

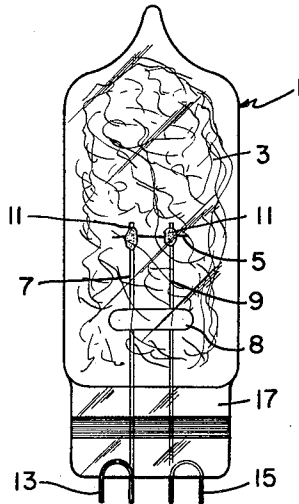
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PHOTOFLASH LAMP

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3,158,014

PHOTOFLASH LAMP

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This invention relates to the manufacture of photoflash lamps and more particularly to those photoflash lamps in which shredded zirconium foil is employed as the combustible light-producing material, the pressure of the combustion supporting gas is above atmospheric and the volume of the lamp is less than about 10 cc.

In recent years shredded zirconium foil has been used more and more extensively and has gradually replaced shredded aluminum foil as the combustible light-producing material in many photoflash lamps. Concurrently therewith, pressures have increased above atmospheric and lamp volume has decreased. Although, for many years, those skilled in the art considered zirconium and aluminum as substantially equivalent to one another insofar as their use as the combustible light-producing material in photoflash lamps is concerned, it has been discovered more recently that such is not the case. As a matter of fact, it has been discovered that these two materials differ significantly from one another in a number of different characteristics. Some of these differences provide direct advantages attainable when zirconium is used instead of aluminum as the combustible light-producing material. On the other hand, there are other characteristics, which distinguish zirconium from aluminum, which pose certain problems in connection with the use of zirconium which were not encountered heretofore when aluminum was used as the combustible.

Some of the physical characteristics of these two materials which differ somewhat appreciably are shredability and shred resiliency. With modern, high speed foil shredding equipment such as that shown in U.S. Patent 2,699,831 for example, no great difficulty has been experienced in recent years insofar as the shredability of aluminum is concerned. However, with the introduction of zirconium as the preferred combustible material, a substantial difference in shredability was noted and considerable time and effort has been spent in an effort to develop techniques which would insure a good clean cut free of burrs each time a strip of zirconium foil is severed from a large sheet of zirconium foil. It has also been noted that shredded zirconium foil is much more springy than shredded aluminum foil. This undesirable characteristic makes handling of the material during lamp manufacturing operations more difficult, particularly in view of the trend to smaller and smaller lamp envelopes.

The burning rate of shredded zirconium foil is substantially different from that of shredded aluminum foil; it is appreciably faster. This is an undesirable characteristic in many cases because it results in the maximum light output being reached too early for some types of camera shutter synchronization. One means which has been suggested to overcome this is the use of a slow, low activity igniter system. However, this is not without its drawbacks because low activity igniters are inherently susceptible to erratic, unreliable ignition characteristics. Since the igniter is the combustion initiating source, it is essential that it function effectively even when the battery power source is in a marginal condition.

In view of the foregoing, one of the principal objects of this invention is to improve the above-mentioned physical and performance characteristics of zirconium.

Another of the principal objects of this invention is to improve the above-mentioned physical and performance characteristics of zirconium without adversely affecting other physical and performance characteristics.

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Other objects, advantages and features are attained in accordance with the principles of this invention by annealing the zirconium foil sufficiently to cause the development of crystal grains in the material in the range of from about 0.003" to about 0.0006" average diameters. The crystal grain average diameter was determined in accordance with the principles set forth in "Methods for Estimating the Average Grain Size of Non-ferrous Metals Other Than Copper and Their Alloys," A.S.T.M. Designation: E91, Plate 1, For Untwinned Metals, published by the American Society for Testing Materials. Material with a grain size somewhat below 0.003" tends to have many of the undesirable characteristics of unannealed material, i.e., the cut shreds are very springy and difficult to handle in lamp making and the combustion rate of the shreds in finished lamps is faster than desirable when used with an active primer which will provide reliable ignition. Material with a grain size somewhat in excess of 0.0006" crumbles readily when cut into shreds since the grain size approaches the cross sectional area of the shred. An intergranular boundary extending across the shred cross section results in a cleavage plane which is inherently weak and fractures easily. In extreme cases, shred fractures of this type can be excessive, causing the formation of many fragments. These fragments, due to their small size, are light, freely airborne, and likely to collect in areas surrounding the shred cutting equipment causing a fire hazard. Due to the extremely combustible nature of zirconium, accumulations of small particles are most dangerous.

In the accompanying drawing, the single figure illustrates one type of photoflash lamp with which this invention may be employed. The lamp comprises a sealed light-transmitting envelope 1 having a volume of about 1.2 cc., within which about 27 milligrams of shredded zirconium foil 3 is disposed. The envelope 1 is provided with a filling of combustion-supporting gas, such as oxygen for example, at a pressure of about 440 cms. Hg. A filament 5 is disposed within the envelope 1 and is attached to lead-in wires 7 and 9 which are supported by and extend through insulator button 8. The inner ends of the lead-in wires 7 and 9 are provided with a quantity of ignition paste 11. The lead-in wires 7 and 9 extend through an end of the lamp envelope and are bent into the form of stirrups 13 and 15 lying along opposite sides of the press 17, the wires finally re-entering the press 17 some distance away from the points at which they emerge. The stirrups 13 and 15 define electrical contact members for engagement with electrical contact members of a flashgun.

Tests were made, using annealed and unannealed zirconium foil, with lamps of the type just described and the following results were obtained:

Foil condition	Foil thickness (inches)	Shred width (inches)	Photometric results		
			Peak time (millise.)	Total output (lumen-sec.)	Efficiency (lumen-sec./mg.)
Unannealed	0.00086	0.0013	8.5	8,921	330
Annealed			9.6	10,153	376
Unannealed			8.5	8,929	331
Annealed	0.00097	.0013	10.3	9,857	365
Unannealed			9.8	9,054	335
Annealed			11.5	10,629	394
Unannealed	0.00086	.0018	10.3	9,562	354
Annealed			13.4	10,002	370

The foregoing tabular data reflects several improvements in performance characteristics obtained when shredded zirconium foil, having grain sizes in the range of about 0.0003" to about 0.0006" average diameters, is

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employed as the combustible material in photoflash lamps. The time to peak has been lengthened, on the average, by about 20%. Thus the slower combustion rate of annealed zirconium makes possible the use of a more active and hence a more reliable igniter than can be used with unannealed zirconium.

A noticeable improvement in physical characteristics is obtained with the annealed zirconium. Its shredability is improved and its springiness diminished.

Most unexpected was a substantial increase in light output and efficiency with the annealed zirconium foil. As the above table indicates, these performance characteristics were improved, on the average, by over 10%.

Similar performance improvements may also be obtained with another family of photoflash lamps identified commercially as M3, M5 and M25. A T6½ bulb is employed in the manufacture of these lamps and the sealed envelope has a volume of about 7.5 cc. These lamps are provided with a filling of about 41 milligrams of shredded zirconium foil and a combustion supporting gas, such oxygen for example, at a pressure of about 120 cms. Hg. The data developed in tests with these lamps are as follows:

Foil condition	Foil thickness (inches)	Shred width (inches)	Photometric results		
			Peak time (millisec.)	Total output (lumen-sec.)	Efficiency (lumen-sec./mg.)
Unannealed.....	0.00097	0.0013	16.0	16,700	402
Annealed.....			17.8	18,045	435
Unannealed.....	.00097	.0018	17.2	17,530	422
Annealed.....			21.8	20,393	491

What I claim is:

1. A photoflash lamp comprising: a sealed light-transmitting envelope; a combustion-supporting gas filling in

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said envelope; a quantity of filamentary zirconium disposed in said envelope, said zirconium being characterized by crystal grains in the range of about 0.0003" to about 0.0006" average diameters; and ignition means disposed in said envelope in operative relationship with respect to said filamentary zirconium.

2. A photoflash lamp comprising: a sealed light-transmitting envelope; a combustion-supporting gas filling in said envelope at a pressure above atmospheric; a quantity of filamentary zirconium disposed in said envelope, said zirconium being characterized by crystal grains in the range of about 0.0003" to about 0.0006" average diameters; and ignition means disposed in said envelope in operative relationship with respect to said filamentary zirconium.

3. A photoflash lamp comprising: a sealed light-transmitting envelope having a volume of less than about 10 cc.; a combustion-supporting gas filling in said envelope at a pressure of at least several atmospheres; a quantity of filamentary zirconium disposed in said envelope, said zirconium being characterized by crystal grains in the range of about 0.0003" to about 0.0006" average diameters; and ignition means disposed in said envelope in operative relationship with respect to said filamentary zirconium.

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