(continued)

Secondary explosives are used in an exploding bridgewire detonator for the initial pressing and output pellet. PETN is the most commonly used secondary explosive for the initial pressing. In general, it will result in the lowest threshold voltages and current if properly processed and matched to the bridgewire characteristics.

THE FUNCTIONING OF AN EBW DETONATOR

To function as an EBW detonator, electrical energy is applied to the bridgewire as described earlier for exploding wires. A capacitor is discharged into the bridgewire circuit. The rate of this energy application and its magnitude result in the explosion of the bridgewire in the detonator. As the bridgewire explodes, the shock wave and thermal energy are transferred into the low density secondary explosive from the wire at about 1500 meters/sec. As the wave travels into the explosive, a detonation of the explosive is initiated and builds up to the normal detonation velocity of the initial pressing explosive. This velocity is approximately 5000 meters/sec., since the initial pressing of explosives is only 50% of crystal density. As the shock wave moves through the initial pressing and into the output pellet, the velocity of the wave again increases due to the higher density pellet. In general, this wave will increase to 8000 meters/sec. prior to breakout.

The time from bridgewire burst to shock wave breakout is called the function or transmission time of the detonator. This time is on the order of one to several microseconds depending upon the overall length of the detonator. Also important is the time from first application of the current or closure of the gap in the firing unit until the shock wave breakout. This time, generally called the total transit time, includes the time shown in Figure 4 for current buildup and dip plus the function time of the detonator.

COMPARISON BETWEEN LOW ENERGY AND EBW DETONATORS

A comparison between an EBW detonator and a low energy detonator is shown in Figure 5. The important physical difference is the explosive next to the bridgewire. In a low energy detonator, this explosive is one or two types of primary explosive pressed to approximately 90% crystal density. In an EBW detonator the explosive next to the bridgewire is a secondary explosive pressed to approximately 50% crystal density. In general the output pellet material and construction are similar.

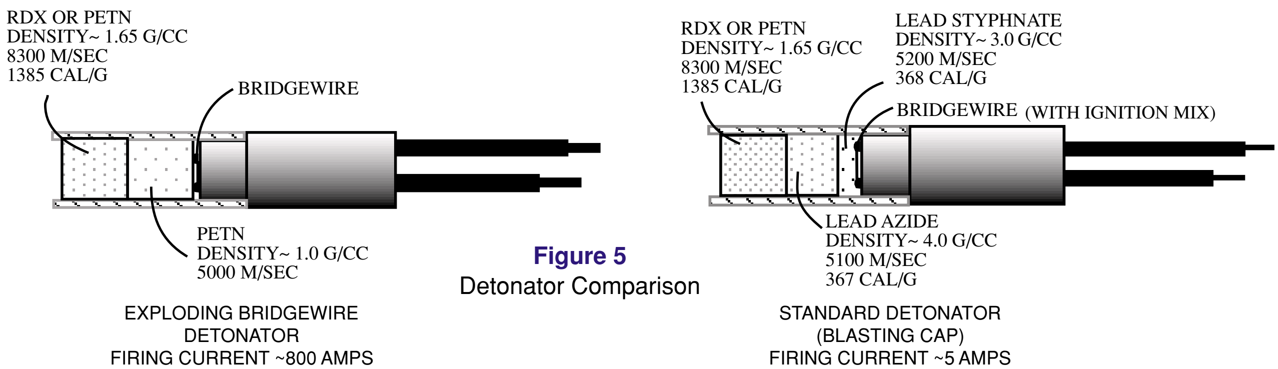

Figure 5
Detonator Comparison

For functioning a low energy detonator the bridgewire need not be exploded, but only heated to the ignition temperature of the ignition mix next to the bridgewire. This will cause ignition of the primary explosive next to the bridgewire. Due to the characteristics of primary explosives, this ignition rate will increase through a deflagration phase and into a detonation. The detonation shock wave in the primary explosive builds up to approximately 5000 meters/sec. As this shock wave moves into the output pellet, it increases to a shock wave velocity of approximately 8000 meters/sec. due to the characteristics of the secondary explosive output material.

Therefore, functional differences between a low energy and an EBW detonator are such that a low energy detonator requires only heating of the bridgewire whereas an EBW detonator requires exploding of the bridgewire. The firing system for a low energy detonator requires a relatively low voltage, low current system for detonation such as may be obtained from a battery or any low voltage D.C. power source. In fact, most low energy detonators require some type of added resistance or circuitry designed into the system or bridgewire such that the detonator will be safe to handle and not accidentally detonate due to stray or induced currents. Generally low energy detonators are designed to be safe and to not fire at one watt and one ampere. On the other hand, an EBW detonator requires approximately 200 kilowatts and 200 amperes for function without any added circuitry. In general, total energy used is two joules for EBW detonators, however, EBW detonators can detonate at less than 0.2 joules total energy if the proper circuit parameters are used.

Several amperes can be applied through the bridgewire of an EBW detonator with no hazard of detonation. However, the current may cause the bridgewire to break and dud the detonator. Under some conditions, if arcing occurs, and if the explosive is confined, it is possible for the secondary explosive next to the bridgewire to deflagrate using relatively low currents.