EXPLODING BRIDGEWIRES

EXPLODING BRIDGEWIRE CONCEPT: The difference between an exploding bridgewire and a bridgewire used in a low energy electric primer, does not necessarily lie in the physical shape or material of the wire. The difference is in the application of energy. In an exploding bridgewire system, a relatively large amount of energy is applied very rapidly into the bridgewire. Due to the very small cross section of the wire, the current heats the wire through the melting, boiling and vaporization phases. For proper function of an exploding bridgewire, this energy must be applied at such a fast rate that the wire material phase change is restricted due to inertia. When this inertia is overcome, vaporization of the wire occurs as an explosion giving off thermal energy and a shock wave. The resulting shock wave can be used to initiate a secondary explosive.

Figure 3
Exploding Bridgewire
Firing Circuit

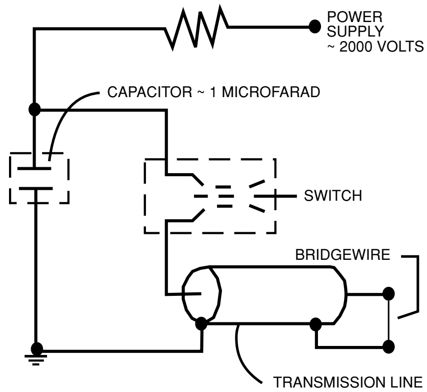
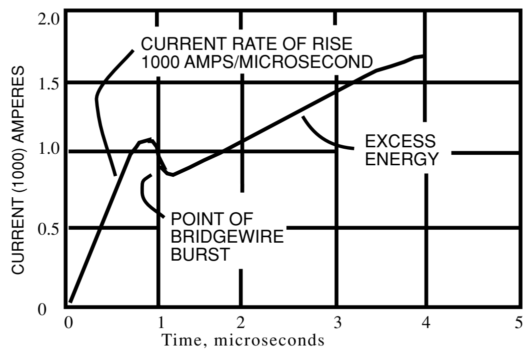


Figure 4
Exploding Bridgewire
Current Trace



A DESCRIPTION OF THE EXPLODING BRIDGEWIRE PHENOMENON

The basic circuit for exploding a wire is shown in Figure 3, and consists of: A power supply to charge a capacitor, a capacitor for storage of electrical energy, a spark gap or trigger switch to discharge the capacitor across the bridgewire, a transmission line to the bridgewire and a bridgewire.

To describe the exploding bridgewire phenomenon, a current versus time trace is shown in Figure 4. When the switch is closed, voltage is applied to the transmission line and bridgewire circuit which causes current to start to flow at a rate controlled by the RLC of the circuit. This is depicted in Figure 4 by an increasing current value from zero. This rate of flow (approximately 1000 amperes per microsecond) and the amount of energy is so great that the wire is heated to vaporization but the physical shape of the wire is maintained by inertia. Because of the heating, the resistance of the wire greatly increases. At this point the current reduces as can be noted in Figure 4 at approximately one microsecond. Within a few nanoseconds after vaporization, the inertia of the wire material is overcome and the wire explodes giving off a shock wave and the contained thermal energy. This causes an inflection point in the decreasing current curve. After a few nanoseconds, ionization occurs and current increases due to the low resistance of ionized gas remaining. The magnitude of current and time shown in Figure 4 is representative of an exploding bridgewire used for the initiation of an explosive in an EBW detonator. These values may vary greatly depending upon the geometry of the exploding wire and circuit parameters.

EXPLODING BRIDGEWIRE DETONATOR CONSTRUCTION

The inert components of an exploding bridgewire detonator are similar to any standard low energy electric initiator. The basic inert components consist of a header which contains the electrical wire leads and the bridgewire. Header material may vary from plastic to a metal/ceramic combination. The electric connection may be hookup wire leads, or a coaxial or multi-pin assembly into which the cable mates directly. The sleeve, which actually contains the explosive, may be part of the header or a separate part which is threaded or crimped into place. End caps may or may not be used depending upon the application.

In an exploding bridgewire detonator, the explosive is pressed in two increments of different density with both increments consisting of a secondary type explosive. There are no primary explosives in an exploding bridgewire detonator. The first increment, or the increment next to the bridgewire, is pressed into the header at a density of approximately 50% of crystal density.

The second increment consists of either the same type or a different type of secondary explosive which has been pressed to approximately 90% of crystal density. This increment is called the output charge of the detonator. The first increment is called the initial pressing.

Since the initial pressing adjacent to the bridgewire is at such low density, it will not stand together by itself and must therefore be pressed directly into the header/sleeve assembly. The output pellet, which is pressed to 90% of crystal density, is free standing and in general is pressed as a pellet and later inserted into the sleeve assembly to make contact with the initial pressing.