

[54] PLASMA ARC FLASH SOURCE

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[51] Int. Cl. H01j 61/04

[58] Field of Search 313/204, 205, 206, 220, 326

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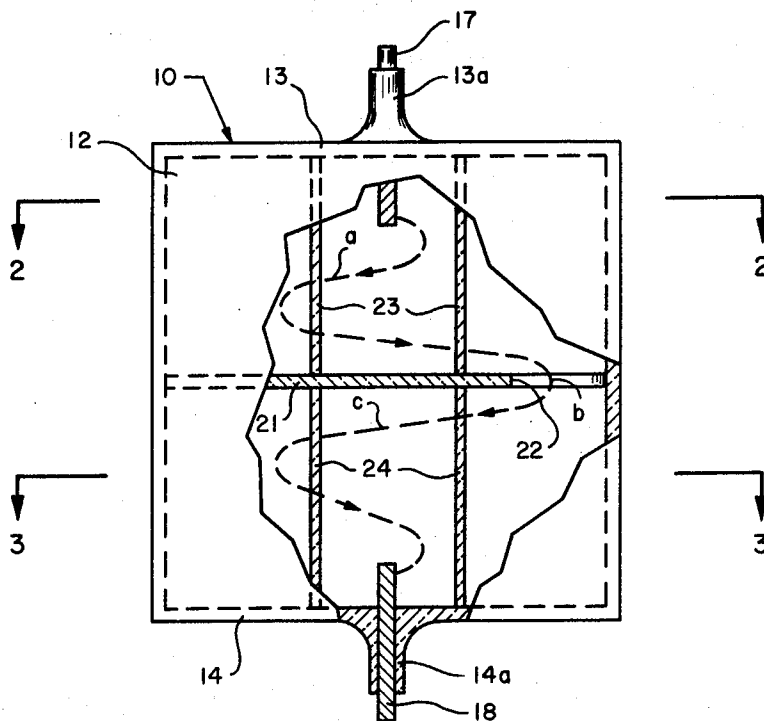
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[57]

ABSTRACT

A plasma arc flashtube for flash photography comprises a tube divided into an upper and lower cylindrical chamber by a disc having a peripheral aperture. Arcuate upright partitions in each chamber define a spiral inductive path leading from a central upper electrode through the upper and lower chambers terminating at a central lower electrode.

4 Claims, 3 Drawing Figures



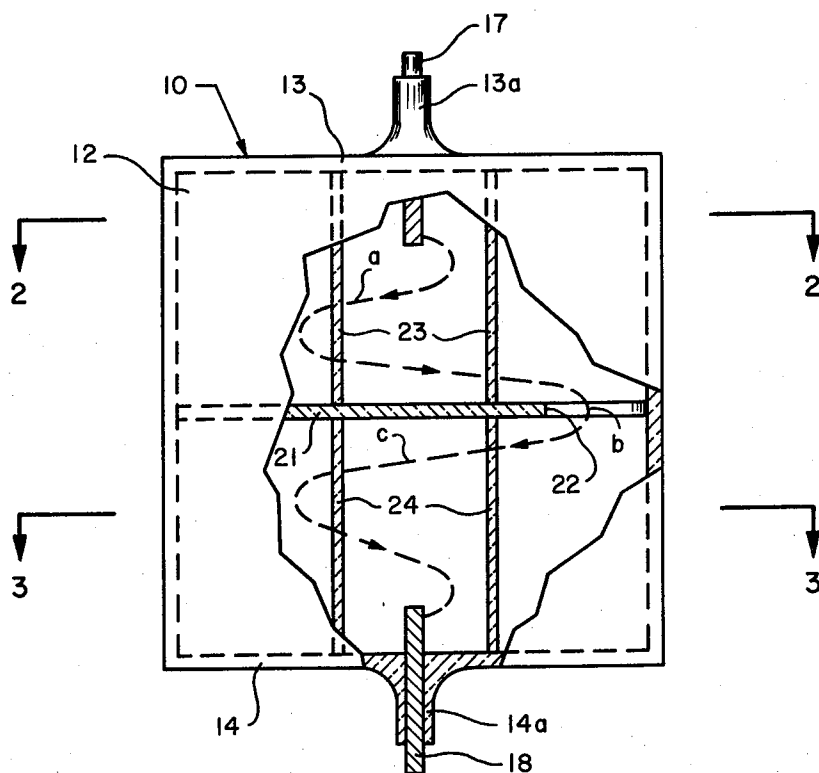


Fig. 1

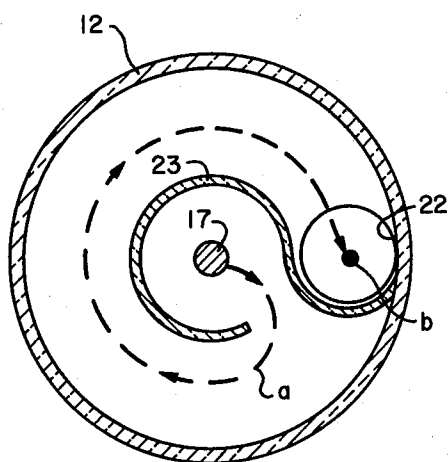


Fig. 2

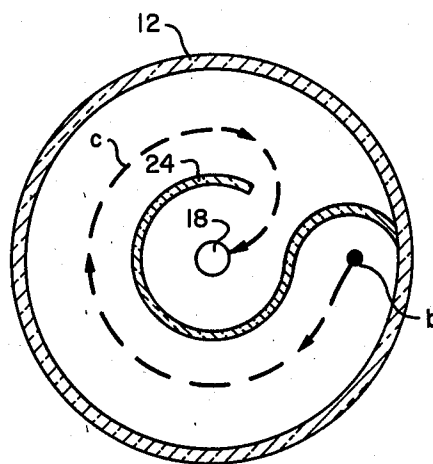


Fig. 3

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PLASMA ARC FLASH SOURCE

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of The United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

The invention relates generally to the field of pulsed high intensity light sources, and more particularly to gas-filled arc discharge tubes.

For photography and other purposes a brief flash of brilliant light may be obtained from a discharge between two electrodes through an ionized gas contained in a transparent tube. To effectively concentrate the omnidirectional radiation in a particular direction a reflector is ordinarily placed adjacent to the tube. The position and shape of the flash source and the curvature of the reflector are among the many parameters which determine the efficiency of reflection. Any illuminating system becomes more efficient with a smaller light source, the ideal condition being a point source of light. The reason is simply that a single reflective surface cannot be optimum for more than one geometrical point. Methods of achieving a smaller light source have taken two directions in the past. One method is to shorten the length of the discharge path, and the other is to make the discharge path tightly wound about itself. It has been found, however, that merely shortening the length of the path reduces the efficiency of electrical to radiant energy conversion. A coiled or spiral path is beneficial because it introduces inductance into the electrical discharge circuit increasing the conversion efficiency. Indeed, commercially available flash sources are today made almost exclusively of coiled glass or quartz tubing. This manufacturing technique, however, limits the overall size of the light source considerably due to the inherent limit to the tightness of the coil.

SUMMARY OF THE INVENTION

The general purpose of the invention is therefore to increase the efficiency of reflection by decreasing the size of a gaseous discharge flash source without degrading the efficiency of electrical to radiant energy conversion. A corollary object is to overcome the size limitations of the prior art by defining an inductive path without using a coiled tube. Another object of the invention is to increase the radiant energy output in a particular spectral bandwidth over that produced by prior art flash sources.

These and other objects are achieved by providing a cylinder enclosed by top and bottom plates carrying a pair of opposed electrodes which extend into the cylinder. A transverse, centrally disposed disc having an aperture near its periphery divides the cylinder into equal upper and lower cylindrical sections. An upright arcuate partition between the top plate and the disc is connected to the cylinder wall at a point adjacent one side of the aperture and extends between the aperture and the cylinder axis continuing around the axis and terminating short of closure. The corresponding electrode extends into the space partially enclosed by the partition. In the lower section a similar partition is disposed beginning on the other side of the aperture. The cylinder, partitions, disc and aperture define a continuous inductive spiral path having two substantially 360° turns. Upon ionization of a suitable gas contained in the cylinder, a plasma arc discharge is established between the electrodes along this path. By eliminating the conventional tubular spiral, space is saved allowing a better approximation of a point source for efficient light reflection.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a fragmentary side view of a flash source according to the invention with portions in cross section;

FIG. 2 is a cross-sectional view taken along lines 2—2 in the direction of the arrows in FIG. 1; and

FIG. 3 is a cross-sectional view taken along lines 3—3 in the direction of the arrows in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1 in the drawings, a hermetically sealed flashtube 10 filled with a suitable ionizable gas such as xenon or krypton provides a miniature plasma arc path approximating a point source for efficient use in a simple parabolic reflector (not shown). Flashtube 10 has an outer cylindrical wall 12 enclosed at either end by a top plate 13 and a bottom plate 14 each having respective neck portions 13a and 14a to support metal electrodes 17 and 18. Flashtube 10 is sectioned into upper and lower chambers by a divider disc 21 having a hole 22 at its periphery. Referring to FIG. 2, an arcuate partition 23 in the upper chamber is connected to wall 12 at one end adjacent one side of hole 22. Partition 23 extends between hole 22 and electrode 17 continuing around electrode 17 and terminating before completing the formation of a cylinder so that a longitudinal slot is formed. Another upright arcuate partition 24 extends between divider disc 21 and bottom 14 in the lower chamber. Partition 24 extends in reverse fashion, compared to partition 23, from the other side of hole 22 in disc 21 passing between electrode 18 and hole 22 and around electrode 18 forming at the inner end a longitudinal slot similar to that formed in the upper chamber by partition 23.

The material for flashtube 10 may comprise glass or quartz. The seams, for example, where partition 23 meets divider 21 may be made by fusing or by a suitable adhesive material.

In operation, flashtube 10 is loaded with a noble gas such as xenon or krypton, or a mixture of noble gases, so that electrons may be freed by ionization to provide a conductive medium. As in conventional flashtubes, the discharge between electrodes 17 and 18 immediately follows the preliminary step of ionization. In the embodiment of FIG. 1 ionization can be induced by first applying a large voltage, on the order of 20,000 volts, across electrodes 17 and 18. Electrodes 17 and 18 would be connected to a bank of capacitors so that when a conductive path is provided between the electrodes, discharge occurs. This type of serial triggering is a well-known technique in the prior art. An alternative method of causing ionization would be to wind a few turns of an auxiliary wire coil around flashtube 10 to produce an electric field within the flashtube causing ionization and resultant discharge.

During discharge, conduction through the ionized gaseous medium is by means of a plasma arc which seeks to utilize the most convenient path between opposing electrodes. In this case, referring to FIG. 2, the current will follow the plasma path indicated by dashed line *a*. Starting from electrode 17 the arc passes out of the enclosure formed by partition 23 and continues around the outside of partition 23 to point *b* where it passes through hole 22 into the lower chamber, as can be seen in FIG. 1. The path continues from point *b* in FIG. 3 in the lower chamber around partition 24 and into the enclosure formed thereby, ultimately terminating at electrode 18. The path taken in each chamber approximates 360° of arc and is shaped in a spiral form having two complete turns. The configuration of the path thus provides electrical inductance, the plasma spiral functioning like a wire coil in this respect. Inductance is important to the operation of the flashtube since it increases the effective resistance of the discharge path causing a higher rate of conversion of electrical energy to radiant energy; that is, the efficiency is increased.

It should be obvious that the precise shape of partitions 23 and 24, as shown in the drawings, represents a preferred system of baffles or partitions. Other configurations of partitions 23 and 24 will suggest themselves to those skilled in the art. A general requirement is that the direct or straight line path between an electrode in either chamber and the hole between chambers be obstructed by a partition which will generally force the plasma to assume a spiral path. While only two chambers are shown in FIG. 1, it would, of course, be possible to multiply the number of chambers to form a ganged

or superimposed system of chambers, each pair of adjacent chambers being connected by a divider having an aperture. For example, to add another pair of chambers to the flashtube in FIG. 1 bottom plate 14 carrying electrode 18 would be replaced by a disc having a central aperture as well as a peripheral aperture in the same position as hole 22 in disc 21. Partitioned chambers like the upper and lower chambers in FIG. 1 would then be affixed below the added divider disc with the central aperture.

The invention yields a significant increase in the radiant energy produced in the infrared bandwidth. Numerous parameters are known to affect the spectral distribution of light energy emitted during discharge. Among these are the cross-sectional area of the plasma arc, the length of the path and the amount of inductance in the path. It has been found that the relatively large cross section of plasma arc obtained and the short length and inductance achieved by the invention greatly increase the infrared conversion efficiency. Infrared flash lamps and camera systems are currently under development for covert night photography.

The cogent advantages of the invention lie in the inherent reduction in size of an inductive or coiled discharge path achieved by using an arrangement of partitions instead of tubing. A high efficiency light source has been provided which more closely approximates a point source. The reduced size greatly increases the efficiency of reflection by conventional parabolic reflectors, thus permitting a greater percentage of light to be usefully directed toward the object to be illuminated.

It will be understood that various changes in the details, materials, steps and arrangements of parts, which have been herein described and illustrated in order to explain the nature of the invention, may be made by those skilled in the art within the principle and scope of the invention as expressed in the appended claims.

What is claimed is:

1. A plasma arc flashtube, comprising:
an envelope containing an ionizable gas;
two opposed electrodes extending into said envelope;
a first partition interposed between said electrodes and forming two chambers in said envelope, said chambers communicating through an opening formed adjacent to the periphery of said partition, said first partition being a plate having a peripheral edge joined to the inside of said envelope, said opening being formed in said plate at said edge; and
second and third partitions arranged in respective chambers to form a spiral-like electric discharge path between said electrodes, said second and third partitions each including an arcuate wall connected between said envelope and respective sides of said plate.
2. A flashtube of the type comprising an envelope containing an ionizable gas and opposed electrodes extending into said envelope, wherein the improvement comprises:
divider means sectioning said envelope into first and second chambers containing one and the other of said electrodes respectively and having an interchamber passageway

formed therein, said divider means passageway being an aperture formed adjacent the periphery of said divider means and said divider means being a plate having a peripheral edge joined to the inside of said envelope, said aperture being formed in said plate adjacent said edge;

first partition means arranged in said first chamber defining an arcuate path between said one electrode and said divider means passageway; and

second partition means arranged in said second chamber defining therein an arcuate path between said divider means passageway and said other electrode, said first and second partition means each including an arcuate wall connected between said envelope and respective sides of said plate;

whereby an inductive electric discharge path is furnished between said electrodes.

3. A flashtube according to claim 1 further comprising:

said second partition wall being joined at one end to said envelope adjacent one side of said plate opening and extending therefrom between said plate opening and one of said electrodes and passing around said one electrode in one direction, terminating at the other end before completely enclosing said one electrode to leave a gap; and

said third partition wall being joined at one end to said envelope adjacent the other side of said plate opening and extending therefrom between said plate opening and the other electrode and passing around said other electrode in the other direction, terminating at the other end before completely enclosing said other electrode to leave a gap;

whereby an inductive spiral-like electric discharge path is created leading from said one electrode around the outside of said second partition wall, passing through said plate opening, passing around said third partition wall and terminating at said other electrode.

4. A flashtube according to claim 2 wherein the improvement further comprises:

said first partition means wall being perpendicular to said plate and connected at one end to said envelope adjacent one side of said plate aperture and extending therefrom between said plate aperture and said one electrode and passing around said one electrode, terminating at the other end before completely enclosing said one electrode to form an opening; and

said second partition means wall being perpendicular to said plate and connected at one end to said envelope adjacent the other side of said plate aperture and extending therefrom between said other electrode and said plate aperture and passing around said other electrode, terminating at the other end before completely enclosing the said other electrode to form an opening;

whereby a path is created leading from said one electrode in said first chamber around the outside of said first partition means wall passing through said plate aperture into said second chamber, passing around the outside of said second partition means wall and terminating at said other electrode.

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