June 9, 1942. W. H. T. HOLDEN ET AL 2,285,972

TELEPHONE SYSTEM

Filed June 22, 1940 4 Sheets-Sheet 1

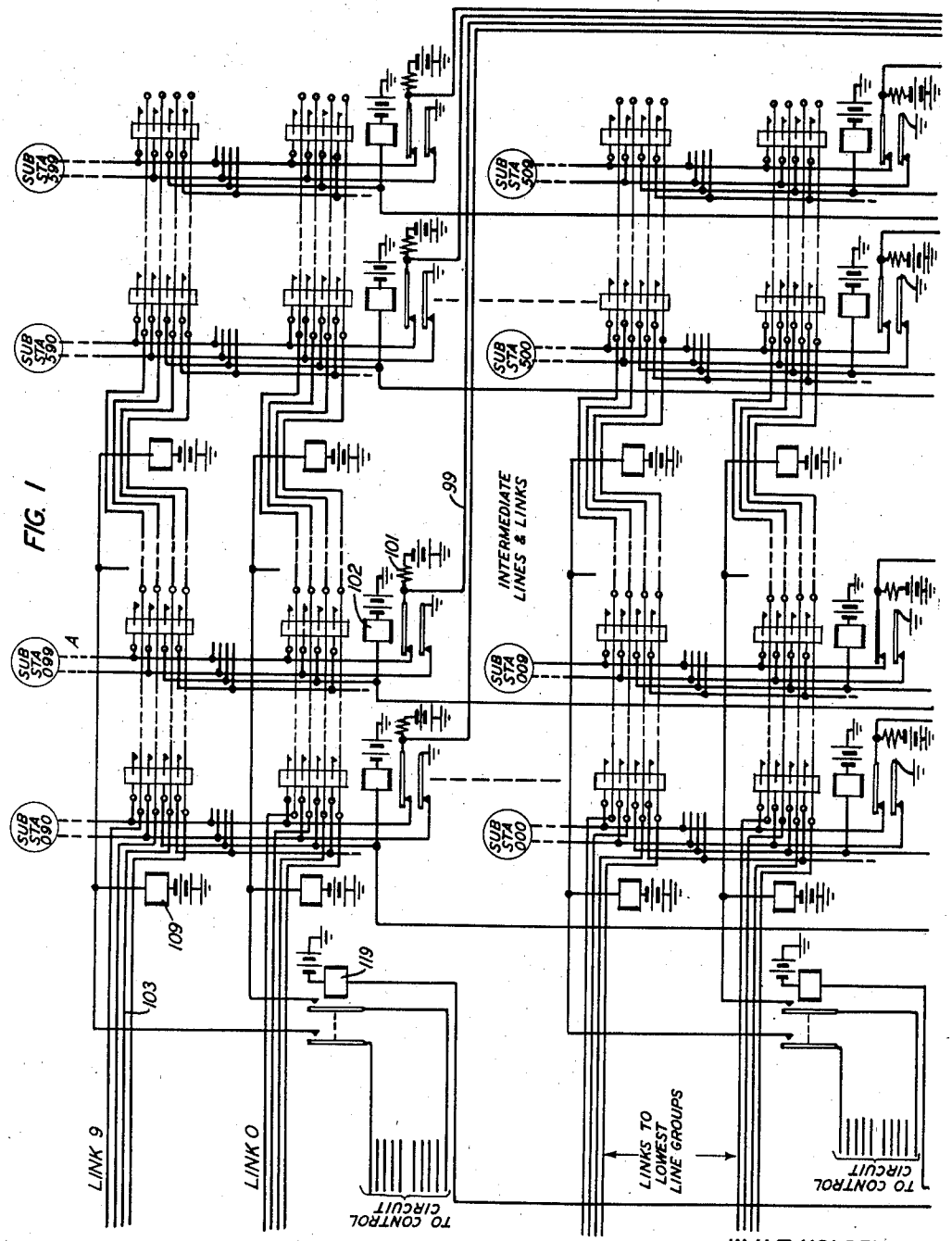

FIG. 1

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TELEPHONE SYSTEM

Filed June 22, 1940 4 Sheets-Sheet 2

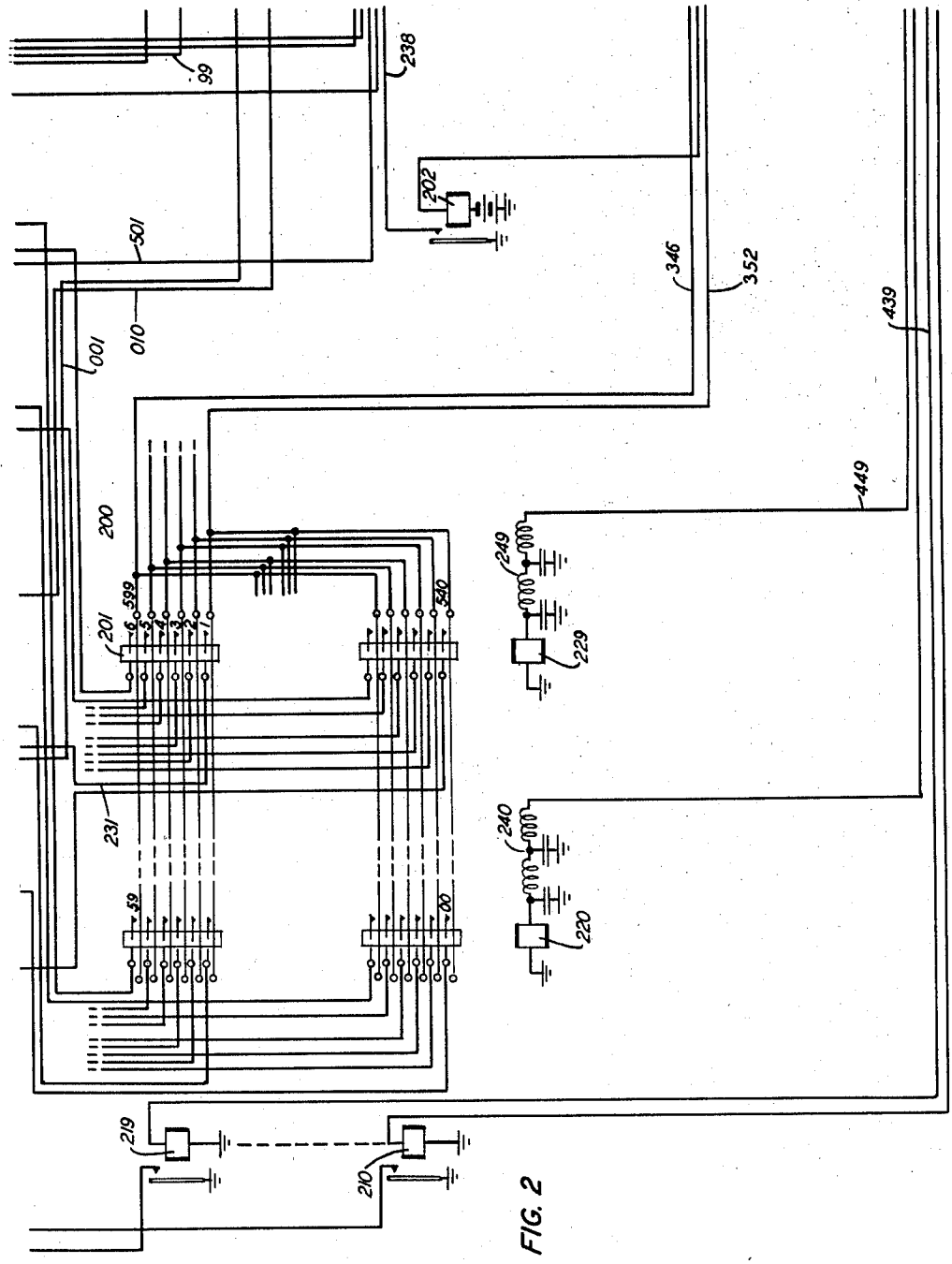

FIG. 2

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TELEPHONE SYSTEM

Filed June 22, 1940 4 Sheets-Sheet 3

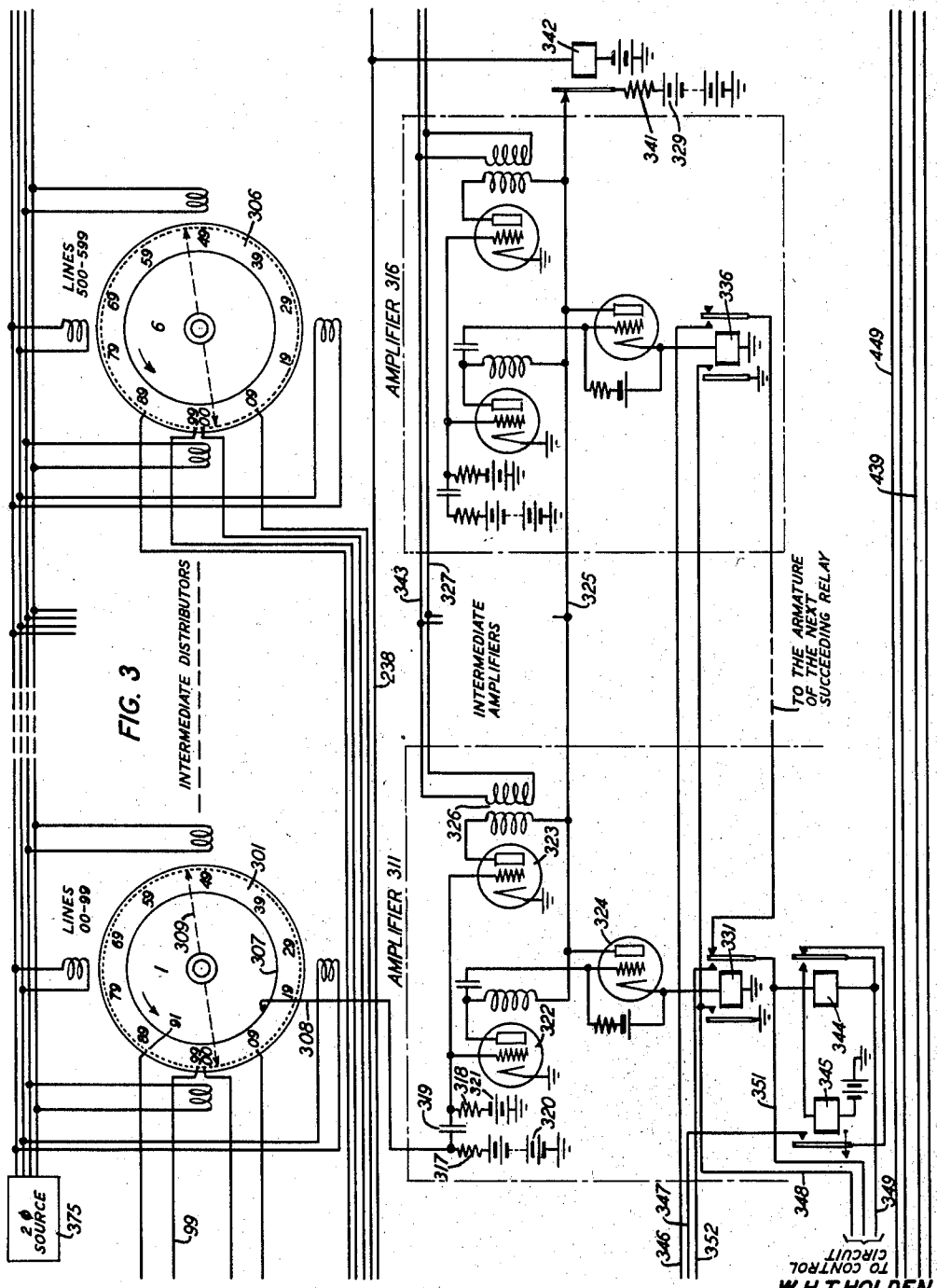

FIG. 3

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TELEPHONE SYSTEM

Filed June 22, 1940 4 Sheets-Sheet 4

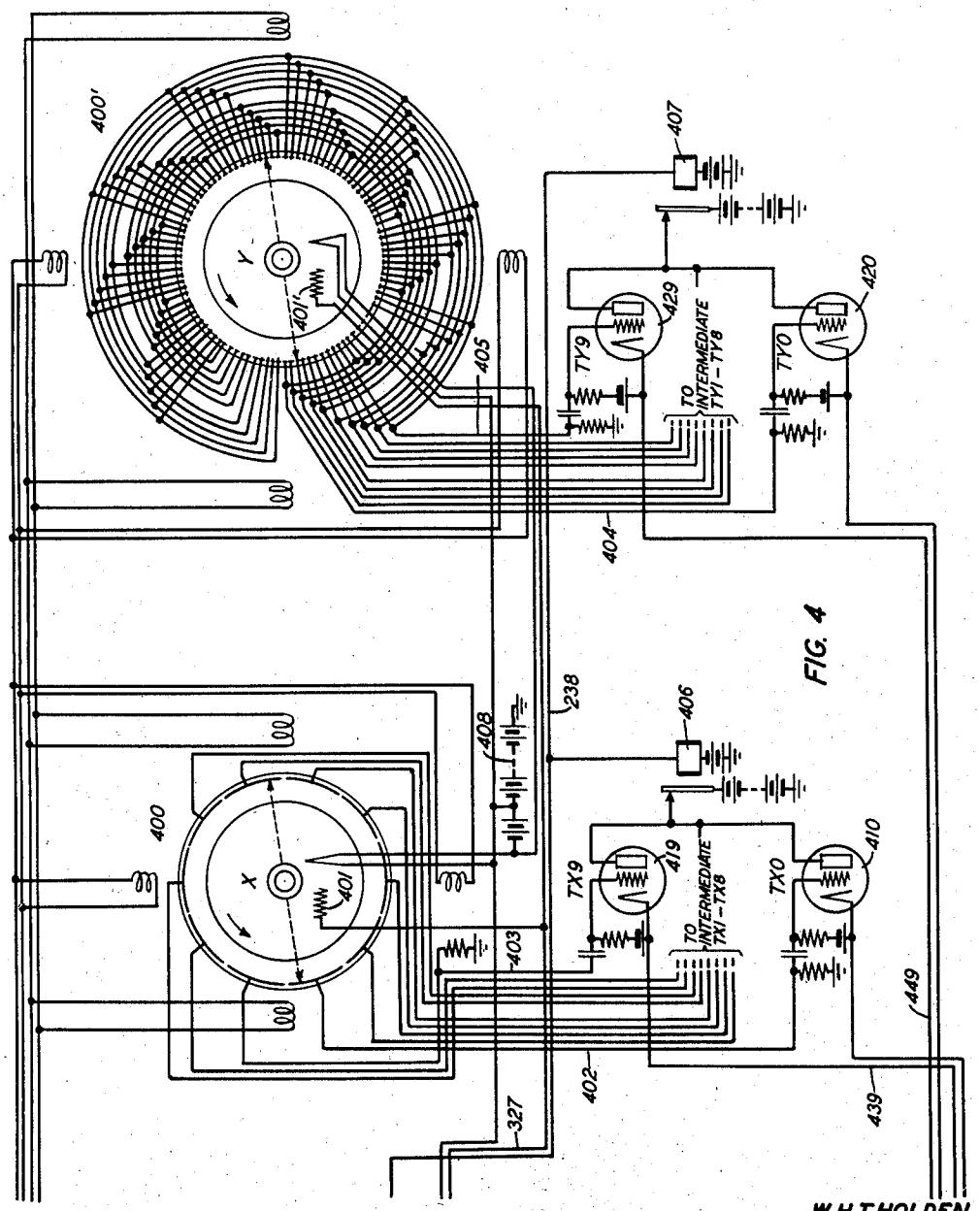

FIG. 4

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Patented June 9, 1942

2,285,972

UNITED STATES PATENT OFFICE

2,285,972

TELEPHONE SYSTEM

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Application June 22, 1940, Serial No. 341,816

8 Claims. (Cl. 179—18)

This invention relates to telephone systems and has for its object the improvement of such systems by the use of novel equipment.

More specifically, the invention contemplates a novel line circuit for a subscriber's line which does not involve the usual line and cut-off relay as parts thereof and, in this respect, one novel feature of the invention is the disposition of telephone lines upon the cross-points of a cross-bar switch, each hold magnet of which forms a part of the line circuit of the individual line disposed upon the cross-points controlled by said magnet.

Another feature of the invention is a novel arrangement of electron distributors which are adapted to operate in response to the initiation of a call to identify the cross-point of the line making the call and to control the circuits which operate the appropriate select and hold magnets that cause the extension of said line to an idle link channel available in common to the lines of the group of which the calling line forms a part. This is accomplished through the application of a discriminating potential upon an electrode individual to the line in a distributor allocated to a group of lines, and through circuits responsive to an impulse generated by the electrode when the scanning beam of the distributor strikes it.

Another feature of the invention is the application of an auxiliary cross-bar switch through whose operated cross-points the respective hold magnets of the various individual line circuits are made accessible.

A further feature of the invention contemplates the use of other scanning distributors by which the magnets of said auxiliary cross-bar switch are controlled.

These and other features of the invention will be more apparent from a consideration of the ensuing description in connection with the drawings, in which:

Fig. 1 shows a cross-bar line switch assembly accommodating six hundred lines divided into vertical subgroups of one hundred lines each;

Fig. 2, which should be placed directly below Fig. 1, shows the auxiliary cross-bar switch unit through whose cross-points the hold magnets of the line switch in Fig. 1 are accessible;

Fig. 3, which should be placed to the right of Fig. 2, shows two of six electron distributors and amplifiers controlled thereby as well as the common release circuit; and

Fig. 4, which should be placed to the right of Fig. 3, shows two other electron distributors and amplifiers controlled thereby.

Reference is here made to the application of W. W. Carpenter, Serial No. 214,356, filed June 17, 1938, now U. S. Patent 2,235,803, granted March 18, 1941, for a detailed description of a telephone system of the type in which the present invention may be employed.

In such a system, a calling subscriber, upon initiating a call, is connected to an idle link channel and thereover to a district junctor circuit and to a sender via sender selecting switches. The subscriber then dials the wanted number which is registered in the sender. When the sender has received the digits identifying the office in which the wanted line is located, it associates itself with an idle marker through a marker connector and transmits these digits to the marker. The marker translates said digits and operates a route relay in consequence thereof which identifies the trunks leading to the wanted office. The present invention has to do with a line circuit for such a system having neither line nor cut-off relays and which operates in conjunction with electron scanning devices that operate to extend the calling line to an idle link channel.

According to the present invention, the line circuit comprises a hold magnet of a cross-bar switch, a loop extending between the line station and the contacts of said magnet, a resistance and a source of current connected to said contacts whereby upon the line initiating a call, current will flow over the loop and through said resistance. A conductor is provided for each line which extends from one side of the resistance to an electrode within an electron distributor which is adapted to hold one hundred such electrodes, each connected to a different line. The electrodes, or anodes, are circularly disposed within the distributor envelope and can be struck by the electron beam in succession if the beam is caused to rotate around the anode ring by suitable sweep controls at the envelope deflecting plates. The potential of any anode is altered when the associated line initiates a call, and when the electron beam strikes the anode a secondary electron emission is induced which, after suitable amplification, operates a thyratron device having a relay in its space current path that operates to close a partial circuit to the hold magnet of the calling line circuit, and is further impressed upon the grids of two other electron distributors whose electron beams rotate synchronously with

that of the "line" distributor. The first of these two other distributors has its one hundred circularly disposed anodes multiplied in ten groups of ten each and the other has its one hundred similarly disposed electrodes multiplied in ten groups of ten, each group being made up of corresponding anodes in each of the groups of ten. Since all three beams rotate synchronously, the beam of the line distributor strikes the anode whose potential has been altered by the calling condition of its associated line at the same time that the beams of the two other distributors strike the correspondingly disposed anodes which, considering the manner in which they are separately multiplied, will indicate the tens and units designation of the calling line. These anodes, when struck by the electron beams, induce secondary electron emissions which, through suitable amplifiers, operate two other thyratron devices that complete circuits to the appropriate select and hold magnets of an auxiliary cross-bar switch that, in operating, close the cross-point through which the line hold magnet circuit is completed by the relay operated in response to the line distributor beam striking the anode of the calling line. The operated select magnet of the auxiliary cross-bar switch locally controls the select magnet of the line switch and the operation of said magnet as well as the line hold magnet, serves to extend the calling line to the link.

The operation of the invention will now be described in detail with respect to the circuits and apparatus shown in the above-mentioned drawings.

In Fig. 1 is shown a subscriber's line group of six hundred lines disposed in vertical subgroups of one hundred lines at the cross-points of the cross-bar switch assembly in the numerical order indicated in each of the circles designating a subscriber's line. The cross-bar switch shown in Fig. 1, as well as that shown in Fig. 2, is disclosed in Patent 2,021,329, granted November 19, 1935, to J. N. Reynolds and reference is made thereto for a complete description of its construction and operation.

Each line circuit, as, for instance, line circuit A, which is line 99 in the first vertical subgroup of lines, has a conductor 99 extending to an anode 99 in the electron discharge distributor 301. Similarly, all other lines in this group have their respective identifying conductors extended to correspondingly numbered anodes in distributor 301. The remaining five groups of one hundred lines each have their respective identifying conductors connected to correspondingly numbered anodes in the other distributors, namely, distributors 302 to 306. This distributor, of which six are used as line distributors for a six hundred line group, namely, 301 to 306, of which the first and last only are shown in Fig. 2, and two more, namely, 400 and 400' shown in Fig. 4 which are used as identifying distributors, are of the kind described in Patent 2,217,774 granted to A. M. Skellett on Oct. 5, 1940. The distributor comprises a cathode, one hundred anodes mounted in a cylindrical boundary coaxial with and encompassing the cathode beam, means for concentrating the electrons emanating from the cathode into a single radial rotating beam focussed and impinging upon the anodes in sequence, and a collector ring which acts as a common electrode. The concentrating means comprises a two-phase current supply 375 for producing a magnetic field normal to the cathode and an electrostatic field in step with the magnetic field and phased with respect thereto so that the electric vector is parallel to the lines of force of the magnetic field.

In the present embodiment of the invention, six electron line distributors are utilized because the auxiliary cross-bar switch 200 is a six-wire switch, which fact limits the capacity of the line group to six hundred lines. It is obvious, however, that the invention is not so limited, it being evident that auxiliary switching facilities can be augmented and the line group increased correspondingly, in which event the line distributors would also have to be increased in accordance with the number of lines which can be accommodated by a single distributor.

In the operation of the invention, a subscriber, say subscriber A, initiates a call and in so doing completes a circuit which is traced from battery, resistance 101, inner contacts of hold magnet 102, subscriber's loop, outer contacts of hold magnet 102 to ground. The current flowing through this circuit establishes a negative potential to the left of resistance 101 which is applied, over conductor 99 to anode 99 of the electronic distributor 301. The revolving beam of the distributor, caused by the 2Φ 20-cycle supply 375 connected to the two sets of coils outside of the envelope and deflecting the beam electromagnetically as explained in the above-mentioned patent to Skellett, sweeps a surface in the form of a circle that coincides with the ring formed by the one hundred anodes to which the conductors of the first one hundred line subgroup are connected. Consequently when the beam strikes the anode connected to conductor 99 of the calling line (this anode now being more negative than normal), a current impulse is produced by the electron emission induced through the circuit formed by the line anode, in the "collector" electrode 307 of the distributor, conductor 308, resistance 317, positive battery 320. The collector electrode 307 is a circular electrode adjacent to the anodes and is connected to the outside of the distributor by a collector conductor 308 which extends, in turn, to the grids of vacuum tubes 322 and 323 and to the resistance-capacity coupling consisting of resistance elements 317 and 318 and capacity element 319.

The current to the collector electrode 307 is due to the secondary electrons emitted from the target anodes when the electronic beam 309 is incident thereon. When an anode is more negative than its normal value, due to the associated line initiating a call, the voltage available to draw the secondary electrons to the collector 307 is increased, which causes the collector current in conductor 308 to increase. The point in the cycle of rotation of the primary beam at which this current increase will occur is characteristic of the identity of a particular anode. For example, as there are one hundred anodes distributed around 360 degrees of the circle, and as the 2Φ field is a bipolar one, the 2Φ current or voltage causing the beam to be deflected will go through 360 electrical degrees for one complete sweep around the circle. Thus if the twenty-fifth anode is the one that corresponds to the calling line, the phase angle between the impulse in the collector circle and the 2Φ supply will be 90 degrees, while if it were the twenty-fourth electrode the phase angle would be 87.4 degrees. In this way, the collector current, when it is produced, identifies which one of the one hundred lines is calling.

When the collector current impulse appears

on conductor 308, it is transmitted to the grids on vacuum tubes 322 and 323 of amplifier 311. The voltage impulse of the collector is applied through the resistance-capacity coupling above described. Battery 320 furnishes the usual positive bias for the collector electrode. Battery 321 furnishes grid bias to the amplifier vacuum tubes 322 and 323, the grids of which are multipled. The output of the tube 322 is applied to the grid of the gas-filled tube 324 which has anode battery supplied to it from positive battery source 329 through resistance 341, contacts of relay 342, conductor 325, and causes it to become conducting when the impulse is received from the collector by the amplifier tube 322. The operation of gas-filled tube 324 causes the operation of relay 331 which operates to ground start conductor 348 to initiate the operation of a control of the kind disclosed in the above-mentioned Carpenter application, performs functions noted hereinafter and lowers the voltage on the anode of each of the other five gas-filled tubes which are connected together by conductor 325 to resistance 341. It also lowers the anode voltage on the vacuum tubes 322 and 323 of amplifier 311 as well as on the other vacuum tubes of the other five amplifiers 312 to 316, so that they are ineffective after gas-filled tube 324 becomes conducting. This reduction in anode voltage results from the drop in resistance 341 due to the arc current of the thyratron tube 324. Resistance 341 is large compared to the resistance of the windings of the relays 331 to 336. In this way, the first calling line anode struck by the electron beam of a line distributor will seize control of the entire circuit (shown on Fig. 1) until this line has been cut through to a free link channel in the manner to be described hereinafter.

At the same time that the amplified impulse from tube 322 reaches the grid of gas-filled tube 324, the same impulse, amplified, is also transmitted through tube 323, transformer 326 to conductor 327, which connects with the control grids 401 and 401' of the electronic distributors 400 and 400' respectively, shown in Fig. 4. These distributors are also of the cathode ray type but differ from distributors of the 301 type in that they have a control grid 401. This grid is connected to conductor 327 and through the secondary winding of transformer 326 and conductor 343 to a source of negative battery 408. The grid bias potential is of such a value as to suppress the electron beam except when an impulse of the proper polarity is received from the transformer 326 at which time the change of grid bias due to the impulse releases the beam for impingement upon whatever anode is in line with the direction indicated by the magnetic field outside of the distributor envelope. The arrangement of the anodes in each of the distributors 400 and 400' is as follows:

In each of the distributors 400 and 400' there are one hundred anodes which correspond in position to the one hundred anodes in each of the line distributors 301 to 306. The leads, however, are not brought out from each of the anodes. They are instead, multipled in the following order: In distributor 400, the anodes 0 to 09 are multipled to a single conductor which is brought out. Likewise, anodes 10 to 19, 20 to 29, etc. are groups each connected to its own group conductor. In distributor 400', on the other hand, anodes 00, 10, 20, 30, etc. up to and including anode 90 are multipled together and one conductor is connected thereto and brought out therefrom. Similarly, anodes 01, 11, 21, 31, etc. are multipled and a single conductor connected to them and brought out. There is, therefore, a total of ten conductors each of which is connected to every tenth anode around the circle.

Each anode conductor from distributor 400 extends to the grid of a gas-filled tube of which one tube 410 of thyratron circuit TX0 is shown connected to conductor 402 which extends to the first group of ten anodes of distributor 400; another conductor 403 which extends to the tenth group of anodes in distributor 400 is connected to the grid of gas-filled tube 419 of thyratron circuit TX9, while the intermediate conductors for the second to ninth groups of anodes are connected to the grids of the intermediate gas-filled tubes 411 to 418 of circuits TX1 to TX8 which are not shown but indicated. Similarly, each conductor from distributor 400' extends to the grid of a gas-filled tube of which one tube 420 of thyratron circuit TY0 is shown connected to conductor 404 extending to the first group of ten anodes connected to said conductor; another conductor 405 which extends to the tenth group of anodes is connected to the grid of gas-filled tube 429 of thyratron circuit TY9, while the intermediate conductors for the second to ninth groups of anodes are connected to the grids of the intermediate gas-filled tubes 421 to 428 of circuits TY1 to TY8 which are not shown but indicated. The anodes of the gas-filled tubes of the circuits TX0 to TX9 are connected to positive battery through the normally made contacts of relay 406 while the anodes of the gas-filled tubes of the circuits TY0 to TY9 are connected to positive battery through the normally made contacts of relay 407. The filament of each of the tubes is heated by a local battery source which is not shown.

The revolving fields which cause the electron beams to traverse the circles of one hundred anodes in distributor tubes 301 to 306, and the virtual beam of distributor tubes 400 and 400' to traverse the circles of the anodes in these tubes, are all in synchronism since they derive their motive power from the same 2Φ driving supply 375. In other words, when the beam in any one of the line tubes 301 to 306 strikes an anode having a negative potential thereon, due to a call having been started on the associated line, the impulse transmitted along conductor 327 will release the virtual beam in both distributors 400 and 400' and strike anodes in their respective envelopes which correspond to the position of the anode struck by the beam of the line distributor. However, since the anodes of distributor 400 are multipled consecutively in groups of ten, it follows that the group containing the anode struck by the beam thereof identifies the tens digit of the calling line. Similarly, since corresponding anodes in each group of ten anodes of distributor 400' are multipled together, it also follows that the anode struck by the beam in this distributor identifies the units designation of the calling line. It has been assumed, however, that the main group of six hundred lines is divided into six subgroups of one hundred lines each. In the present invention, the tens and units designations of the calling line are used to identify the cross-point in auxiliary switch 200 through which accessibility may be had to the hold magnet of the calling line circuit.

When the beams of distributors 400 and 400' strike respective targets in the same relative

positions as the target associated with the calling line in any one of the distributors 301 to 306 when struck by the beam of said distributor, the grid of one of the tubes in each of the two groups of circuits TX0 to TX9 and TY0 to TY9 is made sufficiently positive to override the negative grid bias, in consequence of which these tubes, one in each group, become conducting. If it is assumed, for example, that the calling line is located in the first group and is line 99 in that group, then the beam of line distributor 301 will strike anode 99 therein and cause the operation of relay 331 as already explained. Simultaneously, the beam of distributor 400 will be directed to the ninth group of anodes and that of distributor 400' will likewise be directed to its own ninth group of electrodes. Upon the arrival of the impulse to lower the bias of grids 401 and 401', therefore, both beams are activated thereby causing tubes 419 and 429 to break down and become conducting.

The cathode of each tube in circuits TX0 to TX9 is connected to a corersponding select magnet of the auxiliary cross-bar switch 200 while the cathode of each tube in circuit TY0 to TY9 is connected to a corresponding hold magnet in said switch. Thus the cathode of tube 410 of circuit TX0 is connected to select magnet 210 and that of tube 419 of circuit TX9 is connected to magnet 219 while the cathodes of intermediate thyratron circuits are connected in corresponding numerical order to the intermediate select magnets 211—218 (not shown). Also, the cathode of tube 420 of thyratron TY9 is connected to the hold magnet 220 through reactance 240 and that of tube 429 of circuit TY0 is connected to hold magnet 229 through reactance 249. The cathodes of the intermediate tube circuits TY1 to TY8 are connected to the intermediate hold magnets 221 to 228 through reactances 241 to 248 all of which are not shown.

Hence when tube 419 breaks down and becomes conducting for the reasons above set forth, a circuit path is completed which extends from positive battery, contacts of relay 406, space current path through the tube 419 and cathode thereof, conductor 439, winding of select magnet 219 to ground, causing said magnet to operate. Upon its operation, the magnet causes the fingers of the ninth horizontal channel of the cross-bar switch 200 to be set for engagement upon the operation of any of the hold magnets 220 to 229 and further closes an obvious circuit for relay 119 which operates and connects the sleeve conductors of the ten links 0 to 9 having access to the calling line through the link control circuit. According to the teachings of the above-mentioned Carpenter application, the control circuit tests the district junctor groups (not shown) to which the above links have access, selects the lowest numbered junctor group to which the idle links are available from the calling line and applies ground to the select magnet of a selected link, thus causing said magnet (as, for instance magnet 109 and the other select magnets multipled thereto) to operate.

As already stated, the operation of the control circuit was started by ground applied to conductor 348 at the time relay 331 operates. When the operations above described leading to the selection of an idle district junctor and its connection to an idle link have been completed, substantially as described in the above-mentioned Carpenter application, conductor 349 is grounded by the control circuit.

Similarly, when tube 429 breaks down and becomes conducting a circuit path is completed which extends from positive battery through the contacts of relay 407, space current path through the tube 429 and cathode thereof, conductor 449, reactance 249, winding of hold magnet 229 to ground. After an interval determined by the inductance of reactance 249 which should be made of a value sufficient to allow magnet 219 and relay 119 to operate in advance of magnet 229, magnet 229 operates. In conjunction with the operated select magnet 219, hold magnet 229 causes the cross-point 201 to close its six contact pairs.

The hold magnet 102 of the calling line is operated over a circuit completed by relay 331 which is one of a group of six relays 331 to 336, there being one such relay in the cathode circuit of each gas-filled tube associated with each one of the six amplifiers 311 to 316. The front contact of each of these relays is connected to one of the six channel conductors extending across the auxiliary switch while the six vertical wires of the switch 200 are multipled to corresponding vertical conductors in all ten vertical units of the switch. The back contact of relay 331 is wired in a chain through the armatures and back contacts of the remaining five relays 332 to 336. Consequently when relay 331 operates in the amplifier 311 of the calling group tube, it completes a circuit extending from ground on conductor 349 (applied thereto in the control circuit), through the winding of relay 344, right front contact of relay 331, conductor 352, contact set No. 1 of cross-point 201, conductor 231, hold magnet 102 to battery. Hold magnet 102 operates and since a link select magnet is already operated, a cross-point is operated by which the line A is extended to the link controlled by said operated select magnet. The link is connected to the district junctor which, in turn, is connected to a sender for the further extension of the connection in the well-known manner.

The operation of hold magnet 102 disconnects potential from the anode in the line distributor which is connected to conductor 99. This, however, will have no effect on the thyratron 324 which remains conducting.

Relay 344 also operates in the above circuit and closes an obvious circuit for slow-release relay 345 which operates and extends a path from conductor 347 to the back contact of relay 344. Now when the district junctor becomes connected to the link and is ready to lock in, it applies a holding ground over the sleeve conductor 103, the effect of which is to hold operated hold magnet 102 and apply ground to conductor 352, thereby causing relay 344 to be short-circuited and release. Relay 345, being slow to release, will remain operated and the ground from conductor 349 will be extended over the back contact of relay 344 to the front contact of the still operated relay 345 and thence over conductor 347 to the winding of relay 202. This relay, in operating, grounds conductor 238 which closes obvious circuits for relays 342, 406 and 407. These relays operate and disconnect positive battery from the anodes of the operated gas-filled tubes 324, 419 and 429 causing them to extinguish, the former opening the circuit of relay 331 causing it to release, and the latter opening the circuits of select and hold magnets 219 and 229, respectively. These magnets, upon releasing, cause cross-point 201 to open, while select magnet 219 further causes the release of select magnet 109

of the line switch assembly. Hold magnet **102**, however, is held operated over the sleeve conductor in the usual manner and thereby holds line A connected to the link. The release of relay **331** opens the circuit of relay **344** which, being slow to release, releases after an interval and opens the circuit of relay **345** which thereby releases also, thus restoring all parts of the circuit to normal.

In the event of an abandoned call, no ground will be applied to the sleeve conductor **103**, and the circuit will be released by timing means in the control circuit which applies ground to conductor **349** if release is not received in the normal manner.

While the present embodiment of the invention has been described with reference to a cross-bar automatic telephone system, it is evident that it may be readily applied by anyone skilled in the art to other types of systems.

What is claimed is:

1. In a telephone system, a station line, link circuits, switching means for extending a connection from said station line to any one of said link circuits, an operating magnet for said switching means, said station line extending over normal contacts of said magnet and including a source of current and a resistance, and means responsive to the potential drop through said resistance upon the initiation of a call on said line for controlling said switching means to connect said line to a link circuit.

2. In a telephone system, station lines, link circuits, switching means for extending connections from said lines to said link circuits having an operating magnet for each of said lines, each of said lines extending over normal contacts of its associated magnet and including a source of current and a resistance, and electronic devices each comprising an evacuated envelope and a source of electrons for producing a focussed electron beam operative in response to the potential drop through said resistance upon the initiation of a call on one of said lines for controlling said switching means to connect said line to a link circuit.

3. In a telephone system, station line, link circuits, a cross-bar switch having hold magnets allocated to said station lines, said lines and link circuits terminating in the cross-point contact sets of said switch, each of said lines extending over normal contacts of the hold magnet allocated thereto and including a source of current and a resistance, and means responsive to the potential drop through said resistance upon the initiation of a call on one of said lines to operate the hold magnet allocated to said calling line whereby a set of cross-point contacts of said switch is operated to connect said line with one of said link circuits.

4. In a telephone system, station lines, link circuits, a cross-bar switch having hold magnets allocated to said station lines, said lines and link circuits terminating in the cross-point contact sets of said switch, a start circuit for said lines comprising electron devices each having an evacuated envelope and a source of electrons adapted to produce a focussed electron beam, said devices being responsive to any one of said lines when initiating a call, and means controlled by said devices for operating the hold magnet allocated to a calling line whereby a cross-point contact set of said switch is operated to connect said line with one of said link circuits.

5. A starting circuit for the lines of a telephone system, said lines being disposed in groups upon the cross-point contact sets of a cross-bar switch, comprising an electron distributor for each line group, two identifying electron distribubtors common to all groups, means responsive to a line initiating a call for operating the line group distributor and the two identifying distributors for identifying the location of said calling line upon the cross-bar switch, and means responsive to the operation of said line distributor and said identifying distributors for operating the hold magnet on said cross-bar switch which is individual to said calling line.

6. In a telephone system, the combination with a group of lines disposed upon the cross-points of a cross-bar switch of an electron distrubtor, comprising as many anodes as there are lines in said group and having a revolving electronic beam adapted to impinge upon each of said anodes in succession, a conductor extending between each of said lines and a corresponding anode in said distributor, means responsive to one of said lines initiating a call for altering the potential of its corresponding anode over its said associated conductor whereby upon the impingement of said electronic beam upon said anode a current impulse is produced, and means operative in response to said current impulse for closing a current path to the hold magnet controlling the closure of that cross-point on said switch which is individual to said calling line.

7. In a telephone system in combination, a group of lines disposed upon the cross-points of a cross-bar switch, link circuits available to said lines through said cross-points and means for connecting one of said lines when calling to an idle one of said link circuits, comprising an electron distributor common to said lines and having an anode for each line, two identifying electron distributors having respectively an anode for each line that marks a digital disposition of the correlated line on the cross-points of said cross-bar switch, means for synchronously impinging the electron beams of each of said distributors upon corresponding anodes, means responsive to the electron beam of said electron distributor impinging upon the anode of a calling line for producing a current impulse which is effective to produce two other impulses when the electron beams of said identifying distributors impinge upon corresponding anodes, switching means operative in response to said last two current impulses for closing a path to the hold magnet of said calling line and for providing accessibility to the select magnets of said link circuits available to said calling line, and means responsive to said first current impulse for completing the circuit of said hold magnet.

8. In a telephone system in combination, a group of lines disposed upon the cross-points of a line cross-bar switch, link circuits available to said lines through said cross-points and means for connecting one of said lines when calling to an idle one of said link circuits, comprising an electron distributor common to said lines and having an anode for each line, two identifying electron distributors having respectively an anode for each line that marks a digital disposition of the correlated line on the cross-points of said cross-bar switch, means for synchronously impinging the electron beam of each of said distributors upon corresponding anodes, means responsive to the electron beam of said electron distributor impinging upon the anode of a calling line for producing a current

impulse which is effective to produce two other impulses when the electron beams of said identifying distributors impinge upon corresponding anodes, an auxiliary cross-bar switch providing access to the hold magnets of said line cross-bar switch through the cross-points thereof, means operative in response to said last two current impulses for operating the select and hold magnets of said auxiliary cross-bar switch to close the cross-point giving access to the hold magnet of said calling line, means responsive to the operation of the select magnet of said auxiliary cross-bar switch for giving accessibility to the select magnets of said line cross-bar switch, and means operative in response to said first current impulse for completing the circuit of the hold magnet of said calling line.

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