

July 13, 1943.

W. H. T. HOLDEN

2,324,394

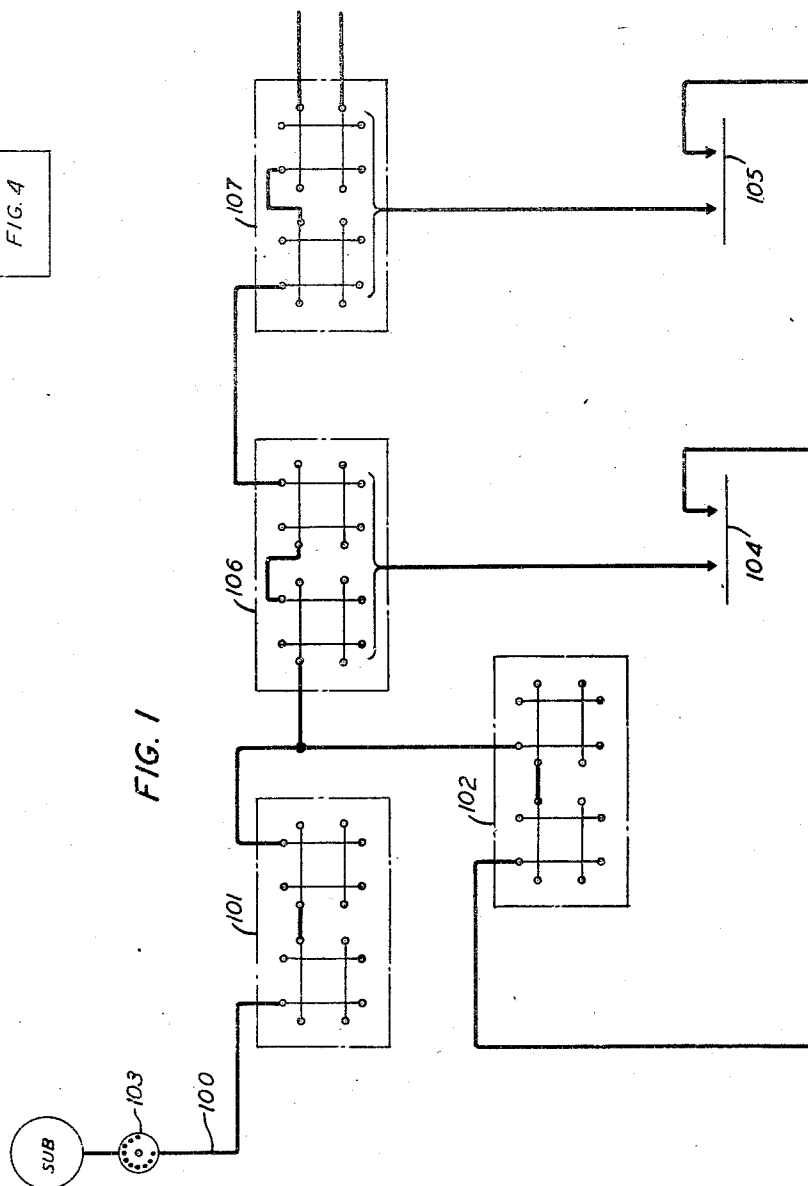
SIGNALING SYSTEM

Filed Oct. 17, 1940

4 Sheets-Sheet 1

FIG. 5

FIG. 1	FIG. 3
FIG. 2	FIG. 4



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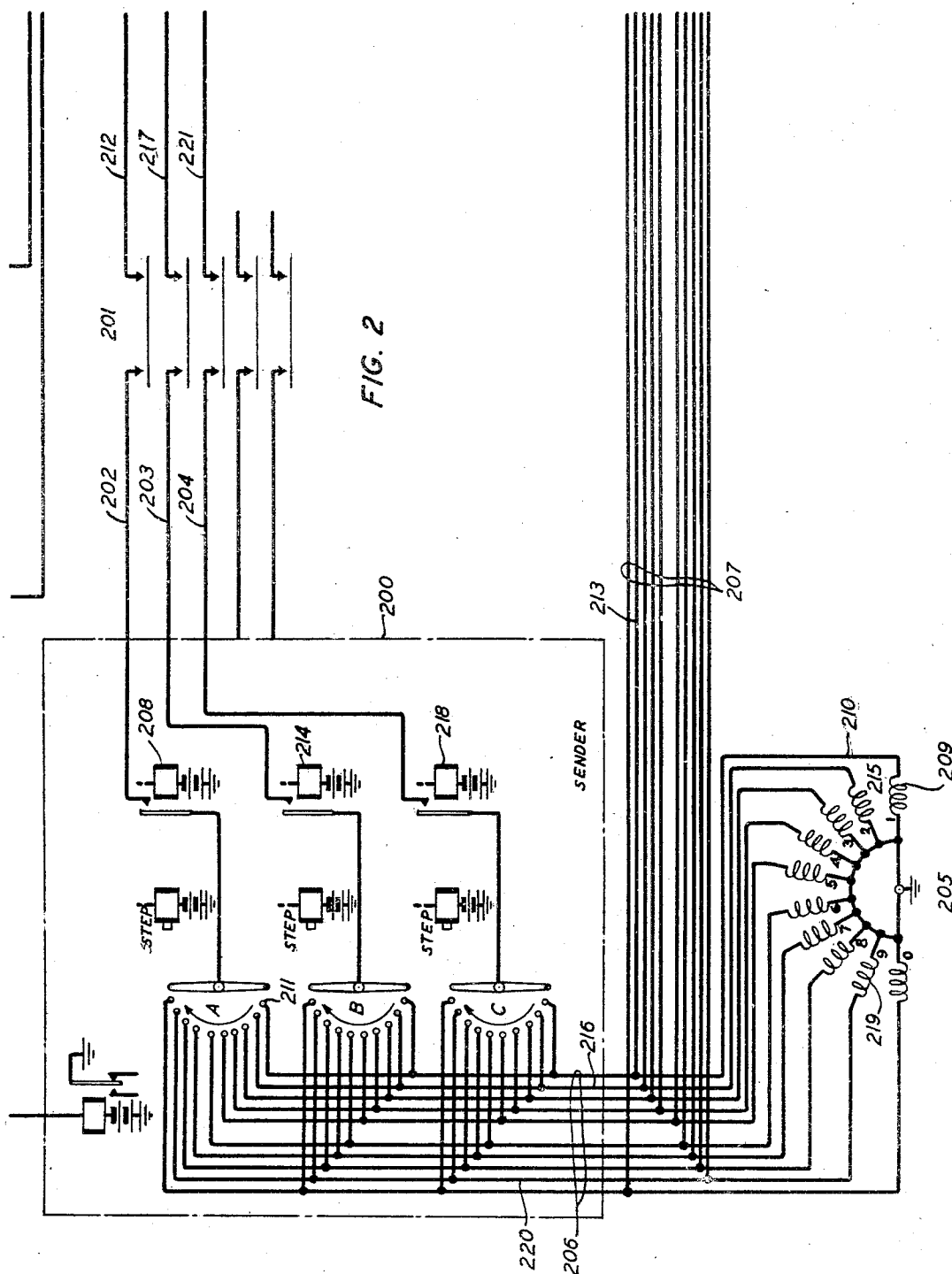
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4 Sheets-Sheet 2



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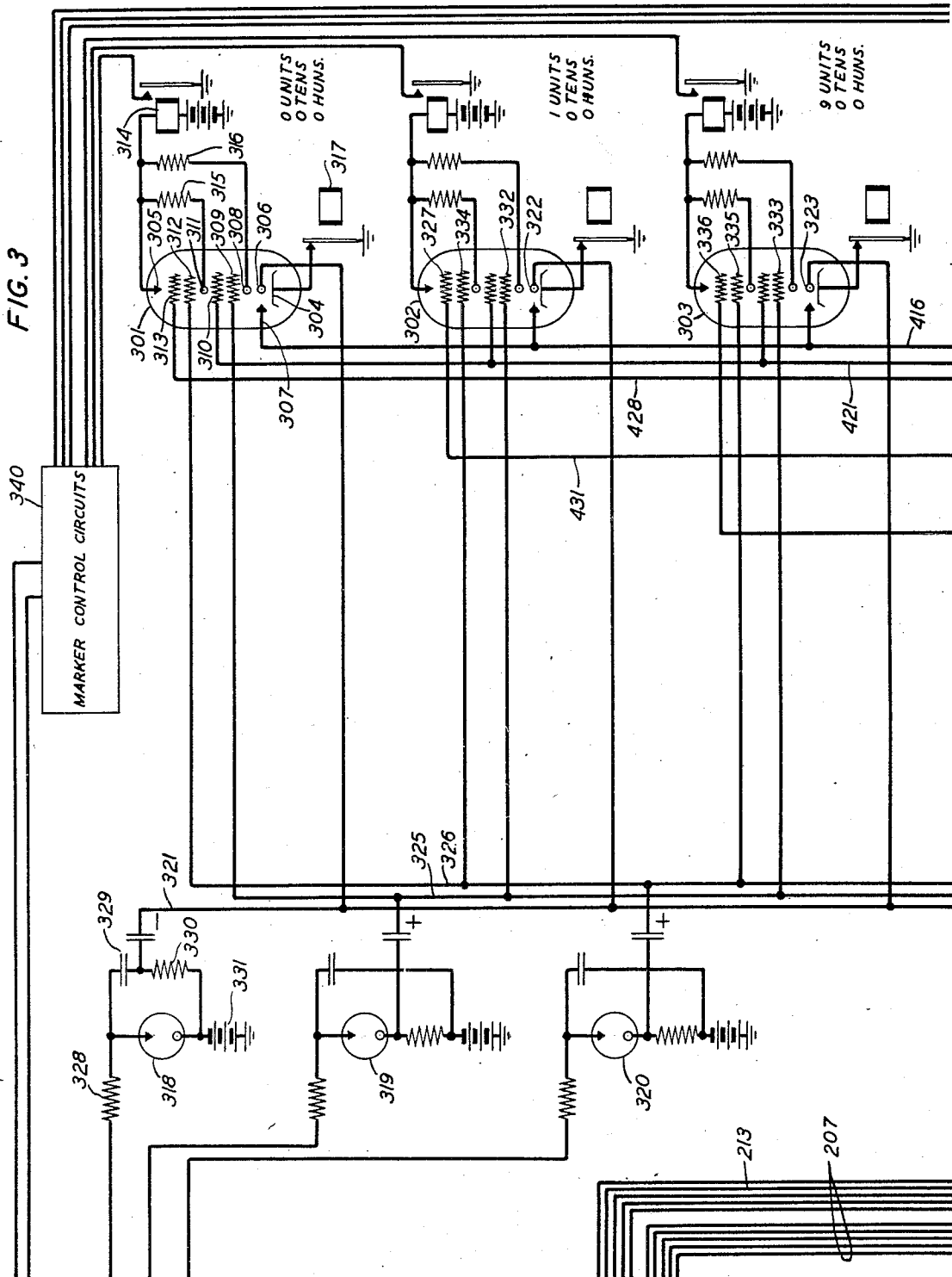
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SIGNALING SYSTEM

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4 Sheets-Sheet 3



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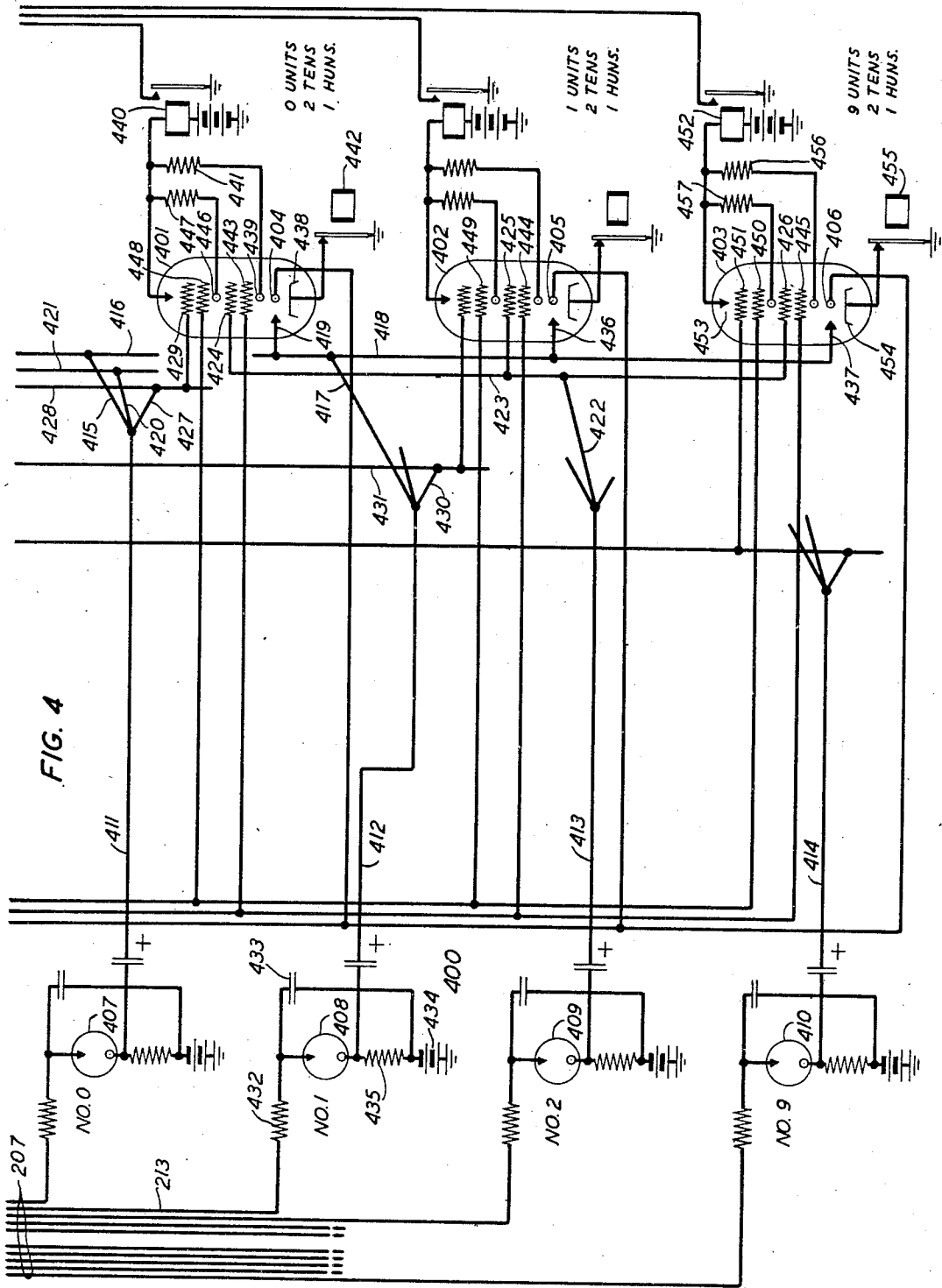
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SIGNALING SYSTEM

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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,324,394

SIGNALING SYSTEM

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Application October 17, 1940, Serial No. 361,536

18 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 transmission line or circuit.

An object of the invention is to increase the signal-carrying capacity of signal transmission lines and circuits.

Another object is to simplify and minimize the equipment needed in a multiplex signaling system for transmitting and receiving signals.

Another object is to obtain improvements in the signal responsive devices which serve to distinguish and register the incoming signals.

In many cases, particularly in automatic telephone systems, it is the practice to provide a multiplicity of transmitting conductors where it is necessary to send a plurality of signals from one part of the system to another. For example, in telephone systems of the cross-bar type the designation registrations in the register sender are transmitted to a switch controlling marker over a multiplicity of leads, each of which transmits a signal pertaining to a portion of the entire designation.

In accordance with the present invention, improvements over these prior signaling systems are obtained by utilizing a plurality of currents of different phases and applying these currents to a single transmitting line or circuit. More specifically, a signaling system arranged in accordance with this invention comprises means for applying to the transmitting end of the line or circuit a plurality of alternating currents of different phases and means at the receiving end responsive to the incoming currents for producing impulses having phases corresponding to said currents, together with detecting means responsive to these current impulses for identifying and registering the signals they represent.

Another feature of the invention is a signaling system in which the signal detecting device is a space-discharge tube having a plurality of elements which serve to operate the tube when potentials of the proper phase are applied thereto. The signal receiving mechanism includes a plurality of these discharge tubes, each of which detects a particular signal which may represent a portion of a telephone designation. The incoming alternating current representing a particular signal causes the application to the control elements of a plurality of tubes of a potential having a phase corresponding to that of the incoming signal current. At the same time potentials of the several phases are applied to cooperating control elements of the several tubes

in the receiving mechanism. The particular tube having potentials of the same phase applied to its control elements discharges to selectively record the receipt of the corresponding signal.

Another feature of the invention is a signal-receiving discharge tube having a plurality of discharge stages. If potentials of the same phase are applied to the cooperating terminals in the initial stage, ionization occurs between the first-stage anode and cathode, but the remaining portion of the tube remain deionized. If thereafter, during the receipt of incoming signals potentials of like phase are applied to the cooperating control electrodes of the next stage, the ionization is extended to the succeeding anode. Similarly, the ionization of the tube is extended from one stage to another in response to potentials of like phase until complete ionization is obtained between the main anode and cathode of the tube, resulting in the operation of a relay or other registering device to denote the completion of a signal.

Another feature of the invention is a telephone system in which signals representing a plurality of telephone designation characters are transferred from a common register sender to a switch controlling marker over a single conductor by means of signal currents of different phases, the different phases serving to designate the various characters involved in the designations.

These and other features of the invention will be discussed more fully in the following detailed specification.

In the drawings accompanying the specification:

Figs. 1 to 4, when arranged in the order shown in Fig. 5, 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 office. This figure also shows a signal generator which is common to a number of senders and also a connecting mechanism for connecting the senders to switch controlling markers; and

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

As explained above, the present invention is useful in signaling systems having a wide variety of applications and particularly in systems where it is desirable to transmit a multiplicity of sig-

nals 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 three code digits, each one of which has ten possible values, it has been necessary heretofore to provide a separate transmission conductor between the sender and the marker for each value of each of these three 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 200, 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 three office code digits and the numerical digits. The code registers are illustrated, but the numerical registers have been omitted in order to simplify the disclosure. The code registers comprise stepping switches A, B and C which are set in any one of ten different positions in response to the successive code impulse series received from the calling subscriber's dial 103.

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 three code digits are transmitted over the three conductors 212, 217 and 221 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 the signal current applied to conductor 202 may have any one of ten different phases, each of which represents a separate digital value, and each of which is selected by the corresponding position of register switch A. Similarly the digital values of the other two code digits B and C are represented by the phases of the currents transmitted over the respective conductors 203 and 204 as a result of the setting of register switches B and C.

The designation signals are received in the marker and utilized to selectively operate one of a plurality of multi-electrode tubes which represents all three digits of the office code. There are a thousand of these tubes representing the thousand different codes that may be obtained from the use of three code digits. The thousand tubes are divided into 10 hundreds groups, each group of a hundred being further divided into 10 tens groups. In the drawings, the No. 0, No. 1 and

No. 9 tubes 301, 302 and 303 of the 0 tens group in the 0 hundreds are shown, and the No. 0, No. 1 and No. 9 tubes 401, 402 and 403 of the No. 2 tens group in the No. 1 hundreds group are shown. Each of these code tubes is provided with a plurality of electrodes to which positive and negative impulses of different phases are applied in accordance with the phases of the signal currents sent from the sender 200 over the conductors 202, 203 and 204. These electrodes are arranged in stages so that the ionization of the tube progresses from one stage to another until some one of the tubes is fully ionized.

The tube 301, for example, comprises a main cathode 304 and a main anode 305. Adjacent the main cathode 304 are the control cathode 306 and control anode 307. When the gap between electrodes 306 and 307 is ionized, ionization occurs between the first intermediate anode 308 and the main cathode 304. Above the intermediate anode 308 are the two control electrodes 309 and 310. When the control electrodes 309 and 310 are raised to the proper potentials, the initial ionization between the main cathode 304 and the first intermediate anode 308 progresses to the second intermediate anode 311. Above the anode 311 are the control electrodes 312 and 313, and these electrodes, when raised to the proper potentials, cause the ionization in the tube to progress from the second intermediate anode 311 to the main anode 305. Thus the tube is ionized in three separate stages, the first stage including the cathode 304 and anode 308, the second stage including the cathode and the anode 311, and the last stage including the cathode and the main anode 305. The signal or route relay 314 associated with the tube 301 has its winding connected to all three of the anodes 308, 311 and 305. This relay, however, only operates when the tube has been fully ionized, since the resistances 315 and 316 in circuit with the intermediate anodes are too high to permit operating current to flow. If, therefore, impulses of like phase and of opposite polarity are applied to electrodes 306 and 307 as a result of the incoming signals, the tube ionizes in the first stage, and current flows from battery through the winding of relay 314, resistance 316, anode 308, cathode 304, contact of a control relay 317 to ground. The tube remains ionized in this circuit after the control impulses have passed, but relay 314 does not operate. If impulses of like phase and of like polarity are applied to the control electrodes 309 and 310 as a result of the incoming signals, the ionization of the tube extends to the second intermediate anode 311, and the circuit of relay 314 may be traced through resistances 315, anode 311, cathode 304 to ground. This circuit maintains the relay ionized in its second stage, but relay 314 does not operate. Finally if impulses of like phase and of like polarity are applied to the control electrodes 312 and 313 as a result of incoming signals, the ionization of the tube extends to the main anode 305. Relay 314 now operates in the main anode-cathode circuit of the tube and remains operated until the relay 317 is energized to open the anode circuit. The remaining tubes 302, 303, 401, 402, 403, etc., are the same as tube 301, each tube having three stages of ionization controlled by the impulses applied to its electrodes, and each tube having an individual signal or route relay connected in its main anode circuit.

The impulses are applied to the multistage tubes by means of impulse generating tubes.

There are three of these tubes 318, 319 and 320, associated respectively with the three signaling conductors 212, 217 and 221. The tube 318 receives the alternating current of the selected phase from the sender 200 and produces an impulse of negative polarity in the conductor 321 for each cycle of alternating current. The conductor 321 is connected to the electrode 306 of tube 301 and to the corresponding electrodes 322, 323, 404, 405 and 406 of tubes 302, 303, 401, 402 and 403 and to the corresponding electrodes of all others of the thousand tubes. Therefore, momentary negative impulses of the phase selected by the register A are applied to one of the control electrodes of the initial energizing gap in all of the thousand tubes. The tube 319 receives alternating current of selected phase from the sender 200 and produces an impulse of positive polarity in the conductor 325 for each cycle of the alternating current. The conductor 325 is connected to the No. 1 control electrode 309 of tube 301 and to the corresponding electrodes of all others of the thousand tubes. Therefore, momentary positive impulses of the phase selected by register B are applied to the No. 1 control electrodes of all tubes. The tube 320 also receives the alternating current of selected phase from the register sender 200 and produces an impulse of positive polarity in the conductor 326 for each cycle of alternating current. The conductor 326 is connected to the No. 3 control electrode 312 of tube 301 and to the corresponding electrodes of all others of the thousand tubes. Therefore, momentary positive impulses of the phase selected by register C are applied to the No. 3 control electrodes of all tubes.

In addition to the impulse tubes 318, 319 and 320 there are provided a group of ten impulse generating tubes 400 for supplying phase control impulses to the remaining control electrodes of the thousand code tubes in the marker. Four of these additional impulse generating tubes are shown, the No. 0, No. 1, No. 2 and No. 9 tubes 407, 408, 409 and 410, respectively. These ten tubes correspond to the ten different phases of the alternating current. The tube 407 generates positive impulses of the No. 0 phase and applies these impulses to the conductor 411. Tubes 408 and 409 generate positive impulses of the No. 1 and No. 2 phases, respectively, and apply these impulses to conductors 412 and 413, respectively. Tube 410 generates positive impulses of the No. 9 phase and delivers these impulses to the conductor 414. In like manner the impulse tubes intermediate the tubes 409 and 410 generate impulses of phases 4 to 8, inclusive, and apply these impulses to corresponding transmitting conductors.

The conductor 411 is connected by way of conductors 415 and 416 to the control anode 307 of tube 301 and to the corresponding electrodes of tubes 302, 303 and the remaining ninety-seven tubes comprising the No. 0 hundreds group. The conductor 412 is connected by way of conductors 417 and 418 to the control anode 419 of tube 401 and to the corresponding electrodes of tubes 402, 403 and the remaining ninety-seven tubes of the No. 1 hundreds group. Likewise, the remaining eight impulse conductors 413—414 are connected to the control anodes of the tubes of the corresponding hundreds groups. Thus impulses of phase No. 0 are constantly applied to the control anodes of all tubes in the No. 0 hundreds group, impulses of phase No. 1 are constantly applied to the control anodes of all tubes in the No. 1 hun-

dreds group, and likewise impulses of the remaining eight phases are applied to the control anodes of the tubes of the remaining eight hundreds groups.

The No. 0 phase impulse conductor 411 is also connected by way of conductors 420 and 421 to the No. 2 control electrode 310 of tube 301 and to the corresponding electrodes of all tubes in the No. 0 tens group of each of the ten hundreds groups. Similarly, the remaining nine impulse conductors 412, 413, etc., are connected to the No. 2 control electrodes in such a manner that impulses of phase No. 1 are applied to all tubes in each of the ten No. 1 tens groups, impulses of phase No. 2 are applied to all of the tubes in each of the No. 2 tens groups, etc. The tubes 401, 402 and 403 illustrated in the drawings are three of the ten tubes in the No. 2 tens group of the first hundred. Accordingly, the impulse conductor 413 is connected by way of conductors 422 and 423 to the No. 2 control electrodes 424, 425 and 426 and to the corresponding electrodes of the remaining tubes in this tens group.

Finally, the ten impulse conductors 411, 412, 413, etc., are connected to the No. 4 control electrodes of the code tubes in accordance with the units designations of these tubes. Since there are ten No. 0 units tubes in the thousand, the impulse conductor 411 of No. 0 phase is connected by way of conductors 427 and 428 to the No. 4 control electrode 313 of the No. 0 units tube 301, to the corresponding electrode 429 of the No. 0 units tube 401, and likewise to the remaining eight tubes having No. 0 units. The impulse conductor 412 producing impulses of the No. 1 phase is connected through conductors 430 and 431 to the No. 4 control electrode 327 of the No. 1 units tube 302, to the corresponding control electrode of the No. 1 units tube 402 and likewise to the remaining No. 1 units tubes. In like manner the remaining conductors 413—414 are connected to the control electrodes of the remaining groups of units tubes.

The multiphase alternating currents may be obtained from any suitable and well-known type of multiphase generator. In the drawings a generator 205 is illustrated diagrammatically having ten windings, each of which produces a separate phase. The respective windings 1 to 0 of the generator 205 are connected over the multiple conductors 206 to the ten positional terminals in each of the register switches A, B and C. Also the ten phase windings of the generator 205 are connected over conductors 207 to the corresponding impulse generating tubes 407, 408, 409, etc. Although the invention is not so limited, the phase generator 205 may be provided in common to a plurality of senders and the generator 205, and the group of impulse tubes 400 may be common to a plurality of markers, each of which contains a thousand code tubes.

The operation of the signaling system will now be described in detail, assuming for this purpose that the subscriber of line 100 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 three series of impulses representing the code letters of the wanted designation together with four series of impulses representing the subscriber's number. The three code digits operate the corresponding code registers A, B and C, and it may be assumed that these

switches come to rest on their No. 1, No. 2 and No. 9 position terminals respectively. 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 200 is operated under the control of the sender and the signaling circuit is closed for applying alternating current to the impulse generating tube 318 in the marker. This signaling circuit may be traced from the No. 1 phase winding 209, conductor 210, terminal 211 of code switch A, contacts of relay 200, conductor 202 through the connector 201, conductor 212 through the resistance 328 and condenser 329, resistance 330, battery 331 to ground. On the next positive half cycle the alternating current source is aided by the battery 331, and the condenser 329 is charged. When the condenser 329 reaches the proper voltage, the tube 318 discharges, and current flows through the resistance 330 in such a direction that a negative potential is impressed upon the conductor 321. The negative potential on conductor 321 is of brief duration, depending on the capacity of condenser 329 and the value of the resistance 330. While this momentary negative impulse exists on the conductor 321, negative potential is applied to the control cathodes 306, 322, 323, 404, etc., of all tubes in the thousand. As soon as the alternating current reaches the next negative half cycle the tube 318 is quenched by the opposing potential of battery 331. For each succeeding positive half cycle of alternating current a negative impulse is applied to the control cathodes of the code tubes.

At the same time that the negative impulse of phase No. 1 is applied to the control cathodes of all tubes a positive impulse of the same phase is applied to the control anodes of the group of one hundred tubes corresponding to the No. 1 hundreds. The No. 1 hundreds group includes the three tubes 401, 402 and 403 illustrated and the impulse generating tube 400 is effective at this time to impress positive impulses of the No. 1 phase on the control anodes of the one hundred tubes in this group. The circuit for energizing the tube 400 may be traced from the No. 1 phase winding 209, conductor 210, conductor 213, resistance 432, condenser 433, battery 434 to ground. At each positive half cycle the battery 434 aids the alternating current and condenser 433 is charged. When the charge on condenser reaches a sufficient value, the tube 400 discharges, and current flows through the resistance 435 in such a direction that a momentary positive impulse is applied to the conductor 412. While this positive impulse exists on conductor 412 positive potential is applied to the control anodes 419, 436, 437 and all similar anodes in the remaining tubes of the No. 1 hundreds group. Hence the initial control gaps of all tubes in the No. 1 hundred are ionized in response to the simultaneous application of negative potential to the control cathodes and positive potential to the control anodes. When the control gap formed by the cathode 404 and anode 419 of tube 401, for example, ionizes, ionization is produced between the main cathode 438 and the first stage anode 439, and ionization is maintained after the potential impulses cease to exist on the electrodes 404 and 419. The ionizing circuit for the initial stage may be traced from battery through the winding of the route

relay 440, resistance 441, anode 439, cathode 438, contacts of relay 442 to ground. Relay 440, however, does not operate in series with the resistance 441. In a similar manner each of the remaining tubes 402, 403, etc., in the hundreds group is ionized in its first stage, and this ionization is maintained following the passing of the momentary phase impulses. Therefore, the effect of selecting the No. 1 phase with the setting of register A is to ionize in the initial stage all tubes of the No. 1 hundreds group.

At the proper time following the setting of the second register B relay 214 is operated to close the transmission circuit for sending the alternating current of selected phase to the impulse generator 319 in the marker. This transmission circuit may be traced from the No. 2 phase winding 215, over conductor 216, contact of register switch B, contacts of relay 214, conductor 203, connector 201, conductor 217 to the impulse generating tube 319. The tube 319, like the tubes of group 400, is arranged to respond to each positive half cycle of the alternating current and to produce momentary positive impulses in the impulse conductor 325. These positive impulses are applied at each half cycle of the current of phase No. 2 to the No. 1 control electrodes 309, 332, 333, 443, 444, 445, etc., of all of the thousand tubes. At the same time the impulse generating tube 400 is applying positive impulses of phase No. 2 to the No. 2 control electrodes 424, 425, 426, etc., of the one hundred tubes 401, 402, 403, etc., having the tens digit 2. Although there are one hundred tubes having the tens digit 2, only ten of these occur in the No. 1 hundreds group. Therefore, only the ten tubes 401, 402, 403, etc., of the No. 2 tens group in the No. 1 hundreds group are ionized to the second intermediate stage. Since the potential of both electrodes 424 and 443 of the second stage of tube 401, for example, are positive simultaneously, the initial ionization already existing between cathode 438 and anode 439, is extended to the anode 446 of the second intermediate stage. The tube 401 is now ionized to this second stage, and it remains ionized after the momentary impulses cease in a circuit traceable from battery through the winding of relay 440, resistance 447, anode 446, cathode 438 to ground through the contact of relay 442. The tube remains ionized, but relay 440 does not operate in series with resistance 447. Likewise the other nine tubes 402, 403, etc., of the No. 2 tens group are ionized to their second stages. Thus the effect of selecting phase No. 1 with the register A and phase No. 2 with the register B is to ionize to their second stages the ten tubes of the thousand which represent the No. 1 hundreds digit and the No. 2 tens digit.

Finally the relay 218 is operated at the proper time following the setting of the register switch C, and the signal transmission circuit is closed for sending the alternating current of selected frequency over the signaling circuit to the impulse generating tube 320. This circuit may be traced from the No. 9 phase winding 219, conductor 220, contacts of register switch C, contacts of relay 218, conductor 204, conductor 201, conductor 221 to the generating tube 320. At each half cycle of the alternating current of phase No. 9 the tube 320 applies a momentary positive impulse over conductor 326 to the No. 3 control electrodes 312, 334, 335, 448, 449 and 450, etc., of all of the thousand code tubes 301, 302, 303, etc. At the same time the impulse tube 410 applies positive impulses of phase No. 9 over conductor

414 to the No. 4 control electrodes 336, 451, etc., of the ten tubes comprising the No. 9 units group 303 403, etc. It will be noted that of the ten tubes of the thousand there are one hundred tubes having the units digit 9, but only one of these, namely tube 403 in the No. 2 tens group has been ionized to its second stage. Therefore, the simultaneous application of positive impulses to the No. 3 and No. 4 control electrodes 450 and 451 of tube 443 is effective to complete the ionization of that tube to its second stage; whereas the simultaneous application of the positive potential to the corresponding remaining tubes of the No. 9 units digit is ineffective to complete their ionization. Hence the effect of selecting the No. 1 phase with register A, the No. 2 phase with register B, and the No. 9 phase with register C is to select and cause the complete ionization of the single code tube 403 of the thousand tubes, and this is the tubes that represent the code 1, 2, 9, or the code expressed in letters having these numerical values. The tube 403 having been completely ionized remains ionized after the impulses are past in a circuit from battery, winding of route relay 452, main anode 453, main cathode 454, contact of relay 455 to ground. Relay 452 operates in the anode-cathode circuit of the tube since the resistances 456 and 457 are excluded. Having selected and operated the desired route relay 452, the control circuits 340 become effective through the connectors 104 and 105 to operate the switches 106 and 107 to extend the subscriber's line in the desired direction. Following the control of the 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.

The advantages of this novel signaling system will now be apparent. By utilizing a single transmission conductor and by selecting any one of a plurality of alternating currents having different phases, it is possible to transmit over the single conductor as many different signals as there are phases available. Furthermore, by providing a plurality of separate signaling conductors it is possible to obtain a large number of signal conditions by combining the individual signals transmitted over the separate conductors. In other words it is possible to transmit as many as a thousand different signals or codes over three conductors extending between the sending point and the receiving point. Furthermore, it will be obvious that this invention is not limited to telephone systems but may be applied to a wide variety of systems where multiplex signaling is required.

What is claimed is:

1. In a signaling system, a signal transmitting conductor, a plurality of sources of current of different phases, means for selectively connecting any one of said sources to said conductor to send thereover a signal current representing a signal character, a discharge device having a main elec-

trode and a pair of control electrodes, means for applying potential of a given phase to one of said control electrodes, means responsive to the signal currents sent over said conductor for applying to the other of said control electrodes potentials having phases corresponding to said signal currents, said device being operative when the potentials on said control electrodes are of like phase, and means responsive to the operation of said discharge device for designating the character represented by the signal current transmitted.

2. In a signaling system, a signal transmitting conductor, a plurality of sources of current of different phases, means for selectively connecting any one of said sources to said conductor to send thereover a signal current representing a signal character, a space-discharge tube having a main electrode and a plurality of control electrodes, means for applying potentials of different phases to certain of said control electrodes, means responsive to the signal currents sent over said conductor for applying to other of said control electrodes potentials having phases corresponding to said signal currents, said discharge tube being operative when potentials of like phase are applied to said control electrodes, and means responsive to the operation of said discharge tube for designating the character represented by the signal current transmitted.

3. In a signaling system, a transmitting conductor, a plurality of sources of current of different phases, means for selecting and connecting any one of said sources to said conductor to transmit a signal current thereover, the phase of which represents a signal character, a signal responsive device having a pair of control elements, means for applying potential of a given phase to one of said elements, means responsive to the signal currents sent over said conductor for producing momentary impulses of like phases and for utilizing said impulses to apply potentials of like phases to the other of said control elements, said signal responsive device being operative when potentials of like phase are applied to said control elements simultaneously, and means responsive to the operation of said signal responsive device for designating the character represented by the transmitted signal current.

4. In a signaling system, a single transmitting conductor, a plurality of sources of current of different phases, means for selectively connecting any one of said sources to said conductor to send thereover a signal current representing a signal character, a discharge tube having main electrodes and a pair of control electrodes, means for applying potential impulses to one of said control electrodes, the phase of said impulses corresponding to the phase of one of said current sources, means responsive to the signal currents transmitted over said conductor for producing impulses of potential of like phase and for applying said potential impulses to the other of said control electrodes, said discharge tube being operative when potential impulses of like phase are applied simultaneously to said control electrodes, and means responsive to the operation of said discharge tube.

5. In a signaling system, a single transmitting conductor, a plurality of sources of current of different phases, means for connecting any one of said sources to said conductor to transmit current thereover, the phase of which represents a signal character, a space-discharge tube having a pair of control electrodes, means for applying

to one of said electrodes momentary potential impulses of one polarity, the phase of said impulses corresponding to the phase of one of said current sources, means responsive to the signal currents flowing over said conductor for applying to the other of said electrodes momentary potential impulses of opposite polarity and having phases corresponding to the phases of said signal currents, said discharge tube being operative when the potential impulses applied to said electrodes are of like phase and of opposite polarity, and means responsive to the operation of said discharge tube.

6. In a signaling system, a single transmitting conductor, a plurality of sources of current of different phases, means for selectively connecting any one of said sources to said conductor to send thereover a signal current representing a signal character, a plurality of discharge devices each having a pair of control electrodes, means for applying a potential to one of the electrodes of each device, the potential applied to said device differing in phase from that applied to the other devices, means responsive to the signal currents sent over said conductor for applying to the other electrode of each device a potential having a phase corresponding to said signal currents to operate selectively the particular one of said devices that has potentials of like phase on both of said control electrodes, and means responsive to the operation of any one of said discharge devices for designating a particular signal character.

7. In a signaling system, a single transmitting conductor, a plurality of sources of current of different phases, means for selectively connecting any one of said sources to said conductor to send thereover a signal current representing a signal character, a plurality of discharge tubes arranged in groups, each tube having two control electrodes, means for applying a potential to one of the electrodes of each tube, the potentials applied to the tubes of a group being of like phase and differing from the phase of the potentials applied to each of the other groups, and means responsive to the signal currents sent over said conductor for applying to the other control electrode of each tube a potential having a phase corresponding to said signal currents to operate selectively the tubes of the particular group in which the potentials applied to each pair of electrodes are of like phase.

8. In a signaling system, a plurality of signal conductors, a plurality of sources of current of different phases, means for selectively connecting said sources to said conductor to send thereover signal currents the phases of which represent signal characters, a plurality of discharge tubes arranged in groups, each tube having control electrodes, means for applying a potential to one of the electrodes of each tube, the potentials applied to the tubes of a group being of like phase and differing from the phase of the potentials applied to each of the other groups, means responsive to the signal currents sent over one of said conductors for applying to a control electrode of all of said tubes a potential having a phase corresponding to the signal current to partially operate the tubes of the particular group in which the potentials applied to the electrodes of each tube are of like phase, and means responsive to the signal currents transmitted over another of said signal conductors for applying to the control electrodes of said tubes potentials having phases corresponding to the phases of

said signal currents to complete the selective operation of the particular tube in the selected group in which potentials of like phase are applied to the control electrodes.

9. In a signaling system, a discharge tube having an anode and a cathode, a plurality of control electrodes, signal means for applying potentials to said control electrodes to cause a plurality of separate stages of ionization, and means responsive to the flow of discharge current between the anode and cathode when said tube is fully ionized.

10. In a signaling system, a discharge tube having an anode and a cathode, a plurality of control electrodes, signal means for applying potentials of different phases to said control electrodes to cause ionization in a plurality of separate stages, and means responsive to the flow of discharge current between the anode and cathode when said tube is fully ionized.

11. In a signaling system, a discharge tube having an anode and a cathode, a plurality of pairs of control electrodes forming corresponding stages, means for applying potentials to said control electrodes to cause ionization at each stage, means for causing the flow of current from the anode to the cathode when all stages have been ionized, and means responsive to the flow of current between the anode and cathode.

12. In a signaling system, a discharge tube having an anode and a cathode, a plurality of successive stages between the anode and cathode, each stage provided with a pair of control electrodes, means for applying potentials to each pair of electrodes to cause ionization at each corresponding stage, means for causing current to flow between the anode and cathode when all stages have been ionized, and means operated in response to the flow of said current.

13. In a signaling system, a discharge tube having an anode and a cathode, a plurality of pairs of control electrodes, forming successive stages between said anode and cathode, means for applying potentials to said control electrodes to cause the progressive ionization of the tube from one stage to the next, and means for causing current to flow between said anode and cathode when all stages have been ionized.

14. The combination in a signaling system of a register sender for registering the designation of a telephone line, a switch controlling marker, means including a signal transmitting conductor for connecting said sender to said marker, means for sending currents of different phases over said conductor from the sender to the marker, the different phases representing different characters of said designation, and means in said marker selectively operated in accordance with the phases of said currents for registering said designation in the marker.

15. The combination in a signaling system of a register sender for registering the designation of a telephone line, a switch controlling marker, means including a signal transmitting conductor for connecting said sender to said marker, a plurality of sources of current of different phases, said phases representing the characters of the telephone designation, means for selectively connecting said sources to said conductor to transmit currents, thereover to the marker, space-discharge tubes in said marker, and means responsive to said currents transmitted over said conductor for selectively operating said space-discharge tubes to register the designation in the marker.

16. In a signaling system, a discharge tube having a cathode and an anode, a plurality of control electrodes forming successive ionization stages between said cathode and anode, means for applying potentials to said control electrodes in sequential order, each control electrode being effective when potential is applied thereto for extending the ionization of the tube to the corresponding stage, the ionization of said tube extending from the cathode to the anode when all of said stages have been ionized, and a circuit including said cathode and anode for the flow of current through said tube.

17. In a signaling system, a discharge tube having a cathode and an anode, a plurality of intermediate control electrodes forming a series of ionization stages between said cathode and anode, circuit means for applying potentials sequentially to any desired number of said control electrodes, each control electrode being effective when potential is applied thereto for extending the ionization of the tube to its corresponding stage, and a circuit including said cathode and

anode for the flow of current through said tube provided all of said intermediate stages have been ionized.

18. In a signaling system, a group of discharge tubes each having a cathode and an anode and a plurality of intermediate control electrodes forming successive ionization stages between the cathode and the anode, means for applying potentials in sequential order to the control electrodes of said tubes, the number of control electrodes in each tube to which said potentials are applied varying among the tubes of said group, each control electrode being effective when potential is applied thereto for extending the ionization of the tube to its corresponding stage, circuits including the anodes and cathodes of said tubes respectively, and means responsive to the flow of current in the circuit including the anode and cathode of the particular tube of said group having all of its intermediate stages ionized by the application of potential to the corresponding control electrodes thereof.

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