

June 9, 1942.

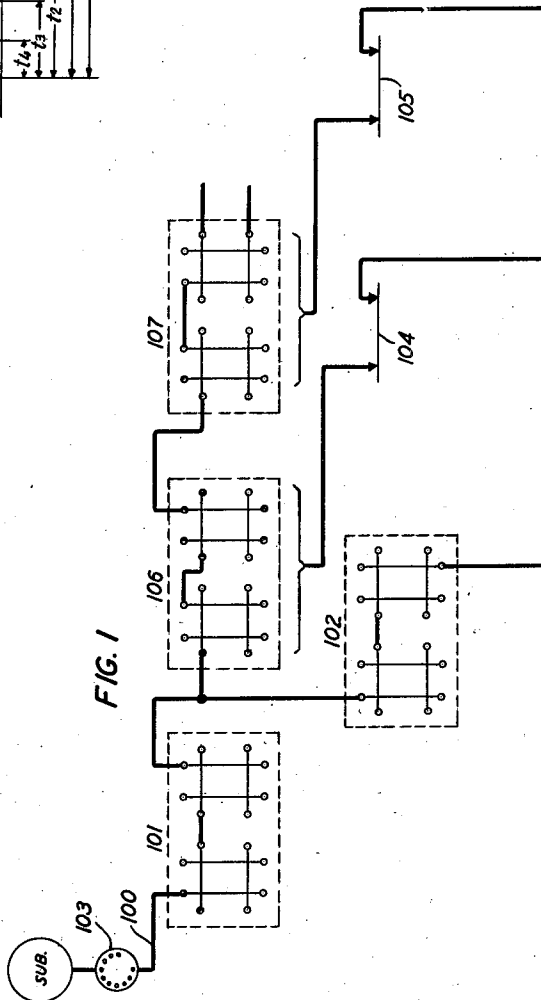
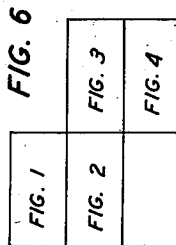
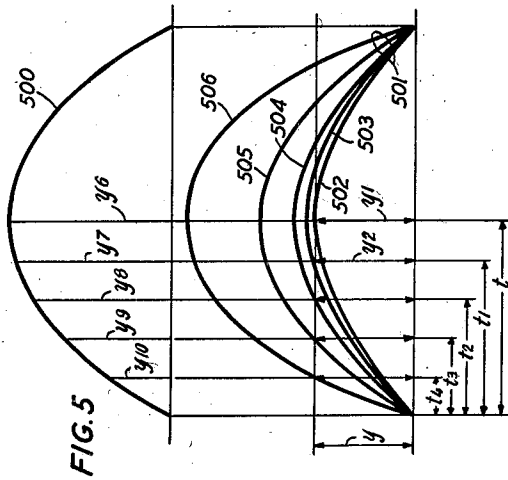
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2,285,815

SIGNALING SYSTEM

Filed Oct. 17, 1940

4 Sheets-Sheet 1



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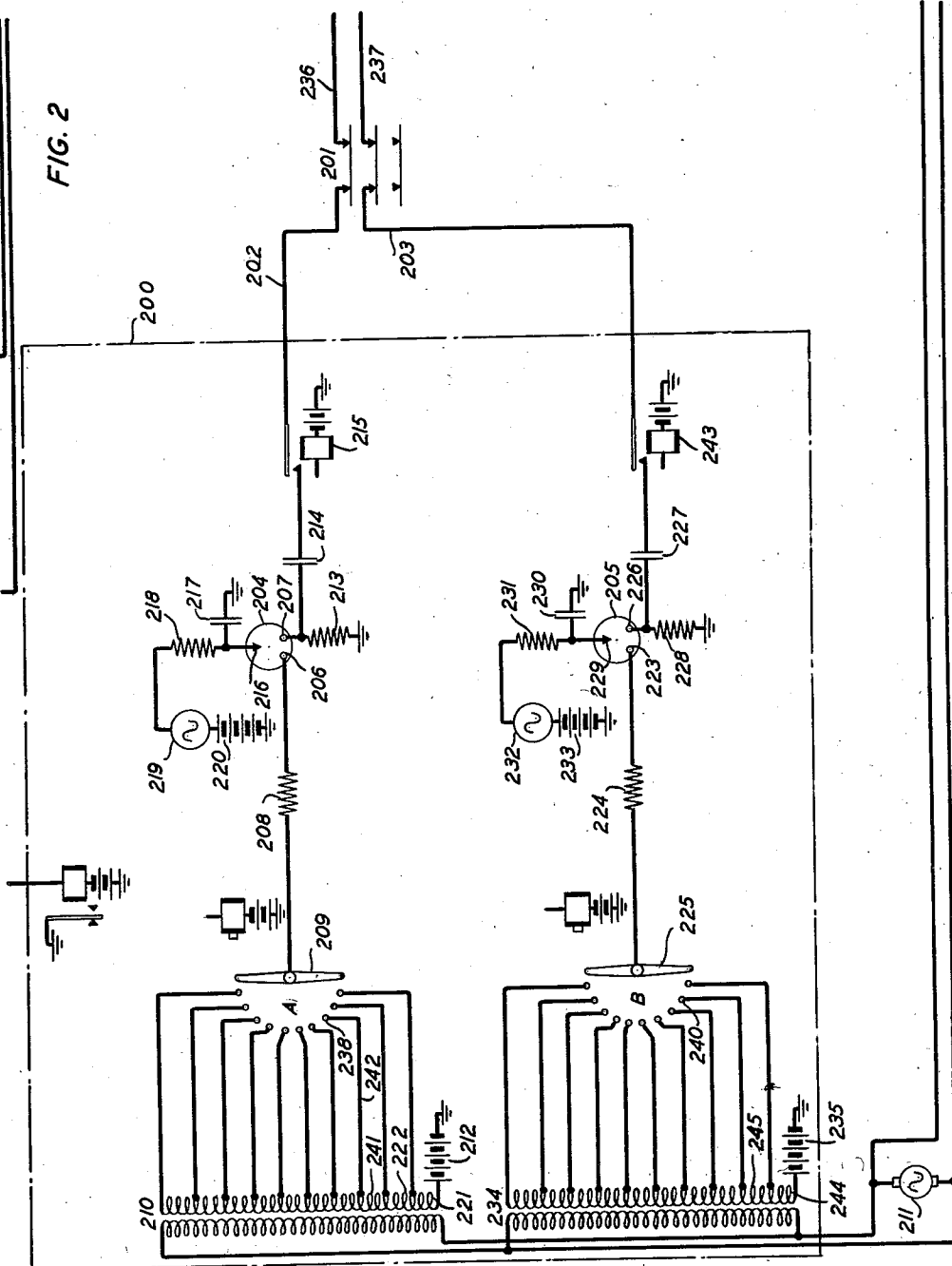
2,285,815

SIGNALING SYSTEM

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4 Sheets-Sheet 2

FIG. 2



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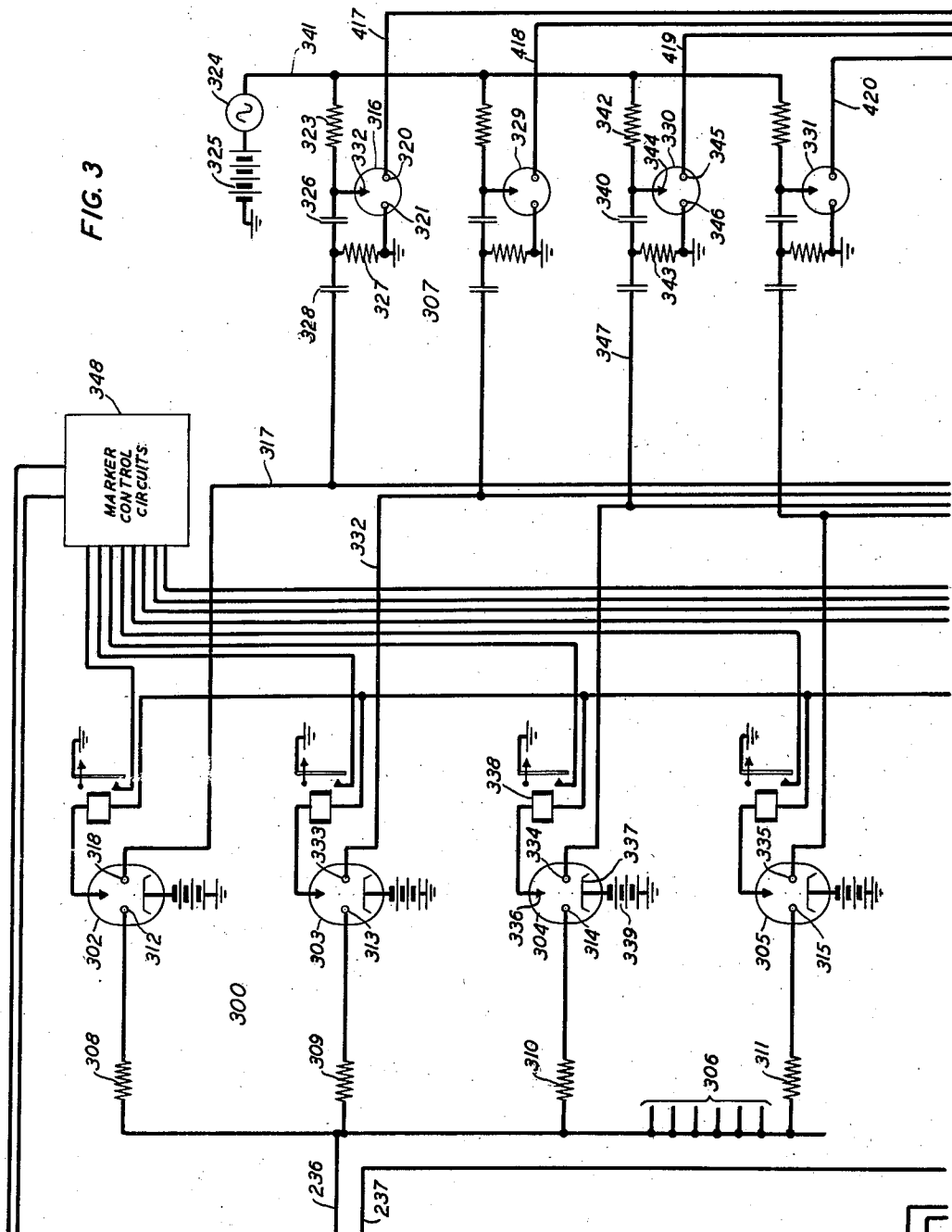
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SIGNALING SYSTEM

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4 Sheets-Sheet 3



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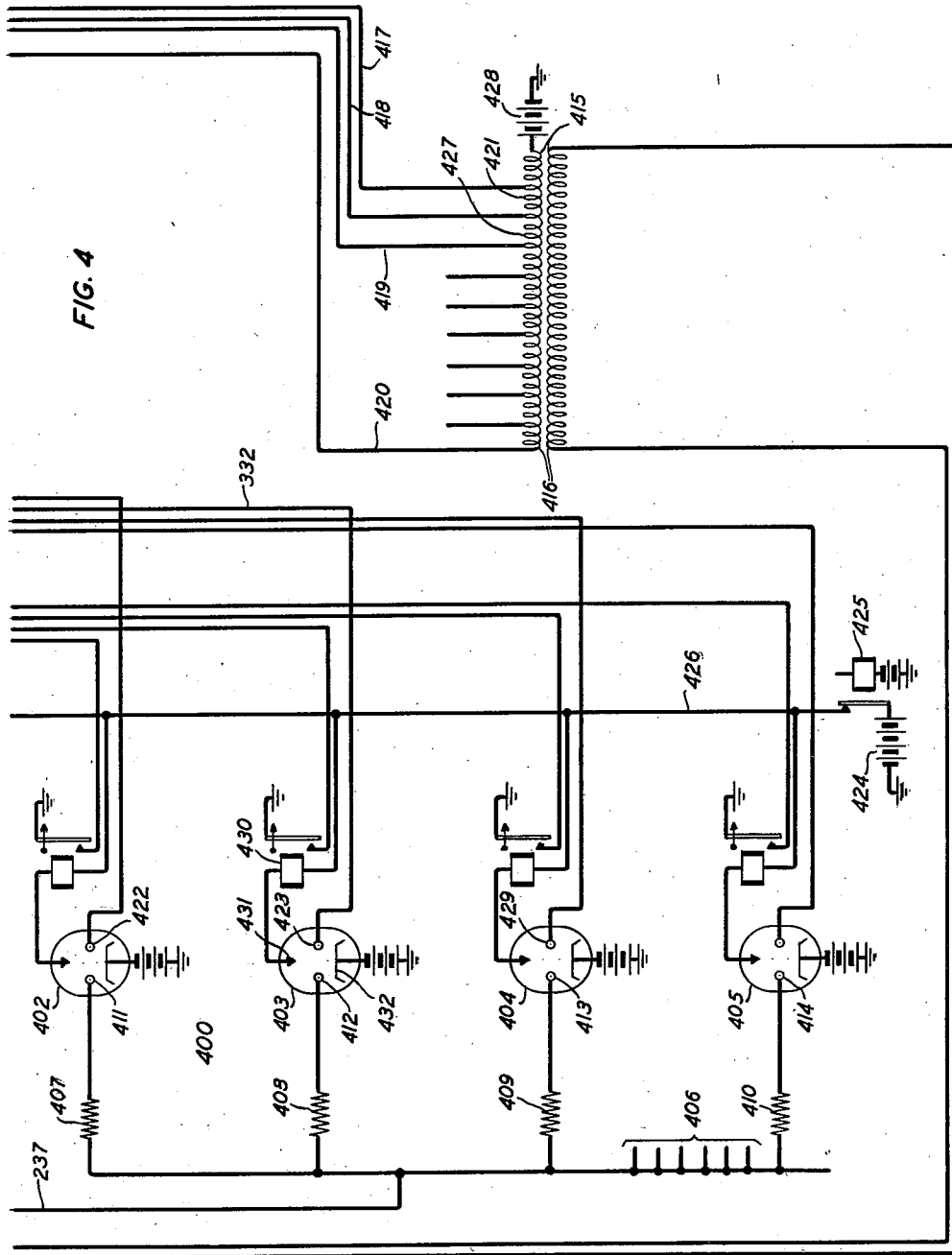
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SIGNALING SYSTEM

Filed Oct. 17, 1940

4 Sheets-Sheet 4



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2,285,815

SIGNALING SYSTEM

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Application October 17, 1940, Serial No. 361,537

10 Claims. (Cl. 179—18)

This invention relates to signaling systems and particularly to systems in which a multiplicity of signals are transmitted over a single line or circuit.

An object of the invention is to obtain improvements in the means utilized for generating and transmitting signals.

Another object is to control the phase of the signal impulses to represent the characters that are being transmitted.

Another object is to utilize the signal characters to cause the generation of signal impulses of varying phase by varying the voltage applied to the impulse generator.

In cases where a multiplicity of signals are transmitted from one point to another within a brief space of time it is frequently the practice to provide a plurality of transmitting conductors to reduce the number of signals that any one conductor is required to transmit. For example, in telephone systems employing register senders and markers it is the practice to transmit the designation registrations from the sender to a marker over a multiplicity of conductors, each conductor serving to carry the signals pertaining to a portion of a designation. In view of the large number of signaling conductors extending from one part of the system to another, it has been proposed to simplify these systems by varying the phase of the signal currents in such a way that a large number of signals may be transmitted over a single conductor.

In accordance with the present invention improvements over these prior signaling systems are obtained by employing a space-discharge tube for generating the signal impulses and by varying the amplitude of the voltage applied to the control electrodes of the tube to control correspondingly the phase of the impulses generated. More specifically, the circuit of the main discharge gap of the tube includes a source of direct current and a source of alternating current which cause the tube to discharge momentarily at each cycle in response to ionization of the control gap. A source of direct current and a source of alternating current are also included in the circuit of the control gap of the tube together with means for varying the amplitude of the alternating component. By varying the alternating component of the control gap voltage in accordance with the signal to be transmitted, the phase of the impulse generated in the main gap circuit is determined correspondingly. The impulse of desired phase thus generated is transmitted over the transmission circuit to the receiving equipment.

Another feature of the invention is a signaling system in which the characters of a telephone designation registered in a register sender are utilized to control the amplitude of the potential applied to the control gap of the tube generator to control correspondingly the phase of the impulses produced in the main gap circuit, and in which these impulses are then transmitted to a switch controlling marker where they are registered and utilized to determine the operation of the selective switches in the telephone system.

These and other features of the invention will be discussed more fully in the following detailed specification and will also be set forth in the accompanying claims.

In the drawings accompanying the specification:

Figs. 1 to 4, when arranged in the order shown in Fig. 6, illustrate an automatic telephone system in which the present invention is incorporated;

Fig. 1 is a diagrammatic showing of the originating equipment in an automatic telephone system, including switches for extending a calling subscriber's line to a register sender and for selectively extending said line to a desired trunk;

Fig. 2 illustrates a portion of a common register sender in the telephone office. This figure also shows a connecting device for connecting the senders to switch controlling markers;

Figs. 3 and 4 illustrate one of the switch controlling markers; and

Fig. 5 is a graph illustrating the relation of the potentials applied to the signal generators.

The present invention is useful in signaling systems having a wide variety of applications and particularly in communication systems, such as telephone and telegraph systems, where it is desirable to transmit a multiplicity of signals over a limited number of signaling conductors. Although the invention is not so limited, it has been illustrated in an automatic telephone system arranged for transmitting designation information from a register sender to a switch controlling marker. These senders and markers constitute the essential control equipment of the well-known cross-bar system, and a more complete understanding of their details of operation may be had from the patent to W. W. Carpenter, No. 2,235,803, issued March 18, 1941.

In the cross-bar system the designation of the wanted line, comprising a plurality of digital characters, is transmitted from the calling line to the register sender where it is received and registered. Thereafter the sender seizes an idle one of the markers, and a portion of the registered

designation is transferred to the marker where it is registered and utilized to select and operate a route relay for determining the routing of the call. Since that part of the designation which is transferred from the sender to the marker usually comprises a plurality of code digits, each of which has ten possible values, it has been the practice heretofore to provide a separate transmission conductor between the sender and the marker for each value of each of these code digits. By using the present signaling system it is possible to transfer all of the ten separate values of a code digit over a single conductor.

Referring particularly to the drawings, the central office register sender, which is seized automatically by a calling subscriber's line 100 through the operation of line switch 101 and sender selector 102, includes the usual means for registering the office code digits and the numerical digits. Two of the code registers A and B are illustrated, but the numerical registers have been omitted in order to simplify the disclosure. The code registers A and B are ordinary stepping switches which are set in any one of ten different positions in response to the series of code impulses received from the calling subscriber's dial 103. Although only two of these code switches are shown, three or more may be included if necessary.

The register sender 200 seizes an idle one of the switch controlling markers shown in Figs. 3 and 4 by operating the marker connector 201 to close a plurality of leads between the sender and the marker. Thereupon the code digits are transmitted over the conductors 202 and 203 to the marker. Since the code digit A may have any one of ten different values from 0 to 9, the particular value represented by the setting of the register A is determined by the phase of the signal current applied to the single conductor 202. In other words, signal impulses of ten different phases may be generated and applied to the conductor 202 to represent any one of the ten different digital values. Similarly the digital values of the code digit B are represented by the phase of the signal impulses generated and applied to the signal conductor 203.

The designation signal impulses are received in the marker and utilized to operate selectively one of a plurality of multielectrode tubes 300 and 400 which represent respectively the successive values of the digits. There are ten of these multielectrode tubes in the group 300 pertaining to the first code digit and ten similar tubes in the group 400 pertaining to the second code digit. As illustrated, the tubes 302, 303, 304 and 305 represent the values 0, 1, 2 and 9, respectively, of the digit A. Other tubes representing the remaining six digital values would be connected to the conductors 306. In like manner the tubes 402, 403, 404 and 405 represent the values 0, 1, 2 and 9 of the second code digit B, and the remaining six tubes in the group 400 are connected to the conductors 406.

The tubes of the groups 300 and 400 in the marker are selectively operated by applying to their control electrodes brief signal impulses of phases which may have any one of ten different values. Each of the tubes of group 300 has a control electrode which is connected to the signal conductor 236 incoming from the sender, and the phase of the impulse applied to these control electrodes depends upon the particular setting of the register A. Likewise the control electrodes of tubes 400 are connected to conductor 237. Also

each of the tubes of these groups 300 and 400 has a second control electrode to which an impulse of a particular phase is applied by an impulse generator associated with the marker, the ten successive tubes of each group having impulses of the ten different phases applied respectively to these second electrodes. The phase controlled impulses, which are transmitted from the sender to the groups 300 and 400, are generated by the impulse generating tubes 204 and 205 located in the sender, and the impulses of ten different phases, which are applied to the second control electrodes of the tubes 300 and 400, are generated by a group of ten impulse generating tubes 307, which may be located in the marker or may be common to a plurality of markers.

The impulse generating tube 204 in the sender has two control electrodes 206 and 207 which form a control or ionizing gap in the tube. The electrode 206 is connected through a resistance 208 to the movable brush 209 of the register A. The ten terminals of the register A are connected to ten successive tap points on the secondary winding of the transformer 210, the primary winding of which is connected to the source of alternating current 211. The positive pole of the direct current source 212 is connected to the lower terminal of the secondary winding of the transformer 210 so that the voltage of the source 212 is applied in series with the voltage of the transformer to the electrode 206 of the tube. The other control electrode 207 is connected through a resistance 213 to ground and also through a condenser 214 to the contact of control relay 215. The control relay when operated extends the impulse circuit from the tube to the signal transmission conductor 202. The anode 216 is connected through a condenser 217 to ground and also through a resistance 218 to the anode source, which consists of the alternating current generator 219 and the direct current battery 220.

The alternating current sources 211 and 219 are of the same frequency, and the voltage produced by the secondary winding of the transformer 210 may be considered to be in phase with the voltage of the source 219. This relationship is illustrated in Fig. 5 in which the graph 500 represents the voltage wave of the source 219 applied to the anode 216 and the graphs 501 represent the voltages applied to the control electrode 206. If it is assumed that the ordinate y represents the voltage necessary to ionize the gap 206—207, it will be seen that the time of ionization in the cycle may be varied by varying the magnitude of the alternating potential component produced by the secondary winding of the transformer 210. For example, when the alternating potential component is derived from the single section 221 of the transformer, its magnitude is at a minimum value, as illustrated by graph 502, and the maximum ordinate y_1 of this wave when added to the direct current component from the battery 212 is just sufficient to ionize the gap 206—207. Hence ionization of the main gap 216—207 occurs at the end of time t following the commencement of the positive half cycle. If the register switch A is stepped to the second position, sections 221 and 222 are both effective, and the alternating potential component is now represented by the wave 503. Since the curve 503 is of greater magnitude its ordinate y_2 is equal to the value y and is reached somewhat earlier in the cycle, namely, at the end of time t_1 . Therefore, when windings 221 and 222

are in circuit, the control gap ionizes at the end of time t_1 and the main anode gap also ionizes at this time to render the tube effective to deliver the impulse. Similarly as additional sections of the transformer are included under control of the stepping switch A the alternating component is increased to values represented by the waves 504, 505, 506 and the time of ionization is shifted correspondingly in the cycle. Since the main gap of the tube 204 must discharge simultaneously with the ionization of the control gap it is assumed that the sum of the direct and alternating voltage components in the anode circuit is sufficient to produce ionization in the main gap at any point in the cycle of the wave 500. In other words, any one of the ordinates y_6, y_7, y_8, y_9 and y_{10} of the wave 500 is sufficient when added to the direct potential component of the battery 220 to ionize the main discharge gap of the tube when the control gap is ionized. This requirement may be satisfied, of course, by selecting the sources 219 and 220 such that the voltage of source 220 is just below the value required to discharge the main gap.

It will be noted that the amplitude of the anode voltage at the time of discharge varies between minimum and maximum values. If the control voltage is high and ionization occurs at the end of the time t_1 , which is early in the cycle, the main discharge voltage available for producing the signal pulse is substantially the sum of the direct component and the alternating potential y_{10} . However, if the control voltage is low and ionization does not occur until the end of time t , the main discharge voltage is considerably greater since the direct component is now supplemented by the maximum alternating component y_6 . Hence the variation of the amplitude of the control gap voltage not only varies the phase of the pulses produced by the tube 204, but also the amplitude of these pulses. If it is desired to minimize the variation of the amplitude of the output pulses this may be accomplished by selecting source 219 having a voltage relatively small when compared with the voltage of the direct source 220.

It will be noted that the potential of the source 212 is aided by the transformer 210 during the positive half cycle of the voltage produced by the transformer. Similarly, the voltage from the battery 220 is aided by the source 219 during the positive half cycle of the latter source. Accordingly the tube 204 is ionized and the impulses are produced by only the positive half cycle of the alternating sources as illustrated in Fig. 5.

The impulse tube 205 associated with the register B is substantially the same as tube 204 already described. The control electrode 223 is connected through a resistance 224 to the brush arm 225 of the switch B, and the other control electrode 226 is connected to the condenser 227 and through a resistance 228 to ground. The anode 229 is connected to condenser 230 and through the resistance 231 to the anode source, comprising the alternating current generator 232 of the same phase as generator 211 and battery 233. The terminal points on the switch B are connected to successive sections of the secondary winding of transformer 234 the primary winding of the transformer being connected to the source 211. The battery 235 supplies the direct potential component to the control gap 223—226.

As will be explained more fully hereinafter the impulses produced by the tubes 204 and 205 in the conductors 202 and 203 are of positive poten-

tial. These positive impulses in the transmission conductor 202 are applied by way of conductor 236 and thence in parallel through resistances 308, 309, 310, 311 to the control electrodes 312, 313, 314, 315 of the respective tubes of the groups 300. In like manner the positive impulses appearing in conductors 203 and 237 are applied over the parallel circuits including resistances 407, 408, 409, 410 to the control electrodes 411, 412, 413, 414 of the corresponding tubes of the group 400.

It was mentioned hereinbefore that impulses of the successive phases are also applied to the second control electrodes of the consecutive tubes of each group 300 and 400. These impulses are of negative polarity and are generated by the impulse generating tubes 307, there being one of these tubes for each of the ten different phases. For example, the tube 316 generates a negative impulse of phase No. 1, corresponding to position No. 1 of switches A and B, and applies this negative impulse over the conductor 317 to the control electrode 318 of the first register tube 302 of the group 300. To this end the first section 415 of the secondary winding of transformer 416 is connected over conductor 417 to the control electrode 320 of the tube 316, the other control electrode 321 being connected to ground. The anode 322 is connected through resistance 323 to the anode source of potential comprising the alternating generator 324 and the direct current battery 325. The anode 322 is also connected through a condenser 326 and resistance 327 to ground, the free terminal of the resistance being connected through the condenser 328 to the impulse conductor 317. Each of the remaining tubes 329, 330, 331, of the group 307 are similarly connected, their control electrodes being wired over conductors 418, 419, 420 to corresponding tap points on the secondary winding of the transformer 416. The primary winding of the transformer 416 is connected to the source 211, and the source 324 is of the same frequency as sources 211 and 219 and produces a voltage wave which is in phase with the voltage waves produced in the secondary winding of the transformer 416. Therefore, a voltage wave of minimum amplitude, corresponding to the wave 502 in the diagram of Fig. 5, is applied to the control gap 320—321 of the first tube 316, and the main anode gap ionizes at the end of time t to produce in the conductor 317 a negative impulse of phase No. 1, which occurs at the end of time t in the cycle, and this impulse is applied to the control electrode 318 of the tube 302 and to the control electrode 422 of tube 402. Similarly a voltage wave of greater amplitude, produced by sections 415 and 421 of the transformer, is applied to the control gap of tube 329, and a negative impulse, occurring earlier in the cycle, is applied over conductor 332 to the control electrode 333 of the tube 303 to the control electrode 423 of the tube 403. In like manner impulses of eight other different phases are produced by the remaining generator tubes 307 and applied to the corresponding tubes 304—305 in the group 300 and to tubes 404—405 in the group 400.

It will now be seen that any one of the digit tubes in the group 300 may be selectively operated by setting the register A in position to cause the transmission over conductors 202 and 236 of a positive impulse, the phase of which is the same as the phase of the negative impulse applied to the desired digit tube by the corresponding one of the impulse generating tubes 307.

For example, if it is desired to select and operate a digit tube 304 the register switch 209 is advanced to its No. 3 position terminal 238. With the register A standing in position 3 the generator tube 204 produces a positive impulse of phase No. 3, and this impulse is applied over conductors 202 and 236 to the control electrodes 312, 313, 314, 315 of all ten digit tubes. Although negative impulses are being applied to the electrodes 318, 333, 334, 335 of these tubes, only the impulses applied to the electrode 334 of tube 304 are in phase with the incoming signal impulses from the tube 204. Hence only the tube 304 ionizes its control gap, resulting in the ionization of the main gap between the anode 336 and cathode 337. Ionization of the main gap of tube 304 results in the operation of the register or code relay 338 in a circuit traceable from positive pole of battery 424, contacts of relay 425, conductor 426, winding of relay 338 through the main gap of the tube 304 to the negative pole of battery 330. In like manner any other one of the tubes in the group 300 or in the group 400 may be selectively operated by the positioning of registers A and B in the sender.

The operation of the signaling system will now be described in detail, assuming for this purpose that the subscriber of line 109 wishes to make a call. When the subscriber removes his receiver, the line switch 101 and the sender link switch 102 operate in the well-known manner to extend the subscriber's line through to an idle register sender 200. Thereupon the subscriber operates his dial 103 to transmit two series of impulses representing the code letters of the wanted designation, together with four series of impulses representing the subscriber's number. The two code digits operate the corresponding code registers A and B, and it may be assumed that these switches come to rest on their No. 3 and No. 2 position terminals 238 and 240. The numerical registers in the sender are not illustrated since they are not particularly concerned with the present invention.

At some suitable time following the seizure and operation of the sender 200 the marker connector 201 is operated to connect the sender to the idle marker shown in Figs. 3 and 4. Thereafter the relay 215 is operated under the control of the sender, and the signaling circuit is closed for applying the generated impulses to the conductors 202 and 236. The manner in which these positive impulses are produced by the tube generator 204 will now be explained. Each impulse is produced by a discharge from the condenser 217 across the anode-cathode gap 216—207. The condenser 217 is charged from the direct voltage source 220 through the resistance 218 and the condenser to ground. At the beginning of the next positive half cycle of the source 219 the charge on the condenser 217 is increased by the addition of the alternating voltage component. As soon following the beginning of the positive half cycle of the source 219 as the voltage wave produced by the sections 221, 222 and 241 of transformer 210 reaches the amplitude y (Fig. 5) the combined potential of the transformer and the source 212 is sufficient to ionize the control gap 206—207. This ionizing potential is applied in a circuit traceable from positive pole of battery 212, sections 221, 222 and 241, conductor 242, terminal 238 of switch A, brush 209, resistance 208, electrodes 206 and 207, resistance 213 to ground. The control gap ionizes, causing the immediate flow of current in the anode-cathode-

circuit, since the source 219, which is now in its positive half cycle, has raised the voltage of condenser 217 above the discharge voltage of the anode-cathode gap. The condenser 217 discharges in a circuit traced from its free pole across the anode 216 and cathode 207 through the resistance 213 to ground. The momentary flow of current through the resistance 213 in this direction produces a positive potential on conductors 202 and 236 and consequently on electrodes 312, 313, 314, 315, etc., of the tubes 300. As soon as the condenser 217 becomes discharged, the impulse ceases. When the next negative half cycle of the alternating sources 212 occurs, these sources oppose the battery 212 and battery 220, reducing the voltages sufficiently to cause the deionization of the control gap and also the main discharge gap of the tube 204. The condenser 217 is again charged from the battery 220, and the next impulse is produced as soon as the control gap ionizes on the next positive half cycle of the alternating current source.

While these positive impulses are being applied to the tubes 300 by the impulse generator 204, negative impulses are being applied by the generators 307. For example, the tube 330 produces a succession of negative impulses by the successive discharges from condenser 340. This condenser is charged over a circuit traceable from the positive pole of battery 325 through the generator 324, thence over conductor 341, resistance 342, condenser 340, resistance 343 to ground. The charge derived from the battery 325 produces a voltage across the anode-cathode gap 344—346 which is not quite sufficient to cause the discharge of the tube even though the control gap 345—346 is ionized. As soon, however, as the source 324 enters its positive half cycle the charge on condenser 340 is raised to the discharge voltage of the anode-cathode gap. When thereafter the voltage wave produced by the sections 415, 421 and 427 of transformer 416 reaches a predetermined amplitude the control gap of the tube 330 is ionized. A circuit for applying the direct and alternating components of the ionizing voltage is traceable from the positive pole of battery 428, windings of sections 415, 421 and 427, conductor 419, gap 345—346 to ground. As soon as the control gap ionizes, the condenser 340 discharges across the gap 344—346, and the discharge current flows in the resistance 343 in such a direction that a negative potential is impressed on the condenser 347. This negative potential is applied to the control electrode 334 of the tube 304. Since the voltage applied to the control gap of the tube 330 includes three sections of the transformer winding 416 corresponding to the three sections of the transformer 210, which are applying voltage to the control gap of the tube 204, the control gap voltages of these two generating tubes are equal and their discharges occur simultaneously. Consequently the positive impulses produced by the tube 204 and the negative impulses produced by the tube 330 are in phase and are applied simultaneously to the control electrodes 314 and 334. The tube 304 ionizes, and the relay 338 operates in the main discharge circuit of the tube.

In like manner the control relay 243 is operated at the proper time to close the signaling circuit from the tube 205 over conductors 203 and 237 to the digit tubes 400 in the marker for receiving the second code digit. Since the code switch B is in position 2, sections 244 and 245 of transformer 234 are effective, and tube 205 pro-

duces positive impulses of phase No. 2 in the signaling circuit 203, 237, and these impulses are applied to the control electrodes of the tubes 400. At the same time the signal tube 329 produces negative impulses of phase No. 2, and these impulses are applied over conductor 332 to the control electrode 423 of the single tube 403 of the group 400. The impulses applied to tube 403 cause a sufficient voltage across the control gap to ionize the same, and the main discharge gap ionizes over a circuit traceable from battery through the contact of relay 425, conductor 426, winding of code relay 430, anode 431, cathode 432 to the negative pole of battery. Relay 430 operates in this circuit to register the second code digit 2.

Having selected and operated the desired digit tubes and register relays 338 and 430, the control circuits 348 of the marker become effective through the connectors 104 and 105 to extend the subscriber's line in the desired direction. Following the control of switches 106 and 107 and such other switches as may be needed in the completion of the connection, the common controlling equipment including the markers, senders and connectors is restored to its normal condition.

Although the invention has been illustrated in an automatic telephone system including switches, senders and markers it is concerned primarily with the transmission of signals over a signaling conductor; therefore, many of the details of the switches, senders and markers have been omitted for the sake of clearness. For a better understanding of a telephone system of this character reference may be had to the patent to W. W. Carpenter, No. 2,235,803, issued March 18, 1941.

As has been explained herein the invention is particularly useful in telephone and other communication systems where the transmission of signals of varying values is required. However, the invention is concerned primarily with the production of signals by the novel method disclosed for determining the signal value by controlling the phase or time position in which the signals occur. Obviously, therefore, the invention may have useful application for many purposes and in many different types and kinds of systems.

What is claimed is:

1. The combination in a signaling system of means for transmitting and registering signal currents representing characters of different values, a signal transmitting conductor, a space-discharge device having a main electrode and a control electrode, a source of alternating potential connected to said control electrode for raising the potential thereof to the operating value at each cycle of said alternating potential, a circuit for said main electrode, a source for causing current to flow in said main electrode circuit to produce a signal impulse in said circuit each time the potential of the control electrode is raised to the operating value, circuit means for applying said signal impulses to said transmitting conductor, and means controlled in accordance with the character registered for varying the phase of said impulses in the cycle of said alternating potential by varying the amplitude of said alternating potential to vary correspondingly the time in the cycle of said potential at which the potential of said control electrode reaches said operating value.

2. The combination in a signaling system of means for transmitting and registering series of

designation impulses of different values, a signal transmission line, a space-discharge tube having a main discharge gap and a control gap, a source of alternating potential connected to said control gap for causing the same to ionize at each cycle of said potential, a circuit for said main gap, a second source of alternating potential for causing said main gap to discharge and produce a signal impulse in said main gap circuit in response to each ionization of said control gap, circuit means for applying said signal impulses to said transmission line, and means controlled in accordance with the registered impulses for varying the amplitude of the alternating potential applied to said control gap to vary the phase of said impulses with respect to the cycle of said alternating potential.

3. The combination in a signaling system of a signal transmitting conductor, a space-discharge tube having a main discharge gap and a control gap, a first source of alternating potential of a given frequency connected to said control gap for causing the same to ionize at each cycle of said potential, a second source of alternating potential for causing said main gap to discharge and produce a signal impulse in said transmitting conductor in response to each ionization of the control gap, said first and second sources being of like frequency and in phase with each other, and means for varying the amplitude of said first potential to vary the phase of said impulses in the cycle of said alternating potentials.

4. The combination in a signaling system of a signal transmitting conductor, a space-discharge device having a main electrode and a control electrode, a source of potential including direct and alternating components connected to said control electrode for causing said device to ionize and deionize at each cycle of the alternating component, a circuit for said main electrode, a source for causing discharge current to flow in the circuit of said main electrode to produce a signal impulse in said transmitting conductor in response to each ionization of said device, and means for varying the phase of said impulses in the cycle of said alternating potential by varying the amplitude of the alternating component of the potential applied to said control electrode.

5. The combination in a signaling system of a line, a space-discharge tube having a main discharge gap and a control gap, a source of potential including direct and alternating components connected to said control gap for causing the same to ionize and deionize at each cycle of the alternating component, a second source of potential including direct and alternating components for causing said main gap to discharge and produce a signal impulse in said line in response to each ionization of the control gap, and means for fixing the occurrence of the signal impulse in the cycle of the alternating component applied to said main discharge gap by varying the amplitude of the alternating component applied to said control gap.

6. The combination in a signaling system of a transmission line, a space-discharge tube having a main discharge gap and a control gap, a source of potential including direct and alternating components connected to said control gap for causing the same to ionize at each cycle of the alternating component, the direct component being insufficient to maintain the ionization thereof, the alternating component being sufficient to quench

the control gap when opposing the direct component, a second source of potential including direct and alternating components connected in circuit with said main discharge gap, the direct component being insufficient to cause discharge of the main gap but sufficient to maintain the discharge thereof independent of the control gap, the alternating component of said second source being sufficient when aided by the direct component to discharge the main gap if the control gap is ionized and sufficient when opposing the direct component to quench said main gap, each discharge of said main gap producing a momentary signal impulse in said transmission line, and means for varying the phase of said signal impulses with respect to the cycle of said alternating components by varying the amplitude of the alternating component applied to said control gap.

7. The combination in a signaling system of a signal register, means for variably setting said register to register any one of a plurality of different signals, a signal transmitting conductor, an impulse generator comprising a space-discharge tube having a main discharge gap and a control gap, a source of alternating potential for causing the ionization of said control gap at each cycle thereof, a source for causing the discharge of said main gap to produce a signal impulse in said signal transmitting conductor for each cycle of said alternating potential, the phase of the signal impulse in the cycle of said potential serving to characterize the different signals being transmitted and means dependent on the setting of said register for varying the amplitude of said potential to determine the ionizing time of said control gap and correspondingly the phase of the signal impulse produced.

8. The combination in a signaling system of a register sender having a register for registering the characters of a designation, a switch controlling marker, a signal transmitting conductor extending from said sender to said marker for transferring the designation to the marker by means of signal impulses, a space-discharge device in said sender having a main discharge gap and a control gap, a source of alternating potential connected to said control gap for causing the same to ionize at each cycle of said potential, a source for causing said main discharge gap to

produce a signal impulse in said signal transmitting conductor for each cycle of said alternating potential, the phase of said signal impulses in the cycle of said alternating potential serving to characterize the designation signals being transmitted, and means controlled by the registers of said sender for varying the phase of said signal impulses by varying the amplitude of the alternating potential applied to said control gap.

9. The combination in a signaling system of means for transmitting designation impulses, a space-discharge device having a main discharge gap and a control gap, a source of alternating potential connected to said control gap for causing the same to ionize on each cycle of said potential, a source of current connected to said main gap for causing signal currents to flow in said main gap in response to each ionization of said control gap, and means controlled by said designation impulses for varying the amplitude of the alternating potential applied to said control gap to vary correspondingly the time of ionization of said control gap in the cycle of said alternating potential.

10. The combination in a signaling system of a space-discharge device having a main electrode and a control electrode, a source of alternating voltage, a transformer having a primary winding and a multiplicity of secondary windings connected in series relation, said transformer serving to apply alternating potential to said control electrode for raising the potential of said electrode to the operating value at each cycle of said alternating voltage, circuit means for connecting said source of alternating voltage to said primary winding, a circuit for said main electrode, a source for causing current to flow in said main electrode circuit to produce a signal in said circuit each time the potential of the control electrode is raised to the operating value, and means for connecting varying numbers of said secondary windings in series to said control electrode to vary correspondingly the amplitude of the alternating potential applied to said electrode for varying the time in the cycle of said alternating potential at which the potential of said control electrode reaches said operating value.

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