May 9, 1967 W. T. SMITH 3,319,115

STANDBY CIRCUIT USING A TWO FILAMENT INCANDESCENT LAMP TO MAINTAIN APPROXIMATELY THE SAME LIGHT OUTPUT

Filed Nov. 4, 1964

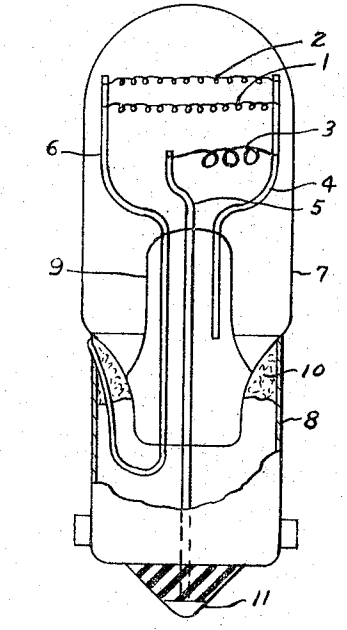


Fig-1

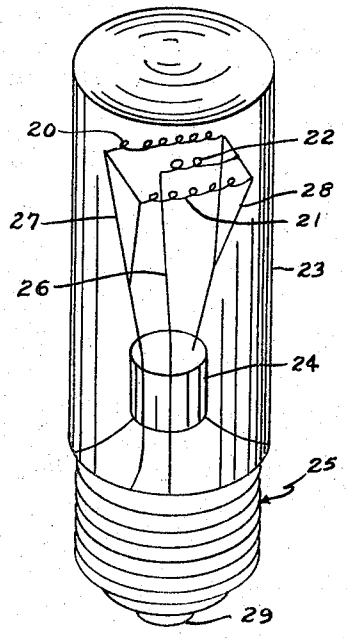


Fig-2

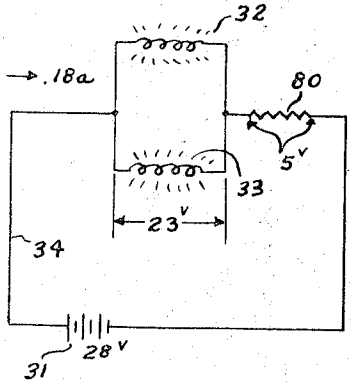


Fig-3

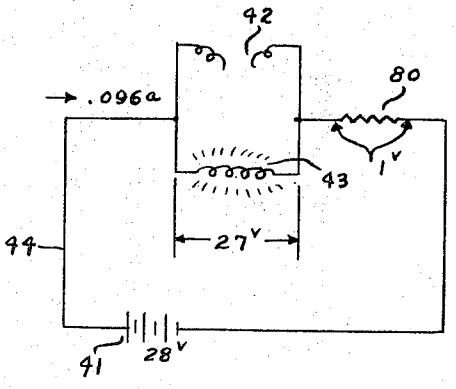


Fig-4

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United States Patent Office 3,319,115 Patented May 9, 1967

3,319,115

STANDBY CIRCUIT USING A TWO FILAMENT INCANDESCENT LAMP TO MAINTAIN APPROXIMATELY THE SAME LIGHT OUTPUT

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Filed Nov. 4, 1964, Ser. No. 409,030
3 Claims. (Cl. 315—66)

The invention described herein may be manufactured and used by or for the United States Government for governmental purposes without the payment to me of any royalty thereon.

This invention relates to an incandescent electric lamp of high reliability, and, more particularly, to an incandescant lamp having two light emitting filaments that will provide approximately the same continuing illumination after one filament has become inoperative such as through burn-out or mechanical breakage.

The life of electric illuminating lamps, also commonly referred to as light bulbs, pilot lights, indicator lights, signal lights, and the various combinations of such words, is quite unpredictable. This is particularly so if the bulb is used for blinking or intermittent service; and even more so if subjected to various amounts of mechanical shock, coupled perhaps also with a fluctuating supply voltage. The inadvisability is well understood of having an indicating light fail at a crucial time, such as when the system bearing the light is experiencing mechanical shock or vibration and the indication is necessary in order to know the corrective action to be undertaken.

Various ways have been utilized to overcome the aforementioned difficulty. The most common and most obvious is to use a system incorporating multiple incandescent lamps with two or more lamps to illuminate a common object, or perform a common indication. This method is very wasteful of space and costly due to the multiplicity of components. Furthermore, after a lamp failure the quantity of illumination is materially reduced.

It is, therefore, an object of the present invention to provide an incandescent lamp that will have long life.

Another object of the present invention is to provide an incandescent lamp that will indicate when an appreciable portion of its useful life has passed.

Another object of the present invention is to provide an electric lamp with two light emitting filaments that will maintain essentially the same amount of illumination after one filament has ceased to emit light.

Another object is to provide an electric lamp that will be interchangeable mechanically with conventional bulbs, requiring no external controls or adjustments, and yet provide greatly improved reliability.

Additional objects and features of the herein disclosed invention will become apparent to those skilled in the art after examining the following detailed description and drawings in which:

FIG. 1 is a drawing of an embodiment of the invention as it may be incorporated in a small bayonet base pilot light.

FIG. 2 is a drawing showing an arrangement of the filiments and control resistor that provides equal heat transfer from each filament to the control resistor.

FIG. 3 is a schematic drawing showing the voltage and current distribution in a specific embodiment of the invention.

FIG. 4 is a schematic drawing of the same embodiment of FIG. 3 showing the voltage and current distribution after one filament has become inoperative.

Referring to FIG. 1, a bayonet base bulb of the pilot lamp type is shown incorporating the advantages of the present invention. Base **8** is of the conventional single tip contact bayonet type. Electrical connections are made

to an external source of electrical power through the insulated tip and the shell of the base. Glass envelope **7** is cemented to the base **8** with conventional adhesive **10**. Light emitting filaments **1** and **2** are essentially identical, conventional, electric lamp filaments. They are connected in parallel by the electric current carrying supports **6** and **4**. The temperature sensitive current control resistive element **3** is series connected with the parallel filaments through the common conductive support **4**. Conductor **5** connects the control element to the external tip contact **11**. The supporting and conducting stiff wires **4**, **5** and **6** are held in place by the molded or fused glass stem member **9**, which is also an atmospheric seal maintaining the atmospheric integrity of light transmitting glass envelope **7**. The sealed interior is evacuated or filled with an inert gas to prolong the life of the filaments by preventing their oxidation, as is done in conventional illuminating lamps having but one filament.

FIG. 2 shows an embodiment of the invention in which the current control element **22** is parallel, adjacent and equally spaced apart from the filaments **20** and **21**. Due to the equal amount of heat received by control resistor **22** from the filaments **20** and **21** this arrangement is generally to be slightly preferred to the vertical plane arrangement of FIG. 1. As in FIG. 1, the light transmitting envelope **23** seals the inert atmosphere contained within the envelope from the outside atmosphere. The conductive support members **26**, **27** and **28** perform the same function as the similar members of FIG. 1 even though in this embodiment they are of slightly different shape. Solid glass stem member **24** is fused about the conductors and maintains them in their proper position. The screw type base has a conductive outer member **25** electrically connected to supporting and conducting member **27**. Insulated center tip contact **29** is electrically connected with member **26**.

The light transmitting glass envelope **7** of FIG. 1 and **23** of FIG. 2 may be either clear or frosted. However, if frosted, it is desirable that the frosting be not so dense as to prevent the observance of the lack of light source from one of the filaments. Thus, if a lamp is replaced soon after one filament burns out, essentially uninterrupted illumination may be obtained by utilizing lamps made according to the teaching of this invention. The physical spacings one from another of the filaments and the control element are not critical; however, they should be separated such that no physical interference occurs when subjected to shock and vibration and preferably arranged such that a broken filament will not drape down over the other filament or the control resistor. Extremely close spacing of the filaments is to be avoided due to the probability of the arc formed at the time of breaking of one filament damaging the remaining filament. From the foregoing, it is seen that it would be desirable to operate the lamp of FIG. 1 with its major axis and the filaments in a horizontal plane. The lamp of FIG. 2 is ideally suited for operation in a vertical manner. If conventional filament supporting wires are used at the approximate midpoint of each filament **20** and **21**, the bulb may be used in any position and the probability of the shorting of remaining members by a broken filament member would be very low. The current control resistive element may be covered with or encased in an insulative coating to further preclude the possibility of malfunction caused by the loose end of a broken filament making an electrical contact with the control element. Likewise, to further preclude the occurrence of an electrical malfunction, the supporting members for the filaments and the control resistor may be coated with an insulating material.

In order to understand the operation and theory of the current control resistor, it is first desirable to examine

the following table, which presents some of the parameters of a typical tungsten filament when operated at normal and at reduced voltages as a percentage of the value at normal rated voltage.

Condition	Percentage of Rated Voltage	Percentage of Rated Resistance	Percentage of Rated Lumens	Percentage of Rated Watts	Percentage of Rated Amperes
1	100	100	100	100	100
2	97	99	90	95	98
3	95	98	80	92	97
4	90	95	60	85	95
5	85	92½	50	78	92
6	80	90	40	70	88

The values shown are approximate and they are dependent upon the size of the lamp (i.e. the designed watt input or the designed candle power output), the designed voltage input, the designed efficiency, and the nominal designed life of the lamp. Examine condition 6. The voltage has been reduced to 80 percent of the rated value. The resistance of the filament has gone down ten percent due to its lower temperature, but the light output in lumens has dropped to 40 percent of that value of light given off at rated voltage. From closer examination of the table, it can be seen that a relatively small change in voltage will produce a relatively large change in the amount of illumination output. It is to be observed in condition 6 that electrical power input to the filament has only decreased to 70 percent of the normal value. Thus, the combined radiated energy (heat and light) has not decreased as much as the light output has decreased indicating that the emitted heat-to-light ratio has gone up.

A very specific example and embodiment of this invention will be set forth as an example. Due to the multiple interactions of the parameters of this lamp, it is advisable that the final determination of the control resistor in a specific embodiment be determined empirically.

A standard 28 volt aircraft indicator light has the following characteristics for normal (100 percent) light output:

Volts	28
Amperes	.1
Watts input	2.8
Ohms resistance	280

If the voltage input to the lamp is reduced to the value of 27 volts, then to 23 volts, the following conditions exist:

Volts	Amperes	Watts Input	Ohms Resistance	Percentage of Normal Illumination
27	.096	2.66	277	90
23	.09	2.07	256	45

It is now apparent that with two standard 28 volt .1 ampere filaments operating at 23 volts, approximately the same amount of illumination is obtained as from one filament operating at 27 volts; i.e., approximately 90 percent of the full amount illumination from one filament. The power in watts dissipated in radiant heat and light energy for the one filament at 27 volts is 2.66 watts; for the two filaments at 23 volts it is 4.14 watts.

Referirng to FIGS. 3 and 4, the example under discussion in diagrammed. In FIG. 3, control resistor **80** produces a 5 volt drop when both filaments **32** and **33** are operating with .18 amperes of current flowing from 28 volt source or energy **31**. This places 23 volts across the parallel filaments **32** and **33** and 90 percent of the illumination of one filament at full rated power is obtained. Neglecting any slight change in the resistance of one filament due to the heat received from the other, the value of control resistor should be approximately 28 ohms.

FIG. 4 shows the redistribution of the voltages and currents after filament **42** fails. With 27 volts across the single filament, approximately 90 percent of normal illumination is obtained the same as shown in FIG. 3. Here, control resistor **80** has changed sufficiently to produce only one volt of votlage drop. That is, it should now have approximately 10.4 ohms resistance.

Two methods of obtaining the desired resistance variation in current control resistor **80** have been found to be feasible. The first is by using a current sensitive resistor that is effectively out of the heat field of the light and heat emitting filaments (or filament), that has a resistance of 28 ohms when .18 amperes of current is flowing through it causing it to dissipate .9 watts of energy, and a resistance change to approximately 10.4 ohms with .096 ampere flowing and a resulting dissipation of approximately .096 watt. Thus, a resistor that has a positive resistance current characteristic of approximately 1.5 to 1.0 would give the desired control. Practically, in most instances, a linear control having a positive resistance-current characteristic ratio from 1 to 1, to 2 to 1 is suitable.

The second method of obtaining the same control characteristics is by using a current control resistor that is essentially temperature sensitive instead of current sensitive. It has been shown that with both filaments operating at approximately 23 volts, approximately 4.14 watts of energy, mainly in the form of heat, is radiated. Then when only one filament remains in operation approximately 2,66 watts should be dissipated and radiated, mainly as heat. Thus, by controlling the area and surface condition of the control resistor, the amount of heat received and reradiated by it can be controlled with the resulting control of its temperature. Assuming, for illustration, the temperature sensitive current control resistor is sufficiently higher in temperature when the two filaments are radiating 4.14 watts that when one filament is radiating 2.66 watts to produce a resistance change of approximately 1.5 to 1. The current control resistance thus provides for a greater current flow through a single filament, after the failure at the other filament, than the amount of current flow previously provided through each filament when both were operating. The desired control is then obtained; in this instance, without any inherent resistance change in the control resistor caused by the current flowing through it.

In practice, both of these methods may be used simultaneously and cooperatively since they both tend to reinforce each other. That is, the resistance is a positive direct function of both the current flowing through it causing internal heating and its environmental temperature. Positive temperature coefficient control resistor **80** may be fabricated from conventional resistance wire such as alloys of nickel and chromium or it may be fabricated from tungsten similarly to another filament. A semiconductor material of the thermistor class that has a positive temperature coefficient may also be used as the current control resistor.

In the illustrative embodiment shown in FIGS. 3 and 4, the metallic current control resistor **80** has a cold resistance of approximately 10 ohms. When both filaments are active, its resistance due to its elevated temperature is approximately 28 ohms. With only the one filament active its temperature is considerably lower and its resistance is approximately 10.5 ohms.

Generally, the degree of control of the illumination is not extremely critical and it is only required that the illumination stay approximately the same after one filament has failed.

Other modifications and changes in the number and arrangement of the components of the incandescent electric lamp set forth herein may be made by those skilled in the art without departing from the nature of this invention, within the scope of the appended claims.

I claim:

1. The improvement in an incandescent electric lamp, heated to incandescence by a flow of electric current, having a light transmitting enclosure with exterior supporting and electrical contacting means affixed on the exterior of said lamp, the said improvement comprising: two similar filaments for radiating light and heat energy; support means for supporting said filaments in substantially parallel physical relationship within said enclosure; means electrically connecting said filaments in electrical parallel relationship; electrical resistive means responsive to the said heat energy having a resistive characteristic approximately proportionate to its temperature for increasing the current flowing in one of the said two filaments after failure of the other; means for positioning the said resistive means within the said enclosure in adjacent, parallel, equally spaced apart, heat receiving relationship to the said filaments; means connecting the said electrical resistive means and the parallel connected filaments in series; and electrical connecting means connecting the said series connected

parallel filaments and resistive means to the said electrical contacting means.

2. The improvement of claim **1** wherein the said electrical resistive means is tungsten wire.

3. The improvement of claim **1** wherein the said electrical resistive means is resistance wire of an alloy comprising nickel and chromium.

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