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2,587,694

FUSE IGNITING AND CONNECTING DEVICE

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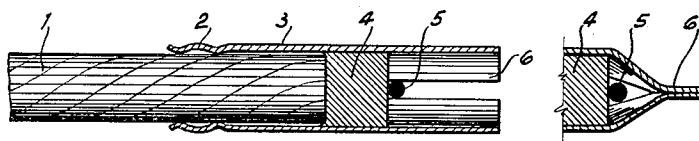


FIG-1

FIG-2

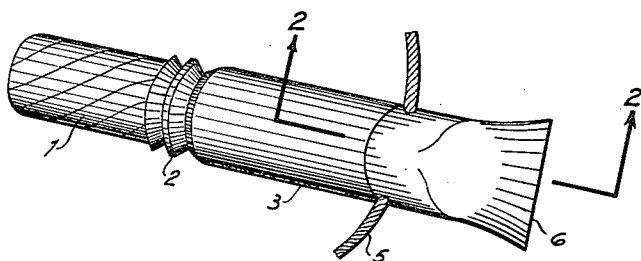


FIG-3

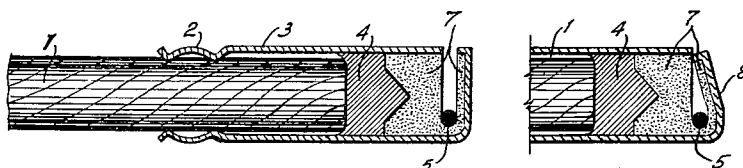


FIG-4

FIG-5

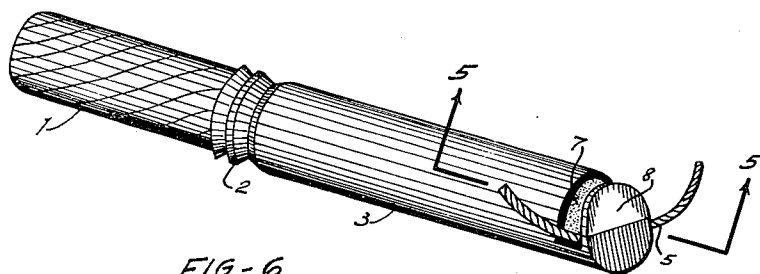


FIG-6

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FUSE IGNITING AND CONNECTING DEVICE

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5 Claims. (Cl. 102—27)

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Our invention relates to a means for igniting fuse as used in blasting operations, pyrotechnique displays, etc., and more particularly to a connecting device to propagate flame from a fuse of the ignition type such as igniter cord (also known as ignition cord) or flash cord, to a different type of fuse such as safety fuse.

Safety fuse of the type described for example in U. S. Patent 1,907,863, has been used for many years in commercial blasting operations for the purpose of carrying fire at a continuous and uniform rate to a blasting cap or explosive charge. It is particularly adaptable for application in the method of rotational firing a round of explosive charges where a number of blast holes are connected in circuit with igniter cord in such a way that the individual holes will fire in selected order at predetermined time intervals. Formerly, in carrying out this operation it was customary to trim from each length of safety fuse that amount corresponding to the delay order in which the blast holes were to be fired prior to lighting the fuses individually. It has now become preferred practice to use in conjunction with safety fuse a faster burning smaller diameter ignition type fuse such as that described in U. S. Patent 2,239,051. In this case igniter cord is used to connect equal lengths of safety fuse in such a manner that the safety fuse will be ignited in the ordered desired, and since they are of the same length, the time consumed by the burning of the igniter cord between connections serves to establish both the intervals between the explosion of successive holes as well as the desired order of firing. An illustration of a typical layout is shown and described in U. S. Patent 2,239,123. "Safety fuse" may be distinguished generally from ignition fuse in that it burns at a relatively slow rate of from 30-40 seconds/foot, the burning being contained within the fuse envelope until it reaches the end of the fuse where it emerges as a characteristic "end spit." "Igniter cord," while burning at a relatively rapid rate of 5-25 secs./ft., is characterized by an external flame and/or sparks emanating radially from the cord. "Flash cord" which resembles igniter cord burns at a rate varying from a fraction of a second to about 3 secs./ft.

Due to differences in the burning characteristics of safety fuse and ignition fuse it is extremely difficult to connect the two types of fuse together so that ignition of the former by the latter is accomplished with certainty under all conditions of use. The most serious problem however is ignition failures due to moisture ab-

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sorption at the connections between the ignition fuse and the safety fuse where of necessity, the burning composition of the safety fuse is exposed. Connectors placed on the ground surface adjacent to bore holes are quite often exposed to extreme conditions of moisture customarily found in blasting areas. It will be appreciated by those familiar with the art that safety fuse is difficult to ignite under moist conditions, and some means of protecting the exposed end thereof is desirable. The purpose of our connector therefore is to provide a practical means of holding ignition fuse in rigid attachment with its associated safety fuse so that positive ignition of the latter is accomplished under all conditions of moisture.

Various arrangements have been used heretofore for this purpose, but none have been entirely satisfactory. One method of connecting fuse is described in U. S. Patent 1,856,419, in which a relatively slow burning wick is attached to a fuse by means of an open type cylindrical clip containing a deflagrating igniter. A serious disadvantage to this type of connector is its poor resistance to moisture penetration, an obvious fact from the very nature of the connector (excess amount of air being required for combustion of the igniter composition). Another serious defect is the mode of attachment of the connector to the fuse and wick ends which are secured only by pressure of the clip itself. Since both the clip and fuse ends are assembled along the same axis it is apparent that either fuse or wick could become easily detached under present day usage in the field.

Another method, which is in common use today is to split the end of the safety fuse by cutting a longitudinal slit about an inch in length and string the ignition fuse in the slit. The halves of the slit fuse are then bound either with a length of small diameter soft wire or by making a reverse loop with the ignition fuse around the split ends of the safety fuse to hold them together and thus maintain the ignition fuse in contact with the core of the fuse. This method is time consuming and open to the serious objection that a small amount of moisture at the notched end of the fuse can prevent ignition of the fuse.

Still another arrangement is a form of T-shaped connector as described in U. S. Patent 1,991,856. The connector comprises a cylindrical shell containing a detonating booster charge at the closed end and into the open end is inserted one of the detonating fuses to be joined. The other detonating fusecord abuts the closed end

of the connector at an angle of 90° to the connector and is attached thereto by means of metal clamp. Such an arrangement could not be used for applicants' purpose, since the ignition of safety fuse is accomplished by the application of incandescent heat only.

It is an object of the present invention to provide an effective waterproof connection between the end of a length of safety fuse and ignition fuse such as igniter cord or flash cord.

It is a further object of the present invention to produce a fusecord connector such that propagation of fire or ignition of safety fuse from a lighted ignition fuse, is accomplished under all conditions encountered in the field.

It is a still further object of our invention to produce a connecting device to which igniter cord or flash cord may be attached quickly in the field, but rigid enough to withstand the effects of blasts from neighbouring explosive charges.

The objects of the present invention are accomplished by the use of a connector which consists of a cylindrical tube similar in size to a standard blasting cap, and containing a small amount of an ignitable composition either in the form of a plug or a pressed charge. One end of the connector is open for insertion of a length of safety fuse, and a groove is cut at the opposite end for insertion of ignition fuse such as igniter cord or flash cord.

The parts of our connector may be more clearly illustrated by reference to the accompanying drawings in which:

Figure 1 is a view of one form of a connector in longitudinal cross section, showing a safety fuse and ignition fuse in operative relation to one another;

Figure 2 is a longitudinal section taken along the line 2, 2 of Figure 3, showing the ignition fuse held in place by pressure from flattened ends of the slotted tube;

Figure 3 is a perspective view of the form of connector illustrated in Figures 1 and 2;

Figure 4 is a cross sectional view of a modified form of a connector showing an alternative method of attaching ignition fuse to the connector;

Figure 5 is a longitudinal section taken along the line 5, 5 of Figure 6, showing the ignition fuse held rigidly by pressure from bent end flap;

Figure 6 is a perspective view of the connector shown in Figures 4 and 5.

Referring now in greater detail to the figures of the drawings, one embodiment of our invention as shown in Figure 1, comprises a cylindrical tube 3 slotted at one end to accommodate ignition fuse 5 placed between end prongs 6 of slot. The opposite end of tube 3 is adapted to receive safety fuse 1 which is held in waterproof relationship thereto by waterproof type crimp 2. A plug of ignition composition 4 relatively impervious to moisture, is located in tube 3 and serves to convey positive transfer of fire from ignition fuse 5 to safety fuse 1.

Figure 2 illustrates the position of ignition fuse 5 held rigidly in direct contact with plug of ignition composition 4 by pressure of end prongs 6 which have been squeezed together around ignition fuse 5.

Figure 3 shows a top view of the complete assembly of connector, associated safety fuse 1 and ignition fuse 5, held in the grip of end prongs 6.

A modified embodiment and preferred form of our connector shown in Figure 4, consists of a cylindrical tube 3 containing at one end, a pressed

base charge 7 and a pressed top charge 4. Safety fuse 1 inserted into the opposite end of connector, abuts top charge 4, and is held in place by waterproof crimp 2. Ignition fuse 5 is held in rigid relationship with connector by placing in a round bottomed transverse slot cut partly through end of connector containing base charge 7 and held in place by bending flap 8 inwards as shown in Figure 5. It will be noted that positive ignition of base charge 7 from lighted ignition fuse 5 is ensured by location of slot at base of tube 3 in order that a portion of base charge 7 remains attached to flap 8 of connector thus allowing base charge 7 to almost completely surround ignition fuse 5.

Waterproofing of our connector is achieved in the first instance by selection of water impervious materials for the connector proper as for example a metal, or metal alloy. We have found that our connector is admirably suited to crimping with standard crimping tools. We have discovered further that when we apply a watertight type crimp 2 as shown in the drawings, no additional waterproofing material is required to seal this end of the connector. The problem of waterproofing the open slotted end of the connector is achieved by the selection of relatively water insoluble ingredients in a heat sensitive ignition base charge 7 which on compression into a plastic-like non-porous mass, is substantially impervious to penetration by water.

The ignition charges of our connecting device are essentially heat sensitive mixtures which on burning produce hot sparks sufficient to ensure ignition of the end of safety fuse. This may be accomplished through the use of either a single charge 4 compacted in the form of a plug as shown in Figure 1 or two or more separate charges compressed to a solid non-porous cake of plastic-like material as shown in Figure 4, in which the lower or base charge 7 in contact with ignition fuse 5 functions both as a waterproofing and igniting composition for top charge 4 which is a hot fast burning ignition mixture emitting flame and/or sparks and suitable for the ignition of the powder train in safety fuse 1. The use of a single plug type charge in the form of connector shown in Figure 1 is illustrative only. It is understood that the compressed two-charge mixtures illustrated in Figure 4 could be used equally well in the connector of Figure 1.

It will be apparent from the above that there are certain prerequisites for the base charge to serve its dual function in a connector of the types described. For example, we have discovered that the material of the base composition must be compressible to a point where a thin layer of it is impervious to water yet readily ignited by igniter cord or flash cord under all conditions of use. Furthermore the charge once ignited must burn fast enough so that the top charge which is essentially a "flash" composition, has ignited the safety fuse before heat conducted by the wall of the connector reaches the waterproofing compositions of the safety fuse causing the latter to melt into the top charge and acting to desensitize it to the extent of preventing ignition of the safety fuse.

We have found that the most satisfactory heat sensitize mixtures suitable for use as a base charge in our invention comprise essentially a standard grade of finely divided nitrocellulose, a relatively water insoluble oxidizer such as lead dioxide (PbO₂) and a readily ignitable, relatively water insoluble fuel such as antimony sulphide

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(Sb₂S₃). These materials when used as the ingredients of a base charge, may be present in the proportions shown as follows:

Nitrocellulose	percent	80-95
Lead dioxide (PbO ₂)	do	5-19
Antimony sulphide (Sb ₂ S ₃)	do	1-7

It will be apparent to one skilled in the art that other materials could be substituted for the components in the above mixture as for example, any readily ignitable and consumable water insoluble organic material, as for example nitrohydrocarbons such as trinitrotoluene, tetryl, etc. might be used in place of nitrocellulose. Similarly other materials, such as barium chromate (BaCrO₄), red lead (Pb₃O₄) etc. substituted for the lead dioxide. Replacement of antimony sulphide with an equivalent material such as calcium silicide (CaSi₂) would be an obvious substitution.

In the development of satisfactory composition for the safety fuse igniting top charge we have obtained superior results from the use of a mixture comprising nitrocellulose, lead dioxide (PbO₂) and silicon metal powder in the following range of proportions:

Nitrocellulose	percent	4-15
Lead dioxide	do	70-90
Silicon metal powder	do	5-15

In the preparation of the above materials for use in the base and top charges of our connector we have found it desirable that all components be ground to a finely divided state prior to mixing; i. e. capable of passing a 100 mesh screen or finer. In the case of nitrocellulose, any of the standard grades such as dynamite and pyro nitrocelluloses are quite satisfactory. We have also found that a cheap grade of smokeless powder known as "Pyro powder" which comprises a gelatinized form of nitrocellulose as the main component may be used in the above compositions. In any case, nitrocellulose suitable for our purpose should preferably have a "finesness" of not more than 140 ml. as determined by a standard settling test, viz., the volume occupied on standing 1 hour of a 250 ml. aqueous slurry of a 10 gram sample of dry nitrocellulose.

Compositions illustrative of our preferred charges are shown in the following examples.

Example 1

Base Charge:

Nitrocellulose	percent	87.5
Lead dioxide	do	8.5
Antimony sulphide	do	4.0

Example 2

Top Charge:

Nitrocellulose	percent	8.0
Lead dioxide	do	82.8
Silicon	do	9.2

Water immersion tests of connectors containing compositions such as in the above examples, were readily ignitable from a lighted igniter cord after immersion in cold water for 60 minutes or more.

In assembling the preferred form of our connector, tube 3 in Figure 4 is charged with base composition 7, top charge 4 added, and the two charges passed under a dead load of 600 to 2000 lbs. using a flat end pressing pin. A transverse slot of width sufficient to accommodate the ignition fuse 5 is the cut part way through the connector by sawing or milling at a point adjacent

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to the base 8 of connector as shown in Figure 4 of the drawings. It is an essential part of our invention that this slot be cut by a tool which will radius the bottom of the slot to conform with the diameter of the ignition fuse to be used. The connector is then ready for use.

In the application of our invention to a blasting operation, suitable lengths of safety fuse, preferably square cut, are inserted into tube 3 so that the freshly cut end abuts charge 4, and fixed in this position by the application of waterproof or choke type crimps 2. This operation is preferably done prior to transporting safety fuse to the working site, since by so doing the exposed ends of the fuse are protected against damage by moisture. Loading of the explosive charges in the boreholes is then performed in the normal manner using safety fuse, but instead of trimming and lighting each fuse individually, the ignition fuse is strung from fuse to fuse and connected to the latter by inserting in the slot of each connector. The ignition fuse is then lighted at a focal point and as it burns the ignition is transmitted to each connector in turn which lights and transmits the fire to the attached length of safety fuse.

Tube 3 of our connecting device is preferably of metal such as brass, aluminum, gilding metal or any water impervious material which is sufficiently ductile to be crimped with standard crimping tools but rigid enough to retain any shape imparted to it.

In the form of connector shown in Figures 4-6 inclusive of the drawings, the ignition fuse slot is shown to form an angle of approximately 90° with the longitudinal axis of the connector. It is understood that such a slot could be cut at any angle between 0° and 180°, and that such a variation is within the scope of this invention.

While the connector of our invention is particularly suited for mining operations in which safety fuse is used, it will be understood that many other uses are conceivable, such as for example in the lighting of pyrotechnique displays where safety fuse is often used in conjunction with igniter cord or flash cord.

One advantage to our form of fusecord connector may be found in the fact that as a means to ignite safety fuse from ignition fuse it ensures positive ignition thereof under all conditions of moisture such as are met with at the blasting site.

A further advantage to the fuse connecting device of the present invention is the means for attachment of the ignition fuse such that this operation can be done quickly in the field; but sufficiently rigid so that the ignition fuse will not be dislodged from the connector either in handling, or by the effects of blasts from neighbouring explosives charges.

It is to be understood that the scope of the present invention is not limited to the details specifically set forth in this disclosure, wide variations therein being possible without departing from the spirit of the invention.

Having thus described our invention what we claim is:

1. A waterproof connecting device for joining in ignitive relationship one end of a length of safety fuse to a line of ignition fuse, said ignition fuse burning with an external flame at a rate at least as rapid as 25 seconds per foot, said connecting device comprising in combination a substantially tubular water impervious shell, one end of said shell being normally open to receive

said safety fuse, the opposite end of said shell having a slotted means to accommodate said ignition fuse, at least one charge of a heat ignitable composition disposed within said shell between said safety fuse and said ignition fuse, said heat ignitable composition comprising a base charge of between 1% and 7% of antimony sulphide, between 5% and 19% of lead dioxide and between 80% and 95% nitrocellulose and a top charge of between 5% and 15% silicon, between 70% and 90% lead dioxide, and between 4% and 15% nitrocellulose, and mechanical clamping means for maintaining said safety fuse and said ignition fuse in ignitive contact with said heat ignitable composition.

2. A waterproof connecting device for joining in ignitive relationship one end of a length of safety fuse to a line of ignition fuse, said ignition fuse burning with an external flame at a rate at least as rapid as 25 seconds per foot, said connecting device comprising in combination a substantially tubular water impervious shell, one end of said shell being normally open to receive said safety fuse, the opposite end of said shell having a slotted means to accommodate said ignition fuse, at least one charge of a heat ignitable composition disposed within said shell between said safety fuse and said ignition fuse, said heat ignitable composition comprising a base charge of finely divided antimony sulphide (1-7%), finely divided lead dioxide (5-19%) and nitrocellulose having a fineness of not more than 140 ml. (80-95%) and a top charge of finely divided silicon (5-15%), finely divided lead dioxide (70-90%) and nitrocellulose having a fineness of not more than 140 ml. (4-15%), and mechanical clamping means for maintaining said safety fuse and said ignition fuse in ignitive contact with said heat ignitable composition.

3. A waterproof connector for joining in ignitive relationship one end of a length of safety fuse to a line of igniter cord, said connector comprising in combination a substantially tubular shell, one end of said shell being normally open to receive said safety fuse, the opposite end of said shell having a slotted means to accommodate said igniter cord, at least one charge of a heat ignitable composition disposed within said shell between said safety fuse and said igniter cord, said heat ignitable composition containing a base charge of powdered antimony sulphide (4.0%), powdered lead dioxide (8.5%), and finely divided nitrocellulose (87.5%), and a top charge of powdered silicon (9.2%), powdered lead dioxide (82.8%) and finely divided nitrocellulose (8.0%) and mechanical clamping means for maintaining said safety fuse and said ignition fuse in ignitive contact with said heat ignitable composition.

4. A waterproof connecting device for joining

in ignitive relationship one end of a length of safety fuse to a line of ignition fuse, said ignition fuse burning with an external flame at a rate at least as rapid as 25 seconds per foot, said connecting device comprising in combination a substantially tubular water impervious shell, one end of said shell being normally open to receive said safety fuse, the opposite end of said shell having slotted means to accommodate said ignition fuse; at least one charge of a heat ignitable composition disposed within said shell between said safety fuse and said ignition fuse, said heat ignitable composition containing a base charge of between 1% and 7% of antimony sulphide, between 5% and 19% of lead dioxide, and between 80% and 95% nitrocellulose, and a top charge of a fast burning "flash" type composition; and means for maintaining said safety fuse and said ignition fuse in ignitive contact with said heat ignitable composition.

5. A waterproof connecting device for joining in ignitive relationship one end of a length of safety fuse to a line of ignition fuse, said ignition fuse burning with an external flame at a rate at least as rapid as 25 seconds per foot, said connecting device comprising in combination a substantially tubular water impervious shell, one end of said shell being normally open to receive said safety fuse, the opposite end of said shell having slotted means to accommodate said ignition fuse; at least one charge of a heat ignitable composition disposed within said shell between said safety fuse and said ignition fuse, said heat ignitable composition containing a base charge of between 1% and 7% of antimony sulphide, between 5% and 19% of lead dioxide, and between 80% and 95% of nitrocellulose, and means for maintaining said safety fuse and said ignition fuse in ignitive contact with said heat ignitable composition.

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