(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 742 565 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
13.11.1996 Bulletin 1996/46

(51) Int Cl.[6]: **H01B 7/34**

(21) Application number: **96303088.7**

(22) Date of filing: **01.05.1996**

(84) Designated Contracting States:
DE FR GB

(30) Priority: **12.05.1995 US 440429**

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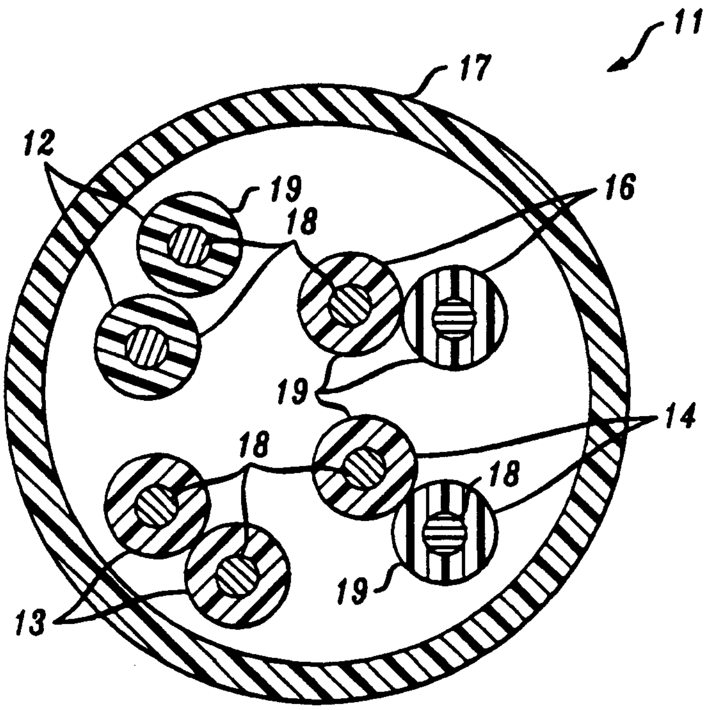
(54) Electronic wire and cable, low pair cable

(57) A CMP rated Category 3 communication cable has a plurality of insulated twisted pairs of wires surrounded by a PVC flame retardant jacket. Each wire has an insulating sheath of PVC having 0.5 to 3.0 parts by weight per one hundred parts of PVC of a fire retardant material and 0.5 to 1.5 parts per weight per one hundred parts of PVC of a smoke suppressant material. The insulating sheath has a maximum dielectric constant of 3.8 radians and a maximum dissipation factor of 0.05.

FIG. 2



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Description

FIELD OF INVENTION

This invention relates to low pair count telecommunications cables having flame and smoke retardant characteristics and, more particularly, to a Category 3 cable for use in building interiors.

BACKGROUND OF THE INVENTION

The increase in the use of computers and associated peripheral equipment, as well as numerous other electronic devices, in offices and other facilities has given rise to a need for electrical cable and associated wires to connect the various pieces of apparatus into a common network. The cable should satisfy numerous requirements as to electrical performance and physical characteristics. Two of the most important requirements are that the cable be capable of substantially error free transmission at relatively high rates over substantial distances, and that it be flame retardant, especially where the cable is to be used in building plenums.

In many buildings, most particularly office buildings, the room ceiling on each floor is usually spaced below the structural floor panel of the next higher floor and is referred to as a drop ceiling. This spacing creates a return air plenum for the buildings heating and cooling systems, which is usually continuous throughout the entire length and breadth of the floor. If a fire occurs within a room or rooms on a floor and below the drop ceiling, it may be contained by the walls, ceiling, and floor of the room. On the other hand, if the fire reaches the plenum, it can spread at an alarming rate. The plenum is a convenient place to route wires and cables, both electrical power and communications types. However, unless these wires and cables are flame retardant, they can contribute to the rapid spread of fire and smoke throughout the floor and, worse, throughout the building.

As a result of the potential danger presented by flammable insulation of wires and cables, the National Electric Code (NEC) prohibits the use of electrical cables in plenums unless they are enclosed in metal conduits. Such metal conduits are difficult to route in plenums congested with other items or apparatus, and where, for example, it is desirable or necessary to rearrange the office and its communications equipment, computers, and the like, the re-routing of the conduits can become prohibitively expensive. As a consequence, the NEC permits certain exceptions to the conduit requirements. Where, for example, a cable is flame retardant, and produces acceptably low smoke, the conduit requirement is waived provided that the cable, in tests, meets or exceeds the code's requirements for flame retardation and smoke suppression. Such tests must be conducted by a competent authority such as the Underwriters Laboratory.

In the prior art, data and other signal transmission has been carried out on cables in which the conductors are insulated with a variety of different materials. However, such cables too often result in transmission losses which are undesirably high for the transmission of high frequency signals. As a consequence, various alternative cable structures, using various types of materials, have been tried. A plenum cable having superior resistance to flame spread and smoke evolution is shown in U.S. Patent No. 4,284,842 of Arroyo, et al., which incorporates a metallic barrier sheath system which reflects radiant heat. For smaller size plenum cables, i.e., fewer than twenty-five pairs of conductors, such a structure is unduly expensive. In U.S. Patent No. 5,162,609 of Adriaenssens, et al., there is shown a fire resistant cable in which the individual wires of the core have a dual insulation system comprising an inner layer of suitable plastic material and an outer layer of flame retardant plastic material. The insulation system has the desirable characteristics of low dissipation factor and low dielectric constant, and the jacket, which surrounds the core, comprises a flame retardant polyolefin material with a low dissipation factor and dielectric constant. The dual insulation arrangement, however, represents an additional cost increment, especially for low pair cables, and can, in some cases, lead to increased structural return loss (SRL).

The electrical performance of cables to be used in local area networks (LAN) must, as discussed hereinbefore, be capable of transmitting data signals at much higher speeds than heretofore over considerable distances. Currently, equipment is commercially available that can transmit 16 megahertz signals over several hundred feet, e.g., 300 to 400 ft. Even at these distances, however, the desired transmission must be substantially error free, which, heretofore, has placed strict requirements on the materials used.

Certain standards have been established for cables used in buildings, in addition to the NEC standards for flame retardation and smoke suppression. Among these is the Commercial Building Telecommunications Cabling Standard TIA/EIA-568, in which cables are classified and categorized as to their electrical characteristics, such as required maxima and/or minima for parameters of D.C. resistance, pair-to-ground capacitance, attenuation, near end cross talk, dissipation factor and the like. Where high frequency operation, such as, for example, up to 100 MHz, is desired or required, as in the case of many computer and other electronically equipped offices, a Category 5 cable is best used. In general, however, because of the stringent requirements for this category, such cables are composed of relatively expensive materials and consequently, represent a large dollar investment. In U.S. Patent Application Serial Number (Bleich 9-11-1-8) there is disclosed a TIA/EIA 568 Category 5 four pair UL CMP plenum rated unshielded cable which materially reduces the cost of such cable. The cable uses of less expensive materials which are chosen to produce a low dissipation factor and dielectric constant, with minimal sacrifice in flame retardation and smoke suppression. This cable represents a reduction in cost of Category 5 cables over those presently used. However, there are many instances where a Category 5 cable is not absolutely necessary, and even the reduced cost cable of the aforementioned Bleich et al. application would be an expensive investment.

In the situation of applications where higher frequencies, e.g., 100 MHz, are not necessary or used, it would be a wasteful expense to install Category 5 cables. The aforementioned Cabling Standard TIA/EIA-568 includes lesser categories for use under less stringent electrical requirements, among which is Category 3, which includes cables intended for use in the frequency range from 750 khz to 16 MHz. Category 3 cables are generally made of less costly materials than those of Category 5, and exhibit greater attenuation throughout the frequency range of use, as well as exhibiting poorer near end cross-talk (NEXT) performance. In addition, the cables, even with the cheaper materials, must still meet the requirements for a CMP rating for use in plenums. Thus, a Category 3 cable, CMP rated, which has reduced attenuation and NEXT without a material increase in cost, is to be desired.

In the prior art, transmission has been carried out on cables in which the conductors are insulated with polyvinyl chloride (PVC) in order to achieve acceptable flame retardant characteristics and reduced overall cable cost. It has been found, however, that PVC, although having acceptable flame retardant characteristics or properties, can result in transmission losses which are undesirably high for the transmission of the higher frequency signals. This may be overcome somewhat by an increase in the gauge size of the metallic conductor portion of the insulated conductor, but, as should be apparent, this is not a desirable nor a particularly practical alternative.

An example of a state-of-the-art Category 3 CMP rated cable is one in which the wire insulation is polyvinyl chloride (PVC) having approximately 51 parts per 100 parts PVC of fire retardant and 15 parts per 100 parts of PVC of smoke suppressant, and the twisted pairs of insulated wires are jacketed with a commercially available smoke suppressed PVC jacket. The material of the insulation has a maximum dielectric constant of approximately 5.0, a maximum dissipation factor of 0.07, and a density in the range of 1.57-1.63 gm/cc. The minimum dynamic thermal stability of the material, in minutes, is approximately 15 which allows longer extrusion runs between clean-ups. Such a material has proved to be reasonably satisfactory for Category 3 CMP rated cable. However, it is somewhat expensive (approximately 1.54 dollars/lb-vol), and the dielectric constant and dissipation factors are higher than is preferred.

SUMMARY OF THE INVENTION

The present invention is a 2 to 6 pair (normally 4 pairs) Category 3 EW&C (Electronic Wire and Cable) unshielded cable design that is CMP rated, and which uses an insulation material having lower dielectric constant and lower dissipation factor, with a consequent improvement in electrical performance compared to prior art cables. In addition, the cable of the invention is less costly to produce. These desiderata are achieved through a unique combination of wire insulating material and fire retardant jacket material.

In an illustrative embodiment of the invention, an EW&C cable comprises a plurality, e.g., four, twisted pairs of insulated conductors or other suitable transmission media, each of which comprises an elongated conductor member encased in an approximately seven mil thick insulation of polyvinyl chloride material which has a low dissipation factor, typically less than 0.05 at 1 MHz, and a maximum dielectric constant of approximately 3.8 radians. The material has a density, in grams per cubic centimeter, of 1.31 to 1.38. The PVC composition contains 0.5 to 3.0 parts antimony trioxide fire retardant; and approximately 0.5 to 1.5 parts of Ongard 2® smoke suppressant, which is a commercially available material. The four twisted pairs are enclosed in a jacket of a commercially available fire retardant PVC material, approximately fifteen mils thick, such as Smokeguard II 6920 produced by the AlphaGary Corporation. The twisted pairs are layless, i.e., they are not stranded together into a core before jacketing, and no filler material or core member is used.

The cable of the invention passes the UL 910 plenum burn test, thus satisfying the requirements for a TIA/EIA 568 Category 3 CMP rating. As a consequence, the cable of the invention meets all of the required standards while, at the same time, is made of less expensive materials, is cheaper to manufacture, and yields an electrical performance that is superior to the prior art Category 3 CMP rated cables generally in use at the present time.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the cable of the invention;

FIG. 2 is a cross-sectional view of the cable of Fig. 1; and

FIG. 3 is a chart comparing prior art insulation material with the material used in the invention.

DETAILED DESCRIPTION

In Figs. 1 and 2 there is shown, in a perspective view, the EW&C Category 3 low pair CMP rated cable 11 embodying the principles of the present invention, and having four twisted pairs of insulated conductors 12, 13, 14 and 16. It is to be understood that the number of twisted pairs may vary between two and six, the four shown in Figs. 1 and 2 being by way of example only. As can be seen, the pairs are grouped within, and surrounded by, a jacket 17.

Each of the conductors of each of the twisted pairs comprises a metallic, preferably copper, conducting wire portion 18 encased in insulating portion 19, which will be discussed more fully hereinafter. The insulation 19 is approximately seven (7) mils thick, whereas most prior art twisted pair insulation for use in cables is eight (8) or more mils thick. Inasmuch as the electrical characteristics of the insulating material, such as resistance, dielectric constant, dissipation factor and the like affect the electrical performance of the cable, as a general rule a thin insulation coating is better than a thicker one. The jacket 17, enclosing the twisted pairs 12, 13, 14, and 16, is approximately fifteen (15) mils thick and is made of a commercially available, flame retardant, smoke suppressed PVC material such as, for example, Smokeguard II 6920® produced by AlphaGary Corporation.

Heretofore, it has been considered that where the wire insulation material is PVC, and the jacket material is also PVC, that both the insulation and the jacket had to be flame retardant and smoke suppressed, with a flame retardant material surrounding the core and insulated wires inside the jacket for the cable to qualify as a CMP rated cable. Applicants have found, however, that a combination of an improved insulating material, designated AT&T type 648B PVC, which has minimal flame retardant and smoke suppressant content, and a jacket of the aforementioned Smokeguard II 6920® yields both electrical and physical results such that the cable readily qualifies as a Category 3 CMP rated cable, contrary to all expectations based upon prior art cable research.

In Fig. 3 there is shown a comparison table between the insulation material of the invention and a typical, widely used PVC insulation material for a CMP rated cable. It can be seen from the comparison, that the insulation material of the invention has thirty parts by weight per one hundred parts PVC of plasticizer, whereas the prior art material has thirty-eight parts of fire-retardant plasticizers. In addition, the material used in the present invention has only one part fire retardant and one part smoke suppressant whereas the prior art material has thirteen parts fire retardant and fifteen parts smoke suppressant. As a direct result of these differences in the composition of the insulation materials, the physical and electrical characteristics also differ to an important extent. Thus, from Fig. 3, it can be seen that the dielectric constant of the PVC insulation of the cable of the invention is a maximum of 3.8 radians, whereas that of the prior art material is a maximum of 5.0 radians. The dielectric constant directly affects the transmission performance of the wires, and hence, the cable, and the lower it is, the better. In like manner, the maximum dissipation factor of the prior art cable insulation, in dimensionless units is approximately 0.07, whereas for the material of the cable of the invention it is approximately 0.05. This too is a case where the lower the figure, the better the electrical performance. Further examination of the table of Fig. 3 reveals that the physical characteristics such as tensile strength, elongation, shear strength, and the like, and the dynamic thermal stability, are all superior to the insulation material of the prior art. Additionally, although not shown in Fig. 3, the insulation resistance of applicants' PVC material is approximately 3 x 10" Ω while for the prior art PVC material it is approximately 5×10^{10} Ω. Obviously, the higher the resistance figure, the better the performance. It is to be understood that the values given in Fig. 3 and in the foregoing discussion are, for the most part, approximations. Measurements performed on any given sample of material might deviate slightly from the figures given, and it is intended that such possible deviations be included in the approximate values given, as well as in the ranges given.

One of the most significant differences between the cable of the present invention and the cable of the prior art, as shown in Fig. 3, is in the volume cost of the insulation material which, for the cable of the invention, is less than half as much as that for the prior art cable. This reduced cost coupled with the reduction in required thickness of the insulation (approximately seven mils versus eight mils) results in an overall reduction in cable costs of approximately twenty percent (20%). Inasmuch as Category 3 CMP rated EW&C cable is manufactured and sold in hundreds of millions of feet per year, it can be appreciated that a twenty percent reduction in cost represents considerable savings.

The features of the invention have been disclosed in a preferred embodiment of the invention, which is a 2-6 pair CMP rated Category 3 EW&C cable that, as compared to prior art cables, has a lower cost per foot, better electrical performance, and better dynamic stability and higher resistance insulating material. Various modifications might occur to workers in the art without departure from the spirit and scope of the invention.

Claims

1. A CMP rated Category 3 unshielded communication cable comprising:

   a plurality of pairs of communications transmission media, each transmission medium of each of said pairs having disposed thereabout a polyvinyl chloride material, said material containing a fire retardant material and a smoke suppressant material and having a maximum dielectric constant of 3.8 radians; and
   a jacket member surrounding and enclosing said transmission media, said jacket member comprising a fire retardant PVC material.

2. A communication cable as claimed in claim 1 wherein said polyvinyl chloride material has a maximum dissipation factor of 0.05.

3. A communication cable as claimed in claim 1 wherein said fire retardant material comprises 0.5 to 3.0 parts by weight per one hundred parts polyvinyl chloride.

4. A communication cable as claimed in claim 3 wherein said fire retardant material is antimony trioxide.

5. A communication cable as claimed in claim 1 wherein said smoke suppressant material comprises 0.5 to 1.5 parts by weight per one hundred parts polyvinyl chloride.

6. A communication cable as claimed in claim 1 wherein each of said transmission media is a copper wire.

7. A CMP Category 3 unshielded communication cable comprising:

a plurality of twisted pairs of electrical conducting wires, each of said wires being encased in a sheath of polyvinyl chloride insulating material;
said insulating material having a density of 1.31 to 1.38 gm/cc and comprising 0.5 to 3.0 parts by weight per one hundred parts of polyvinyl chloride of a fire retardant material and 0.5 to 1.5 parts by weight per one hundred parts of polyvinyl chloride of a smoke suppressant material; and
a jacket of fire retardant polyvinyl chloride material surrounding and enclosing said plurality of twisted pairs of conductors.

8. A communication cable as claimed in claim 7 wherein said fire retardant material is antimony trioxide.

9. A communication cable as claimed in claim 7 wherein said insulating material encasing each of said wires is approximately seven mils thick.

10. A communication cable as claimed in claim 9 wherein the thickness of said jacket is approximately fifteen mils.

11. A communication cable as claimed in claim 7 wherein said insulating material has a maximum dissipation factor of 0.05 at 1 MHz.

12. A communication cable as claimed in claim 7 wherein said insulating material has a maximum dielectric constant of 3.8 radians.

FIG. 1

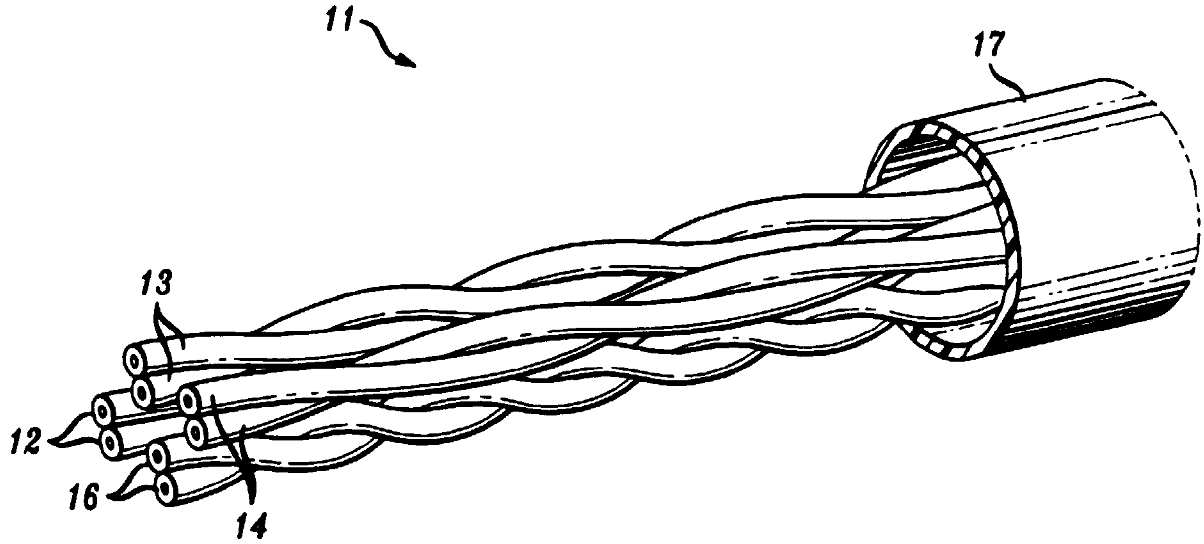

FIG. 2

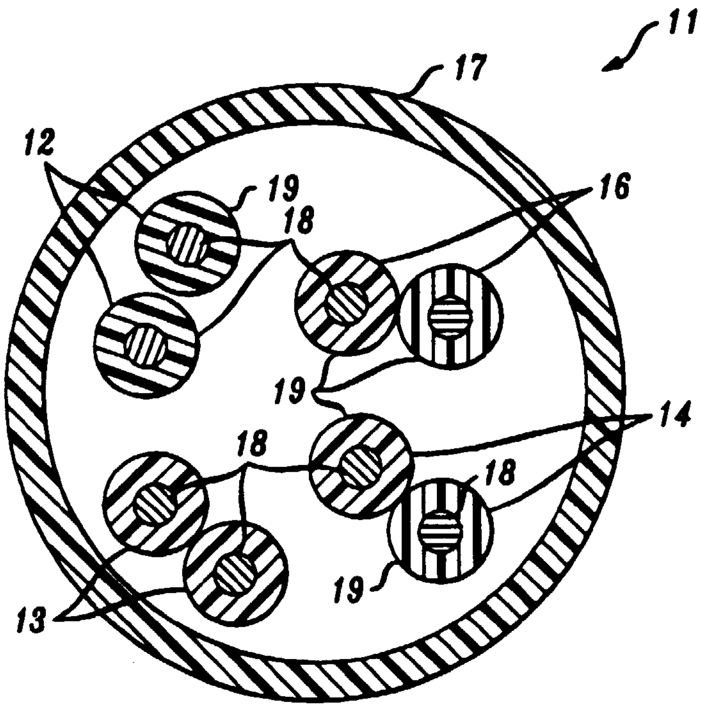

FIG. 3

INGREDIENT	DESIGNATION	INSULATION INVENTION	INSULATION PRIOR ART
		PARTS BY WEIGHT PER HUNDRED PARTS RESIN	
POLY (VINYL CHLORIDE)	RESIN	100.0	100.00
DIISODECYL PHTHALATE	PLASTICIZER	30.0	-
SANTICIZER 2148	FIRE-RETARDANT PLASTICIZER	-	22.0
TETRABROMOPHTHALATE ESTER	FIRE-RETARDANT PLASTICIZER	-	16.0
TRIBASIC LEAD SULFATE	STABILIZER	7.0	-
DIBASIC LEAD PHTHALATE	STABILIZER	-	7.0
EPOXIDIZED SOYBEAN OIL	CO-STABILIZER	-	3.0
THERM-CHEK® 6196W	CO-STABILIZER	-	1.5
ALUMINA TRIHYDRATE	FIRE RETARDANT	-	10.0
ANTIMONY TRIOXIDE	FIRE RETARDANT	1.0	3.0
ONGARD 2®	SMOKE SUPPRESSANT	1.0	-
AMMONIUM OCTAMOLYBDATE	SMOKE SUPPRESSANT	-	15.0
ULTRACARB U-5	FILLER	-	25.0
DIBASIC LEAD STEARATE	LUBRICANT	0.4	-
ETHYLENE-BIO-STEARAMIDE	LUBRICANT	0.4	-
HENKEL G-16	LUBRICANT	-	2.5
HENKEL G-71	LUBRICANT	-	0.5

REQUIREMENT	UNITS	VALUE	
OXYGEN INDEX	PERCENT	30 MINIMUM	30 MINIMUM
DIELECTRIC CONSTANT	RADIANS	3.8 MAXIMUM	5.0 MAXIMUM
DISSIPATION FACTOR	-	0.05 MAXIMUM	0.07 MAXIMUM
ULTIMATE TENSILE STRENGTH	PSI	3000 MINIMUM	2500 MINIMUM
ULTIMATE ELONGATION	PERCENT	175 MINIMUM	200 MINIMUM
WEDGE SHEAR STRENGTH	LBS	1700 MINIMUM	800 MINIMUM
DENSITY	GM/CC	1.31 - 1.38	1.57 - 1.63
DYNAMIC THERMAL STABILITY	MINUTES	18 MINIMUM	15 MINIMUM
VOLUME COST	$/LB-VOL	0.63	1.54