

1

3,415,605

## COMBUSTION FLASH BULBS

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No Drawing. Filed May 15, 1967, Ser. No. 638,631  
Claims priority, application Netherlands, May 17, 1966, 6606713

2 Claims. (Cl. 431-93)

### ABSTRACT OF THE DISCLOSURE

Combustion flash bulb filled with a mixture of oxygen and nitrogen fluoride.

The invention relates to a combustion flash bulb which after ignition supplies actinic light owing to a chemical reaction between a solid substance and a gas.

Flash bulbs of the said kind comprise a closed transparent bulb which contains an ignition mechanism, a solid substance and a gas. The bulb generally consists of glass and is mostly coated with one or more sometimes blue-coloured lacquer layers. The ignition mechanism commonly used comprises a filament wire with ignition paste. The filament wire may be caused to incandesce by electric agency. In general, the solid substance used is a metal wool such as zirconium or an aluminum-magnesium alloy. In the lamps of conventional type, the gas filling consists of a quantity of oxygen which chemically is more or less equivalent to the quantity of solid substance in the lamp. It has been suggested to use as gas filling instead of oxygen fluorine or a gaseous or volatile fluorine compound. In many cases, higher light outputs at a slightly higher colour temperature are obtained with a gas filling of fluorine or a volatile fluorine compound than with lamps having a gas filling of oxygen.

Suitable fluorine compounds are: oxygen fluoride (OF<sub>2</sub>) and nitrogen fluorides (e.g. NF<sub>3</sub>, N<sub>2</sub>F<sub>4</sub>).

Oxygen fluoride has the disadvantage that it is toxic. Therefore, the large-scale use of said gas in flash bulbs seems hardly possible without taking special steps.

One of the quantities with which the behaviour of a flash bulb after ignition can be described is the so-called maximum time. The term "maximum time" is to be understood to mean the time which passes between the ignition of the flash bulb and the instant at which the maximum light current is reached. It has been found that in flash bulbs having a filling of nitrogen fluoride, the maximum time is longer than in similar flash bulbs filled with oxygen and too long for use in combination with certain shutter mechanisms of cameras. However, the maximum time of said bulbs can be shortened by adding to the fluorine-containing filling gas a small quantity of a gaseous or volatile hydrocarbon compound which reacts with the fluorine-containing gas after ignition of the flash bulb. It is known that the 50% flashing time, i.e. the time in which the light current is at least 50% of the maximum light current, can be lengthened in flash bulbs having an oxygen filling by the use of an auxiliary gas having a braking effect on the combustion. For this purpose, suitable auxiliary gases are volatile halogen-containing compounds of boron, carbon, silicon, titanium, germanium or tin having a combustion heat smaller than 200 kcal./mol. Under the conditions prevailing in the bulb, these compounds do not react with oxygen or with the solid substance.

2

When the volume of a bulb of a flashlight lamp decreases, the quantity of solid substance and gas remaining unchanged, the light output decreases. With an increase of the quantity of solid substance and gas, the bulb volume being constant, the light output increases less than proportionally. This effect particularly occurs in flash bulbs having a fluorine-containing gas filling. It was a surprise to find that the light output of flash bulbs having an oxygen filling can be increased by replacing part of the oxygen by an equivalent quantity of nitrogen fluoride, without the maximum time and the 50% flashing time being substantially varied as compared with similar flash bulbs having a filling solely consisting of oxygen. The mixture of oxygen and nitrogen fluoride may be used also in flash bulbs of small volume without the occurrence of additional light losses.

The flash bulb according to the invention is characterized in that the bulb contains a mixture of oxygen and nitrogen fluoride.

The optimum results were obtained if the ratio in the gas mixture between oxygen and nitrogen fluoride, expressed in equivalent quantities, was 1:1. An equivalent quantity of oxygen or of NF<sub>3</sub> is understood herein to mean an amount of oxygen or of NF<sub>3</sub> sufficient to convert ¼ gram atoms of zirconium into the oxide or the fluoride respectively. Consequently an equivalent quantity of oxygen is understood to mean herein ¼ g. mol of oxygen and an equivalent quantity of nitrogen fluoride: 1 g. mol of the fluorine compound divided by the number of fluorine atoms per molecule of the compound; for NF<sub>3</sub>, this is consequently ⅓ g. mol. Satisfactory results were already obtained if the ratio between oxygen and nitrogen fluoride, expressed in equivalent quantities, was 3:1.

In Table I, which relates to a flash bulb having a volume of approximately 1.2 cm.<sup>3</sup> and which contains 22 mgs. of zirconium in the form of a metal wool, the relative pressures in a gas mixture of oxygen and NF<sub>3</sub> are stated in the first and second columns; the third column indicates the ratio between oxygen and NF<sub>3</sub> in the gas mixture, expressed in equivalent quantities. The fourth and fifth columns indicate the light output in lumenseconds and in lumenseconds per mg. of zirconium, respectively. The sixth column indicates the maximum time. The stated values are invariably the average values of measurements on five flash bulbs.

For comparison, the table also includes measurements relating to bulbs solely containing oxygen and NF<sub>3</sub>, respectively.

TABLE I

Pressure O <sub>2</sub> in Torr	Pressure NF <sub>3</sub> in Torr	O <sub>2</sub> /NF <sub>3</sub> in equivalent quantities	Light output—		Maximum time in msec.
			In lmsec.	In lmsec./mg.	
360	-----	-----	7,610	346	8-10
270	119	3:1	8,250	376	9-14
180	238	1:1	9,050	410	13-16
90	357	1:3	7,350	336	21-29
-----	475	-----	5,000	228	60-70

Use is preferably made of a stoichiometric or an excess gas filling, that is to say that the bulb contains a sufficient quantity of oxygen and NF<sub>3</sub> or an excess quantity for burning the whole quantity of zirconium whilst forming zirconium compounds. This is shown in Table II which relates to lamps having a bulb volume of approximately 1.2 cm.<sup>3</sup> and which contain 18 mgs. of zirconium. The fourth column of this table indicates the ratio between gas and zirconium, expressed in equivalent quantities.

TABLE II

Pressure O <sub>2</sub> in Torr	Pressure NF <sub>3</sub> in Torr	O <sub>2</sub> /NF <sub>3</sub> in equivalent quantities	Gas/ zirconium	Light output—		Maximum time in msec.
				In lmsec.	In lmsec./ mg.	
118	156	1:1	0.8	5,640	311	9-14
147	195	1:1	1.0	7,350	408	10-13
176	234	1:1	1.2	8,000	445	10
156	104	2:1	0.8	5,050	280	8-10
195	130	2:1	1.0	7,000	389	8-13
234	156	2:1	1.2	7,400	411	8-10

The stated values are invariably the average values of measurements on ten flash bulbs.

It should be noted that in bulbs solely containing oxygen, the maximum time generally lies between 8 and 15 msec. and that the light output per mg. of zirconium is approximately 350 lumenseconds.

What is claimed is:

1. In a combustion flash bulb capable of supplying actinic radiation upon ignition to a chemical reaction between a solid substance in said bulb and a gas in said bulb the improvement which comprises employing as said gas a mixture of oxygen and nitrogen fluoride, the ratio of oxygen and nitrogen fluoride, expressed in equivalent

quantities being between 3:1 to 1:1 and wherein the total amount of oxygen and nitrogen fluoride is sufficient to convert all of said solid substance present in the bulb to the corresponding saturated oxide and fluoride.

2. A combustion flash bulb as claimed in claim 1, characterized in that the ratio between oxygen and nitrogen fluoride in the gas mixture, expressed in equivalent quantities, is approximately 1:1.

No references cited.

JAMES W. WESTHAVER, *Primary Examiner.*

UNITED STATES PATENT OFFICE  
CERTIFICATE OF CORRECTION

Patent No. 3,415,605

December 10, 1968

Johannes Cornelius van der Tas et al.

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 58, "21-29" should read -- 24-29 --.

Signed and sealed this 31st day of March 1970.

(SEAL)

Attest:

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Commissioner of Patents