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FUSE HAVING CELLULAR PLASTIC SHEATH

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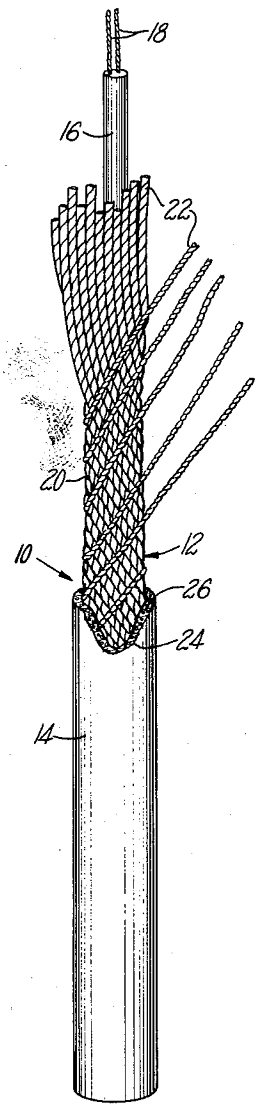

FIG. 1

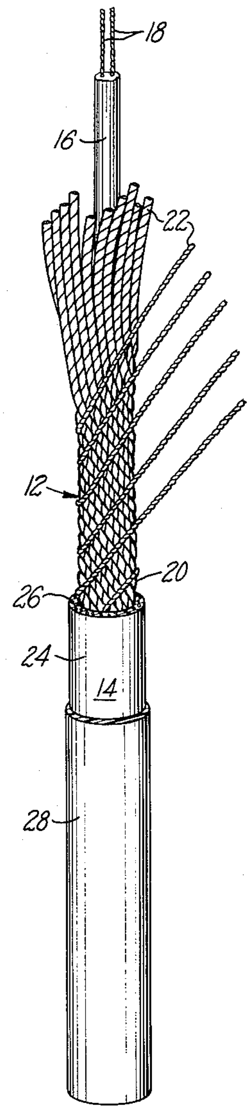

FIG. 2

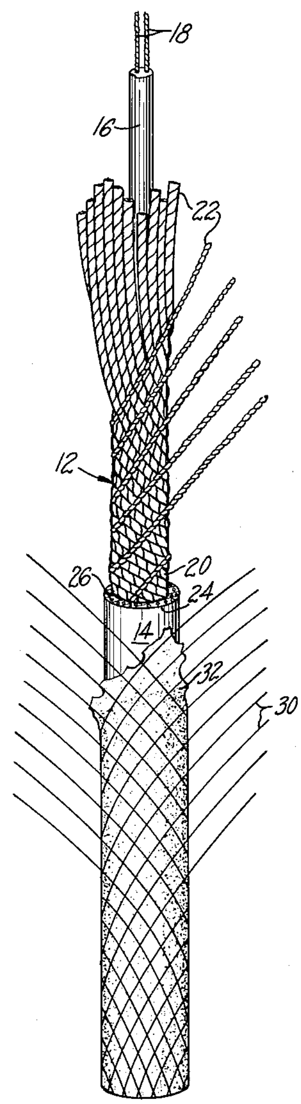

FIG. 3

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FUSE HAVING CELLULAR PLASTIC SHEATH

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The present invention relates to fuses for initiating explosives and the like and more particularly to fuses suitable for mining and other blasting operations.

The principal object of the present invention is to provide an improved fuse which will withstand fluid penetration and is particularly resistant to oil or other unctuous fluids.

Another object of the present invention is to provide an improved fuse which is both reliable and safe when used for commercial blasting in ammonium nitrate fuel oil systems and not only possesses excellent oil resistance but also provides uniform burning speeds under all operating conditions, particularly in liquid environments.

A further object of the present invention is to provide an improved fuse which in operation vents freely under water and prevents the accumulation within the fuse of excessive gas pressures while exhibiting good resistance to static electricity discharge.

A still further object of the present invention is to provide an improved fuse which permits a substantial reduction in the core load of the fuse while maintaining the high standards of reliability and operating performance necessary for such fuses.

An additional object of the present invention is to provide a fuse which not only exhibits the characteristics of uniform burning rate, good liquid resistance both laterally and at cap-crimps, and good static resistance, but also is capable of being manufactured with inexpensive and readily available materials.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

The invention accordingly consists in the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereafter set forth, and the scope of the application of which will be indicated in the appended claims.

In the drawing:

FIG. 1 is a side-elevational view, partially broken away, of the fuse of the present invention;

FIG. 2 is a view similar to FIG. 1 showing another embodiment of the present invention; and

FIG. 3 is a view similar to FIG. 1 showing still another embodiment of the present invention.

Referring now to the drawing wherein similar parts are designated by the same numeral, the invention is illustrated as a safety fuse **10** broadly comprising a raw core, generally designated **12**, and an outer sheath **14** of barrier material resistant to fluids and particularly oil or other unctuous compositions. The raw core **12** is similar in construction to the fuse cores described in United States Patents 1,907,863 and 2,102,024 to D. E. Pearsall and as shown comprises a central pith **16** of an explosive or, more particularly, of an oxygen-sufficient combustible composition which surrounds the central longitudinal filaments or threads **18**. Enclosing the explosive of central pith **16** is the casing **20** which is provided by applying one or more layers of strands **22** around the pith **16**. Where practicable and for purposes of brevity and simplicity of expression, the casing enclosed pith will hereinafter be referred to as the raw core **12**.

In the past it has been the practice to cover the raw core of a combustible time fuse, particularly those blasting fuses known as "safety fuses," with a waterproof coating to prevent misfire, delayed shots or incomplete combustion due to undesirable moisture content within the core. This coating consisted of a layer of asphalt or similar material which in turn was covered by layers of crepe or crinkled paper and strands of yarn, as more fully described in the above-mentioned United States Patents 1,907,863 and 2,102,024. While such safety fuses were sufficiently water impermeable to be commercially useful and did, in fact, experience considerable commercial success, it became apparent with the advent of ammonium nitrate fuel oil systems for commercial blasting that materials of greater oil resistance than asphalt and paper tape would be required to protect the combustible core in the safety fuse. Although plastic jacketed safety fuses appeared to answer this need, it was soon discovered that when such fuses were burned in a liquid environment and particularly under water, they exhibited accelerated and nonuniform burning speeds and caused the accumulation of excessive gas pressures within the fuse due to their poor venting properties.

According to the present invention it has been found that the above-enumerated objects as well as related objects can be readily attained in a facile, economical and efficient manner by enclosing the raw core **12** in a cellular or foam plastic sheath **14**. The sheath **14** is preferably formed by means of conventional dry extrusion operations utilizing a wire coating technique and has been found to exhibit high resistance to most organic solvents, particularly unctuous fluids, and to possess high strength and durability while exhibiting the degree of flexibility characteristic of present-day fuses.

Various explosive compositions may be employed for the central pith **16**. However, for purposes of illustration of the invention as a safety fuse, the compositions utilized are those which burn at a relatively slow rate. In this regard, the compositions described in United States Patents 2,863,353 and 2,909,418 may be used although the well-known black powder, which is a mixture of charcoal, sodium or potassium nitrate and sulfur is preferred.

The central filament or thread **18** as well as the strands **22** are made from combustible or noncombustible yarns and the like, such as cellulosic yarns both natural and synthetic, glass textile and paper yarns; for example, the cotton, jute or glass fiber yarns more fully described and disclosed in the Pearsall patents mentioned above may be used with advantage. As shown in the drawing, it is preferred to utilize at least two central longitudinal cotton threads **18** where at least one of the threads is wet and one is dry. The strands **22** of casing **20** consist of relatively larger diameter yarns which are spun and cross-spun about the central pith **16**. As shown, about ten strands of jute are first spun about the central pith **16** to form a first layer of casing **20**. Subsequently the second layer of casing **20** consisting of five strands of Fiberglas are cross-spun over the jute thus completing the construction of the raw core **12**.

The cellular sheath **14** is made of a plastic foam material having a high degree of strength, flexibility and toughness while exhibiting low moisture vapor transmission and high resistance to most organic solvents, including oil. As shown in FIG. 1, the plastic sheath **14** is characterized by an internal cellular structure 26, either multicellular or composed of single noninterconnected cells, and a substantially solid continuous outer skin 24. While most flexible foam plastic materials, such as flexible silicone resins, vinyl copolymers, cellulose acetate resins and linear polyurethane resins are suitable for use as the sheath material, it is preferred to use a thermoplastic polyolefin, for example polyethylene, as the foam plastic material. Polyethylene is particularly suited to the present invention since it can be easily foamed in place and is readily adaptable to an extrusion process. In addition, it possesses a high strength to weight ratio and exhibits an ease of fabrication which is desirable in the present invention.

The extrusion process broadly comprises charging the thermoplastic composition and blowing agent to the extruder wherein it is heated to a temperature sufficient to liquify the plastic and cause the blowing agent to decompose. The flow of the liquefied composition is restricted at the discharge end of the cylinder thereby causing a considerable back pressure in the cylinder and consequently preventing the gas formed by the decomposition of the blowing agent from expanding within the composition. The unexpanded liquified composition containing the gas from the decomposed blowing agent is applied about the raw core and the coated core passes out of the extruder permitting the compressed gases therein to expand. The expansion of the gases occurs so as to produce a uniform thickness of expanded or blown plastic about the raw core. The extent to which the plastic composition will expand after being applied to a raw core is governed by the amount of blowing agent employed and whether the temperature of the composition is sufficiently high to obtain complete utilization of the blowing agent. The temperature of a polyethylene composition should be at 140° C. or above to insure complete decomposition of the blowing agent which is present in an amount of about 1% by weight. If temperatures below 140° C. are employed the expansion of the polyethylene may not be complete and erratic results in the density of the composition may occur. The final diameter of the foam fuse also will vary depending on the diameter of the die as well as that of the raw core.

In addition to providing a fuse which exhibits high strength, durability and resistance to oil and water, it is an advantage of the present invention that fuses may now be made which exhibit those properties yet have substantially lower core loads than have been previously used. For example, the core load of safety fuses now commercially used throughout the world is substantially uniformly set at approximately 22 grains per foot. However, according to the present invention it is possible, by using the foam sheath, to maintain the required high standards for safety fuses while lowering the core load substantially below 22 grains per foot. For instance, core loads as low as approximately 10 grains per foot have been successfully tested using fuses made according to the invention.

To insure against cross ignition of the higher core-load fuse when it is burned in a tight coil, flame retardant means may be added, if necessary, to the basic cellular-coated fuse 10. For instance, self-extinguishing fire retardant material such as antimony trioxide, chlorowax or the well-known flame supressors described in United States Patent No. 2,891,475 may be added, where compatible, to the cellular plastic before extrusion. Also, further coatings or jackets, as shown in FIGS. 2 and 3, may be added to the basic structure. For example, in the embodiment shown in FIG. 2 there is provided a vinyl jacket 28 which encloses the cellular plastic sheath 14 which in turn circumscribes the raw core 12 while in the embodiment of FIG. 3 additional strands of yarn 30 covered with wax 32 provide the necessary flame retardant means to prevent the undesirable cross ignition.

These embodiments not only prevent the cross ignition of a tightly coiled fuse but in addition advantagueously add carcass strength and durability to the fuse.

As can be seen from the foregoing description, the present invention provides an improved fuse and particularly an improved safety fuse which is light in weight while possessing a high degree of strength, flexibility and toughness. Additionally, the fuse exhibits improved resistance to oil, water and static electricity discharge while providing uniform burning speeds and excellent gas venting properties under water. Further, it facilitates improved safety in handling, is reliable in operation and can be manufactured in a facile, economical and efficient manner while permitting the use of lower core loads.

As will be apparent to persons skilled in the art, various modifications and adaptations of the structure above described will become readily apparent without departure from the spirit and scope of the invention, the scope of which is defined in the appended claims.

We claim:

1. A fuse exhibiting a uniform burning rate under substantially all operating conditions and improved resistance to both oil penetration and static electricity discharge comprising a central raw core of explosive material and a flexible sheath of plastic material which will not support combustion enclosing said core and providing an effective barrier to oil penetration, said plastic sheath being of substanitally uniform thickness and having a generally foam structure throughout.

2. The fuse of claim 1 wherein means are provided for preventing cross ignition of the fuse.

3. A fuse exhibiting a uniform burning rate under substantially all operating conditions and improved resistance to both oil penetration and static electricity discharge comprising a central pith of a combustible composition; a casing enclosing said central pith, the enclosed pith constituting the raw core of said fuse; and a flexible sheath of cellular thermoplastic material which will not support combustion having a generally uniform thickness and possessing individual substantially noninterconnected cells, said sheath enclosing substantially all of said raw core thereby providing an effective barrier to oil penetration.

4. A safety fuse exhibiting a uniform burning rate under substantially all operating conditions and improved resistance to both oil penetration and static electricity discharge comprising a central pith of an oxygen-sufficient combustible composition surrounding at least one central longitudinal strand of yarn; a casing about said central pith provided by applying at least one layer of fiber around said pith, the enclosed pith constituting the raw core of said safety fuse; and a sheath of cellular polyethylene of uniform thickness enclosing substantially all of said raw core thereby providing an effective barrier to oil penetration.

5. A safety fuse exhibiting a uniform burning rate under substantially all operating conditions and improved resistance to both oil penetration and static electricity discharge comprising a central pith of black powder surrounding at least one wet and one dry central longitudinal strand of cotton yarn; a casing about said central pith provided by applying a first layer of fiber around said pith and then a second layer of different fiber in a different direction than said first layer, the enclosed pith constituting the raw core of said safety fuse; and a sheath of extruded cellular polyethylene of uniform thickness having individual noninterconnected cells and a substantially continuous skin and enclosing substantially all of said raw core thereby providing an effective barrier to oil penetration.

6. The safety fuse of claim 5 wherein means are provided for preventing cross ignition of the fuse.

7. The safety fuse of claim 6 wherein the cross ignition preventive means include a wrapping of yarn and wax.

8. The safety fuse of claim 6 wherein the cross ignition preventive means include a vinyl jacket.

9. The safety fuse of claim 6 wherein the cross ignition preventive means include a fire retardant material incorporated within said cellular sheath.

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