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Applicant : **HIBASS INDUSTRIES LIMITED**
Unit 3, Northamptonshire,
Enterprise Park,
Boughton Green Road
Northampton NN2 7AH (GB)

Applicant : **Goad, Christopher F., Sr.**
7005 Monument Avenue
Richmond, Virginia VA 23226 (US)

Inventor : **Goad, Christopher F., Sr.**
7005 Monument Avenue
Richmond, Virginia, VA 23226 (US)

Representative : **Dawson, Elizabeth Ann et al**
A.A. THORNTON & CO.
Northumberland House
303-306 High Holborn
London WC1V 7LE (GB)

High efficiency incandescent lamp.

An incandescent lamp has a bidirectional switch 24 in series with a filament 17 of the lamp, the switch being operable to conduct current during a part of each of the positive and negative half cycles of the sinusoidal a.c. voltage applied to the filament. The envelope 10 of the lamp is filled with a mixture of krypton and nitrogen in order to further extend the life of the lamp without reducing its brightness.

This invention relates to incandescent lamps of the type commonly used in lighting fixtures of houses and other buildings. More particularly, it relates to improvements in such lamps for providing extended lamp life and greater operating efficiency.

The conventional lamp used for home lighting is commonly known as the A-line gas filled lamp and has a wattage between about 40 and 150 watts. The construction parameters for such lamps are substantially uniform among different manufacturers, the lamps being designed for operation from a nominal voltage of 240 volts, 50 cycle a.c. with standard power ratings of all wattages to 150 watts. Such lamps are rated for average operating life, and for standard lamps a rated life of 1,000 hours or less is typical. For convenience, these may be termed short-life lamps as compared with known lamps having extended life ranging upward from 1,000 hours to several years. The primary cause of lamp failure is cohesive failure of the tungsten filament, said filament failure generally being caused by evaporation of tungsten, said evaporation being a temperature-dependent phenomenon.

One way of increasing the life of a given lamp is by operating the tungsten filament at a reduced temperature, as may be achieved by changing the design of the filament. A typical 100 watt lamp has a coiled tungsten wire filament of 0.635 mm in diameter and an uncoiled length of 577 mm. It has an operating temperature of 2577 degrees C. and an average operating life of 750 hours. The life of this lamp could be increased while retaining the same wattage rating by changing the filament configuration so that it operates at a lower temperature; however, the efficiency in terms of lumens per watt would be decreased.

Another way of extending the operating life of an incandescent lamp is to reduce the effective voltage across the filament. This has been done in the prior art by connecting a rectifying diode in series with the filament so that only alternate half cycles of the supply voltage are applied to the filament. This has the effect of reducing the time average value of voltage to about 0.7 of that produced by the unrectified supply voltage. Consequently, the filament is operated at a substantially lower temperature and also at a lower efficiency in terms of lumens per watt. One difficulty encountered in the use of a diode for extending lamp life is that in use with a 50 cycle current, there is a noticeable flickering effect.

It would be advantageous to provide an incandescent lamp having an extended operating life which avoided the problems noted above.

The presently preferred embodiment of the invention comprises an incandescent lamp comprising a glass envelope, a filament supported within the envelope, electrical contacts on the outside of the envelope for applying a sinusoidal a.c. voltage to the filament, and a bidirectional switch in series between

one of the contacts and the filament, the switch being operable to conduct current during a part of each of the positive and negative half cycles of the sinusoidal waveform.

The use of the switching device has the effect of narrowing both the positive and negative portions of the a.c. cycle during which the filament conducts current. However, because the switching device conducts during both half cycles, the "off" time is less than that obtained with a diode and hence no visible flickering occurs.

Preferably, the envelope is filled with a gas mixture containing 75-85% of heavy gas, preferably krypton and the remainder nitrogen. The krypton has been found to increase the brightness of the filament.

The invention is applicable to all normally available incandescent light bulbs e.g. A-line lamps comprising a bulb portion and a neck portion. However, the invention is also applicable to flood lights and high wattage lamps.

The switch used in the present invention is preferably a voltage triggered switch. A switch of this type may be triggered to conduct when the positive or negative voltage across its terminals exceeds a certain threshold. Preferably, once triggered, the switch continues to conduct for the remainder of the instant half cycle. Thus, the switch operates to "chop" the front of every half cycle, and hence reduce the average voltage applied to the filament.

With an operating voltage of 240 volts a.c., the switch preferably conducts when a voltage greater than 180 volts is applied. This enables the average current flowing in the filament to be reduced by at least 25% of the current which would be present without the bidirectional switch. In fact the current can be reduced to between 50% and 75% whilst still achieving the advantages of longer life and no visible flicker.

One suitable voltage triggered switch for use in the invention is a SIDAC, which will be described in more detail below.

The preferred form of lamp according to the invention includes a sleeve, usually metal, surrounding a portion of the glass envelope. The sleeve is often received in a socket in the lamp supply fitting. The switch may advantageously be located within the sleeve.

Embodiments of the invention will now be described by way of example only and with reference to the accompanying drawings in which:

FIGURE 1 is a longitudinal cross-sectional view of a first incandescent lamp according to the invention;

FIGURE 2 is a graph showing the operating characteristics of the bilateral switch used in the lamp of Figure 1; and

FIGURE 3 is a longitudinal cross-sectional view of a second incandescent lamp according to the invention.

Referring firstly to Figure 1, there is shown an embodiment of incandescent lamp according to the invention of the so-called A-line type which is commonly used for home lighting. The lamp comprises a glass envelope 10 including a bulb portion 11 and a neck portion 12. The envelope is completed by the conventional stem press glass mount, referred to herein as the stem 13, the flare 14 of which joins the neck portion 12. The lamp includes a pair of lead-in wires 15 and 16 which extend through stem 13. A coiled tungsten filament 17 is within the envelope 10 supported by the extremities of the lead-in wires. The filament is of such wire size and configuration that the lamp operates at its rated wattage with a filament operating temperature less than about 2250 degrees C. At this temperature, the lamp has an extended operating life with good efficiency in terms of lumens per watt.

The lamp is provided with a conventional screw base or a double pin base 18 attached to the neck portion of the envelope. The base comprises a threaded metal cup 19 and an electrical insulator plug 20 that encapsulates and thereby anchors the lead-in wire 15, which may be considered a centre wire. The exterior face 21 of plug 20 is flat and is oriented perpendicularly to the cylindrical axis of the lamp at a location below cup 19. Lead in wire 15 extends through the plug 20 to central termination 22. The base is adapted to be received in a conventional lamp or double pin socket having a centred contact spring and through which a supply voltage, normally 240 volts, 50 cycle, is applied across centre wire 15 and cup 19. Lead-in wire 16 is connected directly to the cup. The portion of the wire 16 within the cup is preferably insulated with a length of sleeving 16a.

The lamp is filled with a gaseous mixture comprising 75%-85% krypton and the balance nitrogen. It has been found that, at less than a 75% krypton concentration, there is a significant loss of lumens of light per watt of energy consumed. At krypton levels above 85%, undesired arcing of the filament to the glass enclosure occurs.

A silicon bidirectional voltage triggered switch 24 is installed in the lamp in series with the filament 17. In the embodiment shown in Figure 1, the switch is positioned in the threaded sleeve 19 in the space between the plug 20 and the glass envelope 10, in series with the lead-in wire 15. It could alternatively be in series with wire 16.

The operation of the switch is as follows: Upon application of a voltage exceeding a certain break-over voltage, the switch switches on and conducts current until the current is interrupted or drops below the minimum holding current of the device.

The bilateral switch is available in a compact two terminal form known as a SIDAC, from Teccor Corporation, of Texas, USA. Figure 2(a) shows a typical sine waveform and Figure 2(b) shows the output waveform

from the SIDAC in response to an input sine waveform. Points X and Y on the voltage scale indicate the breakover voltage. It should be clear from Figure 2 that the SIDAC can reduce the current applied to the filament by about 25% as opposed to the 50% achieved by a diode which achieves half wave rectification. In contrast to a diode, the bilateral switch conducts in both directions.

With the input sinewave voltage varying between +120 and -120 volts, the switch may suitably conduct at +90 and -90 volts.

Use of a bidirectional switch such as a SIDAC in series with a standard incandescent lamp will achieve a significant increase in the length of the life of the lamp. Also, since the filament is conducting for a larger portion of the cycle, there is no visible flicker at 50 cycles per second, as there would be with a conventional diode. However, using a SIDAC or diode the lamp is also correspondingly dimmer.

It has already been found that the use of krypton in the glass envelope can increase the life of the bulb. This is thought to be because krypton, being a heavy gas, tends to hinder evaporation of tungsten from the filament. Thus, using a SIDAC as well as krypton in the glass envelope, the life of a filament can be extended without any loss of brightness, which is an additional effect of the gas.

Of course, the overall life of the lamp can be further increased by using a so-called "long-life" filament which is made from thicker wire and designed to withstand higher voltages.

Figure 3 shows an alternative embodiment of the invention which is similar to the embodiment of Figure 1 except that the lamp has a so-called "bayonet" fitting. Like parts in Figures 1 and 3 are indicated by like reference numerals. The lamp of Figure 3 has a base 28 comprising a metal cup 29 from which two pins 30 extend at diametrically opposite locations. In use, the pins are received in corresponding slots in the light fitting. The lead-in wires are terminated at contacts 31, 32 which protrude from the base plug 20 and engage corresponding contacts on the fitting in use. The SIDAC 20 can be installed in series with either of the lead-in wires 15 or 16.

Provided the SIDAC is electrically in series with the filament, it may even be possible to locate it elsewhere on the lamp, such as on the outside of the metal sleeve.

Claims

1. An incandescent lamp comprising a glass envelope 10, a filament 11 supported within the envelope, and electrical contacts 15, 16 for applying a sinusoidal a.c. voltage to the filament characterised in that a bidirectional switch 24 is connected in series with the filament 11, the switch being op-

erable to conduct current during a part of each of the positive and negative half cycles of the sinusoidal a.c. voltage.

2. A lamp according to claim 1 wherein the envelope 10 is filled with a mixture of nitrogen and a heavy gas. 5
3. A lamp according to claim 2 wherein the heavy gas is krypton. 10
4. A lamp according to claim 3 wherein there is between 75%-85% krypton.
5. A lamp according to any one of the preceding claims wherein the contacts 15,16 comprise wires extending from a cup 19 for the envelope 10 to the filament. 15
6. A lamp according to claim 5 wherein at least one of the wires is provided with an insulating sleeve 16a. 20

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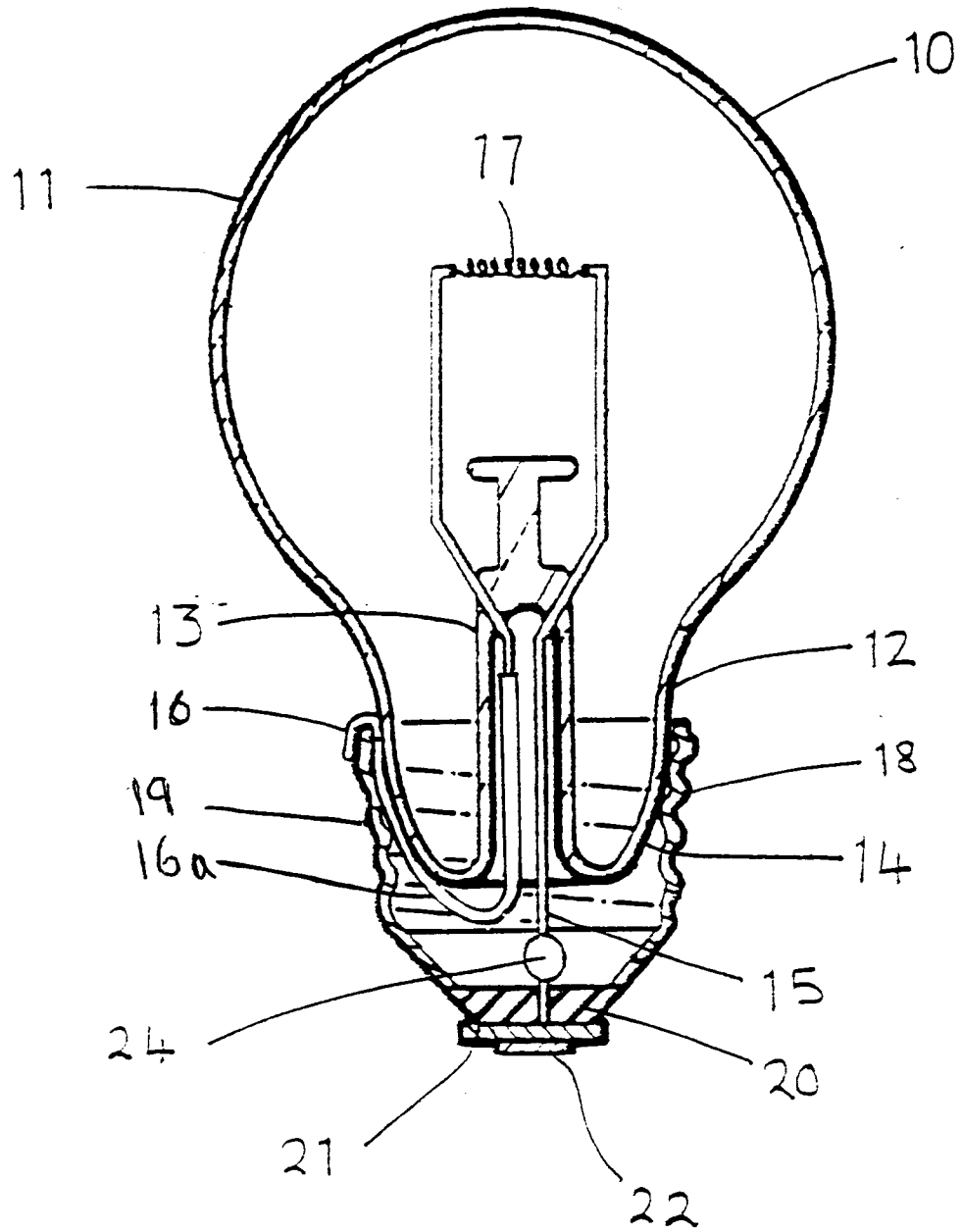


FIGURE 1.

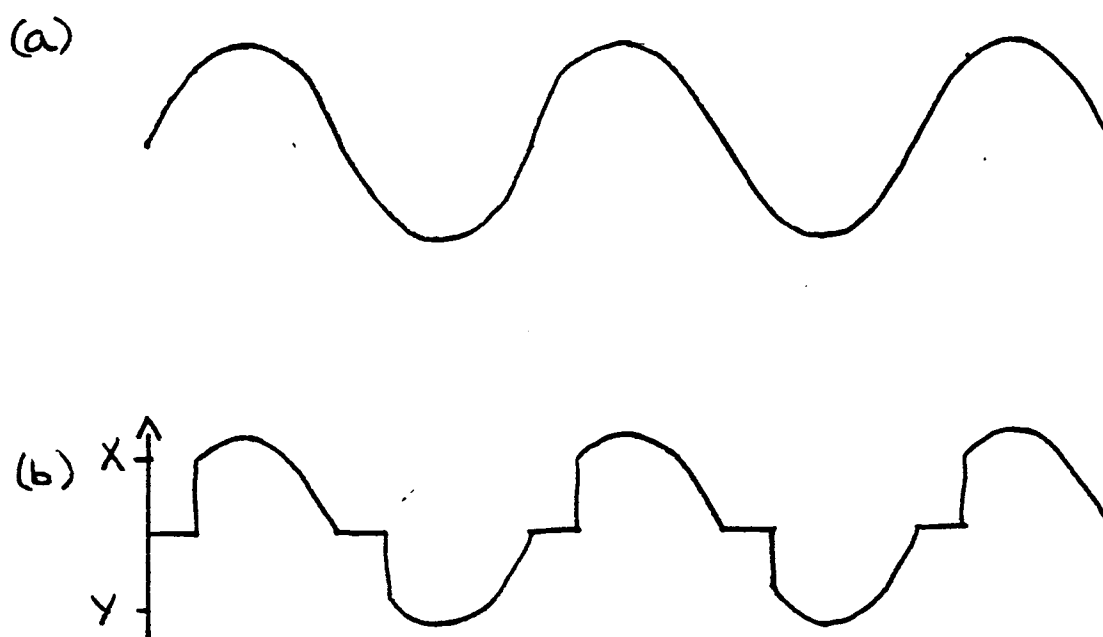


FIGURE 2

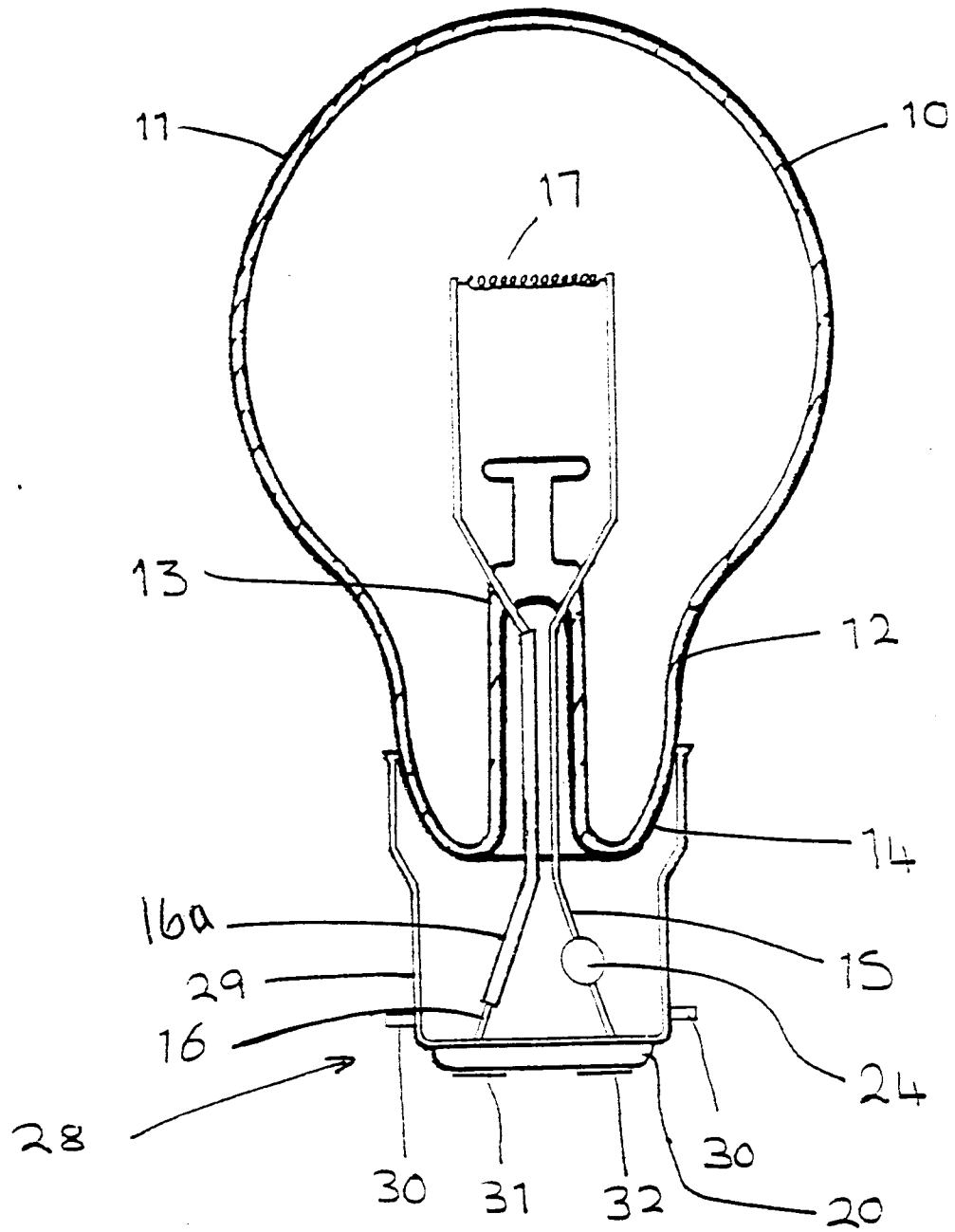


FIGURE 3