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E. H. YONKERS

1,883,269

ELECTRICAL CONDUCTOR

Filed Sept. 12, 1928

Fig. 1.

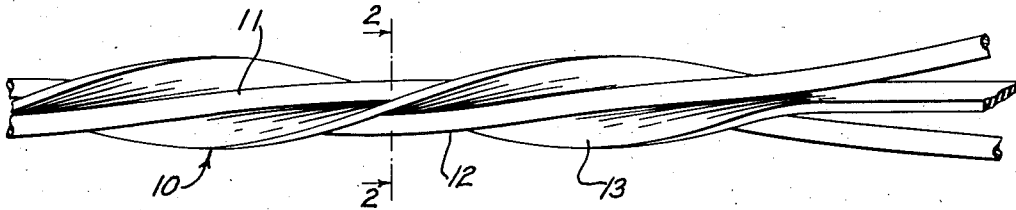


Fig. 2.

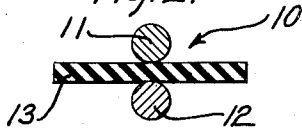


Fig. 3.

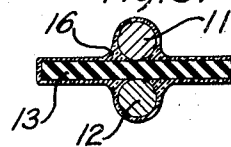


Fig. 4.

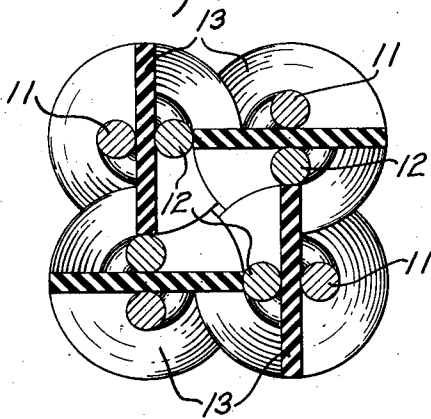


Fig. 5.

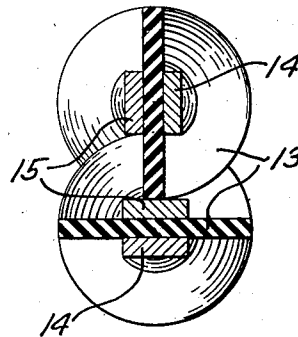
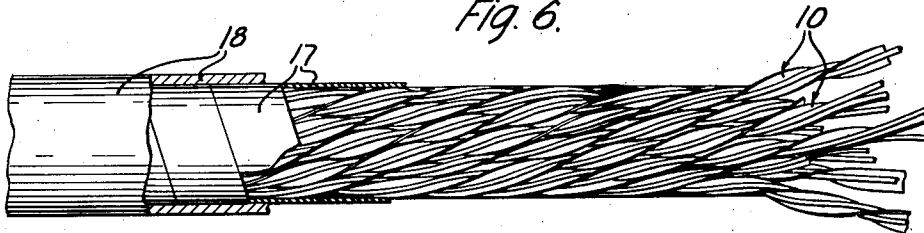


Fig. 6.



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UNITED STATES PATENT OFFICE

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ELECTRICAL CONDUCTOR

Application filed September 12, 1928. Serial No. 305,339.

This invention relates to electrical conductors, and more particularly to insulated conductors such as are used in the telephone industry.

5 An object of the invention is the provision of an insulated conductor which shall possess to a high degree the electrical qualities necessary in electrical conductors.

10 A further object of the invention is to provide an improved core for cables used for electrical transmission, which shall have improved capacitance and power factor characteristics and high resistance to the effects of moisture.

15 The invention contemplates the association of a plurality of conducting elements with a strip of solid insulating material, a continuous spiral twist being imparted to the conducting elements and the insulating strip. The resulting unit, consisting preferably of two conducting elements and an insulating strip, constitutes a multiple conductor which performs the function of the usual single conductor, and may be placed adjacent 20 similar units without danger of a short-circuit between it and the conducting elements of the adjacent units, since the conducting elements of each unit are insulated from the conducting elements of the other units by being mechanically separated therefrom, the insulating strips holding the units apart a sufficient distance to allow air to pass between them and form an effective insulation and materially reduce the capacitance between 25 such conductors.

The invention will be more fully understood by reference to the following description taken in conjunction with the accompanying drawing, in which,

40 Fig. 1 shows in elevation a unit consisting of two conducting elements and an insulating strip arranged in accordance with the invention,

45 Fig. 2 is an enlarged sectional view taken on the line 2—2 of Fig. 1,

Fig. 3 is an enlarged sectional view similar to Fig. 2, but showing a modified unit,

50 Fig. 4 is an enlarged sectional view showing four units positioned contiguous to each other, as in a telephone cable,

Fig. 5 is an enlarged sectional view showing two units of a modified form of conductor, and,

Fig. 6 is an elevation of a cable formed in accordance with the invention.

Referring to the drawing in which similar reference characters represent similar parts in the several views, the unit shown in Fig. 1 is designated generally at 10, and consists of electrical conducting elements 11 and 12 with an insulating strip or separator 13 interposed therebetween, the conducting elements and insulating strip being first assembled and then twisted together to the form illustrated in Fig. 1. The conducting elements 11 and 12 may be copper wires or other conducting strands known to the art, and the separator 13 may be formed of comparatively hard non-absorbent material, preferably of non-fibrous character such as hard rubber, cellulose acetate or other insulating material of sufficient rigidity to withstand the pressures to which the units will be subjected when wound together in a telephone cable. The pitch or distance between successive turns of the conducting elements and of the separator will vary with the electrical and mechanical properties desired, the width and thickness of the separator, and with other factors, but should in general be sufficiently low to insure against crushing under radial pressure.

The conducting units may, after assembly, be given a water-proof coating of hard wax, resin, or any similar adhesive, non-hydroscopic substance, as illustrated at 16 in Fig. 3. Such coating may be applied in any suitable manner, as by passing the unit into contact with a body of the coating material in molten form. The coating is not essential to the production of a satisfactory insulated conductor, for ordinary purposes, but is desirable where high humidity conditions are expected, as it forms a surface protection against humidity effects which makes the unit practically waterproof. The two conducting elements of a unit function as a single conductor; for example, in telephone cables, the above described unit takes the place of the single wire commonly used as a unit conductor, and the conducting elements of the unit may there-

fore each be of one-half of the cross-sectional area of the single wire commonly used. Two units, when twisted together, may be used in place of the "pair" which ordinarily constitutes the simple circuit in telephone practice.

As seen in Fig. 4, the conducting elements of the adjacent units are separated by a distance slightly less than one-half the width of the separator 13.

The arrangement shown in Fig. 4 may be made more compact by using flat conductors such as are indicated at 14 and 15 of Fig. 5. The conductors in such case may consist of flattened wire laid flat against the separator 13. The resulting reduction in the lateral dimension of the conductors considerably reduces the bulk of a cable made up of such units.

Where two or more units are twisted together as in Figs. 4 and 5, the direction of the "lay" or twist of the units about each other should be the same as that of the spiral separating strips, in order to get the maximum mechanical effectiveness of this type of insulation and the least danger of short-circuiting between units. A plurality of units may be twisted together to form a core, which may then be formed into a cable. Such a cable is shown by way of example in Fig. 6, wherein, the core is shown provided with a covering 17 of paper or other insulating or protective material, and encased in a sheath or armor 18.

Insulated conductors formed according to the present invention produce a cable having a very low capacitance per mile between pairs of conductors. This is due to the fact that in a cable formed in accordance with the present invention a greater proportion of air is included as a part of the insulating medium. The invention also produces an insulated conductor having extremely low power losses, as is shown by the fact that under dry conditions the power losses in a conductor provided with hard rubber spiral insulation are exceptionally low.

Another advantage of the construction set forth above lies in the fact that the units, even without the coating above described, are practically humidity proof, since their electrical properties are almost unaffected by the presence of moisture. Thus, a No. 22 copper wire having the spiral insulation of hard rubber formed in accordance with this invention, and not coated with wax or other coating substance, when exposed for 30 hours to an atmosphere of 87% relative humidity and a temperature of 20° centigrade had its capacitance raised by but 1.4% when tested at 1,000 cycles per second, and its conductance was increased by but 91% under the same conditions. The article made in accordance with the present invention, therefore, may be said to eliminate the difficulties arising

from the effects of humidity on stranded conductors.

While the invention has been described with particular reference to the insulation of copper conducting wires in telephone cables, it will be evident that it is applicable wherever it is desired to keep a plurality of substantially parallel strands from contacting with each other, and that it may therefore be used in power lines as well as for telephonic transmission. Where the conducting units above described are used for high tension power transmission, the size of the conducting elements and separators will ordinarily be larger, and it may be found desirable in certain circumstances to replace the air in the cable with oil or other fluid insulating material to thereby increase the dielectric strength of the insulation. This may be done by providing a sheath about the cable and introducing the insulating material into the cable by continuous or periodic pumping, the interstices between the spiral separators forming a continuous path through which the insulating material may flow.

The article formed in accordance with this invention is sufficiently flexible to permit its being wound on spools, and may be twisted into pairs and formed into cables in the same manner as ordinary wire.

Various additional modifications of the invention will suggest themselves to those skilled in the art, and such modifications as fall within the spirit of the invention are intended to be covered by the appended claims.

What is claimed is:

1. A telephone cable comprising a plurality of pairs of conducting elements, and rigid insulated members disposed between each pair of conducting elements and engaging the conducting elements of other pairs for holding the pairs in spaced relation to each other.
2. An electrical conducting unit comprising a pair of conducting elements, a strip of thin, flat, rigid insulating material positioned therebetween, and a thin adherent coating of waterproofing substance on the conductors and strip securing the conductors on the strip.
3. An electrical conducting unit comprising pairs of conducting elements with strips of hard insulating material positioned between the pairs of conducting elements to form units, said conducting elements and strips of each unit being twisted and said units being twisted about each other in the same direction, and overlapping to form a compact structure.
4. A telephone cable comprising a plurality of pairs of conducting elements, a rigid member disposed between each pair of conducting elements and engaging conducting

elements of other pairs for holding the pairs in spaced relation to each other, and a liquid insulating material filling the interstices between the conductors.

5 5. A telephone cable comprising a plurality of pairs of conducting elements, insulating members disposed between each pair of
10 conducting elements and engaging the conducting elements of other pairs for holding the pairs in spaced relation to each other, and a non-absorbent material disposed upon
said conducting elements.

15 6. An electrical conducting unit comprising a pair of conducting elements serving as a single conductor, and a separator composed of a strip of hard rubber between said elements and projecting therefrom, said elements and separator being twisted together
to form a cable strand.

20 7. An electrical conducting unit comprising a pair of conducting elements serving as a single conductor, and a separator composed of a strip of cellulose acetate between said
25 elements and projecting therefrom, said elements and separator being twisted together to form a cable strand.

In witness whereof, I hereunto subscribe my name this 27th day of August A. D., 1928.

EDWARD HENRY YONKERS.

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