Feb. 7, 1967 C. F. SHELTON, JR 3,303,270

INSULATED CONDUCTOR

Filed June 14, 1965

Fig. 1.

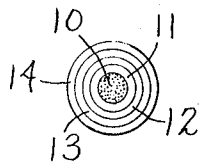


Fig. 2.

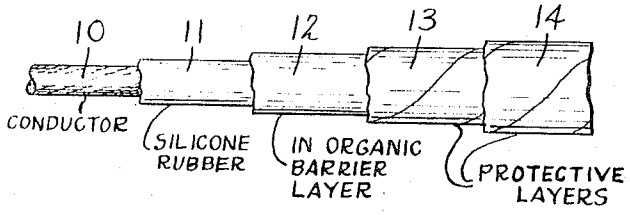
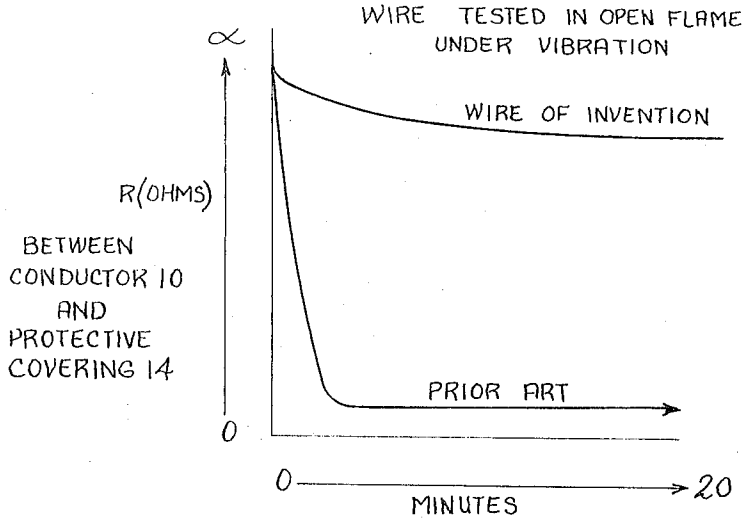


Fig. 3.



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INSULATED CONDUCTOR

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This invention relates to insulated conductors and more particularly to insulated electrical wire conductors which are capable of withstanding high temperature, open or direct flame and vibration.

With the advent of more critical military, aerospace and industrial performance requirements, together with use of higher operating voltages, a demand has been generated for an insulated conductor which will maintain circuit integrity upon exposure to vibration and abrasion conditions while in an open flame environment. The prior art has attempted, but has not been successful, in meeting these more stringent requirements. For example, the prior art has offered conductors insulated with asbestos, glass, Teflon and silicone resins, either singly or in combination with each other, but these materials have not been found suitable. Additionally, the prior art has attempted to meet these requirements by using organic insulators but, again, there has been a notable lack of success due to the out-gassing problem encountered with organic material during exposure to an open flame.

In view of the foregoing, a new and improved insulated conductor which would maintain circuit integrity during exposure to simultaneous vibration and open flame was required. This new insulated conductor has been provided by applicant by utilizing insulation comprising the combination of a layer of material which will revert to an inert layer when exposed to an open flame supported by a substantially inorganic retaining layer.

Accordingly, it is an object of this invention to provide a new and improved insulated conductor.

Another object of this invention is to provide a new and improved insulated conductor having a flexible layer which will revert to an inert layer upon decomposition thereof, supported by a substantially inorganic layer.

Another object of the invention is to provide a new and improved insulated conductor suitable for withstanding simultaneous open flame and vibration conditions, the insulation comprising a layer of silicone rubber supported by a layer of substantially inorganic material.

Other objects and advantages of the invention will in part be obvious and will in part be apparent from the specification.

The invention accordingly comprises an article of manufacture possessing the features, properties and relation of elements which will be exemplified in the article hereinafter described and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention reference is had to the following description taken in conjunction with the accompanying drawing, in which the same reference numerals designate like or corresponding parts in the several views, and in which:

FIG. 1 is an enlarged cross-sectional view of an insulated conductor in accordance with the invention;

FIG. 2 is a front elevational view of the insulated conductor according to this invention with successive layers cut away to show the structure; and

FIG. 3 is a graph illustrating the improved resistance characteristics of the insulated conductor according to this invention in on open flame and during vibration.

Referring to FIGS. 1 and 2, the insulated conductor according to this invention includes a metallic conductor **10**, preferably of a nickel-clad copper-stranded material

although it is to be understood that copper, silver and other metallic conductors may also be utilized singly or in combination with other materials. Directly over the metallic conductor **10**, a layer **11** of silicone rubber is applied. In the preferred embodiment methyl silicone rubber is used. It is also to be understood that although methyl silicone rubber is preferred because of its superior characteristics, other silicone rubber such as methyl, vinyl methyl, phenyl silicone rubber and fluoro silicone rubber as well as other types of silicone rubber could also be utilized. The silicone rubber may be extruded, applied as a tape or film, or applied as part of a silicone rubber-glass tape or polyester fiber silicone rubber tape or film. In the preferred embodiment an extruded silicone rubber layer is used because of its ease of fabrication.

The layer of silicone rubber provides extremely high insulation resistance when exposed to open flame by reverting to a non-conductive, inert, inorganic silica layer. The silica layer, when retained by a substantially inorganic layer, protects the electrical integrity of the wire even in the advent of a long-duration open flame condition. Additionally, the use of silicone rubber material minimizes moisture wicking at the wire ends and enables the conductor insulation to be readily stripped off.

Over the silicone rubber layer **11** is applied, in any suitable manner, a primarily inorganic layer **12** which is capable of retaining or supporting the ash of the underlying silicone rubber upon its reversion to silica in open flame and while under vibration. In the preferred embodiment a methyl silicone resin-saturated asbestos is utilized as the layer **12** and it may be wound on or served as thread or applied in the form of tape or in any other suitable manner. Other materials such as glass, mica, or quartz, singly or in combination with each other or in combination with silicone resin-saturated asbestos, may also be used. It is to be understood that for the purposes of this invention, silicone resin-saturated asbestos is defined as a primarily or substantially inorganic layer. It is to be further understood, for the purposes of this invention, that silicone resin-saturated asbestos is preferred for the high degree of mechanical protection it affords as well as its superior abrasion, cold-flow, cut-through and deformation-resistance qualities.

Referring again to FIGS. 1 and 2, there are shown two layers of protective coverings **13** and **14** positioned over the silicone rubber layer **11**. The layers **13** and **14** provide the remainder of the physical and electrical protection ordinarily required to meet environmental conditions. Layer **13** may comprise a Teflon tape wrapped over layer **12** and the outside layer **14** may comprise a Teflon-coated glass braid. Teflon is the brand name for the compound polytetrafluoroethylene. Additionally, as disclosed by the prior art, other materials such as nylon, cotton, etc., may be substituted for layers **13** and **14**.

While it will be understood that the wire dimensions may vary according to the design for any particular application, the following is a chart showing some of the dimensions of an insulated conductor constructed in accordance with the teachings of this invention:

Conductor: 10–40 mil outside diameter nickel-clad copper.

Layer: 11–11 mil wall of extruded silicone rubber.

Layer: 12–17 mil wall of silicone resin-saturated asbestos.

Layer: 13–6 mil wall of Teflon barrier tape.

Layer: 14–7½ mil wall of Teflon-coated glass braid.

It is to be understood that the above dimensions are illustrative only and are not to be considered as limiting the scope of the invention.

Referring now to FIG. 3, there is shown a graph illustrating, first, the insulation resistance characteristics of

an insulated conductor prepared according to the teachings of this invention when tested in an open flame and while undergoing vibration and, second, the resistance characteristics of an insulated conductor of the prior art tested under the same conditions. The two conductors were tested in open flame and under vibration in accordance with the test specifications outlined in military specification MIL–W–25038B dated May 15, 1963. The Y axis of the graph illustrates the resistance recorded by applying 110 volts A.C. between conductor **10** and layer **14** and measuring the leakage current, and the X axis of the graph illustrates the time of the test.

From the results shown in the graph, it may be seen that the conductor of this invention is far superior to the conductors of the prior art when encountering these types of extreme environmental conditions. As can be seen, the resistance between the conductor **10** and the outside layer **14** remains substantially constant after a small initial drop, whereas the conductor of the prior art exhibits a resistance characteristic which rapidly falls toward zero.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description are efficiently attained and since certain changes may be made in the above article without departing from the spirit and scope of the invention, it is intended that all matter contained in the foregoing description or shown in the accompanying drawing, shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all the generic and specific features of the invention herein described and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

What is claimed is:

1. An electrical insulated conductor for conducting electricity without electrical insulation breakdown in a flame while simultaneously undergoing vibration, including a metallic conductor, a silicone rubber layer on said conductor, a supporting material layer on said silicone rubber layer, said supporting material layer selected from

a class consisting of glass, mica, quartz, asbestos, silicone resin-saturated asbestos, or any combination of the above, and a double protective covering on the supporting layer selected from the class consisting of nylon, polytetrafluoroethylene, cotton, glass and any combination thereof.

2. An electrical cable, for conducting electricity without electrical insulation breakdown in a flame while simultaneously undergoing vibration, including an electrical metallic conductor, a silicone rubber layer on said conductor, a substantially inorganic high temperature barrier layer on said rubber layer, and a double protective layer on said inorganic high temperature barrier layer selected from the class consisting of nylon, polytetrafluoroethylene, cotton, glass and any combination thereof.

3. An insulated electrical conductor, for conducting electricity without electrical insulation breakdown in a flame while simultaneously undergoing vibration, including a metallic conductor, a silicone rubber layer on said conductor, a silicone resin saturated felted asbestos layer on said rubber, and a protective covering on said asbestos layer.

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