ELECTROSTATICALLY SHIELDED WIRE BUNDLE

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Abstract of the Disclosure

A cable contains a plurality of electrical conductors. In each cable, an outer sheath encompasses a plurality of bundles; in each of which a core of one or more insulated conductors is helically surrounded by an insulating electrostatic shield in the form of a wrapping having an inner layer of metal and an outer layer of insulating material. The inner layer has an outer shoulder on which the inner face of the adjacent turn of the inner layer rests; and the outer layer has a projection which overlaps a portion of the outer face of the adjacent turn of the outer layer.

Background of the Invention

The present invention relates to the field of current carrying insulated conductors having electrostatic shielding disposed thereabout.

In the transmission of signals along an electrical conduit, it is desirable to provide an encompassing electrostatic shield to prevent interference from external sources. Since the conduits extend for a considerable length, it is desirable to provide this shielding by winding the metallic shield about the conduit in a series of abutting convolutions. Where several pairs of conductors are contained in one conduit, each pair of conductors has an electrostatic shield to prevent cross-coupling of signals with adjacent conductor pairs and each shield is usually surrounded by an electrical insulator to prevent short circuiting between adjacent shields. One form of shield utilized a spirally overlapping laminated tape of metal and insulating material, with the insulating material being the same width as the metal and covering the entire top of the metal strip. A problem with the prior structure was that gaps appeared in the overlap when the conduit was flexed or otherwise distorted during use. Where such gaps appeared, the electrical shielding effect was diminished or lost, and short circuiting between shields occurred.

A further problem with prior structures was that a grounding wire was required to connect adjacent turns of each shield.

Another problem with the prior art was that extra steps of application were required, such as the turning back of the insulating layer over the shielding layer to prevent short circuiting between adjacent shields; this required extra cost in labor and a decrease in speed of production.

Still another problem was that it was difficult to inspect for faults in the continuity of the shield and it was difficult to solder joints in the conduit when needed.

An additional problem with the prior art was that the outer diameter of the cable was unduly increased, there was a large bend radius and a lesser bend recovery.

One example of one form of the prior art is shown in Patent No. 3,032,604, which had a wrapping of a metal and insulating material lamination and required that one edge of the wrapping be folded underneath in each turn.

Summary of the invention

In accordance with the present invention, each pair of conductors has a wrapping means having an inner and an outer layer of different materials disposed helically and circumferentially thereof wherein each turn of an inner layer overlaps a trailing shoulder of the adjacent turn of the inner layer and a projecting portion of the outer layer overlaps a portion of the outer face of the adjacent turn of the outer layer. In the preferred embodiment, the outer layer is of polymeric material and the inner layer is of a metallic material.

By the foregoing arrangement, an insulated electrostatic shield is provided which may readily be applied in one operation and without complex folding steps. The shield provides a continuous electrostatic shielding despite flexure of the cable in operation, and adjacent shields are isolated from short circuiting each other, even under conditions of extreme flexure. By this arrangement, improved electrostatic shielding, up to 40 D.B. is obtained. Less complex equipment is required to assemble the wrapping, and there is a shorter application time. Inspection for faults is made easier and there is improved ground loop protection and the need for an additional insulating overlap is eliminated. The size of a bundle of conductors is reduced and there is a lower bend radius and a greater bend recovery. The resultant shield is more of a tubular shape than helical; as a result there are less inducive effects, lower shield resistance, and the continuity protection is greater without the need of a ground wire. A further advantage is that, where desired, the joints of the metal may be soldered, thereby increasing reliability and continuity in those applications where some form of soldering is desirable.

Brief description of the drawings

FIG. 1 is a fragmentary perspective view, partially broken away, of a composite cable having a plurality of insulated and shielded bundles of conductors;

FIG. 2 is an enlarged, fragmentary cross-sectional partially broken away perspective view of a novel shielding and insulating wrapping in accordance with the present invention;

FIG. 3 is a fragmentary, partially broken away, partially sectioned side elevation view of one bundle;

FIG. 4 is a fragmentary, partially broken away, partially sectioned side elevation view of a modified wrapping in assembled position; and

FIG. 5 is an enlarged, fragmentary cross-sectional partially broken away perspective view of a modified wrapping.

Description of the preferred embodiments

Referring again to the drawings, and more particularly to FIG. 1 thereof, a composite cable 10 in accordance with the present invention is illustrated. The composite cable 10 has a plurality of shielded and insulated bundles 12a, 12b, and 12c. Each bundle has respective inner core means 14a, 14b, and 14c, such as a pair of insulated conductors. A shielding and insulating wrapping means 20a, 20b and 20c of novel construction in accordance with the present invention is disposed circumferentially of each core means. The entire assembly may be surrounded by a jacket 26, of polymeric material such as polyurethane or the like, which protects the bundles and their associated conductors from the undesirable effects of adverse weather. By the foregoing arrangement, a composite cable is provided wherein a plurality of current carrying conductors may be disposed in side-by-side relationship, with each pair of conductors being electrostatically shielded from any adjacent pair of conductors; with a minimum number of steps required for applying the shielding and insulating wrapping means; and wherein the wrapping means for one bundle does not cause a short circuit with an adjacent bundle.

Since the wrapping for the individual bundles is probably identical, the wrapping of one of the bundles in accordance with a preferred form of the invention will be
described. It is understood that the description of the wrapping for an adjacent bundle would be the same or similar. Each bundle has one or more insulated conductors such as conductors 16 and 17, each of which is surrounded by suitable insulting material 18 and 19 respectively, such as rubber or the like.

A preferred form of shielding and insulating wrapping member is illustrated in FIG. 2. The wrapping means 20a shown in FIG. 2 is an elongated strip of material having a longitudinal dimension of a desired predetermined length and a lateral dimension W. The wrapping means 20a has an outer layer 22 and an inner layer 24 attached thereto.

As shown in FIG. 2, the wrapping 20a is of stepwise cross-sectional construction. The outer layer 22 has a lateral projecting portion 30 having a leading longitudinal edge 32, an inner face 34 and an outer face 36. The outer layer 22 has an opposed, generally parallel trailing longitudinal edge 38. The inner layer 24 has a leading longitudinal edge 40, an inner face 42, a trailing longitudinal edge 44, and an outer shoulder 46 disposed between the trailing longitudinal edge 44 of the inner layer 24 and the trailing longitudinal edge 38 of the outer layer 22.

The outer layer 22 and the inner layer 24 should be sufficiently thin to permit the wrapping 20 to be disposed helically about the core of conductors with which the wrapping is to shield. For example, the inner layer 24 may have a thickness of approximately 0.001 inch and the outer layer may have a thickness of 0.001 inch ±0.0005 inch.

The outer shoulder 46 of the inner layer 24 should be sufficiently wide to permit good overlapping contact with the outer face 36 of the adjacent turn of the outer layer 22. For example, the width of the inner face 34 may be 1/4 of the total width W of the wrapping means 20a, or a ratio of 4:1.

In the preferred embodiment, the inner layer 24 may be of any suitable material for established electrostatic shield, such as current conducting metal foil of aluminum or copper. The outer layer 22, in the preferred embodiment, may be of any suitable insulating material which provides good electrical insulation, and which is sufficiently strong and abrasion resistant to resist tearing, rupture or scoring due to flexing of the cable during operation, and yet which is sufficiently flexible to permit the cable to be flexed without a separation of the overlapping portions of adjacent turns of the outer layer. In addition, the outer layer should be of a material having sufficient frictional characteristics that the inner face 34 of a turn will not shift axially of the cable relative to the coating outer surface 36 of the adjacent turn of the outer layer 22 so that the insulating layer will not separate upon flexure. A suitable insulting material has been found to be Mylar, a polyethylene terephthalate sold by E. I. du Pont de Nemours & Co.

FIG. 3 illustrates the wrapping means 20 of FIG. 2 disposed helically about a core 14 of conductors 16 and 17. As can be seen, a portion of the inner face 42 of the inner layer 24 of each turn is in physical contact with the abutting surface of the insulation 18 and 19 of the conductors 16 and 17 respectively. In addition, in each turn, a portion of the inner face 42 of the inner layer 24 overlaps the outer shoulder 46 of the adjacent turn of the inner layer 24. By this arrangement, a continuous electrostatic shield is provided wherein there is a complete metallic shield circumscribing the conductor pair 14.

In each turn, the inner face 34 adjacent the leading edge 32 of the outer layer 22 overlaps in abutting engagement a portion of the outer face 36 of the outer layer 22 adjacent the trailing edge 38 thereof. By such an arrangement, the outer layer 22 provides continuous and complete insulating sheath about the inner metallic shielding layer 24. By such arrangement, the electrostatic shield provided by the inner layer 24 of one bundle, such as bundle 12a is protected from contact with the electrostatic shield of an adjacent bundle, such as bundle 12b thereby preventing a short circuit between the bundles.

The outer layer 22 may be applied to the inner layer 24 to form a laminate construction such as by extruding the outer layer 22 in the form of a Mylar film in the molten state over the inner layer 24, such as aluminum, in the predetermined offset relationship to establish the projection 30 and should preferably be bonded to the inner layer by a suitable bonding medium.

The wrapping means 20 may be disposed about the conductors 14 of each bundle by a suitable wrapping machine known in the art. The wrapping 20 should be applied with sufficient tension, so that there will be good physical contact between the projection 30 of the outer layer 22 of each turn and the coating outer face 36 of the outer layer 22 of each adjacent turn. A preferred angle of lay, A, for the wrapping means 20a is 60°. The outer jacket 46 may be applied by suitable means known in the art.

A modification of the invention is illustrated in FIGS. 4 and 5. The inner layer 24 includes an inner ply 50 of a strengthening material, such as Mylar, disposed between two outer plies 52 and 54 respectively of metallic shielding material, such as aluminum. The outer layer 22 and inner layer 24 of the wrapping 20 are disposed in offset relationship as in the preferred embodiment. As a result, in the assembled relationship shown in FIG. 4, a portion of the inner face 42 adjacent the leading edge 40 of the inner layer 24 overlaps the outer shoulder 46 of the adjacent turn. Similarly, the inner face 34 of the outer layer 22 overlaps the portion of the outer face 36 of the adjacent trailing edge 38 of the outer layer 22 of the adjacent turn. By this arrangement, the use of a three-ply construction provides for a strengthening of the inner layer. Electrostatic shielding is maintained since metal circumscribes the conductors at right angles to the field which will be generated by current flowing through the conductors. At the point of overlap of each turn, a layer of metal 54 overlaps a layer of metal 52 of the adjacent turn to provide a complete shield.

The terms and expressions which have been used are used as terms of description and not of limitation, and therefore it is recognized that various modifications are possible within the scope of the invention claimed.

1. An electrical cable comprising, in combination, a plurality of electrical conductors disposed in bundled relation for the transmission of electrical energy, an electrical insulating and conductive shield disposed in encompassing relation around each of said conductors, each of said insulating and conductive shields including a continuous composite conductive and insulating laminated strip wrapped in overlapping relation around the respective conductor along its length thereof, said strip having an inner layer of electrical conductive metallic foil material having inner and outer faces and opposed longitudinal leading and trailing edges, and an outer layer of electrical insulating polymers such as Mylar or other similar insulating layers disposed on the outer faces and opposed longitudinal leading and trailing edges, the confronting faces of said inner and outer layers being bonded together in axial off-set relation with respect to the longitudinal central axis of said cable so that the leading edge of said outer layer projects beyond the leading edge of said inner layer and the trailing edge of said inner layer projects beyond the trailing...
edge of said outer layer, the inner faces of the inner layers of said strip adjacent their trailing ends being disposed in contact with the confronting outer periphery of the respective conductor with the confronting respective inner and outer faces of adjacent of the inner layers being disposed in overlapped surface-to-surface contact with one another and with the confronting respective inner and outer faces of adjacent of the outer layers being disposed in overlapping surface-to-surface contact with one another to provide a substantially continuous electrical conductive shield along the length of the respective conductor and a substantially continuous electrical insulation along the length of the respective shield, and a polymeric jacket disposed around said electrical conductors and said electrical insulating and conductive shields and providing a protective cover therefor.

2. An electrical cable in accordance with claim 1, wherein said metallic foil material is aluminum, and wherein said polymeric tape is polyethylene terephthalate.

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174—107, 109