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Madle

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[54] FLEXIBLE CABLE SHIELDING

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[51] **Int. Cl.**.....**H01b 7/18**

[58] **Field of Search**.....174/107, 36, 102 R, 110 FC, 174/110 S, 110 AR, 115, 117 M, 27, 108, 113 R

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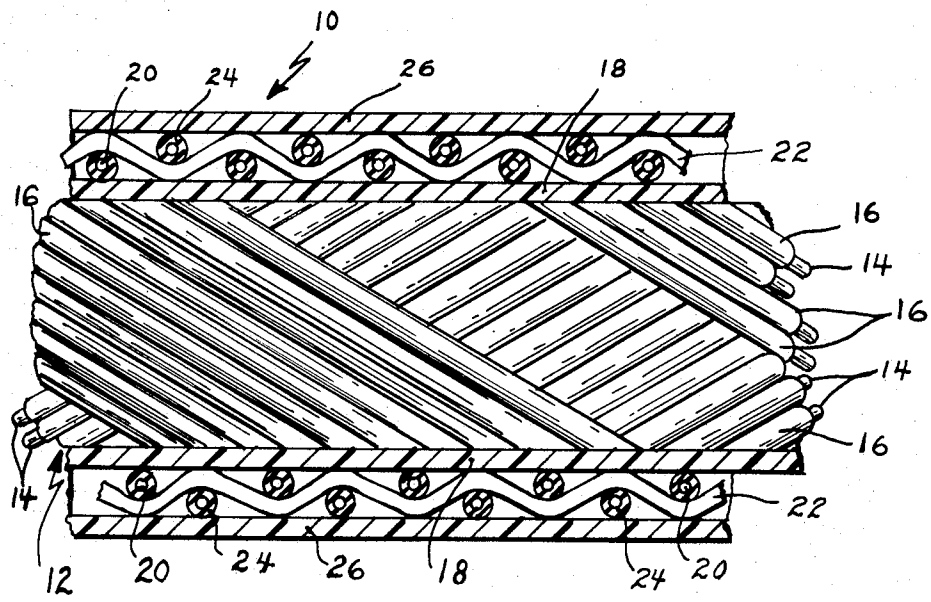
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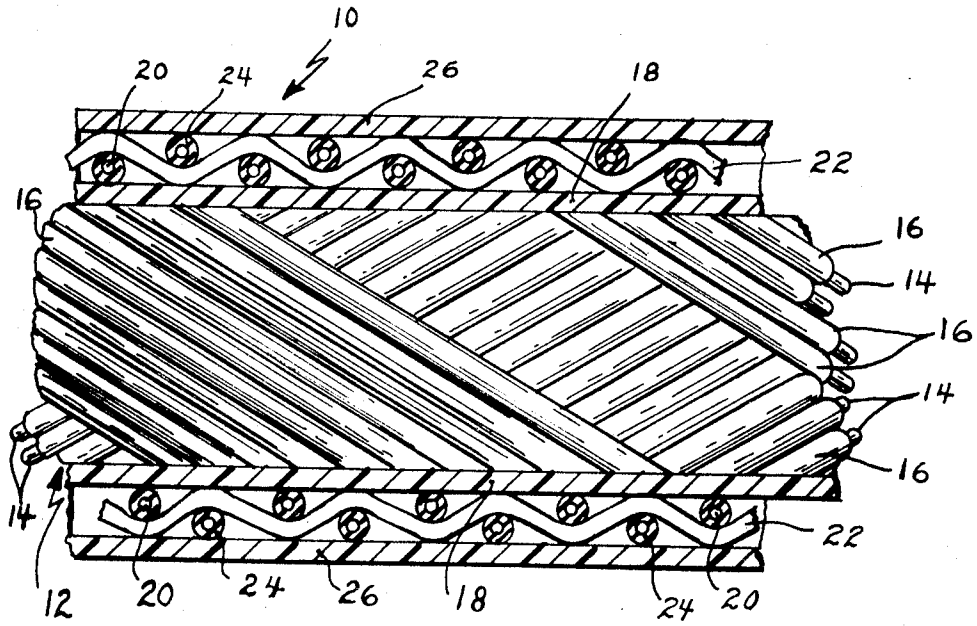
[57] **ABSTRACT**

In a shielded multiple-conductor cable, a shield comprising parallel, longitudinal, convoluted wires symmetrically disposed around the conductor bundle, where the convoluted shield shape is maintained by means of inner and outer tie wraps.

8 Claims, 1 Drawing Figure



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FLEXIBLE CABLE SHIELDING

BACKGROUND OF THE INVENTION

This invention relates generally to electrical cable shielding and more particularly to an improved flexible electrical cable shielding. Large missiles have a need for multiple-conductor cables following complex three-dimensional routes and having connectors at the ends of many branches. These cables must provide a high degree of isolation or shielding between the conductors and outside environment.

Heretofore, such shielding has usually been obtained either through the use of convoluted metallic pipe or by an overbraid of woven wires. These prior art devices are limited in their ability to provide torsional flexibility, thereby causing difficulty where more than one area of design is considered. Thus, if a shielded cable is designed for ease of installation then experience has shown that the cable may be prone to excessive mechanical failure due to repeated torsional stress.

One of the major limitations found in the overbraid type of shielding is the inflexibility caused by the requirements for several layers of tightly woven wire merely to meet the shielding requirements of missile use. In order to attain an idealized cable, several factors must be considered. The overall dominating factor is the shielding effect of the cable. Shielding is determined by considering the skin depth. A skin depth is defined as that distance below the surface of a conductor where the current density has diminished to e^{-1} of its value at the surface.

The shielding attenuation achieved by a homogeneous conductive sheet surrounding the conductor bundle, is a function of the thickness of the conductive sheet expressed in the number of skin depths.

A second consideration taken with regard to the shielding factor is the magnetic coupling that occurs between the current in the shield material and the conductor bundle whenever the shield current is not perfectly symmetrically disposed around the periphery of the shield. Similarly, a capacitative coupling occurs between the shield-current carrying path and the conductor bundle whenever the shield-current passes through a series impedance, regardless of the symmetry or lack thereof. Frequently, mechanically joined surfaces in series with the shield current path having milli or microhm impedances can cause significant energy coupling due solely to the surface contact resistance of metals so joined even when steps have been taken to avoid this situation. Since cables are generally long and relatively thin and are equipped with heavy connectors at multiple branch-ends and must be installed on missiles in contorted and confined spaces, certain mechanical properties are of prime importance in providing an improved cable. These mechanical properties include bending flexibility, torsional flexibility, extensibility, tear strength, kind kink and abrasion resistance. If a cable cannot provide these characteristics, it would lack the properties needed for missiles and would not be an improvement over the prior art.

Possibly the most difficult problem to compensate for in establishing an improved shielded cable is that of fatigue or work hardening caused by the low frequency, large amplitude portions of the vibration and shock environment. A cable structure would then, have to be inherently relatively inextensible under vibration or shock induced tension.

SUMMARY OF THE INVENTION

The shield of the invention utilizes a large number of longitudinal, uninsulated, untwisted, parallel, wires extending the length of a cable assembly and symmetrically disposed around the periphery of the conductor bundle. The invention minimizes the longitudinal impedance of the shield wires themselves as well as eliminates all longitudinal joints except those between the wires and the connector backshells at the ends of the cable.

The longitudinal wires are so arranged around the conductor bundle that they touch each other thereby allowing the shield current to distribute itself symmetrically around the periphery of the cable. Multiple layers of longitudinal wires could be used to vary the thickness of the shield and hence the shielding attenuation factor.

By placing an overcovering around the outside of the shield the invention has relatively high torsional flexibility, in that the overcovering will allow for a slight sliding movement between adjacent wires. To improve the bending flexibility the parallel bundle of wires are convoluted in a manner analogous to that used for convoluted pipes or bellows. The wires are convoluted by the use of tie wraps used under and over each layer of wire causing it to assume a sine wave shape along its longitudinal axis. To provide length stability, the conductor bundle is layed up in a contra-helical fashion such that tensile forces tend to produce equal and opposing torsions resulting in longitudinal stiffness.

It is therefore an object to provide a new and improved cable shield that will increase the overall reliability of shielded cables.

It is another object of the invention to provide a new and improved cable shield that has improved stability of performance during installation, transportation and flight compared with those presently in existence.

It is a further object of the invention to provide a new and improved cable shield that will be economical to produce.

It is still another object of the invention to provide a new and improved cable shielding that is mechanically independent of the shielding design factors.

It is still a further object of the invention to provide a shielded cable that is more flexible than any hitherto known.

It is another object of the invention to provide an electrical cable shield that is relatively uneffected by magnetic and capacitative coupling.

It is another object of the invention to provide an electrically shielded cable that is resistant to kinking and snagging.

It is another object of the invention to provide an electrical cable that has a low degree of linear extensibility.

These and other advantages, features and objects of the invention will become more apparent from the following description taken in connection with the illustrative embodiment in the accompanying drawing.

DESCRIPTION OF THE DRAWING

The FIGURE is a side elevational view partly in section of the invention.

DESCRIPTION OF PREFERRED EMBODIMENT

Referring now to the FIGURE, the electrical cable and shielding are shown generally at **10**. The cable conductor bundle is shown generally at **12** and is formed from stranded copper conductors **14** insulated with a low coefficient of friction resilient insulation **16**, for example Teflon, to allow the relative sliding motions necessary for both bending and torsion.

The inner jacket **18** consists of a relatively loose Teflon spiral wrap having two layers, overlapped and having no bond therebetween. This layer provides good electrical insulation between the conductor bundle and the shield under severe external loads, such as crushing or local impact, while not restricting the sliding motions necessary for bending or torsion.

The inner tie wraps **20** are placed in a wide spaced spiral wrap and are formed of a continuous rubber or rubber like hollow pipe. The inner tie wrap is placed directly upon the inner jacket **18**.

The shield **22** is symmetrical disposition of wires around the inner jacket. Where the conductor bundle has a diameter of 1 inch, for example, approximately 1,000 ends of number 30 AWG bare conductive shield wire would be sufficient for most shielding purposes. This would be the equivalent of three wires radial thickness all around a 1 inch diameter conductor bundle. The outer tie wrap **24** is a wide spaced spiral wrap of

hollow rubber pipe identical with that utilized for the inner tie wrap **20**. This wrap should be of the same hand and centered between turns of the inner tie wrap. The wrap is applied over the shield wires **22** with minimum tension so as to avoid either flattening or ovaling of either itself or the inner tie wrap.

The inner and outer tie wraps lightly grip the shield wires at intervals along the cable length when the cable is straight. As the cable is bent the wraps "flatten" or "oval" thereby allowing the shield wires on the outside of the cable bend to effectively lengthen. The shield wires remain free to slide relative to each other, in the portions of their lengths between the inner and outer tie wraps, when the cable is under torsional force.

The outer jacket **26** is abrasion resistant and highly resillent and may be formed from at least two overlapped and bonded layers of silicon rubber tape and adhesive. The outer jacket may be increased in thickness by the addition of wrap layers as necessary for thermal protection of the shield and conductor bundle.

As may be clearly seen, the mechanical and shielding properties of such construction are interrelated but the general design is such that a sufficient number of details may be varied to meet a broad range of requirements for bending flexibility, torsional flexibility, shielding attenuation, thermal insulation and abrasion resistance.

I claim:

1. A shielded multiple-conductor cable comprising: a plurality of insulated wires forming a conductor bundle and wound in a contra-helical direction; a first layer of insulative material wrapped around the conductive bundle; a first tie wrap, wound in a spaced spiral around the conductor bundle and overlying the insulative layer; a plurality of closely spaced, uninsulated, untwisted, parallel wires extending along the longitudinal axis of the cable overlying the first tie wrap; a second tie wrap, wound in a spaced spiral around the wires and positioned alternately of the first tie wrap; and a second layer of abrasion resistant insulative material providing a covering for the shield and conductor bundle.

2. A shielded multiple-conductor cable comprising:

a plurality of insulated wires forming a conductor bundle and wound in a contra-helical direction;

a first layer of insulative material wrapped around the conductive bundle;

a first tie wrap wound in a spaced spiral around the conductor bundle and overlying the insulative layer; and

a plurality of closely spaced, uninsulated wires extending along the longitudinal axis of the cable overlying the first tie wrap, wound in a spaced spiral around the wires and positioned alternately of the first tie wrap.

3. A cable as claimed in claim **2** wherein said plurality of closely spaced wires are untwisted.

4. A cable as claimed in claim **2** wherein said plurality of closely spaced wires are parallel.

5. A cable as claimed in claim **2** wherein said plurality of closely spaced wires are untwisted and parallel.

6. A cable as claimed in claim **2** and further including:

a second layer of abrasion resistant insulative material providing a covering for the shield and conductor bundle.

7. A cable as claimed in claim **2** and further including:

a second layer of thermally insulating material providing a covering for the shield and conductor bundle.

8. A cable as claimed in claim **2** and further including:

a second layer of thermally insulating and abrasion resistant insulative material providing a covering for the shield and conductor bundle.

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