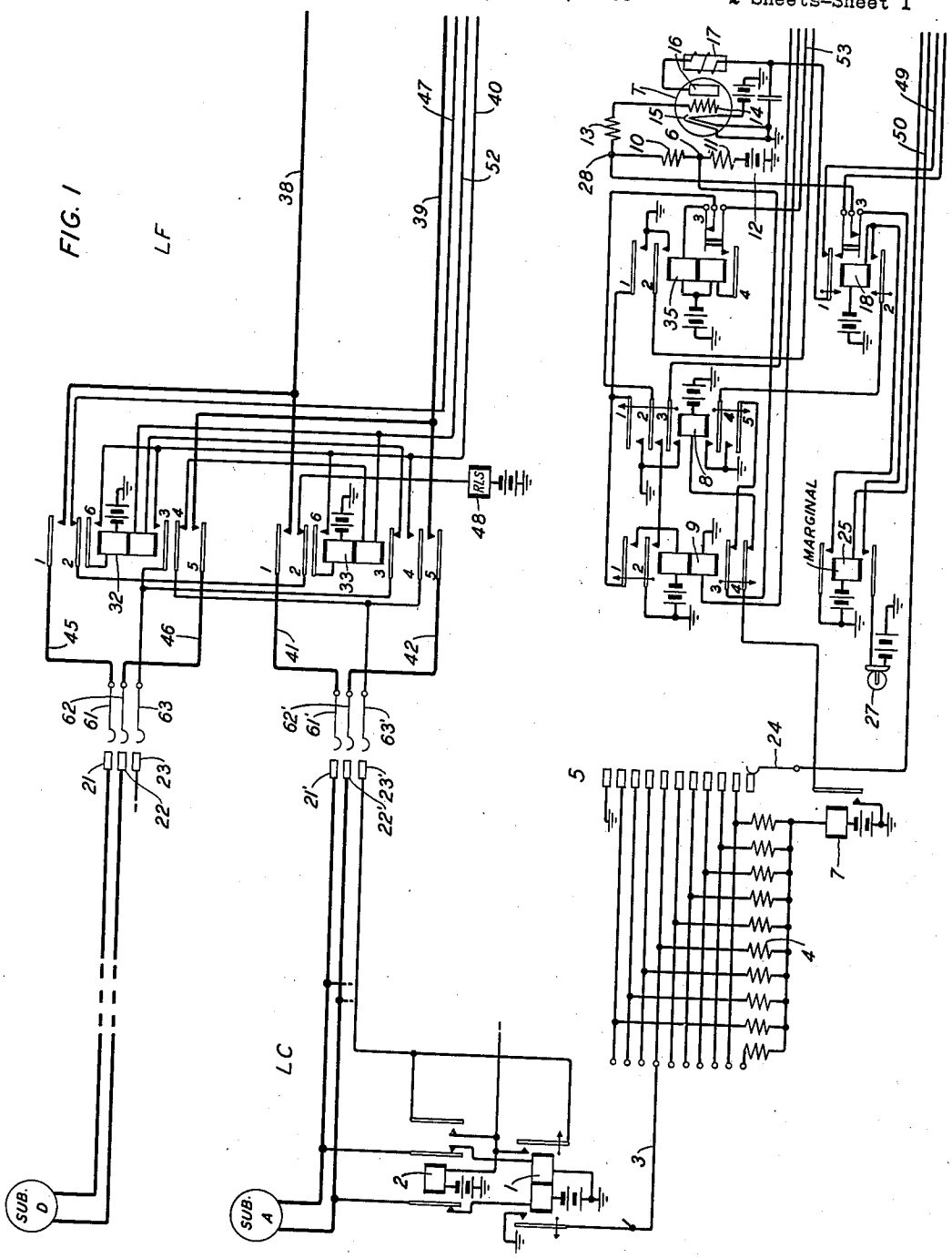
May 20, 1941. J. W. CLARK ET AL 2,242,776

TELEPHONE SYSTEM

Filed April 25, 1939 2 Sheets-Sheet 1

FIG. 1



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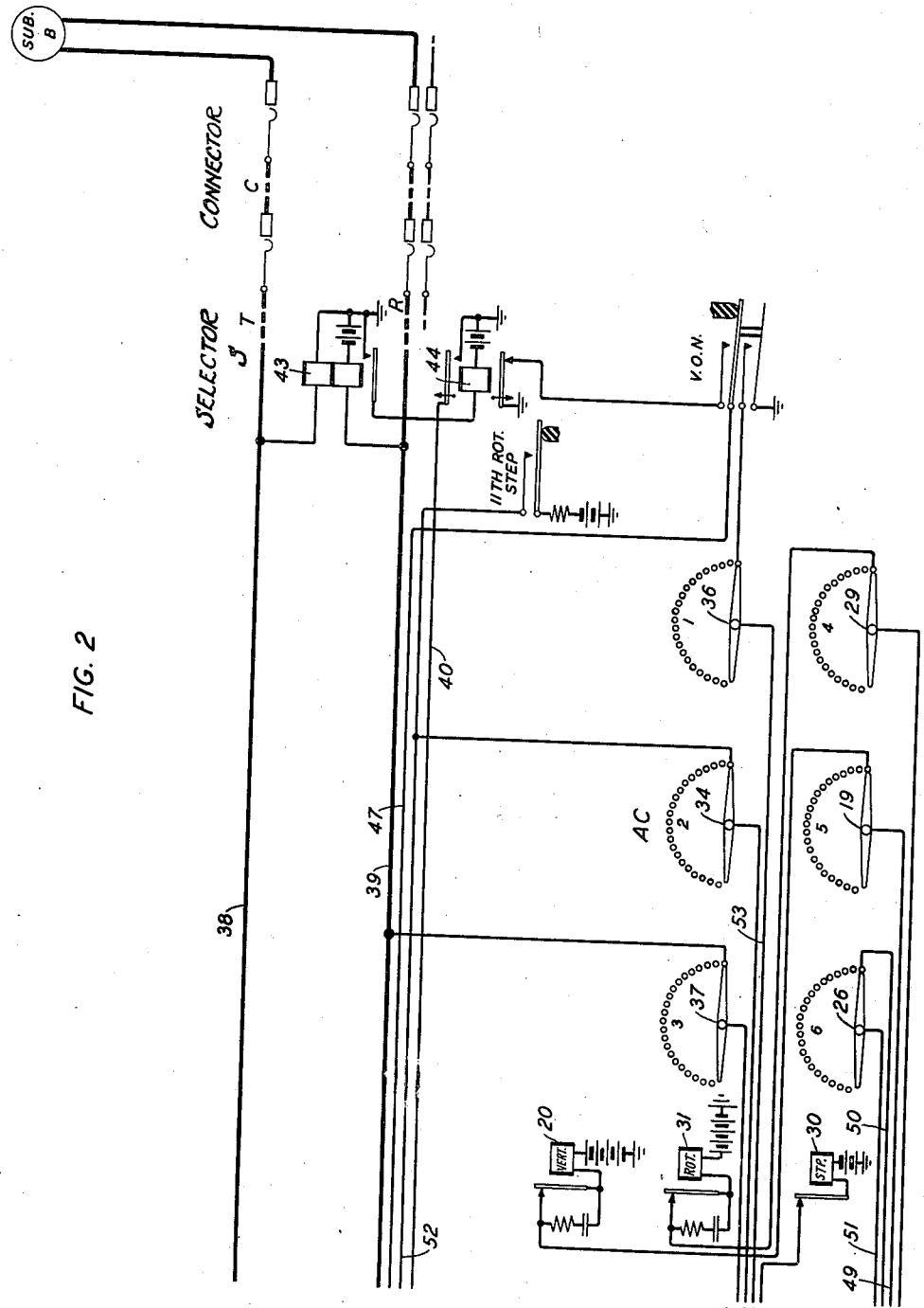

FIG. 2

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TELEPHONE SYSTEM

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Application April 25, 1939, Serial No. 269,840

9 Claims. (Cl. 179—18)

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

The object of the invention is the provision, through an allotter device, of a common source of power for the magnets of each line-finder selector switch of a group available to a group of calling lines. In particular, it is contemplated that this common source of power shall be a space discharge device which is actuated whenever a line initiates a call and which is adapted to oscillate in a manner that will provide impulse current to each of the magnets of the selector taken into use.

The principal feature of the invention is, therefore, the provision of a common allotter for a group of finder switches which is provided with a space discharge device adapted to control the operation of the stepping magnets of the switch taken into use by a calling line.

The foregoing and other features of the invention will be described in detail in the following specification, which should be taken in conjunction with the accompanying drawings, in which:

Figs. 1 and 2, when placed side by side, represent, schematically, a telephone system in which the features of the invention are disclosed in connection with automatic switches of the well-known two-motion step-by-step type.

It is to be understood, however, that the embodiment of the invention in this particular system is given by way of illustration only and that the invention may be applied to any common control circuit supplying power through a space discharge device to the magnets of switching devices selectable by said common control circuit.

Referring to the drawings, there are shown a calling subscriber's station A and the associated line circuit LC, another subscriber's station D, one of a plurality of line-finder switches LF accessible to the station A through the allotter circuit AC, a selector switch S, a connector switch C and a called subscriber's station B.

The subscriber's stations A, B and D are each provided with the usual subscriber's set which is equipped with a dial for controlling the establishment of desired connections. The selector switch S and the connector switch C are of the well-known step-by-step or Strowger type, 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. Only those portions of the circuits of the selector and connector switches are shown as are required for a clear and complete understanding of this invention, the omitted portions of these circuits being indicated by broken lines.

The line circuit LC, the line-finder switch LF and the allotter circuit AC are shown in detail since the features of the invention apply to these circuits. A cold cathode gaseous discharge tube T having a control electrode 14 is a part of the allotter circuit which further comprises a rotary switch AC having six terminal banks to the terminals of which are connected the conductors of each of the line-finder switches available to the line groups typified by lines A and D. Tube T is of the "heater" gas-filled type which breaks down and becomes conducting when the potential on its control electrode becomes sufficiently positive with respect to the cathode potential of the tube. Each individual line circuit of a group, such as line circuit LC, has access to the allotter by way of a common start relay 7, and when a call is originated by a subscriber, it operates to cause the allotter to take into use the line-finder switch with whose terminals the brushes of the switch of allotter circuit AC are then engaged, whereupon the line finder so taken into use operates to engage the terminals of the calling line and to extend said line to the first selector, after which the allotter is operated to preselect another idle line finder in readiness for serving another calling line.

Each line circuit terminates in a set of three terminals appearing in the terminal banks of the line-finder switch, as indicated by the individual line circuit LC which terminates in terminals 21', 22' and 23'. The line-finder switch LF is of the well-known step-by-step type provided with two banks of one hundred sets of terminals each, such as the set including terminals 21, 22 and 23 and the set including terminals 21', 22' and 23'. The terminal sets in each bank are arranged in ten horizontal levels, each level consisting of ten horizontal terminal sets and selectable in the upper bank by brushes 61, 62 and 63, and in the lower bank by brushes 61', 62' and 63'. These brush sets, by means of a common shaft, (not shown), are advanced vertically to the proper level and then horizontally to the terminals of the calling line under control of the vertical magnet 20 and the rotary magnet 31, respectively, each of said magnets obtaining their energizing current from the anode circuit of tube T, as will be described hereinafter. The line finder is provided with a vertical commutator 5

having ten conducting segments, one segment for each two corresponding levels of the line-finder bank terminals. Associated with this commutator is a brush 24 which is mounted on the common brush shaft (not shown) and advances simultaneously with brushes 61 to 63', inclusive, during vertical stepping. When the level of the calling line is reached, the brush sets are rotated under the influence of the rotary magnet 31 until brush 62 (or brush 63' depending on the bank in which the line is located) encounters the sleeve terminal of the calling line, after which said calling line is switched through to the first selector in the known manner.

The operation of the above circuits will now be fully set forth in detail in the following description of a call from station A to station B.

When the subscriber A originates a call, a circuit is completed for line relay 1 extending from battery through its left winding, left contacts of cut-off relay 2, over the line loop, right inner contacts of relay 2, right winding of relay 1 to ground. Line relay 1 operates and connects ground to conductor 3, which is commoned to each line relay of the lines on the same level in each terminal bank and extends directly to the vertical commutator segment which marks the level. Thus if the line A is located in the sixth terminal level, conductor 3 would be extended to segment 6.

Each of the commoned conductors, intermediate a line group and the corresponding commutator segment, is connected to a resistance as, for instance, conductor 3 to resistance 4. The other ends of all said resistances are commoned to one side of the winding of relay 7 so that, upon the operation of a line relay or relays pertaining to calling lines in any particular level and the consequent connection of ground to the level conductor, a circuit is completed through the level resistance (as for instance, resistance 4) winding of relay 7 to battery. Relay 7 operates and completes a circuit for relay 8 via the No. 4 contacts of relay 9. On operating, relay 8 connects ground to junction 6 intermediate resistances 10 and 11 via its own No. 5 contacts and the No. 3 contacts of relay 9. Now tube T is a gas-filled thermionic device of the "hot cathode" type, and prior to the connection of ground to junction 6, negative battery 12, feeding serially through resistances 11, 10 and 13 keeps the grid 14 of the tube negatively biased, thereby preventing the tube from operating. With the connection of ground to junction 6, the bias voltage is reduced to zero, which condition causes the tube to flash and establish a conducting path between the cathode 15 and anode 16 in the known manner. This anode-cathode circuit is further completed through the winding of retard coil 17, No. 1 back contacts of relay 18, conductor 49, brush 19 and the bank terminal with which it is engaged, interrupter contacts of vertical magnet 20 of the line-finder switch preselected by the switch of the allotter circuit AC, to battery. The magnet operates and causes the line-finder brushes 61—63 and 61'—63' to take one vertical step to the first level of terminals, brush 24 to advance from the normal segment to the first segment and the vertical off-normal switch V. O. N. to close its two sets of contacts.

When the vertical magnet 20 interrupts its driving circuit by breaking its interrupter contacts, the cathode-anode circuit of tube T is disrupted and the tube is momentarily rendered non-conducting thereby. However, since the ground connection to junction 6 persists and, therefore, the bias on grid 14 remains at zero, the tube flashes again almost immediately, re-establishing the cathode-anode circuit and causing the vertical magnet 20 to operate and take another step, thereby causing the terminal brushes to be raised to the second level and the commutator brush 24 to be raised to the second segment of commutator 5. In this manner the line-finder vertical magnet 20 keeps on operating and causing the brushes to be raised to successive levels until the sixth level is reached, at which time commutator brush 24 engages the sixth segment, whereupon a circuit is completed for relay 25 in the allotter. This circuit may be traced from ground on the left contacts of relay 1, conductor 3, segment 6 and brush 24, conductor 50, allotter switch brush 26 and the terminal engaged thereby, conductor 51, winding of relay 25 to battery. Relay 25 operates and, through its lower set of contacts and the No. 3 set of contacts of relay 18, connects negative battery through lamp 27 to junction 28 which is intermediate resistances 10 and 13. The negative voltage thus applied to the grid of the tube biases the tube beyond the cut-off point and causes it to disrupt its cathode-anode conducting path. The vertical magnet 20 now releases and causes the brush shaft to come to rest in the plane of the terminal level containing the calling line.

Relay 25 further closes an obvious circuit for relay 18 over its top contacts; and this relay, when it operates, locks over its No. 2 contacts to ground on the No. 4 contacts of relay 8, transfers the tube anode path through its No. 1 front contacts and allotter switch brush 29 to the winding of rotary magnet 31 via its interrupter contacts, and disconnects the negative biasing potential from junction 28 by opening its No. 3 contacts. Since ground is still maintained on junction 6 by the operated condition of relay 8, tube T is immediately rendered conducting and the cathode-anode path is then completed through the winding of rotary magnet 31 as above described, said magnet operating to rotate the brush sets 61—63 and 61'—63' over the respective terminal levels to which they were previously raised. Relay 25 is released immediately when brush 24 disengages commutator segment 6. Rotary magnet 31 now takes successive steps with each refiring of the tube subsequent to each interruption of its cathode-anode circuit at the interrupter contacts of the magnet.

When the brush set 61'—63' reaches the terminal set of the calling line A, battery through the cut-off relay 2 is extended through the right contacts of relay 1, sleeve terminal 23' and brush 63', No. 4 contacts of relay 32, lower winding of relay 33, conductor 52, allotter switch brush 34 and terminal, lower winding of relay 9 to ground. Relays 2, 33 and 9 all operate in series. Relay 2, upon operating, locks over its locking contacts to brush 63' and opens the circuit of line relay 1 which releases and disconnects ground from conductor 3, causing in turn the release of start relay 7, which, on releasing, opens the circuit of relay 8 causing said relay to release after an interval to perform functions shortly to be described. Relay 9 locks over its upper winding and No. 1 contacts to ground on the No. 1 contacts of relay 8, opens the ground connection to junction 6 thereby causing the grid bias negative battery 12 again to be applied to the grid 14

which, in turn, causes the cathode-anode circuit of the tube T to become extinguished and the rotary magnet 31 to take no more steps. Relay 9 further completes a circuit for relay 35 which extends from ground through its No. 2 contacts, No. 2 contacts of relay 8, No. 3 contacts of relay 35, upper winding of said relay to battery, and further opens the circuit of relay 8 which, being of the slow-to-release type, does not release until relay 35 has operated and then locked over its lower winding and No. 3 contacts, conductor 53, allotter switch brush 36 to ground on the lower set of contacts of the vertical off-normal switch V. O. N.

Relay 33, in operating, joins conductors 41 and 42 to conductors 38 and 39, respectively, over its No. 1 and No. 5 contacts, respectively. The loop circuit of relay 43 in the first selector switch S is now completed preparatory to the subscriber A receiving dial tone in the well-known manner as a signal to proceed with dialing. The operation of relay 43 closes an obvious circuit for relay 44. Relay 44, on operating, applies ground to conductor 40, which, over the No. 6 contacts of relay 33, locks said relay and extends locking ground to cut-off relay 2 via its No. 4 contacts, brush 63' and the right outer contacts of said cut-off relay.

The subscriber A, upon the operation of relay 44, receives dial tone in the known manner and then proceeds to dial the wanted number in response to which the selector S and connector C are set to extend the connection to the wanted line. Inasmuch as these operations are old and the apparatus and circuits therefor form no part of the present invention, they have been but briefly indicated herein and schematically shown in the drawings.

The operation of relay 35 causes the opening of its operating circuit at its No. 3 contacts, and further completes an obvious circuit for the allotter stepping magnet 30 which now operates under self-interruptions, stepping the brushes of the allotter switch successively over the terminals of busy line finders, as evidenced by ground on the terminals on the arc of the allotter switch accessible to brush 36 which is applied thereto by the operated V. O. N. contacts of busy line finders. Ground on successive terminals maintains relay 35 locked, but when an idle line finder is engaged, the absence of ground on brush 36 causes said relay to unlock and open the driving circuit of allotter magnet 30 whereby the allotter switch comes to rest on the terminals of the line finder thus preselected. When, thereafter, a call is initiated and relay 7 operates as described, said line finder is taken into use and proceeds to hunt for and engage the calling line in the manner already described.

Should the call originate from a line terminating on any one of the upper set of contacts as, for instance, from line D, all operations will be the same as already described if said line D is on the corresponding level with line A except for the fact that battery from the cut-off relay of line D (not shown) will be applied over brush 63, No. 3 contacts of relay 33, lower winding of relay 32, to brush 34 of the allotter switch as already traced for relay 33, whereupon relay 32 (instead of relay 33) will operate, in which event conductors 38 and 39 will be joined to conductors 45 and 46, respectively, in order to cut line D instead of line A through to the first selector.

Should line D terminate in a different level than the one which corresponds to the level of line A, then all operations will be the same as described except for the fact that the ground from the line relay will be connected to the segment on commutator 5 which marks the level of line D, in which event the switch shaft stops as already described when this level is reached.

When conversation is over and the calling subscriber restores his receiver, relay 43 releases, in turn releasing relay 44 which, in turn, releases relay 33. When said relay has released it completes a circuit path for release magnet 48 extending from ground on the lower contacts of relay 44, upper set of contacts on switch V. O. N., conductor 47, No. 2 contacts of relay 32, No. 2 contacts of relay 33, winding of release magnet 48 to battery, causing said magnet to operate and restore the line-finder brush shaft to normal.

While the invention has been described with respect to a common rotary switching allotter controlling a group of line-finder switches of known construction, 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 plurality of lines, a plurality of line-finder switches accessible to said lines, each of said switches being provided with a driving magnet, an allotter circuit for said switches adapted to be connected to an idle one of said switches, and a gas-filled tube in said allotter circuit operatively responsive to one of said lines when calling for operating the magnet in the line-finder switch to which said allotter circuit is connected.

2. In a telephone system, a plurality of lines, a plurality of line-finder switches accessible to said lines, each of said switches being provided with a vertical driving magnet and a horizontal driving magnet, an allotter circuit for said switches, a gas-filled tube in said allotter circuit operatively responsive to one of said lines when calling for operating in succession the vertical magnet and the horizontal magnet in the line-finder switch to which said allotter circuit is connected.

3. The combination with a group of settable switching devices each provided with a magnet for setting the same, of an allotter circuit for said devices comprising means for connecting said allotter circuit to any one of said switching devices, a gas-filled tube, means for completing the anode circuit of said tube serially through the magnet of the switching device connected to said allotter circuit, and means for rendering said tube conducting whereby said magnet is operated to set said switching device.

4. The combination with a group of settable switching devices each provided with a plurality of magnets for setting the same, of an allotter circuit for said devices comprising a gas-filled tube, stepping means for connecting the anode of said tube serially with a magnet of said plurality of magnets of any one of said switches, means for transferring said anode to each one of the remaining magnets of said switch, means for rendering said tube conducting and non-conducting in succession for operating each of said magnets to set the associated switching device, and means responsive to the setting of the switch for operating said stepping means to connect the anode of said tube with a magnet of another switching device.

5. In a telephone system, the combination with a group of switching devices each provided with a magnet means for setting the same on a set of terminals associated with a calling line, of an allotter circuit for said devices comprising a gas-filled tube, stepping means for connecting the anode of said tube serially with the magnet means of any one of said switches, means controlled by said calling line, for rendering said tube conducting whereby the magnet means with which the anode of said tube is connected is operated to set the associated switching device on the set of terminals of said calling line, means for restoring the tube to its non-conducting state upon the setting of said switch, and means for operating said stepping means for connecting the anode of said tube with the magnet means of another switching device.

6. The combination with a group of plural motion settable switching devices each provided with a magnet for each direction of motion, of an allotter circuit for said devices comprising a gas-filled tube, stepping means for connecting the anode of said tube serially with a magnet of any one of said devices, means for rendering said tube conducting and non-conducting, respectively for operating each of said magnets in succession to set the associated switching device, and means for operating said stepping means for connecting the anode of said tube with the magnet of another switching device.

7. In a telephone system, the combination with a group of lines and a group of line-finder switches adapted for connection with said lines when calling, of an allotting device for said switches comprising a rotary stepping switch adapted for normal connection with a free line-finder switch, a thermionic device for operating said line-finder switch in response to a call initiated from one of said lines for connecting said switch with said line, and means for operating said rotary stepping switch for connecting the same with another free line-finder switch.

8. In a telephone system, a thermionic device for supplying power to a plurality of line-finder switches singly and in succession when taken into use in response to calls initiated from a plurality of telephone lines, comprising a normally heated cathode, an anode having a source of potential therefor connected through a driving magnet of one of said switches, a control element normally biased to prevent a space current from flowing between said cathode and said anode, means controlled by a line when calling for altering the biasing potential of said control element to render said tube conducting for operating said magnet, and means responsive to the connection of the switch associated with said magnet with said calling line for connecting the anode of said tube with a driving magnet of another line-finder switch.

9. A driving circuit for the magnets of a plurality of settable switches comprising a thermionic device having an electron source of emission, an anode path including a source of potential extending through a magnet of one of said switches, a control element for rendering said tube conducting to establish a space current between said source of electrons and said anode path whereby the magnet in said path is operated, and means effective upon the setting of the switch for establishing an anode path through a magnet of another of said switches.

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