Nov. 4, 1930. G. C. OXER 1,780,533

ELECTRICAL CONDUCTOR

Original Filed Feb. 20, 1924

Fig. 1,

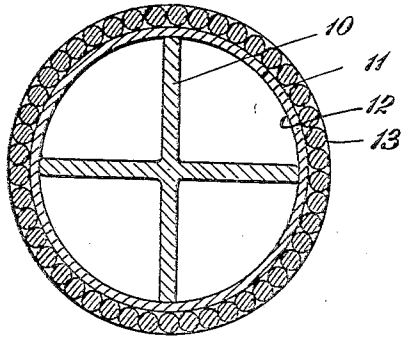


Fig. 2,

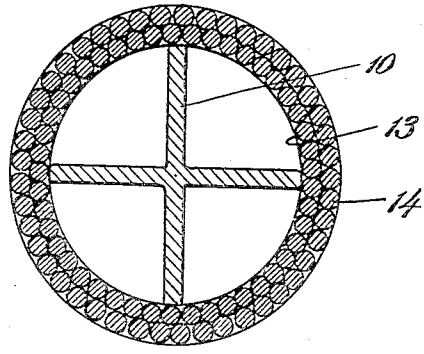


Fig. 3,

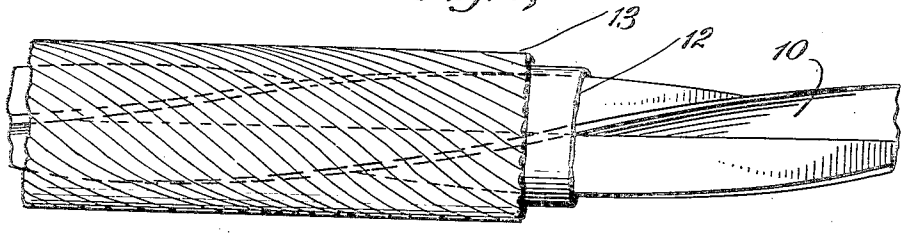
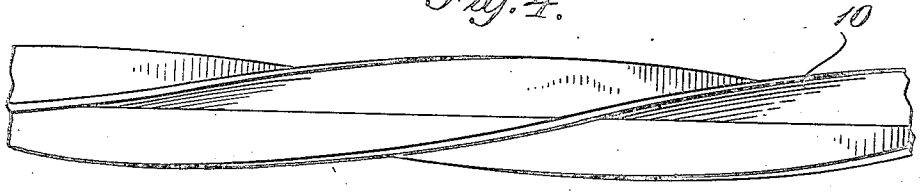


Fig. 4.



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1,780,533

UNITED STATES PATENT OFFICE

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ELECTRICAL CONDUCTOR

Continuation of application Serial No. 693,977, filed February 20, 1924. This application filed April 2, 1927. Serial No. 180,358.

This invention relates to electrical conductors and more particularly to conductors especially adapted for the transmission of electrical energy at extremely high voltages.

In the selection of conductors for high tension lines, various important factors must be taken into consideration, among which is the mechanical strength of the conductor, which is of primary importance in view of the great length of span now commonly used. The climate, topography and the amount of power to be transmitted are also to be borne in mind, and in addition, it is important to select a conductor which fulfills the several requirements and is still as economical as possible both in initial outlay and in upkeep. With the high voltages at which current is now transmitted, such as 220,000 volts, losses due to the corona effect are an element which must not be lost sight of and since the value of any such loss is a function of the voltage, frequency and superficial area of the conductor, it is desirable, all other things being equal, to use a conductor having as large a diameter as is compatible with economical tower design, etc. Also, in the case of a large conductor, the "skin effect" which causes the outer portion of the conductor to transmit more than its proportionate share of energy, makes it advantageous to use a conductor having a hollow core.

Various attempts have been made to design a conductor having the desired characteristics, which have led to the production of cables having cores of various materials, such, for instance, as hemp. A hemp-cored cable, however, is unsatisfactory as the hemp rots in use and the conductor strands become disarranged. Steel-cored cable has also been suggested, but it is not altogether satisfactory, since the weight is great, especially if the cable is to have a superficial area sufficient to reduce corona loss. Also, steel-cored cable having copper conducting strands is objectionable, due to the electrolytic action which may be set up. Hollow core cables have also been suggested but it is found that the unsupported hollow core cable is incapable of withstanding the radial stresses incidental to its use, and when the core collapses the conductor strands wrapped about it are loosened and displaced.

The present invention, therefore, is directed to the provision of a conductor for use in high tension work, which has a superficial area of the desired value, and the mechanical strength required in long span lines, both for withstanding longitudinal and radial stresses, and which is further designed so that the sectional area of the conducting pathway provided is sufficient to prevent serious resistance losses.

The new conductor comprises a body of tubular shape of metal of high electrical conductivity, but of insufficient mechanical strength to resist the collapsing and other stresses to which it would be exposed in normal use. Preferably this body is in the form of conductor strands of metal of high conductivity and within this tubular shaped conducting pathway is a metallic reinforcement which supports the body against collapse. This metallic reinforcement is of great mechanical strength for the weight of metal involved, and has the form of a structural shape, preferably modified somewhat at the outer extremities to conform to the inner curvature of the tubular shaped conducting body. This structural shape reinforcement is arranged to absorb the longitudinal and radial stresses to which the conductor is exposed in normal use, and is of such size that the tubular shaped body of metal forming the conducting pathway for the current has the superficial area necessary to keep corona losses at a minimum, and may also have a sufficient cross-sectional area to carry current without excessive resistance losses. The structural shape reinforcement member may also be used for the transmission of energy, and the new conductor represents a highly economical disposition of metal, so that while it has the desired strength for present installation conditions, the large superficial area required for high voltage transmission does not require a cable of undue weight.

In one form of the conductor embodying the invention, the conducting pathway for the current is of tubular form and made of inner and outer concentric layers of metal of

high conductivity forming a hollow conducting shell. With this hollow conducting shell I employ a reinforcing member in the form of a structural shape, which is a term well known to engineers and used to designate a member which is especially designed to give lateral stiffness as well as vertical strength, without great weight. There are a number of such structural shapes commonly known, and any of these structural shapes may be used for the purpose. A structural shape having the cross-section of a cross, has the advantage that it embodies the required lateral stiffness, as well as vertical strength, and affords a greater number of points of contact and support, for the conducting tubular shaped body, although it is less economical of metal than the other structural shapes, i. e. the Z-bar, channel, angle, and I-beam, each of which provides the necessary lateral stiffness, which is an essential element of this type of reinforcement, as well as vertical strength. It is possible that this economy of metal may prove to be the deciding factor as to the type used commercially. This structural shape reinforcement is preferably made of conducting metal, and it is given a longitudinal twist so that it has the general form of a helix. The conducting pathway may then take the form of a layer or layers of cable strands wrapped about the reinforcement preferably with a lay opposite to the twist of the reinforcement, or if desired, one of these layers of strands may be dispensed with and a thin shell of conducting metal may be laid around the reinforcement to form a substantially continuous surface over which a layer of cable strands is then placed.

A conductor of this type may be used in long spans such as are now commonly used in high voltage transmission, the reinforcement providing resistance to longitudinal and radial stresses, and also serving to some extent as a conductor, the main portion of the current, however, flowing through the hollow shell of metal of high conductivity which is supported by the reinforcement.

The details of construction and the various advantages of the new conductor will be more readily understood by reference to the accompanying drawings, in which

Fig. 1 is a cross-sectional view of one form of the conductor,

Fig. 2 is a view of slightly modified form,

Fig. 3 is a view of the conductor shown in Fig. 1 in side elevation, with parts broken away, and

Fig. 4 is a view of the preferred form of structural shape reinforcement prior to the laying of the conducting metal strands thereover.

Referring now to the drawings, the conductor shown in Fig. 1 is illustrated as consisting of a central reinforcement 10 which is one of the forms known as a structural shape. These shapes may be formed by appropriate rolling or extruding operations, and the one illustrated is the common cross. Around this central structural shape which serves as a reinforcement is a hollow conducting pathway, generally designated 11, and illustrated as consisting of a sheet metal tubular shell 12 folded around the reinforcement, and a layer of cable strands 13 wrapped about the shell. The reinforcement is longitudinally twisted, as shown in Fig. 3, so that it has the general form of a helix, and the cable strands 13 forming a part of the conducting pathway, are wrapped about the metal shell 12 with a lay opposite to the twist of the reinforcement. The reinforcement provides support for the hollow conducting pathway throughout the length of the latter, and by twisting the reinforcement, the points of support continually change from one end of the conductor to the other, thus providing a better support against collapse. It is of course desirable to round the outer extremities of the structural shape member to conform to the curvature of the tubular shaped conducting pathway where such extremities make contact with the inner surface of the metallic conducting pathway to prevent injury thereto.

The form of conductor illustrated in Fig. 2 is in all respects similar to that shown in Fig. 1, except that an additional layer of cable strands 14 has been laid over the first layer of strands 13 which takes the place of the shell of metal 12. With this arrangement it may be necessary to increase the twist of the reinforcement to improve the support provided by the latter, but, as in the case of the conductor shown in Fig. 1, the conducting pathway consists of inner and outer layers of metal, in this instance the two concentric layers of cable strands, and this two-part hollow conducting pathway is supported by a reinforcing member 10 having the form of a structural shape. This hollow conducting pathway is supported by the elements or flanges of the structural shape which extend generally in radial directions and due to their twist, engage the inner surface of the hollow conducting pathway at varying points from one end to the other of the conductor.

With a conductor constructed in accordance with the principles of my invention, the conducting pathway has a great superficial area so that corona losses are reduced. At the same time the hollow conducting pathway is supported against collapse and by means which represent a most economical distribution of metal. This structural shape reinforcement is sufficiently strong to withstand longitudinal suspension stresses, and radial collapsing stresses, but by reason of its form its great strength does not require a quantity

of metal which would add greatly to the weight of the complete conductor.

This application is a continuation of my copending application, Ser. No. 693,977, filed February 20, 1924, entitled Electrical conductor.

I claim:

1. A flexible electrical conductor having a large superficial area adapted for high tension transmission lines, which comprises multiple concentric hollow pathways of annular cross-section made of metal of high conductivity and supported from within by a metallic reinforcement extending throughout the length of the conductor, the said reinforcement consisting of a spiralled metallic member of structural shape cross-section, the extremities of the elements of which engage the inner conducting pathway and support the conductor against collapse.

2. A flexible electrical conductor of large superficial area adapted for high tension transmission lines comprising multiple concentric pathways of hollow annular cross-section made of metal of high conductivity and supported internally throughout the length of the conductor against collapse by a metallic reinforcement of structural shape, the central axis of the structural shape being the axis of the conductor and the extremities of the said shape engaging the inner conducting pathway.

3. A flexible electrical conductor having a large superficial area and adapted for use in high tension transmission lines, which comprises a conducting pathway of tubular form of metal of high electrical conductivity, the said pathway having portions adapted for relative movement as the conductor flexes, and a metallic reinforcement within and extending throughout the length of the conducting pathway, this reinforcement being electrically connected to the conducting pathway and consisting of a metallic member of structural shape cross-section, the extremities of the member engaging the inner suface of the pathway and supporting it against collapse.

4. A flexible electrical conductor for high tension transmission lines which comprises a pathway for current having the form of a hollow tube of relatively large superficial area, the said pathway having portions adapted for relative movement as the conductor flexes, and a metallic reinforcement of metal of high electroconductivity within the pathway and supporting the latter against collapse, this reinforcement having the form of a structural shape with its extremities engaging the inner surface of the pathway, the axis of this reinforcement lying in the axis of the conductor.

5. A flexible electrical conductor for high tension transmission lines, which comprises a pathway of tubular form including a layer of cable strands of metal of high conductivity, this pathway having a relatively large superficial area, and a reinforcement for the pathway to prevent the collapse of the latter under the stresses to which the conductor is exposed in normal use, this reinforcement being a metallic structural shape forming part of the electrical circuit in which the conductor is connected, the said reinforcement placed with its longitudinal axis extending lengthwise of the conductor.

6. A flexible electrical conductor having a large superficial area adapted for use in high tension transmission lines, the said conductor comprising a primary conducting pathway of metal of high conductivity, said primary conducting pathway being so constructed as to form a tubular shaped body of metal enclosing a secondary conducting pathway of metal, said secondary conducting pathway being twisted axially to give its extremities the form of a helix, and consistituting an internal reinforcement to prevent the collapse of the primary conducting pathway, by the engagement of the said extremities with the inner surface of said primary conducting pathway, and constructed in cross-sectior to the form of a structural shape.

7. In a flexible electrical conductor having a large superficial area and adapted for use in high tension transmission lines, a structural shape of metal of high electrical conductivity, twisted axially so that each outer extremity thereof forms a helix, and a flexible conducting pathway of metal of high electrical conductivity formed on said helix, the said structural shape supporting the hollow conducting pathway against collapse during construction and in normal use by the engagement of the extremities of said shape with the inner surface of said pathway.

8. A reinforced flexible electrical conductor for use on high tension transmission lines, the said conductor having a current conducting pathway of multiple concentric layers of metal of high conductivity formed to substantially tubular form, and an internal metal reinforcement to prevent collapse of the current conducting pathway during construction and in normal use of the conductor, the said internal metal reinforcement being twisted to form a helix at its outer extremities, and consisting of a one-piece metal member formed with a web having flanges at angles to the major axis of the member, the said flanges giving the said reinforcement the necessary lateral stiffness.

9. A flexible electrical conductor having a large superficial area and adapted for use in high tension lines, which comprises a hollow pathway of circular cross-section of metal of high conductivity and relatively low mechanical strength, this pathway having portions movable relative to one another as the conductor flexes, and a reinforcement within the said pathway for resisting collaps-

ing stresses to which the conductor is exposed in normal use, this reinforcement being a metal member of structural shape cross-section disposed with its axis coincident with the axis of the conductor and having its extremities continuously engaging the inner surface of the said pathway, said member being twisted about its longitudinal axis.

10. A conducting cable comprising a series of strands cabled so as to form a tube, and a core including a twisted strip and means for stiffening said strip against longitudinal bending.

In testimony whereof I affix my signature.

GEORGE C. OXER.