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[54] **FLASH TUBE WITH REDUCED RF NOISE**

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[52] **U.S. Cl.** **313/178,** 313/181, 313/220, 313/225, 315/85

[51] **Int. Cl.** **H01j 61/16,** H01j 61/18

[58] **Field of Search** 315/85; 313/178, 181, 220, 313/225

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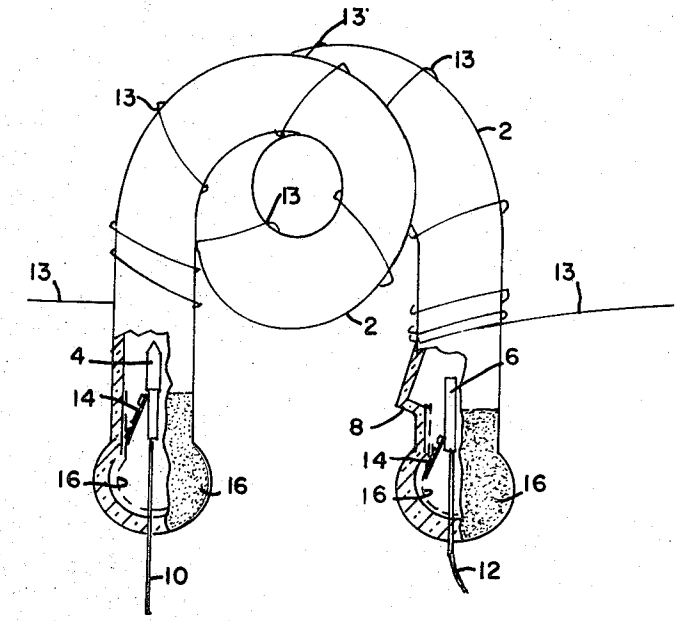
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[57] **ABSTRACT**

A xenon flash tube having a glass envelope with anode and cathode electrodes sealed in respective ends thereof. A barium dispenser is attached to each electrode, and a flashed barium deposit is located on the inside surface of each end of the envelope so as not to mask the arc discharge. The total quantity of barium in the envelope is selected to controllably reduce the radio frequency noise emitted from the flash tube during operation.

9 Claims, 3 Drawing Figures



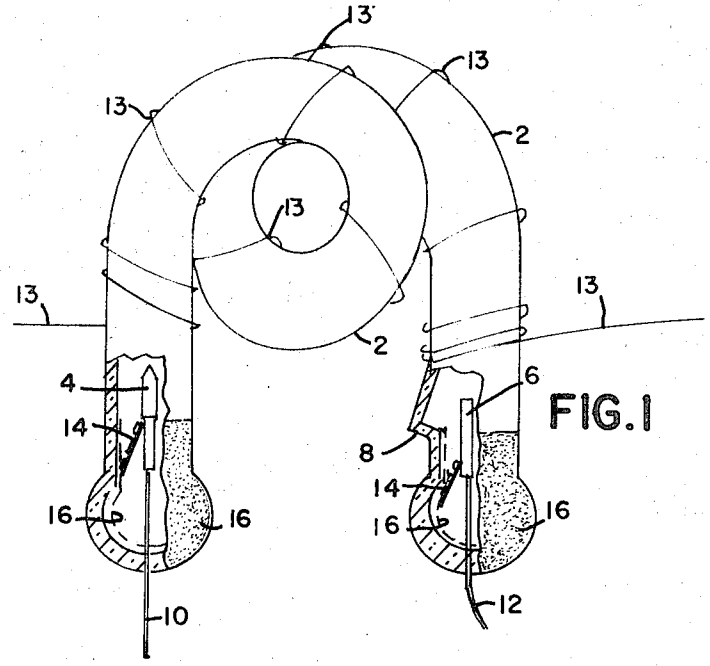


FIG. 1

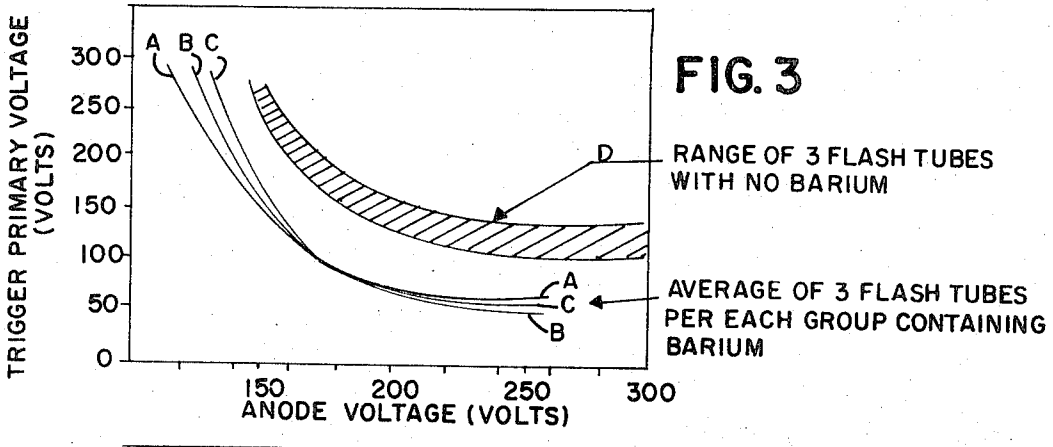


FIG. 3

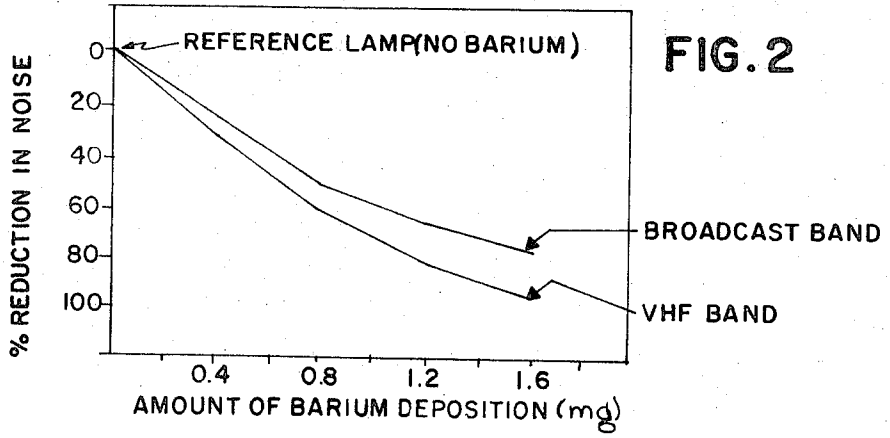


FIG. 2

FLASH TUBE WITH REDUCED RF NOISE

BACKGROUND OF THE INVENTION

This invention relates generally to electric discharge lamps and, more particularly, to means for reducing the radio frequency noise emitted from pulsing flash tubes.

Flash tubes generally comprise two spaced apart electrodes within a sealed glass envelope having a rare gas fill, typically xenon, at a sub-atmospheric pressure. Such lamps are connected across a large capacitor charged to a substantial potential, which is, however, insufficient to ionize the xenon fill gas. Upon application of an additional pulse of sufficient voltage, the xenon is ionized, and an electric arc is formed between the two electrodes, discharging the large capacitor through the flash tube, which emits a burst of intense light, usually of short duration. In many cases the pulse voltage is applied between an external trigger wire wrapped around the envelope and the electrodes; this is referred to as shunt triggering. In other applications, the lamp may be internally triggered by applying the pulse voltage directly across the electrodes, a technique referred to as injection triggering.

When the flash tube ignites upon being pulse triggered, it has been observed to inherently produce radio frequency (RF) interference in the broadcast band (540–1770 KHz) and the VHF band (110–140 MHz). Such RF noise is extremely undesirable in a number of applications, such as situations employing communications equipment in relatively close proximity. Typical of such an application for a flash tube is in the warning system of a small aircraft. The noise emitted from the flash tube itself has become increasingly objectionable with the advent of improved methods for reducing RF interference from flash tube power supplies and the overall reduction in noise level attained in small aircraft by the use of improved materials and processes.

Conventional approaches toward reducing such RF interference have included the use of a metal housing about the flash tube to function as an RF shield. Such a remedy is cumbersome and relatively costly, however, and is particularly disadvantageous for aircraft applications due to the substantial increase in weight and reduction in light output.

SUMMARY OF THE INVENTION

In view of the foregoing, it is an object of this invention to provide improved means for reducing radio frequency interference from a flash tube.

A principal object is to provide an improved flash tube with reduced RF noise emission.

These and other objects, advantages and features are attained, in accordance with the principles of the invention, by providing a flashed barium deposit on portions of the inside surface of the flash tube. In particular, we have discovered that the radio frequency noise emitted from the flash tube can be controllably reduced according to the total quantity of barium selected for the flashed deposition. Further, continued reductions in noise may be obtained for quantities of barium substantially greater than that required for minimum starting voltage. According to one embodiment, a xenon filled tubular glass envelope having a helical shape, with anode and cathode electrodes sealed in the ends thereof and an external trigger wire wrapped about the exterior of the envelope, includes barium dispensers attached to each electrode whereby the flashed barium deposit is located at each end of the envelope in a manner which substantially avoids masking the arc discharge.

BRIEF DESCRIPTION OF THE DRAWINGS

This invention will be more fully described hereinafter in conjunction with the accompanying drawings, in which:

FIG. 1 is an enlarged scale elevational view partly in section of a shunt-triggered flash tube employing barium for RF noise reduction in accordance with the invention;

FIG. 2 shows curves representing the percent of RF noise reduction obtained for increased amounts of barium deposition in the flash tube of FIG. 1; and

FIG. 3 shows trigger primary voltage vs. anode voltage characteristic curves for flash tubes containing varying amounts of barium.

DESCRIPTION OF PREFERRED EMBODIMENT

Referring to FIG. 1, the flash tube comprises an hermetically sealed, light transmitting envelope 2 formed of a helically shaped piece of hard glass tubing (e.g. Corning No. 7740 glass) and having a cathode electrode 4 sealed within one end of the envelope and an anode electrode 6 sealed within the other end. The envelope is filled with a rare gas, such as xenon, at a subatmospheric pressure (e.g., 120 mm.) and is constricted to define an exhaust tip 8.

The flash tube electrodes are energized via lead-in conductors 10 and 12, which are sealed through respective ends of the glass envelope 2. More specifically, lead-in conductor 10 is connected to cathode 4 and lead-in conductor 12 is connected to anode 6. Each of the lead-in conductors typically comprises a plurality of interconnected conductive pieces, at least one of which is a material suitable for providing a good glass to metal seal. The shunt (or external) trigger pulse is applied by means of an external trigger wire 13 wrapped about the exterior of the tubular envelope 2 so as to properly ionize the arc discharge path between the cathode and anode electrodes during pulsed operation.

In accordance with the invention, a barium dispensing device 14 is attached to each of the electrodes and positioned such that, upon flashing of the devices in the sealed envelope, a deposit 16 of the flashed barium is provided on the inside surface of each end of envelope 2 in a manner which substantially avoids masking the arc discharge path. Pursuant to empirical testing for determining the initial design, the total quantity of barium in the flash tube is selected to controllably reduce the radio frequency noise emitted from the flash tube during operation.

According to one specific implementation of a flash tube according to the invention, the glass tubing of the helically shaped envelope 2 has an inside (bore) diameter of 4 mm., an outside diameter of 6 mm., and an overall length of about 2½ inches. The lamp is filled with xenon at 120 mm. pressure. Each of the barium dispensing devices 14 comprises a flag type getter dispenser carrying three pellets of a barium containing getter alloy. The flag comprises a 0.003 to 0.005 inch thick strip of nickel having a width of 0.093 inch and a length of form 0.297 to 0.300 inch and formed with

three cups each containing a pellet of "Barex No. 828" getter alloy ("Barex" is a registered trademark of King Laboratories, Inc.). Such getter dispensers are available from King Laboratories, Inc., 126 Solar Street, Syracuse, NY 13204.

The composition of "Barex No. 828" alloy is given as 38.7% Ba, 34.9%Al, 3.3%Ca, 12.7%Fe, and 10.4%Ni. The getter is flashed at a temperature of 1,050°C – 1,100°C by use of a high frequency induction coil. The total weight of the three alloy pellets before flashing is 2.2 mg. and the barium yield upon flashing is 0.7 mg. for each of the dispensers **14.** Accordingly, the total quantity of flashed barium in the lamp is about 1.4 mg. at a maximum, and more probably about 1.2 mg., allowing for incomplete vaporization.

Each of the nickel getter strips **14** is welded to the electrode or electrode support at one end, as illustrated, with the free end of the strip **14** toward the end of the envelope **2** supporting that electrode. The side of the strip on which the alloy pellets are exposed faces the axis of the tube. By positioning the getter strips **14** in the manner, the flashed barium deposits **16** are restricted to the end areas of the glass envelope behind the portions of the electrodes serving as terminals of the arc discharge path. If the flashed deposit **16** extended higher in the tube (as viewed in FIG. **1**), it would mask a portion of the arc discharge path and thus darken an area of the ignited flash tube. In addition, an overextended flashed barium deposit would reduce the life of the flash tube since the barium would enter the arc stream and be deposited on the bulb wall, thus reducing the light output.

The operating voltage range of this flash tube is from 300–500 volts DC; this is also referred to as the anode or supply voltage. To ignite the flash tube a 4Kv peak trigger pulse (Class I) is applied to the external trigger wire **13.** Upon comparison with a like flash tube containing no barium, the above described flash tube with flashed barium coatings at each end, in accordance with the invention, provided a 66 percent average reduction of RF emissions in the broadcast band and an 80 percent average reduction of RF noise in the VHF band.

To obtain the noise measurements, the flash tube under test is mounted within a closed wooden box and flashed by its power supply as in normal operation. The emitted RF signal is picked up by an antenna placed about three feet from the box containing the flash tube. The antenna is connected by a shielded cable to a remote radio receiver capable of receiving signal frequencies in the broadcast band (540–1,700 KHz.) and the VHF band (110–140 MHZ). The audio output of the receiver is applied to the input of an oscilliscope, which provides a visually indicated deflection proportional to the audio level.

The curves of FIG. **2** illustrate the controlled reduction of RF noise emission obtainable for increased amounts of barium deposition. The 0 percent reference on the ordinate axis represents the RF noise emission as measured by the above-described test set up from a shunt-triggered, helical flash tube of the specific type described above but without barium. The remaining data points were obtained by measuring the noise emissions from a series of flash tubes of the same type but containing increased amounts (by weight) of flashed barium deposits **16** at the ends of the tube. The plotted curves indicate that the degree of noise reduction is a function of the quantity (by weight) of barium included in the flashed deposits **16,** and that RF noise is reduced to a lower level as the amount of barium is increased.

Further, however, we have observed that the quantities of barium employed for obtaining continued reductions in RF noise can be significantly greater than the quantity of barium getter required for minimum starting voltage. This is illustrated by comparing FIG. **2** with FIG. **3,** which illustrates the trigger primary voltage (starting voltage) vs. anode voltage characteristic curves for flash tubes containing varying amounts of barium as flashed deposit **16** at the ends of the tubes. The set of curves D in FIG. **3** represent the range of three flash tubes of the reference type above which contain no barium. Curve A represents the average of three flash tubes each containing 0.4 mg. of barium as flashed deposits at the end of the tube; curve B represents the average of three flash tubes each containing 1.2 mgs. of barium; and curve C represents the average of three flash tubes each containing 1.6 mgs. of barium. FIG. **3** shows a marked decrease in starting voltage for the barium containing flash tubes (A,B,C) as compared to the flash tubes with no barium (D); however, there is little or no difference in minimum starting voltage between the barium containing glash tubes of curves A,B and C. That is, the increase in barium getter from 0.4 mg. to 1.2 mgs. and 1.6 mgs. has little or no effect on minimum starting voltage. In FIG. **2,** however, it is clear that such increased amounts of barium have a very marked effect in continuing to reduce RF noise emissions. Accordingly, the described use of barium in a flash tube provides a noise reducing effect which quite unexpectedly appears to be somewhat independent of the gettering effect and have a wider control range. It is also surprising that this degree of noise reduction is obtainable by merely flashing the barium over the end portions of the flash tube envelopes.

Although the invention has been described with respect to a specific embodiment, it will be appreciated that modifications and changes may be made by those skilled in the art without departing from the true spirit and scope of the invention. For example, some noise reduction may be obtained by flashing the barium at only the cathode end of the flash tube, however, quite unexpectedly the RF noise is further reduced to a significant degree by also flashing barium at the anode end of the flash tube. A variety of means may be employed for flashing the barium on the envelope walls, and it is contemplated that the invention is also applicable to injection-triggered flash tubes and flash tubes of a variety of other shapes and forms than that illustrated.

What we claim is:

1. A flash tube comprising: an hermetically sealed light transmitting envelope; a rare gas in said envelope; a pair of electrodes in said envelope between which an arc discharge path is defined during operation of said lamp; and a flashed barium deposit on portions of the inside surface of said envelope, said flashed barium deposit being located to substantially avoid masking said arc discharge path, and the total quantity of said barium in the flash tube being selected to controllably reduce the radio frequency noise emitted from said flash tube during operation.

2. A flash tube according to claim **1** wherein the quantity of barium in said envelope is substantially

greater than the quantity of barium getter required for minimum starting voltage.

3. A flash tube according to claim 1 further including means for providing external triggering thereof.

4. A flash tube according to claim 1 wherein said rare gas is xenon.

5. A flash tube according to claim 4 wherein said envelope is formed of glass tubing.

6. A flash tube according to claim 1 wherein said electrodes are disposed with one at each end of said envelope, and further including barium dispensing means attached to each of said electrodes.

7. A flash tube according to claim 6 wherein one of said electrodes comprises the cathode and the other electrode comprises the anode, and said barium dispensing means are attached to said electrodes in a manner whereby said flashed barium deposit is located on the inside surface of each end of said envelope in a manner which substantially avoids masking said arc discharge path.

8. A flash tube according to claim 6 further including an external trigger wire wrapped about the exterior of said envelope, and wherein said flashed barium deposit is located on the inside surface of each end of said envelope in a manner which substantially avoids masking said arc discharge path.

9. A flash tube according to claim 8 wherein said envelope comprises a helically shaped piece of glass tubing sealed at both ends.

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