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(54) **Encapsulating composition for use on spliced cable**

(57) An encapsulating material for use on the spliced connections of cable connectors is disclosed. The encapsulating material protects the spliced connections from signal disruptions attributable to both moisture and debris transported onto the cable connectors by insects. The encapsulating material is a mixture of a

styrene-rubber block copolymer and a microbe-resistant extender material. Microbe-resistant extender materials that are hydrophobic include branched hydrocarbon compounds and silicon compounds. The encapsulating material optionally includes polyethylene. The polyethylene improves the flow resistance of the encapsulating material.

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Description

1. Field of the Invention

[0001] The present invention relates generally to cable connectors, and more particularly, to cable connectors including encapsulating compositions that protect spliced connections from moisture.

2. Description of the Related Art

[0002] For many telecommunication applications, environmental factors (e. g., water, temperature) potentially affect system performance. For example, trunk cables typically transmit hundreds of telephone and/or data communications to individual customer lines. Cable connectors splice the individual customer lines to the trunk cables. Substantial portions of the trunk cables and individual customer lines are buried beneath the ground. However, the spliced cable connectors are in enclosures located at or near ground level.

[0003] Under moist conditions (above about 85 % humidity) or upon direct exposure to water, signal leakage (a voltage drop) potentially occurs at the spliced cable connections. The signal leakage disrupts signals transmitted through the cable connector and causes noise (e. g., static, cross-talk) on the customer lines. The intrusion of water onto the cable connectors also fosters corrosion of the spliced cable connections, affecting their durability.

[0004] To avoid the problems associated with moist and/or wet conditions, the cable connectors have an encapsulating material thereon. The encapsulating material prevents the intrusion of water on the spliced cable connections. Many considerations are important to the selection of a suitable encapsulating material such as cost, toxicity, dielectric properties, handling characteristics, its stability over time, the hydrophobic nature of the material, its performance at low temperatures (below about 20 °F), and its resistance to flow at warm temperatures (above about 90 °F).

[0005] U. S. Patents 3,607,487 and 3,717,716 issued September 21, 1971 and February 20, 1973, respectively, discuss encapsulating materials that satisfy most of these criteria. The water-blocking materials described in these patents are essentially a mixture of petroleum jelly and a polymer, usually polyethylene. Such petroleum jelly-polyethylene mixtures are hydrophobic and therefore suitable for water-blocking applications.

[0006] While the petroleum jelly-polyethylene materials provide good water-blocking capability, the handling characteristics of such materials are undesirable. For example, petroleum jelly-polyethylene materials typically have a consistency of a grease-like substance. When operating personnel splice cable connections that contain petroleum jelly-polyethylene materials, their hands, equipment, and clothing are typically soiled. Moreover, removing the petroleum jelly-polyethylene material from

the spliced connections is time consuming and messy. Since telephone installation and repair is labor intensive and therefore costly, there is a desire to make splicing tasks as fast and easy as possible.

[0007] U. S. Patent 4,259,540 issued March 31, 1981 in the name of R. A. Sabia discusses encapsulating materials that have better handling characteristics than the petroleum jelly-polyethylene materials. The Sabia patent describes a water-blocking material that is a mixture of a styrene-rubber block copolymer and a low molecular weight (less than about 500) hydrocarbon compound. The styrene-rubber block copolymer mixture forms an encapsulating material that has the consistency of a gum eraser. Encapsulating materials having the consistency of a gum eraser provide handling characteristics that are suitable for reducing the costs associated with performing splicing tasks.

[0008] The term block copolymer as used in this disclosure refers to a polymer made of at least two polymeric units, arranged in sequences (blocks) where one polymeric unit alternates with sequences of another polymeric unit. For example, the styrene-rubber block copolymer is made of styrene polymeric units and rubber polymeric units, arranged in sequences wherein the styrene polymeric units alternate with the rubber polymeric units.

Summary of the Invention

[0009] In addition to providing water-blocking capabilities, there is a desire to have encapsulating materials that protect cable connectors from insects (e. g., ants, spiders, and beetles). Since cable connectors are in enclosures located at or near ground level, they are susceptible to debris transported by insects. For example, insects transport debris found in soils such as microorganisms (e. g., fungi and bacteria) and chemical elements (e. g., potassium, sodium and magnesium) on their bodies.

[0010] Insect debris, when transported onto many encapsulating materials, has the potential to disrupt signals transmitted through the spliced connections in a variety of ways. For example, many encapsulating materials include hydrocarbon compounds having straight chain configurations. Hydrocarbon compounds having straight chain configurations are capable of assimilation (absorption as food) by microorganisms such as fungi and bacteria. Thus, encapsulating materials having hydrocarbon compounds with straight chain configurations are potentially removed by the microorganisms, leaving the cable connectors unprotected.

[0011] When microorganisms remove encapsulating material from the cable connectors, the spliced connections are potentially affected by water and/or the chemical elements transported on the bodies of insects. For example, as the microorganisms assimilate the encapsulating material, they form paths through such material to the spliced connections. Under moist conditions, wa-

ter and/or chemical elements seep into the paths to the spliced connections, disrupting signals transmitted through the cable connector.

[0012] The present invention is directed to an encapsulating material not assimilated by microorganisms. The encapsulating material is a mixture of a styrene-rubber block copolymer and a microbe-resistant extender material. The term microbe-resistant as used in this disclosure refers to a material with a growth rate for microorganisms of zero (see ASTM Method G21-1996). The term extender material as used in this disclosure refers to a material which solvates and/or gels with the block copolymer. Extender materials that are microbe resistant as well as hydrophobic include branched hydrocarbon compounds and silicon compounds.

[0013] In one embodiment of the present invention, the encapsulating material is about 70 % to about 98 % by weight of the microbe-resistant extender material and about 1 % to about 15 % by weight of the block copolymer. Encapsulating materials with such compositions have viscosities of about 33 centipoise to about 44 centipoise at a temperature of about 110 °C (ASTM Method D2669). Such materials have the handling consistency of a gum eraser at ambient temperatures.

[0014] It is desirable for the microbe-resistant extender material to have a molecular weight greater than about 200. Microbe-resistant extender materials having molecular weights less than about 200 are undesirable because encapsulating materials made therefrom do not have viscosities within the prescribed range.

[0015] Block copolymers suitable for forming the encapsulating material of the present invention optionally include di-block copolymers, tri-block copolymers, or mixtures of di-block copolymers and tri-block copolymers. The term di-block copolymer refers to a polymer which has sequences with two polymeric units. The term tri-block copolymer refers to a polymer which has sequences with three polymeric units. Examples of di-block copolymers and tri-block copolymers include styrene-ethylene butylene (S-EB) di-block copolymers and styrene-ethylene butylene-styrene (S-EB-S) tri-block copolymers.

[0016] Other objects and features of the present invention will become apparent from the following detailed description considered in conjunction with the accompanying drawings. It is to be understood, however, that the drawings are designed solely for purposes of illustration and do not serve to limit the invention, for which reference should be made to the appended claims.

Brief Description of the Drawings

[0017] FIG. 1 is a cross-sectional view of a cable connector with the encapsulating material of the present invention thereon.

Detailed Description

[0018] The present invention is directed to an encapsulating material for use on cable connectors. The encapsulating material protects the spliced connections on the cable connectors from signal disruptions attributable to both moisture and microorganisms (e. g., bacteria and fungi).

[0019] FIG. 1 is a cross-sectional view of a cable connector **100**. Cable connector **100** has a multi-component structure. The multi-component structure includes a top section **102** and a bottom section **103**, connected one to the other. Cable connector **100** has pairs of conductive pads **105** positioned at the interface between the top section **102** and the bottom section **103**. The top section **102** and the bottom section **103** of cable connector **100** are made from a plastic material such as polycarbonate. The pairs of conductive pads **105** are made from a metal such as aluminum.

[0020] Cable connector **100** forms spliced connections between a first transmissive medium **115** (e. g., trunk cables) and a second transmissive medium **120** (e. g., individual customer lines) using the pairs of conductive pads **105**. An encapsulating material **125**, applied on the spliced connections at the pairs of conductive pads, protects the spliced connections from moisture.

[0021] In addition, the encapsulating material **125** prevents signal disruptions attributable to debris transported onto the cable connector **100** by insects. Typically, cable connectors such as cable connector **100** are in enclosures located at or near ground level. Since the cable connectors are at ground level, they are susceptible to debris transported by insects. For example, insects transport debris found in soils such as microorganisms (e. g., fungi and bacteria) and chemical elements (e. g., potassium, sodium and magnesium) on their bodies.

[0022] Insect debris, when transported onto many encapsulating materials, has the potential to disrupt signals transmitted through the spliced connections. For example, many encapsulating materials include hydrocarbon compounds having straight chain configurations. Hydrocarbon compounds having straight chain configurations are capable of assimilation by microorganisms such as fungi and bacteria. Thus, encapsulating materials having hydrocarbon compounds with straight chain configurations are undesirable, since such materials are also capable of assimilation by microorganisms. When microorganisms assimilate the encapsulating material, it is removed and the spliced connections are exposed to water or other environmental factors.

[0023] The encapsulating material of the present invention has a composition not assimilated by microorganisms. The encapsulating material of the present invention is a mixture of a microbe-resistant extender material and a styrene-rubber block copolymer. The term

extender material as used in this disclosure refers to a material which solvates and/or gels with the block copolymer. The term microbe-resistant as used in this disclosure refers to a material with a growth rate for microorganisms of zero (see ASTM Method G21-1996). Extender materials that are microbe-resistant and which are also hydrophobic include branched hydrocarbon compounds and silicon compounds. (See, Potts, J. E. et al., "The Biodegradability of Synthetic Polymers", ACS Polymer Preprints, vol. 13, No. 2, pp. 629-633, (1972)).

[0024] The term branched hydrocarbon compound as used in this disclosure refers to a carbon-based compound having a linear series of carbon atoms with at least one subordinate chain of one or more carbon atoms. For example, isobutane is a branched hydrocarbon compound. Branched hydrocarbon compounds are saturated or unsaturated.

[0025] Branched hydrocarbon compounds suitable for use as the microbe-resistant extender material include hydrocarbon oils. Hydrocarbon oils are mixtures of one or more branched hydrocarbon compounds. Suitable hydrocarbon oils having branched hydrocarbon compounds include polyalphaolefins, polypropylenes, polypropylene glycols, polybutenes, polyisobutylenes, and polyolefins (e.g., polydecenes, polyoctenes, polydodecenes, and mixtures thereof). Examples of commercially available branched hydrocarbon oils include the SHF and Supersyn series of oils made by Mobile Chemical Company.

[0026] Suitable silicon compounds are compounds with a linear series of alternating silicon atoms and oxygen atoms. The silicon atoms are substituted or unsubstituted. Examples of suitable silicon compounds include polysilanes, polysiloxanes, polysiloalkenes, and polysiloarylenes.

[0027] It is desirable for the microbe-resistant extender material to have an average molecular weight greater than about 200. Microbe-resistant extender materials having average molecular weights less than about 200 are undesirable because encapsulating materials made therefrom do not have viscosities of about 33 centipoise to about 44 centipoise at a temperature of about 110 °C. Viscosities within the prescribed range provide encapsulating materials having the handling consistency of a gum eraser.

[0028] The block copolymers suitable for forming the encapsulating material optionally include di-block copolymers, tri-block copolymers, or mixtures of di-block copolymers and tri-block copolymers. Examples of di-block copolymers and tri-block copolymers include styrene-ethylene butylene (S-EB) di-block copolymers and styrene-ethylene butylene-styrene (S-EB-S) tri-block copolymers.

[0029] For encapsulating materials with styrene-rubber block copolymers, the styrene-rubber ratio is preferably about 0.2 to about 0.5. The term styrene-rubber ratio as used in this disclosure refers to the weight ratio

of the styrene block to the rubber block in the polymer. Such a styrene-rubber ratio is desirable since encapsulating materials made therewith typically have an elastic memory. Encapsulating materials with elastic memories have the ability to return to their original configuration after elongation. For example, encapsulating materials deform when electrical wires are inserted therein. Upon the removal of the electrical wires, the encapsulating material with elastic memory returns to its original shape, filling the voids resulting from the removal of the wires.

[0030] The encapsulating material of the present invention has a composition which includes about 70 % to about 98 % by weight of the microbe-resistant extender material and about 1 % to about 15 % by weight of the block copolymer. Encapsulating materials with such compositions have viscosities of about 33 centipoise to about 44 centipoise at a temperature of about 110 °C (ASTM Method D2669). Such materials have the handling consistency of a gum eraser at ambient temperatures.

[0031] The composition of the encapsulating material optionally includes about 1 % to about 15 % by weight polyethylene. Polyethylene increases the flow resistance of the encapsulating material from a temperature of about 90 °C to a temperature between about 110 °C to about 130 °C, without affecting its viscosity. Some polyethylene polymers are low molecular weight (i. e., about 200-600) hydrocarbon compounds with straight chain configurations capable of assimilation by microorganisms. However, encapsulating materials having compositions within the specified range of weight percents for polyethylene, remain resistant to such assimilation.

[0032] Additionally, the composition of the encapsulating material optionally includes additives such as antioxidants, copper deactivators, and colorants.

[0033] The following examples are provided to illustrate a specific embodiment of the present invention.

Example 1

[0034] About 91 % by weight of a straight chain hydrocarbon oil, Drakeol 35, was heated to a temperature of about 130 °C. The Drakeol 35 was obtained from Penreco Company. About 0.5 % by weight of an antioxidant, Irganox 1035, and about 0.05 % by weight of a copper deactivator, Irganox 1024, were added to the Drakeol 35 to form an extender mixture. Both the Irganox 1035 and the Irganox 1024 were obtained from Ciba Geigy Company.

[0035] Thereafter while stirring, about 3 % by weight of a block copolymer, Kraton G 1650, was added to the extender mixture. Kraton G 1650 is a styrene-ethylene butylene-styrene (S-EB-S) tri-block copolymer. The Kraton G 1650 was obtained from Shell Chemical Company. Additionally, about 6 % by weight polyethylene, AC9A, and about 0.002 % by weight of a dye, oil blue

A, were added to the extender-block copolymer mixture. The AC9A was obtained from Allied Chemical Company and the oil blue A was obtained from the Keystone Aniline Chemical Company. The oil blue A was added so the encapsulating material has a blue color.

[0036] The encapsulating mixture was stirred until a homogenous mixture free of agglomerates was obtained. Thereafter, an encapsulating gel was formed by maintaining the encapsulating mixture at a temperature of about 150 °C for 1-2 hours, in a N₂ gas atmosphere.

[0037] A one-inch glass tube was filled with the blue-colored encapsulating gel. Ant debris was placed in the glass tube on the encapsulating gel. The glass tube with the encapsulating gel and ant debris was maintained at a temperature of about 80 °F and stored in an atmosphere with a relative humidity of about 85 % for 30 days. After 30 days, the color of the encapsulating gel changed from blue to a greenish-brown color. Additionally, the volume of the encapsulating material in the glass tube was reduced by about 15 %. Such a color change for the encapsulating material as well as the reduction in volume are indicative of the assimilation of such material by microorganisms.

Example 2

[0038] About 90.5 % by weight of a branched hydrocarbon oil, SHF-82, was heated to a temperature of about 130 °C. The SHF-82 was obtained from Mobile Chemical Company. Thereafter, an encapsulating gel was formed using the same conditions as well as the same weight percents for the antioxidant, the copper deactivator, the tri-block copolymer, the polyethylene, and the dye that were specified in Example 1.

[0039] A one inch glass tube was filled with the blue-colored encapsulating gel and ant debris as described in Example 1. The glass tube and the encapsulating gel were maintained at the same temperature and relative humidity as in Example 1. The blue color of the encapsulating gel as well as the volume of material in the glass tube remained unchanged after 90 days, which is indicative of the microbe-resistance of the encapsulating gel.

Example 3

[0040] About 90.5 % by weight SHF-82 was mixed with about 0.5 % by weight Irganox 1035. The microbe-resistant extender mixture was heated in a nitrogen atmosphere to about 150 °C. While maintaining the microbe-resistant extender mixture at 150 °C, about 3 % by weight Kraton G 1650 and about 6 % by weight AC9A were added, followed by about 0.05 % by weight Irganox 1024 and about 0.002 % by weight oil blue A.

[0041] A one inch glass tube was filled with the blue-colored encapsulating gel and ant debris as described in Example 1. The glass tube and the encapsulating gel was maintained at the same temperature and relative humidity as in Example 1. The blue-color of the encapsulating gel as well as the volume of material in the glass tube remained unchanged after 90 days, which is indicative of the microbe-resistance of the encapsulating gel.

solating gel as well as the volume of material in the glass tube remained unchanged after 90 days, which is indicative of the microbe-resistance of the encapsulating gel.

Claims

1. An encapsulating material for use on a cable connector, the encapsulating material comprising a mixture of:

about 70 % to about 98 % by weight of a microbe-resistant extender material; and
about 1 % to about 15 % by weight of a block copolymer.

2. The encapsulating material of claim 1 wherein the microbe-resistant extender material is selected from the group consisting of a branched hydrocarbon compound and a silicon compound.

3. The encapsulating material of claim 2 wherein the branched hydrocarbon compound comprises saturated branched hydrocarbon compounds.

4. The encapsulating material of claim 2 wherein the branched hydrocarbon compound is selected from the group consisting of polyalphaolefins, polypropylenes, polypropylene glycols, polybutenes, polyisobutylenes, and polyolefins.

5. The encapsulating material of claim 1 wherein the microbe-resistant extender material has a molecular weight greater than about 200.

6. The encapsulating material of claim 2 wherein the silicon compound is selected from the group consisting of polysilane, polysiloxane, polysiloalkene and polysiloarylene.

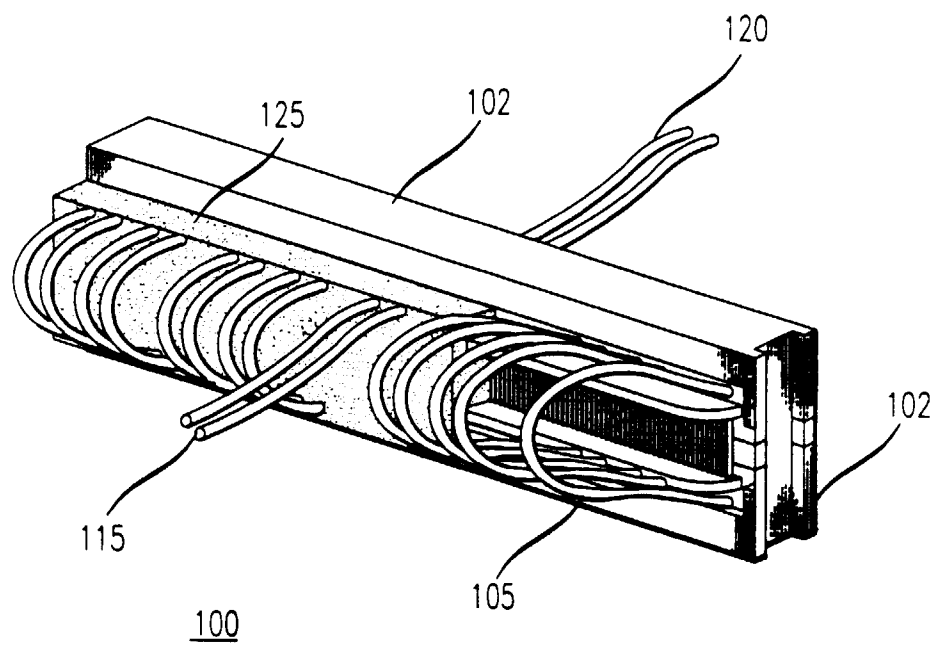
7. The encapsulating material of claim 1 wherein the block copolymer is a styrene-rubber block copolymer.

8. The encapsulating material of claim 7 wherein the styrene-rubber block copolymer has a styrene/rubber ratio of about 0.2 to about 0.5.

9. The encapsulating material of claim 7 wherein the styrene-rubber block copolymer is selected from the group consisting of styrene-ethylene butylene (S-EB) copolymers and styrene-ethylene butylene-styrene (S-EB-S) copolymers.

10. The encapsulating material of claim 1 further comprising about 1 % to about 15 % by weight polyethylene.

FIG. 1





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 98 30 9194

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.6)
P, X	PATENT ABSTRACTS OF JAPAN vol. 098, no. 011, 30 September 1998 & JP 10 172358 A (FUKUOKA CLOTH KOGYO KK), 26 June 1998 * abstract *	1-4, 6	H01B7/28
A	US 4 535 197 A (BUTLER DAVID O) 13 August 1985 * column 5, line 51 - column 12 *	1-4	
A	EP 0 749 128 A (AT & T CORP) 18 December 1996 * claims 1-9 *	1, 7-9	
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			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			H01B
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 2 February 1999	Examiner Drouot, M-C
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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02-02-1999

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82