Aug. 5, 1941. R. F. HAYS, JR., ET AL 2,251,278

GASEOUS ELECTRIC RELAY TUBE

Filed March 31, 1939

Fig. 1.

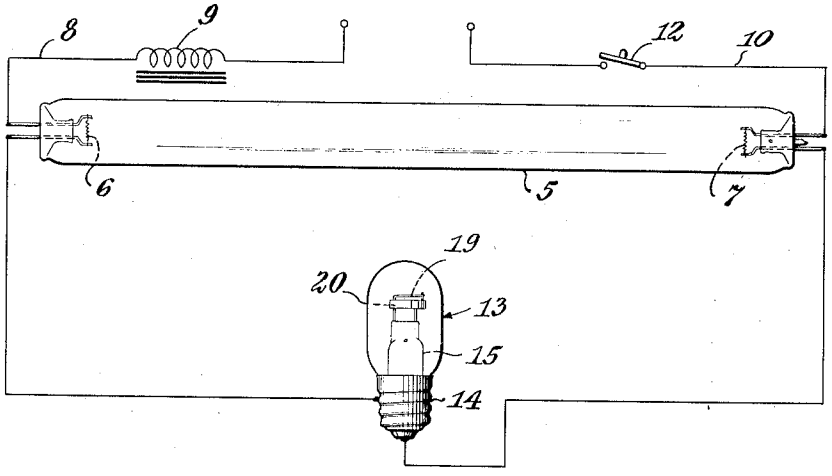


Fig. 2.

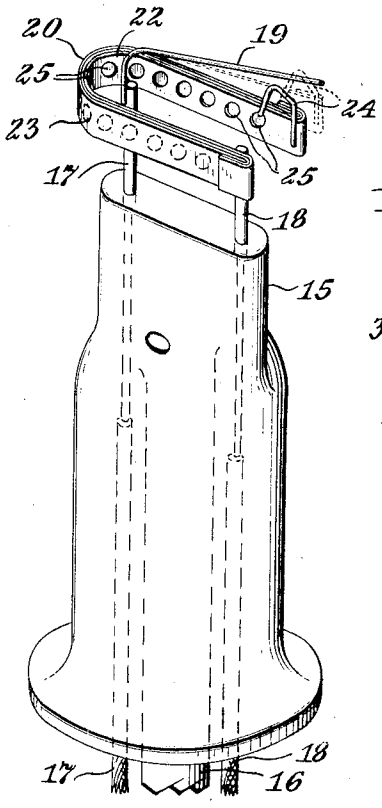


Fig. 4.

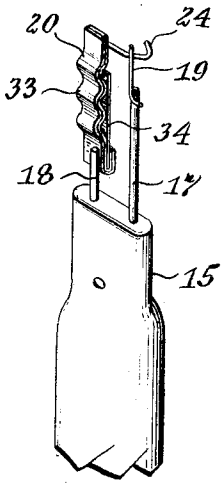
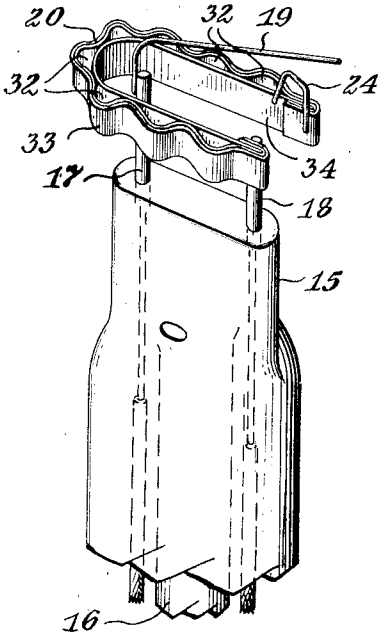


Fig. 3.



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GASEOUS ELECTRIC RELAY TUBE

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Application March 31, 1939, Serial No. 265,164

7 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 has many uses and, as shown in the co-pending applications Serial No. 252,875, filed January 26, 1939; Serial No. 258,382, filed February 25, 1939, and Serial No. 264,705, filed March 29, 1939, and assigned to the same assignee as the present invention, it finds particular utility in the starting of a gaseous discharge lamp. In lamps of the discharge type it is customary to employ electrodes of the thermionic type and to connect such electrodes in series with a suitable source of supply through the medium of suitable switching means.

It is highly desirable in a circuit for a discharge lamp that the relay device which operates to open and close the circuit not only be positive in its operation, but at the same time consume no power from the circuit which is otherwise supplied to the lamp. A relay of this type is shown and described in the above noted applications, and the present invention constitutes an improvement of such device.

During operation of the gaseous electric relay device a glow discharge is initiated, and since at least one of the electrodes is a bimetallic element, it is heated by the ensuing discharge. Upon heating of the bimetallic electrode it deflects into contact with the other electrode to short-circuit the same and extinguish the discharge. This enables the bimetallic element to rapidly cool and return to its normal position with but a momentary contact of the electrodes.

It has been found that this period of engagement of the electrodes is frequently of too short a duration since it is only during engagement of the electrodes that any appreciable current flows to the load. In instances where the load is a gaseous discharge lamp, the filamentary electrodes are not heated sufficiently to initiate a discharge in the lamp, requiring the relay device to repeat its cycle of operation until the lamp is started, after which no further current flows through the relay.

It is accordingly an object of the present invention to provide a gaseous electric relay device wherein the bimetallic electrode is sufficiently heated to provide a definite time delay action during which engagement of the electrodes occurs for a period of time sufficient to enable the load to receive a required amount of energy.

Another object of the present invention is the provision of a gaseous electric relay device having a bimetallic electrode of appreciable surface area to which is affixed a metal which retains a higher temperature than the bimetal for longer periods of time.

Another object of the present invention is the provision of a gaseous electric relay device having a bimetallic electrode of appreciable surface area provided with craters to enable the bimetallic electrode to be rapidly heated and to which is affixed an electron emissive metal for retaining heat longer than said bimetal and for transferring the heat to the latter.

A further object of the present invention is the provision of a gaseous electric relay device having a bimetallic electrode wherein the area of the bimetal is considerably greater than the electron emissive portion thereof to increase the sensitivity of the device and wherein a plurality of craters are formed to cause rapid heating of the electrode, together with obtainment of a time delay action for retaining the electrodes in engagement for a period of time sufficient to allow the flow of substantial current to the 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 a circuit for a discharge lamp employing a gaseous electric relay device constructed in accordance with the present invention.

Fig. 2 is a fragmentary view in perspective of one form which the gaseous relay device of the present invention may take:

Fig. 3 is a fragmentary view in perspective of a modification of the gaseous relay device as shown in Fig. 1, and

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

Referring now to the drawing in detail, a circuit for starting a gaseous discharge lamp is shown in Fig. 1 and illustrates one specific use for the gaseous electric relay device of the present invention. As is now common practice in the art, the discharge lamp 5 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, such as neon, argon, or the like, to facilitate starting, to which is added a few drops of mercury. 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 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 of the discharge lamp 5 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 supplied by the inductance element 9 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 maintain 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 co-pending applications. Inasmuch as the relay 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 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 which may range from approximately 10 to 100 millimeters. The device is provided with any suitable type base 14 and, as shown more clearly in Figs. 2, 3 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 portion 15 and interiorly of the envelope an electrode 19 of suitable refractory metal, such as a tungsten wire or rod, is welded to the extremity of the leading-in and supporting conductor 17 which, as shown in Figs. 2 and 3, extends substantially transversely to the longitudinal axis of the device 13. In a similar manner a U-shaped bimetallic electrode 20 of substantially greater surface area is secured to the leading-in and supporting conductor 18 which, as shown in Figs. 2 and 3 likewise extends transversely of the longitudinal axis of the device 13.

As described in the above mentioned co-pending applications, when a potential from the customary commercial source is applied to the electrodes 19 and 20, a glow discharge occurs which heats the bimetallic electrode 20 causing it to deflect into engagement with the electrode 19, thus short-circuiting the electrodes and extinguishing the discharge.

Upon extinguishment of the discharge, current is directly supplied to the load, which in the instance shown in Fig. 1 is the filamentary electrodes 6 and 7, and at the same time the bimetallic electrode 20 cools very rapidly, returning to its normal spaced position. Frequently the period of engagement of the electrodes is, as above mentioned, of too short a duration to supply sufficient energy to the load and in the case of the discharge lamp 5, it will fail to start, necessitating further operation of the relay 13 until the electrodes 6 and 7 of the lamp reach an electron emitting temperature.

In order to insure rapid heating of the bimetallic electrode and at the same time the proper time delay, the bimetallic electrode 20, as shown in Fig. 2, comprises a bimetallic strip 22 backed by an equal size and substantially equal area strip of metal 23 which gives off a copious flow of electrons. This metal strip of emissive material 23 may be secured in contact with the bimetallic strip in any suitable manner, such as by bending the ends of the bimetal over the electron emissive material, and the latter may include a metal coated with the same material as the coating for the electrodes 6 and 7, but preferably comprises magnesium.

A contact terminal 24 of refractory metal such as tungsten is welded or otherwise secured to the electrode 20 and a plurality of openings 25 are provided in the bimetal to form a series of craters which concentrates the heat of the discharge to cause rapid deflection of the bimetal. At the same time the backing of magnesium is also heated and after engagement of the electrodes simultaneously with extinguishment of the glow discharge, the heat from the magnesium strip 23, due to its large area, is transmitted to the bimetal. In addition, the time delay is controlled by the location of the craters since this governs the time required for the greater heat concentration at the craters to be conducted throughout the bimetal, and particularly to remote parts so that the portion of the bimetal which causes greatest deflection is appropriately heated. This prevents too rapid cooling of the bimetal and insures engagement of the electrodes for a period of time sufficient for the load to receive adequate energy.

Thus upon closure of the switch 12 (Fig. 1) from the customary source of commercial potential of 115 volts a glow discharge occurs in the device 13 due to emission of electrons from the strip of magnesium 23 carried by the electrode 20, when functioning as cathode, causing ionization of the gaseous medium. This discharge, as above mentioned, heats the bimetallic electrode 20, causing it to deflect, as shown by the dotted lines in Fig. 2, until the refractory metal contact terminal 25 engages the electrode 19, thus short-circuiting the electrodes and extinguishing the discharge.

Engagement of the electrodes 19 and 20 causes the circuit controlled by the relay device to receive current and in the case of the circuit illustrated in Fig. 1, the filamentary electrodes 6 and 7 are heated to an electron emitting temperature with the electrodes 19 and 20 remaining in engagement for a sufficient period of time due to transfer of heat from the magnesium strip 23. When the bimetallic electrode 20 cools and deflects to its normal spaced position, a glow discharge is again momentarily initiated as well as an arc-like discharge between the surface of the electrodes which separate last, thus enabling the production of a high transient voltage by the operation of the inductance element 9, as described in the above mentioned so-pending appli-

cation Serial No. 264,705, filed March 29, 1939, which initiates a discharge in the lamp 5. Following the discharge in the lamp 5 the current thus follows the path of least resistance through the discharge and since the voltage drop across the device 13 is higher, both the glow discharge and arc-like discharge are extinguished with the relay device consuming no energy from the circuit during operation of the lamp.

As pointed out more in detail in the co-pending application Serial No. 264,705, filed March 29, 1939, it is desirable to make the electrode 19 of much smaller surface area than that of the bimetallic electrode 20 to increase the effective resistance of the relay 13 so that current consumption during discharge is confined to a minimum. In such construction there is a tendency for the glow discharge to first start on the small electrode because of the higher electric field generated at the smaller electrode when momentarily functioning as cathode during the alternating current cycle. The provision of the craters formed by the openings 25 in Fig. 2 offsets such tendency, thus facilitating the rapidity with which the bimetallic electrode is heated.

Referring now more particularly to Fig. 3, the construction therein shown differs from that of Fig. 2 in that the craters are formed by crimping of one element instead of providing a plurality of openings as in Fig. 2, with the location of the craters again controlling the time delay as previously mentioned. Although the bimetallic element of Fig. 3 may be the same as shown in Fig. 2 without the openings 25, and the magnesium strip crimped to provide craters 32, it has been found desirable to reverse these elements and in doing so the bimetal supports the magnesium strip. Accordingly, in Fig. 3 the crimped bimetal strip 33 is bent upon itself and supports the magnesium strip 34.

This crimping thus produces controlled craters 32 for heat concentration and in addition crimping of the bimetal 33 renders the device 13 more sensitive as the sensitivity is increased approximately in proportion to the extra added length of bimetal as compared to the magnesium strip 34. Moreover, fabrication of the device is greatly facilitated, as the crimped bimetal can be so much more readily stamped out than the openings 25 of Fig. 2 provided, and the bimetal is also easier to crimp since it is not as brittle as magnesium.

The construction as shown in Fig. 4 differs from that of the preceding figures in that the electrodes 19 and 20 are disposed parallel to the longitudinal axis in lieu of transversely thereof. In addition, the bimetal 33 is bent upon itself and supports one end of the magnesium strip 34 while the other end of the latter is free with the entire electrode being supported in the manner previously described, by the leading-in conductor 18. The contact terminal 24 of refractory metal is secured to the bimetallic electrode 20 in the same manner as previously described relative to Figs. 2 and 3 in position to engage the electrode 19.

It thus becomes obvious to those skilled in the art that a gaseous electric relay device is herein provided having at least one bimetallic electrode which is very rapidly heated and deflects into contact with the other electrode for the purpose of closing an electric circuit. Moreover, the device is so constructed that a time delay action causes the electrodes to remain in engagement for a long enough period of time to allow sufficient current to be supplied to a load. In addition the relay device is exceptionally sensitive in its operation due to the provision of more surface area for the bimetal than that of the electron emissive material, which together form one of the electrodes of the device.

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

What is claimed:

1. A gaseous electric relay device comprising an envelope provided with an ionizable medium therein and a pair of electrodes, one of which is a bimetallic electrode provided with an electron emissive material adapted to emit a copious flow of electrons, said electrodes being operable to initiate a glow discharge therebetween upon the application of a suitable potential thereto to cause 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 said bimetallic electrode having spaced concentrating means extending over substantially the entire surface thereof to cause concentration of heat thereat with attendant rapid heating of said bimetallic electrode.

2. A gaseous electric relay device comprising an envelope provided with an ionizable medium therein and a pair of electrodes, one of which is a bimetallic electrode of substantial surface area provided with an electron emissive material adapted to emit a copious flow of electrons, the other of said electrodes having a surface area substantially less than the area of said bimetallic electrode, said electrodes being operable to initiate a glow discharge therebetween upon the application of a suitable potential thereto to cause 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 said bimetallic electrode having spaced concentrating means extending over substantially the entire surface thereof to cause concentration of heat thereat with attendant rapid heating of said bimetallic electrode.

3. A gaseous electric relay device comprising an envelope provided with an ionizable medium therein and a pair of electrodes, one of which is a bimetallic electrode of substantial surface area provided with an electron emissive material adapted to emit a copious flow of electrons, the other of said electrodes having a surface area substantially less than the area of said bimetallic electrode, said electrodes being operable to initiate a glow discharge therebetween upon the application of a suitable potential thereto to cause 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 said bimetallic electrode having a series of craters over the surface thereof to cause concentration of heat thereat with attendant rapid heating of said bimetallic electrode.

4. A gaseous electric relay device comprising an envelope provided with an ionizable medium therein and a pair of electrodes, one of which is a bimetallic electrode, said electrodes being operable to initiate a glow discharge therebetween upon the application of a suitable potential thereto to cause 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, said bimetallic electrode being formed of a bimetallic strip backed by a strip of electron emissive material for transferring heat to said bimetallic strip after extinguishment of said discharge to form a time delay during which said electrodes remain in engagement with each other, and said bimetallic electrode having spaced openings extending over substantially the entire surface thereof to cause concentration of heat thereat with attendant rapid heating of said bimetallic electrode.

5. A gaseous electric relay device comprising an envelope provided with an ionizable medium therein and a pair of electrodes, one of which is a bimetallic electrode of substantial surface area, the other of said electrodes having a surface area substantially less than the area of said bimetallic electrode, said electrodes being operable to initiate a glow discharge therebetween upon the application of a suitable potential thereto to cause 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, said bimetallic electrode being formed of a bimetallic strip backed by a strip of electron emissive material for transferring heat to said bimetallic strip after extinguishment of said discharge to form a time delay during which said electrodes remain in engagement with each other, and said bimetallic strip forming with said strip of electron emissive material a series of craters to cause concentration of heat thereat with attendant rapid heating of said bimetallic electrode.

6. A gaseous electric relay device comprising an envelope provided with an ionizable medium therein and a pair of electrodes, one of which is a bimetallic electrode, said electrode being operable to initiate a glow discharge therebetween upon the application of a suitable potential thereto to cause 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 said bimetallic electrode being formed of a crimped bimetallic strip backed by a strip of electron emissive material.

7. A gaseous electric relay device comprising an envelope provided with an ionizable medium therein and a pair of electrodes, one of which is a bimetallic electrode of substantial surface area, the other of said electrodes having a surface area substantially less than the area of said bimetallic electrode, said electrodes being operable to initiate a glow discharge therebetween upon the application of a suitable potential thereto to cause 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, said bimetallic electrode being formed of a crimped bimetallic strip backed by a strip of electron emissive material for transferring heat to said bimetallic strip after extinguishment of said discharge to form a time delay during which said electrodes remain in engagement with each other, and said crimped bimetallic strip being of greater length than said strip of electron emissive material to increase the sensitivity of said device and forming a series of craters at preselected locations over the surface of said bimetallic electrode for concentrating the heat thereat and cooperating with said electron emitting material in controlling the time delay action of said device by regulating the time required for the conduction of heat to remote portions of said bimetallic strip and the point of greatest deflection thereof.

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