FLEXIBLE ARMOR FOR ARMORED CABLES AND FLEXIBLE CONDUITS

Filed Nov. 14, 1931

FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

George E. Phillips
INVENTOR

Cooper, Jurie & Dunham
ATTORNEYS
FLEXIBLE ARMOR FOR ARMORED CABLES AND FLEXIBLE CONDUITS

George E. Philips, Ben Avon, Pa., assignor to National Electric Products Corporation, New York, N. Y., a corporation of Delaware

Application November 14, 1931, Serial No. 575,837

6 Claims. (Cl. 247—41)

At the present time armored cable and flexible metallic conduit are extensively used for electrical wiring purposes. With both armored cable and flexible armored conduit the metallic armor comprises a spirally wound steel strip with portions formed so that the edges of the strip are overlapped and interlocked. In such convolutions of the strip material interengage one with the other. The completed flexible armor of either flexible metallic conduit or armored cable should possess certain characteristics. First, it should be as flexible as reasonably obtainable. Second, it should have as uniform a diameter as possible both as to exterior diameter and interior diameter. Third, it should have as high a tensile strength as possible so that the convolutions do not open up when being installed or when being subject to tensile strain or upon being bent in sharp curves. Fourth, the end to end electrical resistance of the completed armor should be as low as possible and such low resistance characteristics of the armor should be maintained, notwithstanding flexing of the armor during process of manufacture or before or during installation. The resistance characteristics of armored cable or flexible metallic conduit is such an important factor in its acceptability for use that the Underwriters Laboratories and Inspection Departments in various parts of the country require that the armor of a certain size (14-2) shall have a resistance of not more than 2.5 ohms per hundred feet. The reasons why the low resistance or high conductivity of the armor is a factor of major importance is because, if shorts or grounds occur so that current flows through the armor itself, the resistance of the armor if too high, will prevent the blowing of fuses or other protective devices and accordingly, the armor will overheat and possibly cause a fire. For the foregoing and other reasons it is desirable that the conductivity of the completed armor be as high as possible.

Certain of the desirable characteristics above set forth are to a certain extent antagonistic to one another, for example flexible armor may have a desirably low resistance characteristic and high conductivity, but it will be objectionable because the armor is too stiff and not flexible enough. On the other hand if the armor is freely flexible its resistance characteristic will be poor, being too high.

Flexible armor as previously constructed according to some forms, had the interengaging portions disposed with respect to each other in such a way that the armor opened up when bent upon a sharp curve and such forms of armor also readily open up upon tensile strains being in part placed upon the armor. Other forms of armor have been developed wherein attempt is made to overcome these objectionable features by having more pronounced hook portions. Such other forms, however, are objectionable in certain respects, the interengaging portions of the convolutions are so shaped that line or point contact is provided between adjacent convolutions at the hook portions. Sharp line contact of adjacent convolutions is detrimental to flexibility and accordingly, pre-flexing after or during manufacture is usually necessary to produce a commercial product. When such flexing operations are employed the resistance factor of the armor is increased. Line contact at the hook portions also minimize contact area from convolution to convolution and accordingly, produce an armor with high resistance characteristics and diminished conductivity. With previous forms of armor very slight variations in the flat strip width before the strip is formed into armor are transferred to the finished product, causing a variation in the outside diameter of the armor. This is objectionable because the outside diameter should be maintained fixed to provide desired exactness of fit between the fitting and the outside of the armor.

Armored cable or flexible conduit as now made provides a construction of flexible armor in which there is edge corner contact between convolutions and with such a construction there is lack of permanence in the convolution to convolution conductivity because the edge corner wears at each movement or flexing of the armor, thus increasing the resistance as the armor is flexed. Furthermore, while the resistance of the convolution to convolution contact at the time of test during manufacture may be satisfactory, additional flexing of the material received during the handling of the material on the job while it is being installed, will wear the convolution contact down so that the resistance will have increased beyond the present established standards.

Accordingly, the present invention is directed to and has for its object the provision of an improved form of flexible armor for flexible metallic conduit or armored cable with an improved contour of the armor itself, which contour provides improved and maintained conductivity, improved tensile strength, improved uniformity of diameter both external and internal and improved flexibility.

A further object of the present invention resides in the provision of a flexible metallic armor with an improved form of bond hook by which bond
A hook has an extended flat portion extending longitudinally with respect to the armor adapted for contacting engagement with an adjacent convolution at the inner or outer root or both thereof.

A further object of the present invention resides in the provision of an armor with improved bond hook portions for securing adjacent convolutions to one another, wherein the greater area of contact is provided between the bond hook portion of one convolution and the adjacent convolution.

A further object of the present invention resides in the provision of a bond hook portion for the armor wherein greater area of contact is provided to allow current to flow through this greater contact area with facility directly from convolution to convolution, thus avoiding forcing the current to flow through the path of the spirally wound formed strip.

A further object of the present invention resides in the provision of an improved construction for securing adjacent convolutions to each other, whereby, in lieu of line contact, extended surface contact between the convolutions is provided, which surface contact has a wiping action during bending which tends to clean the contact surface and thus afford and maintain a better electrical contact.

Another object of the present invention is to improve the electrical conductivity of flexible armor for flexible conduit or armored cable by providing means for maintaining desired pressure of contact between the electrically contacting portions and/or increasing the area of contact while maintaining the desired mechanical strength and flexibility of the armor.

Another object of the present invention resides in the provision of improved bond hook constructions in which longitudinally extended portions are provided at or adjacent the contact portions to maintain a desirable wiping contact action under pressure during manufacture, transportation and installation of the flexible metallic conduit or cable.

Further and other objects of the present invention will be hereinafter set forth in the accompanying specification and claims and shown in the drawing, which by way of illustration shows what I now consider to be preferred embodiments of my invention.

In the drawing:

Figure 1 shows a detail sectional view of one embodiment of my improved flexible armor and flexible conduit.

Fig. 2 is a similar sectional view showing a slight modification of the form of bond hook:

Fig. 3 is a sectional view showing the improved flexible armor employed as the armor of an armored cable; and

Fig. 4 shows a section of the metallic strip which is used to make the armor and flexible conduit shown in Figs. 1 and 3.

In describing the different embodiments of the invention, similar reference characters will apply to similar parts of the different views and in the different embodiments. The invention will be first described with reference to the embodiment of the invention shown in Figs. 1, 2 and 3. The metallic strip (Fig. 4) which when interengaged forms the metallic armor is preferably shaped with a sloping portion 10 extending down to a bottom 11 and from the other side of this bottom portion 11 another sloping portion 13 extends upwardly to a flat top portion 12 from which another sloping portion 14 extends downwardly. When the formed metallic strip is assembled into the completed armor as shown in Figs. 1 and 3, an adjacent convolution overlaps portion 10 of an adjacent convolution and forms the bond hook which secures the convolutions together. Previous constructions of armored cable employed the bond hook arrangement as above described, but according to the present invention supplemental extended flat portions are provided. As shown the sloping portion 10 at its terminating upper end is provided with a flat extension 10a, which extension extends longitudinally of the armor under and substantially parallel with and in contacting engagement with the part 13 of the adjacent convolution. Similarly sloping part 14 at its terminating lower end is provided with a flat extension portion 14a which overlaps part 11 of the adjacent convolution. Extension 14a is also substantially parallel with 11 and in contacting engagement therewith.

For clarity of subsequent definition in the specification and claims, 13 will be termed the "outer root" of a convolution and 11 the "inner root" of a convolution. The extended portions 10a and 14a of each convolution are provided with additional metal emboldments which will be formed by an extension of the bond hook which extends longitudinally of the flexible armor, i.e., in a direction parallel with the outer root 13 and the inner root 11.

By providing such extensions 10a and 14a on the bond hook portions of the armor a greatly extended electrical contact area is provided from convolution to convolution which area is much greater than the limited contact area which would be provided by the ends of parts 10 and 14 alone. Without such extensions 10a and 14a, 10 and 14 alone would provide line contact portion to extended surface contact which is afforded by the extensions 10a and 14a. Accordingly, with extended portions 10a and 14a improved conductivity from convolution to convolution is secured so that there is materially less tendency for the current to flow through the path of the spirally wound formed strip and in lieu thereof any current flow through the armor in a large part takes the direct path from convolution to convolution.

The extended portions 10a and 14a of the bond hook portions also provide increased tensile strength for the armor, since such extensions serve as reinforcing for the sloping portions 10 and 14.

Improved uniformity of diameter of the completed armor is also secured by reason of the fact that any slight variation in the flat strip width instead of being transferred to the completed flexible armor and affecting the diameter thereof merely causes a slight variation in the width of the extensions or flanges 10c and 14c. Such variation in the width of the extensions or flanges obviously does not cause any variation in the diameter in the armor, which would be the case if there was a variation in the length of 10 or 14.

By providing extended surface contact between 10a and 14a and the root portions 13 and 11 respectively, (which in the completed armor is a cylindrical surface contact) improved flexibility is attained. Extensions 10a and 14a are such that these extensions freely slide over the flat surfaces 11 and 13. In this way flexibility of the cable is improved because there is no biting in action of the bond hook portions into the surface of the root portions. Any such biting-in action tends to stiffen the complete armor. Furthermore, when the armor is com-
pleted should it be desirable to pre-flex the armor before installation, such pre-flexing does not destroy the desirable maintained large contact area between the extensions and the root portions.

Other incidental advantages are secured with the flat extensions 10a and 14a, among these may be mentioned increased strength in the tensile strength and crushing of the armor by reason of additional material by the providing of the reinf orcing flange portions. Furthermore, according to the present invention the longitudinally extended portion of portions of bond hooks serve as reinforcements so that wiping contact under pressure is maintained, notwithstanding bending or flexing of the armor.

It will be understood that the present invention can be used for flexible metallic conduits as shown in Fig. 1 or that the armor can also be used as the flexible armor of flexible armored cable, the armored cable being shown in Fig. 3. In Fig. 3 the same flexible armor which is shown in Fig. 1 is shown and within this flexible armor there are the usual insulated conductor or conductors 15 which are preferably suitably wrapped with a treated Kraft paper wrappings 16. At the terminating end of the armored cable the usual insulating fibre bushing 17 may be employed.

The embodiment of Fig. 2 will now be described. In this construction a different configuration of strip and a different method of providing the bond hook portions is provided.

Referring to Fig. 2, 13 represents the outer root of a convolution, 11 represents the inner root. Intermediate sloping connecting portions 12 are also provided as in the embodiment shown in Fig. 1. In lieu of providing the bond hook portions by sloping portions 10 and 14 as in the Fig. 1 embodiment the terminating ends of the inner and outer root portions 11 and 13 are reversely folded as indicated at 14b and 10b. It will be appreciated that 14b has an extended cylindrical surface sliding contact upon the surface of inner root 11 and that extension 10b has a similar extended sliding surface contact on the inner surface of root 13. The ends of the extensions 14b and 10b are adapted to abut each other and thus secure the adjacent convolutions together and form the bond hooks for the convolutions.

It will be understood that the flexible armor of the form shown in Fig. 2 can also be employed for armored cable, in which case the insulated conductors will be disposed within the armor during the process of manufacture. It will be appreciated that other arrangements of bond hooks can be shown without departing from the spirit and scope of the present invention. According to the present invention the arrangement of bond hooks is such that portions of the bond hooks are provided with extended surface contact areas adapted for free sliding cooperation with portions of adjacent convolutions as delineated in the various figures. The extensions provide extended cylindrical surface which slidably cooperate with the cylindrical surface portions of adjacent convolutions and thereby secure the desirable extended contact area, etc.

What I claim is:

1. A flexible armored cable including a spirally disposed strip provided with sloping portions extending from cylindrical shaped inner and outer connected root portions, said sloping portions interengaging the sloping portions of adjacent convolutions to form bond hooks and cylindrically shaped extensions upon the ends of said sloping portions to provide extended electrical surface contact with the cylindrically shaped root portions.

2. A flexible armor which is comprised wholly of a single spiral strip interengaged from convolution to convolution by bond hook portions upon said single strip, said strip being shaped with two trough portions both with flat bottom portions which form inner and outer root portions and with a common sloping portion which forms one side of each of the aforesaid trough portions and having other sloping portions forming the other sides of said pair of troughs, and extensions with cylindrically shaped surface portions upon the ends of said last mentioned other sloping portions to provide extended electrical contact surfaces of low resistance at the inside of the outer root portion and at the outside of the inner root portion, said last mentioned sloping portions also interengaging the sloping portions of adjacent convolutions to provide the bond hooks for the armor.

3. A flexible metallic tubular conduit comprising a helically extending strip whose cross-section has four straight portions substantially parallel to the axis of the conduit and spaced by three inclined portions, the end inclined portions of each convolution cooperating with end inclined portions of adjacent convolutions and constituting bond hooks, and the inner portions of two of the straight portions of each convolution engaging the outer portions of two of the straight portions of an adjacent convolution.

4. A flexible conduit comprising an overlapping helical metallic strip which in cross-section has on one side of its median line, in the following order, a straight portion substantially parallel to the axis of the conduit, then an abutment portion, then a marginal straight portion axially beyond the abutment portion and substantially parallel to the axis of the conduit, and which strip has on the other side of its median line, in the following order, a straight portion substantially parallel to the axis of the conduit, then an abutment portion, and then a marginal straight portion axially beyond the last mentioned straight portion and substantially parallel to the axis of the conduit; an abutment of each convolution being adapted to engage an abutment of a preceding convolution to limit relative axial separating movement of the convolutions, and two of the straight portions of each convolution engaging two of the straight portions of a preceding convolution and the other two straight portions of each convolution engaging two of the straight portions of a succeeding convolution.

5. A flexible armor fabricated from a flat strip provided with a pair of inwardly and outwardly facing trough portions with flat bottom surface portions and with bond hook portions and flat extension surface portions, each bond hook portion being disposed between a trough portion and extension surface portion, said strip being spirally wound with the flat extensions shaped into cylindrical form and respectively cooperating with extended cylindrical surface contact of low electrical resistance with the cylindrical portions of inner and outer root portions provided by the flat bottom portions of the troughs of the strip when the strip is spirally wound and interengaged from convolution to convolution, the interengaging portions of adjacent convolutions being related so that the interengaging portion of one edge of the strip is disposed wholly and entirely over the
interengaging portion of the other edge of the strip of an adjacent convolution.

6. A flexible armor which is comprised wholly of a single spiral strip which is interengaged from convolution to convolution by bond hook portions, said bond hook portions being disposed upon said strip and shaped to provide limited endwise sliding movement from convolution to convolution, said strip having the bond hook portions of adjacent convolutions interengaged and said strip further having extended cylindrical surfaces at each edge of said strip which slidably cooperate with extended cylindrical surface contact with the root portions of the convolutions for the purpose of providing an extended contact surface of low electrical resistance from convolution to convolution.

GEORGE E. PHILLIPS.