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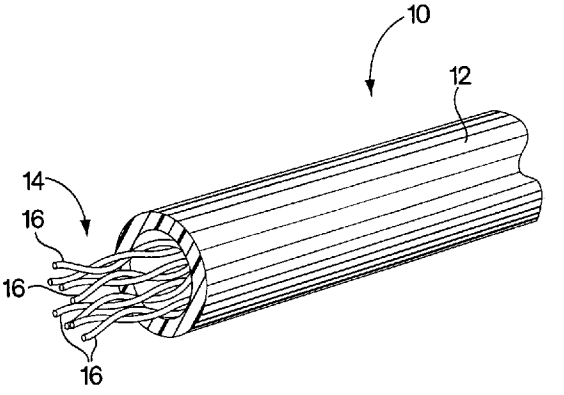
(54) **CABLE DE TELECOMMUNICATION**
(54) **TELECOMMUNICATIONS CABLE**



(57) Câble de télécommunication pouvant être placé dans les caissons de mélange de bâtiments, dont l'âme est constituée de conducteurs électriques entourés chacun de matériau cellulaire ignifuge puis d'une couche de matériau à faible dégagement de fumée. L'ensemble des conducteurs formant l'âme du câble est entouré d'une enveloppe de matériau à faible dégagement de fumée. La couche interne de matériau cellulaire confère au câble des propriétés électriques, notamment une constante diélectrique, qui le rendent propre à des applications haute fréquence.

(57) A telecommunications cable suitable for application in building air plenum chambers includes a core of electrical conductors, each electrical conductor surrounded by a cellular fire retardant material surrounded by an outer layer of low smoke generating material. The entire core is surrounded by a jacket of low smoke generating material. The use of a cellular inner layer results in electrical characteristics including dielectric constant values suitable for high frequency communications applications.

ABSTRACT

A telecommunications cable suitable for application in building air plenum chambers includes a core of electrical conductors, each electrical conductor surrounded by a cellular fire retardant material surrounded by an outer layer of low smoke generating material. The entire core is surrounded by a jacket of low smoke generating material. The use of a cellular inner layer results in electrical characteristics including dielectric constant values suitable for high frequency communications applications.

TELECOMMUNICATIONS CABLE

BACKGROUND

1. Field of the Invention

This invention relates to telecommunications cable. More particularly, the invention relates to the materials and construction of data grade telecommunications cables for plenum use complying with the electrical standards of Electronic Industries Association/Telecommunication Industries Association, EIA/TIA-568A.

2. Related Art

In building design, many precautions are taken to resist the spread of flame and the generation of and spread of smoke throughout a building in case of an outbreak of fire. Clearly, it is desired to protect against loss of life and also to minimize the costs of a fire due to the destruction of electrical and other equipment. Therefore, wires and cables for in building installations are required to comply with the various flammability requirements of the National Electrical Code (NEC) and/or the Canadian Electrical Code (CEC).

Cables intended for installation in the air handling spaces (ie. plenums, ducts, etc.) of buildings are specifically required by NEC or CEC to pass the flame test specified by Underwriters Laboratories Inc. (UL), UL-910, or it's Canadian Standards Association (CSA) equivalent, the FT6. The UL-910 and the FT6 represent the top of the fire rating hierarchy established by the NEC and CEC respectively. Cables possessing this rating, generically known as "plenum" or "plenum rated", may be substituted for cables having a lower rating (ie. CMR, CM, CMX, FT4, FT1 or their equivalents), while lower rated cables may not be used where planum rated cable is required.

Cables conforming to NEC or CEC requirements are characterized as possessing superior resistance to ignitability, greater resistant to contribute to flame spread and generate lower levels of smoke during fires than cables having a lower fire rating. Conventional designs of data grade telecommunications cables for installation in plenum chambers have a low smoke generating jacket material, e.g. of a PVC formulation or a fluoropolymer material, surrounding a core of twisted conductor pairs, each conductor individually insulated with a fluorinated ethylene propylene (FEP) insulation layer. Cable produced as described above satisfies recognized

plenum test requirements such as the "peak smoke" and "average smoke" requirements of the Underwriters Laboratories, Inc., UL910 Steiner test and/or Canadian Standards Association CSA-FT6 (Plenum Flame Test) while also achieving desired electrical performance in accordance with EIA/TIA-568A for high frequency signal transmission.

While the above-described conventional cable meets all of the above design criteria, the use of fluorinated ethylene propylene is extremely expensive and may account for up to 60% of the cost of a cable designed for plenum usage.

An alternate design employs a core of dual insulated conductors, where each conductor has an inner layer of solid flame retardant/smoke suppressed polyolefin and an outer layer of FEP. U.S. Patent Application No. 08/261,073, entitled "Telecommunications Cable", filed June 16, 1994, pending and incorporated herein by reference, describes such a structure. Solid flame retardant/smoke suppressed polyolefin compounds commercially available all possess dielectric properties inferior to that of FEP. In addition, they also exhibit inferior resistance to burning and generally produce more smoke than FEP under burning conditions than FEP.

The cable of the above-referenced patent application has been found to be suitable for in-plenum chamber usage despite the use of a flame retardant polyolefin in the structure. Such a material had previously been considered unsuitable for plenum chamber usage because of its known characteristic of generating opaque smoke during a fire. As referred to, however, in the above-mentioned application, the fluorinated ethylene propylene layer in its flame spread resistant function as an outer layer, is sufficiently protective of the fire resistant polyolefin that flame contact with the flame retardant polyolefin and flame spread along the flame retardant polyolefin is dampened to such a degree that little or no opaque smoke is generated. Thus, in the cable structure described and claimed in the aforementioned patent, while fluorinated ethylene propylene is relied upon for its flame spread resistant function, it also provides damping for the inner layer so as to minimize the opaque smoke which is generated. The quantity of the fluorinated ethylene propylene is significantly reduced compared to conventional plenum chamber constructions. As fluorinated ethylene propylene is an extremely expensive material, the manufacture of the cable of the aforementioned application for plenum usage is remarkably reduced in cost.

While the structure described and claimed in the aforementioned application produces a valuable result which is less costly than previous constructions for plenum cable usage, nevertheless it would be advantageous to further reduce the cost of plenum cable while

producing comparable electrical, fire retardant and opaque smoke retardant characteristics.

SUMMARY OF THE INVENTION

According to the present invention there is provided a telecommunications cable having a cable core comprising a plurality of electrical conductors each individually insulated with a dual layer of insulation having an inner layer of a cellular, i.e. foamed, flame retardant first material, e.g., polyolefin, and an outer layer of a second material, e.g. fluorinated ethylene propylene, surrounding the inner layer, the core being provided within a jacket of low smoke generating material. The relative thickness of the first and second materials are selected to provide a desired dielectric constant.

Foaming the inner insulation layer offers several advantages. The foamed structure exhibits a superior dielectric constant relative to the non-foamed form of the same insulating material. With a cell structure of approximately 20% volumetric expansion, the dielectric constant of foamed polyolefin is essentially the same as that of FEP. In addition, the foam provides less smoke-producing fuel in a fire. As such, the dielectric constant and the flammability/smoke characteristics of the dual insulation are less dependant on the properties of the FEP layer, thus permitting a reduction in the thickness of the FEP layer. For example, at about 34% expanded foam, a 24 AWG conductor may be insulated with a 3.8 mil inner layer of this foam and have an outer layer of FEP only 2.6 mil thick. This combination satisfies the transmission characteristics required by EIA/TIA-568. This combination also represents a 38% reduction in the volume of FEP required for the inventive structure relative to that of the aforementioned patent application. As FEP is significantly more expensive than the flame retardant/smoke suppressed polyolefin, this represents a significant cost improvement for the insulated conductors.

Foaming of the flame retardant/smoke suppressed polyolefin inner layer also permits using a material possessing an inferior dielectric constant and inferior smoke/flammability characteristics such as ethylene chlortrifluoroethylene. For example, a cable constructed with an inner layer at 3.8 mils thickness, a percent expansion of approximately 40% and an outer E-CTFE layer at 2.3 mils will satisfy the TIA/EIA-568 requirements.

With the above cable according to the invention there is the advantage that the amount of flame retardant polyolefin is immediately reduced while enabling the production of a cable

having the required electrical, transmission, attenuation and impedance characteristics required for telecommunications cables while also reducing the source for the possible generation of opaque smoke. In addition to this, the amount of fluorinated ethylene propylene may also be minimized, i.e. below that required for a cable of the aforementioned application. This is at least partly because the quantity of flame retardant polyolefin available to produce opaque smoke is reduced and therefore less fluorinated ethylene propylene is required for damping out the opaque smoke which is indeed generated. All of the above reductions in the quantities of insulating materials, particularly the reduction in the use of fluorinated ethylene propylene, is accompanied by an attendant reduction in the manufacturing cost of the cable.

In addition, as the cellular layer includes localized air spaces as in a normal cellular insulating layer construction, the total thickness of the two insulation layers may be reduced while obtaining the required transmission parameters, attenuation and impedance in the construction. For instance, when using a 24 AWG conductor, suitable transmission parameters attenuation and impedance for a telecommunications cable are obtained using a 3.8 mil thickness inner layer having a cell volume of approximately 34% of the total volume of the inner layer, and also using a 2.6 mil outer layer of the fluorinated ethylene propylene.

By using the above construction, the volume of the fluorinated ethylene propylene is reduced by approximately 38% compared with the volume of fluorinated ethylene propylene which would be required by a construction having a non-cellular inner layer of 3.5 mils surrounded by an outer of 4 mils of fluorinated ethylene propylene. This latter construction yields comparable electrical and transmission requirements to those of the cellular inner layer construction of embodiments of the invention.

Furthermore, where a cellular inner layer of flame retardant polyolefin is used, it has been discovered that by providing the cable core with a surrounding jacket of a low smoke generating material, such as polyvinyl chloride compounds or a fluoropolymer material, the fluorinated ethylene propylene outer layer may be replaced with a different material which may have a lower dielectric performance and lower flame retardancy than the fluorinated ethylene propylene, e.g., a limited oxygen index (LOI) within the 60% range.

In constructions according to embodiments of the present invention described in the preceding paragraph, each 24 AWG conductor may be surrounded by an inner layer of 4.8 mils of fire retardant polyolefin having a cell volume of approximately 40% of the total volume of the inner layer, the inner layer being surrounded by a 2.3 mil outer layer of a fluoropolymer such as

an ethylene chloro-trifluroethylene, e.g. Halar (Allied Chemical) having a 2.5 dielectric constant and 60% LOI.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings, in which like reference designations indicate like elements:

Figure 1 is an isometric view of a cable according to a first embodiment; and

Figure 2 is a cross-sectional view of an insulated conductor from the cable of Figure 1.

DETAILED DESCRIPTION

The invention will be better understood upon reading the following detailed description of an exemplary embodiment thereof in connection with the accompanying drawings.

As shown in the embodiment of Figure 1, a telecommunications plenum cable 10 suitable for high performance data transmission comprises a jacket 12 of minimal smoke emission the jacket surrounding a cable core 14 formed by a plurality, namely four pairs of twisted together and individually insulated conductors 16.

As shown by Figure 2, each individually insulated conductor 16 comprises a 24 AWG copper conductor 18 surrounded by dual insulation. The dual insulation comprises an inner insulating layer 20 made from a flame retardant polyolefin, e.g. polyethylene and an outer layer 22 surrounding the inner layer, the outer layer formed from fluorinated ethylene propylene. The inner layer has a cellular, i.e. foamed, construction having a total cell volume of approximately 34% of the total volume of the inner layer, and a thickness of 3.8 mils. Cell volumes constituting a smaller percentage of the total volume could also be used. The outer layer 22 has a thickness of 2.6 mil thereby producing an outside diameter for the insulated conductor of 33 mils.

Inner and outer layers are provided by successive extrusion steps, possibly within a dual extrusion head of known structure. The two materials are incompatible and there is no adherence between them.

In this embodiment it has been found that with a dual insulation thickness of 6.4 mil, the cable is entirely suitable for use in plenum chamber conditions. In the event of fire, the flame spread is satisfactorily low and comes within the flame spread standards for plenum cable as set by the UL910 Steiner test and or CSA-FT6. Electrical characteristics of the cable have been

evaluated and the cable satisfactorily meets the EIA/TIA-568A standards for high frequency performance. The cable of this embodiment does not use fluorinated ethylene propylene exclusively for its insulation, but instead uses flame retardant polyolefin as an inner layer within a fluorinated ethylene propylene outer layer. Nevertheless, satisfactory results have been achieved.

Although flame retardant polyolefin conventionally is avoided for plenum cable constructions, when used in embodiments of the invention as described above, that particular material is suitable as the inner layer insulation for plenum cables. The desired electrical properties are achieved by the dual layer insulation while also achieving the desired flame retardant properties. Flame retardant polyethylene would conventionally be thought unsuitable for use in the present invention. However, flame retardant polyethylene was incorporated as an inner layer of the dual insulation structure. In this position, it was found that the fluorinated ethylene propylene outer layer minimized the contact of flame with the inner layer and thereby controlled the degree of flame spread along the inner layer and also inhibited the generation of smoke by the polyethylene.

The above cable according to the first embodiment is comparable in its transmission parameters with a cable constructed according to U.S. Patent Application No. 08/261,073 filed June 16, 1994. The structure of the previous application did not use a cellular inner layer, but had instead a non-cellular inner layer. Therefore, the prior construction used a substantially greater amount of material in the two layers of insulation than used in embodiments of the present invention to provide comparable electrical and transmission results for the prior cable as for the cable according to embodiments of the present invention, and also to provide the required flame retardancy and the required low level of smoke during a UL910 Steiner horizontal flame test. The structure having the non-cellular inner layer requires a 3.5 mil thickness inner layer with at least a 3.5 mil outer layer and possibly a 4 mil outer layer of fluorinated ethylene propylene material. Using a 24 AWG conductor in each case, producing comparable transmission and electrical properties, the volume of fluorinated ethylene propylene in the present embodiment is 38% less than the volume of fluorinated ethylene propylene of the outer layer in the conventional non-cellular construction. As will be appreciated, this results in a striking cost reduction of the insulated conductor of the present invention compared with the prior art. In addition of course, the outside diameter is less with the embodiment than in the prior art.

Other embodiments are now described having different insulation materials, but a basic structure as described and shown in Figures 1 and 2. The cable may have a jacket of minimal smoke emission and a core of twisted pairs of dual insulated conductors of 24 AWG. These additional embodiments differ from the first embodiment in that the expensive fluorinated ethylene propylene outer layer is replaced with an outer layer which may have a lower dielectric performance and a lower flame retardancy (LOI 60% range). Nevertheless, these cables are still able to provide the required transmission and electrical properties while also providing the required flame retardancy and smoke reduction. For instance in a second embodiment, a 24 AWG conductor has a 4.8 mil inner layer of insulation of flame retardant polyolefin having a cell volume of approximately 40% of the total volume of the inner layer. The outer layer of insulation is formed 2.3 mil thick from an ethylene chloro-trifluroethylene fluoropolymer, e.g. Halar, having a dielectric constant of about 2.5 and 60% LOI may be used for the outer layer.

The construction and resultant properties of two embodiments of the invention are summarized is Table 1, below.

TABLE 1

EMBODIMENT NO.	1	2
INSULATION COMPOSITION		
first layer	F/R foamed PE	F/R FOAMED PE
skin	FEP	ECTFE
INSULATION CONSTRUCTION		
first layer % foaming	34	40
first layer thickness (mils)	3.8	4.8
skin thickness (mils)	2.6	2.3
PROPERTIES		
Attenuation (db/100m at 100 Mhz)	20.2-20.9	20.4-21.4
Impedance (Ohms/100m at 100 Mhz)	92-103	100-105
UL-910 flammability *		
max. smoke density	0.35-0.94	0.47-1.0
max.flame spread	2.0-6.7	2.5-9.2
max. average smoke density	0.08	0.06

*Results depend on the jacket material and jacket thickness.

It is to be understood that the invention applies not only to 24 AWG conductor, but to any conductor size where the product is for plenum usage.

The present invention has now been described in connection with a number of specific embodiments thereof. However, numerous modifications which are contemplated as falling within the scope of the present invention should now be apparent to those skilled in the art. Therefore, it is intended that the scope of the present invention be limited only by the scope of the claims appended hereto.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A telecommunications cable having a cable core including a plurality of electrical conductors, each electrical conductor individually insulated with a dual layer of insulation having an inner layer of cellular flame retardant polyolefin and an outer layer of fluorinated ethylene propylene surrounding the inner layer, the cable core surrounded by a jacket.

2. The cable according to claim 1 wherein the inner layer has a cell volume which is at least approximately 20% of the total volume of the inner layer.

3. The cable according to claim 2 wherein the inner layer has a cell volume which is approximately 34% of the total volume of the inner layer.

4. The cable according to claim 3 wherein the inner layer has a thickness of about 3.8 mil and the outer layer has a thickness of about 2.6 mil.

5. The cable according to claim 1 wherein the jacket is of low smoke generating material.

6. A telecommunications cable having a cable core including a plurality of electrical conductors, each electrical conductor individually insulated with a dual layer of insulation having an inner layer of cellular flame retardant polyolefin and an outer layer of a fluoropolymer surrounding the inner layer, the cable core surrounded by a jacket.

7. The cable according to claim 6 wherein the inner layer has a cell volume of at least approximately 20% of the total volume of the inner layer.

8. A cable according to claim 7 wherein the outer layer is formed of ethylene trifluoroethylene fluoropolymer.

9. The cable according to claim 8 wherein the inner layer has a cell volume which is approximately 40% of the total volume of the inner layer.

10. A cable according to claim 8 wherein the inner layer has a thickness of about 4.8 mil and the outer layer has a thickness of about 2.3 mil.

11. The cable according to claim 6 wherein the jacket is of low smoke generating material.

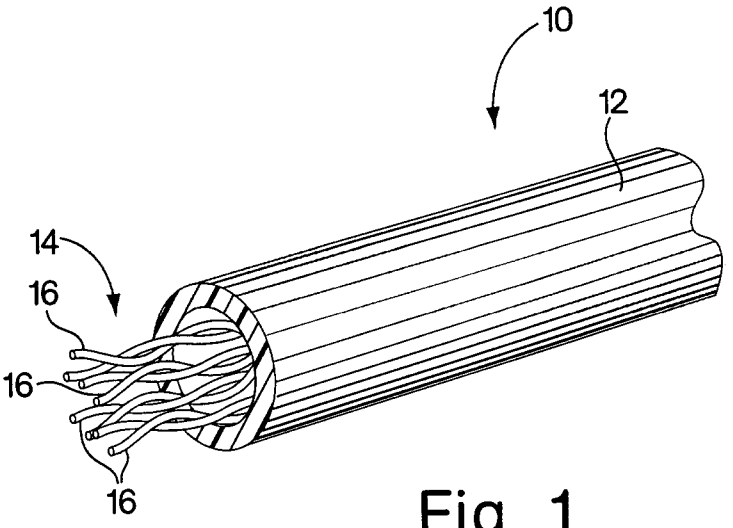


Fig. 1

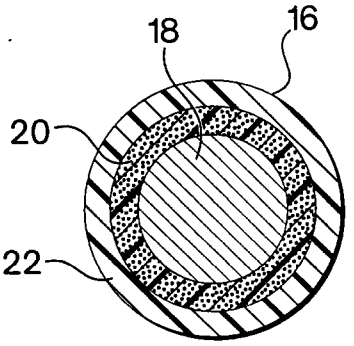
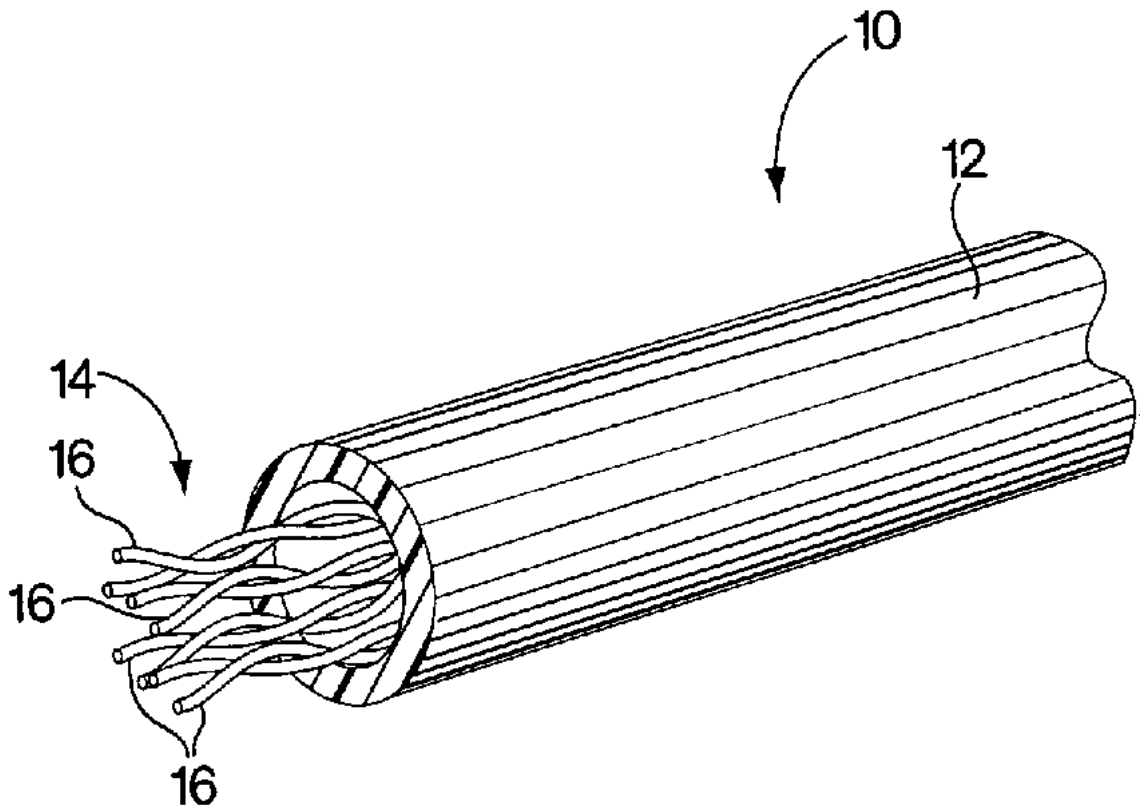


Fig. 2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