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3,718,113

BURIED PIPELINE SIGNAL

Filed July 13, 1970

2 Sheets-Sheet 1

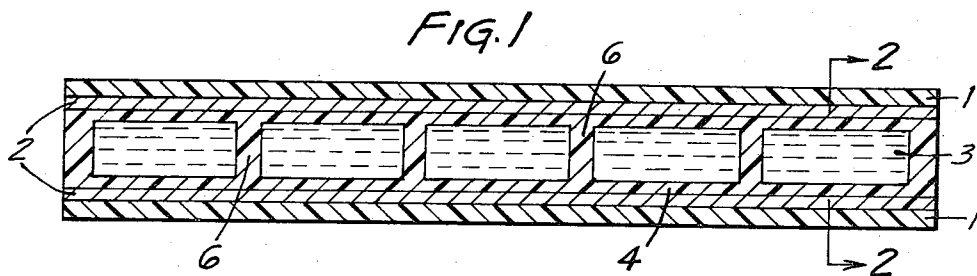
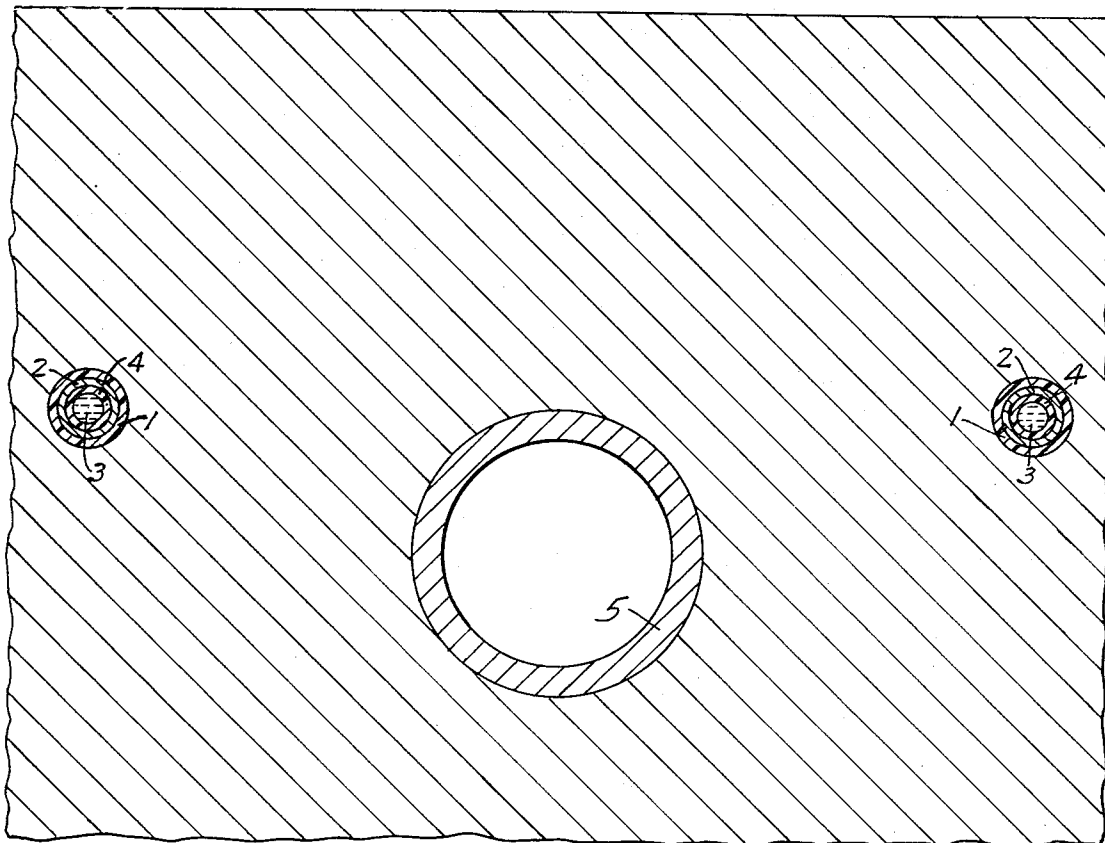


FIG. 3



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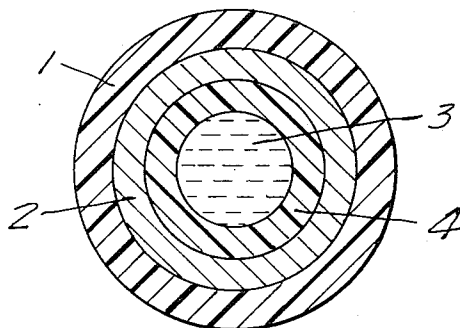
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FIG. 2



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BURIED PIPELINE SIGNAL

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7 Claims

ABSTRACT OF THE DISCLOSURE

A buried visual warning device capable of producing a risable visible signal, comprising an underground corrosion-resistant, flexible, rupturable, essentially moisture and oxygen proof tubular member containing a visual signal producing means released into the air upon rupture of the tubular member. Also contemplated is the use of a plurality of the warning devices in spaced protective relationship about and parallel to a utility conduit.

This invention relates to a visual signaling device and its deployment about utility conduits.

One of the acute problems plaguing public utility companies relates to the rupture of buried underground conduits by heavy machinery. The resultant disruption of service of telephone or electric power resulting from a severing of cables and the acute explosive danger and/or fire hazard from rupturing gas or oil pipelines clearly indicates the need for a protective device for these conduits. The need has become accentuated in recent years as the demand for such underground conduits has increased and the use of heavier earthmoving equipment has also increased to satisfy the increasing demands for building generated by a modern society. While there have been attempts made in the past to produce satisfactory warning signals see, U.S. Pat. No. 3,115,861, issued Dec. 31, 1963, these attempts have not met with practical commercial success. The above mentioned patent for example, discloses frangible, water-insoluble coloring bodies used to provide layers above the conduit with a color contrasting with the ground soil in the area. These layers are designed to aid one who is searching for the conduit in identifying the area in which it is located. Unfortunately, the heavy machinery operator, who is not specifically searching for the conduit is not on the lookout for specks of color in an earth sample of several feet in depth. For this reason he will generally not see the dye indicator.

The warning device of this invention produces a risable visual signal such as clouds of dense smoke, either dyed or undyed, or brilliant flashes of flame. This is done by providing a rupturable tubular member which has within it a smoke and/or a luminescence producing component which becomes visible as the direct result of the rupture.

One embodiment of this invention is illustrated by the drawings.

FIG. 1 is a schematic longitudinal cross-sectional view of a rupturable tubular signaling device.

FIG. 2 is an enlarged sectional view taken along the section line 2—2 of FIG. 1.

FIG. 3 is a schematic transverse cross-sectional view showing a plurality of the tubular signaling devices of FIG. 1 disposed about a utility conduit.

The tubular outer casing 1 of the rupturable tubular signaling device is made of polyethylene or similar flexible corrosion-resistant plastic. An intermediate concentric tubular liner 2 of aluminum is provided to decrease the possibility of moisture contact with a visual signal producing means 3, e.g., titanium tetrachloride. Within the aluminum liner 2 is a tubular interior member 4 such as

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polyethylene, which is formed with a plurality of septa 6 to separate it into individual compartments. For example, a polyethylene tube may be filled with titanium tetrachloride and then heat sealed at intervals to provide individual compartments, each containing the signal producing means 3. The compartmentalized or segmented device is preferred because it allows exposure of some of the signal producing means without allowing the entire amount to react when the first rupture occurs. This reduces to a minimum the need for replacement after each break.

FIG. 3 illustrates a preferred arrangement of the tubular signaling devices disposed about a sunken utility conduit 5. This particular configuration provides protection from both sides and is desirable because it provides the maximum protection for the minimum amount of cost.

The product of this invention is a visual warning device which comprises an underground corrosion-resistant, flexible, essentially moisture and air proof tubular member which is rupturable by mechanized earthmoving equipment. The tubular member surrounds a visual signal producing means capable of producing a risable visible signal.

The casing 1 of the tubular signaling device must resist underground corrosion, preferably to the same extent as the conduit 5. The tubular member comprising the casing 1, the aluminum liner 2 and the interior member 4 must also provide a barrier of air because all of the commonly available signal producers usable to produce a risable signal are extremely sensitive to moisture and/or oxygen present therein. For this reason, an additional moisture barrier layer such as aluminum foil between the outside environment and the signal producing means 3 can be beneficial. Several such barrier layers can, of course, be interposed between the reactive material and the outside layer with the number of layers dictated to some extent by the relative degree of moisture sensitivity of the reactive material and the nature of the underground environment.

The tubular signal device is preferably sufficiently flexible to allow its winding about a reel for deposition by mechanical means, e.g., by a cable plow. For economic reasons, as well as for ease of mechanical deposition, it is preferred that the tubular signaling device be not greater than two inches in outside diameter and it is especially preferred that it be not greater than one inch. Again, for ease of mechanical deposition the tubular signal device should be of a suitable length say 500 to 1500 feet to allow for semicontinuous implantation. In any event, the ratio of length to outside diameter of the tubular signaling device is greater than 50 to 1.

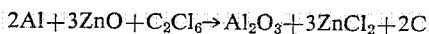
There are a variety of signal producing means which can be used to produce the risable visual signal needed for this invention. By risable it is meant that each of these signal producing means must produce either smoke or luminescence to extend from the depth of the buried tube (which is generally not more than 3 feet below the surface of the ground) to the surface of the ground and preferably above. Pyrotechnic combinations are an example of such signal producing means. A complete discussion of pyrotechnic reactions is found in Kirk-Othmer Encyclopedia of Chemical Technology, 2nd edition, volume 16 (1968). Briefly, pyrotechnic reactions are exothermic, self-sustaining and self-contained, i.e., they proceed without ambient air.

Pyrotechnic materials need energy input before the reaction can become self-sustaining. This is accomplished by putting a more easily ignited "first fire" element in contact with a pyrotechnic mixture. The first fire element is ignited, e.g., by friction, which can be obtained from the rupturing force applied to the tubular signaling device of this invention. Pyrophoric materials placed in contact with the fused pyrotechnic mass can also be used as a "first fire." These materials react rapidly and exothermically

with air to generate sufficient heat to ignite the pyrotechnic mixture.

A typical pyrotechnic device is comprised generally of fuels, oxidizers, binders, and adhesives. The choice of the particular materials obviously depends upon the particular effect desired.

Generally, the pyrotechnic systems most interesting for this invention are those which do not involve predominantly incandescent or luminescent outbursts, but rather produce clouds of dense smoke. The pyrotechnic signal smokes are of two types. The first of these types involves the condensation of exothermic reaction products in the form of finely divided, solid particles to form a smoke. An example of such a reaction is



(in the above reaction the aluminum serves as a fuel while zinc oxide and hexachloroethane serve as the oxidizing component. A grayish white cloud of zinc chloride is produced and it serves admirably as the signal producing means).

A second broad class of signal smokes is that which uses the heat generated by the pyrotechnic mixture to sublime an organic dye. The dyes are vaporized by the heat of the burning composition and the vapor quickly condenses to form clouds of fine-colored dust. A typical composition for this type of signal smoke is as follows:

	Percent
Potassium chlorate -----	28-35
Sugar -----	23-35
Dye -----	30-54
Sodium bicarbonate -----	0-15

While both of these types of signal smokes can be used there are disadvantages inherent in each. The class of signal smokes using the exothermic reaction product condensate provides a mixture which reacts at high temperatures and creates a luminous flame. If the stoichiometry of the mixture is changed to produce more smoke, there is a tendency for erratic burning to take place. This particular class of mixtures is also fairly hard to ignite.

There are difficulties inherent also in the heat vaporizable dye system. The heat transfer to the dye must be controlled because too much heat will destroy the dye and promote loss of color while too little heat will fail to generate sufficient amounts of dye to create an effective signal.

Pyrotechnic materials in general also suffer from a more serious disadvantage, i.e., they require extreme care in handling because of their explosive nature. An alternative to the pyrotechnic signaling system is one based solely on pyrophoric materials. Several materials are sufficiently pyrophoric to serve as signal producing means. (Certain pyrophoric materials react with air to produce a flame with very little smoke generation. The inclusion of a diluent, e.g., oil, will serve to produce large volumes of smoke in materials which would otherwise produce very little.) A discussion of pyrophoric materials can be found in the Handbook of Selected Properties of Air and Water Reactive Materials, Bulletin No. A.D. 688, 422, published by the U.S. Government. Examples of pyrophoric materials are elements such as potassium, lithium and phosphorus; alloys such as potassium-phosphorus, sodium-potassium (the above materials are preferably used with a diluent); metal carbides; hydrides of aluminum, diborane, cerium, cesium, potassium and magnesium; cadmium and certain nitrides; molybdenum dioxide; calcium and stannic phosphide, lithium silicide; and metalloorganic compounds such as ethyl aluminum dichloride, and R_3Al compounds where R is methyl, ethyl, propyl, iso-propyl or n-butyl.

As compared to the pyrotechnic and pyrophoric materials described above, a far superior class of materials is characterized by the ability to produce smoke when in contact with moisture and comparative safety in handling.

Examples of such materials are bromides and chlorides of the transition and amphoteric metals and acetyl chloride and bromide. Examples of other materials which are more difficult to handle than those mentioned above but still produce generous volumes of smoke when placed in contact with moisture are SO_3 and ClSO_3H .

An especially preferred material is titanium tetrachloride which rapidly reacts with available moisture to generate ample clouds of dense, difficultly dispersed white smoke which has proven to be safe to one who comes in contact with it for short periods of time. (It is believed that the TiO_2 , which is a white pigment used in paints, forms around the acid droplets to prevent or inhibit acid burns.) It has also been found that adequate smoke is produced when titanium tetrachloride is held at a temperature of 0°C .

It is preferred and for pyrophoric materials it is necessary to hermetically seal the segments of the tube. A hermetic seal permits the use of a propellant. The choice of propellants will, of course, depend upon the signalling system chosen but any material which will be compatible with the signal producing means and generate enough pressure upon rupture of the tube walls to help thrust the smoke above ground can be used. (For example, sulfur dioxide is an excellent propellant for use in a tube containing titanium tetrachloride.)

The desirability of including a propellant will be dependent upon such factors as cost of the propellant as opposed to the signaling system and amount of the signal producing means likely to be exposed. For example, if a segmented tube is used on terrains of irregular elevation, propellants are desirable because it is possible that only one of the segments would be ruptured and the presence of the propellant would help to ensure that ample smoke appeared above the ground surface.

Examples of the product of this invention follow.

EXAMPLE 1

An unsegmented polyethylene tube 6 yards long having one sealed end with an outside diameter of $\frac{3}{4}$ inch and an inside diameter of $\frac{1}{2}$ inch was filled to 80% capacity with TiCl_4 and heat sealed. A ditch was dug by a trenching machine, the tube was placed in the trench and covered with dirt. The blade on the trencher was set $\frac{1}{2}$ foot lower and the trencher was driven across the tube in a perpendicular direction. The liquid spilled in the trench as the tube was ruptured and almost immediately dense clouds of white smoke rose to a height of about eight feet above the level of the ground, i.e., about 10 feet above the tube. The trencher operator, who was unaware of the purpose of the tube, immediately stopped the machine and ran. The smoke persisted for 3 to 4 minutes in a wind of 15 to 20 m.p.h. at 70°F .

EXAMPLE 2

Example 1 was repeated except that a tube having an outside diameter of $\frac{1}{2}$ inch and an inside diameter of $\frac{3}{8}$ inch was used. The smoke released upon rupture of the tube produced a visual signal not immediately dispersed by the wind but of somewhat lesser height than that produced in Example 1. This signal was adjudged to provide a more than adequate warning signal.

EXAMPLE 3

Three separate tubes were buried and ruptured as in the preceding examples. All tubes were 7 yards long with an outside diameter of $\frac{3}{4}$ inch and an inside diameter of $\frac{1}{2}$ inch. The wind velocity was 10 to 15 m.p.h. and the temperature was 40°F .

All tubes contained TiCl_4 and were filled in the following manner. The first tube was filled to 80% capacity, the second was segmented by heat sealing the tube in 1 yard segments with each segment containing 80% of capacity and the third tube was unsegmented and filled to 80%

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capacity with a mixture of TiCl_4 and SO_2 , the latter being 5% by volume of the mixture.

Upon rupturing the first tube, the smoke signal was similar to that found in Example 1. The segmented tube, upon rupturing, squirted TiCl_4 liquid high into the air which almost instantly formed a dense white cloud almost the equal of the one formed from the first tube. The third tube produced a cloud with the greatest height and volume, i.e., approximately 8 feet above the ground, which completely enveloped the trenching machine.

What we claim is:

1. A visual warning device adapted to be buried near a utility conduit and comprising:

(a) an underground corrosion resistant, flexible, essentially moisture proof tubular member comprising a plastic tubular outer casing, a concentric tubular aluminum liner and a plastic tubular interior member containing a plurality of individual compartments which are hermetically sealed, which tubular member is rupturable by earthmoving equipment and has a ratio of length to outside diameter of at least 50 to 1; and

(b) a visual signal producing means releasably contained in each of said compartments and capable of producing a risable visual signal upon rupture of the tubular member.

2. A visual warning device as defined in claim 1 wherein the visual signal producing means is primarily smoke producing.

3. A visual warning device as defined in claim 1 where-

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in a propellant is included with the visual signal producing means in the tubular member.

4. A protection system for a buried utility conduit comprised of at least one visual warning device as defined in claim 1 buried in essentially parallel spaced relationship with said utility conduit.

5. A visual warning device as defined in claim 1 wherein the tubular member is about 20 feet or more in length.

6. A visual warning device as defined in claim 1 wherein the visual signal means is rapidly reactive with ambient moisture to generate smoke upon rupture of the tube.

7. A visual warning device as defined in claim 6 wherein the visual signal means is titanium tetrachloride.

References Cited

UNITED STATES PATENTS

3,520,275	7/1970	Gawlick et al.	116—124
3,083,542	4/1963	Summers et al.	61—72.1
3,112,645	12/1963	Glass	116—114 X
3,115,861	12/1963	Allen	61—72.1
3,282,057	11/1966	Prosser	61—72.1
3,581,703	6/1971	Hosack	116—67

LOUIS J. CAPOZI, Primary Examiner

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61—72.1; 102—90; 138—127, 139