April 6, 1937. M. E. NOYES 2,075,996

ELECTRICAL CONDUCTOR

Filed May 18, 1933

Fig. 1.

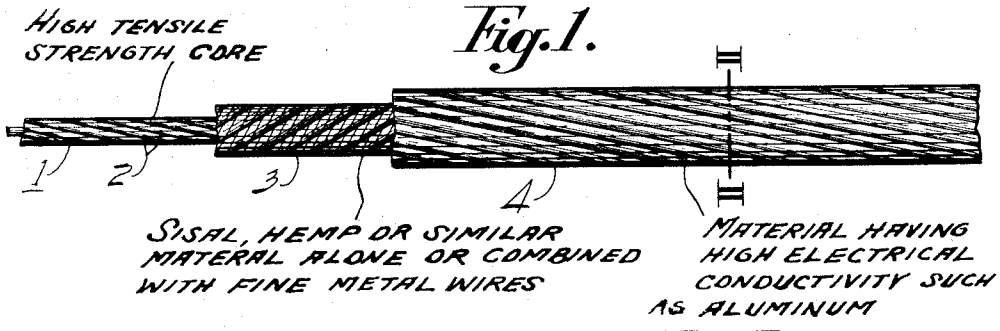


Fig. 2.

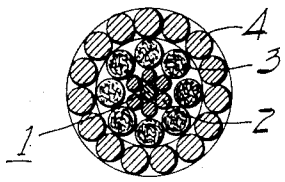


Fig. 3.

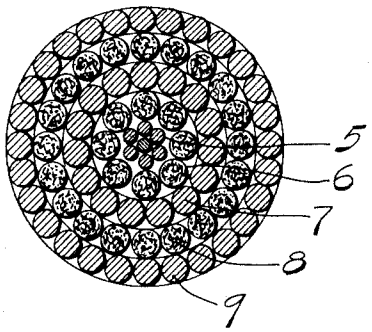


Fig. 4.

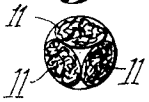


Fig. 5.

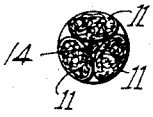


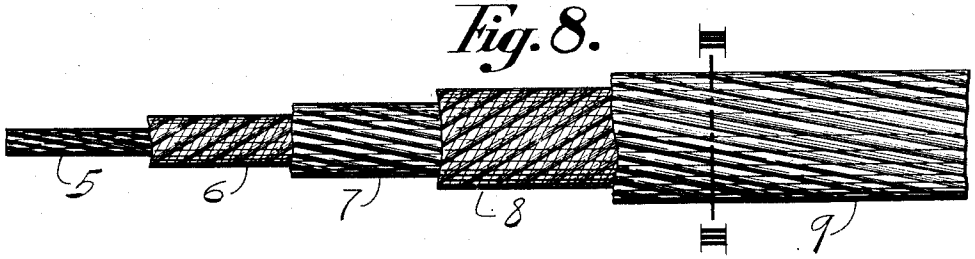
Fig. 6.



Fig. 7.



Fig. 8.



INVENTOR
MAXWELL E. NOYES

BY

ATTORNEY

Patented Apr. 6, 1937 2,075,996

UNITED STATES PATENT OFFICE

2,075,996

ELECTRICAL CONDUCTOR

Maxwell E. Noyes, Mount Lebanon, Pa., assignor to Aluminum Company of America, Pittsburgh, Pa., a corporation of Pennsylvania

Application May 18, 1933, Serial No. 671,629

11 Claims. (Cl. 173—13)

The invention relates to stranded cable for overhead transmission lines and has particular application to the fabrication of conductor cable in which the diameter of the cable for a given amount of conducting metal must be greater than is obtainable by usual concentric stranding practice.

Conductor cables of relatively large diameter have long been recognized to possess desirable characteristics, principal among which are the minimizing of corona loss and the limitation of temperature rise in the conductor. Various constructions have been devised to obtain the desired large diameters. The desired result has generally been accomplished by the fabrication of so-called "hollow cables", in the construction of which many types of spacing elements have been resorted to in order to support the outer layer or layers of conductor wires and to provide a core around which such conducting layers may be wound. Spacing elements of various forms have been suggested and in some designs these are wound in the form of a supporting helix, while in others the spacing element is simply twisted about its own axis. These hollow cable designs are subject to a number of disadvantages which it is the object of the present invention to overcome. The problem will better be understood upon consideration of certain of the undesirable features of the hollow cable designs known to the art.

An important objection to the usual type of hollow cable is that the outer layer or layers of conductor strands are not completely or continuously supported from within by the aforementioned spacing elements. For this reason there is a tendency for the cable to collapse when subjected to the high mechanical tension which overhead transmission lines must withstand. A result of this condition is that the cable will not maintain a true circular shape in cross section and if the cable is subjected to a heavy tension which approaches the breaking strength, upon the relieving of such heavy tension the cross section will not return to its original shape. Moreover, during the bending and handling which is incident to the erection of transmission lines, this absence of complete and continuous internal support may result in destruction of the cable, since it is very difficult to prevent a disturbance of the position of the conductor strands. Also, such a cable is more easily crushed by a wagon or truck running over it than is the case with a cable which is not of hollow construction.

In another form of hollow cable which has heretofore been proposed, the outer layer or layers of conductor wires are supported from within by a flexible metallic tube. This is an expensive and not altogether satisfactory construction, a principal disadvantage being that while such supporting tubes are flexible in a degree, they do not possess sufficient flexibility, and, in fact, lessen the normal flexibility of the cable. This type of hollow cable is also subject to certain of the inherent disadvantages referred to above.

Another form of hollow cable which is representative of the art is that in which the cable is made up of one or more layers of flat strands. Adjacent strands in the same layer are locked together by a tongue and groove connection or other interlocking means. This type of cable is very difficult to handle and does not possess the desired flexibility.

All of the various types of hollow cables described in the preceding paragraphs are subject to a number of further disadvantages which are possessed by them in common. Most of the tension resisting metal is concentrated at and near the surface where it is most readily damaged by abrasion during erection or by pressure from the supporting clamps during service. Electric arcs may also burn away some of the surface. Surface damage to such a hollow cable is more serious than in the case of a solid concentric strand cable having the same amount of metal, for the reason that more of the metal is exposed to damage and because the tensile stress due to bending resulting from vibration or other causes is higher by reason of the greater diameter. Moreover, the amplitude of vibration is greater, due to the greater diameter, thus further increasing the tensile stress. Other disadvantages which may be mentioned are the increase in "notch effect", and the high cost of fabrication.

It is an object of the present invention to provide a conductor cable which is of relatively large diameter as compared with that of an ordinary cable having the same weight of conducting metal or having the same total weight, yet which will not be subject to the many disadvantages which have been pointed out as existing in the constructions previously known to the art. A particular object is to provide a conductor cable which for a given amount of metal has a larger diameter than can be obtained by usual concentric stranding practice, with very slight increase in cost of material and fabrication and with a relatively insignificant increase in weight. Other objects and advantages will more fully appear in the following description when considered in con-

nection with the accompanying drawing, in which:

Fig. 1 is a fragmentary elevational view of a short length of cable constructed in accordance with my invention, succeeding layers being cut away to more fully reveal the inner construction. Fig. 2 is a cross sectional view of the cable of Fig. 1; and Fig. 3 is a similar cross sectional view of another embodiment of the invention. Figs. 4 to 7 are enlarged cross-sectional views of fibrous cords or strands suitable for use in my improved cable construction. Fig. 8 is a fragmentary elevational view of the cable shown in Fig. 3.

According to my invention, I provide an electric conductor cable comprising a metallic core and a layer of conductor wires, the core and the conductor wires being separated by an intermediate layer of hard fibrous cords or strands. The nature of this intermediate layer is of particular importance in obtaining the advantages which I have found to inhere in the particular form of cable which is now being described. These fibrous strands may be of sisal, hemp or similar material, either alone or combined with fine metal wires. They should be suitably treated to give firmness, durability, and resistance to moisture. Whatever the exact nature of the material selected, it is essential in order to secure the benefits of my invention that these fibrous cords or strands be very hard and firm. This characteristic I have chosen to describe by the term "wire-like". The importance of employing such hard, firm, wire-like, fibrous strands for the intermediate layer resides principally in the fact that they must retain as nearly as possible their original shape when wound firmly around the metallic core and when a layer of conductor wires is in turn wound tightly around the spacing layer of fibrous cords. A loose fibrous filling material packed between the metallic core and the layer of conductor wires is not equivalent to the hard cords or strands, and can not be substituted therefor to obtain similar results either in the stranding operation or in service. In the case of the hard fibrous cords, there is no opportunity for any of the spacing material to sift out between the outer strands, or for the metal conductor strands to sink into the cords to an appreciable extent, and deformation of the cable in use is more effectively prevented. Moreover, by the use of the cords a concentric cable of the required number of layers may be fabricated with the use of the usual machinery employed in the production of stranded cable, the intermediate or spacing layer of fibrous strands being fed into the machine in place of the usual layer of metallic wires.

In the drawing I have shown in Figs. 1 and 2, for purposes of illustration, a cable comprising a metallic core 1 of high tensile strength which is preferably formed of a plurality of spirally wound steel wires 2. Bronze wires might be employed, and where the core is to be of steel it may be found desirable to use galvanized wires. Tightly wound around the metallic core 1 is an intermediate layer of closely spaced fibrous strands 3. As previously indicated, these strands may be of sisal, hemp or other fibrous material, either alone or in combination with fine metal wires, which is susceptible of being formed into a firm, hard, wire-like cord. Surrounding the intermediate layer of fibrous strands 3 is an outer sheath of conductor wires 4 which possess high electrical conductivity, such as copper or aluminum, and preferably the latter. I prefer that the successive layers of strands 2, 3 and 4 be spirally wound in opposite directions.

In addition to the advantages previously noted, the intermediate layer of fibrous spacing cords 3 reduces the formation of notches between the layers of metallic wires. When layers of metallic wires are wound one upon the other, successive layers being spiralled in opposite directions as is usual in concentric stranding practice, vibration of the cable in service causes the contacting layers of wires to rub against one another, producing what is known as "notch effect". This is particularly noticeable at or near the supporting clamps, where the weight of the span tends to press the layers of strands closer together. To this is added the pressure exerted by the clamping devices. Fatigue failure of the conductor strands is thus hastened, because of the concentration of stress resulting from the notching or abrasion of the strands at the points of contact. The intermediate layer of fibrous strands reduces the frequency of occurrence of this type of wear.

The layer also tends to improve the vibration characteristics of the cable. I attribute this, in part at least, to the friction between the fibres of the cords, which serves to absorb a certain amount of energy of vibration induced by wind or other causes.

In Fig. 3 there is shown a modified form of cable in which more than one layer of conductor wires is employed, the layers being spaced by closely wound fibrous cords or strands. In this form, the metallic core 5 of high tensile strength is closely surrounded with a layer of hard fibrous cords 6 firmly wound in closely spaced relationship. A layer of conductor wires 7 is in turn wound tightly over the fibrous strands 6, then there is another layer of hard fibrous strands 8 and an outer layer of conductor wires 9. It is obvious that any desired number of alternating layers may be employed. Two or more layers of conductor wires may be disposed adjacent one another with a layer of fibrous cords separating this layer from the central core or from other layers of conductor wires, the essential idea being that the layer or layers of conductor wires are spaced from another layer or layers of wires or spaced from a metallic core by means of a layer of hard, closely wound fibrous cords or strands. The successive layers may be wound in parallel, but I prefer the spiral winding which has been described in connection with Fig. 1. The intermediate layer of fibrous cords, in addition to performing the function of a concentric spacing element, contributes appreciably to the strength of the cable.

The hard fibrous cords or strands 3 in Figs. 1 and 2, and 6 and 8 in Figs. 3 and 8, each consist of a plurality of fibers of sisal, hemp, or the like. These fibers are preferably grouped in small strands, which are usually twisted individually and then twisted together to form the hard finished cords or strands employed in my improved cable construction. Fig. 4 shows somewhat conventionally and on an enlarged scale one type of cord which I have used successfully, consisting of three "strands" 11 tightly twisted together. As stated hereinabove, I sometimes prefer to incorporate fine metal wires in the cords, as indicated at 12 in Fig. 7. This expedient makes possible a harder, stronger cord, and usually improves the electrical contact between the layers of conductor strands. A somewhat similar effect can be obtained by inserting

a wire or wire core 14 in the center of the cord, between the strands of fibrous material, as shown in Fig. 5, and it is also possible to use cords having one or more metal strands 15 twisted wtih the fiber strands 11, as shown in Fig. 6.

It will be seen that by my invention I have provided a cable which combines many of the advantages of the large diameter hollow cable, while avoiding most, if not all, of its disadvantages. My improved conductor cable is simple in construction and can be fabricated at low cost. It is characterized by complete elimination of the air spaces which are found in hollow cable constructions. Corona loss is minimized and temperature rise reduced. The conductor wires are afforded continuous support, avoiding any tendency of the cable to collapse under tension. These and many of the other advantages which have been referred to may be obtained in cable constructions varying somewhat from the preferred forms which have been specifically described, and such constructions are, therefore, to be considered as falling within the purview of my invention.

I claim:

1. An electric conductor cable comprising a central core of high tensile strength and an outer sheath of wires having a higher electrical conductivity than the central core, said central core and wires separated by an intermediate layer of fibrous strands.

2. An electric conductor cable comprising a metallic core of high tensile strength and an outer sheath of strands having a higher electrical conductivity than the central core, said core and strands separated by an intermediate sheath of hard closely wound fibrous cords.

3. An electric conductor cable comprising a metallic core of high tensile strength, a spirally wound layer of wire-like fibrous strands closely surrounding said metallic core, and an outer sheath of spirally wound wires of a material having a higher electrical conductivity than the material of the metallic core closely surrounding said layer of fibrous strands.

4. An electric conductor cable comprising a metallic core formed of a plurality of spirally wound wire strands of high tensile strength, a spirally wound layer of wire-like fibrous cords closely surrounding said metallic core, and an outer sheath of spirally wound wire strands of a material having a higher electrical conductivity than the material of the strands forming the metallic core closely surrounding said layer of fibrous cords.

5. An electric conductor cable comprising a metallic core of high tensile strength, a spirally wound layer of wire-like hemp cords closely surrounding said metallic core, and an outer sheath of spirally wound wires of a material having a higher electrical conductivity than the material of the metallic core closely surrounding said layer of hemp cords.

6. An electric conductor cable comprising a steel core of high tensile strength, a spirally wound layer of wire-like fibrous strands closely surrounding said metallic core and an outer sheath of spirally wound aluminum conductor wires closely surrounding said layer of fibrous strands.

7. An aluminum conductor cable reenforced with a central core of steel and comprising an intermediate sheath of hard wire-like fibrous strands of sisal spirally wound in close relationship to form a concentric spacing element.

8. An electric conductor cable comprising a plurality of concentric layers of spirally wound wires laid over a core of high tensile strength, the outermost layer consisting of metallic conductor wires of higher electrical conductivity than said core, and an intermediate layer consisting of hard fibrous cords.

9. An electric conductor cable comprising a plurality of concentric layers of spirally wound wires laid over a core of high tensile strength, the outermost layer of wires consisting of metallic conductor wires of a material having an electrical conductivity higher than said core, and the intermediate layers comprising layers of hard fibrous cords alternated with layers of metallic conductor wires.

10. An electric conductor cable comprising a core of high tensile strength and a layer of metal conductor wire strands separated by an intermediate layer of hard fibrous cords containing metal wire.

11. An electric conductor cable comprising a metallic core formed of a plurality of spirally wound wire strands of high tensile strength, a spirally wound layer of wire-like fibrous cords closely surrounding said metallic core, said fibrous cords being characterized by their hardness and capability of retaining their original shape, and an outer sheath of spirally wound wires of a material having a higher electrical conductivity than the material of the metallic core closely surrounding said layer of fibrous cords.

MAXWELL E. NOYES.