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Electric Matches and Squibs

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The terms electric match and squib are often used interchangeably in the fireworks industry. However, there are at least two good reasons not to do this, one technical and one legal. Technically, these are two different items both in terms of form and function. Legally, although both are Class C explosives (Explosives, 1.4g), squibs are on the BATF Explosive Materials List, which invokes all the regulatory requirements normally reserved for Display Fireworks, Blasting Caps and Dynamite.

Figure 1 is a sketch of an electric match. The item consists of a short length of high resistance wire (bridge wire) mounted across copper cladding on an electrically insulating substrate. The high resistance element is surrounded by a heat sensitive pyrotechnic composition. Coated on top of this first composition may be a second less sensitive composition that enhances the pyrotechnic output of the device and to some extent serves to protect the first composition. Finally, there is normally a coating of material (often nitrocellulose lacquer) to further protect and strengthen the electric match compositions. Wires to facilitate making electrical connections (leg wires) are usually pre-attached to the electric match. Photo 1 shows a collection of electric matches.

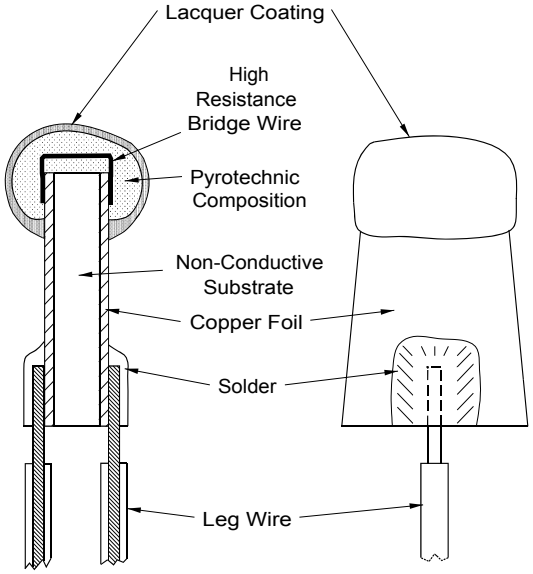

Figure 1. A sketch illustrating the construction of a typical electric match.

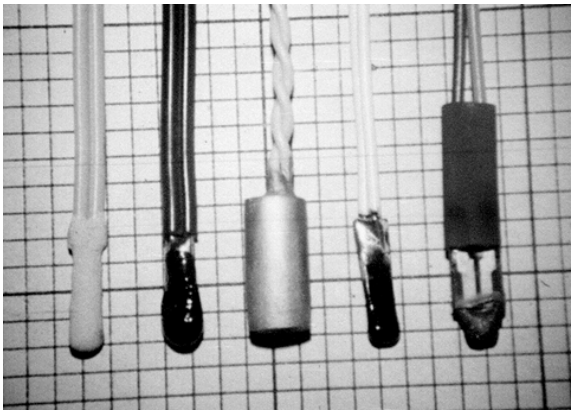

Photo 1. Some typical electric matches. (The grid in the background is 0.1 inch.)

The function of an electric match is to produce a small burst of flame somewhat like that produced by the composition on a safety match. The output is initiated by the passage of an electrical current through the device. This heats the bridge wire and in turn ignites the pyrotechnic composition. It is the amount and duration of the electric current that determines whether an electric match will ignite. Figure 2 (courtesy of Atlas Powder Company, Dallas, TX)[1] illustrates the firing characteristics for Atlas matches as a function of current and time for which it is applied. Note that "all-fire current" is defined as the minimum current that is required to cause 100 of 100 matches to fire, when applied for a specified amount of time. (It is the authors' belief that when no time is specified, it is assumed to be 5 seconds.) "No-fire current" is defined as the maximum current that can be applied that results in 0 of 100 matches igniting, when applied for the same amount of time. Between these two regions in Figure 2 is another narrow region in which it is uncertain whether the electric match will ignite.

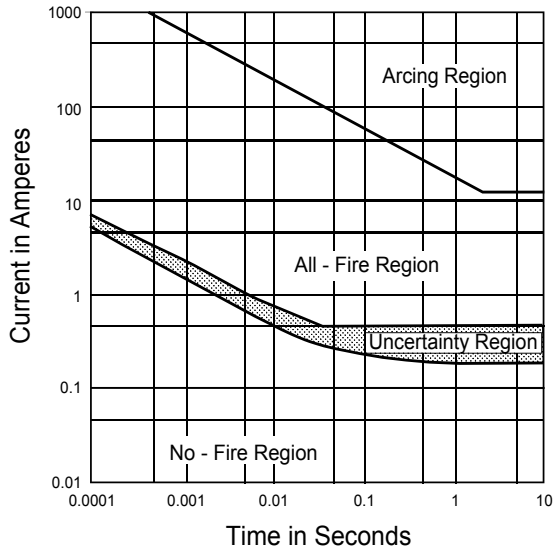

Figure 2. Electrical response characteristics of Atlas electric matches. (Reproduced through the courtesy of Atlas Powder Company, Dallas, TX).

It is true that electric squibs contain an electric match as an initiator; however, squibs contain substantially more pyrotechnic material, a base charge. Also, squibs have an external casing, usually made of metal, giving them an appearance similar to that of a miniature detonator (blasting cap). The effect of these two added elements greatly magnifies their effect upon functioning. In fact some squibs are so powerful as to allow them to initiate high explosives,[2] making them essentially equivalent to a small detonator. Figure 3 and Photo 2 illustrate the construction and appearance of squibs.

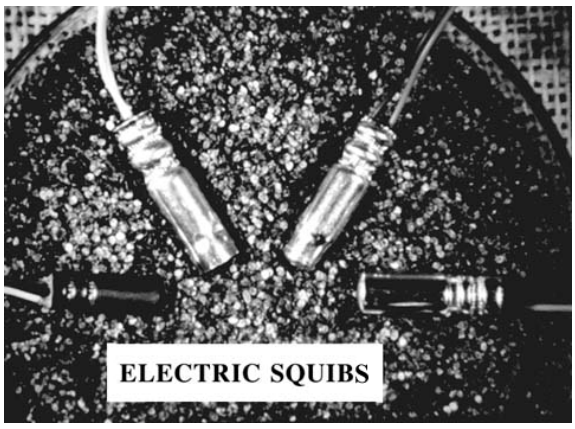

Photo 2. A photograph of some typical electric squibs. (Supplied by George Jackson, FLETC.)

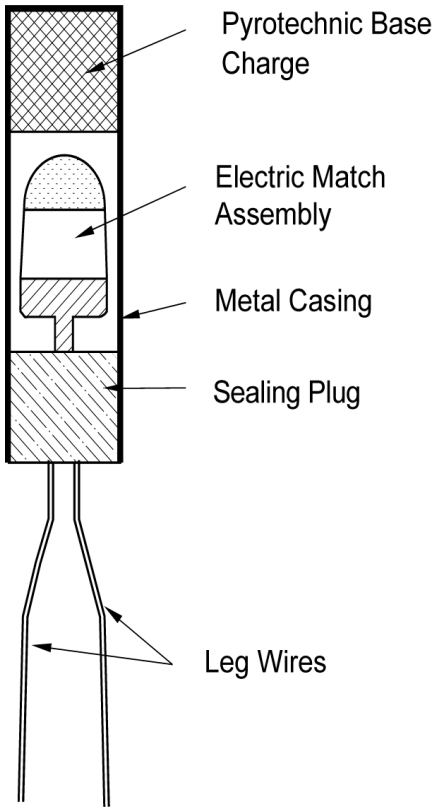

Figure 3. A sketch illustrating the construction of a typical electric squib.

Regarding the correct identification of electric matches and squibs, there are some clarifications that should be made with respect to Photos 1 and 2. Note that the electric match pictured in the center of Photo 1 has an appearance somewhat similar to that of a squib. However this device is essentially solid plastic with only a small recess in the end, in which the bridge wire and match composition are contained. Similarly, the electric match on the right has an inert plastic sleeve over the point where its leg wires attach to the match tip. Also note that there is a small difference in scale between Photos 1 and 2, with the items in Photo 1 appearing slightly larger relative to those in Photo 2.

Thus it should be fairly clear that electric matches and squibs are substantially different classes of items. Presumably that difference is one reason for squibs being on the BATF Explosive Materials List. As most readers already know, the presence of an item on this list invokes stringent storage, record keeping and licensing requirements on the item's possession, sale and use. Thus squibs are definitely BATF regulated items. The regulatory status of electric matches is not entirely

clear. Some might argue that they are included under the general category of "igniters", which is on the explosives materials list. However, note that model rocket igniters, such as those shown in Photo 3, are definitely a form of electric match. These are available for purchase in literally thousands of hobby shops and are certainly not considered to be regulated. Further, the BATF is certainly aware that millions of electric matches are used annually to ignite fireworks and that most are being sold, stored and used as unregulated items by fireworks companies.

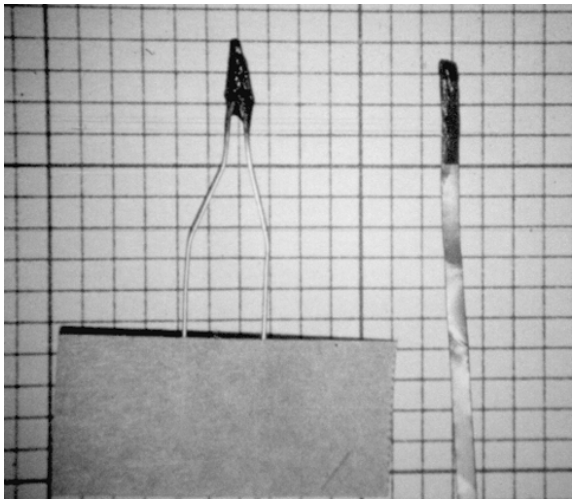

Photo 3. A Photograph of two types of model rocket igniters. (The grid in the background is 0.1 inch.)

It is a mark of a professional to know and use the vocabulary of his field. Also, because of the difference in regulatory status, and because of the limited experience of some enforcement personnel in identifying and differentiating between electric matches and squibs, it is little short of foolish for anyone in the fireworks trade to carelessly refer to electric matches as squibs. [It might be of some interest to note that care was taken in revising *NFPA 1123-1990, Code for the Outdoor Display of Fireworks*, to use the correct term (i.e., electric match).]

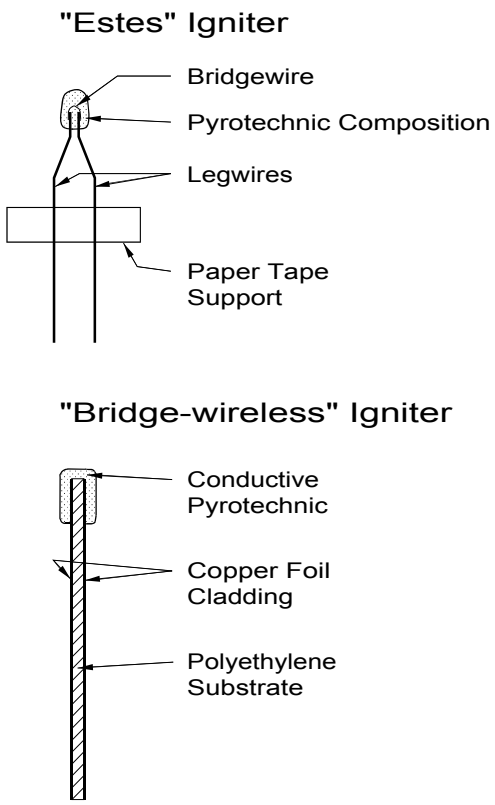

Figure 4. Sketches illustrating the construction of two types of model rocket igniters.

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References

1) Atlas Powder Company, *Explosives and Rock Blasting,* Atlas Powder Company (1987).

2) J.H. McLain, *Pyrotechnics: From the Viewpoint of Solid State Chemistry*, The Franklin Institute Press (1980).