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3,075,121

FLASHTUBE AND SYSTEM

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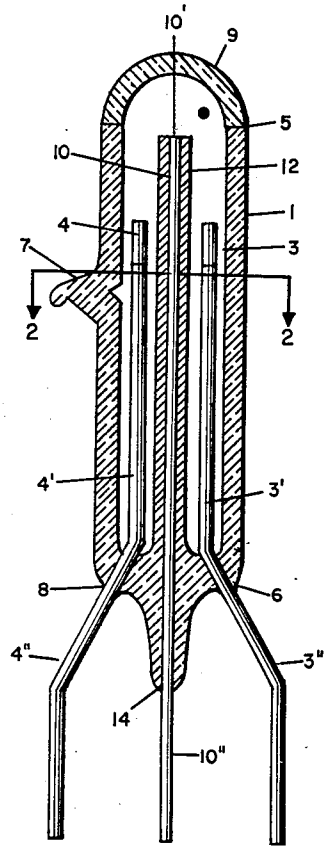


FIG. 1

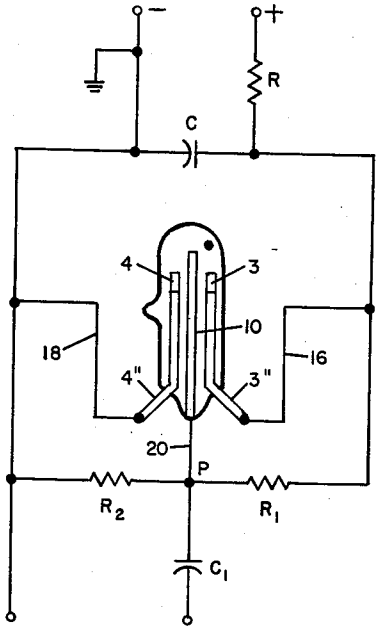


FIG. 3

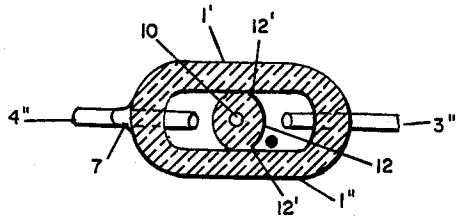


FIG. 2

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FLASHTUBE AND SYSTEM

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The present invention relates to flashtube systems and the like, and, more particularly, to flashlamps of miniature dimensions.

There are occasions when accurately-timed flashes of light of controlled duration are required to be produced by flash devices of very small dimensions. As an illustration, miniature flash devices may be employed to print upon a photographic film characters or numerals formed by stacking a plurality of such devices in appropriate configurations. Ultra-violet light flashes, for example, are useful for direct print-out films that may record characters or numerals in computer or other electronic systems. While the invention will hereinafter be described in connection with its preferred application to the generation of ultra-violet light flashes, it is to be understood that the invention is of broader utility, being useful not only where flashes of other wavelengths in the electromagnetic spectrum may be desired, but also in other cases where electric discharge devices are required, having the properties of the flash devices hereinafter explained.

An object of the present invention is to provide a new and improved miniature flash device that may be used for such purposes, as above described.

A further object is to provide a new and improved flash device.

Still a further object is to provide a novel flashtube system.

Other and further objects will be explained hereinafter and will be more particularly pointed out in connection with the appended claims.

The invention will now be described in connection with the accompanying drawing, FIG. 1 of which is a longitudinal section of a flashtube constructed in accordance with a preferred embodiment of the invention;

FIG. 2 is a transverse section taken upon the line 2—2 of FIG. 1, looking in the direction of the arrows; and

FIG. 3 is a schematic circuit diagram illustrating a preferred circuit for operating the flash device of FIGS. 1 and 2.

The flash device is shown comprising an envelope 1, as of glass and the like, such as Corning Type 7052 glass, preferably deformed into substantially flattened shape, with oppositely disposed walls 1' and 1'', FIG. 2, substantially planar in configuration and substantially parallel to one another. The envelope 1 terminates at its lower end in seals 6, 8, and 14, FIG. 1, through which the electrical connections to the internal electrodes within the envelope 1 may be effected.

At its upper terminal, the envelope 1 is provided with a preferably light-transmitting curved window 9, which, in the case of the transmission of ultra-violet light for the purpose of exposing direct print-out films and the like, may be of Corning Type No. 9741 ultra-violet radiation-transmitting glass, sealed to the remainder of the body of the envelope 1 at 5. The envelope 1 may be filled with a desired gaseous or other ionizable medium through which an electrical discharge may pass to produce a flash of light, such as, for example, argon. Other gases, such as xenon and krypton, having both visible and ultra-violet radiation, may also be employed. Xenon flashlamps, filled at 24 centimeters of mercury pressure, have been found to generate considerable ultra-violet light. The envelope 1 may be sealed at 7 after the gaseous medium is introduced therewithin.

Disposed within the gaseous medium are principal electrodes 3 and 4, which, as later explained, are preferably similar in dimensions and configuration, and preferably of the sintered variety, as described, for example, in United States Letters Patent No. 2,492,142, issued to Kenneth J. Germeshausen. The principal electrodes 3 and 4 are shown supported by respective conductors 3' and 4', such as Kovar wires extending through the respective seals 6 and 8, to permit external leads or extensions 3'' and 4'' to establish connections in the required flashtube circuit. Insulating material, not shown, may be used to cover external leads 3'' and 4'' and the portion of the Kovar wires 3' and 4' external to the tube 1 and the external lead connection 10'' for the trigger electrode 10 to prevent arcing or break-down at these points, particularly when the tube is mounted in small spaces where there is insufficient room to separate the external connectors 3'' and 4'' as shown in FIG. 1.

The principal electrodes 3 and 4 are spaced at positions considerably remote from the light-transmitting terminal window portion 9 in order to avoid darkening the window as a result of sputtering from the principal electrodes, and they extend substantially parallel to the substantially planar walls 1' and 1'' of the flattened envelope 1. Substantially symmetrically disposed in the space between the pair of spaced principal electrodes 3 and 4, is a trigger electrode 10 which extends substantially parallel to the structures 3—3', 4—4', and much closer to the terminal window 9 than the pair of principal electrodes 3 and 4 in order to insure, for purposes of maximum optical efficiency of light transmission, that a discharge is initiated close to the window 9.

The free end 10' of the trigger electrode 10 is shown exposed to the gaseous medium within the envelope 1, with the remainder of the trigger electrode 10 being insulatingly covered, as by a glass sleeve 12. This glass sleeve 12 may be sealed to the envelope walls 1' and 1'' at 12', FIG. 2, and thereby divides the interior of the envelope into two substantially-parallel, elongated chambers joined together at the curved section between the terminal window 9 and the exposed end 10' of the trigger electrode 10, thus forming the discharge chamber into an inverted-U shape. The glass sleeve 12 not only physically divides the tube 1 but it also electrically divides the envelope and thereby prevents any discharge between the principal electrodes 3 and 4 or between either of them and the trigger electrode 10 except in the above described U-shaped discharge chamber. The ionizable medium in the discharge chamber presents a much lower impedance path from the exposed tip 10' of the trigger electrode 10 to each of the principal electrodes 3 and 4, than any path from the trigger electrode 10 through the glass sleeve 12 to either principal electrode 3 or 4. It is for this reason that the discharge to the principal electrodes 3 and 4 is confined to the U-shaped discharge chamber.

The trigger electrode 10 has its external lead 10'' extending through the end seal 14 in the base of the envelope 1, intermediate the seals 6 and 8.

In actual practice, for example, the envelope 1 may be 0.750-inch long, 0.250-inch wide and of thickness 0.10-inch. In such event, pluralities of tubes 1 may be stacked into numeral, character or other configurations about 0.10-inch part, on centers. The electrodes 3 and 4 may be positioned at a region near the central portion of the envelope 1, shown just beyond the same, but more remote from the light-transmitting window 9 than the free end 10' of the trigger electrode 10 for the reasons before explained.

A preferred circuit for operating the flash device 1 is

shown in FIG. 3. Connected between the lead connections 3'' and 4'', by conductors 16 and 18, is an energy storage capacitor C. The capacitor C may be charged through a charging impedance, such as a resistor R, from a charging circuit, the positive terminal of which is shown at +, and the negative terminal of which, is at —, preferably grounded. The tube is electrically symmetrical and therefore either of the principal electrodes 3 or 4 may be connected to either of the charging circuit terminals. The source +, — may, for example, be a 1000-volt direct-current voltage supply, and the charging resistor R may have a value of 100,000 ohms. The flash capacitor C may, for example, be of the order of 0.5 microfarad. Shunting the principal electrodes 3 and 4, and also connected thereto by conductors 16 and 18, is a pair of similar voltage-divider network resistors R_1 and R_2.

The network resistors R_1 and R_2 may, for example, have a value of the order of 22 megohms, and the trigger coupling capacitor C_1 may have a value of the order of 0.005 microfarad. Under such circumstances, an energy input of the order of 0.25-watt-second will produce a flash output, having considerable ultraviolet radiation of the order of 0.08 axial-beam candle-power-second. A flash duration, at one-third peak of the flash intensity, of the order of 1.7 microseconds may thereby be produced. Typical flashing rates may be of the order of four a second, more or less. The minimum starting voltage of such a device is of the order of 600 volts and the self-flashing voltage is of the order of 1700 volts, the flash tube 1 having a nominal tube resistance of the order of 2 ohms.

The purpose of the voltage divider is to maintain the potential of the trigger electrode 10 at substantially the mid-point of the potential difference of the principal electrodes 3 and 4. For this reason, R_1 and R_2 are equal. If the above example of a 1000-volt power supply were used, the trigger electrode 10 would be held at substantially 500 volts. By energizing the trigger electrode 10, which is physically located half way between the principal electrodes 3 and 4, to a potential half way between the principal electrodes electrically, the tube is much more stable electrically. Under these circumstances, it is far more difficult to accidentally trigger the tube by stray electric fields. This is particularly important in miniature tubes stacked very close together because the triggering of an adjacent tube produces an electric field which could cause arcing or breakdown between the trigger electrode 10 and the principal electrode 3 or 4 having the greater voltage gradient to the trigger electrode. When, however, the tube 1 is electrically symmetrical, the voltage gradient between the trigger electrode 10 and each principal electrode 3 and 4, is the same, making the tube 1 more stable and, therefore, more difficult to trigger accidentally.

Another advantage of having an electrically symmetrical trigger is an increased operating range, or, in other words, a lower voltage between the principal electrodes 3 and 4 at which the flash can be triggered, and also a higher voltage without self-flashing.

A trigger pulse, such as, for example, a 1-microsecond, 5-kilovolt impulse, may be applied through coupling capacitor C_1 to a preferably symmetrical point P of the voltage divider network R_1, R_2 and thence by way of conductor 20 to the trigger electrode 10, where it will initiate a discharge between the trigger electrode 10 and one of the principal electrodes 3 or 4. This internal positioning of the trigger electrode 10 not only reduces the required trigger voltage, but tends to confine most of the electromagnetic field within the tube 1 and thereby helps to prevent cross-triggering of adjacent tubes. The subsequent discharge of capacitor C will produce a glow that illuminates substantially the complete terminal window 9 thereby permitting the transmission of light substantially uniformly throughout the collimating curved portion of the window 9 for the purposes before described. The discharge arc is produced close to the terminal portion of the tube, which has heretofore been difficult to accomplish in miniature tubes. The discharge arc, moreover, is shaped into substantially an inverted U-shape in view of the intermediate baffle position and length of the trigger electrode, providing a relatively long discharge path.

Other types of flashing circuits, such as those described in the before-mentioned Letters Patent, may, also be employed, as may gaseous media that produce radiation in other portions of the spectrum. The term "light," moreover, as used herein, is intended to connote not only visible but invisible electromagnetic radiations, as well. As before stated, moreover, other ionizable media may also be employed where the electric discharge characteristics, above-described, are desired.

Further modifications will occur to those skilled in the art, and all such are considered to fall within the spirit and scope of the invention, as defined in the appended claims.

What is claimed is:

1. A flashtube comprising: an envelope with a light-transmitting terminal window and containing a gaseous medium through which an electric discharge may be produced; a pair of spaced principal electrodes disposed within the envelope and between which an electric discharge may take place when the flashtube is rendered effective; a trigger electrode for rendering the flashtube effective, disposed within the envelope between the principal electrodes and having one end closer than either of the principal electrodes to the terminal window; means for insulating the trigger electrode from the principal electrodes at all points except the end closer to the terminal window; and means for confining the discharge between said principal electrodes when the flashtube is effective, to a path adjacent the terminal window and the uninsulated end of trigger electrode, said discharge path being longer than the straight-line distance between the principal electrodes.

2. A flashtube comprising: an envelope containing a gaseous medium through which an electric discharge may be produced, and having a pair of oppositely-disposed side walls and a light-transmitting terminal window; a pair of spaced principal electrodes disposed within the envelope and between which an electric discharge may take place when the flashtube is rendered effective; a linear trigger electrode for rendering the flashtube effective, disposed within the envelope between the principal electrodes, said trigger electrode having sides and one end disposed closer than either of the principal electrodes to said terminal window; and an insulating member enclosing the sides of said trigger electrode but not enclosing the end thereof closer to the terminal window, said insulating member extending to and being sealed to said side walls thereby forming a discharge chamber within the envelope which chamber is adjacent to the terminal window and contains the principal electrodes and the said end of the trigger electrode, the distance between said principal electrodes within said chamber being greater than the straight-line distance between the principal electrodes.

3. A flashtube comprising: an envelope having a discharge chamber containing a gaseous medium through which an electric discharge may be produced, said envelope having a light-transmitting terminal window forming a part of the boundary of said chamber; a pair of principal electrodes disposed within said chamber remote from said terminal window, and between which an electric discharge may take place when the flashtube is rendered effective, the distance within said chamber between said principal electrodes being longer than the straight-line distance between the principal electrodes; and a trigger electrode for rendering the flashtube effective, disposed within said envelope between said principal electrodes, and having one end exposed within said chamber closer than either of said principal electrodes to the terminal window,

and the remainder of said trigger electrode insulated from said principal electrodes.

4. A flashtube as claimed in claim 3 and in which said discharge chamber is substantially U-shaped.

5. A flashtube as claimed in claim 4 and in which said principal electrodes are similar, sintered electrodes.

6. A flashtube comprising: an envelope having a substantially U-shaped discharge chamber containing a gaseous medium through which an electric discharge may be produced, said envelope being provided with a light-transmitting terminal window forming a part of the boundary of said chamber; a pair of spaced, similar, parallel, sintered, principal electrodes disposed within said U-shaped chamber remote from said terminal window, and between which principal electrodes an electric discharge may take place when the flashtube is rendered effective; a trigger electrode for rendering the flashtube effective, disposed substantially symmetrically between, parallel to, and insulated from said principal electrodes and having an exposed end within said chamber closer than either of said principal electrodes to the terminal window.

7. A flashtube as claimed in claim 6 and in which said terminal window transmits ultra-violet light.

8. A flash-producing system comprising: a flashtube with an envelope having a substantially U-shaped discharge chamber containing a gaseous medium through which an electric discharge may be produced, said envelope having a light-transmitting terminal window forming a part of the boundary of said chamber, a pair of principal electrodes disposed within said chamber remote from said terminal window, and between which an electric discharge may take place when the flashtube is rendered effective, and a trigger electrode disposed within said envelope between said principal electrodes and having one end exposed within said chamber closer than either of the principal electrodes to the terminal window, and the remainder of said trigger electrode insulated from said principal electrodes; a flash capacitor; means for connecting the flash capacitor across the principal electrodes; means for charging the flash capacitor to a potential normally ineffective to produce a discharge between said principal electrodes; a voltage-divider network connected between said principal electrodes; means for connecting the trigger electrode to an intermediate point in said voltage-divider network; and means for connecting a source of triggering impulses to the trigger electrode, thereby to render the principal electrodes effective to produce a discharge therebetween in said discharge chamber.

9. A flash-producing system as claimed in claim 8 and in which said intermediate point is substantially the electrical centerpoint in said voltage-divider network.

10. A flashtube for use with a plurality of similar flashtubes stacked in an array where said flashtube may be flashed individually without flashing any of said plurality of flashtubes in said array, comprising: an envelope with

a light-transmitting terminal window and containing a gaseous medium through which an electric discharge may be produced; a pair of spaced principal electrodes disposed within the envelope and between which an electric discharge may take place when the flashtube is rendered effective; a trigger electrode for rendering the flashtube effective, disposed within the envelope substantially symmetrically, both physically and electrically between the principal electrodes and having one end closer than either of the principal electrodes to the terminal window; means for insulating the trigger electrode from the principal electrodes at all points except the end closer to the terminal window; and means for confining the discharge between said principal electrodes when the flashtube is effective, to a path adjacent the terminal window and the uninsulated end of trigger electrode, said discharge path being longer than the straight-line distance between the principal electrodes.

11. A flash-producing system adapted to be positioned in close proximity to a similar system without the danger of cross triggering between said systems, comprising: a flashtube disposed stacked next to a similar flash device, said flashtube being provided with an envelope having a substantially U-shaped discharge chamber containing a gaseous medium in which an electric discharge may be produced, said envelope having a light-transmitting window forming a part of the boundary of said chamber, a pair of principal electrodes disposed within said chamber remote from said terminal window and between which an electric discharge may take place when the flashtube is rendered effective, and a trigger electrode disposed within the envelope between the principal electrodes and having one end disposed within said chamber closer than either of the principal electrodes to the terminal window, and the remainder of the trigger electrode insulated from the principal electrodes; a flash capacitor; means for connecting the capacitor across the principal electrodes; means for charging the flash capacitor to a potential normally ineffective to produce a discharge between said principal electrodes; a voltage-divider network connected between the principal electrodes; means for connecting the trigger electrode to the substantially electrical center point of the said network; a trigger circuit connecting a source of triggering impulses to the trigger electrode for triggering the flashtube.

12. A flash-producing system as claimed in claim 11 and in which said terminal window transmits ultra-violet light.

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