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L. EMANUELI

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HIGH TENSION ELECTRIC CABLE

Filed Sept. 17, 1929

Fig.1.

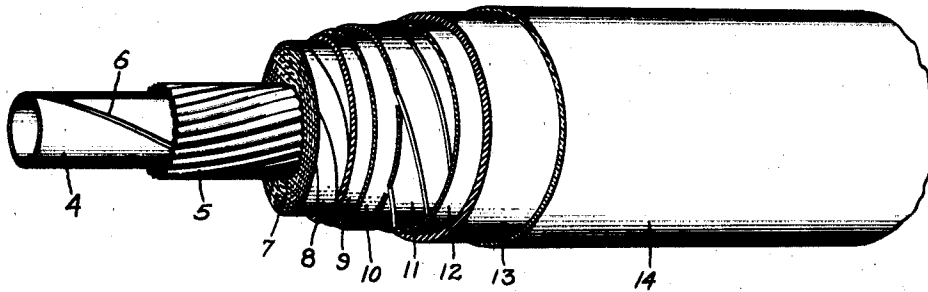


Fig. 2.

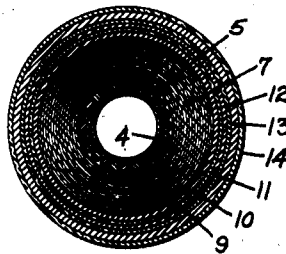
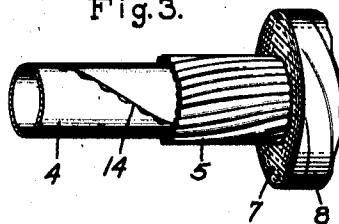


Fig. 3.



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UNITED STATES PATENT OFFICE

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HIGH TENSION ELECTRIC CABLE

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This invention relates to high tension electric cables of the type commonly termed "oil-filled" cables. In cables of this type, as usually constructed, the copper wires or strands forming the conductor are stranded around a hollow metallic core, which serves to support them. The strands are covered with suitable insulation such as paper, and this in turn is enclosed in a lead sheath. The hollow supporting core usually consists of a steel wire or ribbon wound to form a short lay helix after the fashion of a closely coiled extension spring containing a very large number of turns of wire or ribbon, the total electrical resistance of which is very high. The central passage or channel within the core contains oil or other impregnating fluid which passes radially outward through the core and strands and impregnating the paper insulation. In electrical distribution systems comprising cables of the type mentioned, there are provided at suitable points feeding reservoirs containing impregnating fluid such as oil, and which communicate with the channel in the cable formed by the hollow core, with the object of maintaining under a pressure above that of the atmosphere a supply of impregnating fluid in the cable and keeping the paper insulation thoroughly saturated.

Because of the very high resistance of the coil extension spring tube core, none or practically none of the electric current is carried thereby, the current naturally flowing through the path of least resistance. As a result of this construction, the core forms merely a mechanical support for the strands or wires, and has no electrical function. In order to provide sufficient space in the interior of the cable conductor for the impregnating fluid, the outside diameter of the cable has to be increased to compensate for the space occupied by the hollow supporting core. Moreover difficulties not infrequently arise owing to the resistance offered by the large number of turns of material forming the core to the flow of oil there-through. The turns of the core give to the central passage a corrugated form, with the

result of appreciably increasing the resistance to longitudinal flow of the oil.

The present invention has for its object to overcome the disadvantages above referred to and at the same time to improve the construction of the cable while considerably simplifying its manufacture and reducing its cost of production. To this end the hollow metallic core of the cable which serves to contain the impregnating fluid also forms a low resistance conductor for electric current. It is made in the form of a helix with a comparatively long lay and is arranged to have an electrical resistance of such order that the said helix also serves as a current-carrying conductor of the cable. Preferably the hollow core is formed by twisting a strip of copper or other suitable metal of good conductivity and uniform section into a helix of long lay, comparable for example with, or of about the same order as, the long lay of the usual helically stranded conductors of the cable; around the core thus formed the usual strands of bare wire which also convey electric current are stranded or wound, the core and strands forming parallel conductors. Alternatively the thickness of the copper strip may be such as to enable it to carry the whole current, in which case the ordinary exterior stranded wire conductors may be wholly omitted, their place being taken wholly by the current-carrying hollow core itself. The strip is so twisted that the edges are brought into close proximity but leaving between them a narrow longitudinally extending slot of long pitch spiral form through which the oil flows radially. In order to facilitate the flow or passage of oil or other impregnating fluid from the interior of the helically formed tubular core into and through the dielectric, one or both of the edges of the strip from which the core is formed may be indented, notched or fluted at frequent intervals, this being especially desirable when the usual stranded wire conductors are omitted and the whole of the current is carried by the copper strip constituting the core. When the core is provided with current carrying strands of wire wound thereon in the usual manner, it is de-

sirable in order to prevent obstruction of the flow of oil or other impregnating fluid from the interior of the core into and through the dielectric, to slightly deform the wires or strands so that a large number of small radial passages will be formed between adjacent wires of the same layer, as set forth in my Patent 1,662,107, dated March 13, 1928.

For a consideration of what I believe to be novel and my invention, attention is directed to the specification and the claims appended thereto.

In the drawing, which is illustrative of my invention, Fig. 1 is a perspective view of a piece of high tension cable with certain of the parts broken away; Fig. 2 is an end view of the same, and Fig. 3 is a perspective view of a slightly modified form of core.

4 indicates the core which is made of a strip of sheet material having good conductivity, as of copper for example. It is twisted so as to have a long lay, say of the same order as that of the strands of wire 5 but in the opposite direction. That is to say, the core may have a right hand lay and the strands a left hand lay. In forming the core, it is so twisted in the direction of its length that a small space or slot 6 is left between the adjacent edges of strip and through which oil from within the core is free to flow outwardly and impregnate the insulation 7 surrounding the strands 5. The fact that the space or slot 6 extends the whole length of the cable affords ample opportunity for the oil to pass to and from the insulation. Since the core is made of good conductive material and has a length the same as the strands or practically so, and therefore has about the same resistance to the passage of electric current, it follows that less copper is required for the strands. In this case only one layer of strands is provided as contrasted with two for cable of the ordinary construction, both carrying the same amount of current and at the same potential. This results in a substantial saving in cost of manufacture.

The insulation 7 is made of strips of paper 8 and is wound spirally about the strands with overlapping joints as usual. Surrounding the paper is a lead or equivalent sheath 9. Over the sheath is a layer of paper 10 to form a bed of somewhat yielding character for the non-magnetic binding band 11 which strengthens the cable, for example, when it is bent, and also reinforces the sheath 9 to prevent it from being stretched due to internal oil pressure, said bed preventing the band from injuring the sheath. Surrounding the binding band is a thin paper covering 12 which serves as a bed for the outer lead sheath 13. To protect the latter it is covered by a fibrous covering 14 which is impregnated with a suitable and usually water-proof compound.

In Fig. 3 is shown a slight modification of

the core. In this case one or both of the edges of the strip of which it is composed is or are fluted or corrugated as at 14. This arrangement is advantageous since it prevents the edges of the strip from being in such close contact as to prevent or greatly restrict the passage of oil into and through the insulation. Since the edges of the strip touch in spots it results in a somewhat stronger structure upon which to strand the wires than is the case where a slot of appreciable size extends longitudinally of the whole cable.

It is important that the core has a relatively long lay or pitch since otherwise it would tend to crack when the cable is bent as it has to be in reeling and installing. The fact that it is slotted, as distinguished from being a mere tube closed at every point except the ends, means that it has more flexibility than would otherwise be the case. By using a tubular structure for the core as above described, I not only obtain the great advantage of using it as a conductor but it provides a channel for the insulating fluid which has a smooth internal wall and hence the resistance to longitudinal flow of the fluid is greatly reduced over the coiled spring type of core of the prior art.

As an illustration, but not as a limitation, of my invention the cable herein described is intended for carrying electric current having a potential of the order of 66,000 volts.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a high tension cable, the combination of a centrally disposed member of low electrical resistance which is adapted to carry a substantial portion of the current transmitted by the cable and defines a smooth walled internal channel for fluid insulation, said member comprising a strip of good conducting metal twisted in the direction of its length with a long lay and having a narrow slot between the adjacent edges to form an outlet for the fluid, a surrounding body of insulation which is permeated with fluid from the channel, and an enclosing metal sheath.

2. In a high tension cable, the combination of a centrally disposed member of low electrical resistance which is adapted to carry a substantial portion of the current transmitted by the cable, said member comprising a thin strip of metal of uniform section twisted in the direction of its length with a long lay to form a tube and having a narrow slot between adjacent edges of the strip to form a longitudinally extending outlet for the fluid, said member having a smooth interior wall which defines a fluid containing channel and also a smooth outer wall, a paper covering which is impregnated with fluid from the channel, and a metallic sheath.

3. In a high tension cable, the combination of a central hollow core comprising a helical

strip of metal of long lay and low electrical resistance forming a tubular slotted conductor having smooth inner and outer walls, and wires stranded thereon, said core and wires both carrying current and both forming long helices having substantially the same length of lay, a body of permeable insulation which surrounds the wires, a mass of liquid insulating material in said hollow core and permeating said insulation and a metallic sheath which encloses the permeable insulation.

4. In a high tension cable, the combination of a central current carrying core comprising a strip of metal, having a fluted edge and which is twisted in the direction of its length to form a tube, a mass of insulating liquid in said tube said flutes defining radial passages for the liquid in the core, wires stranded on the core, and having approximately the same length of lay, porous insulation surrounding said wires and impregnated with said liquid and an enclosing sheath.

5. In a high tension cable, the combination of a central current carrying core comprising a strip of metal of good conductivity twisted in the direction of its length with a long lay, whereby said core is of relatively low resistance, the edges of said strip being aligned to form a slotted tube, wires stranded on said core, permeable insulation surrounding the said wires, a mass of liquid insulating material in said tube and impregnating said permeable insulation, and a metallic sheath covering said insulation.

6. In a high tension cable, the combination of a central core adapted to carry current and which defines a smooth walled channel for fluid, a mass of insulating liquid in said channel, said core being made of a thin narrow strip of good conducting material which is twisted lengthwise with a long lay to form a slotted tube, strands of wire which closely surround the tube with a long lay, the lay of the strands being opposite to that of the tube, a body of permeable insulation surrounding the strands and impregnated with said liquid, and a metal enclosing sheath.

In witness whereof, I have hereunto set my hand this tenth day of September, 1929.

LUIGI EMANUELI.