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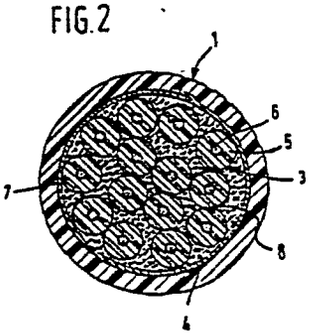
(54) **Foamed petrolatum cable filler.**

(57) A filler for a telecommunication cable containing a pre-foamed petrolatum or petroleum jelly with the petrolatum containing an exceptionally high oil content of at least about 40% by weight and the solids content is in the form of fine particulates of less than 100 µm, and preferably 5 to 10 µm, dispersed throughout the liquid portion. The cell structure is air-filled, closed-cell, and provides a light-weight cable filler with good electrical insulation properties, particularly a low dielectric constant.

FIG.2



EP 0 081 248 A1

FOAMED PETROLATUM CABLE FILLER

Field of Use of the Invention

This invention relates to telecommunication cables of the kind comprising a multiplicity of plastic-insulated conductors enclosed within a water-proof sheath. More specifically this invention relates to a filler to be contained between the conductors and within the interstices of the material of the external sheath.

Background and Discussion of Prior Art

An electrical or communications cable is comprised of a great number of pairs of single conductive wires. Each of these singles is coated with a dielectric material to insulate them individually from one another. A large number of these singles are then collected into a bundle which is the cable. The cable is coated on the outside within a sheath of a dielectric material to make an integral structure.

As is to be expected, collecting a plurality of round wires into a cable results in a large volume of unoccupied space between wires. In the normal course of things this is simply "dead space" which

becomes filled with air. In many applications this is satisfactory since air is an excellent dielectric. However, when the cable is intended to be installed underground, this type cable is usually not satisfactory. The reason for this is that an underground cable is frequently in contact with water. If a flow develops in the outer sheath, water can leak into the dead space in the cable and this can eventually lead to trouble such as, e.g., shorting of a pair of wires.

In order to keep water out of these cables in underground installations, it has become common practice to fill the cable with an inexpensive semi-solid dielectric.

It was known in the prior art to employ petrolatum or petroleum jelly as a filler. However, the use of petrolatums alone was not found to be entirely satisfactory and the prior art sought to chemically modify the petrolatum.

Eager, et al, U.S. 3,745,231, granted July 10, 1973, disclosed a combination of petrolatum and polyethylene filler. Zinser, et al, U.S. 3,775,548, granted November 27, 1973, disclosed adding polyethylene, polybutene -1 and polyisobutylene to the petroleum jelly filler. Woodland, et al, U.S. 3,843,568, granted October 22, 1974, disclosed blending a petrolatum with a partially cross-linked polymer, in further combination with hollow particles of a synthetic thermoplastic polymer. British Patent No. 2,011,154, discloses telecommunication cables with petroleum jelly buffer material.

Other cable manufacturers were directed to using thermoplastic foam in combination with a petrolatum. Wodike, U.S. 2,186,793, granted January 9, 1940, disclosed foamed rubber insulation with a minor percentage of petrolatum. Boult, U.S. 3,706,838, granted December 19, 1971, combined cellular polyethylene with petroleum jelly. Puckowski, et al, U.S. 3,856,980, disclosed a cellular foam with a hydrocarbon wax. Reighter, U.S. 3,684,816, granted August 15, 1972, disclosed an open-cell foam with a liquid dielectric.

Thus the afore-discussed prior art sought to limit the total amount of the petrolatum in the filler, and used principally foamed plastic materials in this regard. Such combinations were often difficult and costly to fabricate, and the industry is desirous of an improvement thereto.

Austrian Patent No. 330,871 discloses gross additions of air at the time of filling the cable with silica jelling agents and oil.

It was also known, such as is disclosed in U.S. 3,060,136, granted October 23, 1961, to Nelson, et al, that certain waxes could be foamed.

Austrian Patent No. 331,883, issued August 25, 1976, discloses dissolving a plastic or viscous sealing agent, including paraffin-like materials, in a solvent, and introducing the solution to a cable core. The paraffin-like materials have melting points of 80°-94°C. The solvent vaporizes and a foam is formed in situ.

German Disclosure Document OLS 2,460,718, filed December 19, 1974, and disclosed June 24, 1976,

mentions the use of supplementary foaming components with vaseline under pressure to provide a foam in situ, in an effort to render a communication cable impervious.

German Disclosure Document OLS 2,243,615, disclosed on March 7, 1974, discloses the combination of liquified gases, such as freon, butane and pentane, with vaseline, then force the mixture under pressure into the cable core, and with pressure relief there is foaming of the vaseline in situ.

Such immediately aforesaid prior art petrolatum based cable fillers had a limited cell volume and required organic foaming agents acting under heat or reduced pressure to form a foam in situ.

Now there is provided by the present invention an acceptable cable filler which utilizes substantially all petrolatum or petroleum jelly foamed with high volumes of a gas, such as air, in a closed-cell, stabile, pre-foamed condition.

It is a principal object of this invention to produce a low density filler for cables.

It is therefore a principal object of this invention to provide a foamed petrolatum, particularly a high oil content petrolatum, as a pre-foamed yet stabile cable filler.

It is another object of this invention to provide a cable filler with a low dielectric content.

It is another object of this invention to provide a foamed cable filler composition which avoids combinations of foaming materials.

It is another object of this invention to provide a novel method for preparing foamed petrolatum for use as cable filler.

It is another object of this invention to provide a readily fabricated filled cable, and yet one which is practical in commercial application.

The aforesaid as well as other objects and advantages will become apparent in the following specification, and the adjoined claims, and the drawings, in which:

Brief Description of the Drawings

Fig. 1 is a perspective view of a filled cable of this invention; and

Fig. 2 is an enlarged sectional view II-II of the cable of Fig. 1.

Summary of the Invention

The cable filler of present invention is a foamed petrolatum having a high hydrocarbon oil content with fine wax particulates dispersed throughout, and which is formed as a gas-filled, closed-cell foam having a cell volume of from 35 to 55%. The gas is preferably air. Surprisingly high oil contents of 40% to 90% by weight were useful in forming the foam, and yet the foam remained stabile. To form the foam, the petrolatum formed of hydrocarbon oil and wax is heated to 50°C to 95°C and preferably 80°-90°C to achieve a 40:60 to 90:10, oil to wax ratio, and then a substantial volume of air under extreme agitation and shear action is pumped through the oil and wax to comminute the wax to fine particulates of less than 100 microns. This is believed to help provide a structural integrity to the foam.

Description of the Preferred Embodiments

The terms "petrolatum" or "petroleum jelly" as used hereinbefore and hereinafter shall be construed as being synonymous with and include hydrocarbons of the methane and olefin series of C_{16} up to about C_{65}. Petrolatums by definition usually contain about 10% by weight of oil. Petrolatums useful in the present invention contain surprisingly much higher percentages of about 40% to 90% by weight of oil at about 50°-95°C, as more fully discussed hereinafter. The petrolatum preferably has a molecular weight range of 600 to 700.

Broadly speaking the present invention comprises a cable with a cable filler which comprises a pre-foamed petrolatum or petroleum jelly in which fine wax particulates are dispersed in a high liquid oil portion of the petrolatum.

In the practice of the present invention, a petrolatum of high oil content is heated to 50°C to 95°C, and preferably about 80°C-90°C, to where the liquid oil-to-solid wax ratio is at least about 90:10. At that point a high volume of 35% to 55% by volume of air is blown into the petrolatum under extreme agitation. It was surprisingly found that this combination of high air volumes with high agitation providing shear forces and high liquid-to-solid ratio created very fine particulates (less than 100 microns) of the solid wax, which particulates were evenly dispersed in the liquid portion of a micro-void (less than 100 micron-voids), closed-cell foam structure. The high shear forces reduce the wax particulates from up to about 1,000 microns to

where substantially all the particulates are less than 100 microns, and preferably less than 5 to 10 microns. The solid wax particulate portion of the petrolatum is generally formed of a mixture of paraffinic and microcystalline waxes. The microcystalline waxes were found to most advantageously form fine particulates.

Another important aspect of the present invention is the petrolatum structural viscosity at foaming. It has been found that petrolatums having oil contents of about 40% - 90% by weight, should exhibit a viscosity in the range of 50 to 10,000 centistokes at about 60°-80°C.

The foam once formed is then pumped into the cable core and flows in the interstices of the cable strands or conductors. Upon cooling in the cable, the foam is further solidified, and found particularly useful in underground cables with operating temperatures of -10°C to +20°C, and also found to be useful even when subjected to temperatures up to 80°C.

The specifications for a typical petrolatum which can be blow foamed pursuant to the present invention is as shown in Table I, and the product foam specifications are shown in Table II.

It has surprisingly been found that a petrolatum when pre-foamed according to the present invention provides an exceptional cable filler material. The pre-foamed petrolatum of the present invention exhibits excellent properties and characteristics particularly, low density, good dielectric, low cost, good stability, and improved flexibility in a cable.

Without wishing to be bound by any theory or mechanism, it is believed that the relatively small quantity of very fine wax particulates dispersed in oil permits a lattice-type network to be formed when air or an inert gas is blown in large quantities through the petrolatum. In blow foaming, the particulates are finely dispersed through the lattice closed-cell foam structure.

By the term "inert gas" as used hereinbefore and hereinafter throughout the specification and claims, it is contemplated to include air and the inert gas series (e.g., argon, neon, xenon, and the like) as well as organic gases which do not react with the petrolatum and will not condense at the normal operating temperatures of the cable (e.g., methane, ethane and propane), but excludes the higher molecular weight hydrocarbon gases such as pentane and butane; the latter being in common use in prior art foams. Furthermore, with the lighter inert gases, the bulk weight of the filler is substantially reduced with a concommitant reduction in savings in cable costs.

Referring to Figs. 1 and 2 there is shown the cable of this present invention generally designated as 1. Cable 1 comprises an outer sheath 2 containing a plurality of individual conductors 3; each of said conductors 3 comprises a wire 6 being covered with an insulator 5. The foamed petrolatum filler 4 of this present invention fills the interstices between the several conductors 3. A metal core wrap 7, which is impervious to the

petrolatum retains the conductors 3 and filler 4 in a fixed manner.

The filler 4 is shown with a plurality of closed-celled voids 8, although in actuality the voids may be microscopic in nature, and therefore not necessarily visible to the naked eye.

It has also been found that to ensure the structural integrity of the foamed petrolatum, hydrocarbon polymeric material of a molecular weight of at least that within the wax range may be added to the petrolatum. Suitable hydrocarbon polymeric material include the microcrystalline waxes; Fischer-Tropsch waxes; polyolefins (e.g. polyethylene, m.w.=2,000-15,000); polyisobutylene (m.w.=100,000-200,000), and the like. The molecular weight (m.w.) of the polymeric stabilizer may be from 2,000 to 200,000 and preferably 5,000 to 100,000. Other high molecular weight stabilizers are also within the contemplation of the invention.

One preferred stabilizer is a polyisobutylene-wax mixture of normal slack wax as obtained from medium neutral oil or bright stock oil, and a polyisobutylene in a m.w. range of 100,000 to 200,000, and up 1,000,000.

The polymeric stabilizer should only present in amounts of from about 0.01 to 0.5 weight percent based on the weight of the unfoamed petrolatum, and preferably 0.02 to 0.2 weight percent.

It has also been found that some of the oil may be substituted with polymeric materials having molecular weights in about the range as the molecular weight of the oil fraction.

It is important to note that the presence of the limited measured proportions of the high polymeric stabilizers further provides a structurally intact petrolatum or petroleum jelly foam, which absent such stabilizers might not necessarily always be the case.

TABLE I

	Viscosity 60°-80°C	DIN 51562	cST(-mm^2/s)	50-10,000
5	ASTM Dropping Point, on a sample conditioned as for penetration	DIN 51801 BI 1	°C	min. 74-78
	Drop Melting Point	ASTM D 127	°C	min. 78
	Cone Penetration at 25°C	DIN 51580	0.1 mm	min. 60-70
	COC Flash Point	DIN 51376	°C	min. 280
10	Volume Resistivity at 100°C	DIN 53482	GRm	min. 20
	Rel. Permittivity 20°C 50 Hz	DIN 53483		max. 2.3
	Congealing Point	DIN 50556	°C	min. 73-74
15	ASTM Colour	DIN 51578	°C	max. 5.0
	Density at 20°C		kg/m^3	890-900
	Plasticity at -10°C	VDE 0291 Teil	1/2.72 S 10	passes
	Requirements M 142 (B.P.O.)			passes
20	Requirement FTZ 72 TV 1 (Bundespost)			passes
	Requirements RIT (Belgium)			passes

DIN - Deutsche Industrial Norm.

VDE - Verein Deutscher Elektrotechniker

Teil - Part of Volume

BPO - British Post Office

FTZ - Fernmelde technisches Zentralamt (Technical Department of the Deutsche Bundespost)

R.T.T. - Regie Telegrafie Telefonie Belgium

TABLE II

	Range	Preferred Range
Foaming Temp	50°-95°C	80-90°C
Liquid: Solid (wt.)-ASTM D-721	40:60 to 90:10	50:50 to 80:20
Solid particulate size	100 microns	5 to 10 microns
Gas volume	35-55%	55%

The following examples illustrate the present invention.

Example I

A petrolatum having the properties of Table I with a melting point of 78°C min., was subjected to foaming in an Oates Foaming Machine having the following settings:

Back pressure - 85 psi
Temperature - 88°C
Air - 6 psi
Line pressure - 110 psi

Rotor - 380

Pump - 380

Valve setting - 5 threads (approx.)

Hose Length - 19 feet, constricting valve to discharge

In an operating period of 25 minutes, a consistent foam was produced having a cupweight of 96 grams (200 ml. cup, tare weight is 6 gm.), which converts into almost a 1:1 air/petrolatum ratio.

A second operating run at the same machine setting produced a foam with cupweights of 110 to 120 grams.

In operating the Oates Foaming Machine, back pressure should be maintained in order to prevent "blow by", and the viscosity is maintained by cooling the material during foam formations.

Example II

A petrolatum as in Example I was formed in a Oates Foaming Machine having the following settings:

Back pressure - 15 psi

Temperature 0-80°C

Air - 14-15 psi

Pump - 400 psi

Rotor - 250

The foam cupweight was 119 grams per 200 ml. cup (sp.gr. 0.6). The foam had a microscopic closed-cell structure.

Example III

A petrolatum as in Table I having a melting point less than that of Examples I and II was foamed in the machine having the following settings:

Back pressure - 15 psi
Temperature - 60°C initially (38° - 40°C)
Air - 15 psi
Pump - 400 psi
Rotor - 250

The foam cupweight was relatively high at 150-165 gm/200 ml. the foam had a microscopic closed-cell structure.

Example IV

Example III was repeated except that 0.1% wax polyisobutylene mixture was added to the petrolatum, and the back pressure increased to 36 psi.

The foamed product had a microscopic cell structure and a cupweight of 129 gms. per 100 ml.

Example V

The foamed products of Examples II, III and IV were injection molded into a braided hose and allowed to set.

Example VI

A petrolatum as in Example I was foamed in the aforedescribed manner (with assurance that the mixing head was cooled) both with and without a polymeric stabilizer, and further compared with a

control sample showing the dielectric constant prior to foaming, as follows:

Sample No.	Foam
1	Petrolatum
2	Petrolatum + 0.27 weight percent polyisobutylene

The foamed products of Samples 1 and 2 had densities of 520 kg/m^3 and 510 kg/m^3 respectively, and exhibited dielectric constants at 500 V at 50 Hz as follows:

Sample No.	Foam
1	$E_r = 1.85$
2	$E_r = 1.85$
Control	Unfoamed Petrolatum
	$E_r = 2.30$

The composition of Example VI were filled into a multi-conductor cable as shown in Figs. 1 and 2.

As previously stated it is within the contemplation of this invention to include certain limited percentages of other materials in the petrolatum composition, such as polyolefins and additional waxes with melting points up to 220°F, particularly relatively high percentages of microcrystalline waxes. Synthetic waxes are also preferred and include Fischer-Tropsch waxes or polyethylene waxes, ester waxes and the like. Natural waxes such as montan, candelilla, carnauba, are also useful. Microcrystalline waxes or other materials that tend to be readily reduced to fine particulates are most preferred.

Other materials may be added to the petrolatum, such as antioxidants, color agents, gelling agents, thickening agents and the like. The useful amounts of these latter said materials are readily known to one skilled in the art.

The composition of the present invention may be formed by one of several known foaming techniques to provide a foam having up to about 55% by volume of a gas in a closed-cell configuration. Particularly suited foaming operations are those mechanical processes involving agitation and whipping action. It has been found that foam cup weight may be 90 gm/200 ml to 135 gm/200 ml and preferably 95 gm/200 ml; although cup weights less than 90 gm/200 ml and more than 135 gm/200 ml have been found useful. The resultant filler should have a dielectric constant of less than 5 and preferably less than 2, and the foam produced pursuant to this invention has been found to exhibit a dielectric constant less than 2.

Cables containing the foamed petrolatum as a filler can be fabricated by suitable techniques well known in the art. An exemplary technique for fabricating a twisted, multi-pair communication cable includes the steps of passing a plurality of twisted pairs of insulated conductors in a forming zone to produce a bundle of the conductors and subsequently passing the bundle of the conductors through a stuffer box. The stuffer box is connected to an injection pump by means of a conduit which serves to inject the foamed petrolatum from the pump to the stuffer box. The foamed composition is passed through the side of the stuffer box under sufficient

pressure to force it into the interstices between the several insulated conductors. The stuffer box can be adjusted to provide a layer of the petrolatum composition around the periphery of the bundle of conductors. The bundle of conductors including the foamed composition disposed within the bundle is passed from the stuffer box to a core wrapping machine which longitudinally folds first a strip of paper and then a strip of aluminum around the bundle. In a preferred embodiment, the strip of aluminum has an adhesive coating of a random copolymer of ethylene and acrylic acid on both sides for the purpose of achieving a bond between the overlapped edges of the strip. After the core wrap has been applied, the bundle having the core as its outer-most surface is passed through a crosshead die attached to an extruder which extrudes a sheath layer of polyethylene containing carbon black around the core wrap. The resulting cable is then collected on a take-up reel. While the several foregoing steps can be performed individually with interruptions between each step, it is generally preferred that the cable be fabricated on a continuous basis to avoid the necessity of using storage reels between the several steps.

It is also within the contemplation of this invention, that in lower (below 100) pair cables, the improved dielectric properties will now make it possible to use less insulation thus resulting in further savings in material costs.

The present foamed material when replacing the prior art liquid fillers, minimizes the practice of cable draining now common with liquid-filler cables.

Although there has been described a preferred embodiment of this novel invention, many variations and modifications will now be apparent to those skilled in the art. Therefore. this invention is to be limited, not by the specific disclosure herein, but only by the appended claims.

C L A I M S

1. A cable filler comprising: a petrolatum, formed in a closed-cell foam, and wherein the petrolatum comprises a liquid oil portion and a solid wax portion, and wherein the solid portion comprises fine wax particulates dispersed in the liquid portion, wherein the oil comprises at least about from 40% to 90% by weight of the petrolatum at about 50°-80°C, whereby the petrolatum foam is used to fill a cable.

2. The cable filler of claim 1, wherein the oil comprises at least about 50% by weight of the petrolatum at about 80°-90°C.

3. The cable filler of claim 1, wherein the structural viscosity of the petrolatum before foaming is about 50 to 10,000 centistokes at about 60°-80°C.

4. The cable filler of claim 3, further comprising air filling said cell volume.

5. The cable filler of claim 1, wherein substantially all the wax particulates are less than 100 microns in size.

6. The cable filler of claim 5, wherein the wax particulates are about 5 to 10 microns in size.

7. The cable filler of claim 6, wherein said filler consists of wax, oil, air, and a polymeric stabilizer.

8. A communication cable comprising: an outer sheath; a plurality of electrical conductor cables disposed at the core of said outer sheath; and a filler disposed between the interstices of said conductor cables; said filler comprising: a petrolatum,

formed in a closed-cell foam, and wherein the petrolatum comprises a liquid oil portion and a solid wax portion, and wherein the solid portion comprises dispersed wax particulates in the liquid portion; and wherein the oil comprises at least about 40% by weight of the petrolatum at about 50°-95°C.

9. The cable of claim 8, wherein substantially all the wax particulates are less than 100 microns in size.

10. The cable of claim 9, wherein the wax particulates are about 5 to 10 microns in size.

11. The cable of claim 10, wherein the viscosity of the petrolatum before foaming is about 50 to 10,000 centistokes at about 60°-80°C.

12. The cable of claim 11, wherein said cell volume is at least about 55% and further comprising an inert gas filling said volume.

13. A method of making a cable filler comprising: heating a petrolatum to a temperature between about 50°C to 95°C so as to provide a liquid oil portion of at least about 40% by weight; adding a gas under pressure at said temperature; and agitating the petrolatum to form a closed-cell foam.

14. The method of claim 13, wherein said petrolatum comprises wax particulates, and wherein said agitating comprises shearing so as to reduce the wax particulate size, wherein substantially all the wax particulates are reduced to less than 100 microns in size.

15. The method of claim 14, wherein the wax particulates are about 5 to 10 microns in size.

16. The method of claim 13, wherein the viscosity of the petrolatum before foaming is about 50 to 10,000 centistokes at about 60°-80°C.

17. The method of claim 13, wherein said cell volume is about 55% and the closed-cells are micro-voids of less than about 100 microns.

18. The method of claim 13, wherein said gas is an inert gas.

19. The method of claim 13, said oil being from 40% to 90% by weight.

20. A cable filler consisting essentially of a petrolatum as a stable, microscopic, air-filled, closed-cell foam.

21. The cable filler of claim 20, further consisting essentially of a polymeric stabilizer present in an amount of from about 0.01 to 0.5 weight percent based on the weight of the unfoamed petrolatum.

22. The cable filler of claim 20, further consisting essentially of a polymeric stabilizer present in an amount of from about 0.02 to 0.2 weight percent based on the weight of the unfoamed petrolatum.

23. The cable filler of claim 20, wherein the petrolatum consists essentially of a liquid oil portion and a solid wax portion, and wherein the solid wax portion comprises fine wax particulates dispersed in the liquid portion, wherein the oil comprises at least about from 40% to 90% by weight of the petrolatum at about 50°-80°C.

24. The cable filler of claim 23, wherein the oil is at least about 50% by weight of the petrolatum at about 80°-90°C.

25. The cable filler of claim 20, wherein the structural viscosity of the petrolatum before foaming is about 50 to 10,000 centistokes at about 60°-80°C.

26. The cable filler of claim 23, wherein substantially all the wax particulates are less than 100 microns in size.

27. The cable filler of claim 25, wherein the wax particulates are about 5 to 10 microns in size.

FIG.1

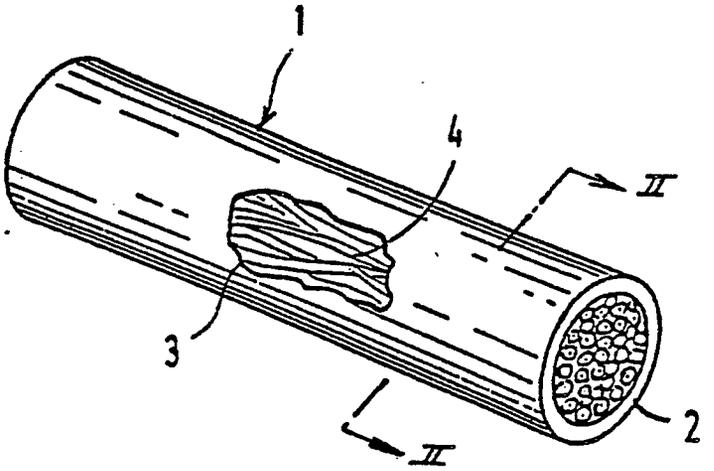
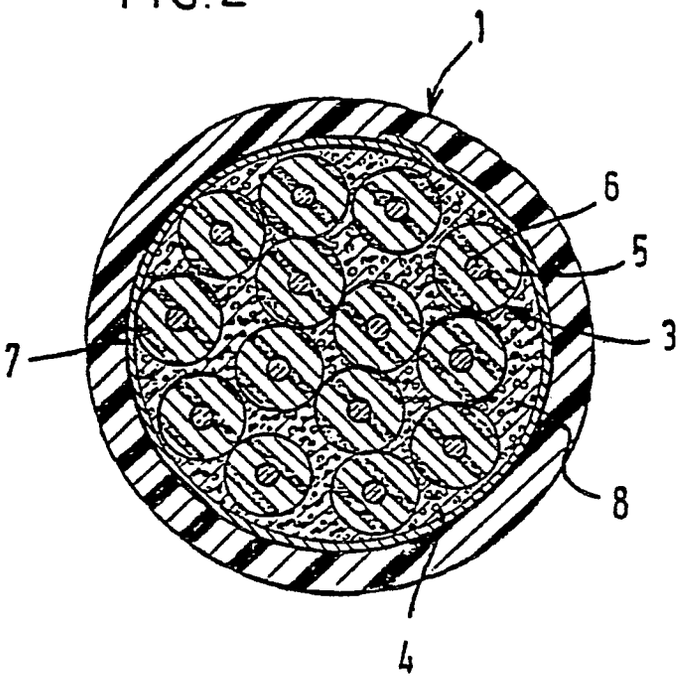


FIG.2



European Patent Office

EUROPEAN SEARCH REPORT

0081248
Application number

EP 82200424.8

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
	EP - A2 - 0 039 867 (SIEMENS)		H 01 B 7/28
X	* Page 10, line 34 - page 13, line 27 *	1,3,4, 7,8,11, 12	H 01 B 13/22
Y	* Page 10, line 34 - page 13, line 27 *	20-23, 25,17-19	
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	EP - A1 - 0 037 611 (WITCO)		
X	* Page 4, line 19 - page 11, line 9 *	13,16, 20-22, 25	
Y	* Page 4, line 19 - page 11, line 9 *	17-19	
	--		
X,D	DE - A1 - 2 243 615 (SIEMENS)	20,21	
	* Page 5, last paragraph - page 8, claim 2 *		
	--		TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
A,D	US - A - 3 060 136 (NELSON et al.)	1,7,13, 20,21	H 01 B 7/00
	* Column 1, line 42 - column 6, table 2 *		H 01 B 13/00
			H 01 B 3/00
	----		H 01 B 11/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	17-02-1983	KUTZELNIGG

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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