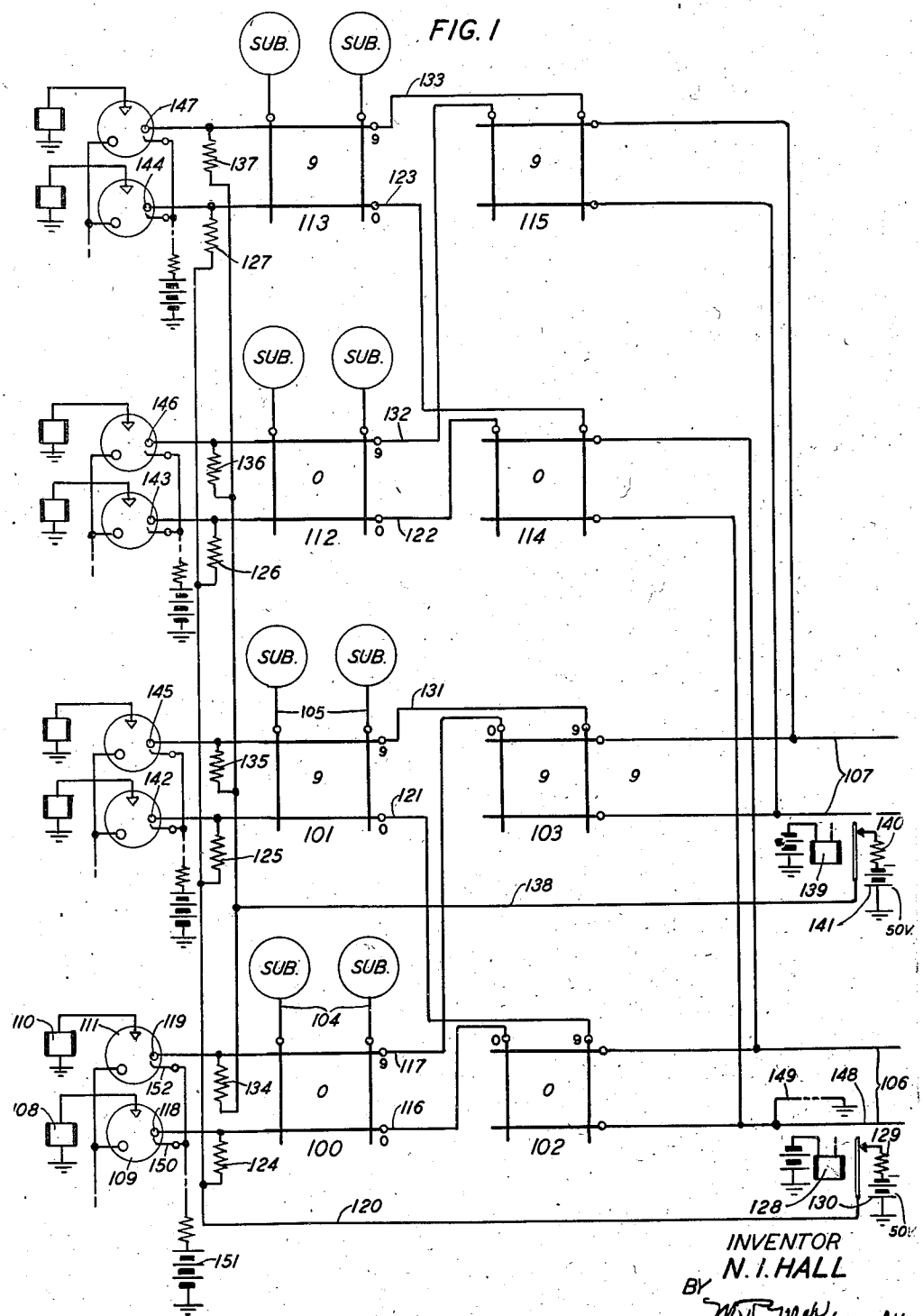
July 28, 1942. N. I. HALL 2,291,224

SELECTING SYSTEM

Filed Feb. 8, 1941 2 Sheets-Sheet 1

FIG. 1



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July 28, 1942. N. I. HALL 2,291,224

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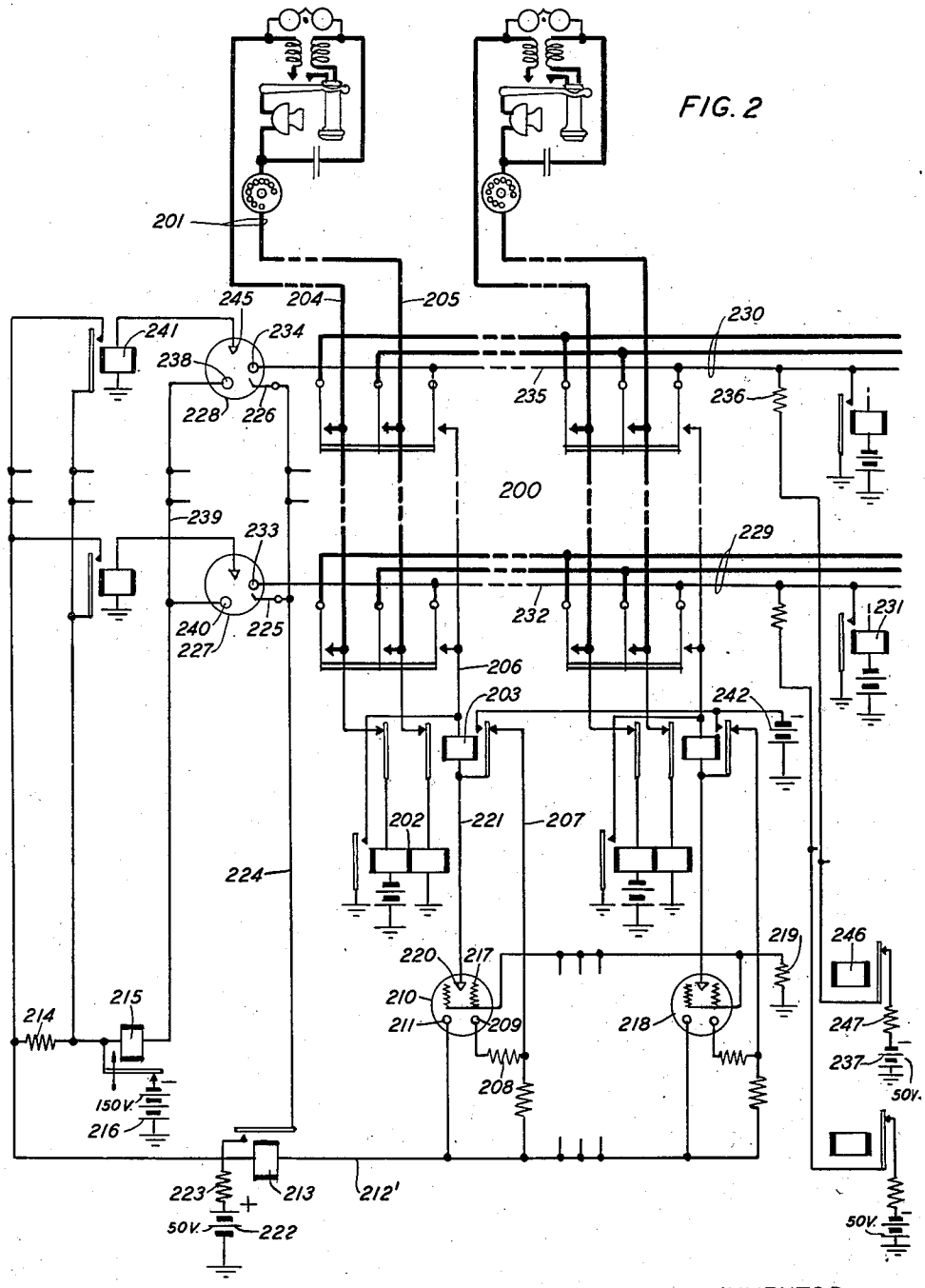
Filed Feb. 8, 1941 2 Sheets-Sheet 2

FIG. 2



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SELECTING SYSTEM

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7 Claims. (Cl. 179—18)

This invention relates to selecting and switching systems and particularly to systems in which selections are made automatically in a group of lines, trunks, or other circuits.

An object of the invention is to obtain a more uniform and more efficient use of the lines, circuits, or other elements comprising a group in which selections are made.

Another object is to obtain a preferential selection of circuits which varies in accordance with the extent of their use.

Another object of the invention is to improve the efficiency of switching systems by obviating the selection of circuits which have no available outlets.

These and other objects of the invention are realized by means of a switching system in which a plurality of equivalent groups of lines or trunks are accessible to automatic switches for extending calls or other connections, in which the several groups are selectable under the control of associated devices having varying degrees of sensitivity, and in which the selectability or preference for any particular group of lines is varied by varying the sensitivity of the associated device in proportion to the number of calls extended to the lines of said group. More specifically the selecting system above mentioned may serve to extend subscribers' lines over automatic switches to the trunks of a plurality of groups. Any line, when calling, causes the application of operating voltage to a plurality of discharge tubes which are related respectively to the several groups of trunks, the first tube to discharge in response to the applied voltage serving to cause the extension of the calling line to an idle trunk in the corresponding group. Since the order in which the tubes of the group operate depends upon the relative speed with which the ionizing current increases in their control gaps, it is possible to obtain a preferential distribution of the calls among the different trunk groups by controlling the sensitivity of said control gaps. This desirable end is accomplished by providing an impedance element for each trunk group and connecting this element in common to the electrodes of all tubes which cause the extension of calls into said group. Each call extended into a particular group causes an increased current to flow through the common impedance element, which in turn lowers the voltage on the control electrodes of all tubes serving this group. This lowered voltage renders these tubes less sensitive than the tubes pertaining to other groups of trunks containing lighter loads. Hence as a group becomes loaded its associated control tubes become less sensitive, and other tubes will discharge first to extend subsequent calls to other groups of trunks.

A feature of the invention is a selecting system in which calling lines have access through links to groups of trunks, in which discharge tubes respond to calls on said lines to extend these calls over associated links to the associated trunk groups, and in which the busy condition of all trunks in any particular group causes the removal of operating voltage from all discharge tubes which serve to extend calls into said group.

In the drawings accompanying the following detailed specification:

Fig. 1 illustrates a switching system incorporating the features of the present invention; and

Fig. 2 shows the details circuits of one of the switches illustrated in Fig. 1.

Although the invention is not limited in its application to any specific type of switching system, it is illustrated herein in connection with a system for extending the subscriber's line of a telephone system to groups of links, trunks, or other circuits. More particularly it is assumed that the subscribers' lines appear on primary line switches of the well-known cross-bar type and that these primary switches have access through links and secondary line switches to groups of trunk circuits.

In Fig. 1 two frames of primary and secondary line switches are illustrated. One of these frames comprises ten primary cross-bar switches of which two, switches **100** and **101**, are illustrated. This frame also includes ten secondary line switches of which two, switches **102** and **103**, are illustrated. Ten groups of subscribers' lines **104**—**105** appear in the vertical contacts of the ten corresponding primary switches, and the horizontal rows of contacts of these switches are connected by link circuits to the vertical contacts of the secondary switches on the frame. For example, the No. 0 rows of horizontal contacts of the ten primary switches **100**—**101** are connected to the ten corresponding vertical rows in the No. 0 secondary switch **102**. Similarly, the No. 9 rows of horizontal contacts of switches **100**—**101** are connected to the corresponding vertical rows of contacts of the No. 9 secondary switch **103**, and the same is true of the intervening contact rows in the switches **100** and **101**.

The ten secondary switches **102**, **103** have access respectively to ten groups of trunks **106**—**107**. These groups of trunks are connected to the hori-

zontal rows of contacts in the respective secondary switches.

Each of the ten horizontal rows of each primary switch is provided with a select magnet and a space-discharge tube. For instance, the No. 0 horizontal row of switch 100 is provided with select magnet 108 and tube 109, and the No. 9 horizontal row of the switch is provided with select magnet 110 and tube 111. As will be described more fully hereinafter, the presence of a call on one of the subscribers' lines causes the application of operating voltage to the control gaps of all tubes associated with the corresponding primary switch. When the first tube discharges in response to the operating voltage, the associated select magnet operates to select the horizontal circuit or link for extending the call to the corresponding secondary switch. Thereafter the voltage on all remaining tubes is reduced to prevent another one from discharging and causing a double connection.

A second frame of primary and secondary line switches is also shown in Fig. 1. This second frame comprises ten primary line switches 112—113 and ten corresponding secondary switches 114—115. The primary switches, like those of the first frame, are provided with select magnets and discharge tubes for each of the horizontal rows. The secondary switches may have access to ten separate trunk groups, or they may, as illustrated herein, have access to the trunk groups 106—107 appearing in the switches on the first frame. The purpose of giving two or more frames access to the same trunk groups is to provide these groups with an adequate load.

The tubes disclosed herein may be of any suitable type, such as those having envelopes filled with argon, neon or other gases.

A description will now be given of the detailed operation of the circuits, and for this purpose reference may be had first to Fig. 2. Assume that the subscriber of line 201, appearing in the primary line switch 200, initiates a call. The removal of the subscriber's receiver closes a circuit from battery through the left winding of line relay 202, contacts of hold magnet 203, thence over conductor 204, through the loop of the subscriber's station and returning over conductor 205 through the contacts of magnet 203 and the right winding of relay 202 to ground. Relay 202 operates and closes a circuit from ground through its contacts, conductor 206 through the winding of magnet 203, armature and back contact of said magnet, conductor 207, resistance 208 to the starting electrode 209 of the discharge tube 210, said tube being individual to the magnet 203 and to the vertical row of contacts in which the line 201 appears. The cathode 211 of the tube 210 is connected over circuit 212, winding of relay 213, resistor 214, armature and contact of relay 215 to the negative pole of battery 216. The voltage thus supplied across the control gap 209—211 is sufficient to ionize this gap, but the current flowing is not sufficient to operate either the magnet 203 or the relay 213. Assuming that no other line is calling at the moment, the screen grid 217 of tube 210, which is connected in common with the screen grids of the other tubes, such as tube 218, through a resistor 219 to ground, is, therefore, at ground potential, and ionization immediately transfers to the main anode 220 of the tube 210. The main anode circuit may now be traced from the negative pole of battery 216, contacts of relay 215, resistor 214, winding of relay 213, cathode 211, anode 220, conductor 221, winding of magnet 203 to ground at the contacts of relay 202. Relay 213 operates in this circuit, but the resistance of this relay and the resistance of element 214 is sufficient to prevent the hold magnet 203 from operating at this time.

When relay 213 operates, it closes a circuit from the positive pole of battery 222, common resistor 223, contacts of relay 213 to the common conductor 224, which is connected to the start anodes 225—226 of the ten discharge tubes 227—228 associated respectively with the ten horizontal links 229—230. Each idle link in the group of ten links 229—230 is characterized by the presence of negative battery potential on the test conductor thereof, and busy links are characterized by the presence of ground potential on the test conductor. For example, if link 229 is busy, ground potential is connected through the contacts of a suitable relay 231 over the sleeve conductor 232 to the start cathode 233 of the associated tube 227. With ground potential connected to the start cathode 233 the voltage applied to the starting gap by the battery 222 is insufficient to ionize the same.

If, however, the link circuit 230 is idle at this time, an ionizing circuit for the tube 228 may be traced from the positive pole of battery 222, resistor 223, contacts of relay 213, conductor 224, starting anode 226, starting cathode 234, test conductor 235, resistor 236, contacts of control relay 246, common resistor 247, to the negative pole of battery 237. The control gap 226—234 ionizes, and in similar fashion the control gaps of all other tubes representing idle links ionize. As soon as the ionizing current in the control gap of some one of the tubes corresponding to idle links reaches sufficient value, ionization transfers from the control anode to the main cathode. Assuming that the tube 228 is the first one to reach this transfer stage, a circuit may be traced from the positive pole of battery 222, resistance 223, contacts of relay 213, conductor 224, anode 226, cathode 238, common conductor 239, winding of relay 215, contacts of said relay to the negative pole of battery 216. The instant current commences to flow in this circuit the inductance of the relay 215 sets up a voltage which increases the positive potential of the cathodes of the remaining tubes in the group. Thus the cathode 240 of tube 227 is instantly made more positive to prevent the transfer of ionization of this tube in the event the link 229 had been idle. Thus the ionization of a single one of the tubes prevents the transfer of ionization in all other tubes to prevent the possibility of any double connections.

Shortly after ionization transfers to the main cathode 238 of the tube 228 the main anode gap discharges, and current now flows in a circuit traceable from the negative pole of battery 216, contacts and winding of relay 215, cathode 238, main anode 245, winding of select magnet 241 to ground. The magnet 241 prepares the switch for the selection of the idle link 230 and also closes a short circuit around the resistor 214. The removal of resistor 214 permits sufficient current to flow in the circuit previously traced for the operation of the hold magnet 203. Magnet 203 completes the connection of the line 201 to the link 230 and locks itself in a circuit from battery 242, through the front contact and winding of said magnet, conductor 206, closed contacts of the switch 200, conductor 235 to ground potential which in the meantime has been connected to this conductor in the well-known

manner. The operation of magnet 203 releases relay 202.

After an interval following the closure of the main discharge gap of tube 228 the slow-operate relay 215 opens its contacts and severs the discharge circuits of the tubes 228 and 210. There upon these tubes deionize, and the magnet 241 and relay 213 release. Also the relay 215 restores its armature and recloses its normal contacts. The connection is now established from the line 201 to the link 230 and is held by ground potential on the sleeve conductor of said link.

Preference for the different trunk groups to which the calling lines have access is automatically varied in accordance with the load imposed upon these groups by controlling the sensitivity of the starting gaps of the tubes associated with the horizontal links in the line switches. The circuits for obtaining this preferential control are disclosed more in detail in Fig. 1. In this figure each of the ten primary line switches on each frame, such as the ten switches 100—101 on the lower frame, corresponds to the switch 200 shown in Fig. 2. Each one of these primary switches, such as the switch 100, has ten horizontal links 116—117 giving access to the ten groups of trunks 106—107. The lines 116—117 representing these horizontal links are the test or control conductors, the two talking conductors having been omitted for simplicity. For example, the No. 0 horizontal link 116 of the switch 100 extends to the secondary switch 102, which has access to all ten of the trunks in the group 106. The No. 9 horizontal link 117 of the switch 100 extends to the No. 9 secondary switch 103, which has access to the ten trunks of the tenth group 107. Similarly the eight intermediate horizontal links of the switch 100 extend respectively to the eight intermediate secondary switches, which in turn have access to the eight intermediate groups of trunks. The same relation between the horizontal links, the secondary switches and the trunk groups exist for the second frame of switches and also for other frames not shown.

The test conductors of the ten horizontal links of the primary switch 100 appear respectively in the start cathodes 118—119 of the ten associated discharge tubes 109—111. And the same is true of the horizontal links of all other primary switches. The No. 0 horizontal link of each primary switch on each frame serving the trunk group 106 is connected through an individual resistor to the common control conductor 120. In other words, the test conductor of links 116, 121, 122, 123 are connected through the respective resistors 124, 125, 126, 127 to conductor 120, and this conductor extends through the contacts of control relay 128, through the common resistor 129 to the negative pole of battery 130. In a similar manner the test conductors of the No. 9 horizontal links 117, 131, 132, 133, which have access to the trunk group 107 are connected through the respective individual resistors 134, 135, 136, 137 to the common conductor 138, which in turn extends through the contacts of relay 139 and the common resistor 140 to the negative pole of battery 141. Likewise, the remaining corresponding horizontal links are connected through individual resistors to common voltage supply circuits.

When all trunk groups 106—107 are idle, all test conductors are free from ground potential, and no current flows through any of the ten common resistors 129—140. Therefore, the full negative potential of battery 130 is impressed upon the start cathodes 118, 142, 143, 144. Similarly, the full negative potential of battery 141 is impressed upon the start cathodes 119, 145, 146, 147, and the same is true for the other groups of trunks. When, however, the trunk in one of these groups is taken for use, such as the trunk 148 of the group 106, ground potential is applied to the test conductor thereof, and current now flows over a circuit traceable from the negative pole of battery 130, resistor 129, contacts of relay 128, conductor 120, resistor 124, conductor 116 through the contacts of switch 102, conductor 148 over the busy ground connection 149 to the opposite pole of battery 130. The voltage drop in the common resistance 129 lowers the potential on the start cathodes of all other tubes serving this group of trunks 106. Therefore, when the next call appears in the switch 100, and the same is true in the other primary line switches, the negative potential on the cathode 118 of the tube 109 is lower than the negative potential on the start cathode of the remaining nine tubes associated with this switch. This being true, the voltage across the starting gap of tube 109, which is the sum of the negative potential applied to cathode 118 by battery 130 and the positive potential applied to the start anode 150 from the battery 151, is less than the voltage impressed across the starting gaps of the other nine tubes. For instance, the voltage applied to the gap of tube 111 is the sum of the full negative potential of battery 141 impressed upon the cathode 119 and the full positive potential of battery 151 impressed upon the anode 152. Therefore, the tube 109 is less sensitive than the other nine tubes, and the probability is that some one of the other nine tubes will discharge and cause the extension of the call over the corresponding link into the associated trunk group thus preventing a second call from going into the group 106 which already has one call.

Whenever two or more trunks in any group are in use simultaneously a corresponding heavier current flows through the common resistor 129, and the negative potential on the start cathodes of the associated tubes is lowered correspondingly. Thus as a group becomes more and more loaded the tubes which cause the routing of calls into this group become less and less responsive with the result that subsequent calls are automatically directed into trunk groups having lighter loads.

When all of the trunks of a group, such as group 106, become busy, a chain circuit of any well-known type may be utilized to cause the operation of the common group relay 128. This relay opens the voltage supply circuit 120 and renders all tubes serving this group inoperative. This condition prevails until some one of the trunks in the busy group becomes idle, at which time the relay 128 releases to render the group again available to subsequent calls.

Although the invention is not limited to the use of any particular type of switching mechanism, it has been illustrated herein in a system employing cross-bar switches. For a better understanding of the structure and operation of these switches reference is made to the Reynolds Patent No. 2,021,329 of November 19, 1935. Also reference is made to the Busch et al. Patent No. 2,224,251 of December 10, 1940, for a general disclosure of the use of primary and secondary cross-bar switches for connecting subscribers' lines to trunks.

What is claimed is:

1. The combination in a selecting system of groups of lines, switches, one for each group, for establishing connections with said lines, devices having different degrees of sensitivity for selecting said switches for operation, and means for varying the sensitivity of said devices to vary the selectability of said switches in accordance with the extent to which the associated line groups are used.

2. The combination in a selecting system of groups of lines, switches, one for each group, for establishing connections with said lines, devices having different degrees of sensitivity for selecting said switches for operation, and means for lowering the sensitivity of said devices to reduce the selectability of said switches in proportion to the increased use of the associated groups of lines.

3. The combination in a selecting system of groups of lines, switches for establishing connections with said lines, discharge devices, one for each of said groups, a source of voltage for discharging said devices to cause the operation of said switches to establish connections with the corresponding groups of lines, and means for varying the voltage applied to each one of said discharge devices in accordance with the number of connections established with the corresponding group of lines.

4. The combination in a selecting system of groups of circuits, discharge devices, one for each group for controlling the extension of connections to said groups, means effective as the number of busy circuits in any group increases for decreasing correspondingly the responsiveness of the associated discharge device to increase the preference for other groups of said circuits.

5. The combination in a selecting system of groups of lines, a plurality of discharge tubes, one for each of said groups, for controlling the extension of connections to said groups, a source of voltage for operating said discharge tubes, and means for decreasing the voltage applied to any one of said tubes in proportion to the number of connections existing simultaneously in the corresponding group of lines.

6. The combination in a selecting system of a plurality of groups of lines, switches having access to said lines, a plurality of groups of discharge tubes, each group serving to cause the extension of connections to a particular one of said groups of lines, a source of voltage, supply circuits, one for each group of tubes for applying voltage from said source to said tubes, and means for lowering the voltage applied to any particular group of tubes in proportion to the number of connections established to the lines of the corresponding group.

7. The combination in a selecting system of a plurality of groups of lines, switches having access to said lines, a plurality of groups of discharge tubes, each group serving to cause the extension of connections to a particular one of said groups of lines, a source of voltage, supply circuits, one for each group of tubes for applying voltage from said source to said tubes, means for lowering the voltage applied to any particular group of tubes in proportion to the number of connections established to the lines of the corresponding group, and means for opening the supply circuit of any group of tubes when all of the lines in the associated group are busy.

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