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HIGH-INTENSITY PHOTOFLASH LAMP

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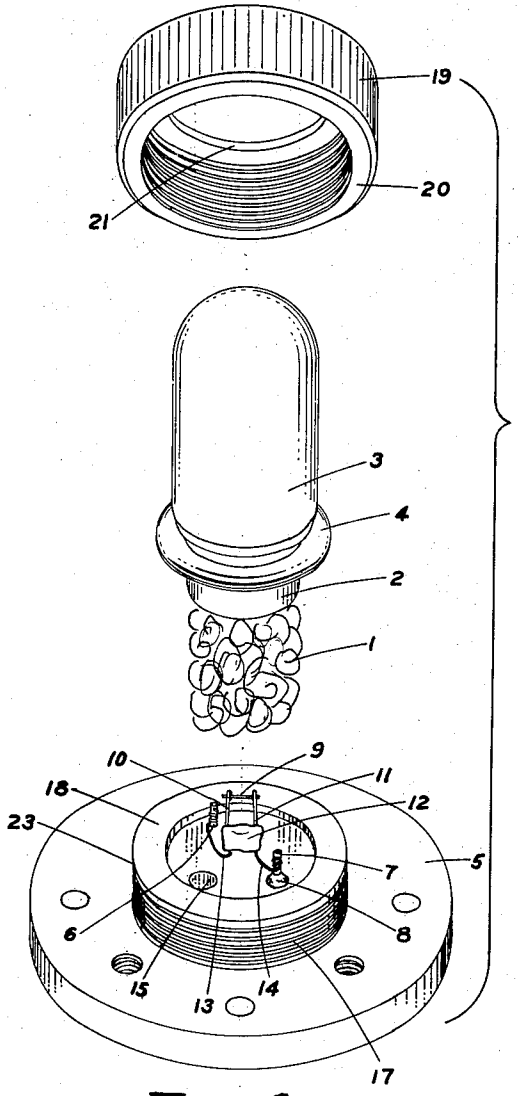


Fig. 1

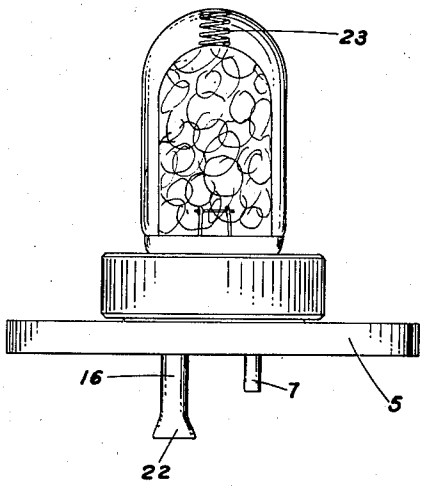


Fig. 2

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HIGH-INTENSITY PHOTOFLASH LAMP

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7 Claims. (Cl. 67—31)

This invention relates to photoflash lamps, and particularly to such lamps in which a flash of light is produced by the combustion of metallic filaments, such as shreds or wires, in a vessel filled with a combustion-supporting gas such as oxygen.

Flashbulbs are ordinary filled with oxygen at a pressure below atmospheric, for example, at a pressure of about 50 centimeters of mercury absolute, but we have found that a tremendously greater quantity of luminous energy can be produced by the use of pressures above atmospheric, and preferably far above atmospheric, for example, 125 pounds per square inch gauge pressure. In describing the invention, we shall specify absolute pressures in centimeters and gauge pressures in pounds per square inch, for convenience.

We have discovered that at pressures above 75 pounds per square inch, the reaction proceeds so rapidly that the cross-sectional area of the metallic filaments can be made 2½ to 5 times as great as that used in present commercial flash lamps. For example, a cross-sectional area of 2×10^{-6} square inches is very effective, as compared with the 0.04 to 0.08×10^{-6} square inches used in present commercial photoflash lamps. The filaments are generally of aluminum or aluminum alloys, but other metals can be used.

We have further discovered that if the quantity of aluminum shreds or wires is increased approximately stoichiometrically with the weight of oxygen present, the light output will increase approximately linearly with pressure up to about 100 pounds per square inch. Further increases of pressure give progressively smaller increments in light output. The reason for such a saturation of output may be self-absorption by combustibles and combustion end products, and decomposition of oxides to sub-oxides or to their elements. Since the oxygen and aluminum contents are increased approximately stoichiometrically to insure as complete a combustion as possible, the saturation light output can also be expressed approximately in terms of the amount of aluminum present or of the aluminum density in terms of the volume of the enclosing envelope. For example, saturation occurs with an aluminum charge density of about 17 milligrams per cc. of envelope volume.

Because of possible non-uniformities in the filling, the best values of light output will ordinarily be obtained when the metallic charges are somewhat different from stoichiometric. For a given weight of oxygen, an excess of about 5% to 10% by weight of aluminum above stoichiometric will yield maximum light output. For a given weight of aluminum, an amount of 5% to 30% by weight of oxygen above stoichiometric will give maximum light output.

The pressure and thermal and mechanical impact shocks developed during the reaction between the high-pressure oxygen and the aluminum are so great that ordinary glass envelopes are susceptible to breakage on flashing. The usual lacquer coatings used on the bulbs of lower pressure flashlamps are ineffective to prevent shattering at the higher pressures of the present invention. At pressure above about 20 pounds per square inch, an inside lacquer coating was found to increase the explosion hazard, probably because the lacquer took part in the reaction on flashing. However, we have discovered that a double envelope, for example one glass envelope enclosed within another glass envelope, is very effective in reducing shattering. The kind of glass used was found to be important, the low-expansion glasses being best; the preferred combination was a Vycor inner envelope with an outer envelope of either Vycor or Pyrex glass. Vycor is a silicate glass very similar to quartz, and quartz can, of course, be used instead where cost is not a consideration. Vycor is a glass having about 96% silica content, a small amount of boron oxide, and only traces of other oxides, as defined on page 616 of the "Handbook of Material Trade Names," 1953 edition, Zimmerman and Lavine, Industrial Research Service, Dover, N. H.; quartz, of course, is substantially pure silica. Pyrex is a borosilicate glass as defined in the same "Handbook."

A single envelope of lime glass can be used up to pressures of about 20 pounds per square inch, and of Pyrex or borosilicate glass up to 50 pounds per square inch with a single envelope and 85 with a double envelope whereas the use of a Vycor internal envelope permitted the use of pressures up to nearly 160 pounds per square inch. The pressure values given are for a metallic charge weight at or near the stoichiometric values for complete combustion.

Various other objects, features and advantages of the invention will be apparent from the following specification in which:

Figure 1 is a view of the various parts of an embodiment of the invention; and

Figure 2 is a view of the assembled device.

In Figure 1, a mass 1 of loosely-packed aluminum shreds is shown just below the tubular glass bulb 2, the latter being shown as partly extending out of an enclosing outer tubular bulb 3, each bulb being open at its bottom, with a metal flange 4 sealed or otherwise firmly affixed to the circumference of the open end of the outer bulb 3.

Below the mass 1 of combustible shreds is shown a brass disc 5, having an upwardly-projecting, externally-threaded cylindrical center portion 17, from which two contact pins 6, 7 extend upwardly, the pin 7 being sealed through an insulating glass bead 8 in order to be insulated from the metal of brass disc 5. The other pin 6 may be in direct contact with disc 5 on portion 17, as shown.

A tungsten igniter filament 9 is supported by the two "lead-in" wires 10, 11, sealed through a glass bead 12 for support, with additional wires 13, 14 being connected respectively, to each of said wires 10, 11 and extending out of said glass bead 12. The wires 13, 14 are wound around, and preferably welded to, the contact pins 6, 7.

Through the central portion 17 of disc 5 there is an opening 15 to which an exhaust tube 16, as shown in Fig. 2 is attached by welding or in some other manner such as to provide a hermetic seal.

In an assembled device, the flange 4 of bulb 3 rests on the annular rubber gasket 18 on top of the central portion 17 of disc 5. The knurled nut 19, the latter being an internally threaded hollow cylinder 20, having its bottom and open and its top end partially closed by a flange 21, fits over the flange 4 and the raised center portion 17, securing the outer envelope 3 to the disc 5, which acts as a closure member for it.

The device is assembled by filling the inner envelope 2 with the mass of aluminum shreds 1 and placing said envelope on the projecting portion 17 of disc 5 inside

the opening in the gasket **18**, in which it fits loosely without being secured. The shreds **1** will be in contact with or near the filament **9**, which, together with the tips of the support wires **10**, **11** are coated with the usual zirconium paste used in flashlamp igniters. The outer bulb is secured in place by placing its flange **4** over gasket **18** on the top of central portion **17** and then screwing the nut **19** over the outside of the externally threaded central portion **17**. The threads on the outside of the latter and on the inside of nut **19** are, of course, designed to cooperate with each other to secure the nut **19** to the central portion **17**.

The assembled unit is shown in Figure 2, the exhaust tube **16** being shown as flattened together in a closed fish tail end **22**, which is welded to form a hermetic seal. In some applications, the exhaust tube **16** may not be sealed off but may be connected directly to an evacuating and filling line, with a shut-off valve in it to disconnect said line while the bulb is being flashed.

The pin **7** extends downward below the disc **5**. The other pin **6** is connected electrically to disc **4** and hence need not project downward, for electrical connection can be made directly to the latter disc.

In the example given above, the inner bulb was of Vycor, 25 mm. in diameter and 2" in length, with a wall thickness of 1/16 inch. The outer envelope was Pyrex, 2½ inches long and of 1¼ inches in diameter, with a wall thickness of 0.04 inch. The flange was made of Kovar metal, sealed to the Pyrex glass. Other metals capable of being sealed to borosilicate glass can be used. Kovar is a glass-sealing alloy of 20% nickel, 17% cobalt, 0.2% manganese, and the balance iron, according to the "Handbook of Trade Names" previously mentioned.

If desired, a Kovar disc can be used instead of the brass disc **5**, and can be sealed to and across the open end of the bulb **3** of Pyrex thus making a simpler unit than the one described. The pin **7** would then be sealed through a glass bead in the Kovar disc, and the wire **13** welded to the disc.

The internal Vycor bulb is contained within, but not attached to the outer Pyrex bulb and is not sealed to the Kovar disc. The volume of the Vycor bulb can be about 17 cc., and with a filling of oxygen at 125 pounds per square inch can give a light output of about 60,000 lumen-seconds during the flash.

A coil spring **23** can be used between the top of envelope **2** and the top of outer envelope **3** to prevent wobbling of the inner bulb in the outer one. If the gas pressure is low enough, the inner bulb **2** can be omitted. A cross-sectional area of about 2×10^{-6} square inches was found best for the metallic filaments.

Various filter coatings can be used on the bulb to restrict the emitted radiation to particular portions of the spectrum, for example to the ultra violet or the infra-red. Accordingly, the word "light" is used herein to include ultra-violet or infra-red radiation, in cases where the lamp is designed to emit radiation of either or both of those types.

The exhaust tube **16**, hermetically sealed to the exhaust opening **15** in disc **5** prior to the sealing-off at the fishtail **22**, extends to a connection to an exhausting and gas-filling system for the device. After the device receives its filling of gas, the exhaust tube **16** is flattened together, welded, and cut off at the middle of the flattened portion, forming the fish-tail **22**. Such sealing methods are known in the art, and exhausting and filling methods are also known.

Although the bulbs **2**, **3** shown are of the tubular type with one end rounded off to a hemispherical shape, bulbs of other types, for example spherical or pear-shaped can be used.

Where the words "above," "below," "top," "bottom," and the like are used in the foregoing description, they merely refer to the positions in which the devices are shown in the drawing.

What we claim is:

1. A photoflash lamp comprising a sealed enclosing outer light-transmitting bulb, an inner unsealed light-transmitting bulb of low co-efficient of expansion, said inner bulb being in communication only with said outer bulb and being sealed by said outer bulb from the atmosphere outside said outer bulb, a filling of combustible material held loosely therein, and a filling of oxygen at a pressure above atmospheric within both bulbs.

2. A photoflash lamp comprising an enclosing outer sealed, light-transmitting bulb of low coefficient of expansion, an inner, unsealed light-transmitting bulb of low co-efficient of expansion, said inner bulb being in communication only with said outer bulb and being sealed by said outer bulb from the atmosphere outside said outer bulb, a filling of combustible material held loosely therein, and a filling of oxygen at a pressure above atmospheric within both bulbs.

3. A photoflash lamp comprising an enclosing outer bulb of light-transmitting material, said bulb being open at one end, a metal closure member hermetically fixed to said bulb at said open end, a smaller bulb within said first-mentioned bulb and also having an open end, a filling of combustible filaments held loosely within said smaller bulb, igniting means for said filaments within said smaller bulb, a spring acting between said bulbs to force said smaller bulb against said metal closure member, the smaller bulb being otherwise free, and a filling of combustion-supporting gas in both bulbs.

4. A photoflash lamp comprising an enclosing light-transmitting bulb, a filling of combustible metal filaments therein, and a filling of combustion-supporting gas therein at a pressure above atmospheric, the quantity of combustible metal being from about 5% to about 10% in excess of the normal stoichiometric proportion for combustion with the quantity of combustion-supporting gas present.

5. A photoflash lamp comprising an enclosing light-transmitting bulb, a filling of combustible metal filaments therein, and a filling of combustion-supporting gas therein at a pressure above atmospheric, the quantity of combustion-supporting gas present being from about 5% to about 30% in excess of the normal stoichiometric proportion for combustion with the quantity of metal filaments present.

6. A photoflash lamp comprising an enclosing light-transmitting bulb, a filling of combustible aluminum filaments therein, and a filling of oxygen therein at a pressure above atmospheric, the quantity of aluminum being from about 5% to about 10% in excess of the normal stoichoimetric proportion for combustion with the quantity of oxygen present.

7. A photoflash lamp comprising an enclosing light-transmitting bulb, a filling of combustible aluminum filaments therein, and a filling of oxygen therein at a pressure above atmospheric, the quantity of oxygen present being from about 5% to about 30% in excess of the normal stoichiometric proportion for combustion with the quantity of aluminum present.

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