United States Patent

Tatum et al.

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[54] **WOVEN CABLE WITH OPPOSITELY-TWISTED CONDUCTOR GROUPS AND FLUID TUBES**

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[52] **U.S. Cl.** ....**174/47**, 174/27, 174/34, 174/117 F

[51] **Int. Cl.** **F16l 11/12**, H01b 7/08, H01b 11/02

[58] **Field of Search** ....174/15 C, 27, 32, 34, 47, 72 TR, 174/103, 113 R, 117 R, 117 F, 117 M

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[57] **ABSTRACT**

A woven cable including two bundles of twisted insulated wires. The wires in the two bundles are twisted in opposite directions. The bundles are bound together in side-by-side relationship by means of warp and weft threads. Two hollow flexible plastic tubes are bound together with the wire bundles in order to form a cable which carries both electrical signals and fluids for use in fluid-pressure controlled systems. The reverse twisting of the wires in the bundles prevents the cable from curling or becoming distorted into other undesirable shapes.

10 Claims, 4 Drawing Figures

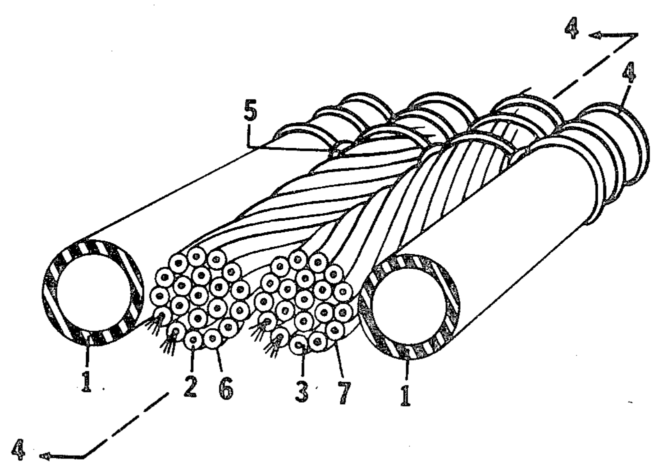

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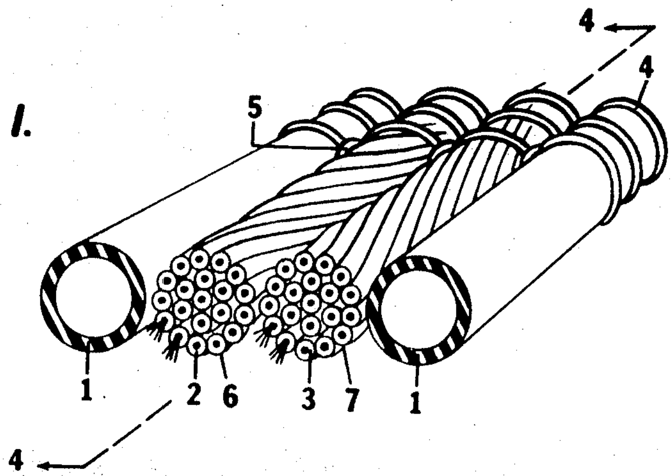
FIG. 1.



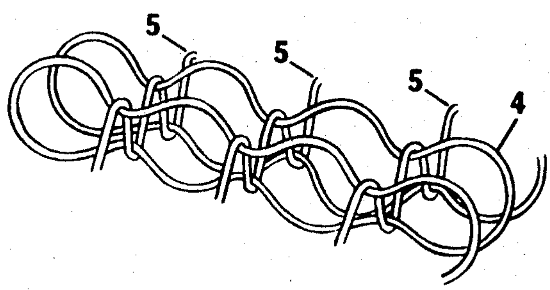


FIG. 2.

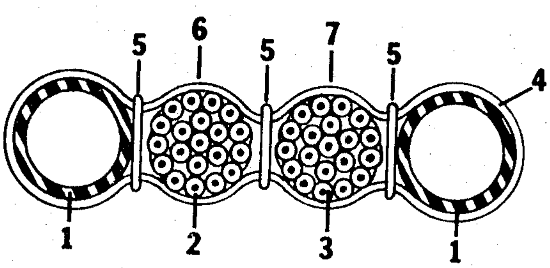


FIG. 3.

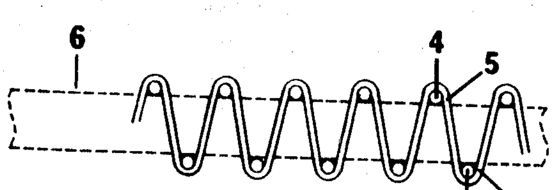


FIG. 4.

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WOVEN CABLE WITH OPPOSITELY-TWISTED CONDUCTOR GROUPS AND FLUID TUBES

The present invention relates to electrical cables, and particularly to woven electrical cables.

A principal object of the present invention is to provide a highly flexible electrical cable with a relatively large number of conductors. Another object of the invention is to provide such a cable which has a relatively flat configuration and retains that configuration without curling or distortion. A further object is to provide a relatively flat, flexible electrical and fluidic cable for carrying electrical signals and fluids.

The foregoing objects are met, in accordance with the present invention, by the provision of an electrical cable with a plurality of bundles of conductors aligned side-by-side with one another. The conductors in one bundle are twisted in one direction, and the conductors in the other bundle are twisted in the opposite direction. The bundles then are preferably bound together by woven warp and weft threads. The twisting of the bundles in opposite directions prevents the cable from becoming distorted due to the twisting of the wires.

The foregoing and other objects and advantages of the invention will be described in or apparent from the following description and drawings.

In the drawings:

FIG. 1 is a perspective, cross-sectional view of the preferred embodiment of the present invention;

FIG. 2 is a perspective view of the woven threads binding together the elements of the cable shown in FIG. 1;

FIG. 3 is a cross-sectional view of the cable shown in FIG. 1; and

FIG. 4 is a partially schematic cross-sectional view taken along line 4—4 of FIG. 1.

The cable shown in FIGS. 1 through 4 includes two bundles 6 and 7 of insulated wires 2 and 3, and a pair of flexible plastic tubes 1. The wires 2 and 3 in the bundles 6 and 7 are twisted together so that the bundles have a substantially cylindrical form. The tubes and the bundles 6 and 7 are aligned parallel to one another with the tubes on the outside edges of the cable.

As is shown most clearly in FIGS. 2, 3 and 4, the tubes and bundles are bound together by a weft thread 4 which is wound in a spiral pattern, and three warp threads 5 which are woven in a basket-weave pattern over and under the weft thread segments. One warp thread is located in the space between the bundles 6 and 7, and the other threads are located in the spaces between the bundles and the tube. The warp threads 5 bind and hold the weft thread 4 tightly against the tubes and wire bundles so as to hold them together. The diameters of the tubes and bundles are substantially equal, and the cable is relatively flat.

In accordance with one particularly advantageous feature of the present invention, the direction in which the wires in the bundles 6 and 7 are twisted are opposite to one another. For example, the wires in the bundle 7 are twisted in a clockwise direction, whereas the wires in the bundle 6 are twisted in a counter-clockwise direction. The amount of twist given to each bundle is approximately the same.

An advantage of this arrangement is that a relatively large number of conductors are provided in the two bundles, and yet the cable assembly is relatively flexible in the flat direction; that is, in the vertical direction as shown in FIG. 1. Furthermore, the wires are twisted into bundles so as to form a cable relatively simply and at a relatively low cost. Were it not for the reverse twist given to adjacent bundles 6 and 7, the cable might curl or become distorted. However, the reverse twist prevents such distortion and gives the cable a relatively flat configuration. Additionally, the cable shown in FIG. 1 is relatively inflexible in the horizontal or lateral direction, so that it can be mounted so as to stand up on edge, if desired.

It is believed that the use of the reverse twist principle balances the tortional restorative forces in the two bundles of

wires against one another so that there is no net tortional force in the cable to cause curling or distortion. The woven binding structure helps in balancing the restorative forces.

The wires 2 and 3 in the bundles 6 and 7 preferably are stranded for greater flexibility. However, they can be solid conductors, if desired. The insulation on the wires can be virtually any insulation desired, such as polyvinylchloride, for example.

The tubes 1 preferably are capable of carrying fluids such as air or liquid for fluidic control systems. The tubes can be made of any suitable plastic material. For example, the tubes can be made of polyvinylchloride with a nylon or steel braid imbedded in the plastic for greater strength to withstand fluid pressures. Thus, the finished cable as shown in FIG. 1 will carry both electrical currents and pressurized fluids for operation of equipment such as numerically-controlled machine tools, automatic window opening systems for automobiles, etc.

The warp and weft threads 5 and 4 preferably are made of synthetic fibers such as nylon or polyester. However, natural fibers also can be used.

The above description of the invention is intended to be illustrative and not limiting. Various changes or modifications in the embodiments described may occur to those skilled in the art and these can be made without departing from the spirit or scope of the invention.

We claim:

1. A woven electrical cable comprising, in combination, a plurality of groups of conductors, the conductors of each group being covered by electrical insulation and twisted together, said groups being aligned side-by-side with one another, the directions of twisting of adjacent ones of said groups being opposite, and warp and weft threads binding said groups of conductors together.

2. A cable as in claim 1 in which each of said groups is substantially cylindrical and including at least one tube bound together in side-by-side relationship with said groups of conductors.

3. A cable as in claim 1 in which there is one weft thread which is wrapped around said groups of conductors in a spiral pattern, and in which said warp threads pass over and under said weft thread in the spaces between said groups.

4. A woven cable comprising a plurality of bundles of insulated wires, the wires in each bundle being twisted together to give the bundle a substantially cylindrical form, said bundles being aligned parallel to and side-by-side one another, insulating warp and weft threads woven together and binding said bundles together to form a cable, the wires in adjacent bundles being twisted in opposite directions.

5. A woven cable as in claim 4 including at least one elongated tubular member aligned parallel to and bound together with said bundles.

6. A woven cable as in claim 5 including two of said tubular members, one at each edge of said cable, each of said tubular members being fluid-tight.

7. Electrical cable comprising a plurality of bundles of insulated wires, said bundles being aligned side-by-side with one another, the wires in adjacent ones of said bundles being twisted in opposite directions, and a woven network of insulating threads binding said bundles together to form a cable.

8. A cable as in claim 7 including a plurality of flexible, fluid-tight tubes bound together in side-by-side relationship with said bundles.

9. A cable as in claim 8 in which there are two of said bundles and two of said tubes, with the tubes located on opposite sides of said bundles.

10. A cable as in claim 7 in which said threads include a single weft thread wound spirally around said bundles and at least one warp thread woven with said weft thread in a basket-weave pattern in the space between said bundles.

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