July 16, 1935. R. O. SOFFEL 2,008,264

SIGNALING SYSTEM

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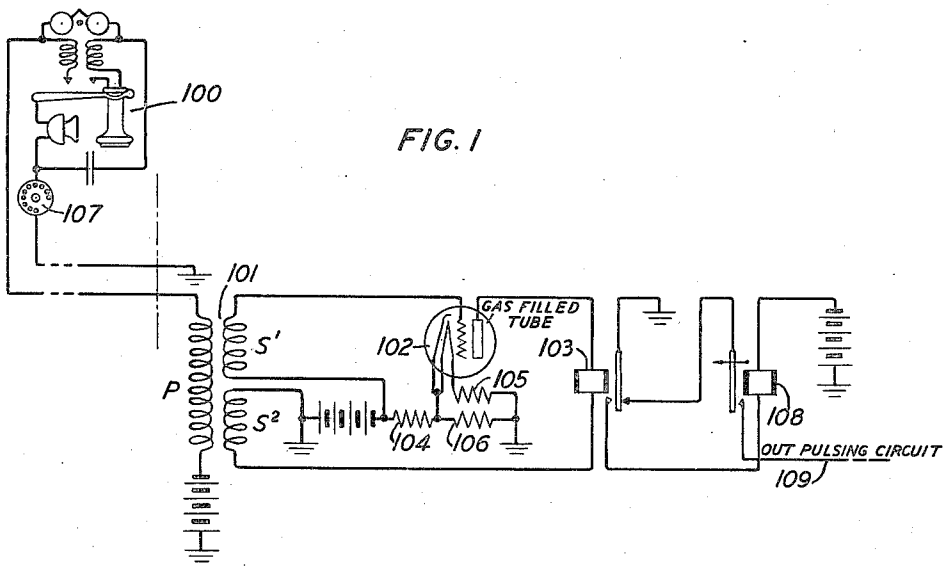

FIG. 1

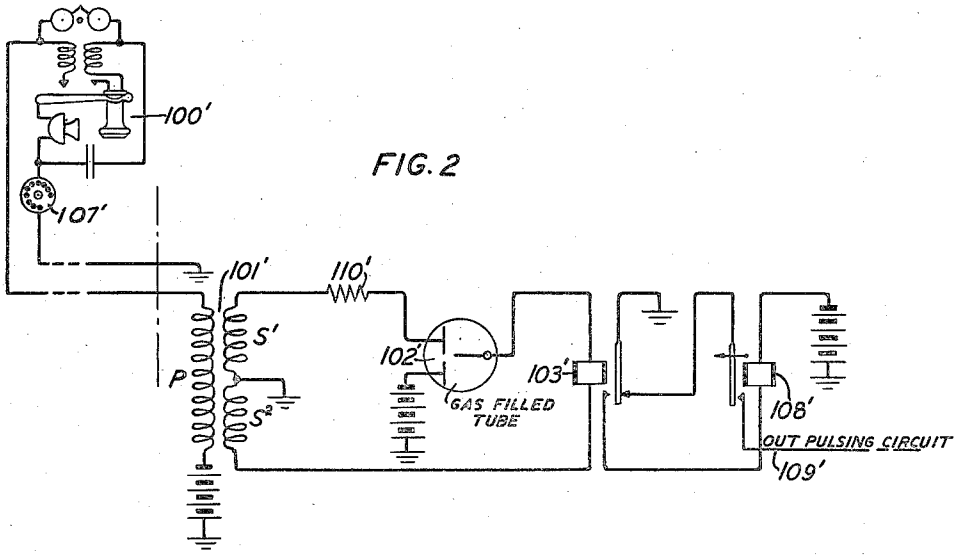

FIG. 2

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SIGNALING SYSTEM

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12 Claims. (Cl. 179—16)

This invention relates to telephone systems and more particularly to the utilization in the impulse recording circuits thereof of gaseous conductor or discharge tubes as impulse responsive relays.

In machine switching telephone systems, the impulses dialed by a subscriber or by an operator may control the setting of selector switches directly as, for example, in the well known systems employing step-by-step type selector switches, or to control the setting of digit registers as in systems employing central office senders, as, for example, in the well known panel or director type systems. In order that proper response to dialing impulses may be obtained over both long and short dialing loops, it is essential that the impulse responsive apparatus shall be very accurately adjusted and sensitive.

It is therefore the object of the invention to provide an impulse responsive device whereby more accurate and faster impulse response may be realized over long dialing loops.

In accordance with the present invention a gaseous conductor or discharge tube is utilized to respond to dial or other sources of impulses and to in turn control an impulse responsive relay. The impulse responsive relay may, as desired, control the stepping magnet of a selector switch, an impulse repeater or control apparatus for recording the dialed impulses. The gaseous discharge conductor tube employed is a tube filled with a low pressure gaseous content which, for purposes of illustration, might be neon, argon, helium, mercury vapor or combinations of gases of this group. The tube has a certain characteristic, namely, that the gaseous content will become ionized and thus conducting on one potential determined by the electrode design, the nature of the gaseous content and its pressure, but once rendered conducting will maintain this condition of conductivity on a much lower potential. The tube may be of the hot cathode type having a filament heated by a direct current source of potential or having a cathode heated conductively from a filament energized from a source of alternating or direct current or may be of the cold cathode type.

The invention has been disclosed in connection with both hot and cold cathode types of tubes. Considering briefly the embodiment of the invention using a tube of the hot cathode type, the dialing loop, disclosed for the purposes of illustration as extended through a subscriber's substation, is connected inductively by a transformer to the grid and cathode-anode circuits of a gaseous conductor tube. The anode of the tube is connected through the winding of an impulse responsive relay to the positive terminal of the central office battery and the grid of the tube is connected to the negative terminal of battery and thus the tube is normally in a quiescent condition. When the dialing loop is closed as, for example, by the removal of the subscriber's receiver from the switchhook, current flows over the dialing loop through the primary winding of the transformer, thereby causing surges of potential in the two secondary windings which are connected respectively to the grid and cathode-anode circuits of the tube. The two secondary windings are so poled with respect to the primary winding that the surge of potential through the secondary winding connected to the grid, which results from the closure of the dialing loop, makes the bias on the grid of the tube less negative and the surge of potential through the secondary winding connected to the anode, which results from the closure of the dialing loop, places positive potential on the anode. The tube will now become conducting thereby operating the impulse responsive relay over the cathode-anode circuit of the tube to prepare the outpulsing circuit. The outpulsing circuit may extend to any type of apparatus which is to be operated in response to incoming impulses such, for example, as the stepping magnet of a selector switch, an impulse repeater or the recording apparatus of a sender.

When the dialing loop is now opened as by the opening of the contacts of the substation dial, surges of potential are produced in the secondary windings of the transformer but in directions opposite to those induced upon the closure of the dialing loop. The surge through the secondary winding connected to the grid now increases the negative bias of the grid and the surge through the secondary winding connected to the anode now reduces the positive potential on the anode to such a degree that ionization of the tube ceases and the impulse responsive relay releases to transmit an impulse to the outpulsing circuit. Upon subsequent reclosures and openings of the dialing loop, the tube becomes conducting and deionizes in this manner to cause the operation and release of the impulse responsive relay to transmit further impulses to the outpulsing circuit. Since the tube responds quickly to changes of potential only and not to current build up, as is necessary when a relay is employed to respond directly to dialing impulses, impulsing may be accurately accomplished over either short or long dialing loops and at much greater speed. Further, since the

impulse responsive relay operates over a local circuit under the control of the tube, it may be of a simple type requiring little maintenance to insure accurate operation.

The object of the invention may equally well be attained through the employment of a cold cathode tube as illustrated in the second embodiment of the invention. In this embodiment the positive terminal of the central office battery is connected through one secondary winding of the transformer to one of the cathodes of the tube, the other cathode being connected to the negative terminal of central office battery and the positive terminal of battery is connected through the other secondary winding of the transformer and the winding of the impulse responsive relay to the anode of the tube. With the dialing loop normally opened, the tube is in a quiescent or non-conducting condition. When the dialing loop is now closed the surges of potential thus resulting through the secondary windings of the transformer will increase the positive potential on both the first or control cathode of the tube and on the anode and the tube will become conducting to operate the impulse responsive relay. Upon the first opening of the dialing loop by the dialing contacts or other impulsing means, surges of potential thus resulting through the secondary windings, now being in the opposite direction from those resulting from the closure of the dialing loop will decrease the positive potential on the first cathode and on the anode to such an extent that the tube will deionize and release the impulse responsive relay.

For a clearer understanding of the invention, reference may be had to the following detailed description taken in connection with the drawing in which:

Fig. 1 shows one embodiment of the invention including a subscriber's substation, dialing loop, hot cathode gaseous conductor tube and impulse responsive apparatus; and

Fig. 2 shows a second embodiment of the invention including a subscriber's substation, dialing loop, cold cathode gaseous conductor tube and impulse responsive apparatus.

Considering first the embodiment of the invention illustrated in Fig. 1, the subscriber's substation 100 having a substation dial 107 may be extended in any well known manner to the central office apparatus which is to be controlled therefrom. At the central office one conductor of the subscriber's dialing loop terminates in the grounded or positive terminal of the central office battery and the other conductor of the loop extends through the primary winding P of a transformer 101 to the negative or ungrounded terminal of battery. The transformer 101 has two secondary windings one of which S′ is included in a path between the control electrode or grid of tube 102 and the negative terminal of battery and the other of which S^2 is included in a path extending from the anode of the tube through the winding of impulse responsive relay 103 to the positive terminal of battery. The cathode of the tube is connected through resistance 104 to the negative terminal of battery and is heated by conduction from the filament of the tube. The filament of the tube is lighted over a circuit extending from the negative terminal of battery through resistance 104, through the filament and resistance 105 to ground. Resistance 106 is connected in parallel with the filament and the serially connected resistance 105. Thus normally with the dialing loop open, the grid of the tube is so negatively biased that the tube is quiescent or non-conducting.

When the subscriber removes his receiver from the switchhook the dialing loop is completed in the well known manner and current then flows over the loop through the primary winding P of transformer 101 resulting in the establishment of surges of potential in the secondary windings S′ and S^2 of the transformer. The secondary windings are so poled with respect to the primary winding that the surge through secondary winding S′ now makes the grid of the tube less negative and the surge through secondary winding S^2 makes the anode of the tube positive. Ionization of the tube now results in making the tube conductive whereupon space current flows from the negative terminal of battery through resistance 104 over the cathode and anode of the tube through the winding of relay 103, secondary winding S^2 to the positive terminal of the battery. Relay 103 operates in turn operating the slow to release relay 108. Thus, as a result of the closure of the dialing loop, relays 103 and 108 both operate.

The subscriber now proceeds to dial by moving his dial 107 off-normal to a degree commensurate with the number of digit impulses which he desires to transmit and then permits the dial to return to normal. As the dial returns to normal it intermittently opens the dialing loop. Upon the first opening of the dialing loop, current ceases to flow momentarily through the primary winding P of transformer 101 thereby producing surges of potential in the secondary windings thereof which are opposite in direction to the surges produced upon the initial closure of the dialing loop. The surge in secondary winding S′ now increases the normal negative bias on the grid of tube 101 and the surge in secondary winding S^2 decreases or substantially nullifies the positive potential on the anode of the tube. The ionization of the tube can not now be maintained and current ceases to flow over the cathode-anode circuit through the winding of relay 103. Relay 103 releases but relay 108 being slow to release does not release and therefore an impulse is transmitted from ground over the back contact of relay 103, front contact of relay 108 over outpulsing circuit 109 to the apparatus which is to be operated. This apparatus may, as previously indicated, be a selector switch, impulse repeater or any desired recording mechanism such as the recording mechanism of a central office register sender.

On the next closure of the dial contacts, the dialing loop is again closed thereby causing surges in the secondary windings S′ and S^2 of the transformer 101 which result, as previously described, is causing the tube 102 to again become conducting and operate relay 103. Relay 103, upon reoperating, reestablishes the circuit of relay 108 and opens the outpulsing circuit 109 to terminate the first impulse transmitted thereover. In response to subsequent openings and closures of the dial contacts or until the dial reaches its normal position, the tube 102 responds to cause the intermittent release and operation of relay 103 to transmit further impulses to the outpulsing circuit 109. Upon the termination of the digit series of impulses, the dialing loop is maintained closed until the next series of impulses is dialed and the tube 102 therefore remains conducting to hold relays 103 and 108 operated. Change over for recording the next series of impulses dialed may be

accomplished by apparatus associated with outpulsing circuit 109 in the usual manner.

The circuits illustrated in Fig. 2 are similar to those of Fig. 1 with the exception that a cold cathode type of tube 102' is employed requiring slight alterations in the circuits for associating it with the windings of the transformer. One cathode of the tube is connected directly to the negative terminal of central office battery and the other or control cathode is connected to the positive or grounded terminal of battery through resistance 110' and the secondary winding S' of transformer 101'. The anode of the tube is connected to the positive terminal of battery through the winding of impulse responsive relay 103' and the secondary winding S^2 of transformer 101'. With the dialing loop normally open, the tube is in a quiescent condition since the difference of potential between the cathodes of the tube is insufficient to start ionization.

When the subscriber at substation 100' removes his receiver, the dialing loop is closed in any well known manner and current flows through the primary winding P of transformer 101' thereby causing surges of potential in the two secondary windings. The two secondary windings are so poled with respect to the primary winding that the surge through secondary winding S' now makes the control cathode of the tube more positive and the surge through secondary winding S^2 makes the anode positive. The difference in potential between the two cathodes of the tube is now increased to such an extent that ionization results and the tube becomes conductive, whereupon space current flows from the negative terminal of battery over the lower cathode and the anode of the tube through the winding of relay 103' and the secondary winding S^2 of the transformer to the grounded or positive terminal of battery. Relay 103' now operates and in turn causes the operation of relay 108'.

The subscriber now proceeds to dial and as the dial returns to normal the dialing loop is intermittently opened and closed. Upon the first opening of the dialing loop, current ceases to flow momentarily through the primary winding P of transformer 101' thereby producing surges of potential in the secondary windings thereof which are opposite in direction to the surges produced upon the closure of the dialing loop. The surge in the secondary winding S' now decreases the positive potential on the control cathode of the tube and the surge in the secondary winding S^2 now decreases or substantially nullifies the positive potential on the anode of the tube. The ionization of the tube can not now be maintained and current ceases to flow over the cathode-anode circuit through the winding of relay 103'. Relay 103' releases but relay 108' being slow to release does not release and therefore an impulse is transmitted from ground over the back contact of relay 103', front contact of relay 108' to the outpulsing circuit 109'.

On the next closure of the dial contacts, the dialing loop is again closed thereby causing the tube 102' to become conducting in the manner previously described to reoperate relay 103'. Relay 103' upon reoperating again closes the circuit of relay 108' and opens the outpulsing circuit 109' to terminate the first impulse transmitted thereover. In response to subsequent openings and closures of the dial contacts or until the dial returns to normal, the tube 102' responds to cause the intermittent release and operation of relay 103' to transmit further impulses to the outpulsing circuit 109'.

As previously stated, since gaseous conductor tubes of the type disclosed respond quickly to changes of potential only and not to current build up over the dialing loop, dialing or impulsing may be accurately controlled over either long or short dialing loops and at much greater speed. Further, the impulse responsive relay such as 103 or 103' need not be of as sensitive a character or require as fine an adjustment as would be necessary were it to be operated directly by current impulses from the dialing loop as heretofore. While the invention has been disclosed in connection with a subscriber's substation dialing loop, it will be obvious that it is equally applicable to the reception of impulses generated in any desired manner.

What is claimed is:

1. In a signaling system, an impulsing circuit, means for closing said circuit, a gaseous conductor tube having a control electrode, a cathode and an anode, an inductive connection between said impulsing circuit and said anode, means operative upon the closure of said circuit for changing the potential on said control electrode, said anode being simultaneously rendered positive by the surge of potential through said inductive connection whereby said tube becomes conducting, and a cathode-anode circuit for said tube for maintaining said tube in operation following the cessation of said surge.

2. In a signaling system, an impulsing circuit, means for closing and opening said circuit, a gaseous conductor tube having a control electrode, a cathode and an anode, an inductive connection between said impulsing circuit and said anode, means operative upon the closure of said circuit for changing the potential on said control electrode, said anode being simultaneously rendered positive by the surge of potential through said inductive connection whereby said tube becomes conducting, and a cathode-anode circuit for said tube for maintaining said tube in operation following the cessation of said surge, said anode being rendered less positive by the surge of potential in the opposite direction through said inductive connection incident to the opening of said impulsing circuit to cause said tube to restore.

3. In a signaling system, an impulsing circuit, means for closing said circuit, a gaseous conductor tube having a control electrode, a cathode and an anode, an inductive connection between said impulsing circuit and said anode, means operative upon the closure of said circuit for changing the potential on said control electrode, said anode being simultaneously rendered positive by the surge of potential through said inductive connection whereby said tube becomes conducting, and a cathode-anode circuit for said tube including a relay over which circuit said tube and relay are maintained operated following the cessation of said surge.

4. In a signaling system, an impulsing circuit, means for closing and opening said circuit, a gaseous discharge conductor tube having a control electrode, a cathode and an anode, an inductive connection between said impulsing circuit and said anode, means operative upon the closure of said circuit for changing the potential on said control electrode, said anode being simultaneously rendered positive by the surge of potential through said inductive connection whereby said tube becomes conducting, and a cathode-

anode circuit for said tube including a relay over which said tube and relay are maintained operated following the cessation of said surge, said anode being rendered less positive by the surge of potential in the opposite direction through said inductive connection incident to the opening of said impulsing circuit to cause the restoration of said tube and said relay.

5. In a signaling system, an impulsing circuit, means for closing said circuit, a gaseous conductor tube having a control electrode, a cathode and an anode, a transformer having its primary winding connected to said circuit, a first of its secondary windings connected to said control electrode and a second of its secondary windings connected to said anode, said secondary windings being so poled with respect to said primary winding that upon the closure of said circuit the surges of potential through said secondary windings alter the potential on said control electrode and render said anode positive whereby said tube becomes conducting, and a cathode-anode circuit for said tube for maintaining said tube in operation following the cessation of said surges.

6. In a signaling system, an impulsing circuit, means for closing and opening said circuit, a gaseous conductor tube having a control electrode, a cathode and an anode, a transformer having its primary winding connected to said circuit, a first of its secondary windings connected to said control electrode and a second of its secondary windings connected to said anode, said secondary windings being so poled with respect to said primary winding that upon the closure of said circuit the surges of potential through said secondary windings alter the potential on said control electrode and render said anode positive whereby said tube becomes conducting, and a cathode-anode circuit for said tube for maintaining said tube in operation following the cessation of said surges, the surges of potential in the opposite direction through said secondary windings incident to the subsequent opening of said impulsing circuit altering the potential on said control electrode and rendering said anode less positive whereby said tube restores to its normal condition.

7. In a signaling system, an impulsing circuit, means for closing said circuit, a gaseous conductor tube having a control electrode, a cathode and an anode, a transformer having its primary winding connected to said circuit, a first of its secondary windings connected to said control electrode and a second of its secondary windings connected to said anode, said secondary windings being so poled with respect to said primary winding that upon the closure of said circuit the surges of potential through said secondary windings alter the potential on said control electrode and render said anode positive whereby said tube becomes conducting, and a cathode-anode circuit for said tube including a relay over which circuit said tube and relay are maintained operated following the cessation of said surges.

8. In a signaling system, an impulsing circuit, means for closing and opening said circuit, a gaseous discharge tube having a control electrode, a cathode and an anode, a transformer having its primary winding connected to said circuit, a first of its secondary windings connected to said control electrode and a second of its secondary windings connected to said anode, said secondary windings being so poled with respect to said primary winding that upon the closure of said circuit the surges of potential through said secondary windings alter the potential on said control electrode and render said anode positive whereby said tube becomes conducting, and a cathode-anode circuit for said tube including a relay over which circuit said tube and relay are maintained operated following the cessation of said surges, the surges of potential in the opposite direction through said secondary windings incident to the subsequent opening of said impulsing circuit altering the potential on said control electrode and rendering said anode less positive whereby said tube and relay are restored to their normal condition.

9. In a signaling system, an impulsing circuit, means for closing said circuit, a gaseous discharge conductor tube having a control electrode, a heated cathode and an anode, said control electrode having a normal negative bias, a transformer having its primary winding connected to said circuit, a first of its secondary windings connected to said control electrode and a second of its secondary windings connected to said anode, said secondary windings being so poled with respect to said primary winding that upon the closure of said circuit the surges of potential through said secondary windings render said control electrode less negative and said anode positive whereby said tube becomes conducting, and a cathode-anode circuit for said tube including a relay over which circuit said tube and relay are maintained operated following the cessation of said surges.

10. In a signaling system, an impulsing circuit, means for closing and opening said circuit, a gaseous discharge conductor tube having a control electrode, a heated cathode and an anode, said control electrode having a normal negative bias, a transformer having its primary winding connected to said circuit, a first of its secondary windings connected to said control electrode and a second of its secondary windings connected to said anode, said secondary windings being so poled with respect to said primary winding that upon the closure of said circuit the surges of potential through said secondary windings render said control electrode less negative and said anode positive whereby said tube becomes conducting, and a cathode-anode circuit for said tube including a relay over which circuit said tube and relay are maintained operated following the cessation of said surges, the surges of potential in the opposite direction through said secondary windings incident to the subsequent opening of said impulsing circuit rendering said control electrode more negative and said anode less positive whereby said tube and relay are restored to their normal condition.

11. In a signaling system, an impulsing circuit, means for closing said circuit, a gaseous discharge conductor tube having a cold control cathode, a second cold cathode and an anode, said second cathode having a normal negative bias, a transformer having its primary winding connected to said circuit, a first of its secondary windings connected to said control cathode and a second secondary winding connected to said anode, said secondary windings being so poled with respect to said primary winding that upon the closure of said circuit the surges of potential through said secondary windings render said control cathode and said anode positive whereby said tube becomes conducting, and a cathode-anode circuit for said tube including a relay,

over which circuit said tube and relay are maintained operated following the cessation of said surges.

12. In a signaling system, an impulsing circuit, means for closing and opening said circuit, a gaseous discharge conductor tube having a cold control cathode, a second cold cathode and an anode, said second cathode having a normal negative bias, a transformer having its primary winding connected to said circuit, a first of its secondary windings connected to said control cathode and a second of its secondary windings connected to said anode, said secondary windings being so poled with respect to said primary winding that upon the closure of said circuit the surges of potential through said secondary windings render said control cathode and said anode positive whereby said tube becomes conducting, and a cathode-anode circuit for said tube including a relay over which circuit said tube and relay are maintained operated following the cessation of said surges, the surges of potential in the opposite direction through said secondary windings incident to the subsequent opening of said impulsing circuit rendering said control cathode negative and said anode less positive whereby said tube and relay are restored to their normal condition.

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