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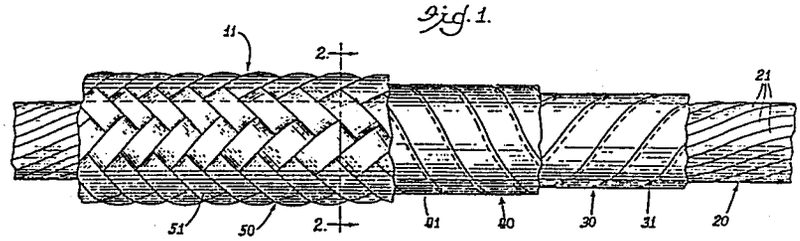
(54) Heat-resistant electrical conducting wire.

(57) An electrical conducting wire (11), capable of withstanding high continuous operating temperatures without emitting smoke or halogens and without supporting flame, includes a conductive core (20) of nickel, or copper or iron plated with tin, nickel or silver and surrounded by a plurality of successive insulating layers (30, 40) of polyimide film strip or tape (31, 41). The first of such layers (30) is formed by helically winding the tape of polyimide film about the core with adjacent edges overlapping. Each successive layer (10) is helically wound in the opposite direction and surrounding the next inner layer. A braided fiberglass jacket (50) encases the core (20) and the insulating polyimide film layers (30, 40).

Fig. 1.



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HEAT-RESISTANT ELECTRICAL CONDUCTING WIRE

Background and Summary

The present invention relates generally to wires used to conduct an electrical current, and more particularly, to wires designed to withstand high continuous operating temperatures suitable for use in commercial and industrial heating systems as well as cooking equipment and appliances.

These wires, sometimes referred to as "appliance wires", are used as power feed wires, not as the heating coils themselves. Nevertheless, because of the applications in which they are used, they must withstand high temperatures for prolonged periods of time.

Electrical wires of this type typically include a conductive core surrounded by an insulating covering or jacket. In wires designed to operate at high temperatures, the primary insulating material is generally asbestos sheathed in an abrasion dampening braided fiberglass jacket.

Asbestos has inherent disadvantages and limitations as an insulating material. Coarse asbestos insulation is relatively inflexible. Further, for a given maximum temperature application, asbestos increases the outer diameter of the wire making it difficult to work with such a wire.

The electrical wire of the present invention affords improvements over the asbestos insulated wires of the type known in the art. Briefly, an embodiment of the present invention includes a conductive core which may be conventional materials, such as nickel or silver-plated, tin-plated or nickel-plated copper or iron. The conductive core is surrounded by a plurality of successive insulating layers of polyimide film. The first of such layers includes a strip of polyimide film helically wound with edges overlapping so as to completely envelope

the conductive core. Each successive outer layer is formed by helically winding a stripe of polyimide film in the opposite direction in surrounding relationship to the underlying layer, also having its edges overlapped. A jacket of two layers of braided fiberglass encases the core and the insulating polyimide film layers.

The fiberglass jacket may be impregnated with "Teflon" or silicone to create an increased abrasion dampening effect. Applicance wires so constructed will not smoke or support a flame. Further, wires incorporating silicone within the fiberglass sheath will not emit halogens even if heated to excessive temperatures.

An embodiment of the present invention having two helically wound layers of polyimide film has an outside diameter approximately 30% less than comparable asbestos-insulated wire and can be bundled in much tighter packages for power, control and communications applications.

The conducting wire of the present invention exhibits outstanding dielectric strength of 15 kilovolts with a wall thickness of 6 mils. The polyimide film provides a mechanical toughness to the wire. The film itself has a tensile strength of 25,000 pounds per square inch for one mil of film at room temperature with ultimate elongation of 70%. The thermal cut-through point for wire insulated with polyimide film is 525° C. as compared with 250° C. for most other high temperature insulators. The wire constructed in accordance with the present invention retains flexibility at cryogenic temperatures and readily dissipates heat from the conductive core. Such wires resist melting or dripping and also resist chemical alteration when contacted by most fuels, solvents, hydraulic fluids, cleaning agents and other chemical agents.

Wires constructed in accordance with the present invention can be readily stripped with mechanical tools ranging from manual to fully automatic and can be adapted

for effective potting.

Other features and advantages of the present invention will be apparent from the following description and claims and are illustrated in the accompanying drawings which, by way of illustration show preferred embodiments of the present invention and the principles thereof in what are now considered to be the best mode to apply these principles. Other embodiments of the invention employing the same or equivalent principles may be used and structural changes may be made as desired by those skilled in the art without departing from the present invention and the purview of the appended claims.

The Drawing

FIG. 1 is a fragmentary side view of an electrical conducting wire embodying the present invention with portions of the various layers removed to expose the underlying material; and

FIG. 2 is a cross sectional view of the wire of FIG. 1 as viewed substantially along sight line 2-2 of FIG. 1.

Detailed Description

The present invention will be described in detail as a electrical conducting wire suitable for use at a continuous operating temperature of 250° C. in applications including ovens, heater bands, motors and internal wiring of domestic, commercial and industrial heating and cooking equipment, with the understanding that the illustrated embodiment is to be considered an exemplification of the principles of the invention and is not intended to limit the invention.

Referring now to the drawing, an electrical wire for conducting electric current, generally designated 11, is comprised of the following principal elements: a conductive core 20, a first or inner insulating layer 30, a second insulating layer 40 and a braided fiberglass jacket 50.

The illustrated conductive core 20 is comprised of multiple strands 21; however, the core can also be of a solid configuration. Preferably conductor is copper or iron, either one being plated with nickel or silver.

Surrounding the conductive core 20 is an inner insulating layer 30 having a composition including polyimide film. As can readily be seen in FIG. 1, the first insulating layer 30 is formed from a thin strip or tape of polyimide film 31 helically wound in surrounding relationship to the conductive core 20. Adjacent edges of the helically wound tape overlap one another so that the core is completely encompassed.

One embodiment of the present invention includes a plurality of successive insulating layers each layer having a composition of polyimide film. The multiple layers, as illustrated, include a first layer 30 and at least one successive layer 40. The first layer 30 is helically wound, as previously described, in surrounding relationship to the conductive core 20. Each successive layer 40 is also formed from a thin strip of polyimide film or tape 41 helically wound in the opposite direction as the preceding layer 30 but at the same pitch and in surrounding relationship thereto--again with adjacent edges overlapped. One commercially available polyimide film is marketed under the trademark "Kapton" by E.I. du Pont de Nemours and Co. of Delaware.

The insulating layers 30 and 40 of polyimide film are further encased in a braided jacket 50 of two layers having a composition including fiberglass. The braided fiberglass jacket 50 is comprised of individual strands 51 of corded fiberglass which includes a plurality of successive insulating layers braided to form a protective sheath. Preferably, the braided fiberglass jacket is impregnated with "Teflon" or silicon for increased abrasion resistance. An electrical conducting wire so constructed will not smoke or support a flame when

exposed to high temperatures such as 250° C. Further, an electric wire 11 incorporating silicone, as opposed to teflon, within the fiberglass jacket 50 will not emit halogens.

The embodiment of the present invention illustrated, utilizing two thin layers 30 and 40 of polyimide film helically wound in opposite directions, produces an electrical conducting wire 11 with improved moisture resistance and with greater dielectric strength, and yet, has an outside diameter approximately 30% smaller than comparable wires utilizing asbestos and provides greater flexibility even at cryogenic temperatures.

From the foregoing it will be seen that the present invention provides for a safe electrical conducting wire capable of withstanding continuous operating temperatures of 250° C. which is yet resistant to moisture, chemicals, abrasion, impact, radiation, and has excellent dielectric strength. Further, embodiments of the present invention will not smoke, support a flame, or emit halogens when exposed to high temperatures. Wire 11, embodying the present invention is easier and safer to work with, to incorporate into electrical equipment, and to manufacture due to the size and flexibility of the wire 11.

The increased flexibility and the compactness of wires 11 embodying the present invention allow such wires to be more readily bundled in tighter packages for power control and communication applications. Wires 11 embodying the present invention can be stripped effectively with mechanical tools ranging from manual to fully automatic.

Thus, while the preferred embodiment of the invention has been illustrated and described, it is understood that this is capable of variation and modification, therefore the present invention should not be limited to the precise details set forth, but should

include such changes and substitutions that fall within the scope of the following claims.

Claims

1. An electrical conducting wire (11) for use in high temperature application, comprising: a conductive core (20); at least one layer (30) of insulating polyimide film (31) in the form of a strip helically wrapped about and completely encompassing said conductive core; and, a braided jacket (50) having a composition including fiberglass, said braided jacket (50) encasing said core (20) and said insulating layer (30); characterized in that said wire (11) will not emit smoke, support a flame or emit halogens when exposed to temperatures up to 250° C.

2. The conducting wire of claim 1 further comprising a second insulating layer (40) of polyimide film strip (41) helically wrapped about said first layer of film.

3. The wire of claim 2 wherein said first and second strips (31,41) of polyimide film are helically wound in opposite directions with adjacent edges of each layer overlapping.

4. The wire of claim 1 wherein said braided jacket (50) is impregnated with at least one of the compositions selected from a group including polytetrafluoroethylene resinous polymers and silicone.

5. The wire of claim 1 wherein said conductive core (20) has a composition including copper, iron or nickel.

6. The wire of claim 5 wherein said nickel, copper or iron comprising the conductive core is plated with a composition including tin, nickel or silver.

7. A wire (11) comprising: a conductive core (20); a plurality of successively overlying insulating layers (30,40), each of said layers including a strip of polyimide film (31,41) helically wound in surrounding relationship to said conductive core and wound in an opposite direction to the adjacent layer; and a braided fiberglass jacket (50) encasing said core and said

plurality of insulating layers.

8. The wire of claim 7 wherein said braided jacket (50) is impregnated with at least one of the compositions selected from a group including polytetafluoroethylene resinous polymers and silicone.

9. The wire of claim 7 wherein said conductive core (20) has a composition including (a) nickel, (b) nickel, tin or silver plated copper or (c) nickel, tin or silver plated iron.

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Fig. 1.

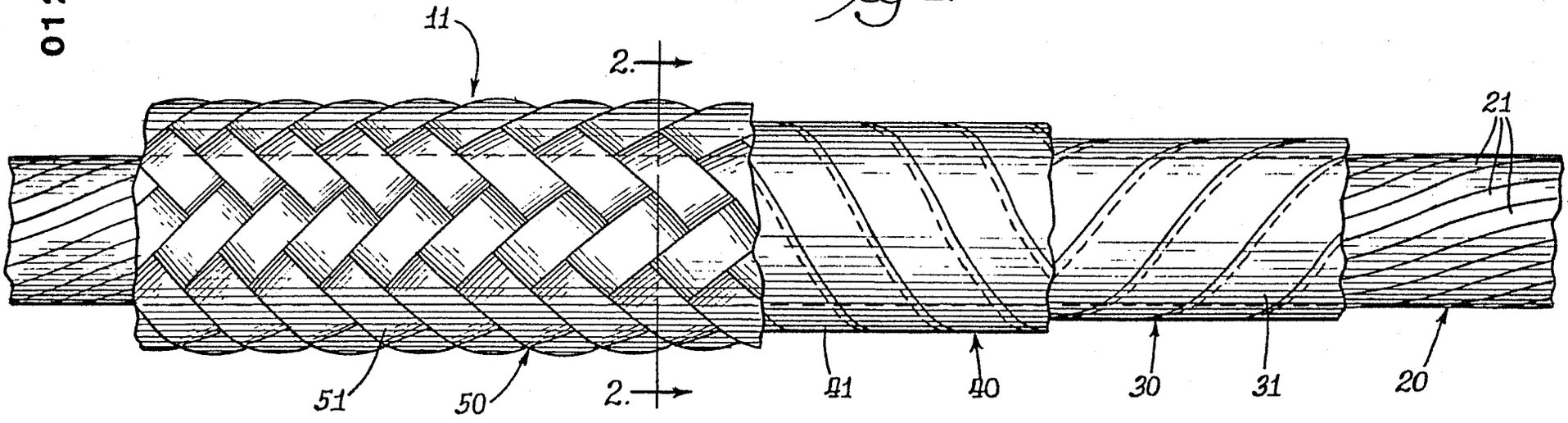

Fig. 2.