# United States Patent

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[54] **INSULATED CONDUCTOR FOR COMMUNICATION CABLE**
**2 Claims, 11 Drawing Figs.**


[52] **U.S. Cl.** ..... **174/124 R,** 174/113 R, 174/117 A
[51] **Int. Cl.** ..... **H01b 7/00**
[50] **Field of Search** ..... 174/110.2, 110, 113, 117, 117.11, 117.6, 121, 124



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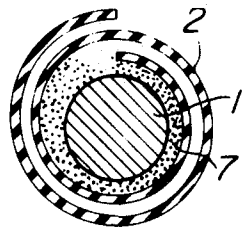
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*Attorney*—Craig, Antonelli, Stewart & Hill



**ABSTRACT:** A paper-insulated conductor for communication cables in which layers of insulating paper surrounding the conductor are bonded to each other or the insulating paper is bonded to the conductor by a bonding agent so that the insulated conductor can be inserted into an insertion connector without becoming loose, jointing work with a jointing tool can easily be carried out, and any short circuit will not occur between the conductors within the cable The insulated conductor has excellent electrical properties in spite of the use of the bonding agent

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SHEET 1 OF 2

FIG. 1

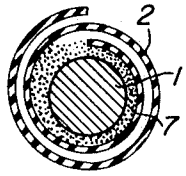



FIG. 3

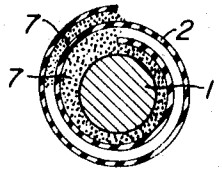



FIG. 2

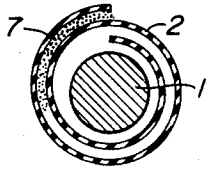



FIG. 4

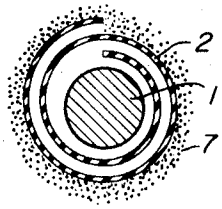



FIG. 5

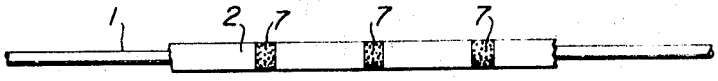



FIG. 6

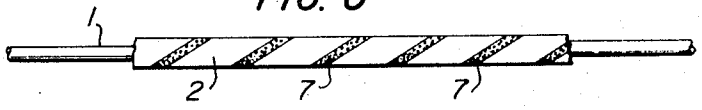



FIG. 7

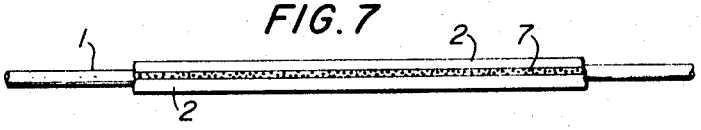
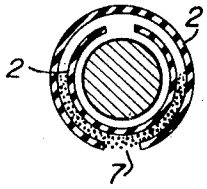



FIG. 8




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FIG. 9

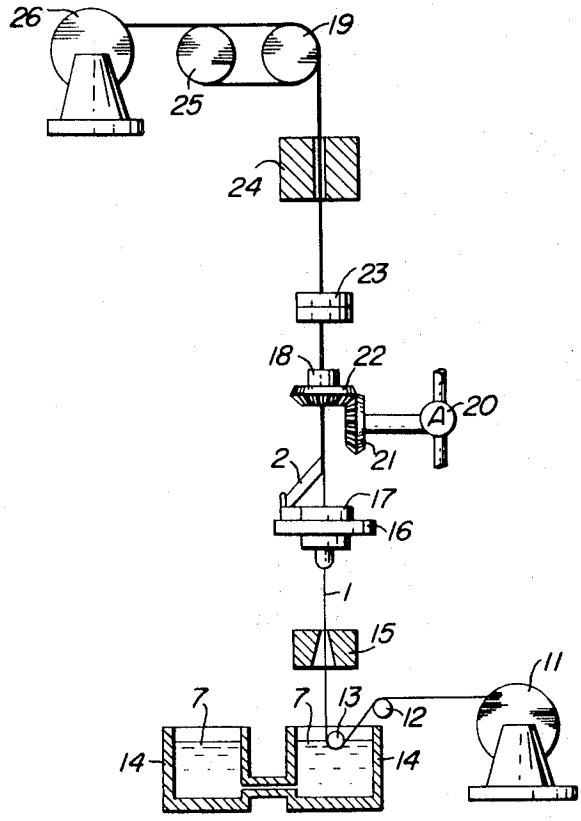



FIG. 10

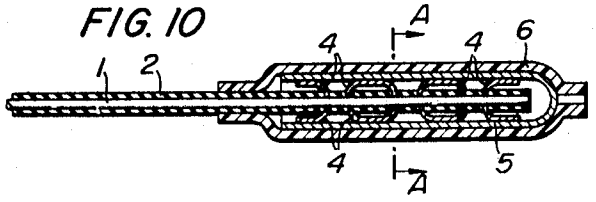
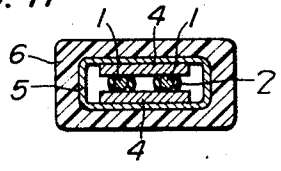



FIG. 11




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# INSULATED CONDUCTOR FOR COMMUNICATION CABLE

This invention relates to insulated conductors for use in communication cables, and more particularly to a paper-insulated conductor of novel structure which is free from undesirable unwinding (shiners) of the insulating paper surrounding the conductor and a method and apparatus for making the same.

Insulated conductors for use in communication cables employed heretofore in the field of communication generally comprise insulating paper which is helically wrapped around or longitudinally applied along the conductor.

However, the conventional insulated conductors of the kind described have had several defects. The first defect is encountered when the insulated conductors are connected with each other by use of an insertion connector. The second defect is encountered in connection with the use of a tool for connecting or branching work on the conductors. The third defect resides in the possibility of short circuiting between the insulated conductors within the cable.

Connecting work and branching work are necessarily required for conductors forming a communication cable so that the communication cable can be laid depending on the desired service, and for this reason, insulated conductors suitable for connecting and branching work are demanded. The connecting work between two conductors is generally effected by an insertion connector of a structure as shown in FIGS. **10** and **11** which is adapted to connect the conductors with each other without the need for stripping the insulating paper surrounding the conductors.

Two insulated conductors to be connected together each comprising a conductor **1** covered with an insulating paper **2** are inserted into the insertion connector from an insertion opening **3**. The insertion connector comprises a plurality of conductive strips **4** of a material such as phosphor bronze which have sharp end edges piercing through the insulating paper **2** to reach the conductor **1**, a brass shell **5** supporting these conductive strips **4**, and a plastic jacket **6** covering the brass shell **5**. After the two insulated conductors have been inserted into the insertion connector, the insertion connector is crushed by a force applied from above the plastic jacket **6** so that the conductive strips **4** pierce through the insulating papers **2** to contact the conductors **1** thereby to electrically connect the conductors **1** with each other. However, because of the fact that the conventional insulated conductors applied to such an insertion connector have merely a layer or layers of insulating paper helically wrapped around or longitudinally applied along the conductors, the insulating paper tends to become loose with the result that the insulating paper **2** unwound at the insertion opening **3** of the insertion connector can not enter the insertion connector leaving the conductor **1** in its bare state. As the unwinding of the insulating paper **2** extends further, the conductor portion at the outside of the insertion connector is exposed resulting in an undesirable short circuit between the conductors **1**.

The tendency of the insulating paper toward unwinding is further increased in case the insulating paper at the end portion of the cable is wetted by absorbing moisture. When the insulating paper is excessively unwound, another problem than that encountered with the insertion connector arises, that is, difficulty is encountered in stripping the insulating paper off the conductor by use of a jointing tool which is employed generally when a connection by means of the insertion connector is not resorted to.

Furthermore, the communication cable is wound around a drum for the sake of transportation and is in many cases placed under severe conditions during its laying. When the prior paper-insulated cable is subject to such severe conditions, the insulating paper is liable to unwind exposing the conductors resulting in an undesirable short circuit of the conductors with each other within the communication cable.

The present invention contemplates the provision of an insulated conductor for use in a communication cable which



overcomes the defects encountered with the prior art insulated conductor.

It is a first object of the present invention to provide an insulated conductor which is suitable for use with an insertion connector.

A second object of the present invention is to provide a paper-insulated conductor in which the insulating paper is free from unwinding and which facilitates splicing work with a jointing tool.

A third object of the present invention is to provide an insulated conductor of such a structure that short circuiting between insulated conductors does not take place within a communication cable.

A fourth object of the present invention is to provide an insulated conductor which has a reduced dielectric constant and a low transmission loss.

The above and other objects, features and advantages of the present invention will be apparent from the following detailed description of preferred embodiments thereof taken in conjunction with the accompanying drawings, in which:

FIGS. **1** through **4** are cross-sectional views of various forms of the insulated conductor according to the present invention, showing how layers of insulating paper are bonded together by a bonding agent applied to different portions of the insulated conductor;

FIGS. **5** through **7** are perspective views of the insulated conductor of the present invention shown in FIG. **4**, illustrating different methods of applying the bonding agent on the layers of insulating paper;

FIG. **8** is a cross-sectional view of another form of the insulated conductor according to the present invention;

FIG. **9** is a diagrammatic view of an apparatus for making the insulated conductor according to the present invention;

FIG. **10** is a cross-sectional view of an insertion connector; and

FIG. **11** is a sectional view taken on the line A—A in FIG. **10**.

Referring to FIG. **1**, there is shown one form of the insulated conductor according to the present invention which comprises a conductor **1**, layers of insulating paper **2** covering the conductor **1**, and a coat of a bonding agent **7** bonding the insulating paper **2** to the conductor **1**. The bonding agent **7** is preferably of the type including an emulsion of water-soluble material such as gum arabic or vinyl acetate. The present invention, however, does not in any way limit the bonding agent **7** to the materials specified above.

It is also preferable that the insulating paper **2** covers the conductor **1** in two layers at any part of the conductor **1**. Insulation with two layers of insulating paper **2** is advantageous in that the insulated conductor can be more effectively insulated than with a single layer and a considerable amount of air entrapped between the two layers of insulating paper **2** is effective to reduce an undesirable increase in the dielectric constant due to application of the bonding agent **7**.

Referring to FIG. **2**, there is shown another form of the insulated conductor which comprises a conductor **1**, two layers of insulating paper **2** covering the conductor **1**, and a coat of a bonding agent **7** which is solely applied to the outer marginal edge of the insulating paper **2** so as to bond the layers of insulating paper **2** to each other at that portion. In this case, a considerable amount of air can be entrapped between the conductor **1** and the inner layer of insulating paper **2** as well as between the outer and inner layers of insulating paper **2**, thereby preventing an undesirable increase in the dielectric constant.

The bonding agent **7** may be applied to the outer marginal edge of the insulating paper **2** by applying the bonding agent **7** to one of the marginal edges of the insulating paper **2** wound around a pad.

Referring to FIG. **3**, there is shown a further form of the insulated conductor which is actually a combination of the structure of the insulated conductor shown in FIG. **1** and the structure of the insulated conductor shown in FIG. **2**. The in-

sulated conductor shown in FIG. 3 comprises a conductor 1, two layers of insulating paper 2 covering the conductor 1, and two coats of a bonding agent 7, one coat being applied between the conductor 1 and the inner layer of insulating paper 2, while the other coat is being applied to the outer marginal edge of the insulating paper 2.

In this embodiment, the amount of application of the bonding agent 7 must be limited to a minimum in order to avoid an undesirable increase in the dielectric constant. However, the effect of bonding is so excellent that the problem of unwinding of the insulating paper 2 resulting in the difficulty of connection by means of the insertion connector would not arise even if the insulating paper 2 at the end portion of the communication cable might be wetted to some extent by absorbing moisture.

Another form of the insulated conductor shown in FIG. 4 comprises a conductor 1, layers of insulating paper 2 which are helically wrapped around the conductor 1 with a certain pitch, and a coat of a bonding agent 7 applied from above the upper layer of insulating paper 2 so that the insulating paper 2 can be impregnated with the bonding agent 7.

FIGS. 5 through 7 illustrate a few practical examples of applying a bonding agent 7 to obtain an insulated conductor as shown in FIG. 4. Referring to FIG. 5, a series of spaced annular coats of a bonding agent 7 are applied on insulating paper 2 covering a conductor 1 to obtain an insulated conductor. Referring to FIG. 6, a helical coat of a bonding agent 7 is applied on insulating paper 2 covering a conductor 1 to obtain an insulated conductor. Referring to FIG. 7, a straight coat of a bonding agent 7 is applied on insulating paper 2 covering a conductor 1 to obtain an insulated conductor.

A portion of the bonding agent 7 thus applied on the insulating paper 2 infiltrates through the upper layer of insulating paper 2 to reach the lower layer thereof or flows through the marginal end edge of the upper layer of insulating paper 2 to enter the interface between the layers to bond the layers of insulating paper 2 to each other. It is to be understood, however, that the method of application according to the present invention is in no way limited to those specified above and the bonding agent 7 may be applied to the entire surface of the insulating paper 2 if it is allowable in respect of the electrical properties of the product.

Referring to FIG. 8, there is shown another form of the insulated conductor which comprises a conductor 1, two webs of insulating paper 2 longitudinally applied along the conductor 1, and a longitudinal coat of a bonding agent 7 applied between the webs of insulating paper 2 for bonding them to each other. In this embodiment, the abutting marginal edges of the insulating paper 2 in the inner layer must be covered with the overlying layer of the insulating paper 2. This structure is important in order to avoid short circuit between the conductors within a communication cable.

FIG. 9 shows diagrammatically an apparatus preferably employed for making the insulated conductor according to the present invention.

A conductor 1 is supplied from a supply stand 11 and is guided past guide rolls 12 and 13 so that a bonding agent 7 contained in an applicator means 14 is applied to the conductor 1. After having been applied with the bonding agent 7, the conductor 1 is passed through a squeezing die 15 to adjust the amount of the bonding agent 7 applied to the conductor 1. The conductor 1 from which any excess of the bonding agent 7 is removed by the action of the squeezing die 15 is then passed through the central perforation of a flyer 16 and through the central perforation of a tape pad 17 carrying a roll of insulating paper 2 thereon and is advanced to an insulating paper wrapping station so that the insulating paper 2 can be wrapped around the conductor 1 and bonded to the conductor 1 by the bonding agent 7.

More precisely, the flyer 16 rotates in interlocked relation with a capstan 19 and is operative to wrap the insulating paper 2 around the conductor 1 at a level beneath a die 18 which rotates in a direction opposite to the direction of rotation of the flyer 16. The rotation of the die 18 in the above direction is caused by a motor 20 through gears 21 and 22 so that the insulating paper 2 wrapped around the conductor 1 can be bonded satisfactorily to the conductor 1. However, the rotation of the die 18 in the direction opposite to the rotating direction of the flyer 16 is not an absolute requirement, and the die 18 may be held stationary or rotated in the same direction as the rotating direction of the flyer 16 to attain the desired purpose. When the insulating paper 2 on the tape pad 17 is exhausted, the die 18 may be removed and a roll of insulating paper in a stock of insulating paper 23 disposed above the die 18 may be brought downward for the wrapping operation.

The conductor 1 thus covered with the insulating paper 2 is passed through a heating die 24 so that heat applied thereto adds an increased degree of shape to the product, ensures a good bond between the conductor 1 and the insulating paper 2, adjusts the outside diameter of the product to the desired dimension and effects complete drying of the product. The thus completely finished insulated conductor is taken up on a takeup means 26 while being measured in its length by a metering means 25.

While the above description has referred to an apparatus which is adapted to make the insulated conductor of the structure shown in FIG. 1, it will be understood that the apparatus may suitably be modified so that it can make an insulated conductor of difficult structure as shown in FIGS. 2, 3, 4 and 8.

For example, the insulated conductor shown in FIG. 2 in which a bonding agent is applied to the outer marginal edge of insulating paper can easily be made by the apparatus shown in FIG. 9. In such a case, the applicator means 14 and the squeezing die 15 are eliminated and a suitable means is provided to apply a bonding agent to one of the marginal edges of the insulating paper 2 wound around the tape pad 17.

In another method for making the insulated conductor, the conductor 1 is not immersed in the applicator means 14 and a roll for applying the bonding agent is provided. According to this method, the lower part of the roll is immersed in the applicator means 14 and the conductor is guided past the upper part of the roll. A brush or like means disposed above the run of the conductor is used to force the conductor onto the roll and the roll is rotated to apply the bonding agent to the conductor.

From the foregoing description, it will be appreciated that the insulated conductor in which the insulating paper is prevented from becoming loose by means of the bonding agent according to the present invention attains the objects described previously and overcomes the prior defects.

While a few embodiments of the present invention have been described above by way of example, it will be understood that the present invention is in no way limited to such specific embodiments and many changes and modifications may be made therein without departing from the scope of the technical contents disclosed herein.

What is claimed is:

1. An insulated conductor for communication cables comprising a conductor, an insulating paper wrapped in two layers around said conductor, and a bonding agent between the inner layer of said insulating paper and said conductor bonding said inner layer to said conductor wherein the inner layer and the outer layer are not bonded by a bonding agent.

2. An insulated conductor for communication cables comprising a conductor of a round cross section, an insulating paper wrapped in two layers, inner and outer, around said conductor and a bonding agent applied only between said inner layer of said insulating paper and said conductor of a round cross section, wherein said inner layer of said insulating paper is bonded to said conductor by said bonding agent and said inner and outer layers of said insulating paper are not bonded to each other.

* * * * *