Aug. 18, 1936. E. C. SCHACHT 2,051,423

INSULATED CONDUCTOR

Filed May 5, 1932

Fig. 1.



Fig. 3.



Fig. 2.

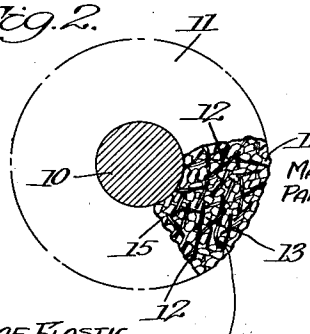


Fig. 4.

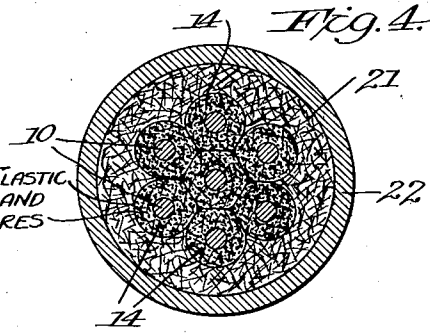
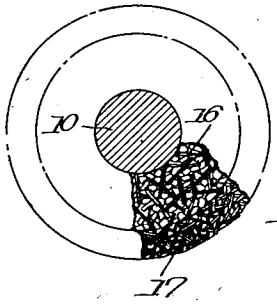
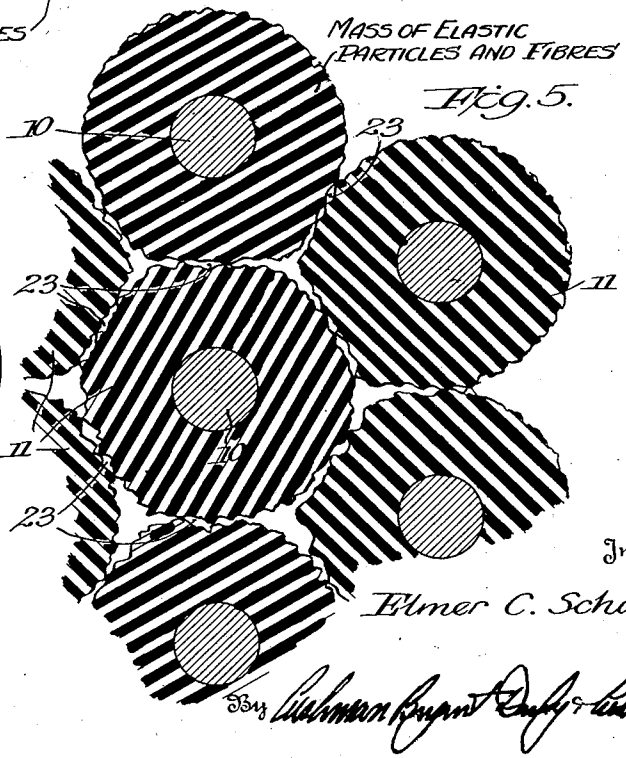


Fig. 6.





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INSULATED CONDUCTOR

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6 Claims. (Cl. 173—264)

The present invention is an insulated conductor. Broadly considered, the invention is an article of manufacture comprising an electric conducting core having a composition consisting of particles of a resilient or elastic nature interlaced with fibres applied thereto.

An object of the invention is to provide an insulated conductor which will have greatly improved electrical and other favorable qualities and the insulated coating of which will possess, to the optimum degree, the qualities of flexibility and low apparent density.

I am aware that insulated conductors formed of wire, cable, or other electrical conducting materials wrapped or coated with various types of fiber compositions are well known. However, none of these prior art conductors are formed in such a manner as to provide small air spaces or voids within the body of the insulating preparation with which the electrical conductor is coated or wrapped. My invention contemplates the provision of such air spaces or voids, and the electrical qualities of my conductor over the prior art conductors will be greatly increased by reason of the existence of these air spaces or voids.

The term "conducting core" as used in the present specification and claims refers to a solid or hollow core of any configuration or to a core of numerous strands twisted together and having any desired exterior configuration.

The terms "coated" or "coating", as used in the specification and claims include wrapping or any other manner of applying the materials used in my invention to a conducting core.

In the drawing:

Figure 1 is an elevation of an insulated conductor made in accordance with my invention;

Figure 2 is a diagrammatic view, partly in cross-section, showing the insulated conductor of Figure 1;

Figure 3 is an elevational showing of a modified form of my invention;

Figure 4 is an enlarged cross-section of a multi-cable conductor formed in accordance with my present invention;

Figure 5 is a greatly enlarged fragmentary cross-sectional showing of the conductor shown in Figure 4; and

Figure 6 is a diagrammatic view, partly in cross-section, showing another modification of my invention.

Referring to Figures 1 and 2 of the drawing, the numeral 10 designates an electrical conducting core such as a copper cable or strip provided with a coating 11 formed of fibres 12 and particles 13 of cork or other suitable resilient or elastic material. In manufacturing this embodiment of my invention, fibres 12 and particles 13 are preferably mixed into a pulp, which can be done by means of an ordinary paper making beater, and the pulp mixture, sufficiently suspended in or diluted with water, is coated directly around the conductor and is afterwards formed and dried into a cover or sheath consisting of intermixed cork particles and fibre without being first formed into an ordinary sheet or web of paper.

In the form of my invention shown in Figure 3, the conducting core 10 is coated with strips 14 of sheet material also formed of fibres 12 and particles 13 of a nature similar to those described in connection with Figures 1 and 2. The material with which the conducting core 10 is coated in this instance is originally formed from the fibre and cork pulp mixture into a continuous sheet on a cylinder or Fourdrinier type of paper making machine and the completed web or sheet is then slit into narrow rolls or strips which are wound or wrapped upon the core 10 according to the methods now followed in insulating conductors with paper.

As will be apparent from the following specification, air spaces or voids will exist within the insulating materials 11 and 14 and these air spaces are designated by the numeral 15 applied to the enlarged view shown in Figure 2.

The fibres 12 may be of various materials, among which are jute, rope, hemp, sisal, kraft pulp fibres, cotton, linen, long wood pulp or alpha-cellulose wood pulp. The particles 13 are preferably cork particles of various sizes or granulated cork, but it will be understood that shredded or ground particles of resilient or elastic materials other than cork may be used, for example, dried and screened sugar cane pith, chopped coarse sugar cane fibres, or ground and screened chipped fragments of wood. Wood particles such as result from turpentine extraction may also be used. However, the use of cork particles in the coating materials used with my insulated conductor gives by far the most satisfactory results because of the high insulating value of cork and its light weight and resiliency. Another attribute of cork which makes it particularly desirable for present purposes is the fact that it cannot be impregnated. If the materials 11 and 14 are saturated with oil or the like in the manner hereinafter described, the saturant cannot work into the particles of cork to change their internal structure, but will

merely coat them. The result is that after the saturating treatment, the particles of cork will still retain their inherent and highly valuable qualities of light weight, resiliency and high insulating value. Cork is therefore preferable to materials which absorb a saturant.

I find that a very satisfactory insulated conductor may be formed from a mixture comprising 20% of the particles 13 and 80% fibre by weight. However, the materials 11 and 14 may be varied through different ranges at least up to 70% of the particles to 30% of the fibre, by weight. The particles 13 used in the materials may range in size from 30 to 150 mesh, or finer, or the range used in a particular batch of the materials may be limited to some range such as between 30 and 80 mesh.

Generally speaking, the materials 11 and 14 are strengthened by having a larger proportion of the fibres present, but the electrical characteristics and flexibility are enhanced by increasing the proportion of the particles 13. The particles 13 act as separators or spacers for the fibres within the sheet 11, thereby producing the air cells or voids 15. I find that the size and number of the air spaces 15 varies in accordance with the size and number of the particles 13, because of the fact that air spaces or voids 15 apparently form adjacent the particles 13 or because the intermixture or interlacing of the particles 13 at various angles necessarily produces voids within the material and exteriorly of the particles and fibres. The natural result is that larger particles 13 cause the presence of larger air spaces or voids. On the other hand, if particles within the smaller size ranges indicated are used, smaller air spaces or voids will occur, but the number of the latter may, of course, be increased by an increase in the number of particles 13. With this in mind, the material 11 may be formed with the particles of the size and in the proportion with respect to the fibres which is best suited to the particular electrical purpose for which the conductor is to be used. However, the particles 13 should have a diameter at least equal to the cross-section of the fibres 12, but should be of somewhat less diameter than the thickness of the coating 11 or 14 applied to the conducting core 10, although if the coating is to have a rough exterior finish, larger particles 13 may be used.

In the formation of the materials 11 and 14, the fibres 12 become so thoroughly interlaced with each other and with the particles 13 that the materials are extremely flexible. This flexibility is apparently due to the fact that the fibres hinge or pivot upon the particles 13 as well as because the existence of the air spaces or voids 15 permits the fibres to distribute themselves under flexure without breaking up the general structure or surface of the material. The flexibility of the material naturally increases the flexibility of my insulated conductor, and I am thereby enabled to produce an insulated conductor which may be sharply bent without danger of cracks occurring in the insulation. It may be noted too that the probability of cracks or tears developing in the coating 14 during the wrapping operation is reduced to a minimum because of its flexibility and resiliency.

When the insulated conductor of this invention is to be used for power transmission purposes, it may be advisable to saturate the coating with some of the well known insulating compounds such as petroleum oil or a mixture of petroleum oil and rosin oil. Cables used for the transmission of high voltages are generally formed of a number of individual conductors of considerable size, each individual conductor being formed by stranding together a number of smaller wires. The individual conductors are coated by wrappings of the types shown in Figure 3 and the finished cable may consist of two or more of these individually insulated conductors wound together into a larger cable as shown in Figure 4 and an additional coating 21 (Figure 4) may then be applied to the wound conductors. The coating 21 will usually consist of a number of wrapped layers of heavier and coarser insulating material composed of cork and fibre. The most satisfactory way of saturating such a high voltage transmission cable is to place the cable in a vacuum tank where it is subjected to a high enough temperature to remove moisture and where it is further subjected to a fairly high vacuum to remove moisture, vapor and air contained in the insulated coating. The hot insulating compound heated to a high degree of fluidity is run into the vacuum tank so as to completely cover the evacuated and heated cable. The entire system is then allowed to cool so as to further increase the absorption of insulating material into the insulation. A protective cover or sheath 22 usually of lead may be applied directly over the saturated coatings. The vacuum treatment of the cable will remove any air which might be present in the spaces 15 and will thereby effect a more thorough impregnation. The presence of the voids 15 in the material will cause the saturant to almost completely penetrate the material with the result that my conductor will be much more thoroughly impregnated than are the usual conductors of such types. The highly dielectric oil in combination with the fibre greatly improves the dielectric properties of the material.

Due either to the peculiar physical characteristics of the materials 11 and 14 or to the improved saturation which is obtained by the use of these materials, or from both causes combined, the finished conductor has very desirable electrical characteristics, such as low power factor loss, resistance to high voltage breakdown and resistance to current leakage under high tension. The improvement in these electrical qualities minimizes the possibility of damage to the conductor through electrical failure and also adds to the commercial efficiency of the conductor.

In preparing the insulated conductor of my invention for use in communication purposes, such as telephony or telegraphy, I do not generally use a saturant, but the high percentage of air spaces or voids within the insulated conductor increases the efficiency of the conductor for communication purposes, evidently because the air spaces or voids reduce the electrical capacity effect. I preferably use the form of conductor illustrated in Figure 3 for communication purposes, applying a single wrapping 14 to each of the conducting cores 10. A large number of these conductors are then twisted together and the whole structure finally covered by an outside protecting layer similar to layer 21 of Figure 4. This outer layer may be formed of a spirally wrapped strip of somewhat heavier and thicker material than the coating about the individual cables. The usual lead sheathing may be applied to the outer wrapping. The electrical charac-

teristics of the individual conductors of this type may be improved if the coating on the individual conductors 10 is not calendered or rolled, but is left somewhat rough, as naturally results from the presence of the particles 13 in the coating. This rough exterior on the individual conductors 10 results in small air spaces 23 between the contacting wrapped surfaces of the individual conductors 10 shown in Figure 5 and these further increase the electrical qualities of the conductors. For some purposes, it may be practical to deposit the outer coating 21 of cork and fibres in the manner described in connection with Figure 1.

In some instances it may be desirable to construct insulated conductors of my invention for use in communication purposes according to the method described in connection with Figure 1. If the individual conductors constructed in this manner are to be used in a cable, they would be twisted and formed into a multi-cable structure generally similar to that illustrated in Figures 4 and 5.

Figure 6 shows an electric conducting core 10 which is coated with a sheet of paper comprising two or more plies, one or more adjacent plies being formed of a mixture 16 of cork and fiber, while a ply 17 on one surface of the material is formed of fibre alone. As is shown in Figure 6, this material is applied to the conducting core 10 in such a manner that the cork and fibre mixture ply or plies 16 will be in contact with the conducting core 10, positioning the fibre ply 17 on the exterior of the insulated conductor structure. This arrangement is very effective when the insulated conductor is to be used in situations where the high coefficient of friction of the cork might be a disadvantage. It may be desirable for some purposes to position the fibre ply or plies 17 adjacent the conducting core 10 and to have the cork and fibre ply 16 form the exterior surface of the insulated conductor structure. For still other purposes, it may be advantageous to use a coating sheet which is formed with fibre plies on both its surfaces, a ply or plies of the cork and fibre mixture being formed centrally of the coating, so that the fibre will be in contact with the conducting core 10 and will also form the outer surface of the insulated conductor structure.

It is obvious that the materials used in coating my insulated conductor are extremely light in weight, and I am thereby enabled to produce a conductor which has less weight than any insulated conductor of a corresponding efficiency now in use.

It may be pointed out that the function of the resilient or elastic particles used in my invention is entirely different from the particles of clay, talc and other exceedingly fine particles which are generally added to various types of papers. These latter particles are generally added to increase the density of the finished product or close the surface and, of course, decrease the air spaces. In my product, as stated above, the particles coact with the fibres to provide air spaces or increase the saturation.

I claim:

1. An article of manufacture comprising a multi-strand insulated cable for low voltage, the individual strands being coated with a mass of resilient and elastic particles and fibres, the particles and fibres being interlaced to form a cellular structure and to provide a rough exterior finish on the individual strands, so that the assembly of the individual strands forms air cells between the individual strands within the multi-strand cable.

2. An article of manufacture comprising a multi-strand insulated cable for low voltage, the individual strands being coated with a mass of resilent and elastic particles and fibres, the particles and fibres being interlaced to form a cellular structure and to provide a rough exterior finish on the individual strands, so that the assembly of the individual strands forms air cells between the individual strands within the multi-strand cable, and the assembled strands being coated with a mass of interlaced particles and fibres.

3. An article of manufacture comprising a low voltage insulated conductor consisting of a conductor core having directly applied thereto a coating formed of an intermingled mass of fibres and cellular particles, the cellular particles being supported in such a manner in the mass as to provide air cells within the mass and exteriorly of the particles and fibres so that electrical capacity effects will be reduced.

4. An article of manufacture comprising a low voltage insulated conductor consisting of a conductor core having directly applied thereto a coating formed of an intermingled mass of fibres and cork particles, the cork particles being supported in such a manner in the mass as to provide air cells within the mass and exteriorly of the particles and fibres so that electrical capacity effects will be reduced.

5. An article of manufacture comprising a low voltage insulated conductor consisting of a conductor core having directly tpplied thereto a coating consisting of fibres and a mass of cellular particles in interlaced relation, said particles having a diameter at least as great as the diameter of said fibres to form air cells within the mass exteriorly of the particles and fibres so that electrical capacity effects will be reduced.

6. An article of manufacture comprising a low voltage insulated conductor consisting of a conductor core having directly applied thereto a coating consisting of fibres and cellular particles in interlaced relation, said fibres being generally of a length at least equal to the diameter of two of said particles to form air cells within the mass exteriorly of the particles and fibres so that electrical capacity effects will be reduced.

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