when the anode circuit is opened. The tube is associated with the lines terminating on the terminal bank of said switch through control electrode 4 which is connected to the commutator brush 8. The commutator 7 engaged by brush 8, has eleven segments, a normal segment N and ten other segments one for each level of lines. Connected to each of the first nine segments 1-9 is a group resistor 2, one for each level, and to each group resistor there are paralleled as many individual line resistors 41 as there are subscriber lines in the level served by the group resistor. One terminal of each individual line resistor is connected to a contact of the subscriber's cut-off relay 42 while corresponding terminals of all the group resistors are connected together through conductor 40 to one side of the primary winding P of transformer 9. The secondary winding S of said transformer is connected to the normal segment at one end and to a source of negative battery 54 at the other.

Each line circuit connects to a set of three terminals appearing in the terminal banks accessible to a group of line-finder switches, as indicated by the individual line circuit LC which connects to terminals 21, 22 and 23. The line-finder switch LF is of the well-known step-by-step type provided with a bank of one hundred sets of terminals typically represented by the set of terminals 21, 22 and 23. The terminal sets are arranged in ten horizontal levels, one above the other, each level consisting of ten horizontal terminal sets selectable by brushes 15, 16, 17. These brushes, as well as brush 8, are carried on a common shaft (not shown) which is advanced vertically to the proper terminal level under the control of vertical magnet 11, which controls vertical stepping, and then horizontally to the terminals of the calling line under control of the horizontal magnet 20, which controls horizontal stepping. The line finder is provided with a vertical commutator 7 which, as said before, has eleven conducting segments, one for each horizontal level. Associated with this commutator is a brush 8 which, also as stated before, is mounted upon the common brush shaft and advances simultaneously with brushes 15, 16 and 17, inclusive, during vertical stepping to engage the successive segments of the commutator. When the brush shaft is in the normal position, brush 8 is in engagement with the normal segment N of the vertical commutator.

The operations of the circuits controlling the setting up of a connection will now be fully set forth in detail in the following description of a call initiated from station A for termination at station B.

When, to originate a call, the receiver is re-

moved from the switchhook at station A, a circuit is completed from ground through the primary winding P of transformer 9, conductor 40, group resistor 2, individual line resistor 41, No. 2 normal contacts of cut-off relay 42, over the loop of subscriber's station A, No. 1 normally made contacts of relay 42, winding of said relay to negative battery 18. During the build-up of current in this path, a momentary surge of potential is induced in the circuit of the secondary winding S of transformer 9, which circuit traces from negative battery 54 through the secondary winding S of transformer 9, normal segment N and brush 8 of the line-finder switch, resistances 55 and 35, grid 4, to ground on the heated filament 5 of tube T. Relay 42 does not operate in this circuit.

It will be observed that control electrode 4 is joined to the mid-point of resistances 55 and 56 through resistance 35. Hence when the surge of potential is induced into the above-traced secondary circuit of the transformer, the potential of electrode 4 is raised to the flash-point of the tube, overriding the normal negative bias of battery 54. Since the cathode 5 is rendered emitting by virtue of the filament heating battery 10, the tube will break down between control electrode 4 and cathode 5, after which a current is established between cathode 5 and anode 19 over the following path: ground at the cathode 5, anode 19, winding of retard coil 45, winding and interrupter contacts of vertical magnet 11 in parallel with the winding of slow-release relay 3, No. 7 and No. 5 normally made contacts of vertical off-normal springs VON, No. 4 contacts of relay 39, No. 3 and No. 2 contacts of the rotary spring contacts 27 which make contact as shown except when the brush shaft is stepped beyond the tenth set of terminals in any horizontal level of terminals, at which time contacts 3 and 2 break and contacts 1 and 2 make, to positive battery 38.

Assume that terminals 21, 22 and 23, associated with the line circuit LC of calling station A are the fifth set of terminals in the ninth level of the bank of terminals of the line-finder switch. Vertical magnet 11 operates in the circuit just traced and lifts the brush shaft one vertical step to the first level of terminals, breaks its own interrupter contacts which, in turn, open the driving circuit of the magnet, extinguishes the tube T, and lifts the brush shaft one terminal level thereby causing the vertical off-normal springs VON to be operated. With the breaking of its own interrupter contacts, vertical magnet 11 releases but relay 3, being slow-release, does not.

When brush 8 engages segment 1, the positive terminal of battery 18 through the primary winding P of transformer 9 is connected to the grid 4 of the tube via the group resistor 2 for the first level, segment 1 and brush 8, resistance 55 and resistance 35. Inasmuch as the tube was extinguished by the interruption of the anode circuit at the time the vertical magnet opened its own contacts, the tube is again made conducting by the connection of the above traced positive potential through the primary winding of transformer 9 to the grid of the tube, whereupon a self-interrupted drive circuit is closed from the tube anode, the winding of the magnet 11, and its interrupter contacts, No. 3 front contacts of relay 3, No. 6 and No. 5 contacts of the off-normal springs VON, to the aforetraced positive battery 38. It should be observed, in this connection, that relay 3 operates before the vertical off-nor-

mal springs VON operate and that, with respect to said off-normal springs, contact No. 6 makes with contact No. 5 before contact No. 7 breaks with contact No. 5. Vertical magnet 11 now operates again, causing the brush shaft to take another vertical step after which it will release again through the breaking of its own interrupter contacts, the tube T being again rendered non-conducting by the opening of the anode circuit. The circuit of relay 3, being likewise controlled through these interrupter contacts will also be opened, but since this relay is of the slow-to-release type, it will hold up between vertical steps. On the second vertical step, the tube will again be rendered conducting by the connection of the positive terminal of battery 18 to the grid via the second group resistor 2. The vertical magnet drive circuit, therefore, will be again completed to step the brush shaft to the third level of terminals. These operations and circuit interruptions will continue until the shaft has been lifted to the ninth terminal level in which the calling line is located.

At the ninth level, brush 8 will engage segment 9 of the commutator 7, and it will be observed that on this segment the previously traced positive battery is similarly applied to the grid via group resistor 2 allocated to the ninth level. However, the value of the potential at the grid is now reduced by the additional IR drop through the individual line resistor 41 traced through the winding of cut-off relay 42 to the negative battery 18. The value of this drop in potential is such that, when applied to the control electrode 4 through resistances 55 and 35, it renders said control electrode negative and causes the space discharge cathode-anode circuit to be disrupted, thereby causing the vertical magnet 11 to take no more additional steps and causing relay 3 to release.

The release of relay 3 transfers the cathode-anode driving circuit from the vertical magnet 11 to rotary magnet 20 and the paralleled slow-to-release relay 12 via its No. 3 back contacts. Positive battery from source 24 over the No. 1 contact of relay 3 is further applied to the control electrode 4 via the No. 2 and No. 3 VON contacts, resistance 56 and resistance 35. This overcomes the negative potential applied to the control electrode through the commutator segment 9 and tube T again becomes conducting, thereby causing the rotary magnet 20 to take one step, brush 8 to become disengaged from commutator segment 9 and brushes 15 to 17 to engage the first set of terminals on their corresponding levels.

When the magnet 20 recloses its interrupter contacts the previously traced anode path of the tube to positive battery 38 is reestablished and since biasing battery 24 is still connected to the grid via its aforetraced circuit, the tube is rendered conducting, completing thereby the cathode-anode circuit of the rotary magnet which operates and causes the brush shaft to take another step. These operations continue until the brush set 15-17 reaches the fifth set of terminals which are assumed to be connected to the conductors of station A. Brush 17, in engaging terminal 23 of lines previous to line A whether idle or busy by virtue of established connections, will cause positive potential through the primary winding P of transformer 9 and individual line resistors 41 to be connected to the grid 4 via the No. 1 contacts of relay 12 and

resistance 30. This, however, will not interfere with the conductivity of the tube since its only effect is to reinforce the positive potential on the grid thereof from positive battery source 24.

Terminal 23 of the calling line is, however, at a negative potential due to the connection of negative battery 18 through the winding of cut-off relay 42 to terminal 23 via the line loop and the normal contacts of said relay so that, when brush 17 engages this terminal, the negative potential is applied to resistance 30 over a previously traced path and thence to grid 4 via resistance 35. The ohmic values of resistances 30 and 56 are such that the potential produced at the terminal of resistance 35 when current is flowing through resistance 56 from positive battery 24 and current is flowing through resistance 30 from the aforetraced negative battery 18, is sufficiently negative to cause the tube to become extinguished. Magnet 20 releases and, after an interval, relay 12 also releases, the latter opening the grid test circuit to brush 17. A circuit is now completed for relay 39 which extends from battery through the winding of said relay, normal contacts of relay 31, No. 2 contacts of relay 3, No. 2 contacts of relay 12, No. 2 and No. 1 contacts of vertical off-normal springs VON to ground. Relay 39 operates, opens the anode battery 38 at its No. 4 contacts and completes the connection from brush wipers 15, 16, 17 to the circuits extending to the selector S. As the wipers 15, 16 now engage the calling line circuit, a relay (not shown) in selector S will operate, causing thereby the connection of ground on the sleeve wiper thereof which extends back to brush wiper 17. Relay 31 operates in a circuit completed to said ground and, in operating, transfers the holding circuit of relay 39 to said ground. Cut-off relay 42 also operates to ground on the sleeve conductor in selector S and will lock thereto over its No. 2 operated contacts. In so doing, it disconnects the line sleeve from line resistor 41 and the line conductors from battery 18. The calling line A is now cut through to the selector S, and the motion of this switch as well as that of connector C is now controlled by dial pulses in the well-known manner.

When the line finder is to be released subsequent to the termination of the connection, the release of the supervisory relay (not shown) in the connector C opens the ground on the sleeve conductor, causing relays 42 and 39 to release. The circuit of relay 31 is also opened, but since this relay is slow-to-release it remains in an operated position for an interval, whereupon immediately upon the release of relay 39 tube T is rendered conducting by positive battery 24 being connected to the grid over a previously traced path, the anode circuit of the tube being completed to positive battery 38 via the winding of rotary magnet 20 and paralleled relay 12. The brush shaft now takes six rotary steps to drive the brush wipers off the tenth set of terminals whereupon springs 27 are operated to close an obvious circuit for release magnet 33 which operates. Magnet 33 restores the brush shaft to normal after which the vertical off-normal springs are restored and the tube is reset.

While I have described my invention in connection with a specific application thereof to a known type of switch structure, it is to be understood that various other applications and embodiments thereof may be made by those skilled

in the art without departing from the spirit of the invention as defined within the scope of the appended claims.

What is claimed is:

1. In a telephone system, a line-finder switch having a number of fixed terminals divided into groups, a separate terminal for each group, a line appearing on each of said fixed terminals, a test brush for engaging said terminals, a thermionic device for controlling the movement of said brush, and a resistance network for said lines comprising a line resistance connected to each line terminal, a group resistance connected to each group terminal and common to the line resistances of the associated group and to all other group resistances, a source of positive potential connected to said group resistances, a source of negative potential, and means responsive to one of said lines initiating a call for combining said two sources of potential to produce a negative potential on the group terminal of the group containing the calling line and on the terminal of said line, whereby upon the connection of said brush with said group terminal and with said line terminal, respectively and successively, said thermionic device responds to stop said brush on each of said terminals.
2. In a telephone system, a line-finder switch having a bank of fixed terminals, lines appearing on said terminals, each of said lines being adapted to connect a negative potential to its associated terminal when it initiates a call, a test brush for engaging said terminals, a stepping magnet for advancing said test brush over the contacts of said bank, and a thermionic device for testing the idle or busy condition of said terminals and for supplying current to said magnet comprising a control electrode connected to said brush, another electrode connected to said magnet, said device being arranged to permit or prevent the flow of current therethrough according to whether positive or negative potential is applied to said control electrode, and means for rendering said control electrode initially positive to operate said device when one of said lines initiates a call.
3. In a telephone system, a line-finder switch having a bank of fixed terminals, lines appearing in said terminals, a test brush for engaging said terminals, means for placing a negative potential on the terminals of a line when an associated line is calling, a stepping magnet for advancing said test brush over the contacts of said bank, a gas-filled tube having a control electrode and a pair of other electrodes adapted to permit or prevent the passage of current therethrough according to whether positive or negative potential is applied to said control electrode, means for including said control electrode in circuit with said testing brush and means for

including one electrode of said pair of electrodes in circuit with said stepping magnet.

4. In a telephone system, a plurality of lines terminating respectively in the terminal sets of a line-finder bank, said terminal sets being divided into groups, a group terminal for each group of line terminal sets, a source of negative potential connected to one terminal of each terminal set, a first resistance connected between each of the other or line test terminals of each terminal set and the associated group terminal, a source of positive potential, a second resistance connected between each of said group terminals and said source of positive potential, a line-finder having a group testing brush and a line terminal testing brush, means for successively advancing said brushes in their testing movements, a thermionic device for controlling said advancing means, and means responsive to the closure of a line loop for connecting said sources of potential in series through a first resistance individual to said calling line group whereby negative test potential is applied to the individual test terminal and to the group test terminal of said line for controlling said thermionic device.

5. In a telephone system, a hunting switch provided with a magnet, a gas-filled thermionic device and a resistance network for the terminals of said hunting switch adapted to be set by said magnet operatively responsive to the conductive condition of said gas-filled thermionic device whereby the resistance of said network connected to the unwanted terminals of said switch maintains said device in a conductive condition to operate said magnet and whereby the resistance connected to a wanted terminal renders said thermionic device non-conducting to arrest the operation of said magnet.

6. In a telephone system, the combination with a group of lines divided into subgroups, each subgroup terminating on a different terminal level of a line-finder frame, a thermionic device and a line-finder switch accessible thereto having a vertical and a horizontal magnet operatively controlled by said thermionic device, of a resistance network to control said device comprising a resistor for each level and a resistance for each line whereby when a line in said group initiates a call the group resistor of each level preceding the level of the calling line is adapted to render said device effective to maintain an operating circuit for said vertical magnet and the line resistances of the lines in the group preceding the calling line are adapted to render said device effective to maintain an operating circuit for said horizontal magnet.

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