Aug. 3, 1948. E. S. McCONNELL ET AL 2,446,292

INSULATED ELECTRICAL CONDUCTOR

Filed June 8, 1945

Fig. 1

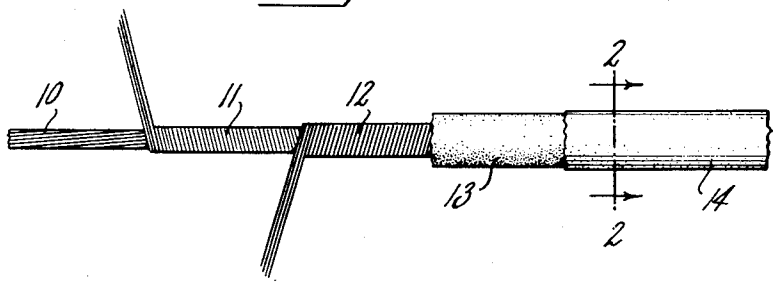
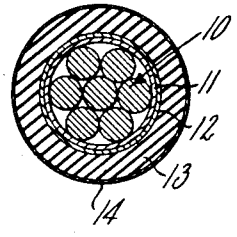


Fig. 2



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INSULATED ELECTRICAL CONDUCTOR

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2 Claims. (Cl. 174—120)

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This invention relates to an insulated electrical conductor that is so constructed that it has an exceptionally small over-all diameter and light weight for its service conditions.

The present insulated electrical conductor may be used in many kinds of services but because of its light weight, small size and resistance to fire, solvents and the deteriorating effects of fungus, it is particularly well adapted for use in the wiring of aircraft.

One object of the present invention is to provide an insulated conductor that is highly resistant to an external flame and to internal heat from an over-loaded conductor.

Another object is to provide an insulated conductor, that is lighter in weight and smaller in over-all diameter than the insulated conductors available heretofore for use in wiring aircraft.

Another object is to provide an insulated conductor which will render satisfactory service under an extremely wide range of high and low temperatures and is capable of withstanding repeated cycles of high heat and extreme cold.

Another object is to provide an insulated conductor which is highly resistant to fungi, by selecting materials which are immune to fungi, or by completely enclosing any material subject to such attack with other resistant covering material.

Another object is to provide an insulated conductor which is highly resistant to the deteriorating influence of solvents such as gasoline, lubricating oil, ethylene glycol, fluids used in hydraulic systems, and fresh and salt water.

Another object is to provide an insulated conductor that is highly flexible and has a tough smooth finish which together with its small diameter facilitates its installation.

Another object is to provide an insulated conductor which is so constructed that the insulation can be easily and quickly pushed back adjacent an end of the metal conductor to expose a short end portion of the bare conductor, without damaging or nicking the conductor. This permits an end of the conductor to be quickly exposed so that it can be soldered or otherwise attached to a terminal.

Another object is to provide an insulated conductor having a light color and smooth finish that will remain clean and thus facilitate identification of circuit markings printed or stenciled on the surface.

Another object is to provide an insulated electrical conductor that makes more effective use of the dielectric properties of fibre glass. Heretofore fibre glass has been used as an outer braid or covering because of its fire resisting qualities.

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However, fibre glass is very difficult to convert into a moisture resisting layer or covering and furthermore it has been found extremely susceptible to mechanical abrasion. In applying fibre glass next to the metallic conductor and subsequently covering it with an insulating and moisture resisting elastic jacket as herein disclosed it is no longer necessary to impregnate or moisture proof the insulating layer of fibre glass. Furthermore, by covering the metallic conductor with the fibers parallel as obtained by wrapping and serving, it is found that cutting and breaking of the glass and fibres is much diminished as compared with a braid wherein the fibres of glass cross over and under each other.

The insulated electrical conductor of the present invention may have a solid or stranded conductor, around which is placed one or more layers of fire and fungi resistant non-adhering material, such as a serving or wrapping, a tape, or a braid formed of non-combustible fibers such as fiber glass or asbestos. This serving is laid directly upon the metal conductor and can be slid appreciably thereon to expose a short end portion of the conductor when desired.

Over the fiber glass or other non-combustible layer is provided an insulating material forming an elastic jacket that has good resistance to moisture. The insulating jacket is preferably formed of polychloroprene latex (neoprene latex) which has good flame and fungi resistant properties, but may be formed of natural rubber or other rubber or rubber-like materials including the vinyl derivatives that are compounded to give them elastic properties.

However since the fiber glass layer is likely to have minute fibers extending radially from the surface thereof, it is desirable to cause these minute fibers to be held down before the plastic jacket is applied, in order to secure a maximum degree of dielectric strength from a minimum wall thickness of the plastic jacket. This may be done by applying a thin film of varnish or lacquer over the fiber glass before or after it is applied as a layer. Better results however are obtained by wrapping a layer of textile fibers such as cotton, rayon or nylon over the fiber glass layer, or by winding a thin tape of flexible plastic material such as Cellophane over the fiber glass.

The elastic jacket when formed of neoprene latex is preferably applied by the liquid-dipped method to insure that the coating will be disposed concentric to the metal conductor. A good practical form of apparatus for applying this latex jacket is disclosed in the Bartlett Patent No. 2,353,987 for Liquid applicator. However, the insulating jacket may be applied by extrusion,

taping or other processes which are known in the insulated wire industry.

It is desirable to provide the present insulated conductor with a harder and smoother outer surface than is provided by neoprene. This is accomplished by placing over the neoprene jacket a thin tough coating of varnish, lacquer, or resinous material such as nylon or vinylite. This thin tough coating may be applied by a liquid dip process or by extrusion or taping.

The above and other objects of the present invention will be further understood from the following description when read in connection with the accompanying drawing illustrating one good practical embodiment of the invention, wherein:

Fig. 1 is a side elevation of an insulated electrical conductor constructed in accordance with the present invention and showing each insulating layer partly removed; and

Fig. 2 is an enlarged transverse sectional view taken on the line 2—2 of Fig. 1.

The conductor 10 may be formed of a single wire but is preferably formed of a number of strands of annealed copper and these strands are preferably tinned, as this will give a protruding bare end portion of the wire added protection and facilitate soldered connections. About the conductor 10 is wound a serving 11 of non-combustible material. This serving is preferably formed of a number of parallel filaments or strands of fibre glass and is wound tightly around the conductor 10 but is not adhesively secured thereto, so that the serving may be slid back a short distance from an end of the wire 10 when it is desired to expose a short end portion of the wire so that it can be secured to a contact member.

As above stated fine glass fibres are likely to protrude from the surface of the fibre glass layer 11 and if it is attempted to deposit an insulating material such as neoprene as a jacket directly over the layer 11, these protruding fibres will extend into such jacket and reduce its dielectric strength. This difficulty may be overcome by applying a film of varnish or shellac over the layer 11 or to the fiber glass before or after it is wound upon the conductor, but this makes it more difficult to slip the layer 11 by a sliding movement back from an end of the conductor 10. Therefore a serving of cotton, rayon, nylon or other fibrous material is preferably wound over the layer 11 in the opposite direction as shown in the drawing to form the second insulating layer 12. However this second layer may be wound in the same direction as the first layer. The cotton or rayon may be treated with a fungi resistant material before or after it is applied to increase the protection of the electric conductor from fungi. This second layer 12 holds down and covers the protruding fibres of the layer 11 and provides a satisfactory surface to receive a jacket 13 of insulating rubber or other elastic material. The jacket 13 may be formed of various types of natural or synthetic rubber and of elastic vinyl derivatives, but preferably is formed of neoprene latex; that is polychloroprene latex because of its good resistance to moisture, solvents and combustion or burning, and the neoprene latex is preferably applied by the liquid-dipped method above mentioned so as to make sure that this jacket will be of uniform thickness around the conductor. The neoprene when applied in this manner will not enter the underlying serving to any appreciable extent but will be bonded firmly thereto.

It is desirable to provide the insulated electrical conductor of the present invention with a smoother and harder outer surface than is provided by neoprene. Therefore in accordance with the present invention the neoprene jacket 13 has deposited thereover a thin film 14 of a synthetic linear polyamide such as nylon. The nylon used for this purpose is preferably an alcohol soluble nylon such for example as is sold on the market under the designation of type 6B and which is made as defined by claim 8 of the patent to Brubaker et al., No. 2,285,009. This nylon solution is preferably applied over the neoprene jacket by employing the apparatus disclosed in the above cited Bartlett patent, as it is found that this causes the nylon film to embrace the neoprene jacket tightly. The nylon which has high tensile strength appears to shrink about the jacket to hug it tightly. The alcohol used as a solvent for the nylon does not produce any harmful swelling of the neoprene. The nylon however may be otherwise applied. It may be desirable to add a white pigment or coloring matter to the nylon solution so as to give the finished insulated electric conductor any desired color which will facilitate identification of the same when installed. A white or light colored outer surface for the conductor affords the further advantage in that identification numbers printed or stenciled thereupon will show up clearly.

As further disclosing the present invention, the following dimensions are given of one good practical construction that is now being manufactured for installation in aircrafts and which has an AN conductor size 18, this being very nearly the same as A. W. G. size 18.

	Over-all diameter
Stranded conductor 10	.050"
Fiber glass layer 11	.055"
Cotton layer 12	.060"
Neoprene latex jacket 13	.089"
Nylon film 14	.093"

Insulated electrical conductors of the present invention having these dimensions have met satisfactorily aircraft service conditions.

It is stated above that the present insulated electrical conductor is smaller in size and lighter in weight than other commercial insulated electric conductors now on the market and having the same cross-sectional area of conductor. The following table is given as showing a comparison between several conductors of the present construction and that of representative commercial constructions now on the market and having a corresponding metallic conductor.

Size [1]	Present Construction		Prior Commercial Construction	
	Maximum Overall Diam.	Weight lbs. 1000 ft.	Maximum Overall Diam.	Weight lbs. 1000 ft.
	Inches		*Inches*	
22	.073	4.25	.090	4.69
20	.091	5.55	.100	6.57
18	.093	8.30	.110	9.08
16	.104	10.80	.118	11.54
14	.123	16.30	.141	17.31
12	.143	24.40	.163	25.75
10	.175	39.50	.196	41.07

[1] AN (Army-Navy) Conductor size which is very nearly the same as A. W. G. size.

This table shows that the present construction is considerably smaller in diameter and lighter in weight than a representative prior construction that meets the same service conditions.

By employing a fiber glass layer 11 that is wound next to the conductor 10 but is not adhesively secured thereto a lighter and more flexible construction is secured than when the fiber glass layer is impregnated with a bonding material. Furthermore if all the other layers 12, 13 and 14 are destroyed by fire the fiber glass layer 11 may still serve to insulate the conductor 10.

The fibrous cover 12, as above stated, prevents fibers from the cover 11 from entering the jacket 13. It also increases the insulating properties of the covering materials, and it is protected from moisture by the jacket 13.

The jacket 13 when formed of neoprene latex will have excellent flame and moisture resisting properties and will be highly resistant to the deteriorating influences of solvents such as gasoline, lubricating oil, ethylene glycol, fluids used in hydraulic systems, fresh water and salt water, all of which may be present at different times to conductor wires installed in an airplane. Furthermore neoprene is well adapted to withstand cold temperatures.

The nylon film 14 has high tensile strength and provides the conductor with a tough, smooth outer surface of light color, so that the wire identification numbers placed thereupon will show up clearly and will not be readily obscured by grease or dirt.

All of the covers 11, 12, 13 and 14 are so formed and applied that they afford the conductor 10 excellent protection and insulation for the total thickness of the insulating material, and produce a highly flexible insulated conductor. The insulating material is sufficiently compressible as a whole to be readily pushed back from an end of the conductor 10 to expose a short end portion so that it can be secured to a terminal. This makes the use of a mechanical stripping tool which is likely to nick or otherwise injure the conductor 10 unnecessary.

Having thus described our invention, what we claim and desire to protect by Letters Patent is:

1. An insulated electrical conductor having excellent abrasion, flame and moisture resisting properties, comprising a metal conductor, a ribbon-like serving of fiber glass wound in short spirals about the conductor in direct contact

therewith but not bonded thereto, a serving of fibrous textile material wound over the fibre glass so as to hold down stray glass fibres, an elastic jacket formed of a homogeneous plastic having good resistance to flame and moisture covering said textile serving, and a thin strong film of synthetic linear polyamide covering and snugly embracing said elastic jacket and having an outside diameter that is less than twice the diameter of the bare metal conductor, whereby a well covered highly flexible conductor of excellent insulating properties is provided and the insulation adjacent an end can be readily slid back to expose a short portion of the conductor.

2. An insulated electrical conductor having excellent abrasion, flame and moisture resisting properties, comprising a metal conductor, a ribbon-like serving of fibre glass wound in short spirals about the conductor in direct contact therewith but not bonded thereto, a serving of fibrous textile material wound over the fibre glass so as to hold down stray glass fibres, a jacket of poly-chloroprene bonded to the textile serving, and a thin strong film of synthetic linear polyamide covering and snugly embracing said jacket and having an outside diameter that is less than twice the diameter of the bare metal conductor, whereby a well covered highly flexible conductor of excellent insulating properties is provided and the insulation adjacent an end can be readily slid back to expose a short portion of the conductor.

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