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[54] THIN FILM DEVICE

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[52] **U.S. Cl.** .... **102/28 EB**

[51] **Int. Cl.** **F42b 3/12**

[58] **Field of Search** .... 102/18, 28 EB

[56] **References Cited**

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[57] **ABSTRACT**

A thin film device which may be used as a fuze or fuse. The device comprises a pair of conductive layers separated and joined to opposite faces of a thin insulating layer to thereby form a three layer sandwich. One of the conductive layers and the insulating layer have a plurality of pin holes therein, the sides of each being coated by a bridge element of low density, low specific heat metal so as to short circuit or bridge the conductive layers. Terminal means are connected respectively to the conductive layers to supply electrical energy which passes from one conductive layer to the other conductive layer via the metal bridge elements. When the electrical energy exceeds a predetermined amount, the bridge elements vaporize. The vaporization of the bridge elements can be employed to initiate detonation of an explosive train thereby serving as a fuze. Alternatively, the device may be employed as an electrical fuse wherein the vaporization of the bridge elements caused by electrical energy interrupts the flow of electrical energy in an electrical circuit.

5 Claims, 3 Drawing Figures

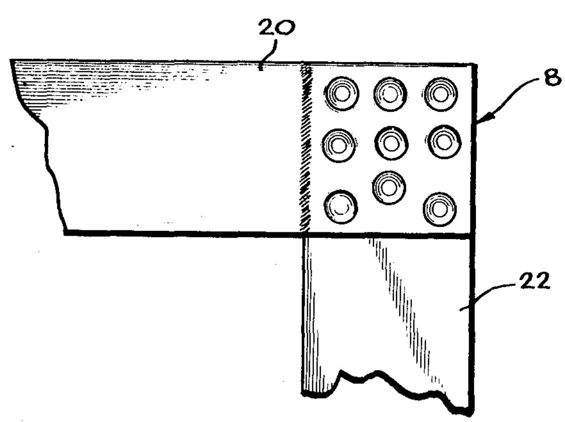


Fig.1

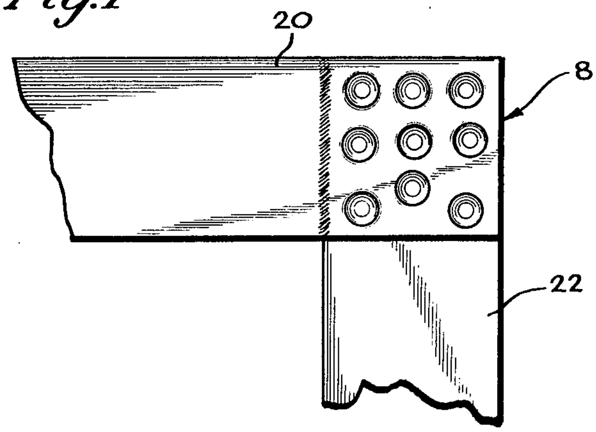
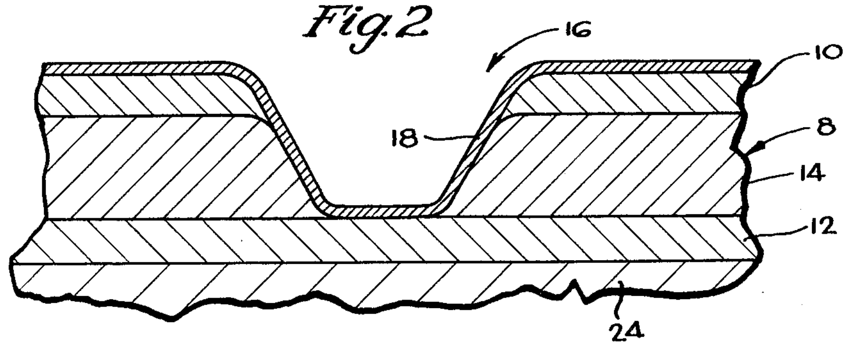


Fig.2



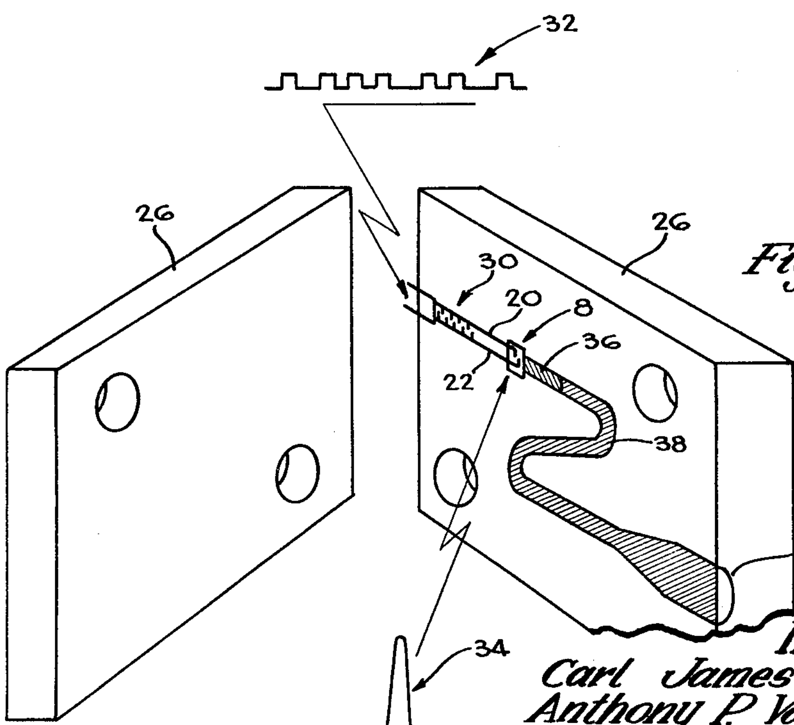


Fig.3

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THIN FILM DEVICE

The present invention relates to a thin film device which may be employed as a fuze or a fuse.

There is a need for a fuze or a detonation initiation mechanism which will offer a very reliable initiation function for a very low production cost and small physical size, without sacrificing fuzing safety. Such a fuze should be capable of initiating an explosive train upon the application of a small discrete electrical energy pulse. An object of the present invention is the provision of a thin film device which may serve as such a fuze. There is also a need for a fuse for use in low power electrical circuits. An object of the present invention is to provide such a fuse.

These and other objects will become apparent by reference to the following description and accompanying drawings in which:

FIG. 1 is a diagrammatic view of a thin film device in accordance with the present invention, the pin holes in the device being greatly exaggerated in size;

FIG. 2 is a greatly enlarged diagrammatic cross-sectional view of a portion of the device shown in FIG. 1; and

FIG. 3 is an exploded, isometric view showing the device shown in FIG. 1 being employed as a fuze.

Generally, in accordance with the invention, a thin film device **8** is provided which may be used as a fuze or fuse. The device comprises a pair of conductive layers **10** and **12** separated and joined to opposite faces of a thin insulating layer **14** to thereby form a three layer sandwich. One of the conductive layers **10** and the insulating layer **14** have a plurality of pin holes **16** therein, the sides of each being coated by a bridge element **18** of low density, low specific heat metal so as to short circuit or bridge the conductive layers **10** and **12**. Terminal means **20** and **22** are connected respectively to the upper and lower layers **10** and **12** to supply electrical energy which passes from one conductive layer **10** to the other conductive layer **12** via the metal bridge elements **18**. When the electrical energy exceeds a predetermined amount, the bridge elements **18** vaporize. The vaporization of the bridge elements can be employed to initiate detonation of an explosive train thereby serving as a fuze. Alternatively, the device may be employed as an electrical fuse, wherein the vaporization of the bridge elements caused by electrical energy exceeding a predetermined level interrupts the flow of the electrical energy in an electrical circuit.

More particularly, the illustrated thin film device **8** comprises a layered thin film structure which is preferably made by thin film techniques (i.e., evaporation or sputtering) because the thickness of the film in such techniques can be closely controlled. However, in certain applications, the layered structure may be formed by photo resist techniques.

In the illustrated embodiment, the device **8** includes a substrate **24** which may be of any material which has sufficient strength and stability to withstand the environment in which the device is to be used. The first or lower layer **10** is formed on the substrate **24** by depositing a thin film conductive metal, such as aluminum, beryllium, or chromium on the upper surface of the substrate.

A plurality of minute beads (not shown) of glass or plastic (e.g., polystyrene) are disposed on the first or lower layer **12** which beads serve to form the pin holes **16** in the upper layer **10** and the insulating layer **14**. The pin holes **16** may be formed by beads of different shapes such as spheres or fibers.

The insulating layer **14** which is made of non-metallic material, such as boron, silicon, quartz or silicon monoxide, is deposited on the upper surface of the first metallic layer **12**. Alternately, the insulating layer **14** may be formed by oxidizing the first metallic layer **12**. The second metallic layer **10** is then deposited on the upper surface of the insulating layer **14**. The second metallic layer **10** may be made of the same material as the first metallic layer.

The beads are then removed to provide the pin holes **16** by a cleaning procedure which may comprise shaking, brushing or washing. The thin film bridge element **18** is deposited in the

pin holes **16** to thereby short circuit the upper and lower metallic layers **10** and **12**, as shown in FIG. **2**. The bridge elements **18** should be made of a low density, low specific heat metal, such as titanium or aluminum.

In operation, electrical power is connected by terminals **20** and **22** to the upper and lower metallic layers **10** and **12** whereby current is caused to flow through the bridge elements **18**. When the electrical energy input exceeds a predetermined wattage, the bridge elements **18** vaporize thereby providing a shock wave which is sufficient to explode a primer placed in intimate contact with the bridge elements.

When used as a fuse, the vaporization of the bridge elements **18** breaks the circuit between the two terminals thereby opening up the electrical circuit.

In one specific embodiment of the thin film device, a metal film of aluminum approximately 5,000 Angstroms thick is deposited on a substrate which is made of an insulating material. A plurality of glass beads having a diameter of about 10 microns are sprinkled on the upper surface of the metal film. An insulating film of silicon monoxide material, approximately 1 micron thick, is deposited on the first metallic film. A second metallic film, approximately 5,000 Angstroms thick is deposited on the insulating film. The glass beads are removed by mechanical, physical or chemical means to provide the pin holes. A titanium film approximately 1,000 Angstroms thick is deposited in the pin holes to form the bridge elements.

In FIG. 3, the thin film device **8** is employed in a detonation initiation device or fuze. In this connection, the thin film device **8** is disposed on the inner surface of one of a pair of rectangular blocks **26** which form a clip board **28**, the block thus serving as the substrate **24**. The blocks **26** are made of a plastic which will not react with the explosives selected, such as PETN, RDX, HNS, etc. and are joined together as by screws (not shown) after the explosive train is deposited on the surface of one of the blocks. The clip board **28** is made of a size such that it may be rotated 90° so as to provide a safety feature. In other words, to be put in use the clip board must be rotated 90°.

To ensure that the thin film device **8** is not accidentally activated, the input terminals **20** and **22** of the thin film device **8** are connected to an input signal conditioner or coded filter **30**, which is designed to accept a discretely coded input signal and deliver a relatively high voltage electrical signal to the thin film device **8**. In the illustrated embodiment, the coded filter **30** comprises a conventional multiple tapped, surface-wave delay line deposited on a small crystal, in which the taps are correlated to the information contained in a coded signal (e.g., signal **32** in FIG. 3) applied to the input of the delay line. At a particular instant in time, depending on the signal code, all the tap outputs will add in phase to produce a single high level output (e.g., signal **34** in FIG. 3) corresponding to the information pulses. At other instants, the tap outputs are out of phase and cancel each other giving a zero or low signal output. In fact the coded filter has an improvement factor of the square root of N, where N is the number of stages or taps in the filter. This provides a safety feature in that only the specific code selected actuates the thin film device and the explosive.

In applications where the discretely coded signal is of a low bit rate, an integrated circuit, shift register may be employed as the coded filter **30**. The relatively large output pulse provided by the coded filter **30** is applied across the input of the thin film device **8** to thereby cause the bridging elements **18** to vaporize. This vaporization produces a shock wave or front which initiates an explosion in an explosive mix or primer **32** disposed on the surface of the thin film device **8** in intimate contact with the bridging element **18**. The explosive used as the primer **36**, its particle size, its geometry, its level of homogeneity (or heterogeneity), etc. should be selected so that the energy can be translated physically into the explosive efficiently and at a level far above the activation energy of the particular explosive. The primer **36** may be loaded onto the bridging elements **18** by binder solution (buttering) or press loading. For example, a lead deposition or metal oxide deposition is coated on the upper surface of thin film device **8** and is subsequently treated to yield lead azide or metal oxide.

The primer **36** is also disposed on a base charge **38** which is disposed in a long groove **40** in the rectangular block **26** of the clip board **28** which extends to the edge of the block. The base charge **38** may be an extrudable PETN, RDX based explosive. Other methods which may be employed to provide the base charge **38** are explosive adhesive binders which are bonded directly to the block **26**, explosive precipitation into a chemical binder installed on the block **26**, metal oxide and explosive in solution deposited onto the block **26**, and chemical composition exchange after loading into the block **26** of a compound which produces a chemical explosive.

The output at the end of the base charge **40** is sufficient to initiate a quarter inch by one-half inch booster (not shown).

From the above, it can be seen that a relatively small thin film device is provided which can be operated by a small discrete electrical energy pulse. The device may be used to reliably initiate a main explosive charge while insuring maximum fuze safety. The device costs relatively little to produce and is of small physical size. The device may also be used to protect low energy electrical circuits.

Various changes and modifications may be made in the above-described thin film device without deviating from the spirit or scope of the present invention. Various features of the invention are set forth in the accompanying claims.

What is claimed is:

1. A thin film device for use as a fuze or fuse, comprising a pair of conductive layers, a thin insulating layer disposed between said conductive layer, said conductive layers and said insulating layer forming a sandwich, one of the said conductive layers and said insulating layer having pin holes therein, a bridging element of low density, low specific heat metal disposed in said pin holes so as to short circuit said conductive layers, and terminal means connected to said respective conductive layers to supply electrical energy thereto, whereby when said electrical energy exceeds a predetermined amount, the metal in said pin holes vaporizes.

2. A thin film device in accordance with claim **1** in which an explosive is disposed in intimate contact with said bridging element, and a coded filter is connected to said terminal means.

3. A thin film device in accordance with claim **1** in which the metal of said bridging element is selected from the group consisting of aluminum and titanium.

4. A thin film device in accordance with claim **1** wherein one of the conductive layers is deposited on a substrate and is about 5,000 A thick, the insulating layer is deposited on said one conductive layer and is about **1** micron thick, the other conductive layer is deposited on the insulating layer and is about 5,000 A thick and the bridging element is deposited in the pin holes and is about 1,000 A thick.

5. A thin film device in accordance with claim **4** in which the pin holes are formed by disposing beads about **10** microns in diameter on the one conductive layer prior to the depositing of the insulating layer, and the beads are removed after the second conductive layer is deposited and prior to the depositing of the bridging elements.

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