Patented Aug. 12, 1952

2,606,849

UNITED STATES PATENT OFFICE

2,606,849

INSULATED ELECTRICAL LEAD

Christian Dantsizen, Schenectady, N. Y., assignor to General Electric Company, a corporation of New York

Application May 24, 1949, Serial No. 94,970

4 Claims. (Cl. 154—2.27)

1

This invention relates to electrical leads and methods for constructing them. More particularly, the invention relates to electrical conductors arranged singly or in groups of two or more within an outer sheath with the conductors separated from each other and from the sheath by electrical insulating material. The invention relates also to the construction of barriers for electrical conductors and cables for preventing the flow of insulating compound or other fluids between separate sections of a conductor or cable.

An object of my invention is the provision of an insulating medium for one or more conductors within a sheath, which completely fills the intervening space between conductors and between conductors and sheath so as to prevent pockets of air or other vapors which might result in a breakdown under electrical stress.

A further object of the invention is the provision, for an electrical lead assembly having one or more conductors within a sheath, of an insulating medium which tightly engages the conductors and the sheath to prevent the entry into the assembly of moisture, vapor, gases or the like which might cause a breakdown under electrical stress.

A further object of my invention is to provide an electrically insulative material which is suitable for tightly engaging an electrical conductor or conductors and a surrounding sheath or other outer member to form a barrier to prevent the flow of insulating compound or other fluid along the conductors.

A still further object of the invention is to provide an insulated electrical lead or group of leads which, in addition to performing the usual current carrying functions, can be used to seal the opening in a container through which the leads are brought into the container in order to prevent the escape of the contents of the container through the opening.

In carrying out my invention in one form, I place around a copper wire a layer of a material of that class of materials which, upon being deformed while cold, return to substantially their original shape when subsequently heated to the proper temperature. The copper wire and the layer of material around it are placed within a steel sheath. The entire assembly is then swaged to reduce its cross sectional dimensions, after which it is heated to cause the intervening layer of material to attempt to regain its original shape. In this manner, the intervening layer of material is caused tightly to engage the center

2

copper conductor and the outer steel sheath and seal the electrical lead, thus formed, against moisture and other foreign materials.

For a clearer and more complete understanding of my invention, reference should be had to the accompanying drawing, Fig. 1 of which is a longitudinal sectional view illustrating one step in the construction of an electrical lead in accordance with my invention; Fig. 2 is a sectional view of this lead in finished form; Figs. 3 and 4 illustrate a step in the construction of a barrier or seal in accordance with a modification of my invention; and Fig. 5 is a sectional view illustrating an additional step in the construction of such a barrier.

In the preferred embodiment of my invention illustrated by Figs. 1 and 2, an electrical conductor which may be copper wire of circular cross section is represented by the numeral 1. An outer tubular sheath which may be of steel or other malleable material having sufficient tensile strength is represented by the numeral 2. Between conductor 1 and sheath 2 is a layer of electrically insulative material 3.

Layer 3 may be composed of any of the class of materials, including polymerized tetrafluorethylene, which have the characteristic of returning to substantially their original shape when heated, after having been deformed while cold. In the case of polymerized tetrafluorethylene, for example, if it is deformed while cold and then heated at 350 to 400 degrees centigrade for a short time, it will regain substantially its original shape, if it is not restrained while being heated. Other examples of materials having this characteristic are polymerized monochlorotrifluorethylene and polymerized methyl methacrylate. The former returns to substantially its original shape, after having been deformed while unheated, when it is heated at approximately 200 degrees centigrade for a short time. The latter tends to return to its original shape, or reform, when heated at temperatures less than 65 degrees centigrade.

In the construction of a typical insulated electrical lead in accordance with my invention, I first provide a cylindrical piece of polymerized tetrafluorethylene having a length and diameter equal to the length and diameter of layer 3 in Fig. 1. I then drill a hole through the piece of polymerized tetrafluorethylene along the center line thereof, into which conductor 1 will fit snugly. Conductor 1, which is of circular copper wire in this instance, may then be sandblasted to improve the subsequent adherence between

the wire and the surrounding insulating material, after which the conductor 1 is inserted into the hole in the polymerized tetrafluorethylene. The member 3 of polymerized tetrafluorethylene is then inserted into sheath 2, the inside diameter of which is such that a very close fit results between sheath 2 and insulating layer 3.

The insulated lead assembly is then swaged and reduced in diameter, being simultaneously elongated, until it is of the form illustrated in Fig. 2. The entire assembly is then heated at 350 to 400 degrees centigrade for a short time. During the heating operation, the polymerized tetrafluorethylene attempts to shrink in a direction parallel to the center line of the assembly and return to its original diameter, which causes it to expand with considerable force against the sheath 2. The sheath prevents outward expansion so the pressure is reflected against the sandblasted or knurled surface of conductor 1. In this manner, the existence of vapor pockets in the insulated electrical lead is precluded and a tight seal is provided between the conductor and the insulation and between the insulation and the outer sheath which prevents the subsequent entrance of any fluid, vapor, or other foreign material.

A modification of my invention in which the characteristics of polymerized tetrafluorethylene and other similar substances are utilized to create a sealed barrier around one or more electrical conductors is illustrated in Figs. 3, 4 and 5. In this modification, a cylinder of polymerized tetrafluorethylene is swaged or otherwise subjected to pressure while cold to reduce its diameter and elongate it. The resulting elongated cylinder of reduced diameter is illustrated in Figs. 3 and 4. One or more holes, depending upon the number of electrical conductors desired, are then drilled longitudinally through the cylinder and electrical conductors are inserted in the holes. Fig. 3 illustrates such a cylinder 4 in which a single conductor 5 has been inserted, while Fig. 4 illustrates a similar cylinder 6 in which three electrical conductors 7, 8, and 9 have been inserted.

The cylinder 4 or 6 of polymerized tetrafluorethylene is then inserted in a steel shell 10 of circular cross section. In this instance, cylinder 4, having a single conductor, is used for purposes of illustration. A longitudinal sectional view of shell 10, with cylinder 4 and conductor 5 assembled therein, is shown in Fig. 5. It can be seen in this figure that the inner surface of this typical outer shell is flared from both ends toward the center, which forms an annular space 11 between cylinder 4 and shell 10. After cylinder 4 is placed within shell 10, the entire assembly is heated at 350 to 400 degrees centigrade for a short time. This causes the cylinder 4 of polymerized tetrafluorethylene to expand against the side walls of the steel shell, filling the annular space 11, and against the conductor 5, thus forming a tight seal between insulation 4 and both conductor 5 and shell 10.

It is readily apparent that an insulated electrical lead forming a sealed barrier, as illustrated in Fig. 5, has many uses. For example, it may be used as a termination or connection for a conventional fluid filled electrical cable to prevent the escape of the insulating fluid or the flow of the insulating fluid from one section of such a cable to another. An additional use is to permit the introduction of electrical energy into a container through an opening and simultaneously provide a seal for the opening. In the latter instance, it has a great advantage over other sealing means now in use because it allows the use of copper conductors. With other sealing means, such as glass, less efficient conductors of metals other than copper must be used, because of the necessity of matching the coefficient of expansion of the conductor as closely as possible to that of the glass. By utilizing my invention, copper can be successfully used for the electrical conductors. I have found, for example, that a sealed electrical lead constructed in accordance with my invention, utilizing a copper conductor, polymerized tetrafluorethylene as the electrical insulating material, and a steel sheath, and assembled in the manner illustrated by Fig. 5, will successfully withstand an air pressure greater than 80 lbs. per sq. inch.

While I have illustrated and described one preferred embodiment of my invention, together with one modification thereof, many additional modifications will occur to those skilled in the art and, therefore, it should be understood that I intend to cover by the appended claims any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. The method of forming an electrical lead which comprises covering an electrical conductor with a layer of a material of the class which after being deformed while cold returns to substantially its original shape when subsequently heated, applying a sheath of malleable material on the outer surface of said material, swaging the assembly thus formed to reduce the cross sectional area thereof, and then heating said material to cause it to attempt to return to its original shape whereby said material tightly engages said conductor and said sheath.

2. The method of forming an insulated electrical lead which comprises placing around an electrically conductive wire a layer of a material of the class including polymerized tetrafluorethylene, which tends to regain its original shape upon being heated at a suitable temperature after having been deformed while cold, placing said wire and said layer of material within an outer sheath strong enough to prevent deformation of the sheath when the layer of material is subsequently heated, swaging said sheath to reduce the cross sectional area of the assembled sheath, wire and intermediate layer of material, and heating said assembled group to cause said layer of material to attempt to regain its original shape whereby said material tightly engages said wire and said sheath.

3. The method of forming an insulated electrical lead which comprises boring a hole along the axis of a cylinder of a material of the class including polymerized tetrafluorethylene, which tends to regain its original shape upon being heated at a suitable temperature after having been deformed while cold, inserting an electrically conducting wire in said hole, placing said material and said wire into a tubular sheath, swaging the assembly thus formed to reduce the cross-sectional area of the said wire, said material, and said sheath, heating said assembly to cause said material to attempt to expand radially to regain its original shape whereby said material tightly engages said wire and said sheath.

4. The method of forming an insulated electrical lead which comprises boring a hole along

the axis of a cylinder of polymerized tetrafluorethylene, which tends to regain its original shape upon being heated at a suitable temperature after having been deformed while cold, inserting a sand-blasted electrically conducting wire in said hole, placing said cylinder and said wire into a tubular sheath, swaging the assembly thus formed to reduce the cross-sectional area of said wire, said cylinder, and said sheath, heating said assembly to from 350° C. to 400° C. to cause said cylinder to attempt to expand radially to regain its original shape whereby said cylinder tightly engages said wire and said sheath.

CHRISTIAN DANTSIZEN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,233,807	Head	July 17, 1917
2,225,298	Cook	Dec. 17, 1940
2,341,235	Palmer	Feb. 8, 1944
2,405,057	Rosenstein	July 30, 1946
2,431,085	Shelmerdine	Nov. 13, 1947
2,454,625	Bondon	Nov. 23, 1948
2,466,271	Pfleumer	Apr. 5, 1949
2,469,416	Smyers	May 10, 1949