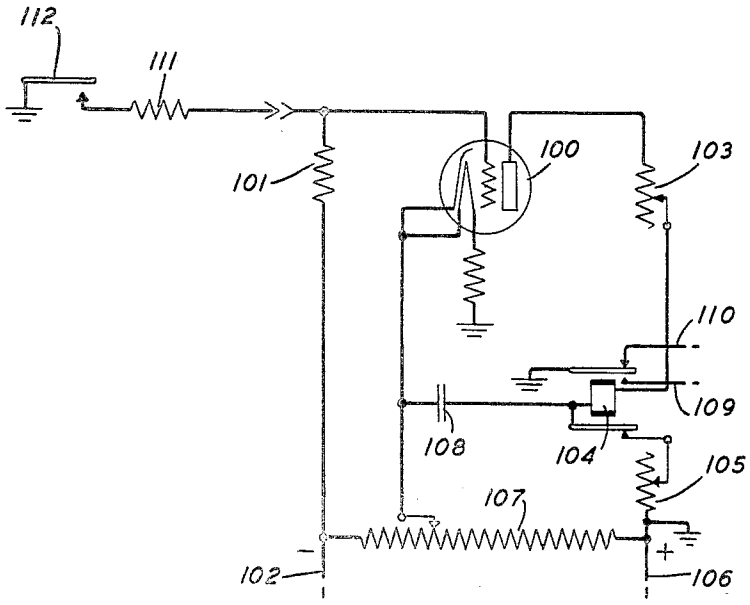
Oct. 30, 1934. W. H. SCHEER 1,979,054

SIGNALING SYSTEM

Filed Dec. 1, 1933

FIG. 1



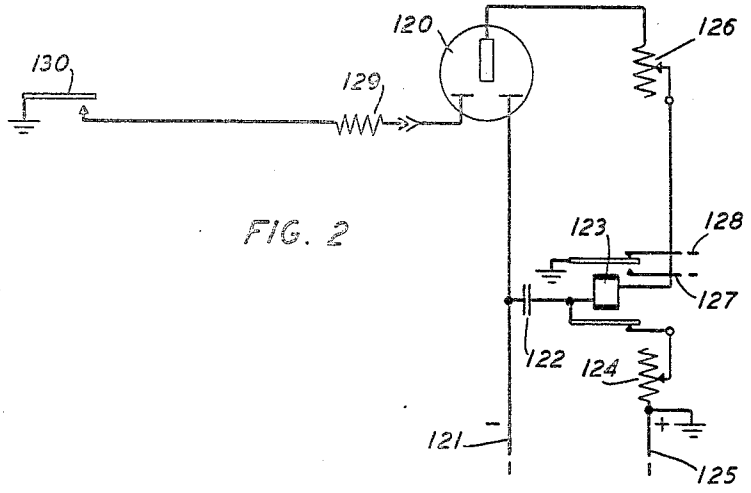


FIG. 2

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Patented Oct. 30, 1934

1,979,054

UNITED STATES PATENT OFFICE

1,979,054

SIGNALING SYSTEM

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Application December 1, 1933, Serial No. 700,550

13 Claims. (Cl. 179—16)

This invention relates to signaling circuits and more particularly to the utilization in such circuits of gaseous conductor or discharge tubes.

The gaseous conductor tube utilized in the circuits of this invention 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 will have a certain characteristic, namely, that the gaseous content will become ionized and become 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 present invention has as one of its objects the utilization of this characteristic of the discharge tube to provide a novel signaling arrangement which may be designed for producing impulses at a speed which is simply and easily adjustable within wide limits. A further object of the invention is the utilization of a tube of this character for receiving impulses and controlling thereby the transmission of impulses corrected as to their relative make and break periods.

In accordance with one embodiment of the present invention, a gaseous conductor tube having a control electrode, an anode and a cathode is employed, the cathode being heated either directly by a source of current or indirectly by conduction from a filament energized by either direct or alternating current. The control electrode or grid is normally negatively biased and the anode is connected to the positive terminal of a source of potential through the winding of a relay. The cathode is connected to the slider of a potentiometer bridged across the terminals of the source of potential so that normally the potential between the cathode and anode is less than the potential required to ionize the gaseous content of the tube. A condenser is also provided in a bridge including the winding of the relay and a first adjustable resistance between the cathode and anode and has a charging circuit extending over a back contact of the relay and through a second adjustable resistance. With the condenser fully discharged and its charging circuit closed the condenser gradually charges through the second adjustable resistance until the potential across its plates reaches the ionization potential of the tube when the tube will become conducting and establish a discharge path therethrough over which the condenser discharges through the winding of the relay thereby operating the relay. The relay upon operating opens the charging circuit of the condenser and closes any desired work circuit and is maintained operated for a period dependent upon the capacitance of the condenser and the value of the first resistance until the potential across the condenser falls to a point sufficiently below the ionization potential of the tube to cause the tube to become non-conducting. The relay then releases reclosing the charging circuit of the condenser. This cycle of operations may be continued so long as potential is applied to the tube the resulting periodic operation and release of the relay producing periodic impulses in the work circuit controlled thereby. The periodicity of the impulses so generated may be controlled by varying the capacitance of the condenser and the charging and discharging rate thereof through the adjustment of the resistances.

The circuits of the invention may by slight modification be made equally effective to receive incoming impulses and to repeat impulses corresponding in number to the work circuit. This is effected by selecting the capacitance of the condenser so that when it is fully charged the potential across its plates is somewhat less than the ionization potential of the tube and by rendering the control element sufficiently positive through the connection of an impulse of positive potential thereto to cause ionization of the tube. Upon ionization the relay will operate and close the work circuit. The values of capacitance and resistance in the discharge path through the tube and relay will in this case be so chosen that the relay will not release until the impulse of positive potential has been removed from the control electrode. The relay will thus follow the incoming impulses and produce corresponding impulses in the work circuit.

In accordance with a further embodiment of the invention, a gaseous conductor tube of the cold cathode type having two cathodes and an anode may be employed. One cathode is normally negatively biased and the anode is connected to the positive terminal of a source of potential through the winding of a relay. The other or control cathode is arranged to be connected to a source of potential by a circuit closing device so that it may be made sufficiently positive with respect to the other cathode as to cause ionization between the cathodes to start. The ionization will not however be sufficient to cause the tube to become conducting until the anode has become sufficiently positive with respect to the first cathode. This is accomplished by the charging of a condenser in the same manner as previously de-

scribed in connection with the first embodiment of the invention. To operate the tube as an impulse repeater it is only necessary to make and break the circuit to the control cathode in response to incoming impulses and to select values of capacitance and resistance in the discharge path of the condenser through the tube and relay so that the relay will not release until the impulse which causes the closure of the control cathode circuit ceases.

To operate the cold cathode type tube as an interrupter for producing periodic impulses the anode and one cathode are used. The circuit to the other or control cathode is open under this condition as the control cathode performs no function. The capacitance of the condenser, in this case, is so chosen that when fully charged, the potential across the plates of the condenser is sufficient to cause the tube to ionize and become conducting.

A clearer understanding of the invention may be obtained from a consideration of the following detailed description read in connection with the accompanying drawing in which:

Fig. 1 shows a hot cathode gaseous conductor tube in a circuit arranged to produce periodic impulses of an adjustable speed in an associated work circuit, or to repeat incoming impulses, corrected as to their relative make and break periods, in an associated work circuit.

Fig. 2 shows a cold cathode gaseous conductor tube in a circuit arranged to produce periodic impulses of an adjustable speed in an associated work circuit, or to repeat incoming impulses, corrected as to their relative make and break periods, in an associated work circuit.

Gaseous conductor tubes 100 of Fig. 1 and 120 of Fig. 2 are of the type which ionize and become conducting at a certain potential, but once rendered conducting maintain their conductivity at a much lower potential.

Production of periodic impulses—Fig. 1

Referring to Fig. 1, the control electrode or grid of gaseous conductor tube 100 is connected through resistance 101 to the negative terminal of a source of potential over lead 102. The anode of tube 100 is connected to the grounded positive terminal of the source of potential through variable resistance 103, winding and lower back contact of relay 104, variable resistance 105 and lead 106. The cathode of tube 100 is connected to the sliding contact of potentiometer 107 which is bridged across the source of potential. Potentiometer 107 is adjusted in such a manner that the potential between the anode and cathode of tube 100 is less than that required to ionize the gaseous content of the tube. Condenser 108 is connected in a bridge from the cathode of tube 100 to the anode of tube 100 through the winding of relay 104 and variable resistance 103, and to the grounded positive terminal of the source of potential over the lower back contact of relay 104 and through variable resistance 105. The cathode of tube 100 is heated indirectly by conduction from the filament.

With potential applied across leads 102 and 106, negative potential connected to one plate of condenser 108 through potentiometer 107, and positive potential connected to the opposite plate of condenser 108 through variable resistance 105 and the lower back contact of relay 104, gradually charges condenser 108. When the potential across the plates of condenser 108 reaches the ionization potential of tube 100, tube 100 ionizes and becomes conducting, causing condenser 108 to discharge in a circuit through the winding of relay 104, variable resistance 103, to the negative terminal of the source of potential through the anode and cathode of tube 100 thereby operating relay 104.

Relay 104 operating, opens the charging circuit for condenser 108 from the grounded positive terminal of the source of potential, through adjustable resistance 105, and over the lower back contact of relay 104. Relay 104 operating, also connects ground over its upper front contact to lead 109 and removes ground over its upper back contact from lead 110 to function any desired work circuit associated with leads 109 and 110. Relay 104 remains operated until the potential across the plates of condenser 108 falls sufficiently below the ionization potential of tube 100 to cause tube 100 to deionize and become non-conducting. Tube 100 deionized, opens the discharge circuit for condenser 108, through the winding of relay 104, variable resistance 103 and anode circuit of tube 100, causing relay 104 to release.

Relay 104 releasing, removes ground over its upper front contact from lead 109, connects ground over its upper back contact to lead 110, and also closes the charging circuit for condenser 108 from the grounded positive terminal of the source of potential, through variable resistance 105, lower back contact of relay 104, condenser 108, potentiometer 107, to the negative terminal of the source of potential over lead 102.

The above cycle of operations, namely, charging condenser 108, ionizing tube 100, discharging condenser 108 and operating relay 104, deionizing tube 100, and releasing relay 104, continues as long as potential is applied across leads 102 and 106. The periodic operation and release of relay 104 produces periodic impulses in the associated work circuit which is controlled over leads 109 and 110. The impulses generated over the leads 109 and 110 through the periodic operation of relay 104 may be used, for example, for the production of interrupted busy tone, for the control of interrupted ringing and in time measuring circuits. Many other applications will suggest themselves to those skilled in the art for replacing power operated interrupters now commonly used. The periodicity of the impulses so generated may be controlled by varying the capacitance of condenser 108 and the charging and discharging rate thereof. The discharge rate of condenser 108 is controlled by variable resistance 103 and, since relay 104 operates in the discharge circuit for condenser 108, the adjustment of resistance 103 determines the time interval during which relay 104 is maintained operated, the relay remaining operated until the charge on condenser 108 is reduced to a point below the ionization potential of tube 100. The charging rate of condenser 108 is controlled by variable resistance 105 and, since relay 104 does not operate until the charge on condenser 108 is sufficient to cause tube 100 to ionize, the adjustment of variable resistance 105 determines the time interval during which relay 104 remains released.

Repeating incoming impulses—Fig. 1

Referring again to Fig. 1, by making a slight modification the circuit hereinbefore described may be arranged to repeat incoming impulses, corrected as to their relative make and break periods, to an associated work circuit.

The required modification consists of selecting the capacitance of condenser 108 so that when fully charged, the potential across the plates of

condenser 108 is slightly less than the ionization potential of tube 100. In addition, the grid of tube 100 is arranged to be made sufficiently positive through the connection of an incoming impulse of positive potential thereto to cause tube 100 to ionize.

With potential applied across leads 102 and 106, condenser 108 charges from the grounded positive terminal of the source of potential through variable resistance 105, lower back contact of relay 104, condenser 108, to the negative terminal of the source of potential through potentiometer 107. When fully charged, the potential across the plates of condenser 108 is not quite sufficient however to cause tube 100 to ionize.

An incoming impulse, transmitted under control of contact 112, connects grounded positive potential through resistance 111 to the grid of tube 100 which renders the grid sufficiently positive to cause tube 100 to ionize and become conducting. With tube 100 in the conducting condition, condenser 108 discharges through the winding of relay 104, variable resistance 103 and anode and cathode of tube 100, thereby operating relay 104.

Relay 104 operating, connects ground over its upper front contact and lead 109 to the associated work circuit, and opens the charging circuit for condenser 108 from the grounded positive terminal of the source of potential, through variable resistance 105 and over the lower back contact of relay 104.

Relay 104 remains operated until the potential across the plates of condenser 108 falls to a point sufficiently below the ionization potential of tube 100 to cause the tube to deionize and become non-conducting. Tube 100 deionized, opens the discharge circuit for condenser 108, through the winding of relay 104 which releases. Relay 104 releasing, removes the ground from the associated work circuit over its upper front contact and lead 109, and also closes the charging circuit for condenser 108, over the lower back contact of relay 104, to the grounded positive terminal of the source of potential through resistance 105. Condenser 108 again charges and the circuit is thereby prepared to repeat the next incoming impulse, functioning in the same manner as hereinbefore described, for each succeeding impulse impressed on the grid of tube 100.

When this circuit is used for impulse repeating, as in this instance, the capacitance of condenser 108 and the value of variable resistance 103 are so chosen that the time interval required to discharge condenser 108, to a point where the potential across its plates falls below the value required to maintain ionization of tube 100, at least equals the time interval of the longest incoming impulse to be repeated. Also, the value of variable resistance 105, which controls the charging rate of condenser 108, is so chosen as to insure the complete charging of condenser 108 during the interval between successive incoming impulses. Since relay 104 remains operated during the discharge time of condenser 108, the impulses repeated by the relay to the work circuit over lead 109 are of uniform length, being independent of variations in the length of the incoming impulses impressed on the grid of tube 100. As an impulse repeater this circuit would find utility in repeating impulses dialed, for example, by a subscriber to set selector switches or to control the setting of the registers of a central office sender, in which case contacts 112 would be under the control of the subscriber's dial and relay 104 would control the repeating of impulses to the selector switch or register. The repeated impulses being corrected as to their relative make and break periods, irrespective of the distortion of the impulses received, accurate dialing response would be possible over long dialing loops.

Production of periodic impulses—Fig. 2

Referring to Fig. 2 one cathode of gaseous discharge tube 120 of the cold cathode type is connected to the negative terminal of a source of potential over lead 121. Condenser 122 is connected in a bridge from the negative terminal of the source of potential to the grounded positive terminal of the source of potential over the lower back contact of relay 123, through variable resistance 124, and over lead 125, and to the anode of tube 120 through the winding of relay 124 and variable resistance 126.

With potential applied across leads 121 and 125, condenser 122 gradually charges over the lower back contact of relay 123 and through variable resistance 124. When the potential across the plates of condenser 122 reaches the ionization potential of tube 120, the tube ionizes and becomes conducting thereby closing the discharge circuit for condenser 122. Condenser 122 discharges through the winding of relay 123 and variable resistance 126 to the negative terminal of the source of potential over the anode and cathode of tube 120, operating relay 123.

Relay 123 operating, connects ground over its upper front contact to lead 127 and removes ground over its upper back contact from lead 128 to function any desired work circuit associated with leads 127 and 128. Relay 123 operating, also opens the charging circuit for condenser 122 from the positive terminal of the source of potential through resistance 124, over the lower back contact of relay 123 to condenser 122. Relay 123 remains operated until the potential across the plates of condenser 122 falls sufficiently below the ionization potential of tube 120 to cause the tube to deionize. Tube 120 deionized, opens the discharge circuit for condenser 122 over its anode circuit thereby releasing relay 123.

Relay 123 releasing, removes ground on its upper front contact from lead 127, connects ground over its upper back contact to lead 128, and also closes the charging circuit for condenser 122 from the positive terminal of the source of potential, through variable resistance 124 and the lower back contact of relay 123. When sufficiently charged, condenser 122 again causes tube 120 to ionize which closes the discharge circuit for condenser 122 and operates relay 123.

The above cycle of operations continues as long as potential is applied across leads 121 and 125, the periodic operation and release of relay 123 producing periodic impulses in the work circuit associated with leads 127 and 128. The impulses generated over the leads 127 and 128 through the periodic operation of relay 123 may be used, for example, for the production of interrupted busy tone, for the control of interrupted ringing and in time measuring circuits.

The periodicity of the impulses generated may be controlled by varying the capacitance of condenser 122 and the charging and discharging rate thereof. Variable resistance 126 controls the discharge rate and variable resistance 124 controls the charging rate of condenser 122, which in turn

determine the impulse periods as hereinbefore set forth in the corresponding description for Fig. 1.

Repeating incoming impulses—Fig. 2

Referring again to Fig. 2, the impulse producing circuit hereinbefore described, may, with a slight modification, be arranged to repeat incoming impulses, corrected as to their relative make and break periods, to an associated work circuit.

For this purpose the capacitance of condenser 122 is selected so that when the condenser is fully charged the potential across its plates is slightly below the ionization potential of tube 120. In addition, the second or control cathode of tube 120, which performed no function in the impulse producing circuit, is arranged to be made sufficiently positive through the connection of an incoming impulse of positive potential thereto to cause tube 120 to ionize.

With potential applied across leads 121 and 125, condenser 122 charges from the positive terminal of the source of potential through variable resistance 124 and the lower back contact of relay 123. The potential across the plates of condenser 122, when it is fully charged, is not sufficient however to cause tube 120 to ionize.

When an incoming impulse connects positive grounded potential, under control of contact 130 and through resistance 129, to the second or control cathode of tube 120 the tube ionizes and becomes conducting. With tube 120 in the conducting condition, condenser 122 discharges through the winding of relay 123 variable resistance 126, anode and cathode of tube 120 to the negative terminal of the source of potential, operating relay 123.

Relay 123 operating, connects ground over its upper front contact and lead 127 to the associated work circuit, and opens the charging circuit for condenser 122 from positive potential, through variable resistance 124 and over the lower back contact of relay 123.

When the charge on the plates of condenser 122 falls sufficiently below the ionization potential of tube 120, the tube deionizes and opens the discharge circuit for condenser 122 over its anode circuit which releases relay 123. Relay 123 releasing, removes the ground over its upper front contact over lead 127, and also closes the charging circuit for condenser 122 to the grounded positive terminal of the source of potential through variable resistance 124 and the lower back contact of relay 123. Condenser 122 again charges, thereby preparing the circuit to repeat the next incoming impulse. For each succeeding impulse of grounded positive potential connected to the control cathode of tube 120, the circuit functions in the same manner as described above.

When the circuit is used as an incoming impulse repeater, as in this case, the capacitance of condenser 122 and the value of variable resistance 126 are so chosen that the time interval required to discharge condenser 122, to a point where the reduced potential across its plates causes tube 120 to deionize, at least equals the time interval of the longest incoming impulse to be repeated. Also, the value of variable resistance 124, which controls the charging rate of condenser 122, is so chosen as to insure the complete charging of condenser 122 during the interval between successive incoming impulses. Since relay 123 remains operated during the discharge time of condenser 122, the impulses repeated by relay 123 to the associated work circuit over lead 127 are of uniform length, being independent of variations in the length of the incoming impulses impressed on the control cathode of tube 120. As an impulse repeater this circuit would find utility in repeating impulses dialed, for example, by a subscriber, to set selector switches or to control the setting of the registers of a central office sender in which case the contacts 130 would be under the control of the subscriber's dial and relay 123 would control the repeating of impulses to the selector switch or register. The repeated impulses being controlled as to their relative make and break periods, irrespective of the distortion of the impulses received, accurate dialing response would be possible over long dialing loops.

What is claimed is:

1. A circuit control device comprising a source of potential, a gas-filled tube having a cathode and an anode and arranged to flash when a definite potential exists between the anode and the cathode, a relay connected in a circuit between the positive terminal of said source of potential and said anode, a condenser bridged in series with said relay between said cathode and said anode, a circuit for charging said condenser from said source of potential until the potential across its plates is equal to the flashing potential of said tube, said relay operable when said tube flashes to open said charging circuit and said anode circuit, and a work circuit controlled by said relay.

2. A circuit interrupting device comprising a source of potential, a gas-filled tube having a cathode and an anode and arranged to flash when a definite potential exists between the anode and the cathode, a relay connected in a circuit between the positive terminal of said source of potential and said anode, a condenser bridged in series with said relay between said cathode and said anode, a circuit for charging said condenser from said source of potential until the potential across its plates is equal to the flashing potential of said tube, said relay operable when said tube flashes to open said charging circuit and said anode circuit, said condenser then discharging through said tube and holding said relay operated until the potential across said condenser falls below the flashing potential of said tube, whereupon said relay releases to again establish said charging circuit and said anode circuit to repeat the cycle of operations, and a work circuit controlled by the intermittent operation of said relay.

3. A circuit control device comprising a source of potential, a gas-filled tube having a cathode and an anode and arranged to flash when a definite potential exists between the anode and the cathode, a relay connected in a circuit between the positive terminal of said source of potential and said anode, a condenser bridged in series with said relay between said cathode and said anode, a circuit for charging said condenser from said source of potential until the potential across its plates is equal to the flashing potential of said tube, a variable resistance in said charging circuit for determining the charging time of said condenser, said relay operable when said tube flashes to open said charging circuit and said anode circuit, and a work circuit controlled by said relay.

4. A circuit interrupting device comprising a source of potential, a gas-filled tube having a cathode and an anode and arranged to flash when a definite potential exists between the anode and the cathode, a relay connected in a circuit between the positive terminal of said source of po-

tential and said anode, a condenser bridged in series with said relay between said cathode and said anode, a circuit for charging said condenser from said source of potential until the potential across its plates is equal to the flashing potential of said tube, said relay operable when said tube flashes to open said charging circuit and said anode circuit, said condenser then discharging through said tube and holding said relay operated until the potential across said condenser falls below the flashing potential of said tube, whereupon said relay releases to again establish said charging circuit and said anode circuit to repeat the cycle of operations, and means for varying the rate of charge of said condenser to determine the length of the unoperated periods of said relay.

5. A circuit interrupting device comprising a source of potential, a gas-filled tube having a cathode and an anode and arranged to flash when a definite potential exists between the anode and the cathode, a relay connected in a circuit between the positive terminal of said source and said anode, a condenser bridged in series with said relay between said cathode and said anode, a circuit for charging said condenser from said source of potential until the potential across its plates is equal to the flashing potential of said tube, said relay operable when said tube flashes to open said charging circuit and said anode circuit, said condenser then discharging through said tube and holding said relay operated until the potential across said condenser falls below the flashing potential of said tube, whereupon said relay releases to again establish said charging circuit and said anode circuit to repeat the cycle of operations, and means for varying the rate of discharge of said condenser to determine the length of the operated periods of said relay.

6. A circuit interrupting device comprising a source of potential, a gas-filled tube having a cathode and an anode and arranged to flash when a definite potential exists between the anode and the cathode, a relay connected in a circuit between the positive terminal of said source and said anode, a condenser bridged in series with said relay between said cathode and said anode, a circuit for charging said condenser from said source of potential until the potential across its plates is equal to the flashing potential of said tube, said relay operable when said tube flashes to open said charging circuit and said anode circuit, said condenser then discharging through said tube and holding said relay operated until the potential across said condenser falls below the flashing potential of said tube whereupon said relay releases to again establish said charging circuit and said anode circuit to repeat the cycle of operations, and means varying the rate of charge and the rate of discharge of said condenser to determine the length of the unoperated and operated periods respectively of said relay.

7. A circuit interrupting device comprising a source of potential, a gas-filled tube having a cathode and an anode and arranged to flash when a definite potential exists between the anode and the cathode, a relay connected in a circuit between the positive terminal of said source and said anode, a condenser bridged in series with said relay between said cathode and said anode, a circuit for charging said condenser from said source of potential until the potential across its plates is equal to the flashing potential of said tube, said relay operable when said tube flashes to open said charging circuit and said anode circuit, said condenser then discharging through said tube and holding said relay operated until the potential across said condenser falls below the flashing potential of said tube whereupon said relay releases to again establish said charging circuit and said anode circuit to repeat the cycle of operations, and a variable resistance in the charging circuit of said condenser for varying the rate of charge thereof to determine the length of the unoperated periods of said relay.

8. A circuit interrupting device comprising a source of potential, a gas-filled tube having a cathode and an anode and arranged to flash when a definite potential exists between the anode and the cathode, a relay connected in a circuit between the positive terminal of said source and said anode, a condenser bridged in series with said relay between said cathode and said anode, a circuit for charging said condenser from said source of potential until the potential across its plates is equal to the flashing potential of said tube, said relay operable when said tube flashes to open said charging circuit and said anode circuit, said condenser then discharging through said tube and holding said relay operated until the potential across said condenser falls below the flashing potential of said tube, whereupon said relay releases to again establish said charging circuit and said anode circuit to repeat the cycle of operations, and a variable resistance in the series circuit of said condenser and relay for varying the rate of discharge of said condenser to determine the length of the operated periods of said relay.

9. A circuit interrupting device comprising a source of potential, a gas-filled tube having a cathode and an anode and arranged to flash when a definite potential exists between the anode and the cathode, a relay connected in a circuit between the positive terminal of said source and said anode, a condenser bridged in series with said relay between said cathode and said anode, a circuit for charging said condenser from said source of potential until the potential across its plates is equal to the flashing potential of said tube, said relay operable when said tube flashes to open said charging circuit and said anode circuit, said condenser then discharging through said tube and holding said relay operated until the potential across said condenser falls below the flashing potential of said tube whereupon said relay releases to again establish said charging circuit and said anode circuit to repeat the cycle of operations, and variable resistances in the charging circuit of said condenser and in the series circuit of said condenser and relay for varying the rate of charge and the rate of discharge of said condenser to determine the length of the unoperated and operated periods respectively of said relay.

10. An impulse repeater comprising a source of potential, a gas-filled tube having a grid, a cathode and an anode and arranged to flash when its grid is made sufficiently positive with respect to its cathode, a condenser for establishing a potential between said anode and said cathode sufficient to prevent said tube from flashing when said condenser is fully charged, a circuit for charging said condenser from said source of potential, means for applying an impulse of potential to said grid to render it sufficiently positive to cause said tube to flash, an impulse repeating relay in the cathode-anode circuit of said tube operable when said tube flashes to open said charging circuit and said cathode-anode circuit, and means

for holding said relay operated until the application of said impulse of potential to said grid ceases.

11. An impulse repeater comprising a source of potential, a gas-filled tube having a grid, a cathode and an anode and arranged to flash when its grid is made sufficiently positive with respect to its cathode, a condenser for establishing a potential between said anode and said cathode sufficient to prevent said tube from flashing when said condenser is fully charged, a circuit for charging said condenser from said source of potential, means for applying an impulse of potential to said grid to render it sufficiently positive to cause said tube to flash, an impulse repeating relay in the cathode-anode circuit of said tube operable when said tube flashes to open said charging circuit and said cathode-anode circuit, and means including said condenser and an adjustable resistance for holding said relay operated until the application of said impulse of potential to said grid ceases.

12. An impulse repeater comprising a source of potential, a gas-filled tube of the cold cathode type having a control cathode, a second cathode and an anode and arranged to flash when its control cathode is made sufficiently positive with respect to its second cathode, a condenser for establishing a potential between said anode and said second cathode sufficient to prevent said tube from flashing when said condenser is fully charged, a circuit for charging said condenser from said source of potential, means for applying an impulse of potential to said control cathode to render it sufficiently positive to cause said tube to flash, an impulse repeating relay in the cathode-anode circuit of said tube operable when said tube flashes to open said charging circuit and said cathode-anode circuit, and means for holding said relay operated until the application of said impulse of potential to said control cathode ceases.

13. An impulse repeater comprising a source of potential, a gas-filled tube of the cold cathode type having a control cathode, a second cathode and an anode and arranged to flash when its control cathode is made sufficiently positive with respect to its second cathode, a condenser for establishing a potential between said anode and said second cathode sufficient to prevent said tube from flashing when said condenser is fully charged, a circuit for charging said condenser from said source of potential, means for applying an impulse of potential to said control cathode to render it sufficiently positive to cause said tube to flash, an impulse repeating relay in the cathode-anode circuit of said tube operable when said tube flashes to open said charging circuit and said cathode-anode circuit, and means including said condenser and an adjustable resistance for holding said relay operated until the application of said impulse of potential to said control cathode ceases.

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