May 9, 1944. W. H. T. HOLDEN 2,348,626

CHANNEL SELECTING CIRCUIT

Filed Nov. 14, 1942 3 Sheets-Sheet 1

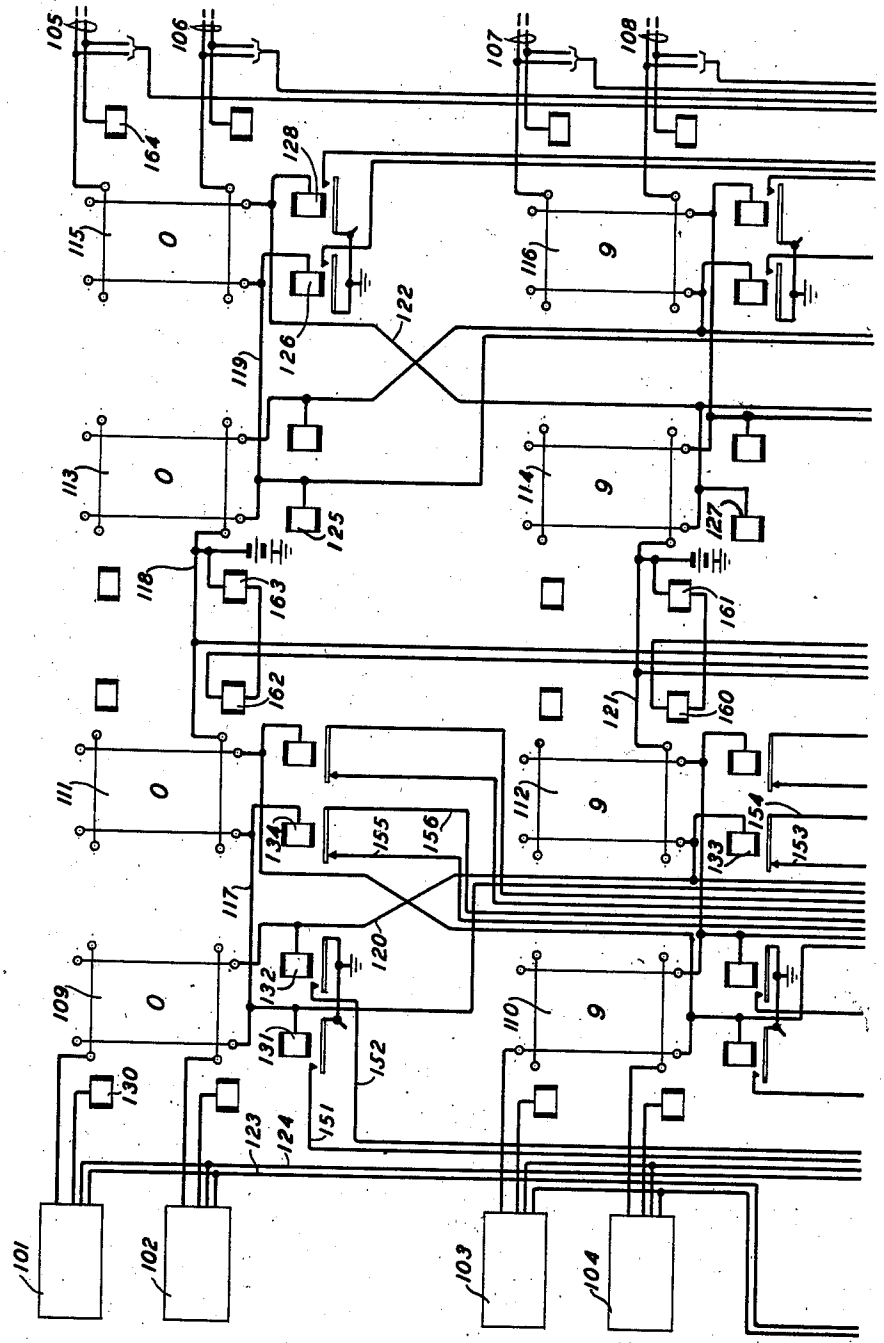

FIG. 1

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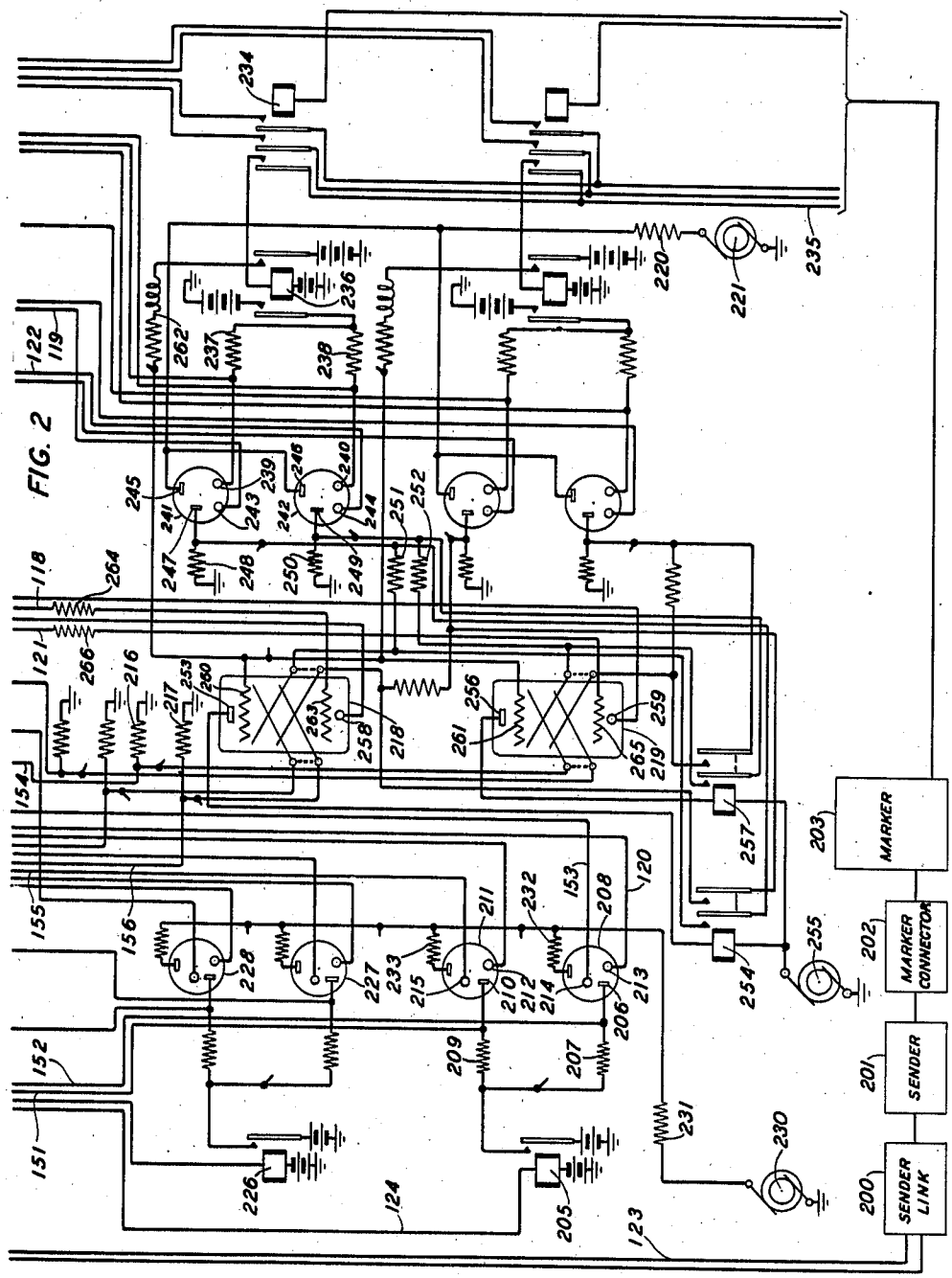

FIG. 2

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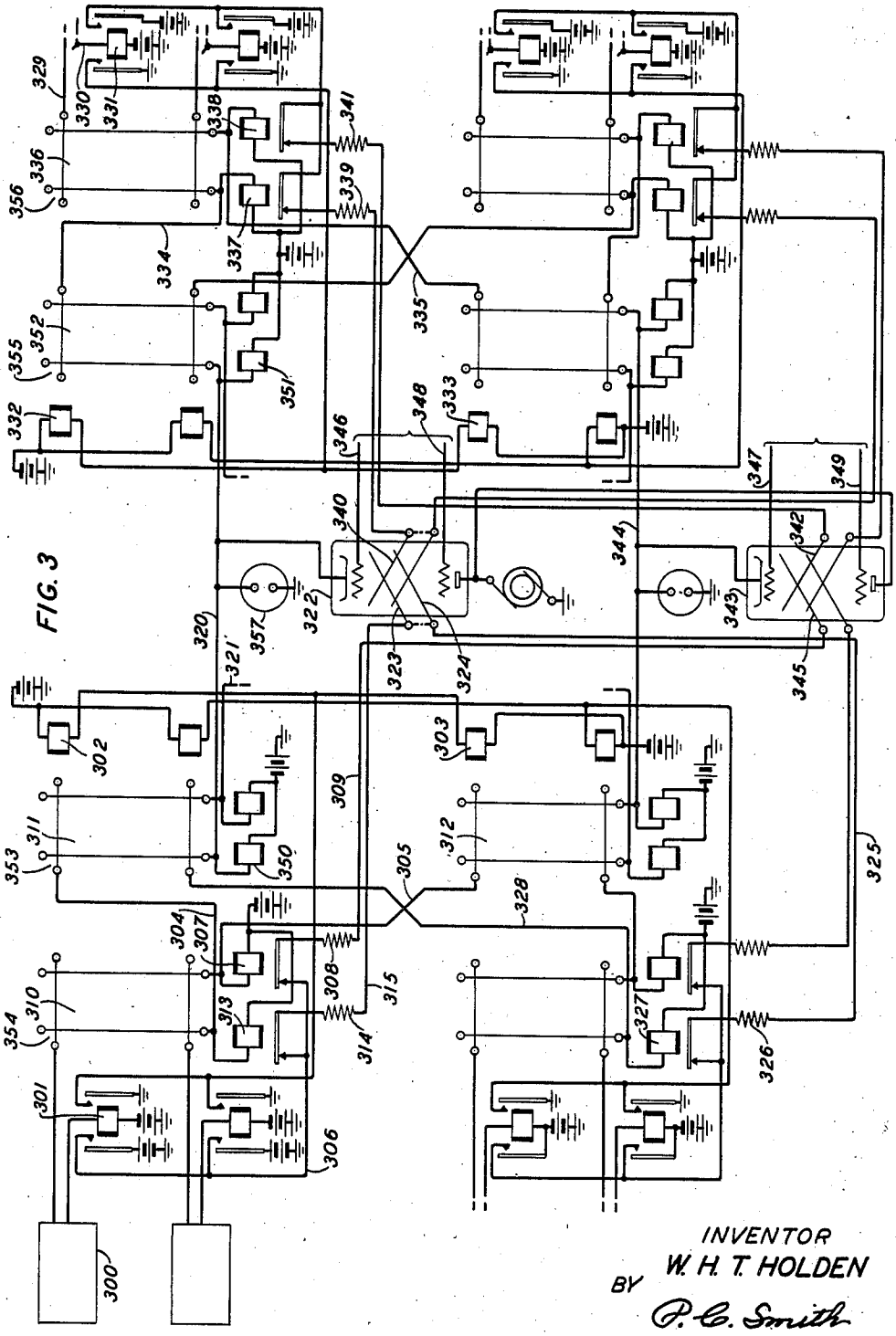

FIG. 3

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2,348,626

CHANNEL SELECTING CIRCUIT

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Application November 14, 1942, Serial No. 465,573

5 Claims. (Cl. 179—22)

This invention relates to telephone systems and has for its object to facilitate the establishment of connections therein.

In the cross bar system connections are established in two stages, each of which includes the identification of the incoming and outgoing circuits, followed by the identification of three sets of links forming channels over which the incoming and outgoing circuits may be connected, testing these links to select an idle channel and operating the switches to connect the incoming and outgoing circuits by means of the selected idle channel.

The channels of the first stage, located at the originating office, connect a district junctor to a trunk and each channel includes a district link, an office junctor and an office link, while the channels of the second stage, located at the terminating office, connect the trunk to the called line, each channel including an incoming link, a line junctor and a line link. The operation of each stage is controlled by a marker.

If the channel testing function were removed from the marker, that circuit would be greatly simplified and its holding time would also be decreased.

In accordance with the present invention, means is provided for testing for and selecting an idle channel independent of the marker by the use of gas-filled tubes.

To this end each intermediate link (office junctor or line junctor) is provided with a gas-filled tube having a control or starting anode for each incoming link (district link or incoming link) having access to the intermediate link and a control or starting cathode for each outgoing link (office link or line link) having access thereto. When testing for an idle channel, the control anodes of idle incoming links serving the calling or incoming circuit are marked and the control cathodes of idle outgoing links serving the selected trunk or outgoing circuit are marked. A control gap breakdown will occur in the tubes in which both a control anode and a control cathode are marked. In one and only one of the tubes associated with an idle intermediate link a main gap breakdown will occur, in response to which the switches connecting the corresponding links will be operated to complete the desired connection.

In accordance with one form of the invention the control electrodes are marked by gas-filled tubes individual to the incoming and outgoing links, while in accordance with another form of the invention the control electrodes are marked under the control of the hold magnets of the switches having direct access to the incoming and outgoing circuits, for example, the district junctor and the wanted trunk.

The invention will be more clearly understood from a consideration of the following description taken in connection with the drawings in which Figs. 1 and 2 show the form of the invention employing tubes for marking the control electrodes while Fig. 3 shows the form of the invention employing contacts on the hold magnets for the marking.

For an understanding of the operation of the cross bar system as now used, reference may be made to United States Patent 2,235,803, granted to W. W. Carpenter on March 18, 1941.

In the form of the invention shown in Figs. 1 and 2 a schematic set of switches which for convenience may be called district and office switches are controlled to connect any one of the incoming circuits 101 to 104 to any one of the outgoing circuits 105 to 108. The incoming circuits 101 and 102 appear in horizontal elements 0 and 9 of district primary switch 109 which is in the 0 level of the frame. The vertical elements of switch 109 are connected to the 0 verticals of the secondary switches 111, 112, etc. The horizontals of secondary switch 111 in the 0 level connect with the 0 levels of the office primary switches on a plurality of frames, including switch 113, while the verticals of switch 113, located in the 0 level of the primary office switch frame, connect with the 0 verticals of secondary office switches 115, 116, etc.

This arrangement differs somewhat from that used in practice but does not differ therefrom in theory. It will be apparent that, if in response to a call incoming on circuit 101 outgoing circuit 106 is selected, the connection may be completed over a channel including switch 109, link 117, switch 111, link 118, switch 113, link 119 and switch 115; over a channel including switch 109, link 120, switch 112, link 121, switch 114, link 122 and switch 115 or over eight other channels, involving other switches, not shown.

In the previous cross bar arrangements, it has been necessary in establishing such a connection to connect each of the links which make up a channel to the marker and then test each link to find an idle channel. This required a large number of relays and complicated the marker circuits.

In the setting up of a connection employing the circuits of Figs. 1 and 2, when a call reaches an incoming circuit 101, that circuit will be con-

nected over circuits indicated by conductor 123 through the sender link 200 to an idle sender 201. The wanted line designation is set up in the sender which then connects with an idle marker 203 by means of marker connector 202. A part or all of the designation is transmitted to the marker which selects an outgoing circuit, for example, circuit 105, connects with the frame on which that circuit appears and locks out all other markers in a manner similar to that used in the Carpenter patent above mentioned. The marker then prepares the circuit to find an idle channel connecting circuit 101 with circuit 105.

The channel testing arrangement of Fig. 2 employs cold cathode gas-filled tubes as a means of selecting and closing through an idle channel. One tube is provided for each link of each channel.

Since each incoming circuit has access to only ten incoming links, that circuit may control the selection of the ten tubes associated with these incoming links. When the marker is ready for the channel test to take place, it signals the incoming circuit 101 which grounds conductor 124, leading to the winding of relay 205 and battery. Relay 205 identifies the ten links serving incoming circuit 101 by connecting +100 volt battery to the starting anodes of the tubes belonging thereto. For example, relay 205 connects battery through resistance 207 to the starting anode 206 of tube 208 which is individual to link 120, and through resistance 209 to the starting anode 210 of tube 211 which is individual to link 117. Hold magnet 131 of the district primary switch 109, when operated, connects ground over conductor 151 in shunt of resistance 209 and hold magnet 132 connects ground to conductor 152 to shunt resistance 207, so that starting voltage does not reach the starting anodes in the case of busy incoming links.

The starting cathode 214 of tube 208 is connected over conductor 153, back contact of hold magnet 133 of district secondary switch 112, in which link 120 terminates, conductor 154 to ground through resistance 216. Starting cathode 215 of tube 211 is connected over conductor 155, back contact of secondary hold magnet 134 and conductor 156 to ground through resistance 217. Therefore it will be apparent that the starting cathode circuit is open whenever the corresponding link is busy. Furthermore, no current surge can reach the intermediate tubes when busy links are released.

The value of resistances 216, 217, etc., is such that for idle links a low current, insufficient to bring about transfer to the main gap, flows through the associated tubes. Tubes 208, 211, etc., are intentionally so made that transfer does not take place readily, with the purpose of preventing transfer at this time. However, a voltage of approximately +40 volts will exist across resistances 216 and 217, which voltage is applied to one starting anode in each of the tubes 218 and 219 individual to the intermediate links 118 and 121 to which the incoming links 117 and 120 have access. Resistance 216 associated with incoming link 120 is connected to a starting anode of tube 219 individual to intermediate link 121, while resistance 217 associated with incoming link 117 is connected to a starting anode of tube 218 which is individual to intermediate link 118. Resistances 216 and 217 are also connected to starting anodes in tubes not shown which are individual to the intermediate links connecting switches 112 and 111 to other office frames.

The main anodes of tubes 208 and 211 are connected in multiple to alternating current source 230 through common resistance 231 and individual resistances 232, 233, etc. The main cathode 213 of tube 208 is connected to the sleeve conductor of link 120 and through the windings of magnets 132 and 133 to central office battery. Similarly the main cathode of tube 211 is connected to the sleeve conductor of link 117 and through the windings of magnets 131 and 134 to battery. With either link busy, ground is connected to the sleeve conductor thereby further preventing transfer by a tube corresponding to a busy link.

When the marker selected the group of outgoing circuits including circuit 105 it operated relay 234 to connect them to the marker for test. Having selected outgoing circuit 105 and signalled incoming circuit 101 to operate relay 205, the marker closes a circuit from ground over conductor 235, outer left contact of relay 234 to the winding of relay 236 and battery. Relay 236 is individual to the group of trunks 105, 106 and therefore to the group of secondary links 119, 122, etc., which have access to that group of trunks. Relay 236 connects a potential of −100 volts in multiple through individual resistances 237, 238, etc. to the starting cathodes 239, 240, etc., of tubes 241, 242, etc. Tube 241 is individual to link 119, having its main cathode 243 connected to the sleeve conductor and through the windings of hold magnets 125 and 126 to battery, while tube 242 is individual to link 122, having its main cathode 244 connected to the sleeve conductor of that link and through the windings of magnets 127 and 128 to battery.

In a manner similar to the arrangement of tubes 208 and 211, hold magnets 126 and 128 when operated connect ground in shunt of resistances 237 and 238, rendering the starting potential ineffective in the case of busy outgoing links. The main anodes 245, 246, etc., of tubes 241, 242, etc., are connected in multiple through resistance 220 to alternating current source 221. The starting cathodes 247 and 249 are connected to ground through resistances 248 and 250 respectively and these resistances are in turn connected through high resistances 251 and 252 to the corresponding starting cathodes in tubes 218, 219, etc., individual to the intermediate links to which the outgoing links have access. Each resistance 248 will be multiplied to ten resistances 251 since each outgoing link may be reached over ten intermediate links.

As in the case of tubes 208 and 211, tubes 241, 242, etc. and their circuits are designed so that a low current flows in the starting gap which is insufficient to cause the main gap to break down but does cause a potential of −40 volts to appear on the corresponding starting cathodes of tubes 218, 219, etc.

Therefore there is a potential of +40 volts on one starting anode in all tubes 218, 219, etc., individual to intermediate links having access to idle incoming links and a potential of −40 volts on one starting cathode in all tubes 218, 219, etc., individual to intermediate links having access to idle outgoing links.

The main anode 253 of tube 218 is connected to the winding of relay 254 and alternating current source 255 while the main anode 256 of tube 219 is connected through the winding of relay 257 to source 255. The main cathode 258 of tube 218 is connected to battery through the windings of select magnets 162 and 163 which identify the level at which intermediate link 118 appears in

switches 111 and 113. Similarly the main cathode 259 of tube 219 is connected to battery through the windings of select magnets 160 and 161 which mark the level of intermediate link 121 in switches 112 and 114.

Each of the tubes 218, 219, etc., has a pair of grid electrodes. Anode grids 260 and 261 of tubes 218 and 219 are connected in multiple through impedance 262 to +100 volt battery. Cathode grid 263 of tube 218 is connected through resistance 264 to the sleeve conductor of intermediate link 118 and cathode grid 265 of tube 219 is connected through resistance 266 to the sleeve conductor of intermediate link 121. The office battery having a potential of —50 volts is connected to these sleeve conductors when the links are idle, while ground over the switch contacts marks busy links.

In those tubes 218, 219, etc., in which a starting anode and a starting cathode are marked by idle incoming and outgoing links, there will be a potential difference of 80 volts across the start gap and that gap will break down. If the cathode grids 263 and 265 are at —50 volts due to the intermediate links being idle, transfer will take place to these grids, followed by transfer to the gap between the cathodes 258, 259 and the anode grids 260, 261. Since all of the grids 260, 261, etc., are connected to +100 volts through a common impedance the main gap in one tube will break down and lock out all the remaining tubes.

The breakdown of one main gap, for example in tube 218, causes relay 254 and select magnets 162 and 163 to operate. The select magnets prepare the proper levels in the district secondary switch 111 and office primary switch 113. Relay 254 closes a short circuit around resistance 251 and also around the resistances connected to the other starting cathodes of tube 218. This reduction in resistance increases the current flow in the starting gaps of tubes 211 and 241 so that the main gaps in these tubes will break down.

The breakdown of the main gap of tube 211 causes the operation of hold magnets 131 and 134. Since the incoming circuit 101 operated the select magnet 130 of the primary switch 109 corresponding to that circuit the incoming circuit 101 is now connected to intermediate link 118.

The breakdown of the main gap of tube 241 permits hold magnets 125 and 126 to operate. When the outgoing circuit 105 was selected by the marker, the select magnet 164 was operated so that the circuit from the incoming circuit to the outgoing circuit 105 is now completed.

The incoming circuit now grounds the sleeve conductor of the operated channel, thereby grounding the cathode 212 of tube 211. The incoming circuit also releases relay 205 which opens the start gaps of the tubes whose main gaps did not break down. The operation of magnet 131 connects ground to the start anode 210 of tube 211 so that, with ground on cathode 212, when alternating source 231 passes through the next half cycle tube 211 releases.

Similarly, ground on the sleeve of link 119 extends to cathode 243 of tube 241 and magnet 126 connects ground to start cathode 239 resulting in the release of tube 241 on the next half cycle of source 221.

The marker receiving an indication that the connection has been completed releases relays 234 and 236 to open the start gaps of the tubes in which the main gaps did not break down. Relay 236 also opens the screen grid circuit of tube 218 and this tube also releases, since its main anode supply is alternating current and the control gaps have been deenergized.

It is to be understood that all of the magnets as well as relays 254 and 257 are provided with copper sleeves so that they will function with pulsating current.

This circuit enables the switch frames to find routes from trunk to junctor without extending large numbers of sleeve conductors to the marker and greatly reduces the number of connector relays.

In Fig. 3 is shown an alternative form of the invention.

When a calling subscriber's line is extended to an incoming circuit such as circuit 300 and that circuit is connected with a marker, contacts are closed which cause the operation of the select magnet 301 individual to that circuit in the primary incoming switch 310. Magnet 301 prepares the cross-points of primary incoming switch 310 in which incoming circuit 300 appears and at its right auxiliary contact operates the twenty select magnets 302, 303, etc., which relate to the twenty incoming links 304 and 305 which connect the primary switch 310 with the twenty secondary switches 311, 312, etc. At its left contact magnet 301 connects positive battery to conductor 306. Twenty hold magnets such as magnets 307 and 313 are individual to the twenty incoming links 304, 305, etc., extending from primary switch 310 to the twenty secondary switches 311, 312, etc. Whenever any one of these links is in use in a connection, the corresponding hold magnet is operated, opening its normal contact. Assuming that both links 304 and 305 are idle, the positive battery connected to conductor 306 is extended over the back contact of the hold magnet 313, through resistance 314 to conductor 315 and over the back contact of hold magnet 307 through resistance 308 to conductor 309.

At the secondary switch 311 a group of ten incoming links 304, etc., has access to ten intermediate links 320, 321 which appear in the verticals of the switch. The select magnet 302, corresponding to link 304 which extends to the primary switch 310 in which the calling incoming junctor 300 appears, has been operated, as above described. Associated with each intermediate link 320, 321 is a multielement cold cathode tube 322, etc., having separate pairs of starting anodes and starting cathodes, ten such pairs per tube. The starting anodes of these tubes are connected through suitable current limiting resistances to the armatures of the hold magnets corresponding to the incoming links having access to the intermediate link. For example, starting anode 323 of tube 322 is connected over conductor 315 through resistance 314 to the armature of hold magnet 313 which is individual to incoming link 304. Similarly, starting anode 324 is connected over conductor 325, through resistance 326 to the armature of hold magnet 327 which is individual to incoming link 328. Starting anode 345 of tube 343 is connected over conductor 309, and resistance 308 to the armature of hold magnet 307 which is individual to incoming link 305.

The number of the wanted line may be recorded in a sender, the designation transferred to a marker and an idle outgoing circuit selected as described in the Carpenter patent above mentioned. When the idle outgoing circuit has been selected the marker connects ground to the winding of the select magnet individual to the outgoing circuit in the secondary outgoing switch.

Assuming that trunk 329 has been selected, ground will be connected to conductor 330 leading to select magnet 331, this ground serving to mark the outgoing circuit busy to other markers. Magnet 331 prepares the contacts in the level of secondary outgoing switch 336 in which outgoing circuit 329 appears and also closes at its left contact a circuit for the twenty select magnets 332, 333, etc., one for each of the primary outgoing switches, which are individual to the outgoing links 334, 335, etc. having access to the outgoing circuit selected.

At its right contact magnet 331 connects negative battery to armatures on the hold magnets 337, 338, etc., of the secondary outgoing switch 336. If outgoing links 334 and 335 are idle, magnets 337 and 338 will be released and battery will be extended over the back contact of magnet 337, through resistance 339 to starting cathode 340 of tube 322. Similarly, over the back contact of magnet 338, battery is extended through resistance 341 to starting cathode 342 of tube 343 individual to intermediate link 344.

In order that the tubes 322, 343, etc., may be operative the starting electrodes of the tubes must be so arranged that breakdown may be possible from any starting anode to any starting cathode. Any arrangement which would give this result might be used, but according to the preferred arrangement which is suggested by the criss-cross pattern of the drawings, the starting electrodes are made in the form of two groups of ten insulated parallel wires, the wires in one group being at right angles to those in the other, the two groups forming a grid pattern.

As a result of the operations above described, it will be seen that negative battery has been applied to a starting cathode of twenty or less intermediate link tubes 322, 343 and that positive battery has been applied to the starting anode of twenty or less such tubes. If any of the incoming links or outgoing links are busy, battery will not appear on the starting anodes or cathodes corresponding thereto. In order that one and only one intermediate link tube shall operate, positive impulses are applied successively to the anode grid leads 346, 347, etc., and negative impulses are applied successively to the cathode grid leads 348, 349, etc., so that the impulse voltages are present at the same time in any one tube, but not simultaneously in more than one tube. The circuit for applying this pulse has not been shown but may be substantially similar to the circuit used in my Patent No. 2,252,766, granted August 19, 1941. Therefore, only one of the tubes 322, 343 will operate, because as soon as one tube operates, the impulse supply to all the grids is shorted out by the grid current flow resulting. If the intermediate link is busy, ground on the cathode of the corresponding tube from the sleeve of the link renders the impulses supplied to that tube ineffective. As a result, an idle intermediate link having access to the calling incoming circuit by way of an idle incoming link and also having access to the wanted outgoing circuit, by way of an idle outgoing link is selected by the operation of the tube corresponding thereto. Assuming that tube 322 is operated, intermediate link 320 is selected, this link having access to incoming circuit 300 over incoming link 304 and to outgoing circuit 329 over outgoing link 334.

The main discharge circuit of tube 322 extends to negative battery through the winding of hold magnet 350 of the secondary incoming selector 311 and through the winding of hold magnet 351 of the primary outgoing selector 352 and these magnets operate. Magnet 350 closes cross-point 353, connecting hold magnet 313 of primary incoming selector 310 in parallel with magnet 350. Magnet 313 closes cross-point 354.

Similarly, the operation of magnet 351 closes cross-point 355, connecting hold magnet 337 of secondary outgoing selector 336 in parallel with magnet 351, and magnet 337 operates to close cross-point 356 to complete the connection between incoming circuit 300 and outgoing circuit 329. Hold magnets 313, 350, 351 and 337 are held operated from ground on the sleeve conductor of the incoming circuit 300.

The operation of hold magnets 313 and 337 opens the circuits supplying operating voltage to the corresponding starting electrodes, while the incoming circuit responds to the completion of the circuit to outgoing circuit 329 by releasing select magnet 301 and the marker which in turn releases select magnet 331. Magnets 301 and 331 release the select magnets 302, 333, 332, 333, etc. Tube 322 is also released as the anode circuit alternating current component now overrides the direct current component.

The diode tube 357 is connected to the sleeve of intermediate link 320 to prevent reoperation of tube 322 when the circuits release, at which time tube 357 breaks down and dissipates the energy stored in the hold magnets.

What is claimed is:

1. In a telephone system, incoming circuits, outgoing circuits, a plurality of channels each comprising an incoming link, an outgoing link and an intermediate link for connecting one of said incoming circuits to one of said outgoing circuits, means to identify a particular incoming circuit, means to mark a plurality of idle incoming links having access to said identified incoming circuit, means for identifying a wanted outgoing circuit, means for marking a plurality of idle outgoing links having access to said wanted outgoing circuit, a gas-filled tube individual to each intermediate link, a control anode in each tube individual to each incoming link having access to said intermediate link, a control cathode in each tube individual to each outgoing link having access to said intermediate link, a main cathode and a main anode in each tube, means to cause a discharge between a control anode and a control cathode connected to idle incoming and outgoing links having access to the same intermediate link, means to cause a discharge between the main cathode and main anode of one of said tubes in which a control gap discharge occurs and means under the control of said main cathode-anode discharge to establish a circuit between said identified incoming circuit and said wanted outgoing circuit including the intermediate link to which the tube in which said discharge occurs is individual.

2. In a telephone system, incoming circuits, outgoing circuits, a plurality of channels each comprising an incoming link, an outgoing link and an intermediate link for connecting one of said incoming circuits to one of said outgoing circuits, means to identify a particular incoming circuit, means to mark a plurality of idle incoming links having access to said identified incoming circuit, means for identifying a wanted outgoing circuit, means for marking a plurality of idle outgoing links having access to said wanted outgoing circuit, a gas-filled tube individual to each intermediate link, a control anode in each

tube individual to each incoming link having access to said intermediate link, a control cathode in each tube individual to each outgoing link having access to said intermediate link, a main cathode and a main anode in each tube, means to cause a discharge between a control anode and a control cathode connected to idle incoming and outgoing links having access to the same intermediate link, means to cause a discharge between the main cathode and main anode of one of said tubes in which a control gap discharge occurs, means under the control of said main cathode-anode discharge to establish a circuit between said identified incoming circuit and said wanted outgoing circuit including the intermediate link to which the tube in which said discharge occurs is individual and means to prevent a main cathode-anode discharge in tubes individual to busy intermediate links.

3. In a telephone system, incoming circuits, outgoing circuits, a plurality of channels each comprising an incoming link, an outgoing link and an intermediate link for connecting one of said incoming circuits to one of said outgoing circuits, means to identify a particular incoming circuit, first gas-filled tube means to mark a plurality of idle incoming links having access to said identified incoming circuit, means for identifying a wanted outgoing circuit, other gas-filled tube means for marking a plurality of idle outgoing links having access to said wanted outgoing circuit, a multielectrode gas-filled tube individual to each intermediate link, a control anode in each multielectrode tube connected with the first gas-filled tube marking each incoming link having access to said intermediate link, a control cathode in each multielectrode tube connected with the other gas-filled tube marking each outgoing link having access to said intermediate link, a main cathode and a main anode in each multielectrode tube, means controlled by the gas-filled tubes marking idle incoming links and idle outgoing links to cause a discharge between a control anode and a control cathode individual to idle incoming and outgoing links having access to the same intermediate link, means to cause a discharge between the main cathode and main anode of one of said multielectrode tubes in which a control gap discharge occurs, and means under the control of said main cathode-anode discharge to render the first gas-filled tube and the other gas-filled tube connected with the control anode and control cathode of the control gap effective to establish a circuit between said identified incoming circuit and said wanted outgoing circuit including the intermediate link to which the tube in which said main cathode-anode discharge occurs is individual.

4. In a telephone system, incoming circuits, outgoing circuits, a plurality of channels each comprising an incoming link, an outgoing link and an intermediate link for connecting one of said incoming circuits to one of said outgoing circuits, means to identify a particular incoming circuit, first gas-filled tubes individual to the incoming links having access to said identified incoming circuit, each of said first gas-filled tubes having a control gap and a main gap, means responsive to the identification of said incoming circuit to establish a control gap discharge in said first gas-filled tubes individual to idle incoming links, means for identifying a wanted outgoing circuit, other gas-filled tubes individual to the outgoing links having access to said wanted outgoing circuit, each of said other gas-filled tubes having a control gap and a main gap, means responsive to the identification of said outgoing circuit to establish a control gap discharge in said other gas-filled tubes individual to idle outgoing links, a multielectrode gas-filled tube individual to each intermediate link, a control anode in each multielectrode tube connected with the first gas-filled tube marking each incoming link having access to said intermediate link, a control cathode in each multielectrode tube connected with the other gas-filled tube marking each outgoing link having access to said intermediate link, a main cathode and a main anode in each multielectrode tube, means responsive to the control gap discharge in the gas-filled tubes marking idle incoming links and idle outgoing links to cause a discharge between a control anode and a control cathode individual to idle incoming and outgoing links having access to the same intermediate link, means to cause a discharge between the main cathode and main anode of one of said multielectrode tubes in which a control gap discharge occurs, means responsive to said main cathode-anode discharge to cause a main gap discharge in the first gas-filled tube and the other gas-filled tube connected with the control anode and control cathode of the associated control gap, and means responsive to the main gap discharges in said first gas-filled tube and said other gas-filled tube to establish a circuit between said identified incoming circuit and said wanted outgoing circuit including the intermediate link to which the tube in which said main cathode-anode discharge occurs is individual.

5. In a telephone system, an incoming circuit, outgoing circuits, a plurality of channels each comprising primary and secondary cross bar incoming selectors, primary and secondary cross bar outgoing selectors and an intermediate link for connecting an incoming circuit to one of said outgoing circuits, select magnets and hold magnets for each of said selectors, means under the control of said incoming circuit to operate the select magnets of the primary and secondary incoming selectors having access to said incoming circuit, selection control equipment, means in said selection control equipment to select an idle one of said outgoing circuits and to operate the select magnets of the primary and secondary outgoing selectors having access to said outgoing circuit, a gas-filled tube individual to each intermediate link, a control anode in each tube individual to one hold magnet in each primary incoming selector having access to the corresponding intermediate link, a control cathode in each tube individual to one hold magnet in each secondary outgoing selector having access to the corresponding intermediate link, a main cathode and a main anode in each tube, means controlled by idle ones of said hold magnets to cause a discharge between a control anode and a control cathode, means to cause a discharge between the main anode and main cathode of one of said tubes in which a control gap discharge occurs, and means under the control of said main cathode-anode discharge to operate the hold magnets of the incoming and outgoing selectors of the channel including the corresponding intermediate link to establish a circuit between said incoming circuit and said selected outgoing circuit.

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