This invention relates to corrosion resistant wire rope and, more particularly, to wire rope in which wrappings applied about respective strands protect the wires of the rope from nicking, corrosion and abrasion.

It is not uncommon to subject wire rope to severe working conditions where the individual wires of the structure can become weakened from nicking, corrosion and abrasion. In oceanographic projects, for example, extended lengths of wire rope are required to withstand wear and to support substantial tensile loads in a corrosive salt water environment. Wires of steel which are desirable for their tensile bearing properties in a wire rope are especially vulnerable to corrosive attack in water. It is one of the objects of this invention to adapt the known principal of a sacrificial anti-corrosion element to the strands of wire rope by associating each strand with a multi-purpose protective metal wrapping which is cathodic with respect to the metal of the tensile wires.

Nicking of the wires in rope often results during its fabrication from the radial compression to which the rope is subjected in order to reduce its cross section and minimize its drag resistance in water. Since many adjoining wires of a rope are skewed with respect to one another, radial compacting of this sort tends to nick either or both of them at their crossing point and appreciably reduce their effective strength. This is particularly true of the wires on the exterior of a given strand in the rope which cross over the exterior wires on a neighboring strand. One of the purposes of the protective wrapping of this invention is to protect the exterior wires of each strand from the nicking which otherwise results during compacting of the rope cross section.

In addition the exterior strands of a wire rope may be subjected to considerable abrasion from passing repeatedly over sheaves or sliding against other structures. Combined with nicking and corrosion, this wear imposed on the exterior wires of rope strands is a further significant adverse factor in its effective operation.

The foregoing factors are neutralized by particular improvements in a wire rope wherein a multiplicity of metal tensile wires are helically stranded together into a plurality of strands which in turn are helically stranded together into a rope structure. Pursuant to the invention the rope is improved in that at least one metal protective wire is wrapped helically about at least one of the strands, the metal of the protective wire being cathodic with respect to the metal of the tensile wires. All of the strands are compressed radially together with respect to the rope axis to compact the rope and increase the intimacy of contact of the wires thereof.

This wrapping of protective wire fulfills at least three functions concurrently. Because it surrounds each strand, it provides a cushion between crossed wires of neighboring strands and thus protects those crossed wires from being nicked when the wire rope structure is compacted in order to reduce its cross section and eliminate drag. To an equal extent, the wrapping of protective wire encases the exterior tensile wires of the strands which face outwardly on the surface of the rope and thereby isolates them from abrasion forces to which they would otherwise be subjected when the rope is run over sheaves or other structures. Because the protective wire is cathodic with respect to the tensile wires, it corrodes preferentially and neutralizes chemical attack of water on the tensile wires. The compacting of the rope, which is a problem from the standpoint of nicking, produces particular benefits in the anti-corrosion function of the protective wrapping because it enhances the intimacy of electrical contact between the tensile and protective wires. All of these objects are achieved by a structure which can easily be formed on stranding apparatus simply by laying the protective wire wrapping about each strand before the strands are laid together in the form of a rope.

It is to be understood that the invention is not limited to wire rope of any one particular construction. A preferred embodiment of the improvement of the invention applied to one example of wire rope is described hereinbelow with reference to the accompanying drawing, wherein

FIG. 1 is an enlarged lateral section of wire rope according to the invention; and

FIG. 2 is a fragmentary elevation partly broken away of a length of one outer strand from the wire rope of FIG. 1.

For purposes of illustration, a 7 x 7 wire rope construction is shown in the drawing. This is a rope made up of a core strand 10 about which six outer strands 11 are helically applied. Each of the strands 10 and 11, as shown in FIG. 1, consists of seven tensile wires, namely a core wire 12 about which six outer wires 13 are helically formed. The improvement of the invention which is described below could be applied as well to 3 x 7 or 3 x 19 wire rope constructions or many others. In this sense the particular construction is not material to the present invention, nor is the presence or absence of filler wires, non-metallic cores, or other auxiliary features of wire rope which are well known in the art.

The feature of importance provided by the invention is that a wrapping of protective wire 14 is applied about at least some of the strands. In this embodiment, the protective wire 14 is of flat cross section (somewhat enlarged in thickness in FIG. 1 for clarity), its turns are slightly spaced to maintain flexibility, and it is applied about each of the outer strands 11 (but not the core strand 10) in the rope structure. If desired more than one protective wire could be applied to a given strand in a multipule lead fashion. The metal of the protective wire 14 is cathodic with respect to that of the tensile wires 12 and 13 in each strand. Thus, under most conditions of operation, the protective wire 14 may be of zinc, aluminum or magnesium when the wires 12 and 13 are of steel. When stainless steel tensile wires 12 and 13 are employed, the protective wire 14 may be of a nickel-bearing copper alloy, such as 90% copper and 10% nickel. The purpose of this choice of metal is to insure that the protective wire 14 stands in the electromotive series with respect to the metal of the tensile wires 12 and 13 under the known environmental conditions of use such that the protective wire 14 corrodes preferentially with respect to the tensile wires.

After each of the strands 10 and 11 is formed and the strands 11 are wrapped about with the protective wire 14, each of the strands is individually compacted radially, by swaging or rolling or the like, to reduce its cross-sectional area. This also increases the intimacy of contact between the wires 12 and 13 and promotes the anti-corrosion function of the protective wire 14. During this individual compacting of each of the strands 10 and 11, the tensile wires 12 and 13 thereof are deformed into polygonal cross section.

When each of the strands has been compacted, the outer strands 11 are laid up helically about the core.
strand 10 in the form of a rope in the conventional manner. The direction of lay may be the same as or opposite to that of the individual wires in each strand, depending upon whether long lay or regular lay rope is desired. Once the rope is formed, however, it is subjected to another compacting step whereby all of the strands 10 and 11 are compressed radially together. This further reduces the cross-sectional area of the rope, flattens the rounded crowns of the outer strands 11, and additionally deforms the individual wires of the strands into different cross sectional shapes.

During this latter compacting step of the entire rope, the wires 13 of neighboring strands would tend to nick where they cross over one another, but for the interposition of the protective wire 14 on each strand. This cushions the outer wires 13 from one another and all nicking is limited to the flat wire 14 itself, which is of no concern because it is not a tensile bearing element. The outermost surface of the completed rope defined by the crowns of the outer strands 11 is effectively sheathed with the protective wire 14 to isolate the individual wires 13 immediately thereabehind from abrasion and wear during use. Throughout the entire cross section of the rope there is the closest possible contact between the various tensile wires 12 and 13 and protective wires 14 so that the galvanic effect of the protective wire 14 is enhanced. All of these various protective functions are achieved by the addition to certain of the strands of the rope of only one element which can be readily applied in a simple and inexpensive fashion by standard stranding procedures.

We claim:

1. In a wire rope wherein a multiplicity of metal tensile wires are helically stranded together into a plurality of strands which in turn are helically stranded together into a rope structure, said rope being improved in that (a) at least one metal protective wire is wrapped helically about at least one of said strands, the metal of said protective wire being cathodic with respect to the metal of said tensile wires, and (b) all of said strands are compressed radially together with respect to the rope axis to compact the rope and increase the intimacy of contact of the wires thereof.

2. A wire rope according to claim 1 wherein the metal of said tensile wires is steel, and the metal of said protective wire is selected from the group consisting of zinc, aluminum and magnesium.

3. A wire rope according to claim 1 wherein the metal of said tensile wires is of stainless steel, and the metal of said protective wires is a nickel-bearing copper alloy.

4. A wire rope according to claim 1 wherein said protective wire is of flat cross section.

5. In a wire rope wherein a multiplicity of metal tensile wires are helically stranded together into a plurality of strands which in turn are helically stranded together into a rope structure, said rope being improved in that (a) at least one metal protective wire is wrapped helically about each of a plurality of the respective strands, the metal of said protective wire being cathodic with respect to the metal of said tensile wires, and (b) all of the wires in each respective strand are compressed radially together with respect to the strand axis and all of the strands are compressed radially together with respect to the rope axis to compact the rope and increase the intimacy of contact of the wires thereof.

6. In a wire rope wherein a multiplicity of metal tensile wires of round cross section are helically stranded together into a plurality of strands which in turn are helically stranded together about a core into a rope structure, said rope being improved in that (a) a metal protective wire of flat cross section is wrapped helically with spaced convolutions about each of a plurality of the respective strands, the metal of said protective wire being cathodic with respect to the metal of said tensile wires, and (b) all of the wires in each respective strand are compressed radially together with respect to the strand axis and all of said strands are compressed radially together with respect to the rope axis to compact the rope and increase the intimacy of contact of the wires thereof.

7. A wire rope according to claim 6 wherein the metal of said tensile wires is steel, and the metal of said protective wire is selected from the group consisting of zinc, aluminum and magnesium.

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