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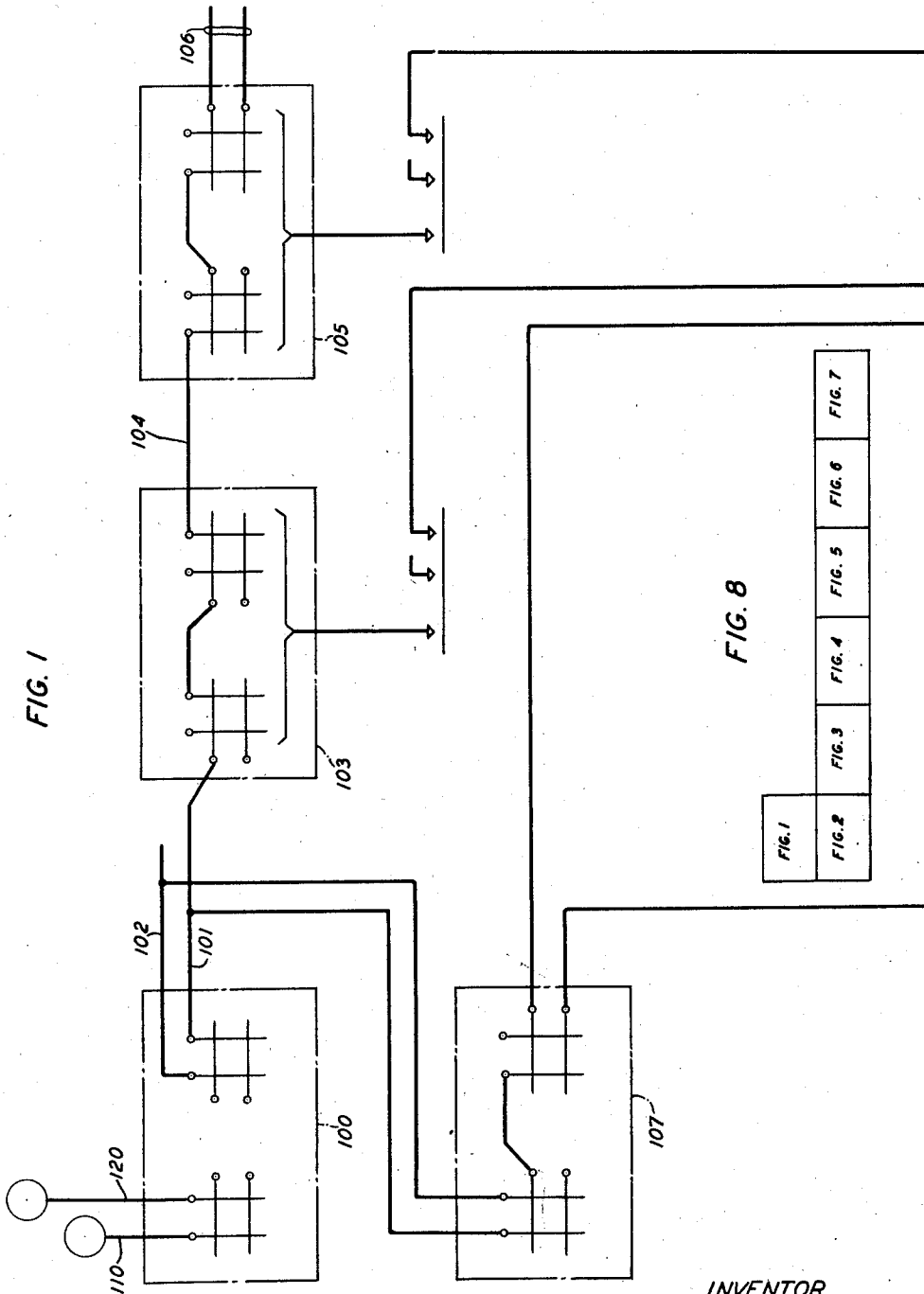
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2,299,479

SIGNALING SYSTEM

Filed April 26, 1941

7 Sheets-Sheet 1



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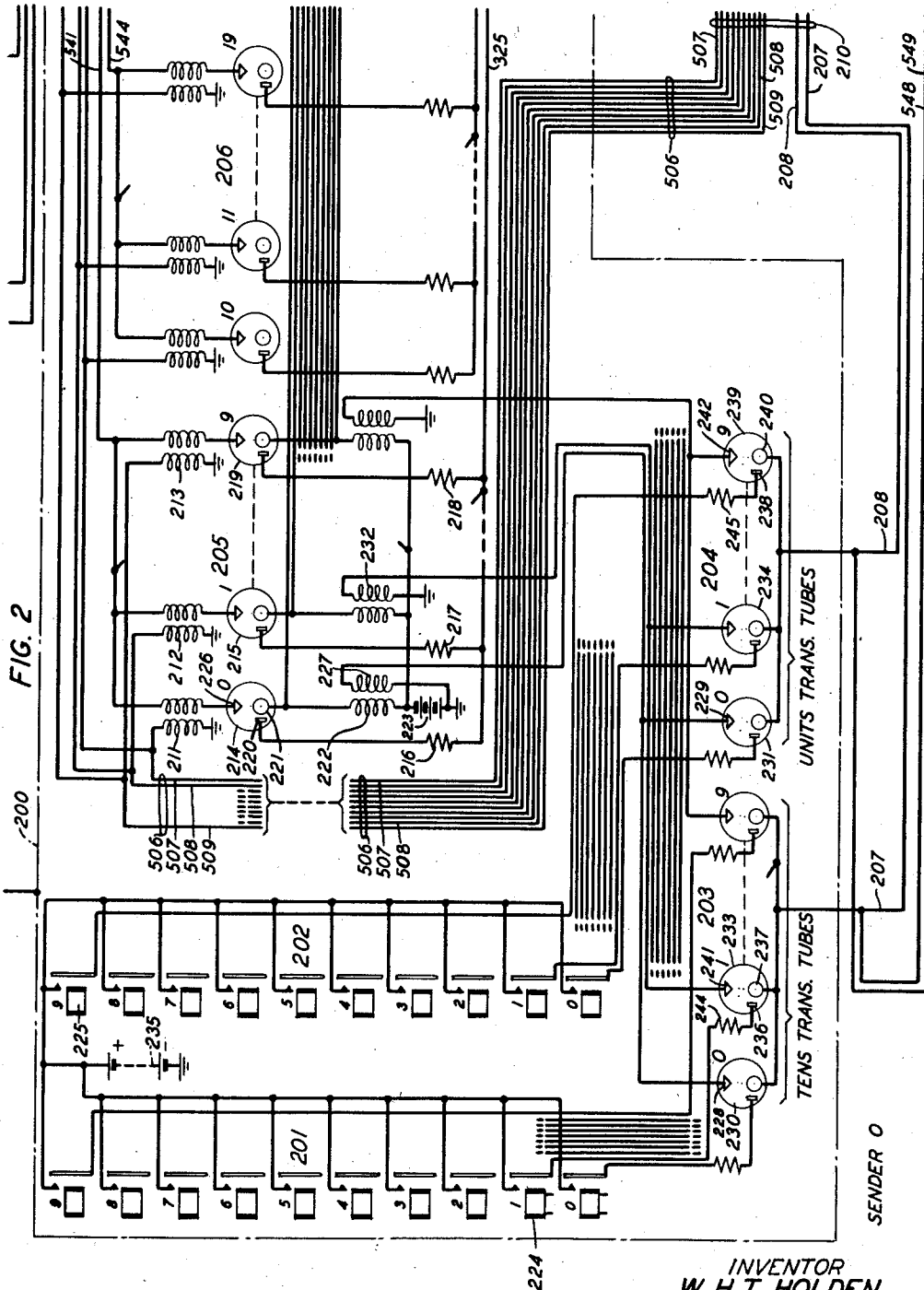
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SIGNALING SYSTEM

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7 Sheets-Sheet 2



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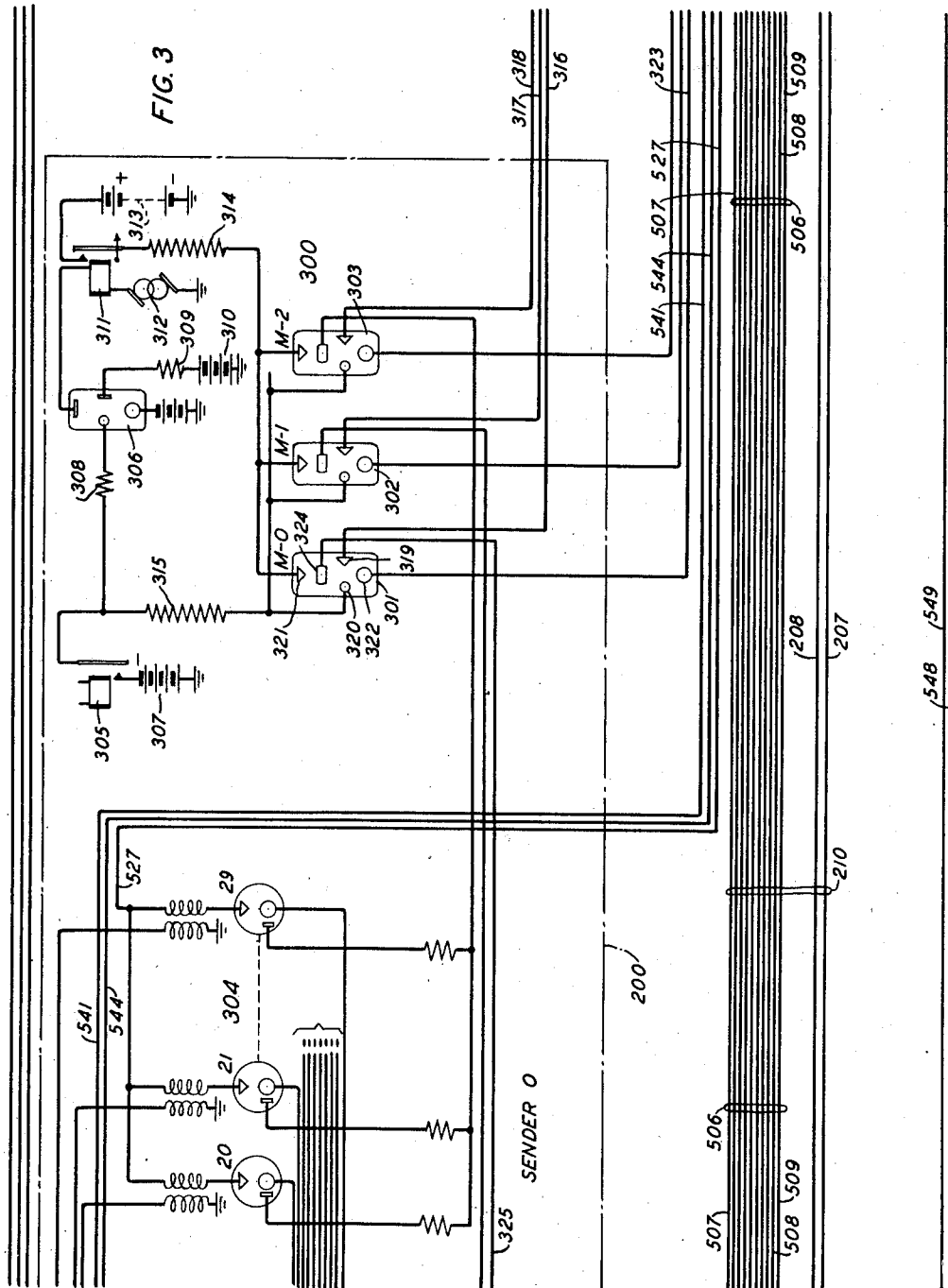
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SIGNALING SYSTEM

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7 Sheets-Sheet 3



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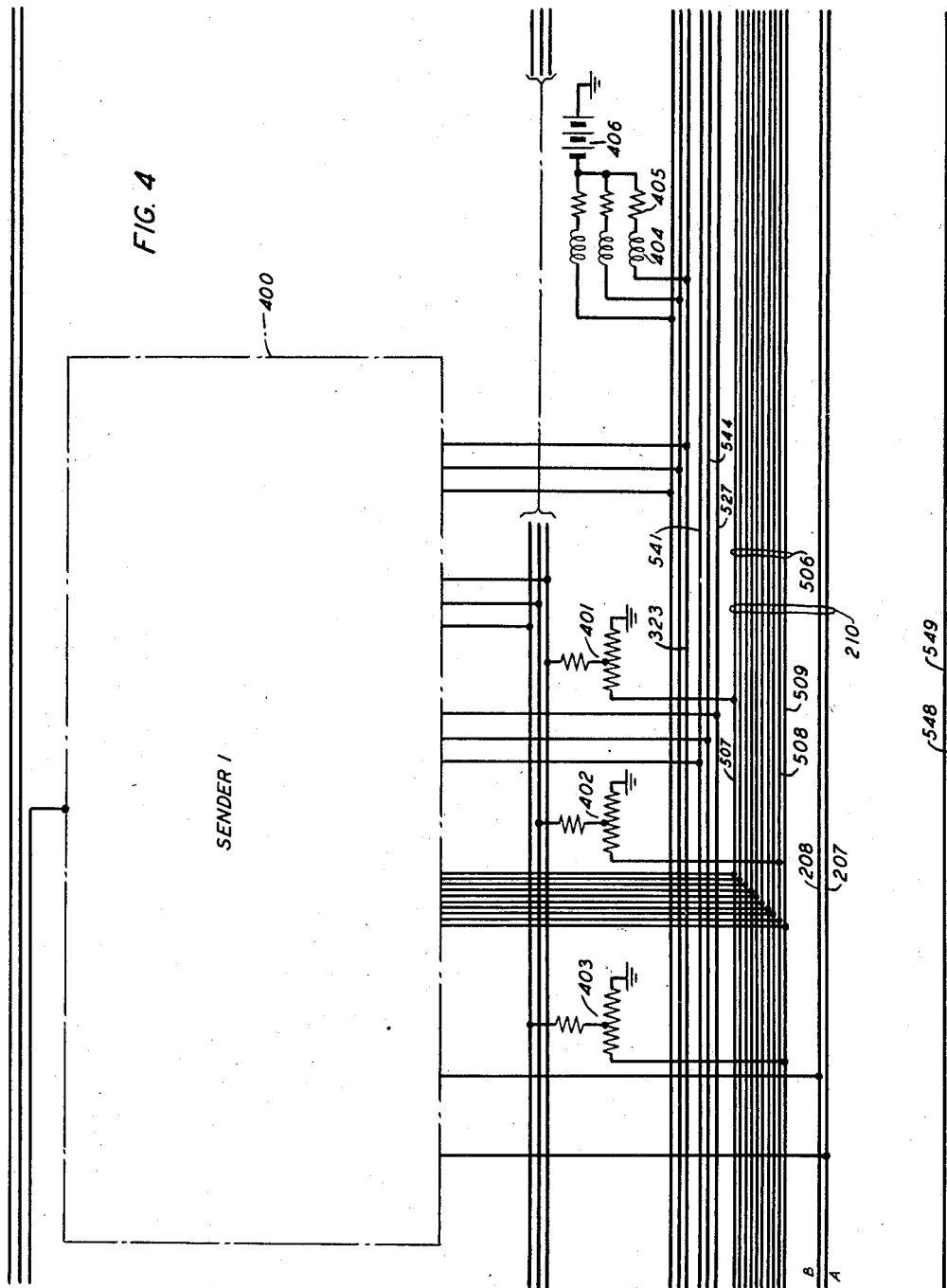
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SIGNALING SYSTEM

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7 Sheets-Sheet 4



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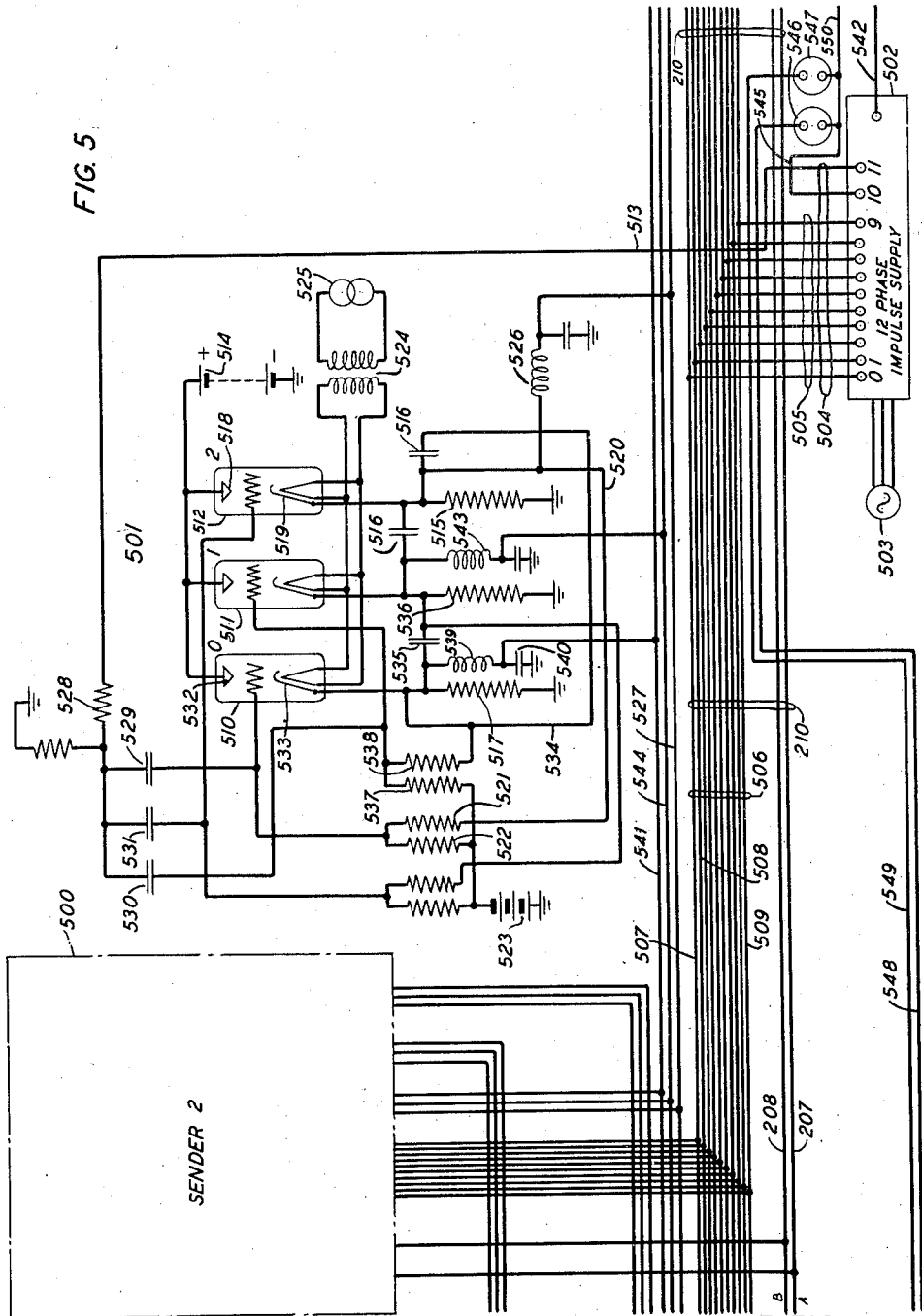
2,299,479

SIGNALING SYSTEM

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7 Sheets-Sheet 5

FIG. 5



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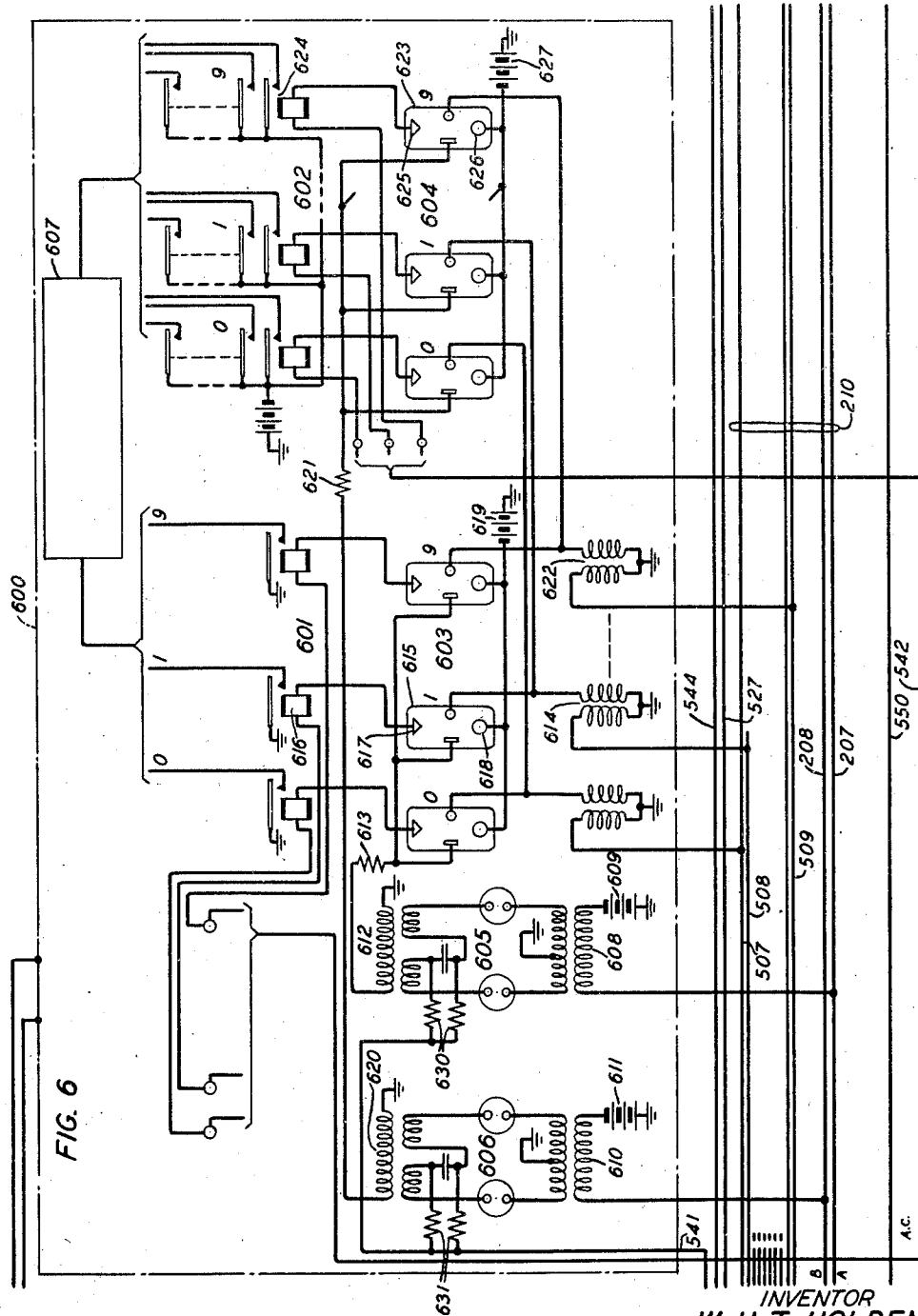
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SIGNALING SYSTEM

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7 Sheets-Sheet 6



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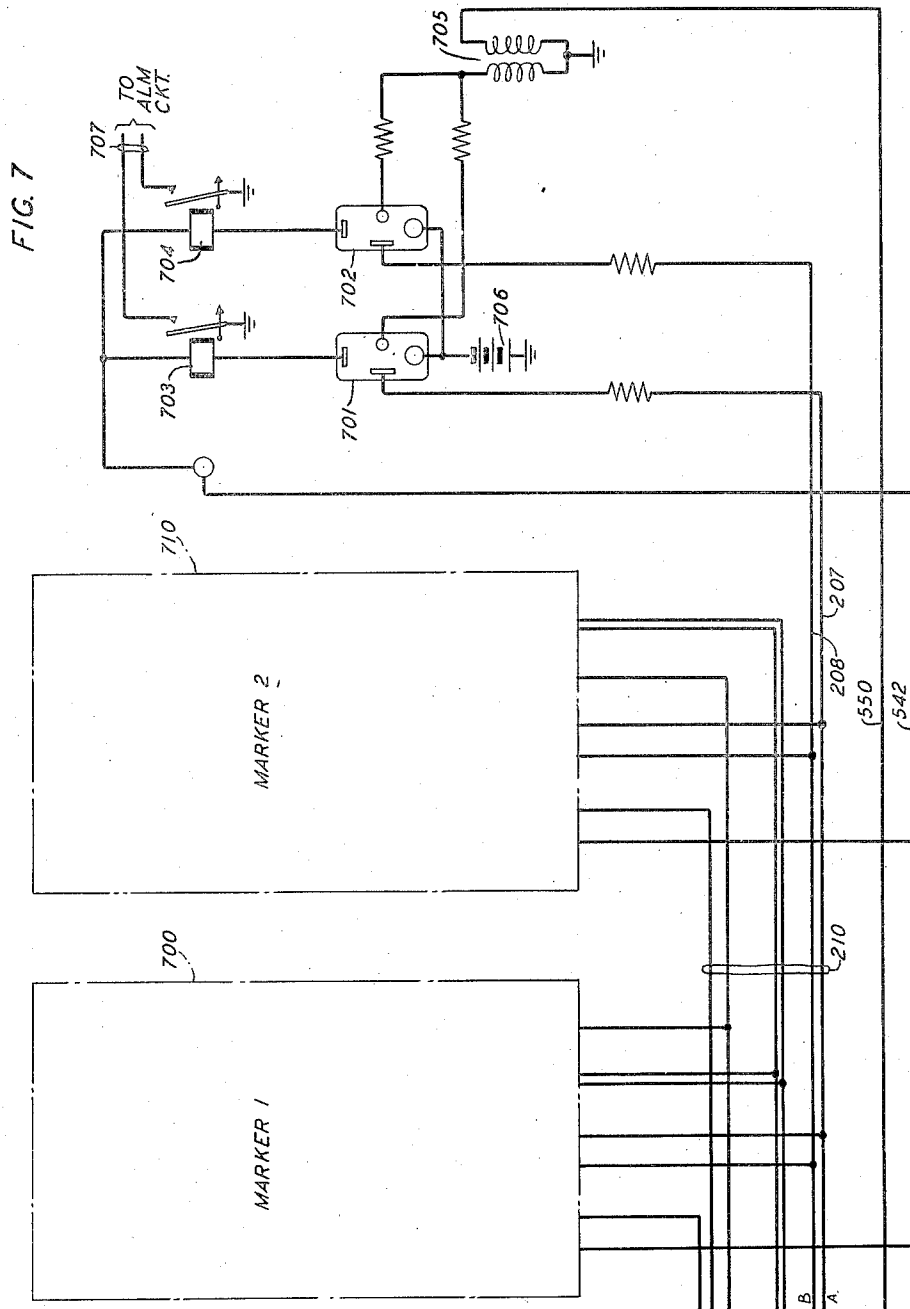
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SIGNALING SYSTEM

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7 Sheets-Sheet 7



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UNITED STATES PATENT OFFICE

2,299,479

SIGNALING SYSTEM

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Application April 26, 1941, Serial No. 390,457

5 Claims. (Cl. 179—18)

This invention relates to electric signaling and particularly when used in automatic telephone or other communication systems.

The objects of the invention are to simplify the sending of signal information from one part of a signal system to another; to eliminate much of the connecting equipment heretofore used for establishing signaling connections; to utilize the same transmitting conductors for sending a plurality of sets of signals simultaneously; to increase the speed of sending signal information; and in other respects to improve signaling and telephone systems.

It has been the practice heretofore in automatic telephone systems to provide connectors for establishing individual connections between the mechanisms of one group, such as senders, and the mechanisms of a second group, such as switch controlling markers. By providing these connecting devices it is possible to establish a plurality of electrically separate simultaneous connections between a number of senders and a corresponding number of markers. These connectors, however, are expensive since they involve a large amount of equipment, particularly if the sender and marker groups are large. If multicontact relays are employed for establishing the connections, it is usually necessary to provide a relay for each sender in the sender group and one for each marker in the marker group. Similar connecting devices are also required in other parts of an automatic telephone system. For example, in a system of the cross-bar type these connectors are used to establish controlling circuit connections between the switch frames and the common markers.

In accordance with the present invention substantial savings and other advantages may be realized over these prior systems by eliminating to a large extent the connecting equipment between the different controlling mechanisms and by providing permanent signal transmitting connections between these mechanisms. More specifically, the foregoing objects of the invention are realized by means of a signal system in which the individual mechanisms of a group, such as a sender group in an automatic telephone system, are connected permanently to all of the individual controlling mechanisms of a second group, such as the group of switch controlling markers, and in which the signal information is transmitted from the senders to the markers by the impulses of a group which vary in phase or otherwise and which are transmitted during each of a succession of cyclically recurring impulse periods, each period in the cycle representing a particular one of the markers and the particular sender from which it is receiving the signal information. By means of a relatively simple selecting circuit arrangement each calling sender

appropriates for its use the first idle one of the markers and excludes other senders from the use of the seized marker. During each of the successive impulse periods a plurality of impulses of different phases are produced, and the particular marker which is characterized by such impulse period is enabled to the exclusion of the remaining markers. According to the information registered in the sender that has seized the enabled marker, impulses of the appropriate phase are transmitted from the sender over the common signaling conductors to the enabled marker where they serve to register the information corresponding to that first registered in the sender. Since the other markers are disabled during this particular impulse period, they are not affected. During the remaining impulse periods of the cycle, representing the corresponding markers, phase impulses are transmitted from the senders over the common signaling conductors to the corresponding markers which have been seized by these senders, only one marker being enabled in each impulse period to permit the signal information to pass to such marker to the exclusion of all others. Therefore, several signaling channels may exist concurrently between senders and markers, and the information pertaining to each sender and its associated marker is transmitted over the common connecting conductors or medium without interference with other channels.

The foregoing and other features of the invention will be discussed more fully in detail in the following specification.

In the drawings accompanying the specification:

Figs. 1 to 7, when arranged as illustrated in Fig. 8, disclose an automatic telephone system incorporating the features of the invention.

Fig. 1 illustrates in diagrammatic manner the line switch and certain of the selector switches of an automatic telephone exchange and also a sender link or sender selector switch for associating the calling lines with idle common register senders;

Figs. 2 and 3 show a portion of one of the common register senders;

Fig. 4 is a diagrammatic illustration of a second one of the register senders;

Fig. 5 illustrates a third one of the register senders and also shows a counting mechanism for producing cyclically the periods during which the successive markers are in a receptive condition;

Fig. 6 shows a portion of one of the common switch controlling markers; and

Fig. 7 illustrates diagrammatically two more of the common markers and also shows a testing mechanism for determining the condition of the

common transmitting medium between the senders and the markers.

The present invention in its broadest aspects relates to the transfer of signal information over a common medium between sending devices of one group and receiving devices of a second group, and it should be understood that said invention is not limited in its application to telephone systems or to systems of any other particular type. It is, however, especially useful in automatic telephone systems where registered designations and other kinds of information must be transferred from one part of the system to another during the controlling operations incident to the establishment of the desired connections. Therefore, the invention has been illustrated herein when applied to the common register senders and the common switch controlling markers of an automatic telephone exchange system of the well-known crossbar type. For a better understanding of the various operations involved in these systems and of the details of the equipment used, reference may be had to numerous patents, including the patents to W. W. Carpenter, 2,093,117 of September 14, 1937, and 2,235,803 of March 18, 1941.

Referring to the drawings, the subscribers' lines appear in the crossbar switches 100 and through these switches have access over trunks 101, 102 to the district selector switches 103. The district selectors have access over trunks 104 to office selector switches 105, and these in turn have access to the groups of outgoing trunks 106. The calling lines also have access through the sender selector switches 107 to the common register senders which receive and store the telephone designations.

Three of these senders, 200, 400 and 500, are illustrated in the drawings, and as many more could be provided as are needed to handle the traffic through the office. The senders are seized at random in response to calling lines and receive and register the designations transmitted from the calling substations. Thereafter the senders transfer these registered designations to the common switch controlling markers, which in turn make use of the designations received from the senders to control the selective operation of the automatic switches. Three of the common switch controlling markers, markers 600, 700 and 710, are shown in the drawings and as many more would be provided as are needed.

In the systems of the prior art, as hereinbefore mentioned, connecting devices are required for selectively connecting a calling sender with an idle one of the common markers. If, for example, four or five senders are in use concurrently, each serving a calling line, these connecting devices serve to establish individual and separate connections between each of the calling senders and each of the associated markers. In this way, the designation information may be transmitted at the same time from as many of the senders as there are markers, and no interference results because the connections are separate from each other. In the present system, however, these intermediate connecting devices between the senders and the markers have been eliminated, and a common transmitting medium comprising the conductors 210 is connected permanently and in multiple between all of the senders 200, 400, 500, etc., and all of the common markers 600, 700, 710, etc. As will be explained hereinafter, the signal information for a plurality of senders, which may be taken for concurrent use, is transmitted over

the common medium 210 to the respective markers without mutual interference by the use of impulse signals occurring in different time periods and in different phases in each of said periods.

Each of the register senders includes registers for the office and numerical portions of the telephone designations, means for transmitting the office registration over the common medium to the associated marker, the usual means for transmitting the numerical designation to distant senders, together with controlling relays and circuits. Two office code registers 201 and 202 have been shown in full in the sender 200, the assumption being that the office part of the designation consists of two letters or other characters. Two groups of transmitting tubes 203 and 204, associated with the registers 201 and 202, respectively, serve to transmit the office registration over the conductors of the common medium 210 to the associated marker. The sender 200 is also provided with a marker selector or allotter 300 comprising space discharge tubes 301, 302, 303, there being one of these tubes for each of the markers to which the sender has access. Furthermore, the sender 200 is equipped with a plurality of groups of discharge tubes 205, 206, 304, each group consisting of ten tubes, there being as many of these groups as there are markers to which the sender has access. The purpose of the tubes 205, 206, 304 is to select from the cyclically recurring periods the particular period representing the marker which has been seized by the sender and to deliver to the transmitting tubes 203 and 204 during the selected period the phase impulses which serve to characterize the values of the code digits registered on the registers 201 and 202 of the sender. To this end one of the groups 205, 206, 304, namely, the group characterizing the seized marker, is rendered effective by the particular one of the tubes 300 which operates to cause the seizure of said marker and the remaining groups of tubes remain ineffective.

In like manner each of the remaining senders is provided with a marker-allotter, with transmitting tubes, and with a plurality of groups of tubes corresponding to the groups 205, 206, 304, for selecting the proper periods for the signal transmission. The several allotters are so related to each other that each calling sender selects and seizes the first available idle marker, and each busy marker is rendered unselectable to all other senders. Thus, if a plurality of senders are concurrently associated with a corresponding number of markers, the transmitting tubes of these senders are rendered effective during the respective transmitting periods corresponding to the seized markers. In other words, one of the calling senders will transmit its signal information over the common medium to the associated marker during the particular one of the sending periods which characterizes said associated marker; the next sender will transmit its information during the particular period characterizing the marker with which it is associated; and the same is true of each of the remaining senders which may concurrently use the transmitting medium.

The marker 600 (and the same is true of each of the other markers) is equipped with two relay registers 601 and 602 for registering the office code digits and with corresponding sets of discharge tubes 603 and 604 which receive from the sender the impulses representing these digits and cause the operation of the corresponding relays of said registers. The marker is also provided

with two sets of receiving tubes 605 and 606, one for each of the office code digits, which receive the digit impulses incoming over the conductors 207 and 208 from the sender. These receiving tubes 605 and 606 are rendered effective only during the impulse period which characterizes the marker 600 and are ineffective to receive impulse signals during the transmitting periods characterizing other markers. The effectiveness of these receiving tubes 605 and 606 is controlled by the timing mechanism 501 which cyclically produces the impulse periods characterizing the different markers.

The marker is also provided with the necessary routing relays and other controlling circuits and devices whereby the office designation registered on the registers 601 and 602 is utilized to determine and control the selective operation of the switches 103 and 105. These controlling means are illustrated by the diagram 607 and have not been shown in detail since they are well understood in the art.

The phase impulses by which the signal information is transferred from the senders to the markers are produced by a common impulse generator 502. The energy for this generator is supplied from an alternating current source 503, and the generator in response to each cycle of the source 503 produces impulses of a different phase in each one of the output circuits 504. There are twelve of these phase circuits, and the first ten of them are used for sending the signal information between the senders and the markers. The eleventh phase is used for the marker testing mechanism shown in Fig. 7, and the twelfth phase is used to operate the period measuring mechanism 501. The first ten phase circuits 505 are connected over corresponding conductors 506 to the primary windings of the ten transformers 211, 212, 213, associated with the anodes of the ten tubes of the group 205. More specifically the conductor 507, to which impulses of phase No. 0 are delivered by the generator 502, is connected to the transformer 211 associated with the No. 0 tube 214. Likewise the remaining conductors of the group 506, including conductor 509 to which impulses of phase No. 9 are delivered, are connected to the transformers associated with the remaining tubes of the group 205. Furthermore, the ten impulse conductors 506 are multiplied and connected to the input transformers associated with the respective tubes of each of the remaining groups 206, 304, etc. Thus the signal impulses of the ten different phases are applied once per cycle of the generator 502 to the anodes of the corresponding tubes of the groups 205, 206, 304, etc. Since only one of these groups is effective in a particular sender, such as sender 200, only the tubes of the effective group discharge and pass impulses to the transmitting tubes 203 and 204. Furthermore, only one tube in each of the groups 203 and 204 is rendered effective by the corresponding registers 201 and 202. Hence an impulse of the phase corresponding to the operated relay of register 201 is transmitted through the corresponding tube 203 to the common conductor 207 and thence to the receiving tubes 605 of all markers. Likewise a single impulse corresponding to the operated relay of the second register 202 is transmitted through the corresponding tube 204 and over conductor 208 to the receiving tubes 606 of all markers.

The discharge tubes 203, 204, 205, 206, 304, 300, 603, 604, 605, 606 and the tubes 701 and 702 may be of any suitable type such as those commonly

known in the art as gas-filled tubes. The tubes of the group 51 may also be of the gas-filled type, but these are preferably equipped with heated cathodes.

The impulse generator 502 may be of any suitable type whereby brief impulses of positive polarity of twelve successive phases are generated during each cycle of the source 503. Generators of this type are illustrated in the application of W. H. T. Holden, Serial No. 361,536, filed October 17, 1940; and the patents to W. H. T. Holden, No. 2,252,766 of August 19, 1941, and No. 2,285,815 of June 9, 1942.

The operation of the transmitting system will now be described in detail. For this purpose it may be assumed that a call is made by the subscriber of line 110. A call by this subscriber causes the operation of the line switch 100 to extend the line over an idle junctor 101 to the district selector 103 and also through the sender selector 107 to an idle one of the register senders such as the sender 200. Upon the seizure of the sender the start relay 305 operates and closes a discharge circuit as follows for the tube 306: negative pole of battery 307, contact of relay 305, resistor 308, control gap electrodes of the tube 306, resistor 309 to the positive pole of battery 310. The tube 306 ionizes its control gap, and current flows in the main discharge circuit of said tube, including the slow-release relay 311 and the alternating current source 312. The relay 311 operates and retains its armature during the time the voltage from the alternating current source 312 is passing through zero value at each alternation. Relay 311 connects the positive pole of battery 313 through resistor 314 to the main anodes of all of the tubes 301, 302 and 303. The operation of relay 305 also connects the negative pole of battery 307 through resistor 315 to the start cathodes of all of the tubes 301, 302 and 303. The start anodes of these tubes are connected over conductors 316, 317, 318 through the potentiometers 401, 402, 403, respectively, to ground. These potentiometers are also connected to respective ones of the phase impulse conductors 506. As illustrated, the potentiometers are connected respectively to the No. 0, No. 1 and No. 9 phase impulse conductors 507, 508, 509; although they may be connected as desired to any corresponding number of these conductors. The purpose of these potentiometers 401, 402, 403, etc., is to deliver potential impulses at spaced intervals to the starting anodes of the allotter tubes 300.

Assume that the No. 0 marker 600 is idle at the time the sender 200 is seized and the start relay 305 operated and that the impulse generator 502 has just passed the phase corresponding to the last idle marker in the group following marker 600 at the time relay 305 is operated to condition the allotter tubes 300. When, therefore, the generator 502 commences its next cycle and an impulse of positive polarity is generated in the No. 0 phase conductor 507, this impulse is applied through the potentiometer 401 over conductor 316 to the starting anode 319 of tube 301. Since negative potential is applied to the starting cathode 320 of this tube, the voltage across the control gap 319-320 is sufficient to ionize the tube. The momentary flow of current through the resistance 315 when the control gap ionizes alters the potential of the starting cathodes of the remaining tubes 302 and 303 of the sender 200 to discourage the ionization of a second one of these tubes when the starting anode thereof is raised

to a positive potential in response to the next phase impulse. The ionization of the control gap of the tube 301 causes transfer of the ionization to the main gap, and current now flows from the positive pole of battery 313, contact of relay 311, resistance 314, anode 321, main cathode 322, conductor 323, inductor 404, resistor 405 to the negative pole of battery 406. Since the inductor 404 is common to the allotter tubes in all senders corresponding to tube 301, the voltage drop produced by the inductance of this element alters the potential on the cathodes of these tubes to prevent another one of them from discharging and seizing the same marker. As soon as the current flow in the main discharge circuit of tube 301 reaches a steady state the voltage drop across the common resistor 405 serves the same purpose of preventing another one of the senders, that may be seeking a marker while sender 200 is in use, from causing the discharge of its allotter tube corresponding to the tube 301. Thus the tube 301 of the calling sender 200, which identifies the idle marker 600, has been operated to the exclusion of the remaining tubes of the allotter 300 and in its operated condition guards against the subsequent operation of the corresponding tube in any other one of the senders.

The operation of tube 301 effects the seizure of the marker 600 by energizing the group of tubes 205 representing said marker to the exclusion of the remaining tube groups 206, 304, etc., representing other markers. The flow of current in the main discharge circuit of the tube 301 raises the collector electrode 324 to a positive potential with respect to the cathode 322. This positive potential is transmitted over conductor 325 through resistors 216, 217, 218 to the starting anodes of tubes 214, 215, 219 of the group 205. Since the cathodes of these tubes are at negative potential the starting gaps of all tubes ionize. For example, the circuit for ionizing the starting gap of tube 214 may be traced from conductor 325, resistor 216, starting anode 220, cathode 221, transformer winding 222 to the negative pole of battery 223. The other tubes of the group 205 are ionized in similar circuits.

The sender 200 having been seized and connected to the calling subscriber's line 110, the subscriber now proceeds to operate his dial to send the wanted designation, including the office code digits and the usual numerical digits, into the sender. The two code digits cause the operation of the registers 201 and 202 in the well-known manner, and one of the relays in each of these registers is energized to register the value of the digits. Assume that the office code is represented by the digits 1-9, in which case the relay 224 of register 201 and relay 225 of register 202 are operated and all of the other relays of these registers remain deenergized. The operation of register relay 224 completes a circuit from the positive pole of battery 235, contact of relay 224, resistor 244, starting anode 236 of transmitting tube 233, cathode 237, conductor 207 through the primary winding of transformer 608 to the negative pole of battery 609. The voltage applied to the control gap of tube 233 in this circuit causes the tube to ionize preparatory to the transmission of a signal impulse from the sender to the marker representing the office code digit 1. Similarly, the operation of register relay 225 closes a circuit from the positive pole of battery 235, contacts of relay 225, resistor 245, starting anode 238 of tube 239, cathode 240, conductor 208, the primary winding of transformer 610 to

the negative pole of battery 611. The control gap of tube 239 ionizes in this circuit preparatory to the transmission of the signal impulse representing the code digit No. 9.

It will also be assumed that the subscriber of another line, such as line 120, initiates a call at about this time. Line 120 is extended over the line switch 100 to an idle junctor 102 and through the sender selector switch 107 to the next idle sender in the group, such as sender 400. The seizure of sender 400 causes the closure of the start circuit and the operation of the allotter tube, corresponding to tube 302 of sender 200, assuming the next marker 700 to be idle. The operation of the tube in sender 400 representing the idle marker 700 serves to condition the group of tubes in sender 400 corresponding to the group 206 shown in full in the sender 200. In other words the initiation of a second call concurrently with the first one causes the selection of the second idle sender 400, which in turn seizes the next idle marker 700 and prepares the impulse transmitting tubes in the sender for sending its information during the transmission period of the seized marker. In like manner other concurrent calls result in the seizure of idle senders and the connection of these senders to respective idle markers. Assuming, however, that only the two senders 200 and 400 are in concurrent use at this time, an explanation will now be given of the manner in which the transmission periods are produced cyclically and of the manner in which these senders transmit their information over the common medium to the associated markers during the transmission periods assigned to these particular markers.

As hereinbefore mentioned, the transmission periods are produced by the time measuring mechanism 501, which consists of a plurality of hot cathode gas-filled tubes 510, 511, 512, etc. The cathodes of these tubes are heated by filaments energized through the transformer 524 by a suitable source of alternating current 525. The tubes 510, 511, 512, which correspond to the respective transmission periods, are ionized and deionized in succession by impulses delivered from the generator 502 in the No. 12 phase position thereof. That is, once per cycle of the generator 502 an impulse is delivered over conductor 513 to the mechanism 501 to cause the ionization of the next succeeding tube and the deionization of the tube already in an ionized condition. The No. 12 phase position is chosen so that the transmitting tubes of the senders may be conditioned and ready to receive the designation impulses when, subsequently, the generator 502 passes through phase positions No. 0 to No. 9. In order to describe the details of the mechanism 501 it may be assumed that tube 512 is in an ionized condition. Therefore, current flows from the positive pole of battery 514 from the anode 518 to the cathode 519 of tube 512 through the resistor 515 to ground. This current flow raises the cathode to a positive potential with respect to ground, and charging current flows through the condenser 516 and resistor 517 to ground. The condenser 516 assumes a charged condition in this circuit. The positive potential of the cathode 519 is applied over conductor 520 through the potentiometer resistance 521 to the grid of tube 510, which is the next tube in the series. The resultant of this positive potential applied through the potentiometer resistance from the cathode 519 and the negative potential applied from the biasing battery 523 through resistor

522 renders the grid of tube 510 less negative than normal but not sufficiently positive to allow discharge to occur. The positive potential of the cathode 519 is also applied through the choke coil 526 over conductor 527 through the windings of the associated transformers to the anodes of the ten tubes of the group 304 in the sender 200 and likewise to the anodes of the corresponding groups of tubes in all of the other senders. Since, however, the marker 710 to which the group of tubes 304 relates is not in use at this time, the application of this potential to the anodes of these tubes is without effect.

When the generator 502 completes its next cycle and reaches phase No. 12, an impulse is applied over conductor 513 to the potentiometer resistance 528 and thence through condensers 529, 530 and 531 to the grids of the tubes 510, 511, 512, respectively. The normal negative potential of the grid of tube 511 applied thereto by the battery 523, is sufficiently high so that the positive impulse applied to the grid through condenser 530 does not cause the tube to discharge. The grid of tube 510, however, is more positive than its normal biasing potential by reason of the positive potential of the cathode 519 of the operated tube 512. Therefore, when the positive impulse is applied through the condenser 529, the grid 510 is made sufficiently positive to cause this tube to discharge. Current now flows from battery 514 from the anode 532, cathode 533, resistor 517 to ground. The positive potential of the cathode 533 is now applied over conductor 534 to the right-hand terminal of the charged condenser 516. This raises the potential of the other terminal of condenser 516 and cathode 519 to a value sufficient to extinguish the discharge in the tube 512. Thus the impulse applied to the conductor 513 ionizes the next tube 510 and extinguishes the preceding tube 512. As soon as the tube 512 is extinguished, the condenser 516 dissipates its charge through resistances 515 and 517. The positive potential of the cathode 533 causes the charging of condenser 535 through the resistor 536. Also the positive potential of cathode 533 is applied through the potentiometer resistor 538 to render the cathode of the next tube 511 more positive than normal, thus conditioning the tube 511 for operation when the next impulse is received. As soon after the tube 510 discharges as the surge is absorbed by the choke coil 539 and condenser 540, the full positive potential of the cathode 533 is applied over conductor 541 through the windings of transformers 211, 212, 213 to the anodes of all ten tubes in the group 205 and similarly to the anodes of the tubes of the corresponding group in each of the other senders.

Since the control gaps of the ten tubes 205 are ionized as above explained, current now flows through the main discharge gaps of these tubes. For example, the circuit for the flow of current in the main discharge gap of tube 214 may be traced from conductor 541, to which positive potential is applied by the measuring mechanism 501 during this period, winding of transformer 211, main anode 226, cathode 221, transformer winding 222 to the negative pole of battery 223. Similar circuits are traceable from the remaining tubes in the group 205. During this transmission period, which continues as long as the tube 510 of the mechanism 501 is in a conducting condition, and during which period the relays of the group 205 are conducting, the generator 502 passes through its first ten phases No. 0 to No. 9

and transmits impulses of these phases over the conductors 505 and 506 to the primary windings of the transformers 211, 212, 213, associated with the anodes of the tubes 205. For instance, in phase No. 0 of the generator 502 an impulse is transmitted over conductor 507 through the primary winding of transformer 211 to ground. This impulse is induced in the secondary winding of transformer 211 and produces a corresponding increase in the current flow through the transformer winding 222. This increased flow of current produces an induced impulse in the transformer winding 227 which appears as a positive potential impulse on the anodes 228 and 229 of the No. 0 transmitting tubes 230 and 231, respectively. Similarly, in phase No. 1 of the generator 502 an impulse is transmitted over conductor 508 through the primary winding of transformer 212, and a corresponding impulse is produced in the transformer winding 232 and appears as a potential impulse on the anodes of the two No. 1 transmitting tubes 233 and 234. Likewise, each of the remaining eight phase impulses are sent in succession to the remaining tubes of the group 205 and are reproduced as impulses on anodes of the corresponding transmitting tubes of the groups 203 and 204. Although these impulses are applied to the anodes of all tubes in the groups 203 and 204, discharge occurs only in the main gaps of tubes 233 and 239, these being the only tubes that have their control gaps ionized in response to the operation of the register relays 224 and 225. Therefore, current flows from the anode 241 of the ionized tube 233 to cathode 237 thence over conductor 207 through the primary winding of the transformer 603 to the negative pole of battery 609. Likewise current flows from anode 242 to cathode 240 thence over conductor 208 through the primary winding of transformer 610 to the negative pole of battery 611. Similarly these signal impulses, which are transmitted from the sender 200 over the conductors 207 and 208 to the marker 600 in phase positions No. 1 and No. 9, are also transmitted to each of the remaining markers 700, 710, etc. As above mentioned, however, only the tubes 605 and 606 of marker 600 are in a transmitting condition during this transmission period. The ionization of these tubes during this period is effected over the circuits from conductor 541, on which a positive potential is maintained by tube 510, resistors 630 and 631, windings of transformers 612 and 620, tubes 605 and 606, to ground, respectively, through the windings of transformers 603 and 610. Consequently the signal impulses transmitted over the conductors 207 and 208 are conducted through the tubes 605 and 606 but are not conducted through the corresponding tubes in any other marker.

When tube 605 transmits the incoming impulses of phase No. 1, an impulse appears in the secondary winding of transformer 612 and is applied through resistor 613 to the starting anodes of all ten of the receiving tubes 603 in the marker. At the same instant, namely, in phase No. 1 of the generator 502, an impulse is supplied over conductor 508 through the windings of transformer 614 to the starting cathode of tube 615. The voltage thus produced by the simultaneous applications of these impulse potentials, which are of opposite polarity, to the starting electrodes of the single tube 615 causes the ionization of the control gap, whereupon a discharge circuit for the main gap of the tube is closed from the generator supply lead 542, which

has positive potential thereon at this time, through the winding of slow-release relay 616, anode 617 of tube 615, cathode 613 to the negative pole of battery 619. Relay 616 operates in this circuit to register the code digit 1 in the marker. In like manner the transmission of phase impulse No. 9 through the ionized tubes 606 causes an impulse in the secondary winding of transformer 620, which impulse is applied through the resistor 621 to the starting anodes of all tubes in the group 604. At the same instant, namely in phase No. 9, an impulse is applied from the generator 502 over conductor 509 through the windings of transformer 622 to the starting cathode of tube 623. The simultaneous potentials on the electrodes of tube 623 being of opposite polarity by reason of the direction of the transformer windings, the tube ionizes its starting gap, and current flows from the generator supply lead 542 through the winding of slow-release relay 624, anode 625 of tube 623, cathode 626 to the negative pole of battery 627. Relay 624 operates to register the code digit 9. Although phase impulses of the ten different phases are applied to the starting cathodes of all tubes in the groups 603 and 604 during this transmission period, only the two tubes 615 and 623 operate because these are the only tubes having simultaneous impulses applied to their starting anodes from the common transmitting conductors 207 and 208. Therefore, only the registers 616 and 624 operate as explained. The operation of these register relays 616 and 624 causes the selection and operation of the proper routing relay in the controlling and routing mechanism 607, wherefrom the routing of the call and the operation of the selector switches is determined.

At the end of the transmission period just described, during which the registration was transmitted from the sender 200 to the associated marker 600, the generator 502 enters phase No. 11, and another impulse is transmitted over conductor 513 through the condensers 529, 530 and 531 to the grids of the tubes 510, 511, 512. Tube 512 is unaffected by this impulse, but tube 511, which has been conditioned by the operated tube 510, discharges, and current flows through the resistance 536 to ground. In the manner already described the discharge of tube 511 extinguishes the preceding tube 510 and conditions the succeeding tube 512 for operation at the end of the next transmission period. The extinguishment of the tube 510 removes the positive potential from the conductor 541 and also from the anodes of the tubes of the group 205 in the sender 200 and from the corresponding group in each of the remaining senders. Consequently the tubes 205 and the corresponding tubes in other senders cease to conduct current through their main discharge gaps.

The flow of current in the resistance 536 when the tube 511 discharges as above explained causes the application of a positive potential through the choke coil 543 over conductor 544 through the associated transformer windings to the anodes of the ten tubes of the next group 206 of the sender 200 and of the corresponding group in each of the remaining senders. The application of this potential to the anodes of the tubes 205 is without effect since the sender 200 at this time is associated with marker 600, and the tubes 206 are inactive. In the sender 400, however, which is associated with marker 700 at this time, the ten relays corresponding

to relays 206 have their control gaps ionized, and the application of the positive potential over conductor 544 to the anodes of these tubes in the sender 400 causes them to discharge their main gaps preparatory to the transmission of signal impulses through the tubes corresponding to the transmitting tubes 203 and 204 and thence over the common transmission conductors 207 and 208 to the marker 700. Thus as the impulse generator 502 passes through its phases No. 0 to No. 9 for the next period impulses of the particular phases characterizing the operated register relays in the sender 400 are transmitted over the conductors 207 and 208 and are recorded only on the registers of the marker 700 with which sender 400 is associated.

At the end of this second transmission period the time counting tube 512 discharges and extinguishes the preceding tube 511 and prepares the sender 500 for transmitting its record, in case it is engaged at this time, to the marker with which it is associated. In like manner the transmission periods follow in succession under the control of the counting mechanism 501, and the records of all engaged senders are transmitted during the appropriate periods over the common conducting medium to the associated markers.

After all controlling functions have been completed by the marker 600, the sender relay 305 may be released to open the ionizing circuit for the control gap of the tube 306. On the next opposing cycle of the source 312 the main gap of the tube 306 quenches, and relay 311 releases to open the discharge circuit of the allotter tube 301. The tube 301 quenches and removes potential from the starting anodes of the tubes 205 permitting these tubes to quench their control gaps. The quenching of the tube 301 also restores the potential of the main cathode of the corresponding tube in each of the remaining senders so that the marker 600 will appear idle to these other senders. Also the sender 200 is released after it completes all the functions necessary in connection with the extension of the calling line to its destination and is free for selection by other calling subscribers' lines.

Each time the generator 502 passes through phase No. 10 a test is made to determine the continuity and operating condition of the common transmitting conductors 207 and 208 extending from the senders to the markers. This test is performed by the testing and alarm mechanism shown in Fig. 7. As the generator 502 enters phase No. 10 an impulse is transmitted over impulse lead 545 through the discharge tubes 546 and 547 thence over conductors 548 and 549 to join conductors 207 and 208, respectively, at a point near the first sender 200, and from thence the circuits continue over conductors 207 and 208 to the starting anodes of the tubes 701 and 702, respectively. At the same instant an impulse of phase No. 10 is transmitted over conductor 550 through the winding of transformer 705 to ground. The impulse produced in the secondary winding of the transformer 705 is applied to the starting cathodes of the tubes 701 and 702 and is opposite in polarity to the impulses applied to the starting anodes. Therefore these tubes ionize their control gaps, and current flows from the generator supply lead 542 through the windings of slow-release relays 703 and 704, main anodes of the tubes 701 and 702, main cathodes of these tubes to the negative pole of battery 706. These impulses recurring

in the conductors 207 and 208 once per cycle of the generator 552 are sufficient to maintain the relays 703 and 704 continuously operated to hold open the alarm circuits 707. However, should a failure occur in one of the conductors 207, 208, the ionizing impulses cease to appear, and the corresponding relays 703, 704 release to close the alarm circuit.

What is claimed is:

1. In combination, a group of sending devices, a group of receiving devices, means for registering information in said sending devices, a common signaling medium permanently connecting each of said sending devices with all of said receiving devices, means for seizing said sending devices for use, means for causing each sending device taken in use to seize an idle one of said receiving devices, means for producing a group of impulses in each one of a succession of time periods, said group comprising impulses of a plurality of phases, said impulse periods representing, respectively, said receiving devices, means for sending over said signaling medium from the sending devices to the receiving devices impulses of said plurality of phases in each of the time periods representing a seized receiving device for the purpose of transferring over said medium the information registered in all sending devices in use, means in each receiving device for selecting the phase impulses in the period representing such receiving device, and means in each receiving device responsive to the phase impulses selected for registering the information transferred from the sending device that seized said receiving device.

2. In combination, a group of sending devices, a group of receiving devices, means for registering information in said sending devices, a common signal transmitting conductor joining all of said sending devices in a continuous conducting path with all of said receiving devices, means for seizing for concurrent use variable numbers of said sending devices, means for causing each sending device taken in use to seize the next idle one of said receiving devices, means for producing a group of impulses in each one of a succession of time periods, each group comprising impulses of a plurality of phases, said impulse periods characterizing, respectively, said receiving devices, means controlled by said impulse producing means for enabling each one of the seized receiving devices during the corresponding impulse period, means for sending over said common conductor from the sending devices to all of the receiving devices impulses of said plurality of phases in each of the time periods characterizing a seized receiving device for transferring the information registered in all sending devices in use, means in each receiving device responsive to said phase impulses during each period said receiving device is enabled, and means in each receiving device responsive to the phase impulses received for registering the information transferred from the corresponding sending device.

3. In combination, a group of sending devices, a group of receiving devices, means for registering information in said sending devices, a signaling conductor permanently and continuously connected between all of said sending devices and all of said receiving devices, means for seizing for concurrent use a variable number of said sending devices, means for causing each sending device

taken in use to appropriate for use an idle one of said receiving devices, a source for producing a group of impulses in each one of a plurality of successive time periods, said group comprising impulses of a plurality of phases, means for rendering the appropriated receiving devices effective, respectively, during successive impulse periods and for repeating said periods cyclically, means for sending over said signaling conductor from each sending device in use an impulse of the phase characterizing the information registered in said sending device in the time period corresponding to the appropriated receiving device, and means in each receiving device responsive to the phase impulses received during the period such device is effective for registering the information transferred from the associated sending device.

4. The combination in a telephone system of a group of senders, a group of markers, means for registering telephone information in said senders, a common signaling conductor permanently connecting all of said senders with all of said markers, means for seizing a number of said senders for concurrent use, means for causing each sender to appropriate for use an idle one of said markers, a source of alternating current, means for generating a group of impulses in each of a plurality of successive time periods, each period corresponding to a cycle of said source and characterizing a particular one of said markers, said group comprising impulses of a plurality of phases, means for sending over said signaling conductor from each sender in use an impulse of any one of said phases in each of the time periods characterizing an appropriated marker, said phase impulses representing the information registered in said senders, means controlled by said impulse generating means for rendering each appropriated marker responsive to the phase impulses transmitted during each of the successive periods characterizing said marker to register therein the information transferred from the associated sender, and automatic switches controllable by the information registered in said markers for establishing telephone connections.

5. The combination in a telephone system of a group of senders, a group of markers, means for registering telephone designations in said senders, a common signaling conductor connecting all of said senders in multiple with all of said markers in multiple, means for seizing any one or more of said senders for concurrent use, means for causing each sender taken in use to appropriate an idle one of said markers, a source of alternating current, means for generating a group of impulses of different phases in each of a plurality of successive and cyclically recurring time periods, each period corresponding to a cycle of said source, each period representing one of said markers, means for sending over said signaling conductor from each sender in use to all of said markers an impulse of any one of a plurality of said phases during the impulse period representing the particular marker appropriated by such sender, means controlled by one of the phase impulses produced in each of the successive impulse periods for enabling the corresponding marker to the exclusion of the remaining markers, and means in each marker responsive during each period in which it is enabled for receiving and registering the phase impulses transmitted from the associated sender.

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