Jan. 19, 1971 KOICHI TAKAHASHI ET AL 3,556,699

DISCHARGE IGNITION TYPE PHOTOFLASH LAMP

Filed Jan. 28, 1969 2 Sheets-Sheet 1

FIG. 1

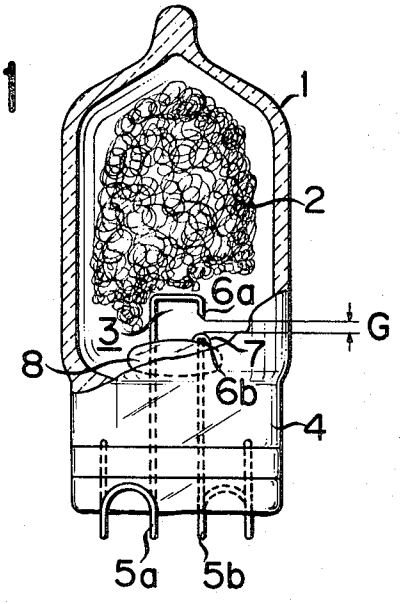
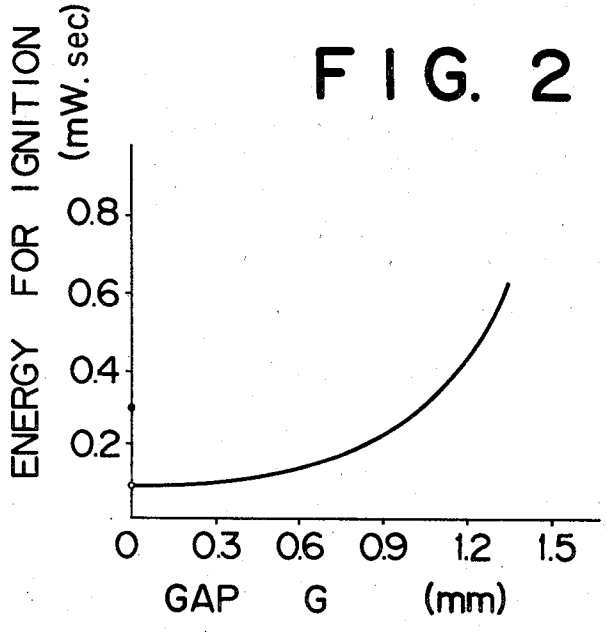


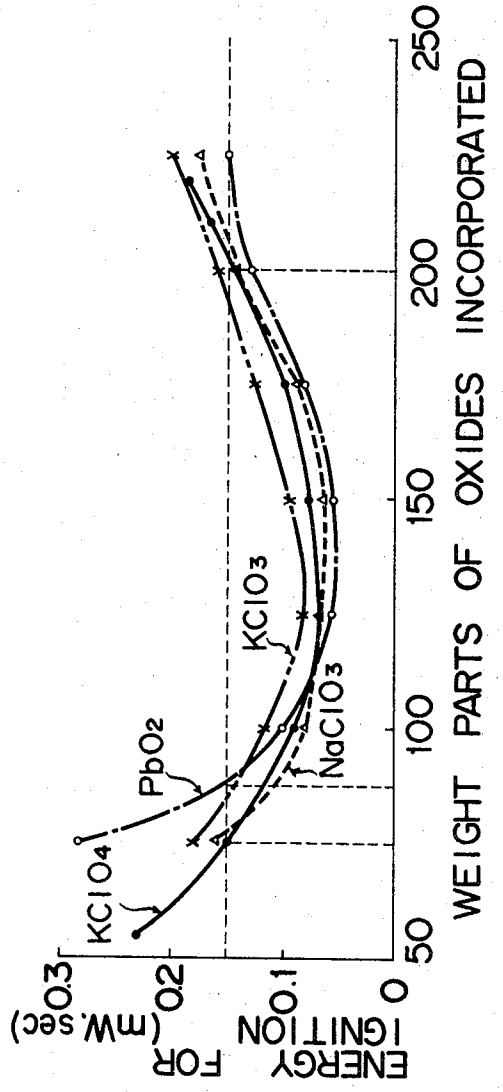
FIG. 2



DISCHARGE IGNITION TYPE PHOTOFLASH LAMP

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FIG. 3



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DISCHARGE IGNITION TYPE PHOTOFLASH LAMP

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Int. Cl. F21k 5/02
U.S. Cl. 431—95 7 Claims

ABSTRACT OF THE DISCLOSURE

A photoflash lamp of the discharge ignition type is provided with a pair of discharge electrodes, at least one of which is covered at its inner end with a primer material of high electrical resistance. Between the electrodes is formed a gap ranging from 0.05 to 0.8 mm., which is filled with a combustion-supporting gas. A high voltage pulse is impressed upon the electrodes to dielectrically break-down the combustion-supporting gas as well as the primer, thereby to ignite said primer.

The present invention relates to a photoflash lamp and more particularly to a filamentless photoflash lamp wherein the primer material is ignited by discharge.

Hithertofore it has been known some filamentless photoflash lamps of this type comprise a sealed envelope, and a combustible material, combustion-supporting atmosphere, primer material and a pair of spaced electrodes sealed therein. The primer material is ignited by discharge and its explosive combustion causes the combustible material to be ignited.

According to one prior art photoflash lamp of discharge ignition type, at least one of two leads was coated with a porous insulating material. Both leads were bridged by a primer material. For operation of the prior art photoflash lamp, there was impressed a pulse of more than 10 kv. across the leads. This impression caused spark discharges to be produced across the porous insulating material between the lead coated with said material and the primer material to ignite the latter. With this prior art photoflash lamp, it was difficult fully to coat the lead with an insulating material, and the resultant occurrence of discharges across the leads due to impression of the high voltage pulse prevented the primer from being reliably ignited.

With another prior art photoflash lamp of discharge ignition type, at least one of the leads was coated with an insulating material. With at least a portion of said insulating material used as a primer, the combustible material formed an electrically conducting path between primer coated on the aforementioned one of the leads and the other lead. To operate this prior art photoflash lamp, there was supplied across the leads a power surge of 200 to 500 volts to ignite the primer. In this prior art photoflash lamp as in the above-mentioned lamp, it was difficult fully to coat the lead with an insulating material, and the primer-coated lead tended to be shorted with the other lead, failing to cause the primer to be reliably ignited.

Still another prior art photoflash lamp of discharge ignition type allowed the leads to be directly bridged by a primer so as to eliminate the insulating coating of the

leads as in the preceding prior arts. And across the lead there was supplied an impulse of several hundred volts to ignite the primer. In this prior art photoflash lamp, the leads were often short-circuited with the resultant failure to ignite the primer unfailingly.

As mentioned above, any of the prior art photoflash lamps displayed the uncertain ignition of the primer, resulting in the extremely low reliability of flashing. Even to date, therefore, the photoflash lamp of discharge ignition type has not yet been widely used.

It is accordingly the object of the present invention to provide a photoflash lamp of discharge ignition type capable of being reliably ignited.

According to the present invention, at least one of a pair of spaced electrodes has its end coated with an electrically insulating primer material. The gap between the primer material and the other electrode which is filled with a combustion-supporting atmosphere is limited in width to 0.05 to 0.8 mm. thereby to reduce the energy required for ignition of the primer and elevate the reliability of flashing. Further, according to the present invention, the composition of the primer material is improved so as to assure the substantial reduction of said required energy.

The discharge ignition type photoflash lamp according to the present invention comprises a sealed radiation-transmitting envelope, a combustible material and a combustion-supporting gas sealed in said envelope, a pair of spaced leads which are partly extended outwardly of said envelope and whose ends within said envelope are opposed to constitute a pair of electrodes, a primer coated on at least one of said electrodes, and a gap from 0.05 to 0.8 mm. formed between said electrodes with said primer disposed therebetween and filled with said combustion-supporting gas.

The present invention can be more fully understood from the following detailed description when taken in connection with the accompanying drawings, in which:

FIG. 1 is an elevation of a photoflash lamp according to an embodiment of the present invention, with a part shown in section;

FIG. 2 is a graph showing the relationship of the gap (denoted as G) between the primer material coated on one of the electrodes and the other versus the energy required for ignition of the primer material, as associated with the embodiment of FIG. 1; and

FIG. 3 is a graph showing the relationship of the composition of the primer material and the energy required for ignition thereof.

There will now be described a preferable embodiment of the present invention by reference to FIGS. 1 and 2. The illustrated photoflash lamp is of the AG–1 type and comprises a radiation-transmitting sealed envelope **1**, preferably a glass bulb, 12 mm. in diameter and 34 mm. long, a combustible material **2** sealed in said envelope, for example, a shredded foil of zirconium, a combustion-supporting atmosphere similarly sealed in said envelope, for example, oxygen gas at 4.5 atmospheres and an igniting mechanism **3** sealed therein. In manufacture, the combustible material **2** and the electrode mount **3** are introduced into the glass bulb **1** (which initially has an open end at the bottom of the illustration). The open end of the glass bulb **1** is sealed by being pressed flat so as to fix the electrode mount **3**. Thereafter the evacuation of the glass bulb **1** and the filling of the combustion-supporting atmosphere are carried out through an ex-

haust tube. Then the exhaust tube is tipped off to form the baseless photoflash lamp.

The igniting mechanism or electrode mount **3** consists of a pair of lead-in wires **5***a* and **5***b* extending into the sealed glass bulb **1** and passing airtightly through a pinch seal section **4** thereof, a pair of electrodes **6***a* and **6***b* spatially formed in opposite relationship at the furthest end of each of the lead-in wires, an electrically insulating primer material **7** coated on at least one of the electrodes (in the embodiment, only the electrode **6***b*) and a glass bead **8** bridging both lead-in wires to hold the electrodes at a prescribed space in opposite relationship. The electrode **6***b* slightly projects from the top surface of the glass bead **8** and the other opposite electrode **6***a* rises above the glass bead **8** and is bent in an inverted U shape and faces the electrode **6***b* from above at a space from the primer material **7**. The electrode **6***a* preferably has a pointed end to allow for easy discharge. Between the electrode **6***a* and the primer material **7** is defined a gap G filled with a combustion-supporting atmosphere

The photoflash lamp of FIG. 1 is operated as follows. Across the lead-in wires **5***a* to **5***b* is impressed a high voltage pulse, for example, of 8 kv. Such pulse voltage is obtained by a piezoelectric device or condenser discharge means. With impression of such pulse, there are dielectrically broken-down the primer **7** coated on the electrode **6***b* and the combustion-supporting atmosphere filled into the gap to start discharge. Joule's heat resulting from said discharge causes the surface of the primer **7** to reach an ignition point, leading to the explosive scattering of the primer **7**, so that the combustible material **2** sealed in the glass bulb **1** is ignited and vigorously burns, sending forth bright flashes.

Indispensable to the method of the present invention is the formation of the aforesaid gap G, which is intended to elevate sensitivity to ignition. With the prior art photoflash lamp wherein the inter-electrode distance is set at between 0.1 mm. and 0.5 mm. and the electrodes are directly bridged by a primer, there is required about 0.3 mw. of energy for ignition of the primer. In contrast, where, as in the present invention, the electrodes are not directly bridged by the primer, though at least one of them is coated with said primer, but they are spaced to form the aforementioned gap G, the energy required for ignition can be reduced without fail to below 0.3 mw. sec., with the resultant elevation of sensitivity to ignition. This is supposed to originate with the following fact. The primer has a larger heat capacity than the combustion-supporting atmosphere, so that discharges through the primer suffer larger loss of heat transfer. In contrast where discharges take place in a gaseous phase, the pointed polar surface of the primer corresponding to the outlet of discharges easily rises in temperature, resulting in the reliable ignition of said primer. Further, if the gaseous phase is raised in pressure, the discharges occurring therein are reduced in the cross sectional area to cause the resultant energy to be more concentrated, thus enabling the primer to be ignited unfailingly.

If the composition of a primer is properly selected as described hereinbelow, both electrodes **6***a* and **6***b* are respectively coated with a primer to a thickness of about 0.2 mm. and the gap between these primers is set at about 0.3 mm., then energy required for ignition will be reduced to 0.15 mw. sec. Also where, as in the illustrated embodiment, only one **6***b* of the electrodes is coated with the primer **7** and the gap G between the other electrode **6***a* and the primer **7** is set at about 0.3 mm., then there will be only required less than 0.1 mw. sec. energy for ignition.

For the purpose of the present invention, the aforementioned gap G is limited in width to 0.05 and 0.8 mm. FIG. 2 represents, the relationship of the gap G in mm. and the energy required for ignition in mw. sec. In this

case the primer consists of a mixture of 100 parts by weight of zirconium powder, 100 parts by weight of potassium perchlorate and 10 parts by weight of nitrocellulose. As apparent from FIG. 2, the narrower the gap G, the smaller will be the energy required for ignition. However, in case of the Gap G=0, namely, when both electrodes **6***a* and **6***b* are directly bridged by a primer, said energy will sharply rise to 0.3 mw. sec. Accordingly, as small a gap G as possible, excluding the zero value, is more preferable to obtain reliable flashing. However, the reduction of the gap G to less than 0.05 mm. is difficult to realise in actual manufacture and unsuitable for mass production, because such an extremely narrow gap would cause the primer material **7** likely to contact the electrode **6***a*. Conversely, where the gap G exceeds 0.8 mm., energy required for ignition will increase over 0.15 mw. sec., and not meet the practical purpose. From the standpoint of manufacturing a photoflash lamp, therefore, the gap G most preferably ranges between 0.3 mm. and 0.6 mm.

There will now be described the composition of the primer **7**. As previously mentioned, proper selection of a primer composition remarkably reduces the energy required for ignition and consequently elevates the reliability with which the photoflash lamp gives forth flashes. Generally, the primer consists of zirconium powders to which are added oxides and nitrocellulose.

The smaller the specific heat and the degree of heat transfer, the more easily is heated and ignited the primer **7**, but there is required dielectric break-down for the ignition discharge. The primer **7** is therefore desired to have a large dielectric constant. If the primer **7** has a small resistance, it will be better for the breaking-up of its insulation. However, if said resistance is too small, temperature rise due to Joule's heat will not be large, presenting difficulties in igniting the primer **7**. Accordingly, it is preferred that the resistance of the primer **7** be large to a certain extent.

The inventors studied the relationship of the mixing proportions of zirconium, oxides and nitrocellulose versus the energy required for ignition of the primer. The oxides used in the experiments included potassium perchlorate ($KClO_4$), potassium chlorate ($KClO_3$), lead dioxide (PbO_2) and sodium chlorate ($NaClO_3$). The results of experiments are presented in the tables below. Throughout Tables 1 to 4, the parts by weight of these oxides are on the basis of 100 parts by weight of zirconium powders and 10 parts by weight of nitrocellulose. Energies required for ignition are indicated in mw. sec. Throughout the experiments, the gap G was maintained at about 0.3 mm.

TABLE 1

Potassium perchlorate ($KClO_4$)

Parts by weight:	Energy required for ignition, mw. sec.
60	0.23
75	0.15
100	0.09
125	0.07
150	0.08
175	0.10
200	0.14
210	0.17
220	0.19

TABLE 2

Potassium chlorate ($KClO_3$)

Parts by weight:	Energy required for ignition mw. sec.
75	0.18
100	0.12
125	0.08
150	0.10
175	0.13
200	0.16
225	0.20

TABLE 3

Lead dioxide (PbO_2)

Parts by weight:	Energy required for ignition mw. sec.
75	0.28
100	0.10
125	0.055
150	0.055
175	0.08
200	0.13
225	0.15
250	0.20

TABLE 4

Sodium chlorate ($NaClO_3$)

Parts by weight:	Energy required for ignition mw. sec.
75	0.16
100	0.08
125	0.07
150	0.07
175	0.085
200	0.14
225	0.18

As clearly seen from the above tables, energy required for ignition of the primer **7** varies with amounts of oxides added. FIG. 3 is a diagram plotted from the values of these tables. As apparent from this figure, the reduction of the energy to about 0.15 mw. sec. or less requires that potassium perchlorate ($KClO_4$), potassium chlorate ($KClO_3$) and sodium chlorate ($NaClO_3$) be added in 75 to 200 parts by weight and lead dioxide (PbO_2) in 87 to 200 parts by weight on the basis of 100 parts by weight of zirconium. When addition of the oxides rises above the upper limits or falls below the lower limits, the amount of energy externally supplied for ignition of the primer **7** will undesirably increase in either case.

When a primer conforming to any of the aforesaid specified compositions was formed into a circular disk about 0.4 mm. thick and about 1.5 mm. in diameter and its resistance was measured by impressing a voltage of 500 v. thereon, said resistance indicated as high a value as from several tens of hundreds MΩ. Such high resistance results from the large addition of oxides, and contributes to cause the dielectric breakdown to concentratedly appear (the breakdown of the primer is not produced at many points therein).

As mentioned above, the present invention provides a photoflash lamp of the discharge ignition type which permits easy fabrication and accomplishes reliable flashing. Also proper selection of a primer composition greatly reduces the amount of energy to be externally supplied for flashing.

What is claimed:

1. A photoflash lamp comprising a sealed radiation-transmitting envelope, a combustible material and a combustion-supporting gas sealed in said envelope, a pair of spaced leads which are partly extended outwardly of said envelope and whose ends within said envelope are opposed to constitute a pair of electrodes, a primer coated on at least one of said electrodes, and a gap from 0.05 to 0.8 mm. being formed between the primer material coated on one of said electrodes and the other electrode, said gap being filled with said combustion-supporting gas.

2. A photoflash lamp according to claim **1**, wherein one of said electrodes is coated with said primer, and the other electrode has its extreme end formed into a point shape.

3. A photoflash lamp according to claim **1**, wherein said primer comprises a mixture of 100 parts of zirconium, 10 parts of nitrocellulose and 75 to 200 parts of an oxide selected from a group consisting of potassium perchlorate, potassium chlorate and sodium chlorate, all parts being by weight.

4. A photoflash lamp according to claim **1**, wherein said primer comprises a mixture of 100 parts of zirconium, 10 parts of nitrocellulose and 87 to 200 parts of lead dioxide, all parts being by weight.

5. A photoflash lamp according to claim **1**, wherein said gap ranges from 0.3 to 0.6 mm.

6. A photoflash lamp according to claim **1**, wherein said combustible material is a shredded foil of zirconium.

7. A photoflash lamp according to claim **1**, wherein said combustion-supporting gas is oxygen.

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