Oct. 30, 1956 R. H. ATKINSON ET AL 2,768,517

FOIL-FILLED PHOTOFLASH LAMP AND IGNITER THEREFOR

Filed Sept. 1, 1954

Fig. 1.

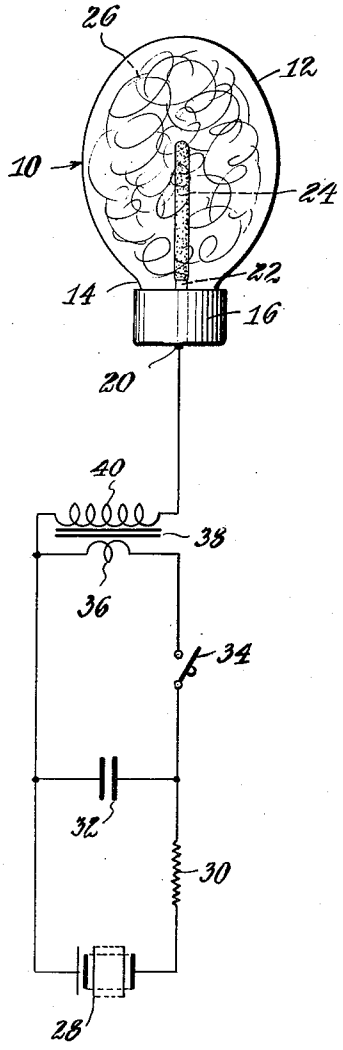


Fig. 2.

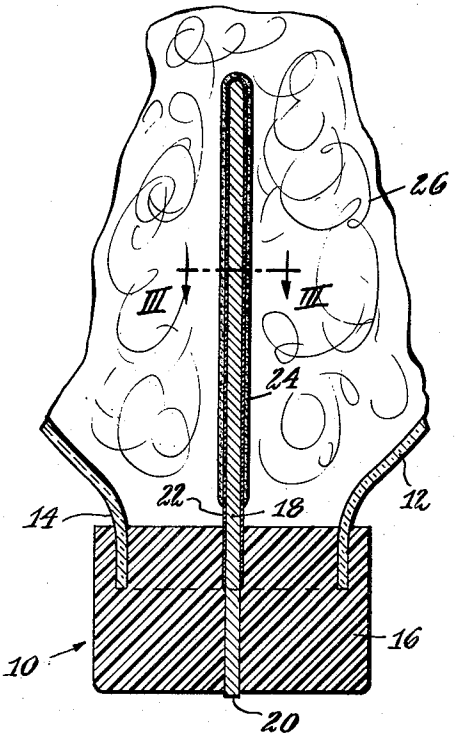
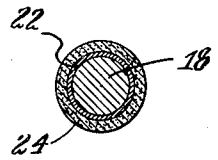


Fig. 3.



INVENTORS
R. H. ATKINSON and
N. C. BEESE
BY
ATTORNEY

United States Patent Office 2,768,517
Patented Oct. 30, 1956

2,768,517

FOIL-FILLED PHOTOFLASH LAMP AND IGNITER THEREFOR

Russell H. Atkinson, North Arlington, and Norman C. Beese, Verona, N. J., assignors to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application September 1, 1954, Serial No. 453,639

4 Claims. (Cl. 67—31)

This invention relates to foil-filled photoflash lamps and, more particularly, to an improved igniter for such lamps.

Heretofore, foil-filled photoflash lamps have been ignited or flashed by passing a current through a fine tungsten filament which is thus heated to incandescence. This filament is mounted on two relatively heavy lead wires which are coated with a primer material at a junction of the filament and the lead wires. The heat from the incandescent filament initiates a highly exothermic chemical reaction at the primer, and hot primer particles are sprayed about the inside of the lamp which causes the finely shredded aluminum foil flash material to ignite. The rapid liberation of energy when the foil reacts with oxygen contained within the photoflash lamp envelope produces the well-known flash. The main difficulties encountered in the manufacture and operation of such a lamp are:

a. Mounting the fine tungsten filament wire is a painstaking and relatively costly operation.

b. A rapid filament temperature rise is required to ignite the primer and this will not occur if the flash gun batteries are low.

c. Base contact between the photoflash lamp and the flash gun must be good, so that excessive IR drops are not introduced. In line with this, the lamp socket contacts must be clean and the solder button on the lamp base must make firm contact with the corresponding socket lead or the lamp may fail to fire.

There is disclosed in co-pending application of Clair M. Rively, Ser. No. 358,415, filed May 29, 1953, entitled Manufacture of Photoflash Lamps and Operating Apparatus Therefor, and owned by the present assignee, a method of firing foil-filled photoflash lamps by means of a spark discharge. In this arrangement, the igniter consists of a metallic lead inserted in a glass or plastic tube with a primer applied to the upper end thereof. The metallic lead is so spaced in relation to the primer as to allow a spark discharge to occur between the upper tip of the lead and the lower side of the primer. This discharge occurs by charging the metallic lead to about 20,000 volts while the primer, which is in contact with the foil of the lamp, is at ground potential. Such an arrangement eliminates the base contact problem and also the filament and, since the discharge of a condenser is the source of the electrical energy, the battery problem is somewhat alleviated, since a battery which has a relatively high internal resistance will still charge the condenser. The main problems arising from this arrangement are the positioning of the center metallic lead and the proper setting of the gap between the lead and the primer. If the gap is too large no discharge will occur since the applied potential will not break down the gap between the primer and the lead. If the lead makes contact with the primer, no spark discharge will be set up since a low resistance path from the high voltage lead to ground will exist.

It is the general object of this invention to avoid the foregoing and other difficulties of and objections to prior art practices by the provision of an improved primer material-lead arrangement whereby positive primer firing is insured.

It is a further object to provide an improved primer material-lead arrangement whereby a constant gap between the primer and the high voltage lead is readily obtained and is insured.

It is another object to provide a more positive and faster primer while utilizing less primer material.

It is yet another object to avoid foil to high voltage lead contacts, which may keep the lamp from firing.

The aforesaid objects of the invention, and other objects which will become apparent as the description proceeds, are achieved by providing a thin even coating of primer on a metallic lead, which lead preferably has a thin coating of its own oxide, which oxide is of relatively high dielectric strength. This oxide coated lead insures against direct contact between the primer and metallic portion of lead and also insures that the breakdown voltage of the material between the lead and the primer will not be sufficiently large as to prevent a spark discharge being initiated.

For a better understanding of the invention, reference should be had to the accompanying drawing wherein:

Fig. 1 is an elevational view of a lamp constructed according to this invention and diagrammatically illustrating a circuit for igniting such a lamp;

Fig. 2 is a fragmentary, expanded, axial, sectional view of the base and lead portion of the lamp as shown in Fig. 3.

Fig. 3 is a cross-sectional view of the lead, taken on the line III—III in Fig. 2 in the direction of the arrows.

With specific reference to the form of the invention illustrated in the drawing, the numeral **10** in Fig. 1 indicates generally a photoflash lamp comprising an envelope or bulb **12** of radiation transmitting, transparent or translucent material such as glass, the edge of the bulb neck **14** being embedded in a block of plastic **16** which forms a base for the lamp. A lead **18** projects through this base so that the outer end thereof forms a contact electrode **20** by means of which an igniting potential may be introduced across the lamp. The entire portion of the lead **18** which extends into the envelope carries a thin coating **22** of dielectric material over its surface and there is coated over this dielectric a thin coating of primer **24**, see Figs. 2 and 3.

The envelope **12**, as is customary, contains a combustible material **26** such as finely shredded aluminum and/or magnesium in an atmosphere of oxygen or other combustion-supporting gas such as suitable oxides of nitrogen.

As a specific example, the high voltage lead **18** may extend 1" within the bulb and have a diameter of 25 mils. 35 mg. of finely shredded aluminum foil may be placed within the bulb in an oxygen atmosphere at a pressure of 600 mm. The plastic base **16** may consist of a plastic material known under the trademark "Vinnapas," manufactured by Dr. Alexander Wacker, Gesellschaft für Electrochemische Industrie, G. m. b. H., 22 Prinzregentenstrasse, Munich, Germany. This is 45% polyvinyl acetate, 25% powdered talc and 30% microcrystalline wax. Other available plastic materials which have melting points lower than that of the bulb and low enough to permit softening prior to ignition of the primer, when fabricating the lamp, may be employed, as by melting and casting to shape.

The wiring diagram of Fig. 1 indicates how the lamp as illustrated may be fired. In this diagram the reference character **28** represents a source of power, which may be a 22½ volt hearing aid dry cell battery. Connected to the battery is a resistor **30**, of preferably about 10,000 ohms and a condenser **32**, of preferably about 50 microfarads capacity, said condenser being across the battery terminals and in series with the resistor **30**.

The condenser terminals are in turn connected through a switch 34 to the primary winding 36 of a step-up transformer 38. The transformer secondary winding 40 has one terminal connected to a terminal of the primary winding 36 and other terminal connected to the contact electrode 20 of the lamp 10. With such an arrangement the condenser is slowly charged through the resistor 30 and is always in condition for delivering a surge of electrical energy to the primary winding 36 on closing the switch 34.

The ratio between the turns of the transformer primary and secondary windings is desirably such that a potential of at least 10,000 volts, and preferably 20,000 volts, is delivered to the contact electrode 20 of the lamp 10 on closing the switch 34 to thereby produce a spark discharge between the lead 18 and the aluminum coil 26, thereby producing sufficient heat to ignite the primer material 24, which in turn causes the combustible aluminum foil to ignite and react with the combustion supporting atmosphere within the envelope to produce a flash of light.

The lead 18 on which the dielectric and the primer are coated is preferably of a metal whose oxide has a relatively high dielectric strength, and which metal may be oxidized by a simple and easily controlled process. It has been found that an aluminum lead is very satisfactory in such an application.

Where an aluminum lead is utilized, the surface of the lead may be oxidized by an anodizing process in which a length of aluminum wire is made the anode and an inert electrode is made the cathode. The electrolyte may be about 0.1 molar sulphuric acid. A current of 2 to 3 amps. at 30 volts is passed for about 15 seconds, after which the wire is withdrawn, washed with hot water and air dried. The process as described will produce an oxide coating of about 1 mil thickness, which is the preferred thickness for such a coating, although the oxide dielectric coating may vary between about 0.5 mil and 5 mils thickness. Below 0.5 mil thickness, the coating tends to become irregular so that the coated primer may contact the aluminum base metal of the lead. Above 5 mils thickness the aluminum oxide tends to chip off thus creating low resistance paths to ground which eliminate the spark discharge 34.

The breakdown voltage for the dielectric coating should not exceed about 1000 volts where the applied potential is 20,000 volts if firing of the lamp is to be reproducible. It should be understood that under ideal conditions the breakdown strength for the dielectric might be as high as 95% of the voltage which is available to create the spark, but under such conditions a reproducible spark cannot be guaranteed. At the other extreme the breakdown strength for the dielectric should be not less than the dielectric strength of air and the minimum breakdown strength for the dielectric as used in this application should be at least 100 volts. It should be understood that these dielectric breakdown strength limitations are given only for a practical working embodiment and can be exceeded in either extreme under ideal conditions, which conditions, however, are not readily reproducible on a production basis.

The oxide coating on the lead desirably extends down to or slightly into the plastic base 16 in order that the aluminum foil cannot contact directly the metal of the lead so as to create a low resistance path to the foil and thus short circuit the high resistance path from the lead, through the dielectric and the primer to the foil.

The primer 24 may consist of any material which is readily combustible and will serve to ignite the aluminum foil. It has been found that zirconium powder and an oxidizer is satisfactory in such an application and a mixture of 90% zirconium and 10% potassium perchlorate is preferred. In such an application as the instant one, 3 to 8 milligrams of the preferred primer are distributed over the dielectric in a thin, even film, and as a specific example 5 mg. may be used. This primer may be applied by suspending the zirconium powder and potassium perchlorate mixture in a solvent such as amyl acetate and a binder, such as 2% by volume of nitrocellulose. The dielectric coated leads are dipped into this suspended primer-solvent solution and the solvent volatilized. Other suitable primers are magnesium plus an oxidizer or nitrostarch plus aluminum and an oxidizer, for example.

After the base and the lead are prepared the bulb may be sealed to the base, exhausted and gas-filled by an apparatus as disclosed in Fig. 13 of the heretoforementioned copending Rively application.

In firing the lamps of this invention, a high voltage is applied to the contact electrode 20 and a spark discharge is set up between the high voltage lead 18 and the aluminum foil, which foil is in contact with the coated primer in at least several places. The aluminum foil is at ground potential because of its capacitive coupling with the flash gun reflector.

Normally where dielectrics are employed their purpose is to insure against a breakdown and to insure that a spark discharge is not set up. In the instant application, however, the dielectric is so applied as to insure that a spark discharge will be set up and that the dielectric will break down. Aluminum oxide is particularly adapted as a dielectric in the instant application, for microscopic examination of a 1 mil coating of aluminum oxide reveals that there exists a plurality of crevices or rifts in the aluminum oxide, which crevices parallel the length dimension of the wire electrode. These crevices are about 1 micron in width and occur on an average of about one every 50 microns. When the primer material is coated onto the anodized aluminum lead the surface tension of the primer is sufficient that these crevices or rifts in the aluminum oxide coating will not be filled, but will be bridged by the primer. Thus, there exists through the aluminum oxide coating a series of air gaps which are particularly adapted to facilitate the setting up of a spark discharge through the dielectric.

The primer material when applied in a very thin coating is replete with pores therethrough and microscopic examination of such a primer reveals in the order of 1,000 pores per sq. millimeter. When the switch 34 is closed, a very high voltage is applied between the metallic lead and the aluminum foil which contacts the primer. This sets up a spark discharge between the high voltage lead and the contacting portions of the aluminum foil, which spark discharge follows the path of the crevices of rifts through the dielectric, through the pores of the coated primer and thence to the contacting aluminum foil. Were the primer in direct contact with the metallic portions of the high volage lead, no spark discharge would be set up since the resistance of the primer is relatively low and the energy would be dissipated by leaking to ground without igniting the primer.

While aluminum oxide on an aluminum base metal is preferred and is excellent in such an application as the instant one, other base metals may be oxidized and be very satisfactory. For example, the high voltage lead and dielectric may be fabricated of nickel and nickel oxide, tantalum and tantalum oxide and titanium and titanium oxide, to mention a few. Alternatively, a dielectric other than an oxide of the base metal may be coated onto the high voltage lead, providing of course that such a dielectric has a relatively low breakdown strength to facilitate the setting up of the spark discharge. For example, graphite may be embedded in polystyrene or methyl methacrylate and coated onto the high voltage lead.

Also, the aforementioned rifts in the dielectric oxide coating are not necessary, provided the dielectric will break down under an applied potential of at least 100 volts and not exceeding 1000 volts, as heretofore noted. Of course, if the total applied potential is other than the specified 10,000 to 20,000 volts, the permissible break-

down voltage for the dielectric coating may vary, and the permissible dielectric breakdown voltage in such cases may readily be determined by one skilled in the art.

It will be recognized that the objects of the invention have been achieved by providing a foil-filled photoflash lamp wherein positive primer firing is insured, and wherein unwanted low resistance paths between the foil and the high voltage lead are eliminated.

While in accordance with the patent statutes one best known embodiment of the invention has been illustrated and described in detail, it is to be particularly understood that the invention is not limited thereto or thereby.

We claim:

1. A photoflash lamp comprising a radiation-transmitting bulb with a neck, a block of plastic forming a lamp base in which the edge of the bulb neck is embedded, a conducting lead projecting from the outer surface of said base, through said base and within said bulb, a thin coating of dielectric formed on that surface of said lead which extends within said bulb, a coating of primer material on said dielectric, a shredded combustible material in said bulb, part of which is contacting said primer, and a combustion supporting atmosphere contained within said bulb.

2. A photoflash lamp comprising a radiation-transmitting bulb with a neck, a block of plastic forming a lamp base in which the edge of the bulb neck is embedded, a conducting lead projecting from the outer surface of said base, through said base and within said bulb, a thin coating of low voltage breakdown dielectric formed on that surface of said lead which extends within said bulb, a coating of primer material on said dielectric, a shredded combustible material in said bulb, part of which is contacting said primer, and a combustion supporting atmosphere contained within said bulb.

3. A photoflash lamp comprising a radiation-transmitting bulb with a neck, a block of plastic forming a lamp base in which the edge of the bulb neck is embedded, a conducting lead projecting from the outer surface of said base, through said base and within said bulb, a thin coating of dielectric formed on that surface of said lead which extends within said bulb, said dielectric having a plurality of minute voids to facilitate its breaking down under applied voltage to form a spark discharge, a coating of porous primer material on said dielectric, a shredded combustible material in said bulb, part of which is contacting said primer, and a combustion supporting atmosphere contained within said bulb.

4. A photoflash lamp comprising a radiation-transmitting bulb with a neck, a block of plastic forming a lamp base in which the edge of the bulb neck is embedded, a conducting aluminum lead projecting from the outer surface of said base, through said base and within said bulb, a thin coating of aluminum oxide dielectric formed on that surface of said lead which extends within said bulb, a coating of porous primer material on said dielectric, a shredded combustible material in said bulb, part of which is contacting said primer, and a combustion supporting atmosphere contained within said bulb.

References Cited in the file of this patent

UNITED STATES PATENTS

2,071,369	Williams	Feb. 23, 1937
2,263,179	Lockwood	Nov. 18, 1941