Jan. 27, 1959 M. A. LIPTON 2,871,151

ELECTRICAL CABLE

Filed March 7, 1956

FIG. 1

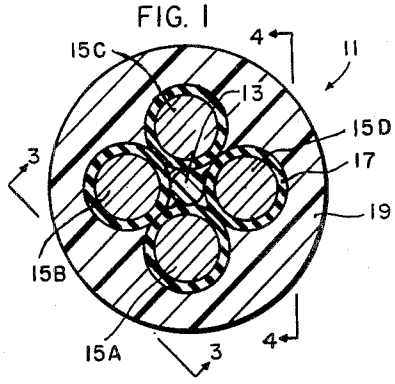


FIG. 2

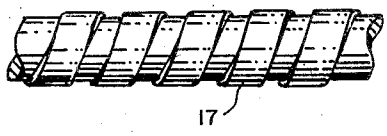


FIG. 3

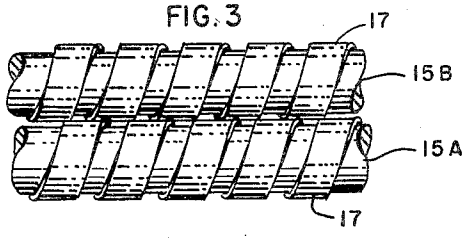
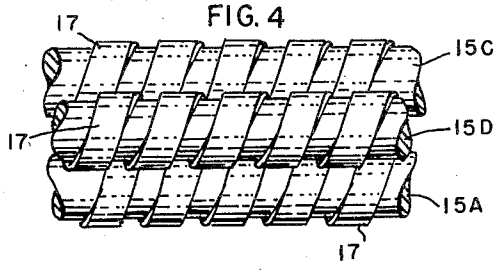


FIG. 4



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United States Patent Office 2,871,151
Patented Jan. 27, 1959

2,871,151

ELECTRICAL CABLE

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Application March 7, 1956, Serial No. 570,192

1 Claim. (Cl. 154—2.24)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment of any royalty thereon.

The present invention relates to an insulated cable and one more particularly adapted for low-frequency, low-voltage, voice circuits. Many important advantages can be realized in terminal and transmission equipment from the use of physical 4-wire circuits in voice-frequency applications. Such advantages accrue principally from the ease of utilizing and controlling amplification in such circuits. However, it has been found in the past that one overriding disadvantage which has generally discouraged the universal use and adoption of 4-wire circuitry cable has been the associated increase in weight and bulk of such cables.

In the past, many known methods for insulating electrical conductors have been utilized, such as coatings of rubber, lacquer, or the winding of layers of cotton, silk, or other fibrous materials about the individual conductors. Conductors thus insulated may be wound into coils or in other forms with the adjacent turns of the conductors being insulated by means of the insulating coating. However, it has been found very difficult to reduce the volume occupied by the insulation in wound coils because of the inherent thickness of the insulation itself.

It is accordingly an object of this invention to provide a transmission cable particularly adapted for 4-wire voice-frequency applications of exceedingly small size wherein the thickness of the dielectric between the four conductors is likewise exceedingly small and less than provided in insulation of cable conductors heretofore provided.

An important feature of the present invention lies in a field cable capable of providing an electrically balanced, electrically stable 4-wire voice-frequency facility that will have very little or practically no increase in weight, bulk, and attenuation over presently designed 2-conductor cable.

Another important feature of the invention lies in the utilization of an insulating material and of a filler and jacket material having substantially the same dielectric constant thereby producing in effect a continuous dielectric insulation having excellent dielectric and high breakdown values.

The advantages, objectives, and features of such a lightweight, 4-wire cable as described above can be accomplished by the use of a new insulating material, monochlorotrifluoroethylene, in tape form which is spirally wound with successive turns in spaced relationship about the discrete or separate conductors and jacketing the assembly of the conductors and core about which such conductors are disposed, with a material such as polyethylene. The polyethylene fills the spaces not occupied by the insulating tape and further acts as a jointure of the tape turns as well as a bond between the tape and the conductors.

The invention can best be understood from the description hereinafter to be considered in view of the accompanying drawing in which:

Figure 1 is a greatly enlarged cross-sectional view of a preferred embodiment showing a 4-wire transmission facility;

Figure 2 shows the manner in which the insulating tape is applied to an individual conductor;

Figure 3 is a view taken on the line 3—3 of Figure 1, omitting the filler and jacket, and

Figure 4 is a view taken on the line 4—4 of Figure 1, also omitting the filler and jacket.

Referring to the drawings, the complete assembly is shown in Figure 1 showing a 4-wire transmission facility generally designated as **11**, comprising, in part, a core **13** which may be polyethylene string, or if more strength is desired may comprise a fiber glass cord. In the specific embodiment herein a 14-mil diameter string is approximately the proper size for the geometrical configuration of the resultant transmission facility. Disposed about the core **13** are the conductors shown at **15A**, **15B**, **15C**, and **15D**. Each of the conductors is a single, solid metal strand approximately 25 mils in diameter, and has wrapped about it an insulating material **17** such as monochlorotrifluoroethylene in exceedingly thin tape form. Such tape is approximately 5 mil in thickness and is wound about each of the conductors **15**, in the manner as shown in Fig. 2, so as to afford approximately 60 percent coverage over each of the said conductors. From the manner in which the insulation **17** is disposed about each of the conductors it can be readily seen that a plurality of interstices will occur between successive windings of the insulation about the conductor. The four wires and the core are then covered with a combined seal, filling, and jacket shown at **19**. It is preferred to use a material having substantially the same dielectric constant as that of the insulating tape and it has been found that polyethylene having a dielectric constant of 2.6 is substantially the same as that of the monochlorotrifluoroethylene tape thereby producing the resultant advantages set forth in the earlier part of this application.

Figures 1, 3 and 4 show the final configuration which the 4-wire transmission line of this invention assumes. The core **13** provides a center around which the four insulated conductors **15A**, **15B**, **15C**, **15D** are cable to form a star quad. The quad and the core are then jacketed with a single extrusion of polyethylene which fills all interstices and serves as a filler and jacket. In this regard attention is directed to Figures 1, 3 and 4, wherein the manner in which the insulating tape is applied to the conductors is shown. It can be seen that windings of the tape about the conductor **15B** is such that the windings thereon are so spaced relative to the winding on conductor **15A** that the windings on **15B** are in abutment with and overlap the interstices formed by the spaced windings on conductor **15A**. The same manner of winding is effected between adjacent conductors as shown in Figure 4. By this means it is apparent that each of the conductors will be completely insulated from each other and will be precisely spaced an exact and equal amount from each other to afford inductive and capacitive balance. By utilization of the techniques herein described and choice of the particular materials used, there has been devised a 4-wire transmission facility having an outside diameter of about 130 mils, which is considerably less than provided on transmission wires designed for the same purpose.

It will be recognized by those skilled in the art that the novel features of my invention do not stem from the exercise of mere mechanical skill in the design of a 4-wire transmission facility herein disclosed. What I have discovered is an entirely new approach to the design and construction of cable of exceedingly small diameter as heretofore described. This solution to the problem is characterized by the selection of a new, exceedingly thin,

tape form of insulation in combination with a jacket or cover of substantially the same dielectric constant.

What is claimed is:

The method of forming a star-quad cable including four conductors comprising spirally winding an insulating material in the form of a tape of approximately 5 mil thickness about each of said conductors in fixed spaced convolutions so that a series of interstices are formed between successive windings of said insulation, disposing said conductors about a core whereby the windings of insulation about any one conductor are in abutment with and overlap separate discrete interstices formed by the windings of a conductor immediately adjacent said one conductor and applying a filler and jacket of a material having a dielectric constant of 2.6, which is substantially the same as the insulation tape about said core and said conductors.

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