

⑫ **EUROPEAN PATENT APPLICATION**

⑳ Application number: 81301965.0

⑤① Int. Cl.³: **H 01 B 7/02**
H 01 B 3/30

㉔ Date of filing: 05.05.81

③① Priority: 08.05.80 GB 8015249

④③ Date of publication of application:
18.11.81 Bulletin 81/46

⑧④ Designated Contracting States:
AT BE CH DE FR GB IT LI LU NL SE

⑦① Applicant: **BICC Limited**
21, Bloomsbury Street
London, WC1B 3QN(GB)

⑦② Inventor: **Sullivan, Thomas**
8 Wroxham Avenue
Urmston Manchester(GB)

⑦④ Representative: **Poole, Michael John et al,**
BICC Limited Patents Department 38 Wood Lane
London, W12 7DX(GB)

⑤④ **Insulated wires and electric cables.**

⑤⑦ A cable, suitable for aircraft wiring purposes comprises:
at least one metallic conductor; a single layer of an aromatic
polyimide tape, optionally coated with a bonding layer of a
fluorinated ethylene-propylene copolymer, applied to the
conductor with an overlap; and an extruded outer layer based
on a polymer consisting of chains of aromatic rings linked by
groups selected from -O-, -S-, SO₂-, -CO-, and -CR₂- (where
R=H or alkyl or acyl), of which polyether ketone (PEEK) is
preferred. The extruded layer is preferably oriented.

- 1 -

INSULATED WIRES AND ELECTRIC CABLES

This invention relates to insulated wires and electric cables, all of which are hereinafter included in the term 'cables'. The cables of the invention are primarily, but not exclusively, suitable for aircraft wiring and other electronics purposes.

One of the more successful cables at present used in this market is the Applicants' "KPA150" cable. In this cable two tapes of aromatic polyimide foil, each thinly coated on both sides with fluorinated ethylene-propylene
10 copolymer as a bonding agent, are lapped on the conductor each overlapping by 67% (nominally) so that each tape forms three complete overlapping layers, and a pigmented lacquer is applied to give an abrasion-resistant coating that is receptive to printing.

This cable is suitable for continuous service at 150°C, and is generally satisfactory, though the slightly irregular surface has occasionally caused difficulties in sealing round the cable at terminations and may reduce the legibility of markings, and the fluorine and nitrogen
20 contents may imply some toxic hazard under severe fire conditions.

The present invention provides a cable which
(i) has at least as good temperature rating; (ii) has a smooth surface; (iii) contains no, or at least substantially less, fluorine and substantially less nitrogen; (iv) is easier to manufacture and requires simpler plant; and

- 2 -

(v) can be at least as low in weight and bulk as the "KPA150" cable (an important consideration as the weight of cables in a modern aircraft can be a significant fraction of the payload).

The cable in accordance with the invention comprises: at least one metallic conductor; a single layer of an aromatic polyimide tape applied to the conductor with an overlap; and an extruded outer layer based on a polymer consisting of chains of aromatic rings linked by groups selected from
10 -O-, -S-, -SO₂-, -CO-, and -CR₂- (where R=H or alkyl or acyl).

If it is desired to bond the layers of tape, the conventional type of tape coated with a bonding layer of fluorinated ethylene-propylene copolymer can be used, but this is not essential and the use of uncoated tape has the advantage of completely eliminating fluorine compounds from the cable.

Preferably the tape is helically applied to the conductor, preferably with an overlap of at least 60%.
20 Alternatively, however, the tape could be applied longitudinally or as a further alternative could be applied initially in a longitudinal direction and converted to a helical form by twisting the wrapped wire (before or after applying the outer layer) for example using a flyer-type winding machine (as conventionally used for twinning and bunching).

The conductor may be solid or stranded and is

- 3 -

preferably of plain, tinned, nickel-plated or silver-plated copper.

The preferred polyimide for the tape is that sold under the trademark Kapton, which is believed to consist essentially of the polymeric pyromellitate of p,p' diamino diphenyl ether. Preferably the tape is no more than 0.04mm thick and any coating thereon no more than 0.005mm thick. More especially Kapton 010 tape, an uncoated tape 0.025mm thick and Kapton 616 tape, a coated tape in which the
10 polyimide is about 0.025mm thick and the coating about 0.0025mm thick, are preferred.

Suitable polymers for the outer layer are described in British Patent Specifications 971,227, 1,016,245, 1,019,266, 1,019,458, 1,078,234, 1,086,021, 1,102,679, 1,153,035, 1,153,527, 1,164,817, 1,177,183, 1,383,393, 1,387,303, and 1,414,421, 1,414,422 and 1,414,423 and in European Patent Application 0001879. Linear polymers are usually preferred, but some can be crosslinked, and this may sometimes be beneficial. Polymers
20 in which the aromatic groups are predominately phenylene and the linking groups are selected from -O-, -CO- and -SO₂- are preferred; most preferred are polyether ketones and polyether sulphones in which (in both cases) -O- linkages are in the majority, and more especially paraphenylene polyether ketones having about twice as many -O- linkages as -CO- linkages (such as the polymer sold by ICI as "PEEK").

The outer layer is preferably extruded, either as a single operation or in two (or more) steps. Alternatively

it might be in tape form applied helically or applied longitudinally with or without subsequent twisting; further it might be a composite layer applied partly in tape form and partly by extrusion (under, over or between tapes). When the outer layer is in two or more parts they may be of identical composition or they may differ within the range of polymers defined above.

Preferably the outer layer is oriented, suitable techniques for extruded layers being described in our
10 British Patent Application 16614/78 and our European Application No. 79301544.7.

Two or more wires, insulated as described, may be assembled together by twisting or otherwise to form a multiconductor cable, with or without a suitable overall sheath, braid or other coverings.

Preferably the combined radial thickness of the polyimide tape layer and the outer layer is not more than 0.25mm.

The following examples illustrate typical forms
20 of the invention.

Example 1

A single-conductor low-toxicity airframe cable consists of a conventionally stranded conductor made up of 19 silver plated annealed copper conductors each 0.20 mm in diameter lapped with a single tape of FEP-coated polyimide tape (Kapton 616HF), 9.6 mm wide and applied with

67% overlap (nominal diameter over tape 1.18 mm), heat-sealed and then covered with 0.15 mm radial thickness of a polyphenylene ether-ketone (having about two ether linkages for each ketone linkage). This covering is applied by extrusion using a conventional thermoplastic extruder operating at 400°C, and raises the nominal overall diameter to 1.48 mm. The polyphenylene ether-ketone can be coloured with suitably-chosen pigments, if desired; other additives are unnecessary.

Examples 2 and 3

- 10 Two and three respectively of the conductors described in Example 1 are twisted together with a lay-length of 20 times pitch diameter, right handed.

Example 4

A braided 2-core aircraft-wiring cable consists of the cable of Example 2 braided with 0.10 mm diameter silver-plated annealed copper wires, 16 spindles 8 ends, 19 mm lay (nominal diameter over braid 3.46 mm) and sheathed to a radial thickness of 1.0 mm with an ethylene-acrylic polymer composition formulated as follows:

	Parts by weight
20 Vamac N-123 masterbatch	47.50
(believed to consist of about	
80% of a terpolymer of ethylene,	
methyl acrylate and a carboxylic	
monomer together with about 20%	
of an inert silica filler)	

Parts by weight

	Hydrated alumina,	44.63
	Paper grade SD	
	(particle size around	
	1 micrometre)	
	Silica filler (Vulcasil S)	1.91
	Process Aids:	
	Stearic acid	0.80
	Another fatty acid sold as 'Armeen 18D'	0.20
	Antioxidant:	
10	Santowhite powder	0.76
	Solid formulation of vinyl	
	trimethoxy silane (Drimix silane A172)	0.60
	Curing system:	
	Peroxide (40% active)	2.70
	(Perkadox 14/40)	
	Triallyl cyanurate (75% active on	0.90
	powder carrier)	
	(Drimix 75% TAC)	
		100.00

Example 5

20 The single core of Example 1 is braided and sheathed substantially as described in Example 3.

Example 6-10

These are identical with Examples 1-5 respectively

except that the polyimide tape is uncoated (Kapton 010 tape) and not heat sealed.

Example 11

A thirty-core cable comprises conductors according to Example 6 laid up 4, 10 and 16 with the lay-length of each layer 20 times the respective pitch diameter, with a sheath (1.2 mm radial thickness) of the same formulation set out in Example 4.

Example 12

10 This is similar to Example 11, but each core is the screened and sheathed conductor of Example 10.

The cables of the Examples all have excellent radiation and water resistance; those of Examples 1-5 have good resistance to notch propagation, whereas the others have the merit of a substantially zero halogen content.

CLAIMS

1. An insulated wire or electric cable comprising:
at least one metallic conductor; a single layer of an aromatic polyimide tape applied to the conductor with an overlap; and an extruded outer layer based on a polymer, consisting of chains of aromatic rings linked by groups selected from -O-, -S-, -SO₂-, -CO-, and -CR₂- (where R=H or alkyl or acyl).
2. An insulated wire or cable as claimed in Claim 1 in which the linking groups are selected from -O-, -CO- and -SO₂-.
3. An insulated wire or cable as claimed in Claim 1 in which the polymer is a polyether ketone in which the linking groups are -O- and -CO-, -O- groups being in the majority.
4. An insulated wire or cable as claimed in any one of Claims 1-3 in which the aromatic groups in the polymer are predominately phenylene groups.



European Patent
Office

EUROPEAN SEARCH REPORT

0040034

Application number
EP 81 30 1965

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
	<u>US - A - 4 161 564</u> (T.J. LEGRANDT) * Column 3, lines 18-60; claims 1,4 *	1	H 01 B 7/02 3/30
	--		
	<u>US - A - 3 822 147</u> (C. KOERNER et al.) * Claims 1,13 *	1	
	--		
	<u>GB - A - 1 397 261</u> (STANDARD OIL CO.) * Claim 1 *	1	TECHNICAL FIELDS SEARCHED (Int. Cl.)
	--		
A	<u>US - A - 3 922 465</u> (M. KAWAGUCHI et al.) * Claim 1 *		H 01 B 3/30 7/02 3/42 7/34
	--		
A	<u>US - A - 3 842 192</u> (D. HILKER et al.) * Claims 1-9 *	1	

			CATEGORY OF CITED DOCUMENTS
			X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
			&: member of the same patent family, corresponding document
The present search report has been drawn up for all claims			
Place of search	Date of completion of the search	Examiner	
The Hague	17-08-1981	VAN DEN BULCKE	