Aug. 7, 1956 C. S. SZEGHO 2,758,240

ELECTRON-DISCHARGE DEVICES

Filed Dec. 30, 1953

FIG. 1

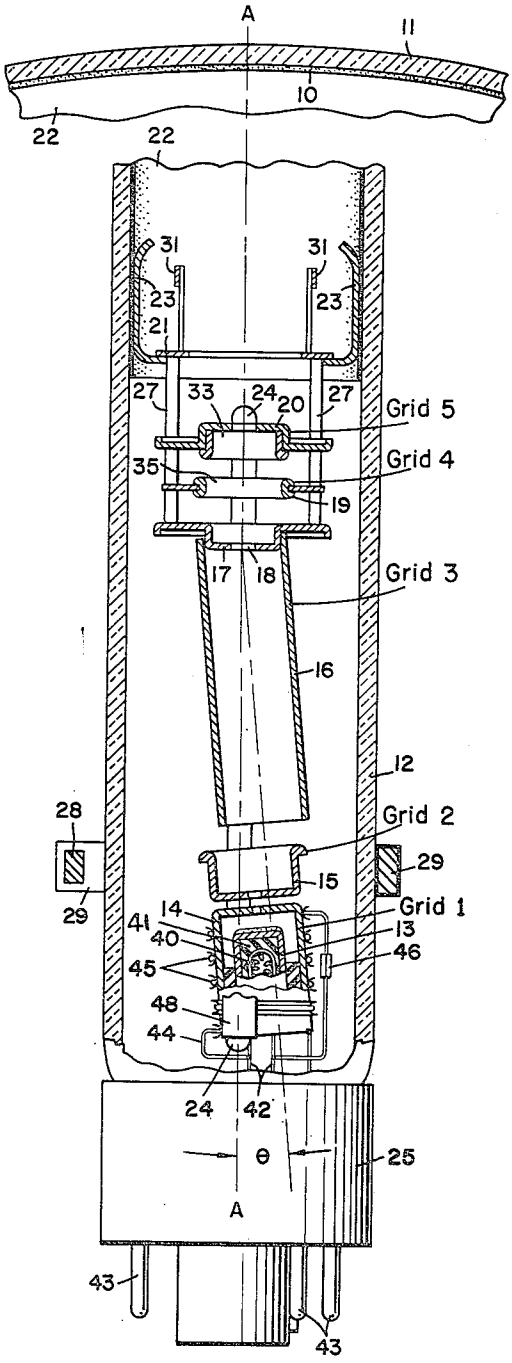


FIG. 2

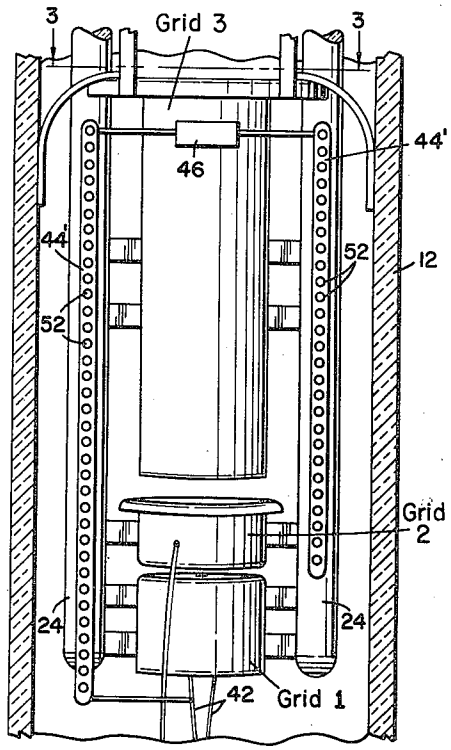
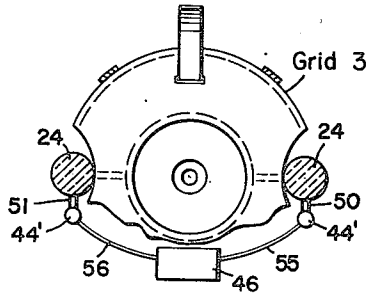


FIG. 3



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ELECTRON-DISCHARGE DEVICES

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10 Claims. (Cl. 315—3)

The invention relates to electron-discharge devices and more particularly to electron-discharge devices of the cathode-ray type suitable for use as image-reproducing devices in television receivers.

Conventional electron-discharge devices of the cathode-ray type comprise a substantially evacuated envelope enclosing a luminescent screen and an electron gun for producing and accelerating an electron beam toward the screen. The screen is normally composed of a coating of discrete phosphor particles which emit light in response to electron bombardment, and is disposed upon the viewing surface of the envelope. Suitable focussing and deflecting systems are employed to concentrate the electron beam and to deflect it in the formation of a two-dimensional scanning pattern or raster upon the screen. In the fabrication of such devices, a high degree of vacuum is produced through the use of a mechanical evacuation means; a dispersion pump is commonly used for this purpose. It is well known that the efficiency of operation and the emission life of the electron source varies with the degree of evacuation of the tube. Residual gas molecules may form positive and negative ions through bombardment by the electron beam in its passage toward the screen, and since the cathode or electron-emissive surface is normally at a negative potential with respect to the other electrodes, the positive ions are propelled toward it and reduce the emission life by bombarding and physically displacing particles of electron-emissive material.

In an effort to meet this problem, a getter material is usually introduced into the tube to absorb the gas molecules remaining after mechanical evacuation. The getter material is normally distributed within the tube by flashing with an external source of energy such as radio-frequency electromagnetic radiation. In the flashing process the getter material is heated to a temperature at which it vaporizes and is thus deposited in a thin film upon a large area of the enclosing envelope. This technique of gettering is imperfect in many instances because the one flashing may dispose of gas molecules present at the time but it does effect the continuous absorption of additional gas molecules which often times are released in the normal course of operation of the tube. In accordance with another technique, the getter is continuously energized by electric current during normal operation of the tube. Although the use of such a continuous getter results in prolonging the life of an electron-discharge tube, the maximum attainable extension of tube life is not realized because the continuous energization of the getter causes it to deteriorate at a relatively rapid rate.

It is an object of the present invention, therefore, to provide a new and improved electron-discharge device which avoids one or more of the disadvantages of prior art structures.

It is a further object of the present invention to provide an electron-discharge device in which the emission life of the electron source is extended by more effective absorption of gas molecules through the action of a getter material than has been achieved by conventional practices.

It is yet another object of the present invention to produce an electron-discharge device in which the tube life is extended by replenishing the electron-emissive source with emissive material released in the volatilization of the getter material.

In accordance with the invention, an electron-discharge device comprises a substantially evacuated envelope including an electron gun having a plurality of electrodes and including a thermionic cathode. An energizing circuit is coupled to the cathode to cause electron emission by heating the cathode. Additional energizing circuits are provided for applying predetermined operating potentials to the other tube electrodes. A thermally responsive switch is mounted within the envelope in a position exposed to heat originating at one of the electrodes. An electrical circuit is coupled in parallel with one of the energizing circuits and includes a conductive element of current-responsive getter material supported within the envelope and connected in series with the switch.

The features of the invention which are believed to be novel are set forth with particularity in the appended claims. The organization and manner of operation of the invention, together with further objects and advantages thereof, may best be understood by reference to the following description taken in conjunction with the accompanying drawing in the several figures of which like reference numerals indicate like elements and in which:

Figure 1 is a fragmentary side elevation partly in cross section and partly cut away, of an electron-discharge device constructed in accordance with the invention;

Figure 2 is a fragmentary view, similar to a portion of that of Figure 1, of an alternative embodiment of the invention; and

Figure 3 is a top view, partly in cross-section of a portion of the illustrated embodiment of Figure 2.

The image-reproducing device of Figure 1 comprises a luminescent screen 10 affixed to the glass target portion 11 of an evacuated cathode-ray tube envelope which also comprises a glass neck portion 12 enclosing an electron gun and an electrostatic focussing system. The electron gun comprises a plurality of electrodes including a cathode 13. A heater element 40, which may be of any conventional construction such as a helically wound conductor, is disposed within cathode 13 and physically maintained in place by a spacing element 41 of suitable heat conducting but electrically insulating material such as aluminum oxide. Conductive leads 42 connect heater 40 to appropriate external pins 43 in the base of the tube to constitute an energizing circuit to which an external potential source (not shown) is applied for the purpose of heating cathode 13 to an emitting temperature.

The electron gun further includes a control electrode 14, and first and second tubular accelerating electrodes 15 and 16, respectively. A diaphragm 17 having a central aperture 18 is disposed across the outlet end of second accelerating electrode 16, and aperture 18 is symmetrically centered with respect to the tube axis A—A which is perpendicular to the center of the fluorescent screen 10. Electrode 16 is laterally offset relative to electrode 15 to provide a steady transverse electrostatic-deflection field component in the region between these two electrodes, and the entire electron gun structure is tilted with respect to the tube axis A—A by an angle ϕ.

An electrostatic focussing system of the unipotential lens type is disposed between the electron gun and the screen. The focussing system comprises the outlet end of electrode 16, a lens electrode 19, and an additional electrode 20 which are all coaxially mounted with respect to the tube axis A—A. Electrodes 19 and 20 may be provided with corona rings 33 and 35. A centrally apertured conductive disc 21 is disposed in the neck portion

of the envelope between the focussing system and target portion **11**. A conductive coating **22** of colloidal graphite, such as aquadag or the like, extends from the direction of target portion **11** into the neck portion of the envelope, and conductive disc **21** is maintained at a common potential with conductive coating **22** by means of metal contact springs **23**.

For convenience, electrodes **14**, **15**, **16**, **19** and **20** may be termed "grids" and may be designated by number starting with control electrode **14** as the first grid and progressing in the direction of beam travel to electrode **20** which is the fifth grid. All five grids are supported in predetermined mutually spaced relation by means of a pair of glass pillars **24**, of which only one is shown, in a manner which will be apparent to those skilled in the art. Separate leads for grids **1**, **2** and **4** extend through the base **25** of the tube, as do the supply leads for the cathode **13** and its heater **40**. Conductive disc **21** is mechanically supported from and electrically connected to grids **3** and **5** by means of metal strips **27**. Operating potential for the conductive coating **22**, and therefore for the third and fifth grids, may be supplied by means of a conventional contact button if the envelope is of the all glass type, or directly to the metal cone if the tube is of the glass-metal variety. In other words the electrode leads, basing pins or high-voltage terminals provide energizing circuits for applying operating potentials to the electrode system of the tube.

An external permanent magnet **28**, supported in a spring clamp **29** which fits snugly around the neck of the tube and is movable both axially and rotationally, is provided to develop a magnetic field within the tube to provide separation of the negative ions from the electron beam.

The tube is evacuated, sealed and based in accordance with well known procedures and suitable getters **31** are supported from the surface of conductive disc **21** facing fluorescent screen **10** to absorb residual gases after evacuation.

The structure as thus far described is a well-known cathode-ray tube and the details of its electrode system as well as its operation in developing a beam of electrons, separating unwanted ions from the beam, and projecting the purified beam toward the luminescent screen are well understood. They are described in particular, for example, in U. S. Patent No. 2,658,160, issued November 3, 1953, in the name of Russel S. Peterman, and assigned to the same assignee as the present invention. The details of corona rings **33** and **35** and their function in the tube are described and claimed in a copending application of Constantin S. Szegho, Serial No. 229,013, filed May 31, 1951, now U. S. Patent 2,673,305, and assigned to the same assignee.

In order to extend the useful life of the tube, recognizing that conventional gettering techniques utilizing pellets **31** may not adequately protect against the possibility of occluded gases, the present invention provides an improved gettering structure. More specifically, an electrical circuit including a conductive element **44** of tantalum or the like is electrically connected in parallel with filament leads **42** and is wound externally around control grid **14**, preferably in the form of a spiral or helix. Conductive element **44** is semitubular in cross section and is so wound as to define a spiral-like U-shaped trough facing toward the inner surface of tube neck **12**. The mechanical bias resulting from the resiliency of the conductive element mechanically supports that element on grid cylinder **14**. Although element **44** may be conveniently wound in contact with the surface of electrode **14**, it may be insulated therefrom by simple spacers of electrically non-conducting material, as for example, aluminum oxide or the like. Of course, in either case the support for element **44** may be grooved to strengthen the assembly mechanically. In addition, element **44** may be wound around and supported by glass supports **24**. The trough of element **44** is filled with a current responsive getter material **45**, which preferably consists of an alloy of barium; however, other commercial products such as alloys of magnesium or calcium, may be employed.

Suitable getter materials may be composed of any of the following mixtures of barium, aluminum and magnesium or other convenient percentages of these elements: Ba 25%, Mg 55%, Al 20%; Ba 37%, Mg. 37%, Al 26%; Ba 43%, Mg 20%, Al 37. Metallic barium would be preferable to an alloy except for its instant reaction to gaseous molecules or to gaseous vapors present in the air. The use of an alloy of barium has an advantage in that in this form barium is inert, but may be energized by flashing. Another getter material that may be used is a carbonate or oxide of barium which is reduced to barium by outgassing at a temperature lower than that of the flashing temperature. In the latter case a temperature of 800 to 1100 degrees centigrade reduces the barium compound to yield about 40% barium. By flashing at a higher temperature, usually in the range of 1200 to 1300 degrees centigrade, the barium acts as a getter in the well known manner.

A normally-closed thermally responsive switch **46**, preferably of the bimetallic type, is connected in series with element **44** and is positioned adjacent to electrode **14**. Switch **46** may comprise any thermostatic structure known in the art which makes or breaks an electrical circuit in response to its attaining a predetermined temperature. Such switches are composed of two metals having different temperature coefficients affixed to one another to distort away from and open a contact upon the application of heat. Frequently, a strip of nickel and a strip of copper are employed although other combinations of dissimilar metals are equally satisfactory. It has been found that sufficient heat is generated by the cathode structure, which may attain an operating temperature in the vicinity of 800 degrees centigrade, to actuate switch **46** and the positioning of the switch is not critical so long as during the operation of the tube the elements of the switch achieve the temperature at which the switch opens. A shield **48**, which may be a small piece of sheet metal welded to electrode **14** and disposed between getter **45** and glass support **24**, prevents volatilized getter material from being deposited upon the surface of the glass support and causing a short circuit between some of the gun electrodes.

In explaining the operation of the described getter circuit, it may be assumed that the tube is incorporated into suitable apparatus; for example, it may serve as the image-reproducing device of a television receiver. To operate the tube in any such environment, energizing potentials are applied to its several electrodes. Concurrently with the application of such energizing potentials, current flow is initiated through the getter circuit since it is connected in parallel with the filament of the cathode. The flow of current through element **44** generates sufficient heat in this element to vaporize getter material **45** which in the art is referred to as "flashing the getter." The actuation of the getter causes any undesirable gas molecules present in the tube to be absorbed in the usual manner and the activation of the getter continues until such time as switch **46** of the getter circuit is opened. After a relatively short interval, the energizing potentials applied to the electrode systems of the tube raise the cathode structure in particular to an operating temperature which, as has been described, is sufficiently high to open switch **46**. At this point, current no longer flows in the getter circuit.

When the electron-discharge device is turned off, electrode **14** returns to ambient temperature, resulting in the closure of the contacts of bimetallic switch **46**. Upon reenergization of the electron-discharge device, however, another cycle of the above-described operation is begun and the getter material vaporizes further to absorb any

residual gas molecules. Since during the normal operation of the tube occluded gas molecules are liberated from many areas, particularly from fluorescent screen **10**, it is advantageous to re-energize the getter in this cyclic fashion to prolong the life of the tube.

It has been found that if the emissive coating of cathode **13** is composed of metallic barium and if the getter material is also composed of a preponderance of barium, an additional extension of the emissive life of cathode **13** may result. Apparently, the barium coating upon the surface of cathode **13** is replenished in part by molecules of the barium getter material when it is volatilized. It would appear that because of random movement the molecules of barium from the getter are deposited upon cathode **13** to replace the electron-emissive coating depleted by normal tube operation.

The full benefits of the invention are not realized if the getter material completely flashes upon the first application of current to element **44**. Protection against exhausting the getter at the first flashing may be attained by employing as conductive element **44** a tube that is substantially continuous in cross section but is so thin in wall thickness as to be porous and hence partially pervious to barium vapor. With such a construction the getter material is not completely vaporized in any one cycle of operation; instead a substantial portion is retained within the tube from one flashing to the next. Alternatively, the enclosing tube may be impervious to vapors of the getter material except for a narrow section that may be slotted, perforated or otherwise rendered pervious to the getter vapor to permit vaporization of the getter in a controlled manner and to direct the vapor over a predetermined area of tube neck **12**. Such a construction is represented in the embodiment of Figures 2 and 3, which is identical in function and structure to that of Figure 1 except that conductive element **44'** entirely encloses the getter material and further, instead of being wound externally of electrode **14**, in this embodiment it is disposed upwardly in the neck of the cathode-ray tube. In this latter arrangement, getter material **45** may be deposited over a greater area of neck **12** resulting in a more efficient absorption of residual gas molecules. In this embodiment conductive element **44'** enclosing the getter material is mechanically supported by rigid spacers **50** and **51** inserted into supports **24** and extends into the neck portion **12** of the cathode-ray tube longitudinally along these supports. Perforations **52** are disposed along the longitudinal surface of element **44'** to permit controlled vaporization of the enclosed getter. Electrical terminations are connected to one filament lead of heater element **40** and to grid **2**. The energizing current which heats element **44'** to volatilize the getter material is produced by the potential difference between grid **2** which is usually maintained at B+ and the grounded side of the filament lead to heater element **40**. Although this arrangement may be suitable for practical re-energization of the getter material in cyclic fashion, conductive element **44'** may be advantageously wound spirally about the surface of grid **3** provided it is maintained therefrom by insulating spacers (not shown). The particular configuration of the getter support structure is shown for purposes of illustration only and should not be considered a limitation upon the subject invention.

In addition, although switch **46** may be conveniently operated by heat generated in the cathode structure, it may also be operated by heat generated in other portions of the tube. A simple proportioning of the thickness of one of the metallic strips comprising the bimetallic elements permits an adjustment of the radius of curvature formed by the distortion of the armature of the switch in response to heat. In the usual case the bias necessary to make positive electrical contact may be enhanced by a mechanical spring in the manner well known in the art. As an illustration of another of the possible operating positions of switch **46**, Figure 2 shows it disposed in the

vicinity of diaphragm **17** of grid **3**. This area of the tube is heated by electron bombardment upon the surface of diaphragm **17**. Switch **46** is maintained in position by metal rods **55** and **56** mechanically and electrically connecting it to element **44'** as illustrated in Figure 3, a top view taken along line **3—3** of Figure 2.

Therefore the present invention discloses a new and improved electron-discharge device which includes a built-in provision for extending life of the cathode by momentarily actuating a getter material automatically each time the device is placed in normal use. It is through a simple structural addition that the residual gas molecules remaining within the envelope and liberated in the course of normal operation are absorbed to prolong the useful tube life. In addition, an even greater extension of tube life may be realized by employing an appropriate getter material to replenish the electron-emissive material from time to time with molecules of volatilized getter which upon deposition also become electron-emissive. Further the cyclic operation of applicant's invention prolongs the effective life of the getter beyond that usually found in the use of a continuous getter which is rapidly dissipated.

While particular embodiments of the invention have been shown and described, modifications may be made and it is intended in the appended claims to cover all such modifications as may fall within the true spirit and scope of the invention.

I claim:

1. An electron-discharge device comprising: a substantially evacuated envelope; a plurality of electrodes including a thermionic cathode supported within said envelope; an energizing circuit for heating said cathode to cause electron emission therefrom; additional energizing circuits for applying predetermined operating potentials to said electrodes; a thermally responsive switch mounted within said envelope in a position exposed to heat originating at one of said electrodes; and an electrical circuit coupled in parallel with one of said energizing circuits and including a conductive element of current-responsive getter material supported within said envelope and connected in series with said switch.

2. An electron-discharge device comprising: a substantially evacuated envelope; a plurality of electrodes including a thermionic cathode supported within said envelope; an energizing circuit for heating said cathode to cause electron emission therefrom; additional energizing circuits for applying predetermined operating potentials to said electrodes; a normally-closed thermally responsive switch mounted within said envelope in a position attaining at least a predetermined temperature in normal operation of said device and adapted to open upon attaining said predetermined temperature; and an electrical circuit coupled in parallel with one of said energizing circuits and including a conductive element of current responsive getter material supported within said envelope and connected in series with said switch.

3. An electron-discharge device comprising: a substantially evacuated envelope; a plurality of electrodes including a thermionic cathode supported within said envelope; an energizing circuit for heating said cathode to cause electron emission therefrom; a normally-closed thermally responsive switch mounted within said envelope in a position attaining at least a predetermined temperature in normal operation of said device and adapted to open upon attaining said predetermined temperature; and an electrical circuit coupled in parallel with said energizing circuit and including a conductive element of current-responsive getter material supported within said envelope and connected in series with said switch, whereby said getter material is momentarily activated each time normal operation of said electron-discharge device is initiated.

4. An electron-discharge device comprising: a substantially evacuated envelope; a plurality of electrodes including a thermionic cathode and a control grid sup-

ported within said envelope; an energizing circuit for heating said cathode to cause electron emission therefrom; additional energizing circuits for applying predetermined operating potentials to said electrodes; a thermally responsive switch mounted adjacent said control grid in a position exposed to heat emanating from said control grid; and an electrical circuit coupled in parallel with one of said energizing circuits and including a conductive element of current-responsive getter material supported within said envelope and connected in series with said switch.

5. An electron-discharge device comprising: a substantially evacuated envelope; a plurality of electrodes including a thermionic cathode and an accelerating anode supported within said envelope; a first energizing circuit for heating said cathode to cause electron emission therefrom; additional energizing circuits for applying predetermined operating potentials to said electrodes; a thermally responsive switch mounted within said envelope in a position exposed to heat originating at one of said electrodes; and an electrical circuit coupled between said accelerating anode and said first energizing circuit and including a conductive element of current-responsive getter material supported within said envelope and connected in series with said switch.

6. An electron-discharge device comprising: a substantially evacuated envelope; a plurality of electrodes including a thermionic cathode supported within said envelope; an energizing circuit for heating said cathode to cause electron emission therefrom; additional energizing circuits for applying predetermined operating potentials to said electrodes; a thermally responsive switch mounted within said envelope in a position exposed to heat originating at one of said electrodes; an electrically conductive element of semitubular cross-section partially enclosing current-responsive getter material supported within said envelope; and an electrical circuit coupled in parallel with one of said energizing circuits and including said electrically conductive element and connected in series with said switch.

7. An electron-discharge device having a longitudinal dimensional greater than its transverse dimension and comprising: a substantially evacuated envelope; a plurality of electrodes including a thermionic cathode, all maintained in fixed relationship within said envelope by a plurality of supporting elements; an energizing circuit for heating said cathode to cause electron emission therefrom; additional energizing circuits for applying predetermined operating potentials to said electrodes; a thermally responsive switch mounted within said envelope in a position exposed to heat originating at one of said electrodes; an electrically conductive element of substantially circular cross-section mechanically maintained in a predetermined position by at least one of said supporting elements along said longitudinal dimension and partially enclosing current-responsive getter material supported within said envelope; and an electrical circuit coupled in parallel with one of said energizing circuits, including said electrically conductive element and connected in series with said switch.

8. An electron-discharge device comprising: a substantially evacuated envelope; a plurality of electrodes including a thermionic cathode supported within said envelope; an energizing circuit for heating said cathode to cause electron emission therefrom; additional energizing circuits for applying predetermined operating potentials to said electrodes; a thermally responsive switch mounted within said envelope in a position exposed to heat originating at one of said electrodes; an electrically conductive element of semitubular cross-section wound spirally around one of said electrodes and partially enclosing current-responsive getter material supported within said envelope; and an electrical circuit coupled in parallel with one of said energizing circuits and including said electrically conductive element and connected in series with said switch.

9. An electron-discharge device comprising: a substantially evacuated envelope; a plurality of electrodes including a thermionic cathode and an accelerating anode supported within said envelope; an energizing circuit for heating said cathode to cause electron emission therefrom; additional energizing circuits for applying predetermined operating potentials to said electrodes; a thermally responsive switch mounted within said envelope in a position exposed to heat originating at said accelerating anode; and an electrical circuit coupled in parallel with one of said energizing circuits and including said electrically conductive element and connected in series with said switch device.

10. An electron-discharge device comprising: a substantially evacuated envelope; a plurality of electrodes including a thermionic cathode supported within said envelope and comprising an electron emissive element of barium; an energizing circuit for heating said cathode to cause electron emission therefrom; additional energizing circuits for applying predetermined operating potentials to said electrodes; a thermally responsive switch mounted within said envelope in a position exposed to heat originating at one of said electrodes; and an electrical circuit coupled in parallel with one of said energizing circuits and including a conductive element of current-responsive getter material comprising barium supported within said envelope and connected in series with said switch.

References Cited in the file of this patent

UNITED STATES PATENTS

1,739,043	Ruben	Dec. 10, 1929
1,787,300	Alexanderson	Dec. 30, 1930
2,392,969	Bickley	Jan. 15, 1946
2,575,835	Pohle	Nov. 20, 1951
2,638,559	Giacchetti	May 12, 1953
2,668,253	Taylor	Feb. 2, 1954