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Electric Ignition of Shock Tube Firing Systems

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NOMATCH™ is a new system for igniting fireworks that replaces quick match with shock tube plus flame-to-shock (or electric-to-shock) and shock-to-flame attachments. The system was introduced by B & C Products, Inc., with a press release included in the July 1994 Issue of *American Fireworks News*, an article in the July 1994 issue of *Fireworks Business*, and a demonstration and seminar at the 1994 Pyrotechnics Guild International (PGI) convention.[1] There was considerable discussion, among the PGI convention attendees, of the potential usefulness of this new system in various fireworks environments. The safety and performance advantages of the system seem obvious.[1] Below is a brief discussion of two low cost alternatives for electric ignition of shock tubing. For the most part, these are well known and commonly used methods; however, probably not among those in the fireworks trade. It is hoped that this information is interesting and possibly will aid in the introduction of this system.

Shock tube is initiated by the simultaneous application of flame and pressure. (Some information on shock tube, its construction and manner of functioning, was presented in an earlier article.[2] The flame and pressure can be supplied by a number of sources, such as a small explosion, as might be provided by a small arms ammunition primer. This is the method commonly used in the blasting industry.

At the PGI convention, ODA Enterprises was selling a one circuit capacitor discharge (CD) "Blasting Box". This unit reportedly charges to about 300 volts and delivers about 8 joules of energy. The unit is different than some on the market, in that it does not have a series resistor to limit the firing current in the event of firing into a short circuit. In the application described below, this is an important difference. ODA Enterprises was also selling electric match heads, with the Nichrome bridge wire, but without any pyrotechnic coating. When these uncoated match heads are fired by the CD Blasting Box, the energy is sufficient to produce a flash of fire and a modestly loud "snap" (i.e., flame and pressure). Having used similar but more powerful devices to initiate shock tube in experiments in the laboratory, it seemed worth while to consider whether the ODA Blaster Box and match tips would successfully fire shock tube. Bill Ofca, B & C Products, speculated that it would.

Upon return from the PGI Convention, a test of the ODA Blaster Box and match tips' ability to initiate shock tube was undertaken. In this test, Ensign-Bickford "Noiseless Trunkline" (shock tube) was used. The match tips were positioned in front of the shock tube simply using a short length (≈0.5 in.) of 1/8 in. (internal diameter) Tygon tubing, see Figure 1. Using this arrangement, 10 of 10 successful ignitions of the shock tube resulted.

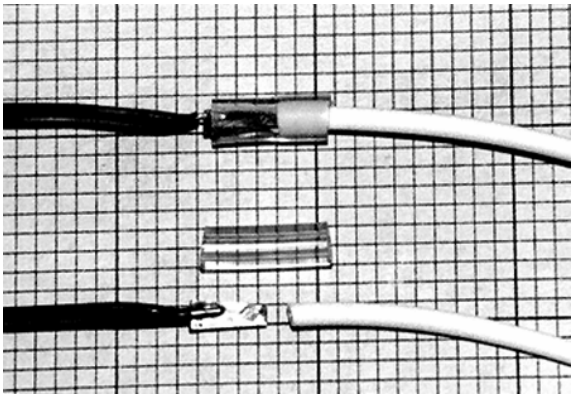

Figure 1. Illustration of positioning/attachment of bare electric match tip for firing shock tube.

Another common method for igniting shock tube was demonstrated by Gerald Laib during a lecture at the 1993 PGI Convention. This is to simply cause an electric spark at the end (or preferably just inside) of shock tube. In a conversation with Scott Anderson, it was suggested that a device could be made, somewhat like the Pyrodigital firing module, except that instead of

having plug-ins for electric match wires, there could be plug-ins for shock tube. On the inside end of the connector there would be a small spark gap which would be actuated by a signal from a computer. In this way, shock tube could be initiated directly by the spark discharge, without using a match tip. After firing a series of shock tubes attached for one display, they could be removed, and for a subsequent display, new shock tubes inserted for the next use of the firing module.

Upon return from the PGI Convention, a test of the reusable spark gap was conducted, again using Ensign-Bickford Noiseless Trunkline. Two configurations were tried. In one case, a simple spark gap was made by inserting a tight fitting pair of wires into a short length (≈0.4 in.) of shock tube, which was then cut off to expose the ends of the pair of the wires centered in the shock tube. This spark gap and the shock tube to be initiated, were simply connected using the same piece of Tygon tubing described above, see Figure 2. Using this arrangement, 10 of 10 pieces of shock tube were fired using the discharge of a 0.05 mF capacitor charged to about 6 kV. Note that connection of the capacitor to the spark gap was made by causing a spark to jump between the capacitor lead wire and the spark gap. Accordingly, only a small fraction of the 1 joule of energy delivered by the capacitor was dissipated by the spark gap for the shock tube. In a commercially produced system, the spark energy would likely be produced using solid state electronics and a transformer attached directly to the spark gap.

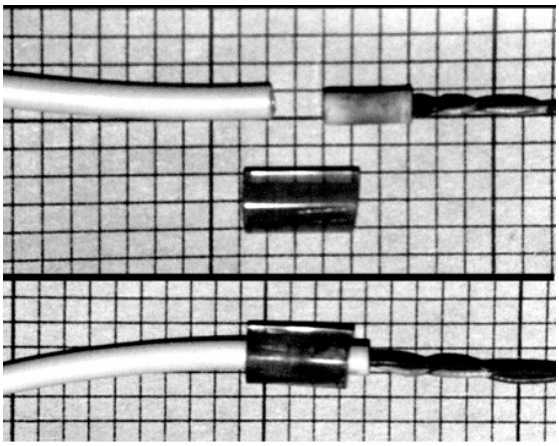

Figure 2. Illustration of positioning/attachment of a simple spark gap for firing shock tubing.

As a test of an inexpensive reusable attachment system, a spark gap was built into a compression fitting for 1/8-inch tubing, see Figure 3. In this case, the shock tube is simply inserted into the fitting and the nut tightened to hold it in place. In this fitting, there is a somewhat elastic compression ferrule, such that it can be used repeatedly, providing it is not over tightened. Using this system, multiple successful firings of shock tube was achieved. However, because of haste in assembling the unit, the spark gap was not properly centered, and higher spark energies were required.

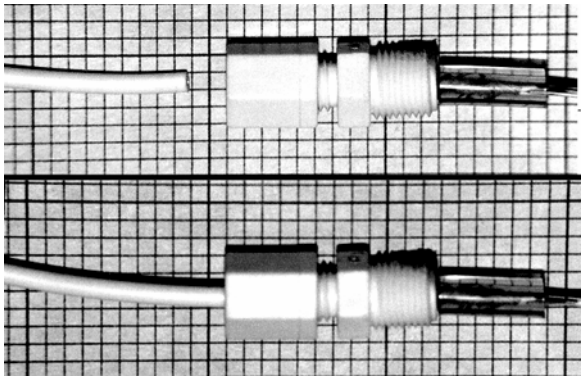

Figure 3. Illustration of reusable connector for shock tube fired using a spark gap.

It would seem the NOMATCH™ firing system offers significant potential for improved safety and reliability in firing aerial shells, particularly under adverse conditions. It is hoped the above article contributes by identifying some low cost electric initiation systems for shock tube.

References

1) Ensign-Bickford Co. and B & C Products, Press Release, *American Fireworks News*, p. 154, 1994; "Nomatch™ New Display Breakthru", *Fireworks Business*, p. 127, 1994; Bill Ofca, "Ensign-Bickford's NOMATCH", Pyrotechnics Guild International Seminar, 1994.

2) K.L. and B.J. Kosanke, "Dautriche - Shock Tube Measurement of High Propagation Rates in Pyrotechnic Materials", *Pyrotechnics Guild International Bulletin*, 80, 1992.

3) ODA Enterprises, 97 Mark Bradford Drive, Holden, MA 01529.