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CABLE CONSTRUCTION

Original Filed April 6, 1948

FIG.1.

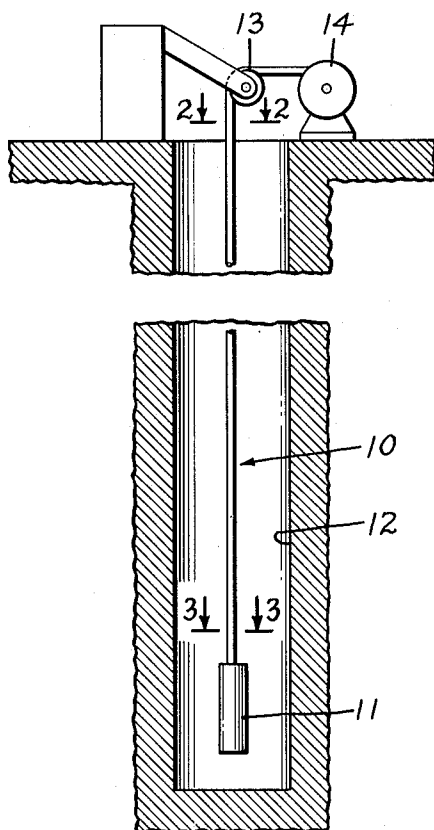


FIG.2.

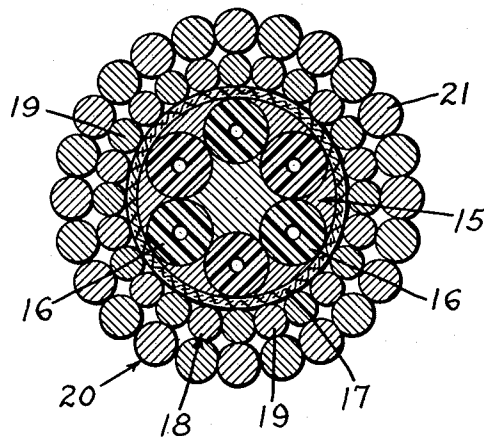
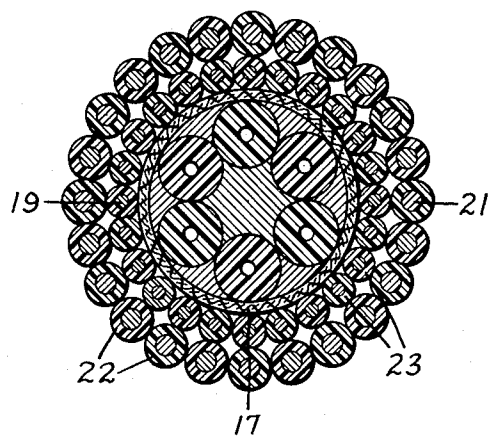


FIG.3.



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CABLE CONSTRUCTION

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Original application April 6, 1948, Serial No. 19,281, now Patent No. 2,604,509, dated July 22, 1952. Divided and this application May 13, 1952, Serial No. 287,572

5 Claims. (Cl. 57—149)

The present invention relates to cables and more particularly to armored electrical cables of the type employed in operations in deep oil wells or bore holes drilled into the earth, although they are not limited to such use.

This application is a division of the copending application Serial No. 19,281, filed April 6, 1948, by the same applicant, for "Electric Cable," now Patent No. 2,604,509, which issued July 22, 1952.

Heretofore, electric cables designed for use in operations such as electrical logging, gun perforating and the like in deep oil wells, have usually comprised a core including a group of helically wound, short lay, insulated conductors surrounded by two protective, load carrying layers of steel armor, the layers being wound in opposite directions around the core. It is well known that the stresses in a cable of this type, when unwound into a bore hole, vary from a minimum value at the lower end to a maximum value at the upper end which is usually wound on a winch at the surface of the earth. It has been proposed, therefore, to design cables of this type so that the cross-sectional area of the load carrying portion tapers from the top to the bottom of the cable in direct relation to the load carrying requirements at different points along its length. Cables so constructed have not been entirely satisfactory, however, because, when wound on a winch, gaps are left between turns on top layers which is undesirable. Moreover, in both cables of this type and in cables of uniform cross-section, wear, due to abrasion, is greater in the lower portion than in the upper portion so that the lower portion tends to wear out first.

It is an object of the present invention to provide a new and improved cable construction which is free from the above-noted deficiencies of the prior art.

Another object of the invention is to provide a new and improved cable construction in which the cross-sectional area of the cable is substantially uniform along its length, although the load carrying portion of the cable is tapered from one end to the other.

A further object of the invention is to provide a new and improved cable construction embodying means for alleviating wear due to abrasion as a function of the wear anticipated at different portions of the length thereof.

These and other objects of the invention are attained by applying to the outside of the cable a tough, non-load carrying, abrasion-resistant coating which varies in thickness between maximum and minimum values, respectively, at the bottom and top of the cable. For a cable having a load carrying portion which is tapered from the top to the bottom thereof, the coating is made to vary inversely with variations in the load carrying portion, so that the cross-sectional area of the cable is substantially uniform along its length. Where the variation in load carrying capacity of the cable at different points along its length is effected by changing the cross-sectional area of the individual strands in the load carrying portion, as will usually be the case, the coating is applied to individual strands as required to maintain a substantially uniform cross-section along the length of the cable.

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The invention may be better understood from the following detailed description of a typical embodiment, taken in conjunction with the accompanying drawings, in which:

Fig. 1 illustrates a cable constructed according to the invention, lowered into a bore hole drilled into the earth;

Fig. 2 is a view in transverse section taken along the line 2—2 of Fig. 1 and looking in the direction of the arrows; and

Fig. 3 is a view in transverse section taken along the line 3—3 of Fig. 1 and looking in the direction of the arrows.

Referring now to Fig. 1, a cable 10 constructed according to the invention is shown supporting well logging apparatus 11, for example, in a bore hole 12 drilled into the earth. The cable 10 passes over a pulley 13 at the surface of the earth and its upper end may be secured to a conventional winch 14 by means of which the apparatus 11 may be lowered into and withdrawn from the well 12.

As shown in greater detail in Fig. 2, which is a view in transverse section of the upper end of the cable, the cable 10 may comprise, for example, a core 15 which may include one or more insulated electrical conductors 16 formed in a short lay helix, for example. While six conductors 16 are shown in Fig. 2, obviously, any desired number may be employed. Preferably, the conductors 16 are covered by a layer 17 of any suitable material such as textile braid, plastic, or tape wrapping which serves to hold them in place and insures an essentially circular form for the core 15.

Surrounding the core 15 is an inner layer of armor 18 comprising a plurality of metal strands 19 which are preferably preformed and which are wound in a helix about the core 15. The pitch of the strands 19 should preferably be so chosen that the layer of armor 18 substantially covers the core 15. While twenty-four strands 19 are shown in Fig. 2, the exact number employed in any case will depend upon the strength and lay desired. In electrical logging operations, the cables employed usually have from eighteen to twenty-eight strands in the inner layer of armor. Wound on top of the inner layer 18 is an outer layer of armor 20 comprising a plurality of metal strands 21 wound in the opposite direction to the strands 19.

In accordance with the invention, the cross-sectional area of the load carrying portion of the cable comprising the armors 18 and 20 is tapered from the top of the cable to the bottom so that the cable will have different load carrying properties at different points along its length. Thus, at the upper end of the cable, where the section corresponding to Fig. 2 is taken, the cross-sectional areas of the armors 18 and 20 will be relatively large as required to support the load represented by the weight of the well logging apparatus 14 and the portion of the cable suspended in the well. On the other hand, at the level of the section shown in Fig. 3, which is at the bottom of the well, the cross-sectional areas of the armors 18 and 20 will be considerably less, as shown in Fig. 3, since the cable at this point has to support only the weight of the well logging apparatus 11 and the relatively short portion of the cable lying between this point and apparatus 11. Between the sections represented by Figs. 2 and 3, the cross-sectional area of the load carrying portion of the cable will vary from point to point, as required to meet the different load carrying properties of the cable at different points.

In order to maintain a substantially uniform cross-sectional area along the length of the cable 10, there is applied to the outside of the cable a relatively tough, essentially non-load carrying, abrasive-resistant coating having a thickness varying inversely with variations in the diameter of the load carrying portion of the cable.

As shown in Fig. 3, a coating 22 may be applied to the individual strands 21 comprising the outer armor 20, or a coating 23 may be applied to the strands 19 comprising the inner armor 18, or coatings may be applied to both sets of strands as required to maintain a substantially uniform cross-sectional area for the cable from top to bottom.

The properties of the coating for the strands will depend upon the specific characteristics desired for the cable. In general, it should be tough and relatively resistant to abrasion but it can be of low tensile strength since it does not carry any of the load. If the cable should be insulated from any casing that may be in a well, a coating having suitable insulating properties may be provided for this purpose. On the other hand, if a cable of minimum density is desired, a coating material having a density less than that of steel should be employed.

Suitable coating materials may comprise any of the so-called plastic compounds with or without inert fillers, such as synthetic fiber forming polymeric amides having a protein-like chemical structure, acetol type of polyvinyl resins, or rubber, for example. If electrical insulating properties are not essential, metal having a low modulus of elasticity might be employed as the coating material. The coating may be applied in any conventional manner, such as by extrusion, dipping, polymerization or electrolytic deposition.

As stated, in both cables of uniform cross-section and cables of tapered cross-section, wear, due to abrasion, is a maximum at the bottom of the cable and is progressively less at points between the bottom and the top in inverse relation to the distance from the bottom. By applying to either type of cable an abrasion-resistant coating having a thickness which varies along the cable length in essentially the same manner as the anticipated wear at different points, the tendency of the cable to wear unevenly may be materially reduced.

The invention thus provides a novel and highly effective cable construction which is of particular utility for use in wells drilled into the earth, although it is not limited to this field. By applying to the cable a coating having a thickness which is a maximum at the bottom and which varies inversely with the distance from the bottom, the problem of uneven wear due to abrasion may be alleviated. Further, the load carrying portion of the cable may be tapered from one end to the other, so as to have different load carrying properties at different points therealong while maintaining a substantially uniform cross-sectional area along the cable.

It will be understood that the specific embodiment described above is susceptible of considerable modification within the spirit of the invention. While, in the representative embodiments described, electrical conductors have been shown in the core, and only two layers of armor have been provided, obviously, the invention can be applied to cables which do not include electrical conductors and which may have any number of concentric layers of armor, as desired. It can also be applied to

cables utilizing, in the layers of armor, strands having shapes other than round. The specific embodiment disclosed, accordingly, it is to be regarded only as illustrative and not as restricting the scope of the following claims.

I claim:

1. In a load bearing cable adapted for use in a bore hole or the like, the combination of a tapered load carrying portion, and a coating on the outside of said cable having a thickness which is a maximum at the one end of the cable at which the load carrying portion has the least cross-sectional area and is progressively less at different locations between the two ends of the cable in inverse relation to the distance from said one end.

2. In a load bearing cable adapted for use in a bore hole or the like, the combination of a load carrying portion the cross-sectional area of which varies as a function of the length of said cable, and a nonload carrying portion the thickness of which varies inversely with the cross-sectional area of said load carrying portion so as to maintain the cross-sectional area of said cable substantially constant over its length.

3. In combination, a load bearing cable having a load carrying cross-section that tapers from one end to the other so as to have different load carrying properties at different points therealong, and a coating formed on portions of said cable, said coating being made of a tough, essentially non-load carrying, abrasion-resistant material and having a thickness which varies inversely with the load carrying cross-section of the cable so as to maintain a substantially uniform cross-section along the cable.

4. In a load bearing cable adapted for use in a bore hole or the like, the combination of a core, load carrying armor means comprising metallic strands wound over said core, the cross-sectional area of said armor means varying from a maximum at one end of the cable to a minimum at the other end of the cable, and a tough, non-load carrying coating for metallic strands of said armor means, the thickness of said coating varying inversely with the cross-sectional area of said armor means so as to maintain the cross-sectional area of the cable substantially constant over the length thereof.

5. In combination, a load bearing cable having a load carrying portion that is tapered from one end to the other so as to have different load carrying properties at different points therealong, and a coating on said cable having a thickness varying inversely with variations in the diameter of the load carrying portion so as to maintain the cross-sectional area of the cable substantially uniform along its length.

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