Aug. 17, 1965 J. N. JOHNSEN 3,201,507

HOLLOW CONDUCTOR FOR POWER CABLES

Filed Nov. 15, 1962

Fig. 1.

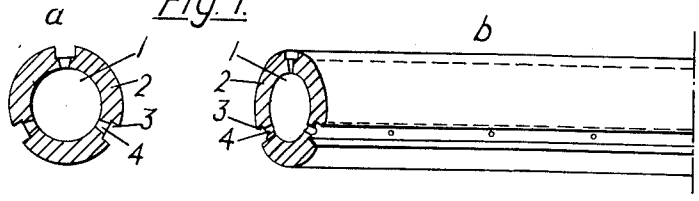


Fig. 2.

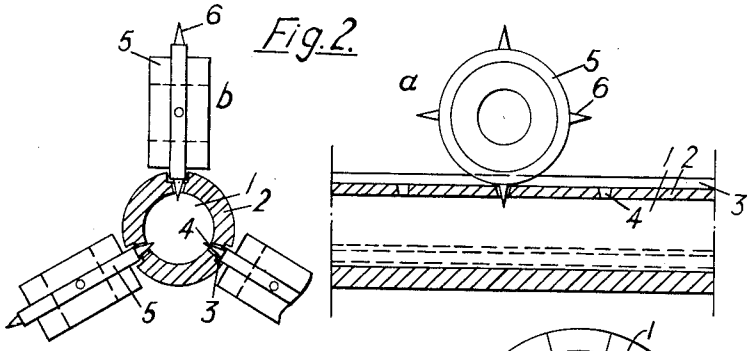


Fig. 3

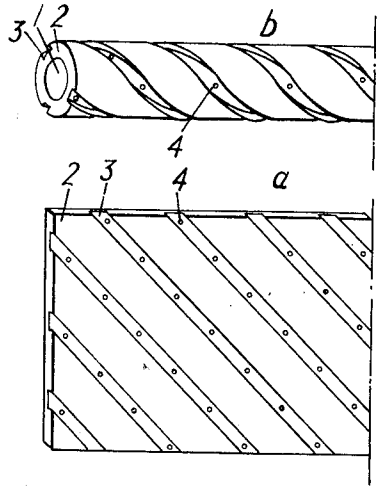
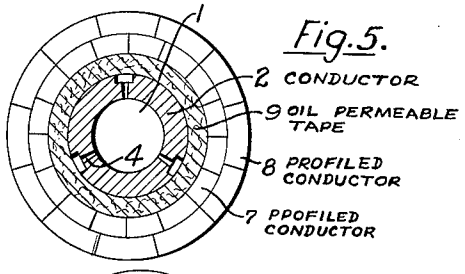


Fig. 5.



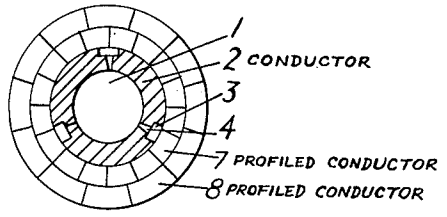


Fig. 4.

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HOLLOW CONDUCTOR FOR POWER CABLES

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2 Claims. (Cl. 174—25)

This invention relates to hollow conductors for power cables and more particularly to hollow conductors for power cables having impregnated paper insulation.

Present single core oil filled cables are usually provided with a hollow conductor which is hydraulically coupled with an expansion reservoir of oil. The main purpose of the oil is to provide good dielectric properties. The oil pressure tanks or expansion reservoirs cause the oil to flow back-and-forth in the cable when it expands or contracts due to temperature variations. The original design of such a hollow conductor consists of an inner cylindrical open helix of steel or aluminum tape having circular wires of conductive material stranded around the helix. The purpose of the helix is to keep the conductor wires in a fixed position so that the formed hollow conductor maintains its shape. This embodiment has proved to be relatively expensive to manufacture and the diameter of the finished cable is larger than required as the inner helix uses a certain amount of space.

In order to overcome these disadvantages, a hollow conductor of profiled wires without an inner helix was developed. It has proved not to be suitable for conductors where the wall thickness of the tube is relatively thin and it has been found difficult to manufacture a small conductor which will not collapse due to radial directed mechanical forces as there is no inner support. Next, a conductor was provided which consisted of a complete tube having holes in its walls which permitted an oil flow from the inside of the tube to the insulation. This type conductor can be made in either large or small cross-sections. However, this conductor suffers from the disadvantage that the holes must be arranged relatively close together in order to let the oil flow easily in-and-out of the insulation as otherwise the insulation tends to clog up the holes. A further disadvantage of this conductor is that the forming of the holes is relatively complicated and expensive as the conductor must not be deformed and cuttings of the conductor material must not be allowed in the center duct.

It is therefore an object of my invention to overcome the aforesaid disadvantages which arise with known conductor types.

It is another object of my invention to provide a method of producing conductors having holes in their walls which is both simple and economical.

It is another object of my invention to provide a conductor which will insure an even distribution of oil along the cable.

A novel feature of my invention is the provision of a hollow conductor having one or more longitudinal grooves in its surface. These grooves may be either parallel with the axis of the conductor or they may be in the form of a helix around the conductor.

Another novel feature of my invention is the provision of conductors having grooves and holes pierced in the bottom of the grooves to insure an even distribution of oil along the cable so that a minimum amount of holes need be provided and the material to be pierced is thinner than the tube wall itself.

According to my invention the grooves and the holes may be manufactured before, during, or after the conductor is manufactured. This will depend upon the manufacturing process. Both the grooves and the holes can be produced by metal separating tools. If the conductor is to be formed by welding metal tape along a longitudinal seam it will be advantageous to produce the grooves prior to the forming of the tube. Grooves can be formed during the rolling of the metal tape with the use of a rolling tool having a suitable profile. If the conductor is to be manufactured by extrusion, it will be advantageous to produce the grooves during the extrusion process by providing an extrusion die which is shaped to cause the tube to have grooves upon being extruded. This method has proved to be particularly advantageous when the conductor is made of aluminum and extruded in a modern aluminum extruder.

It has been found to be easier and cheaper to use a tool for producing holes which presses or cuts the holes than to use a metal separating tool. For instance, a pulley-shaped tool having a number of pointed prongs has proved to be suitable. This method has the further advantage of eliminating undesirable cuttings from the conductor metal which tend to partially clog the holes, flow into the insulation and disturb the electrical field, and collect in low places in the cable line where they may partially or wholly clog up the central duct.

The above-mentioned and other features and objects of this invention will become more apparent by reference to the following description taken in conjunction with the accompanying drawings in which:

FIGURE 1*a* is a cross-sectional view of a conductor in accordance with my invention;

FIGURE 1*b* is a perspective view of the conductor of FIGURE 1*a*;

FIGURE 2*a* is a schematic illustration of how a pulley-shaped tool having pointed pins is used for piercing holes in my conductor;

FIGURE 2*b* is a cross-sectional view of the pulley and conductor shown in FIGURE 2*a*;

FIGURE 3*a* is a perspective view of a metal tape which is provided with grooves and holes in accordance with my invention;

FIGURE 3*b* is a perspective view of a conductor formed out of the metal tape of FIGURE 3*a*, and;

FIGURE 4 is a cross-sectional view of a hollow conductor and two layers of profile conductor wires in accordance with my invention;

FIGURE 5 is a cross-sectional view of a hollow conductor having a layer of wound oil permeable tape and two layers of profile conductor wires in accordance wih my invention.

Refer now to FIGURE 1*a* and 1*b* in which is shown a hollow conductor in accordance with my invention. The duct 1 in the center of the conductor or tube 2 communicates with an expansion reservoir (not shown). The conductor 2 may be made of any suitable conductor material. The rectangular-shaped grooves 3 are arranged on the outside of the conductor parallel to the axis of the conductor. Obviously, the grooves may have a variety of cross-sections and may be arranged on the inside of the conductor. The holes 4 are pierced through the conductor in the bottom of the grooves 3 to assure effective communication between the oil in the duct and that in the insulation (not shown) which would surround the conductor. The conductor may be provided with almost any number of grooves arranged in any desired pattern.

Refer now to FIGURES 2*a* and 2*b* in which is shown apparatus for piercing holes in accordance with my invention. The apparatus comprises three pulleys 5 having pointed pins 6 thereon. The pointed pins 6 have a cone-shape or needle point, however, they may have any desired shape which will cause a hole to be formed. The piercing operation may be performed in tandem with an

extruder, if the tube is made by an extrusion process, or at a later time. The number of pulleys should equal the number of grooves and they should be arranged so that the pins are perpendicular to the grooves. They should preferably be built in the same rack. This method may also be used when the tube is manufactured from a rolled metal tape.

When the grooves are produced during an extrusion process, the hollow conductor will sometimes tend to assume a non-circular shape due to the abrupt changes in the wall thickness. The conductor may be worked to assume a circular shape during the extrusion process or in a separate operation before it is put into an insulating machine, by pressing it between a set of rollers having suitable shapes, or a die having a suitable cross-section. Helically-shaped grooves may be produced by means of a rotating tool during the extruding process, or they may be produced during the rolling process by means of suitable rollers if the conductor is manufactured from a rolled metal tape.

FIGURE 3*a* shows a metal tape in accordance with my invention. FIGURE 3*b* shows the complete tube with helically-shaped grooves. An advantage which accrues to a conductor having helically-shaped grooves is that it may be bent more easily and more sharply without being deformed than a conductor with straight grooves.

A hollow conductor having my grooves has the disadvantage of electrical field constrictions which may arise at the edges of the grooves when the conductor is used in high tension cables. This disadvantage may be easily overcome by winding an oil permeable tape 9 (FIG. 5) of conducting or semi-conducting material on to the conductor. Such a tape may be carbon black paper which is widely used in the cable industry and consists of paper impregnated with carbon black.

When manufacturing cables for large currents, it is not practical to use a conductor consisting solely of a massive tube with grooves. One or more layers of profiled or circular wires should, therefore be stranded over the tube-shaped conductor in order to increase the cross-sectional area. A cross-section of such an embodiment having two layers of profiled wires 7 and 8 stranded over the tube and having grooves 3 with holes 4 in their bottom is shown in FIGURE 4. A profiled wire is a straight wire having a trapezoidal cross-section.

My invention is particularly suitable for single core oil filled cables. However, my conductor may also be used for single core gas pressure cables of the type having inner gas pressure. When used in a gas pressure cable, the conductor need not always be provided with holes

as the gas can flow through the grooves alone to the insulation. The center duct may then be connected to an arrangement for circulating a cooling fluid through the duct in order to increase the current carrying capacity of the cable considerably.

While I have described above the principles of my invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of my invention, as set forth in the objects thereof and in the accompanying claims.

What I claim is:

1. A hollow conductor for power cables comprising a circular tube having at least one groove in its surface and holes in the bottom of each said groove, the diameters of said holes being smaller than the width of said grooves whereby fluid flowing through said holes into said grooves is guided along said grooves, and at least one layer of profiled metal wires which are stranded over the conductor whereby the conductor cross-section is increased.

2. A hollow conductor for power cables comprising a circular tube having at least one groove in its surface and holes in the bottom of each said groove, the diameters of said holes being smaller than the width of said grooves whereby fluid flowing through said holes into said grooves is guided along said grooves, said grooves being arranged on the outside of the tube surface, means for eliminating electrical field construction at the edges of said grooves, said means comprising an oil permeable tape of conduction material wound around said hollow conductor.

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