June 11, 1940. A. M. SKELLETT 2,204,055

TELEPHONE SYSTEM

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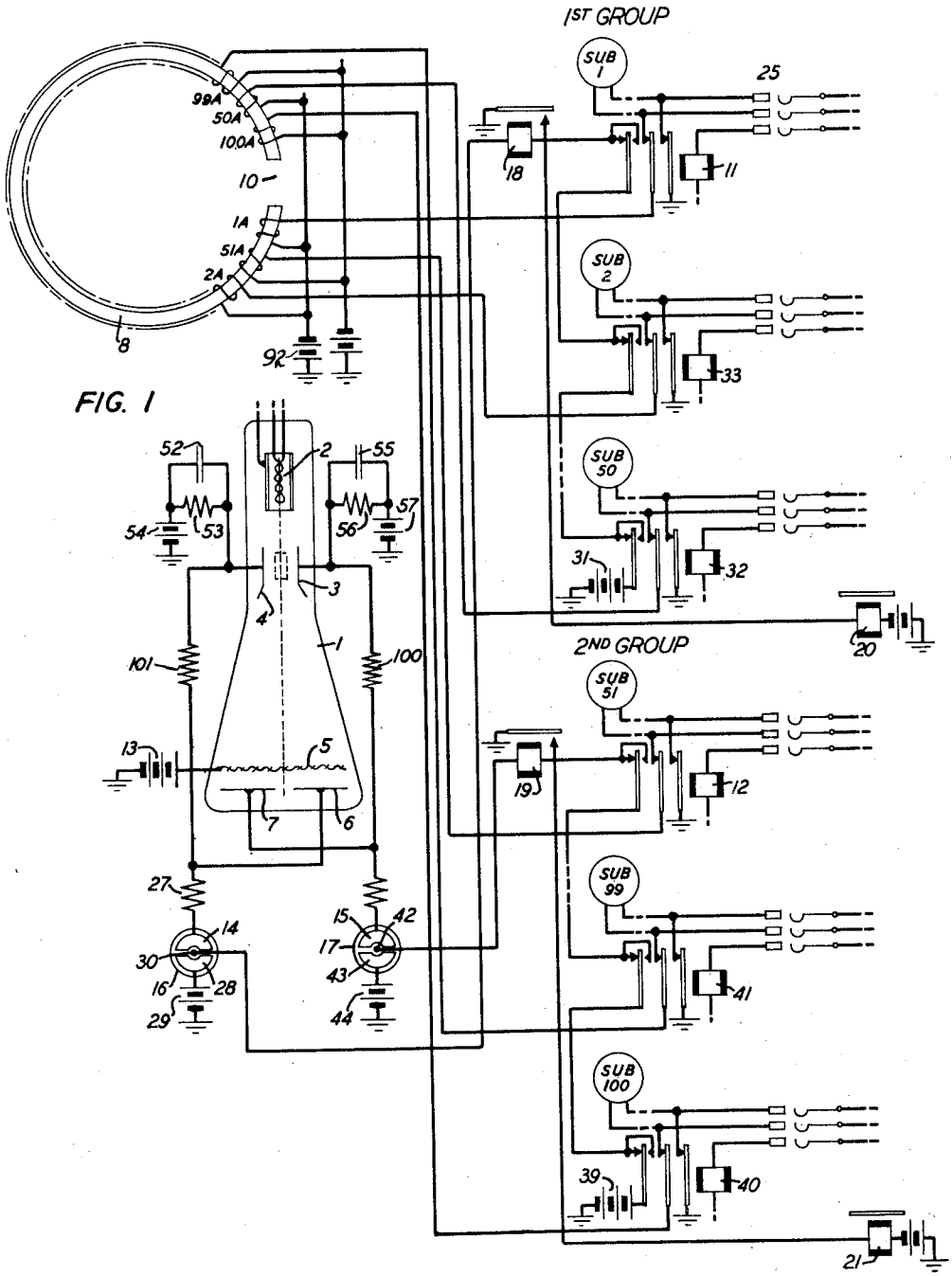

FIG. 1

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TELEPHONE SYSTEM

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FIG. 3

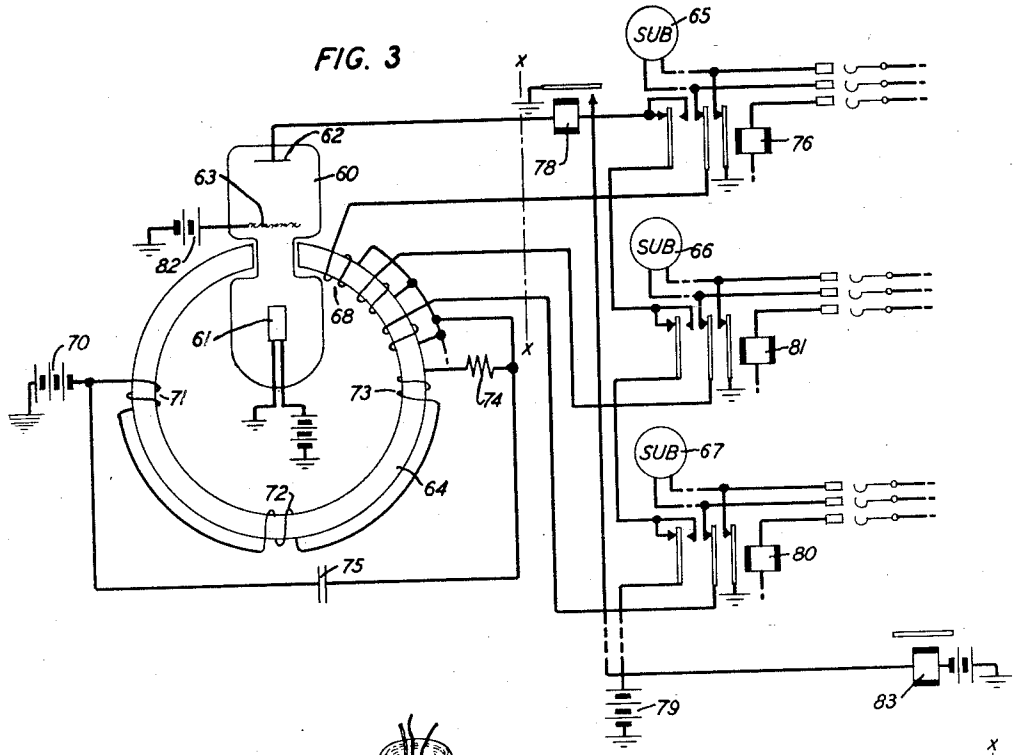

FIG. 2

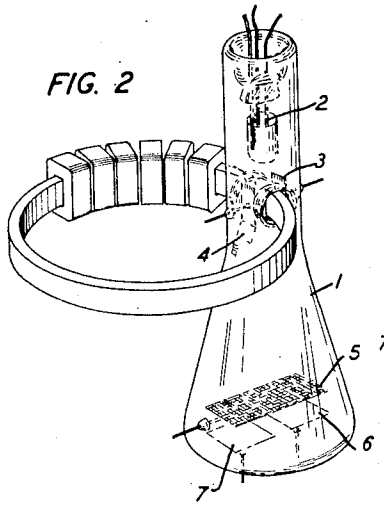

FIG. 4

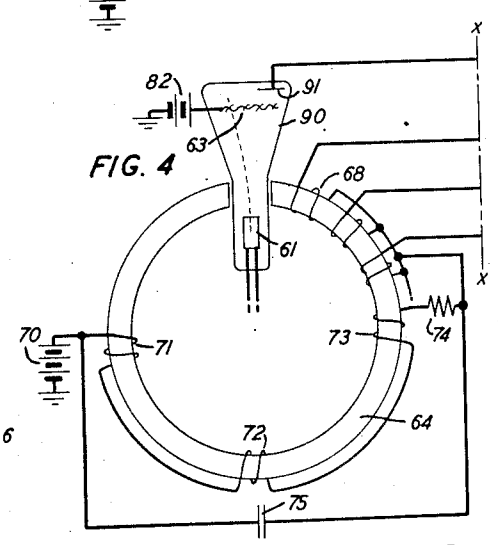

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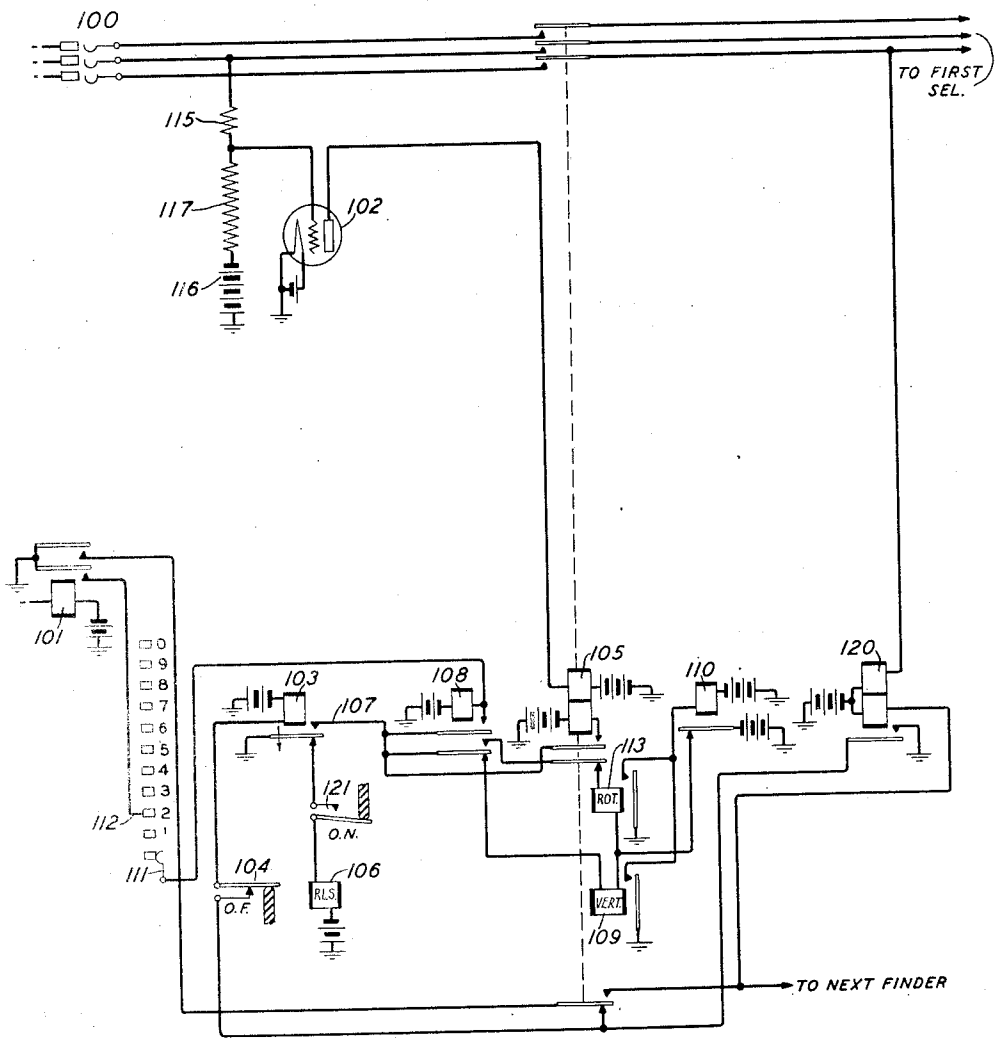
FIG. 5



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Patented June 11, 1940 2,204,055

UNITED STATES PATENT OFFICE

2,204,055

TELEPHONE SYSTEM

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Application November 25, 1938, Serial No. 242,183

14 Claims. (Cl. 179—18)

This invention relates to telephone systems and particularly to improvements in automatic telephone systems.

Objects of the invention are to improve, simplify and reduce the necessary equipment for controlling the establishing of connections in such systems, and particularly to the elimination of some of the individual equipments usually provided for subscribers' lines.

Heretofore in automatic telephone systems, various arrangements have been provided whereby when a subscriber calls, an individual line relay is operated to cause common mechanisms and circuits to seize an idle line finder and cause it to operate to find the calling line and connect it to succeeding switches for the extension of a connection. Usually the line relay operates a common start relay for this purpose. Systems have also been provided whereby such individual line relays have been eliminated by relay mechanisms or other devices such as vacuum tubes common to a plurality of lines.

It is a feature of the present invention to provide a common mechanism for one or more groups of calling subscribers' line circuits for the operation of start relays individual to such groups of lines for starting control operations to connect the calling line to an idle line finder. This common mechanism may consist of a plurality of coils, one for each line wound on a common core and a cathode ray tube and circuit means whereby an electron beam in said tube may be deflected by the energization of any one of said coils when the corresponding subscriber is calling to cause said beam to operate a particular common start relay.

Another feature is the provision of means for preventing the straying of the beam from a neutral position to cause false operation of a common start relay due to leakage conditions on the lines. Deflection plates are employed for this purpose and circuit means are operated by the beam and caused to control the potentials on said plates to return the beam to its neutral position.

A special feature relates to the arrangement of the coils on the core. The coils may, for example, be divided in two groups and so connected that one group produces flux in one direction across the air-gap of the core and the other group produces flux in the opposite direction across this air-gap. This requires the tube to be equipped with two anode plates so that the energization of any one of one group of coils will deflect the beam to one anode and the energization of any one of the coils in the other group will deflect the beam to the other anode. If the tube is arranged in this manner, one anode circuit may control one start relay for one group of lines and the other anode circuit may control another start relay for another group of lines.

A modified form of the invention may be an arrangement whereby a gas-filled tube is controlled by the flux of a permanent magnet core which prevents the tube from operating normally and whereby when any one of the coils on this magnet core is energized the tube is caused to operate to close the circuit for the start relay. This modification of the invention may be so arranged that a cathode ray tube is used in place of the gas-filled tube in which case the permanent magnet deflects the beam away from a single anode and when a coil is energized the beam is deflected to strike this anode to close the circuit for the start relay.

A modified form of the feature relating to the balancing out of leakage effects may be employed in connection with the above modifications and take the form of a special coil in series with a line coil. This special coil may be distributed over the entire permanent magnet core and wound to produce flux in the opposite direction to the flux produced by the line coil to counteract leakage currents.

The invention has been illustrated in the accompanying drawings in which:

Fig. 1 shows a preferred form of applicant's invention applied to a telephone system;

Fig. 2 shows in perspective the cathode beam tube, core and coils used in Fig. 1;

Fig. 3 shows a modified form of the applicant's invention in which a gas-filled tube and a permanent magnet core are substituted in place of the cathode beam tube and core in Figs. 1 and 2; this figure also shows a modification of the applicant's invention of the feature relating to the balancing out of the leakage effect; and

Fig. 4 shows a modified form of the applicant's invention in which a cathode beam tube is substituted for the gas-filled tube shown in Fig. 3.

Fig. 5 shows a typical line-finder circuit in detail for seizing a calling line arranged in accordance with the applicant's invention when applied to a telephone system as illustrated diagrammatically in Figs. 1 and 3.

Referring now to Figs. 1 and 2, a cathode ray tube 1 may contain the usual beam producing element or cathode 2, a pair of deflecting plates

3 and 4, a usual high potential screen 5 and the anode plates 6 and 7. The core 8 is located in relation to the cathode beam and the deflection plates 3 and 4 as shown in Fig. 2 so that the magnetic lines of force passing across the air-gap 10 between the poles of this core are at right angles to the deflection plates 3 and 4. As is well known in cathode beam tubes of this type, the beam will be deflected, referring to the picture of the tube in Fig. 1, to the right or to the left to strike the anode 6 or 7 by the magnetic lines of force passing between, across the air-gap 10 and varying potentials on the deflection plates 3 and 4 will deflect the cathode beam in the same directions. Normally the beam is not deflected but extends in a neutral position directly through the center of the tube to pass between the anodes 6 and 7. In other words, with the deflection plates and the magnet core placed as shown in these figures, the electrostatic and magnetic deflections are effective in the same direction. The direction of deflection of the beam depends in the case of the magnetic deflection on the polarity of the magnetic field and is perpendicular to the field, and the electrostatic deflection, the amount of which is proportional to the potential difference between the deflecting plates, is in a direction toward the plate of the higher potential. In Fig. 1 the magnetic core 8 has been pictured above the tube 1 for the sake of clearness but it should be understood that this core is placed in relation to the tube as shown in Fig. 2.

On core 8 may be placed individual coils of individual lines and these may be divided in groups. In Fig. 1 the coils of six lines have been shown, three of each of two groups which may be representative of lines of two groups of fifty each. Of the upper group of subscribers' lines, 1, 2 and 50 have been shown and in the lower group of subscribers' lines, 51, 99 and 100 have been shown with their respective coils on the core 8. The coil 1—A of line 1, is connected in a circuit from battery through this coil, contacts of the cut-off relay 11, the subscriber's loop and contacts of relay 11 to ground. Next to this coil 1—A has been placed coil 51—A of line 51 in a circuit from battery through this coil, contacts of the cut-off relay 12 of line 51, the subscriber's loop, contacts of relay 12 to ground. The succeeding coils of the succeeding lines are placed on the core 8 alternately, that is, the next coil after 51—A will be the coil 2—A of line 2 and the last three coils 99—A, 50—A and 100—A on core 8 are those of lines 99, 50 and 100. It should be noted that the coils of lines 1 to 50 are wound on core 8 in the opposite direction to the coils of lines 51 to 100 so that when a coil in the first group is energized, the magnetic lines of force across air-gap 10 will be in one direction and when a coil in the other group is energized, the magnetic lines of force across air-gap 10 will be in the opposite direction. Thus when any of the coils in the first group are energized, the beam will be deflected towards the right and when a coil in the second group is energized, the beams will be deflected toward the left, to cause secondary electron emissions to be produced between anode 6 or 7 and the screen 5. These secondary electrons cause potentials to be established on the control element 14 or 15 of the gas-filled tube 16 or 17 to cause either of these tubes to discharge, as will be explained hereinafter, and operate relay 18 or 19, to close circuits for the operation of the start relay 20 or 21. As shown, the subscribers' lines in these two groups are connected to the terminals of line-finder switches at 25 to extend connections from the subscribers' lines as is well known in the art and described hereinafter in connection with Fig. 5. To start the establishing of such connections, the start relay 20 is provided for the first group of subscribers' lines and the start relay 21 is provided for the second group of lines.

The operation of this system is as follows: If it is assumed that the subscriber 1 in the first group calls by removing his receiver from the switchhook, a circuit is completed from battery, winding 1—A, contacts of the relay 11, the subscriber's loop, contacts of relay 11 to ground. This energizes core 8 to produce electromagnetic lines of force across air-gap 10 to deflect the beam of tube 1 to strike anode 6. This establishes a conducting path between anode 6 and screen 5 and thus the potential as determined by the high potential battery 13, this conductive path between anode 6 and screen 5 is established on the control electrode 14 of tube 16 through the resistance 27. As this potential is more positive than the potential on the cathode 28 as determined by the battery 29 the tube breaks down. Tube 16 now discharges between the cathode 28 to the main anode 30, and a circuit established for the operation of relay 18 from the positive pole of the high potential battery 31 through contacts of the cut-off relays of the subscribers of the first group such as 32 of line 50, 33 of line 2 and 11 of line 1, winding of relay 18, main anode 30, cathode 28 to the positive pole of the lower voltage battery 29 to ground. Relay 18 in operating closes an obvious circuit for the operation of relay 20 which now serves to start operations, as will be hereinafter described in connection with Fig. 5, towards the seizing of the calling subscriber's line 1 by an idle line finder to extend the subscriber's line to switches of any well-known automatic system for the establishing of a connection to a called subscriber's line. When the connection is extended through a line finder for subscriber 1, cut-off relay 11 will operate in the usual manner and release the relay 18, extinguish tube 16 and deenergize coil 1—A of core 8, and the beam is thus rapidly returned to the normal or neutral position. However, the circuit for relay 18 is again closed on the full operation of relay 11 to permit any other subscriber to call while subscriber 1 is engaged. Thus the momentary opening of the circuit for relay 18 permits relay 20 to deenergize. In a similar manner any other subscriber of the first group may by removing his receiver from the switchhook cause the corresponding coil on core 8 to be energized to deflect the beam on anode 6 and reoperate relays 18 and 20.

If a subscriber in the second group has called, for example subscriber 51, the circuit for coil 51—A on core 8 would have energized over a circuit from battery, winding of this coil, contacts of cut-off relay 12, the subscriber's loop, contacts of cut-off relay 12 to ground and thus cause the beam to be deflected to anode 7. This would have established a potential on the control electrode 15 of tube 17 to cause this tube to discharge over a circuit from the positive pole of the high potential battery 39, contacts of the cut-off relays of all the subscribers in the second group, such as 40 of subscriber 100, 41 of subscriber 99 and 12 of subscriber 51, winding of relay 19, main anode 42 and cathode 43 of tube 17 to the positive pole of a lower voltage battery 44. Relay 19 in operating would close an operating circuit for the start relay

21 and thus start operations for connecting the subscriber 51 through an idle line finder for the extension of a connection. If the calling subscriber's line 51 is extended to the line finder, the cut-off relay 12 operates and releases relays 19 and 21 and causes tube 17 to cease discharging and the beam is returned to normal.

As stated, the beam in tube 1 is normally pointed at a position between the two anodes 6 and 7 and to prevent the beam from wandering off this neutral position to cause false operation of a start relay, feedback circuits are provided. It should be observed here that these feedback circuits are not effective in this respect when a subscriber calls. That is, they are too slow in operating during the extremely short period the beam is deflected by the energization of a coil, this being due to the characteristics of resistance 101, for example, in case the beam is deflected on anode 6, and as due to the characteristics of resistance 100 in case the beam is deflected on anode 7. The feedback circuits are connected, respectively, from the anodes 6 and 7, through resistances 100 and 101, to the deflecting plates 3 and 4, and the circuit for anode 6 is also connected through the resistance 101, condenser 52 and resistance 53 in parallel to battery 54, while the circuit for anode 7 is also connected through resistance 100, condenser 55 and resistance 56 in parallel to a battery 57. The wandering of the beam from neutral position may be caused by leakage currents on the subscribers' lines, through the coils around the case 8 which would cause corresponding coils to be partially energized. If such leakages occur and remain for any length of time, a potential difference is established between the deflecting plates 3 and 4 to cause the beam to be returned to the neutral position. That is to say, for example, if the leakage occurs on any of the lines in the first group, a corresponding coil of this group on core 8 will deflect the beam towards anode 6. This will through resistance 101 cause an increase of potential to be established on plate 4 which will draw the beam back to the neutral position. The nature of the leakage is generally such that it will cause the beam to be deflected so that only a part of it will strike anode 6 or 7. The secondary emissions between either of these plates and the screen 5 will therefore not be sufficient to cause the corresponding tube 16 or 17 to discharge. On the other hand the feedback circuit will become effective due to such emissions as, for example, if the beam is partially deflected to strike anode 6, the condenser 52 will have sufficient time to receive a charge as determined by the values of resistances 101 and 53 and thus increase the potential on plate 4 which, in turn, causes the beam to be returned towards the normal position. It is evident that this effect can not be produced when the beam is fully deflected on the anode 6 when a line is closed, as in this case tube 16 will discharge immediately due to the potential drop across resistance 101, and in this case plate 4 will not have time to change its potential as the beam will be almost immediately deflected back to normal position by the operation of a cut-off relay which, as stated, deenergizes the associated coil on the core 8. To recapitulate, the potential of deflecting plates 3 and 4 cannot be changed rapidly because of the relatively long time constants of the combinations of condenser and resistance 52, 53 and 55, 56 connected to them. Thus they are effective in returning the beam to its neutral position only for slow variations of flux, such as are produced by leakage currents in the subscribers' lines.

Referring now to Fig. 3 which shows the applicant's idea modified to employ a gas-filled tube 60 having an electron emitting element 61 and anode 62 and a screen 63, a permanent magnet core 64 is placed in proximity to this tube so that magnetic flux across its air-gap passes between the element 61 and the screen 63 to normally prevent electrons from passing to the anode 62. On this core are wound individual windings of, for example, fifty lines, three of which have been shown extending to subscribers' stations 65, 66 and 67, respectively.

This device operates as follows: If, for example, the subscriber at 65 removes his receiver from the switchhook, a circuit is completed for the corresponding coil 68 on the core 64 from the positive pole of the high voltage battery 70, three auxiliary windings 71, 72 and 73 wound in a direction opposite to winding 68 and opposite to all other line windings on core 64, resistance 74, and across the condenser 75 in parallel of windings 71, 72 and 73 and resistance 74, winding 68, contacts of the cut-off relay 76 through the subscriber's loop of line 65, contacts of cut-off relay 76 to ground. The sudden flow of current through this circuit charges the condenser 75 before coils 71, 72 and 73 receive sufficient current to produce any effective flux in the permanent magnet core. The purpose of coils 71, 72 and 73, and resistance 74 is to restore the tube to normal condition and to counteract leakage effects and their functions in those respects will be explained hereinafter. The immediate effect of the current in this circuit therefore is that winding 68 becomes energized and the flux produced thereby in the core 64 will be in opposition to the normal flux across the air-gap of the core 64 and thus permits the tube to operate to permit electrons from the element 61 to pass through plate 63 to anode 62. This provides a path for the operation of relay 78 from the positive pole of the high voltage battery 79, contacts of all the cut-off relays such as 80 of the line 67, 81 of line 66 and 76 of line 65, winding of relay 78, anode 62, cathode 61 to ground. Relay 78 operates in this circuit and closes an obvious circuit for the start relay 83 which causes an idle line finder to seize line 65 and extend it beyond for further automatic extension. When a line finder has seized this line, the cut-off relay 76 operates and opens the circuit for coil 68 and relay 78 which releases start relay 83. However, prior to the operation of the cut-off relay 76 and as soon as condenser 75 is fully charged, the coils 71, 72 and 73 will receive sufficient current to cause flux produced thereby in the core 64 to counteract the flux produced by winding 68 and hence permit the flux produced by the permanent magnetism in the core to soon prevent electrons from passing through from the element 61 to anode 62 and thus blocking any further current through relay 78. These coils are also effective to restore the tube to a condition where energization of any line winding will become ineffective until the circuit of relay 76 has operated when any other subscriber removing his receiver from his switchhook will cause the circuits to operate to extend a connection in the same manner as described in connection with a call from subscriber of line 65.

As stated, to overcome leakage current effects in this arrangement, the auxiliary windings 71, 72, and 73 and resistance 74 are provided in series

with line windings over the circuit as hereinbefore traced for the first line through the line winding 66. It should be noted that these auxiliary coils may be distributed over the entire core or in sections and, as stated, are wound in opposite directions to the line windings. Their functions in regard to counteracting any leakage currents that may exist in any one of the lines are as follows: As leakage currents in the lines are of low values, the coils 71, 72 and 73 become effective on such leakage currents to balance out the flux in any of the line windings through which leakage currents may pass. That is to say, if a small leak in current occurs in the line and as the resistance value of the resistance 74 is comparatively small, the condenser 75 will have a correspondingly small difference of potential across it, and hence the leakage current flowing through the windings 71, 72 and 73 may be of the same value as the leakage current flowing through said line windings and its coil such as 66, and consequently no effective flux will be produced in the core 64.

Fig. 4 shows the arrangement in Fig. 3 modified to substitute a cathode ray tube 90 in place of the gas-filled vacuum tube 60 but otherwise functions the same with the exception that the core 64 need not be a permanent magnet as normally the beam does not fall on the anode 91. In this case, therefore, when a line coil is energized, the flux produced by this coil in the core 64' causes the beam to be deflected onto the anode plate 91 and thereby closes a circuit for the relay 78 and start relay 83. When a current is built up in the coils 71, 72 and 73, the beam is restored to the normal position in the same manner as hereinbefore described in connection with Fig. 3 both in regard to the restoring after the energization of a line coil due to the seizure of the corresponding line or due to leakages.

A description will now be made of the function of a typical line-finder circuit such as is disclosed in Fig. 5 whereby a connection may be established from a calling line of the kind disclosed in Fig. 1 or 3 as embodying the applicant's invention.

Assuming as hereinbefore described that, for example, a relay such as 20 in Fig. 1 operates indicating that a subscriber in the associated group has initiated a call, it is evident that an idle line finder such as is disclosed in Fig. 5 will operate to seize the calling line and connect it through its line terminals through to a connection beyond. This line finder disclosed in Fig. 5 is of the usual well-known type that operates in a vertical direction to advance its brushes, such as 100, to the level in the switch in which the calling line is located and to then advance the brushes in a rotary direction to connect the brushes with the terminals of a calling line. The testing for the calling line will be controlled primarily by a vacuum tube 102 and associated circuits over the ring terminal and the ring brush as will hereinafter be described. A relay 101 corresponding to a relay such as relay 20 in Fig. 1 will operate when a subscriber initiates a call and the effect is that a start circuit is closed for the operation of a relay 103 over a circuit from battery, winding of this relay, the usual eleventh step contacts 104, contacts of relay 105 to ground at contacts of relay 101. When relay 103 operates it opens a point in the circuit of release magnet 106 and places ground potential on the conductor 107. This prepares a locking circuit for relays 108 and 105 and operates the vertical magnet 109 over a circuit from battery, contacts of interrupter relay 110, winding of magnet 109, the lower outer contacts of the transfer relay 108 to ground at contacts of relay 103. Magnet 109 in operating closes a circuit for relay 110 at its contacts whereupon relay 110 operates and opens the circuit for magnet 109. Magnet 109 thereupon deenergizes and opens the circuit for relay 110 whereupon relay 110 deenergizes and again closes the circuit for the magnet 109. This action continues until the circuit for this magnet is opened on the operation of relay 108 which takes place when the vertical magnet has advanced the vertical wiper 111 to the third level of bank contacts. In this position the wiper 111 is brought into engagement with the test contact 112. When this occurs a circuit is completed for relay 108 from battery through its winding, wiper 111, contact 112, contacts of relay 101 to ground. Relay 108 in operating closes a locking circuit for itself through its inner lower armature and front contact to the ground at contacts of relay 103. Relay 108 also opens the circuit for the vertical magnet 109 and thereby terminates the vertical movement. Relay 108 now extends the ground connection from relay 103 to the rotary magnet 113 which operates over a circuit from battery, contacts of relay 110, winding of magnet 113 and contacts of relays 105, 108 and 103 to ground. The rotary magnet in operating closes a circuit for the operation of relay 110 which opens the rotary magnet circuit so that this magnet releases and causes the release of relay 110. These actions are continued until the brushes 100 are opposite the terminals of the calling line.

It should be noted at this point that the grid of the tube 102 is connected to the ring brush of the line finder through a resistance 115 and to a suitable source of current 116 through a resistance 117 and that the plate circuit extends through the upper winding of relay 105. Normally the potential on the grid of tube 102 is sufficiently negative to prevent the tube from operating. If it is then assumed that the subscriber No. 1 in Fig. 1, for example, is the calling subscriber, it should be noted that the source of current 92 is connected with its negative terminal to the ring terminal over the winding 1A of the core 8 and contacts of the cut-off relay 11. Hence, when the ring brush of the line finder finds this ring terminal of the calling line, the connection through the calling subscriber's loop to ground over contacts of relay 11 will change the normal grid potential to become sufficiently less negative to cause the tube 102 to operate. The resulting current through the plate circuit will operate relay 105 and stop the line finder. That is, relay 105 in operating provides a locking circuit for itself through its lower winding and lower inner armature and front contact to ground at contacts of relay 103 and opens the circuit for the rotary magnet 113, so that the line finder will therefore remain connected to the calling line terminals. Relay 105 now extends the connection from the calling line over the brushes 100 through contacts of the relay to a first selector for the establishing of a connection beyond, as is well known in the art. Relay 105 also extends the starter wire from relay 101 to the next finder. When ground is encountered over the sleeve conductor from the first selector, relay 120 operates from battery over an upper winding and provides a connection to ground for maintaining the relay 103 operated

after the starting ground is removed by the operation of relay 105. Relay 103 is slow in releasing so as to remain operated during this transfer of the connection. This ground connection of the sleeve from the first selector also causes the operation of relay 11 which disconnects, as hereinbefore described, the connection from the calling subscriber to a winding on core 8 and this in turn causes the tube 102 to be restored to normal and discontinue the current through the upper winding of relay 105.

The connection now established from the calling subscriber over the line finder to the first selector may now be extended to a called subscriber in the usual manner through any well-known automatic telephone system by having the subscriber dial the called subscriber's number. When the connection is released, ground is removed from the sleeve connection and thus causes the release of relays 120 and 103 which in turn causes the release of relays 108 and 105. The release of relay 103 closes the circuit for the release magnet 106 from battery through the winding of this magnet, the vertical off-normal contacts 121 to ground. The release magnet restores the line finder to normal. It is evident that this relay 120 will not cause the release of the line finder if the starter wire is used for operating another succeeding line finder at the time the circuit for the upper winding of relay 120 is opened as this relay 120 will be locked from battery through its lower winding to the starter wire ground. This locking circuit will, of course, be opened when the starter wire is no longer needed at which time the ground will be disconnected from this wire by the release of relay 101 which takes place when a line finder has found a calling line and the associated cut-off relay is operated.

What is claimed is:

1. In combination, a plurality of lines, a coil for each line, a relay, a circuit for said relay, means for producing an electron beam, and means responsive to the energization of any one of said coils on the seizure of the corresponding line for controlling said electron beam to close said circuit to cause the operation of said relay.

2. In combination, a plurality of lines, a winding for each line, a core for said windings, a relay, a circuit for said relay, means for producing an electron beam, said core being so located in relation to the electron beam that when flux is produced in said core by current in any one of said windings, said electron beam is flexed from its normal direction, and means responsive to the flexing of said electron beam for closing said circuit to cause the operation of said relay.

3. In combination, a plurality of lines, means for transmitting current over any one of said lines, a relay, a circuit for said relay, a device for producing an electron beam, an electromagnetic core having its poles adjacent said electron beam for the deflection of said beam by flux between said poles, windings on said core each connected to a different line, a terminal in said device connected to said circuit and so located that when current is passing through any one of said lines flux produced in said core by the winding associated with said line flexes said beam to cause a current to flow over said beam through said circuit to operate said relay.

4. In combination, a device for producing an electron beam, an electromagnetic core having its poles in such a position in relation to said electron beam that flux flowing between said poles causes said beam to be deflected, a terminal in said device, a relay, a circuit for said relay connected to said terminal, a plurality of windings on said core, means for energizing any one of said windings to produce flux in said core to direct said beam on to said terminal to cause current to flow in said circuit to operate the relay.

5. In combination, a relay, a device for producing an electron beam, an electromagnetic core arranged so that flux between its poles will flex said beam, a plurality of windings on said core, means for energizing any one of said windings to produce flux between the poles of said core, means responsive to the flexing of said beam by said flux for operating said relay.

6. In combination, a device for producing an electron beam, two anodes in said device not in the path of said beam when in a neutral position, a relay associated with each anode, means for deflecting said beam onto either anode, and means operative if the beam is deflected slowly onto either of said anodes for restoring it to the neutral position and operative if the beam is deflected quickly onto either of said anodes for actuating the corresponding relay.

7. In combination, a device for producing an electron beam, two anodes located in said device on opposite sides of said beam, a pair of flexing plates for said beam in said device, circuit means electrically associating said plates and said anodes operative on the slow straying of said beam on to either of said anodes for restoring it to its neutral position between said anodes.

8. In combination, a device for producing an electron beam, two anodes located in said device on opposite sides of the beam when in a neutral position, a relay for each anode, a pair of flexing plates for said beam in said device, circuit means electrically associating one anode with one relay and a flexing plate, circuit means electrically associating the other anode with the other relay and the other flexing plate, means for deflecting said beam on to either of said anodes, said means being operative on the quick deflection of said beam on to either anode for operating the corresponding relay and then restoring the beam to its normal position, and operative on the slow deflection of said beam on to either anode for restoring it to its neutral position without causing the operation of the corresponding relay.

9. In combination, a device for producing an electron beam, two anodes in said device within reach of said beam but not in the path of said beam when in a neutral position, a gas-filled tube for each anode, a relay for each tube in the plate circuit thereof, circuit means connecting one anode with the filament of one tube and for connecting the other anode with the filament of the other tube, two groups of energizing windings, electromagnetic means controlled by the energization of any winding in one group for deflecting said beam on to one anode and controlled by the energization of any winding in the other group for deflecting said beam on to the other anode for changing the potential on the control element of the associated tube to cause the operation of the relay in the plate circuit of said tube.

10. In combination, a device for producing an electron beam, two anodes in said device within reach of said beam but not in the path of said beam when in a neutral position, a relay for each anode, an electromagnetic coil arranged so that flux between its poles will flex said beam, two groups of energizing windings on said core, one

group wound to energize said core to produce flux in one direction to flex the beam on to one anode and the other group wound to energize said core to produce flux in the opposite direction to flex the beam on to the other anode, and means responsive to the change in the electrical characteristics of said anode when the beam is directed thereon at a slow rate for restoring said beam to its neutral position and when the beam is directed on said anode at a faster rate, for causing the operation of the associated relay.

11. In combination, a relay, a device for producing an electron beam, an electromagnetic core arranged so that flux between its poles will prevent said beam from being produced, a plurality of windings on said core, means for energizing any one of said windings to produce flux between the poles of said core so as to permit said beam to be produced, means operative when said beam is produced for operating said relay, an auxiliary winding associated with all of said plurality of windings on said core, so wound that when any one of said windings is energized to a certain degree only, it produces an electromagnetic flux in opposition to the flux produced by any one of the said plurality of windings to neutralize said last-mentioned flux in said core to prevent the production of said beam.

12. In combination, a plurality of coils, a relay, a device for producing an electron beam, means for normally suppressing said beam, and means responsive to the energization of any one of said coils for overcoming said suppression means to produce the beam, and means operative over said beam when produced for operating said relay.

13. In combination, a plurality of coils, a relay, a circuit for said relay, a device for producing an electron beam, means for normally suppressing said beam, means responsive to the energization of any one of said coils for overcoming said suppression means to produce said beam, and means operative over said beam when produced for closing said circuit to operate said relay.

14. In combination, a plurality of lines, a coil for each line, a relay, a device for producing an electron beam, a permanent magnet core for said coils arranged in relation to said device so that normally magnetic lines of force suppress said beam and so that when any one of said coils is energized, the normal magnetic lines of force are counteracted by the magnetic lines of force produced by the energized coil to permit the beam to be produced and means operative over said beam when produced for operating said relay.

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