Jan. 7, 1941. R. F. HAYS, JR 2,228,210

GASEOUS RELAY DEVICE

Filed March 29, 1939

Fig. 1.

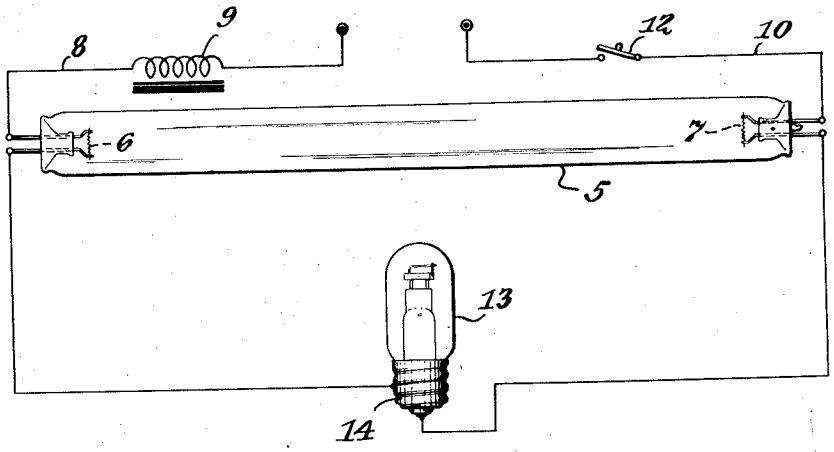


Fig. 2.

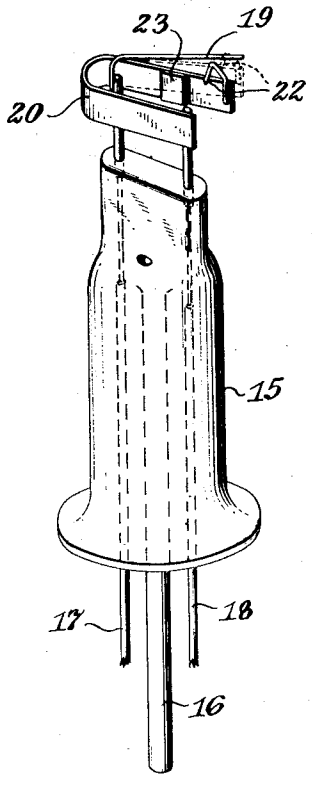


Fig. 3.

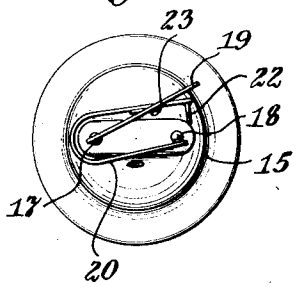
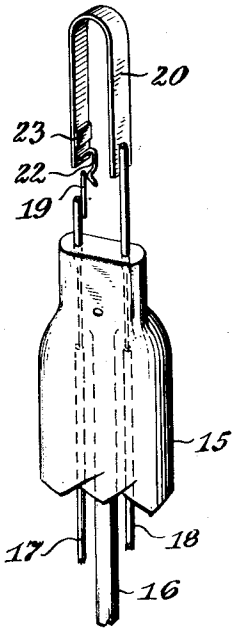


Fig. 4.



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Patented Jan. 7, 1941 2,228,210

UNITED STATES PATENT OFFICE

2,228,210

GASEOUS RELAY DEVICE

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Application March 29, 1939, Serial No. 264,705

8 Claims. (Cl. 250—27.5)

The present invention relates to a gaseous electric discharge device and more particularly to what may be termed a no-power-loss relay for making and breaking an electric circuit.

A device of this type is particularly adaptable where it is desired to momentarily close a control circuit for initiating the operation of numerous electrically operated apparatus. In the pending application, Serial No. 258,382, filed February 25, 1939, of which I am a co-inventor, and which application is assigned to the same assignee as the present invention, a similar no-power-loss gaseous relay is shown and claimed and the present invention constitutes an improvement thereover.

The above noted application shows such gaseous relay device in conjunction with a discharge lamp to initiate a discharge between the thermionic electrodes of the lamp. The relay tube is connected to the filamentary electrodes in such manner as to connect the electrodes in series relationship to a suitable source of electrical energy of the customary commercial potential. Upon closure of the circuit a glow discharge momentarily occurs in the gaseous relay which heats the electrodes, one of which is a bimetallic element, causing the electrodes to engage each other, thus extinguishing the discharge and effecting a positive closure of the series circuit for the filamentary electrodes of the discharge lamp allowing the latter to be heated to electron emitting temperature.

By the time the filamentary electrodes have reached electron emitting temperature the bimetallic electrode of the gaseous relay device will have cooled sufficiently to cause the electrodes to become disengaged. Due to the provision of an inductance element in series with the discharge lamp, a discharge is again initiated by the electrodes of the relay device separating. This produces a high transient voltage in the relay device, which voltage is impressed upon the electrodes of the discharge lamp, causing ionization of the gas therein, together with the initiation of a discharge between the filamentary electrodes.

A high transient voltage alone, however, is insufficient to cause ionization and the initiation of a discharge in the lamp as a certain amount of energy is necessary. During momentary voltage surges the glow discharge resulting in the relay device upon separation of the electrodes has a positive volt-ampere characteristic. This high voltage thus causes the glow discharge to draw more current, somewhat in the same manner as is obtained by the operation of an inductance element in parallel with a resistance.

Moreover, for a given voltage the current drawn during the high transient voltage is proportional to the surface area of the electrode and where the surface area of the electrode is comparatively large, as in the structure shown in the above mentioned application, too much of the transient energy is consumed which should be available for the load or discharge lamp in order to facilitate more rapid starting.

It is accordingly an object of the present invention to provide a gaseous relay tube wherein the current drawn by the device during high transient voltages is maintained low.

Another object of the present invention is the provision of a gaseous relay device which during operation has a high effective resistance to permit high transient voltages with very small current consumption during the formation of a discharge.

Another object of the present invention is the provision of a gaseous relay device having electrodes of widely differing surface area which results in low energy consumption at high transient voltages.

A further object of the present invention is the provision of a gaseous relay device having electrodes of widely differing surface area and a gaseous atmosphere within a preselected pressure range so that a glow discharge is originally initiated at a low voltage and subsequently a high transient voltage at low current passes through the device for supplying a load.

Still further objects of the present invention will become obvious to those skilled in the art by reference to the accompanying drawing wherein:

Fig. 1 is a diagrammatic illustration of an electrical circuit for energizing a load such as a discharge lamp and wherein the gaseous relay device of the present invention is utilized to control the circuit;

Fig. 2 is a fragmentary view in perspective of the gaseous relay device of the present invention;

Fig. 3 is a plan view of the relay device as shown in Fig. 2, and

Fig. 4 is a fragmentary view in perspective of a modification which the gaseous relay device of the present invention may take.

Referring now to the drawing in detail, a circuit is shown in Fig. 1 for starting a gaseous discharge lamp and illustrates one specific use for which the gaseous electric discharge relay device of the present invention may be employed. The gaseous discharge lamp 5 as shown in Fig. 1 is provided with oppositely disposed filamentary electrodes 6 and 7 of a refractory metal, such as tungsten or the like, which may be in the form of a coiled coil coated with an electron emissive material, such as an oxide of barium, strontium, or the like, to provide a copious flow of electrons when heated.

After evacuation the lamp is filled with a rare gas to facilitate starting, to which is added a few drops of mercury, as is well known in the art. One terminal of the electrode 6 is connected

by a conductor 8 through an inductance element 9 to one side of the source of supply of the customary domestic potential of 115 or 230 volts. Likewise, one terminal of the electrode 7 is connected by a conductor 10 and switch 12 to the opposite side of the domestic source of supply. The remaining terminal of each electrode is connected through the medium of a gaseous electric discharge relay device 13 so that upon closure of the relay contacts, the electrodes 6 and 7 are initially in series with each other and the source of supply, thus heating the electrodes to an electron emitting temperature.

When the temperature of the electrodes reaches a value sufficient to cause a copious flow of electrons, the relay device 13 automatically operates to interrupt the series heating circuit for the electrodes. The attendant voltage increase, upon operation of the device 13, causes a discharge between the electrodes 6 and 7 with the result that the discharge carries the current and the voltage across the electrodes of the device 13 is too low to start a discharge therebetween until extinguishment of the discharge between the electrodes 6 and 7 of the lamp 5.

Except for the construction of the gaseous electric relay device 13, the circuit of Fig. 1 in no way differs from that shown and described in the above identified copending application. Since the device of the present invention may be employed in conjunction with any circuit where a sequential operation of the various elements of a given system is desired, Fig. 1 serves merely as illustrative and further description thereof is believed unnecessary.

The gaseous electric relay device 13 as shown in Fig. 1 comprises an envelope which after evacuation is filled with an ionizable medium, such as neon or the like, at a pressure below approximately 30 millimeters, depending upon the particular line voltage and at the voltage of the customary commercial source of 115 volts, the pressure approximates 15 millimeters. The device is provided with any suitable type base 14 and, as shown more clearly in Figs. 2 and 4, it has a reentrant press portion 15 provided with an exhaust stem 16, as customarily employed in the fabrication of incandescent lamps.

A pair of leading-in and supporting conductors 17 and 18 are sealed into the reentrant press and interiorly of the envelope an electrode 19 of suitable refractory metal, such as tungsten in the form of a wire or rod, is welded to the extremity of the leading-in and supporting conductor 17 which extends substantially transversely to the longitudinal axis of the device 13 or may be parallel to such axis, as shown in Fig. 4. In a similar manner, a U-shaped bimetallic electrode 20 of appreciably greater surface area is secured to the leading-in and supporting conductor 18 which likewise extends transversely of the longitudinal axis of the device 13 or may be parallel therewith, as shown in the modification of Fig. 4.

This latter electrode 20 is provided with a contact terminal 22 of refractory metal, such as tungsten, and a coating or a small piece of material 23, such as magnesium or the like, is secured to the surface of the bimetallic electrode 20 which emits a copious flow of electrons.

Upon the application of a potential of approximately 115 volts from the customary commercial source to the electrodes 19 and 20, a glow discharge occurs due to the emission of electrons from the coating or strip of magnesium 23 carried by the electrode 20 when functioning as cathode. These electrons cause ionization of the gaseous medium, with the result that the glow discharge at this low voltage of 115 volts occurs between the electrode 20 serving as cathode and the electrode 19 functioning as anode during one half wave of the alternating current cycle. This ensuing discharge heats the bimetallic electrode or cathode 20 causing deflection thereof, as shown in dotted lines in Fig. 2, until the refractory metal contact terminal 22 engages the electrode 19, thus short-circuiting the electrodes and extinguishing the discharge.

The circuit controlled by the relay device 13 accordingly receives current due to the positive engagement of the electrodes 19 and 20. During this period of current flow, however, the bimetallic electrode 20 cools sufficiently to cause it to again deflect to its original position and in separating the glow discharge is re-established and an arc-like discharge is initiated between the points of contact. At the same time a high transient voltage of approximately 600 to 1800 volts is produced by the inductive voltage "kick" of the inductance 9 (Fig. 1) which is impressed upon the load or lamp 5, as well as upon the relay.

In order for the relay device to allow the inductance to produce such high transient voltages, its effective resistance must be high. The inductance forces current to flow for an instant after separation of the electrodes 19 and 20 and the transient voltage is equal to the product of the current at the instant of disengagement of the electrodes and the effective resistance of the relay device. The effective resistance of the device is composed of the resistance of the glow discharge in parallel with the resistance of the arc-like discharge which is established between the electrodes as they separate. Reducing the surface area of one electrode to a minimum increases the resistance of the glow discharge to a maximum for the half cycles of alternating current during which that electrode serves as cathode.

The resistance of the arc-like discharge between the electrodes may be increased by decreasing the pressure of the filling gas below 30 mm. of mercury, but at the same time the pressure must not be decreased below a value at which a glow discharge can be initiated at the line voltage, although it should be noted that the higher the line voltage, the lower the pressure may be. This is because the mean free path is so great that insufficient atoms of gas are between the points of contact of the electrodes which part last during separation thereof to enable the arc-like discharge to conduct appreciable current and because at lower pressures considerable time is required for the ionization of the gas to build up thereby increasing the resistance of the device during the moment of application of the high transient voltage. High effective resistance of the relay device not only results in higher transient voltages, but also causes a greater portion of the transient current to be diverted from the relay device through the load or discharge lamp for the purpose of establishing the discharge.

It thus becomes obvious to those skilled in the art that a gaseous relay device is herein shown and described for controlling a circuit to a load which initiates a glow discharge upon the application of a voltage thereto from the customary commercial source of approximately 115 volts, and such discharge heats at least one of the electrodes to cause it to be deflected into engagement with the other electrode and extinguish

the glow discharge. Upon cooling the electrode and its deflection back to normal position, an arc-like discharge is initiated as a result of the high transient voltage. Moreover, by employing electrodes of comparatively wide variation in surface area wherein the area of one electrode is not greater than fifty per cent and preferably much less than the area of the other electrode, the relay device has a high effective resistance and low current consumption so that substantially no power is lost, which is thus available for the load.

Although two embodiments of the present invention have been shown and described, it is to be understood that still further modifications of the present invention may be made without departing from the spirit and scope of the appended claims.

What is claimed is:

1. A gaseous electric device comprising an envelope provided with an ionizable medium therein and a pair of electrodes, one of which is a thermo-expansive electrode adapted to emit electrons to cause a glow discharge between said electrodes thereby heating said thermo-expansive electrode with attendant movement thereof into contact with the other of said electrodes to short-circuit the same and extinguish said discharge and said thermo-expansive electrode being movable away from said other electrode upon cooling, and the other of said electrodes having a surface area substantially less than the area of said thermo-expansive electrode to increase the transient voltage between the electrodes at the instant of separation thereof.

2. A gaseous electric relay device comprising an envelope provided with a pair of electrodes and an ionizable medium therein at a pressure below 30 millimeters of mercury, one of said electrodes being a thermo-expansive electrode provided with an electron emissive material adapted to emit a copious flow of electrons to cause a discharge between said electrodes thereby heating said thermo-expansive electrode with attendant deflection thereof into contact with the other of said electrodes to short-circuit the same and extinguish said discharge, and the other of said electrodes being of substantially smaller area for the purpose of increasing the effective resistance of said device to thereby increase the transient voltage between the electrodes and to limit the current consumption at the instant of separation of the electrodes upon cooling of said thermo-expansive electrode.

3. A gaseous electric device comprising an envelope provided with an ionizable medium therein, a pair of electrodes in said envelope, one of said electrodes being a thermo-expansive electrode provided with an electron emissive material adapted to emit electrons and movable toward said other electrode when heated by the discharge between said electrodes to short-circuit the latter and extinguish said discharge and movable away from said other electrode upon cooling, and the other of said electrodes having a small area compared to that of the thermo-expansive electrode to increase the transient voltage between the electrodes at the instant of separation thereof upon cooling of said thermo-expansive electrode.

4. A gaseous electric device comprising an envelope provided with an ionizable medium therein, a pair of electrodes in said envelope, one of said electrodes being a bimetallic element adapted to emit electrons to cause a glow discharge between said electrodes thereby heating said bimetallic electrode with attendant movement thereof toward said other electrode into engagement therewith to extinguish said discharge and movable away from said other electrode upon cooling, and the other of said electrodes having an area substantially less than that of said bimetallic electrode to increase the transient voltage between said electrodes at the instant of separation thereof upon cooling of said bimetallic electrode.

5. A gaseous electric device comprising an envelope provided with an ionizable medium therein, leading-in conductors extending through said envelope, and a pair of electrodes connected to said leading-in-conductors and disposed interiorly of said envelope, one of said electrodes being a bimetallic electrode bent upon itself with its free end disposed adjacent the other of said electrodes and provided with an electron emissive material adapted to emit a copious flow of electrons to cause a glow discharge between said electrodes and heating of said bimetallic electrode with attendant deflection thereof into contact with the other of said electrodes to short-circuit the same and extinguish said discharge, and the other of said electrodes having a surface area less than one-half the area of said bimetallic electrode.

6. A gaseous electric device comprising an envelope provided with an ionizable medium therein, a pair of electrodes in said envelope, one of said electrodes being a U-shaped bimetallic element provided with an electron emissive material and having its free end disposed adjacent the other of said electrodes to cause a glow discharge between said electrodes and heating of said bimetallic electrode with attendant deflection thereof into contact with the other of said electrodes.

7. A gaseous electric relay device comprising an envelope provided with an ionizable medium therein, a pair of electrodes in said envelope, one of said electrodes being a U-shaped bimetallic element with its free end disposed adjacent the other of said electrodes and provided with an electron emissive material adapted to emit a copious flow of electrons when heated to cause a glow discharge between said electrodes and heating of said bimetallic electrode with attendant deflection thereof into contact with the other of said electrodes, and the other of said electrodes being of rod-like configuration.

8. A gaseous electric device comprising an envelope provided with an ionizable medium therein, a pair of electrodes in said envelope, one of said electrodes being a U-shaped bimetallic element provided with an electron emissive material adapted to emit a copious flow of electrons when heated, and a contact terminal carried by the free end of said bimetallic electrode adjacent the other of said electrodes and engageable therewith upon the application of a potential between said electrodes and the occurrence of an ensuing discharge with attendant heating and deflection of said bimetallic electrode.

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Disclaimer

2,228,210.—*Robert Fred Hays, Jr.*, Bloomfield, N. J. GASEOUS RELAY DEVICE. Patent dated Jan. 7, 1941. Disclaimer filed June 14, 1951, by the assignee, *Westinghouse Electric Corporation.*

Hereby enters this disclaimer to claims 1, 2, 3, 4, 5, 6, and 7 of said patent.

[*Official Gazette July 10, 1951.*]

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