

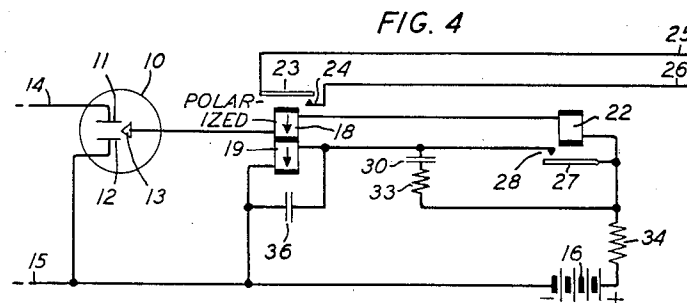
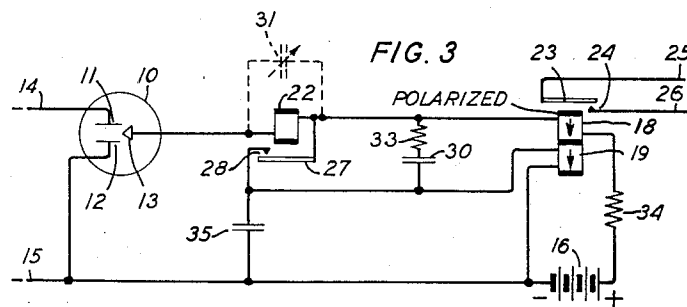
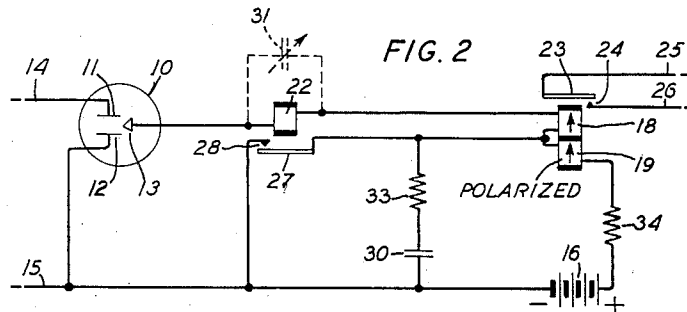
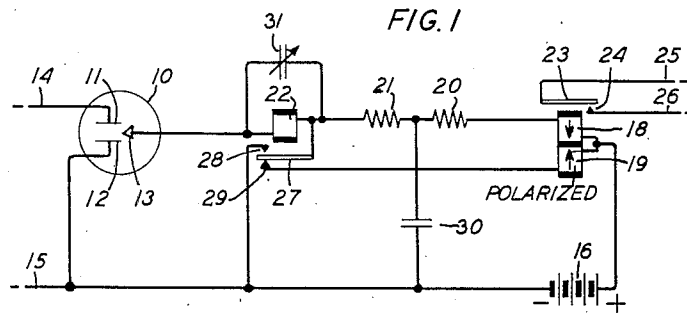
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L. K. SWART

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## RESETTING CIRCUIT FOR TRIGGER DEVICES

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## RESETTING CIRCUIT FOR TRIGGER DEVICES

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This invention relates to resetting circuits for trigger devices and more particularly to such circuits including a multi-electrode gaseous discharge device and an output circuit associated with two of the electrodes of the device and including a plurality of relays, one of which is adapted to control a load circuit in accordance with potential impulses in the input circuit of the device.

In systems such as shown in my Patent 1,977,256 granted October 16, 1934 suitable for voltage recording and the like, the output circuit of the gaseous discharge device may include a vibrating relay and an operating relay connected in series with each other and with the source for applying a positive potential to the output electrode or anode of the device, and a condenser in circuit with the operating relay. One of the principal functions of the condenser is to suppress the voltage induced in the operating relay when the vibrating relay releases, so that this induced voltage will not be of sufficient magnitude, together with the potential of the source, to impress upon the output electrode or anode of the discharge device a potential great enough to reionize the device after it has been deionized as a result of operation of the vibrating relay. When the vibrating relay releases, the condenser becomes charged, the charging current flowing through a circuit including the winding of the operating relay, and when fully charged acts as an open circuit. The charging current flowing through the winding of the operating relay may serve to hold the contact of the operating relay closed for an appreciable period which may be sufficiently long to prevent release of the operating relay before another impulse is impressed upon the input electrode of the discharge device, so that the circuit controlled by the operating relay will not be energized in accordance with the input impulses.

One object of this invention is to insure quick release of the operating relay so that impulses in the input circuit of the gaseous discharge device will result in corresponding impulses in the load circuit controlled by the operating relay.

In accordance with one feature of this invention, an operating relay having two windings is used, only one of the windings being in series with the winding of the vibrating relay. The second winding of the operating relay may be shunted across the source for applying a positive potential to the output electrode of the gaseous discharge device through a circuit independent of the first winding of the operating relay.

In a specific circuit illustrative of one embodi-

ment of this invention, the operating relay may be of the polar type and have two windings wound in the same direction. One of the windings forms a part of a series circuit between the cathode and output electrode of the gaseous discharge device and including the source for applying a positive potential to the output electrode, the winding of the operating relay, and two resistances of widely different values between the winding of the vibrating relay and the one winding of the operating relay. The vibrating relay is provided with two contacts, one of which is closed when the relay is not energized, and the other of which is adapted to be closed when the relay is energized. The contacts are shunted by a condenser in series with the smaller of the two resistances. The second winding of the operating relay is connected at one end to the end of the other winding connected to the source, and at the other end to the contact of the vibrating relay which is closed when the vibrating relay is deenergized.

In this circuit when the vibrating relay releases upon deionization of the gaseous discharge device, the charging current for the condenser may flow in two paths, one of which includes the first winding of the operating relay and the larger of the two resistances, and the other of which includes the second winding of the operating relay and the smaller of the two resistances. The portion of the charging current flowing through the latter circuit will be large in comparison with the portion flowing in the former circuit so that it will overcome the tendency of the latter portion to hold the operating relay operated and result in quick release of this relay. Inasmuch as the circuit in which the major portion of the charging current for the condenser flows is of relatively low resistance and inductance, the period of time required for the condenser to become fully charged will be relatively short, thereby further increasing the speed at which the operating relay releases.

The invention and the features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing in which:

Fig. 1 shows one resetting circuit, illustrative of this invention, for a three-electrode gaseous discharge device of the trigger type;

Fig. 2 shows another resetting circuit in accordance with this invention wherein the vibrating and operating relays operate simultaneously upon the ionization of the trigger device;

Fig. 3 shows still another resetting circuit illustrative of this invention wherein the two wind-

ings of the operating relay are electrically separate; and

Fig. 4 illustrates another resetting circuit in accordance with this invention wherein one winding of the operating relay is connected between the armature of the vibrating relay and the negative terminal of the source in the anode or output circuit of the discharge device and the charging circuit for the condenser does not include the operating relay windings.

Referring now to the drawing, the circuit shown in Fig. 1 comprises a trigger device 10, which may be a gaseous discharge device, having a pair of cold input electrodes 11 and 12 and an output electrode or anode 13. The electrode 12 may be operated as a cathode and the electrode 11 as a control electrode. As is known in the art, the potential between the cold electrodes 11 and 12 may be utilized to control the initiation of a discharge between one of the cold electrodes, for example, the electrode 12, and the output electrode or anode 13. The cold electrodes 11 and 12 may be connected to an input circuit by conductors 14 and 15 respectively, and a suitable source, not shown, may be included in the input circuit for applying a suitable biasing potential to the control electrode 11. An output circuit is connected between the cathode 12 and the anode 13 and includes a suitable source, such as a battery 16, for applying a positive potential to the anode 13, an operating relay, which may be of the polar type and include two windings 18 and 19 wound in the same direction and each connected at one end to the positive terminal of the source 16 and also connected non-inductively to a pair of resistances 20 and 21, and a vibrating relay 22. For reasons to be set forth hereinafter the resistance 20 preferably is much larger than the resistance 21. For example, it may be of the order of 1000 ohms and the resistance 21 may be of the order of 200 ohms. The operating relay has an armature 23 and a contact 24 which are connected to a load circuit by conductors 25 and 26 respectively. The vibrating relay has an armature 27 which is connected to the end of the winding 22 connected to the resistance 21, and has two contacts 28 and 29, the contact 28 being connected to the negative terminal of the source 16 and the contact 29 being connected to the other end of the winding 19 of the operating relay. A condenser 30 is shunted across the armature 27 and contact 28 of the vibrating relay in series with the resistance 21, and serves to prevent arcing between the armature and the contacts and also to suppress the voltage induced in the winding 18 of the operating relay when the vibrating relay releases, as described hereinafter.

When the device 10 is in the deionized state, the armature 27 of the vibrating relay is against the contact 29 so that the windings 18 and 19 of the operating relay are connected in series with the resistances 20 and 21 through a path including the windings 18 and 19, contact 29, and armature 27. The resistances 21 and 20 are connected in parallel with the source 16 through the condenser 30 and windings 18 and 19. One of the branches of the parallel circuit extends from the positive terminal of the source 16, through the winding 18, resistance 20 and condenser 30 and thence to the negative terminal of the source 16; the other branch extends from the positive terminal of the source 16 through the winding 19, contact 29, armature 27, resistance 21, and condenser 30 and thence to the negative terminal of the source 16.

When a suitable potential, which may be an alternating or a periodic direct potential, is applied between the control electrode 11 and cathode 12 to cause ionization in the device 10 and a discharge between the cathode 12 and the anode 13, a current flows in the circuit including the cathode 12, the source 16, the windings 18 and 19 in parallel, the resistances 20 and 21, the winding 22, and the anode 13. This current energizes the vibrating relay so that the armature 27 immediately leaves the contact 29 and moves toward the contact 28 with the result that the aforementioned current flows only through the winding 18 and the armature 23 engages the contact 24 to close the load circuit including the conductors 25 and 26. When the armature 27 reaches and engages the contact 28, the condenser 30 discharges through the relatively small resistance 21 and simultaneously an additional current flows through the winding 18 through the circuit including the source 16, winding 18, resistances 20 and 21, armature 27, and contact 28. Also when the armature 27 engages the contact 28, a short-circuiting connection is established between the cathode 12 and anode 13 so that the device 10 deionizes and as a result the winding 22 is deenergized and the armature 27 falls away from the contact 28. While the armature 27 is moving toward the contact 29, the condenser 30 is charged over a circuit including the source 16, winding 18 and resistance 20. The charging current energizes the winding 18 and causes the armature 23 of the operating relay to be held against the contact 24. However, as soon as the armature 27 reaches the contact 29, the charging current flows through both windings of the relay and is divided in the two branch circuits, set forth hereinbefore, each including one of the resistances 20 and 21 and one of the windings 18 and 19. Inasmuch as the resistance 21 in series with the winding 19, through the contact 29, armature 27, condenser 30, and source 16, is less than the resistance 20 in series with the winding 18, through the condenser 30 and source 16, the greater portion of the charging current flows through the winding 19 so that the armature 23 leaves the contact 24 and opens the load circuit.

It will be apparent that the portion of the condenser charging current flowing through the winding 19 may be adjusted at will by varying the value of the resistance 21 so that the period required for release of the operating relay may be varied. Inasmuch as the condenser is charged through a low resistance circuit and the windings 18 and 19 are connected non-inductively, the condenser 30 is charged very rapidly so that the operating relay will release very quickly. It will be understood, of course, that if the armature 27 of the vibrating relay is vibrating at high speed, insufficient time will be given to allow the operating relay to release during such vibrations. However, as soon as the armature 27 comes to rest against the contact 29, the operating relay will release very quickly to open the load circuit.

It will be noted that when the armature 27 is in engagement with the contact 28, a direct connection of very low resistance is established between the winding 22 and the negative terminal of the source 16 so that the potential upon the anode or output electrode 13 is quickly decreased and the device 10, therefore, is quickly returned to its deionized state. In order to insure engagement between the armature 27 and the contact 28 for a sufficient period to allow the voltage be-

tween the cathode 12 and anode 13 to fall below the value necessary to sustain a cathode-anode discharge, a condenser 31, which may be fixed or variable, may be shunted across the winding 22.

In another circuit illustrative of this invention, shown in Fig. 2, the vibrating relay may have but one contact 28, which normally is out of engagement with the armature 27, and the contact 28 and armature 27 may be shunted by a condenser 30 and a resistance 33 in series with the condenser 30. The two windings 18 and 19 of the operating relay are connected in series with the source 16, a resistance 34, and the winding 22 of the vibrating relay. The winding 18 is shunted by the condenser 30 and resistance 33, through the source 16 and resistance 34. The mid-point of the two windings 18 and 19 of the operating relay is connected directly to the armature 27 of the vibrating relay.

When a potential sufficient to cause ionization of the device 10 is impressed between the electrodes 11 and 12, a current will flow in the path including the cathode 12, source 16, resistance 34, windings 18 and 19 of the operating relay, winding 22 of the vibrating relay and anode 13. The vibrating and operating relays, therefore, will operate simultaneously and the load circuit will be closed through the armature 23 and contact 24. Energization of the winding 22 causes the armature 27 to engage the contact 28 so that a shunt is placed across the cathode 12 and anode 13 through the winding 18, and the potential between the cathode and anode, therefore, is decreased so that the device 10 deionizes. When the armature 27 engages the contact 28, an additional current flows through the winding 19 through the path including the source 16, resistance 34, winding 19, armature 27 and contact 28, which tends to hold the operating relay operated. Simultaneously, however, due to the transformer action between the windings 18 and 19, a potential of considerable magnitude is induced in the winding 18 and this potential is of a polarity in opposition to that of the source 16, so that the potential upon the anode 13 is quickly reduced below the sustaining value and rapid deionization of the device 10 results.

When the device 10 deionizes, the winding 22 becomes deenergized and the armature 27 falls away from the contact 28 so that the circuit through the winding 19, source 16, contact 28 and armature 27 is interrupted. Also the condenser 30 is charged by a current flowing through the circuit including the condenser, source 16, resistance 34, winding 19, and resistance 33 and this current tends to hold the operating relay operated until the condenser is charged. However, due to the inverse voltage induced in the winding 19 and the small counter-voltage induced in the winding 18, the condenser 30 may be made of relatively small capacity so that it will charge quickly and the operating relay will, therefore, release quickly to open the load circuit including the armature 23 and contact 24.

In the resetting circuit illustrated in Fig. 3, the armature 27 of the vibrating relay is connected to one end of the winding 22. A condenser 30 in series with a resistance 33 is connected across the armature 27 and contact 28. The operating relay has two electrically separate windings 18 and 19, the winding 18 being in series with the source 16, resistance 34. Winding 19 is connected at one end to the negative terminal of the source 16 and at the other end to the contact 28. A condenser

35 may be shunted across the winding 19 as shown.

When the device 10 ionizes in response to the impressment of a suitable potential between the electrodes 11 and 12, a current flows in the circuit including the cathode 12, source 16, resistance 34, winding 18, winding 22, and anode 13 so that the operating and vibrating relays operate simultaneously. Operation of the operating relay closes the load circuit through the armature 23 and contact 24. Operation of the vibrating relay causes the armature 27 to engage the contact 28 so that the condenser 30 is discharged and also a short circuit is established between the anode 13 and cathode 12 through the winding 22, armature 27, contact 28 and winding 19. Furthermore, engagement of the armature 27 with the contact 28 allows an additional current to flow through the winding 18 in a circuit including source 16, resistance 34, winding 18, armature 27, contact 28, and winding 19, and this current tends to hold the operating relay operated. As a result of deionization of the device 10, the winding 22 becomes deenergized so that the armature 27 leaves the contact 28. The condenser 30 then becomes charged, the charging current flowing through the circuit including the source 16, resistance 34, winding 18, resistance 33, and winding 19.

The winding 18, it will be seen, may be designed to have a low inductance so that the counter-electromotive force induced therein by the decay of current caused by deionization of the device 10 and by the armature 27 leaving the contact 28 is relatively small. Hence, the condenser 30 also may be relatively small so that it will charge rapidly and the operating relay will release quickly to open the load circuit at the contact 24. Any counter-electromotive force induced in the winding 19 when the armature 27 leaves the contact 28 will be quickly suppressed by the condenser 35.

In the circuit illustrated in Fig. 4, the winding 18 of the operating relay is connected in series with the winding 22 of the vibrating relay. The winding 19 of the operating relay is connected at one end to the contact 28 and at the other end to the negative terminal of the source 16, and is shunted directly by a condenser 36.

When the device 10 ionizes, the windings 18 and 22 are energized by the current flowing in the path including the cathode 12, source 16, resistance 34, winding 22, winding 18, and anode 10, and as a result the armature 23 engages contact 24 to close the load circuit. Simultaneously, the armature 27 engages the contact 28 so that potential is withdrawn from the windings 22 and 18 and from the anode-cathode circuit of the device 10, that is between the cathode 12 and anode 13. Also, when the armature 27 engages the contact 28, current flows through the winding 19 in the path including the source 16, resistance 34, armature 27, contact 28, and winding 19, which tends to hold the operating relay operated. Simultaneously, the condenser 36 is charged by a current flowing in the path from the source 16, through the resistance 34, armature 27 and contact 28 and the rate of charge will be great inasmuch as aside from the condenser the circuit is purely resistive. The rate of charge may be varied by varying the resistance 34.

When the device 10 deionizes, the windings 18 and 22 become deenergized and the armature 27 moves away from the contact 28 so that the circuit through the winding 19 and source 16, above

described, is opened and the current through the winding 19 decays. The current through the winding 19 will decay rapidly to a point below that necessary to hold the operating relay operated inasmuch as the condenser 30 will become fully charged very rapidly by the current flowing through the path including the source 16, resistances 34 and 33, condenser 30, and condenser 36 and winding 19 in shunt. Thus, quick release of the operating relay will be attained and the load circuit will be opened rapidly.

If the armature 27 is vibrating at relatively high speed, the operating relay will be held operated in the short intervals of time that the device 10 is deionized, by the energy stored in the condenser 36. However, when the potential between the electrodes 11 and 12 is removed, the operating relay will release very quickly so that the load circuit will be opened before a potential again is applied between the electrodes 11 and 12. For example, it has been found that if a 60 cycle potential is applied between the electrodes 11 and 12 the operating relay will remain operated during the application of the potential but will release in about one-half cycle after the potential is removed.

Although specific illustrative circuits have been shown and described, it will be understood, of course, that modifications may be made therein without departing from the scope and spirit of this invention as defined in the appended claims. It will be understood also that although the invention has been illustrated with reference to circuits including cold cathode devices, it may be practiced also with circuits including devices of the hot cathode type or devices having more than three electrodes.

What is claimed is:

1. In combination, a trigger device having a cathode, an input electrode, and an output electrode, an input circuit coupled to said cathode and said input electrode, an output circuit coupled to said cathode and said output electrode, said output circuit including a vibrating relay, a source of potential and an operating relay having a pair of windings, one of which is in series with said vibrating relay and said source and the other of which is connected at one end to said source and at the other end to a point in the output circuit, and a condenser shunted across one of said windings and said source.

2. In combination, a gaseous discharge device having a cathode, an input electrode, and an output electrode, an input circuit coupled to said cathode and said input electrode, an output circuit connected between said cathode and said output electrode including a source of potential, a vibrating relay in series with said source, and an operating relay having a pair of windings one of which is in series with said vibrating relay, said vibrating relay having a contact adapted to be closed when said device ionizes whereby the other winding of said operating relay is shunted across said source, and a condenser in shunt with said contact.

3. In combination, a gaseous discharge device having a cathode, an input electrode, and an output electrode, an input circuit coupled to said cathode and said input electrode, an output circuit coupled to said cathode and said output electrode and including a vibrating relay, a double wound polar relay, and a source of potential, said source, vibrating relay and one winding of said polar relay being in series between said cathode

and said output electrode, said vibrating relay having a contact normally closed and adapted to be opened when said device ionizes, and a shunt circuit across the other winding of said polar relay including said contact, said source, and a condenser.

4. In combination, a trigger device having a cathode, an input electrode, and an output electrode, an input circuit coupled to said input electrode and said cathode, and an output circuit coupled to said cathode and said output electrode, and comprising a source for applying a positive potential to said output electrode, a vibrating relay in series with said source and having an armature connected to one end of the winding of said relay and a pair of contacts one of which is normally closed to said armature and the other of which is normally open and connected to said cathode, an operating relay having a pair of windings one of which is in series with said vibrating relay and said source and the other of which is connected at one end to said source and at the other end to said normally closed contact, a pair of resistances of different magnitude in series with said vibrating relay, the resistance of greater magnitude being connected at one end to said first winding of said operating relay, and a condenser connected at one end to the negative terminal of said source and at the other end to the connected ends of said resistances.

5. In combination, a trigger device having a cathode, an input electrode and an output electrode, an input circuit coupled to said cathode and said input electrode, an output circuit coupled to said cathode and said output electrode and comprising a source for applying a positive potential to said output electrode, a vibrating relay in series with said source and having an armature connected to the positive terminal of said source and a contact normally disengaged from said armature, and an operating relay having a pair of windings one of which is in series with said vibrating relay and the other of which is connected at one end to said contact and at the other end to the negative terminal of said source, and a condenser connected between said contact and said armature.

6. The combination defined in claim 5 and including another condenser in shunt with said other winding of said operating relay.

7. In combination, a gaseous discharge device having a cathode, an input electrode and an output electrode, an input circuit coupled to said cathode and said input electrode, an output circuit coupled to said cathode and said output electrode and including a source for applying a positive potential to said output electrode, a vibrating relay in series with said source and output electrode and having an armature connected to the positive terminal of said source and a contact normally disengaged from said armature, and an operating relay having a pair of windings one of which is connected in series between said vibrating relay and said output electrode and the other of which is connected between said contact and the negative terminal of said source, a condenser connected across said armature and said contact, and another condenser shunted across said other winding of said operating relay.

8. In combination, a gaseous discharge device having a cathode, an input electrode and an anode, an input circuit coupled to said cathode and said input electrode, an output circuit coupled to said cathode and said anode and including a source of potential, an operating relay hav-

ing a pair of windings one of which is in series between said anode and said source, a vibrating relay in series between said one winding and said anode, said vibrating relay having an armature connected to said anode and having a contact adapted to be engaged by said armature in response to the flow of current in said output circuit, the other winding of said operating relay being connected at one end to the negative terminal of said source and at the other end to said contact, a condenser shunted across said contact and armature, and another condenser shunted across said other winding of said operating relay.

9. In combination, a gaseous discharge device having a cathode, an input electrode and an out-

put electrode, an input circuit coupled to said cathode and said input electrode, an output circuit connected between said cathode and said output electrode including a source of potential, a vibrating relay having a winding in series with said source, said cathode and said output electrode, and an operating relay having a pair of windings one of which is in series with the winding of said vibrating relay, said vibrating relay having a contact adapted to be closed when said device ionizes whereby the other winding of said operating relay is connected in series with said source and said one winding, a condenser in shunt with said contact, and another condenser in shunt with said other winding.

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