snow science

Burn, Baby, Burn

Story by John Brennan

Necessity, they say, is the mother of invention. Certainly that sentiment held true during the early stages of explosive engineering. While seaside forts were concerned over static predetonation of their black-powder caches in the 14th century, the mining industry in the 1800s was plagued by accidents surrounding the ignition methods for their black-powder blasts.

William Bickford had no immediate connection with the mining industry. His financial well-being was attributed to his career as a currier and leather merchant. Nonetheless, he was keenly aware of the accidents occurring in the tin mines in England during the early 1800s, and he set out to find a solution.

During this period, black-powder shots were ignited by crudely fashioned fuses made of black-powder-filled goose quills or paper straws. After some initial failures, Bickford found providence when he saw a rope-making machine in action around 1830. He soon fashioned a machine that wound jute, a plant fiber, around a core of gunpowder. Completing the process, a varnished outer sheath was added to waterproof the assembly.

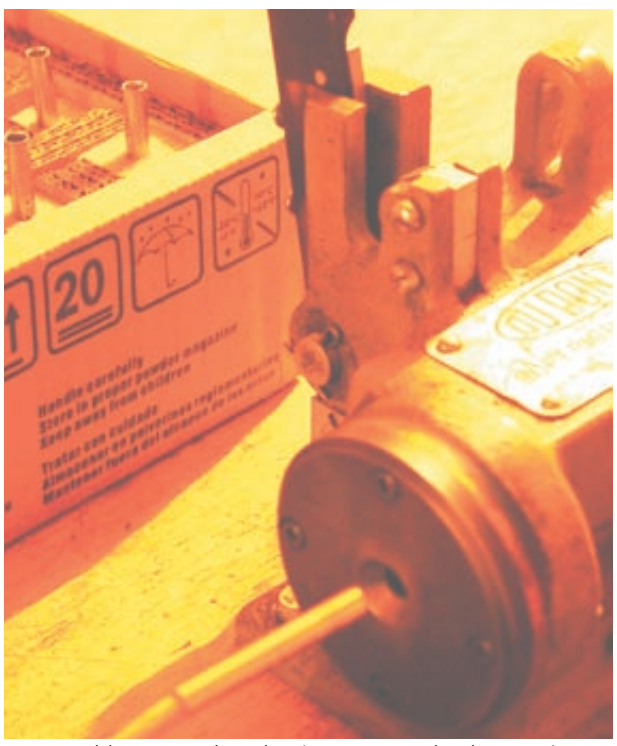
In an unfortunate twist of fate, Bickford perished in 1834 just prior to the opening of his first safety-fuse factory. It would have made the ingenious Bickford proud to know that in his Tuckingmill factory's first year, almost 45 miles of his invention was produced.

Several years after opening the first commercial safety-fuse factory in the world, the corporation took their business overseas to the United States. It was at this point that the company became Ensign-Bickford, with its headquarters relocated to Connecticut.

As an avalanche and explosive specialist, I have heard many times that safety fuse is an old and antiquated technology. While the former is certainly true, I adamantly disagree with the latter. From its humble beginnings, safety fuse saw immense growth over the decades since its invention. The simplicity of use, cost effectiveness, and reliability are several of the factors that can be attributed to its continued success.

Fuse winding machines in action. *Photo courtesy of WANO Schwarzpulver GmbH*

Part of the fuse-fabrication process in India.
Photo courtesy of Commercial Explosives (India) Ltd



A venerable DuPont bench crimper at work. These units are no longer manufactured. *Photo by John Brennan*

Reliability of safety fuse cannot be understated. In his excellent article, *In Defense of Safety Fuse*, in the International Society of Explosive Engineering's journal, Fred Hynes states, "As a field employee of the DuPont company and, later, the Ensign-Bickford company, I investigated many safety-fuse accidents, mostly fatalities, and never once was there any evidence of fast-burning fuse, although fast-burning fuse was always the claim of the survivors. I realize that what I am going to say hereafter flies in the face of old, treasured mining folklore, but it needs to be said in order to convince the younger generations of miners, most of whom have never seen safety fuse, that safety fuse is just that, it is safe; it never burns faster or slower than it is designed to burn. However, safety fuse is only as safe as the man who is using it, and that is where the problem lies."

One of the world's largest producers and users of safety fuse in recent years has been Africa. In an ironic twist that would see Bickford grinning proudly from the grave, a used Tuckingmill fuse-fabrication machine was sold to the African explosive behemoth African Explosives Limited (AEL) in the early 1960s. AEL not only began production of safety fuse, but they also manufactured their own black powder for their product. This seems to be a typical trait of fuse manufacturers; Wano, a fuse manufacturer from Germany, has been making black powder since 1682.

During AEL's fuse plant's heyday in the mid-1980s, over 1.4-million meters of fuse were spun each day! At this point, it took 182 fuse manufacturing machines to meet the market demands. While production has slowed at AEL to only about 700,000 meters per day, it can be clearly seen that safety fuse is in no imminent danger of extinction in Africa.

Indeed, aside from the geocentric philosophy of most US explosive users, safety-fuse manufacturing is still alive and well in many other countries around the world. India is a major manufacturer, with numerous producers of black powder and safety fuse. Annual countrywide production numbers are in the hundreds of millions of meters. Peru deserves mention at 60-million meters a year. And, while Germany manufactures a quality fuse, their production numbers are only in the 1000-kilometer-a-year range.

Bulk fuse is currently imported into North America through Petro-Explo, Inc., in Arlington, Texas. Their staple fuse products from Tec Harseim in Chile were recently cut as that factory, most recently owned by Dyno Nobel International, shut their doors in 2003. Petro-Explo now imports similar products from Mexico.

The majority of USA bulk fuse users are now using the Dyno USA-owned Compañia Mexicana de Mechas Para Minas fuse sold under the trade name Cobra Fuse. Previously, Tec Harseim produced a military spec fuse that found favor with avalanche-control programs that liked its hotter spit and burning characteristics. While Compañia Mexicana produces a similar product, contractual agreements with Ensign-Bickford Aerospace make it unavailable for commercial use until at least 2012.

Despite the staggering amounts of safety fuse still being produced worldwide, users should resist being lulled into a false sense of product availability. Shock tube initiating systems are drastically cutting into the safety-fuse market. Several countries, such as Russia and the United States, have prohibited the use of safety fuse in some mining applications.

AEL, the largest manufacturer of safety fuse in the world, has invested heavily in the manufacturing of shock tube: a thin plastic tube lined with a dusting of high explosive. When initiated, the detonation signal is passed through the tubing at 6500 feet per second without rupturing it. The tubing is an inexpensive, highly reliable, and safe way to initiate a blast. Unfortunately, it is a system that doesn't lend itself readily to avalanche control. The need to couple the blaster to the explosive charge is an obvious challenge, as is the need to collect the spent tubing.

An interesting characteristic of the core of some safety fuse is its ability to carry a static charge – a phenomenon that Canadian authorities feel could cause predetonation. Because of this concern Canada, and only Canada, mandates the use of pre-manufactured blasting-cap/safety-fuse assemblies that have a shunting staple installed. This staple provides a preferential pathway for the static charge to ground itself through. It is important to note that blowing snow can generate in excess of 20,000 volts of static electricity.

There is quite a bit of commercial interest in the cap and fuse market that exists in North America and around the globe. A better-educated consumer can ask their explosive distributors about the availability and cost of other international product alternatives. It is Avalanche Mitigation Service's aim to be apprised of the safety-fuse options available. Contact us with your comments and concerns at jb@avalanchemitigationservices.com

Related Reading

Increasing Explosive Safety, John Brennan, 2002, www.avalanchemitigationservices.com/articles.htm

In Defense of Safety Fuse, Fred Hynes, ISEE, March/April 1985. Contact John Brennan for copies.

John Brennan has been a member of the National Ski Area Association's Explosive Committee since 2002 and on the Avalanche Artillery Users of North America Committee since 2004. He is pleased to note that he recently sold his 10th Falcon GT Avalauncher.