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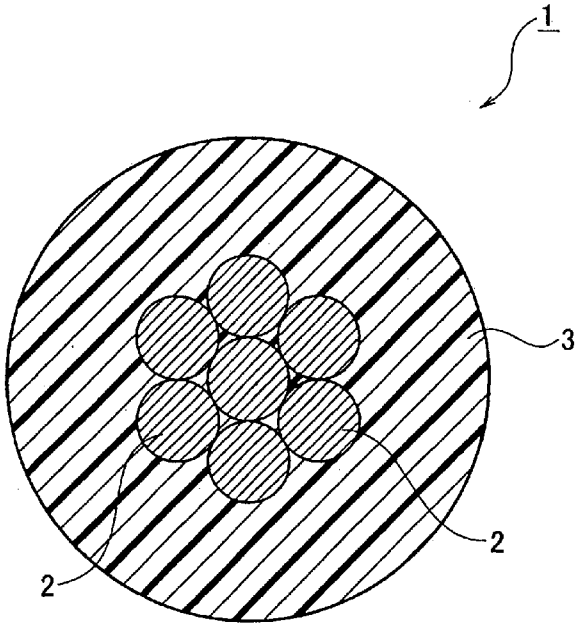
(54) Title: SHEATHED ELECTRICAL CABLE FOR MOTOR VEHICLE

FIG.4



(57) Abstract: The present invention is to provide a sheathed electrical cable for motor vehicle having a f ire-retardancy as well as a mechanical property such as a wear resistance. An insulation sheath of the electrical cable is made of a f ire-retardant resin composition containing 100 parts by weight of a base resin and 70-200 parts by weight of a metal hydrate f ire-retardant additive. The base resin contains (A) 70-90 parts by weight of a polypropylene resin and (B) 30-10 parts by weight of an olefin or a styrene thermoplastic elastomer, and the metal hydrate fire- retardant additive is halogen free, and surface-treated with a fatty acid including unsaturated bond or with a silane treatment agent.

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Published:

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DESCRIPTION

SHEATHED ELECTRICAL CABLE FOR MOTOR VEHICLE

Technical Field

The present invention relates to a sheathed electrical cable for motor vehicle having an insulation sheath formed with a fire-retardant resin composition.

Related Art

It is requested that a fire-retardant resin composition of an insulation sheath of a sheathed electrical cable does not generate a halogen gas, which is harmful to a human body and a cause of corrosion. A conventional fire-retardant resin composition contains a fire-retardant additive such as magnesium hydroxide (for example, see JP 2009-40947 A, JP 2008-169273 A).

The conventional fire-retardant resin composition contains a large amount of the fire-retardant additive such as magnesium hydroxide to attain the fire-retardancy. The large amount of the fire-retardant additive largely reduces a variety of mechanical properties such as wear resistance. Demand for the fire-retardancy of the electrical cable insulation increases year by year. The conventional insulation sheath of the electrical cable contains 60-90 parts by weight of magnesium hydroxide. However, this

amount does not satisfy the fire-retardancy of the electrical cable. The increase of the amount of the fire-retardant additive further reduces the mechanical properties.

Disclosure of the Invention

An object of the present invention is to provide a sheathed electrical cable for a motor vehicle having a satisfactory fire-retardancy, while keeping a variety of mechanical properties such as a wear resistance, without generating a halogen-based gas.

According to a first object of the present invention, a sheathed electrical cable for motor vehicle, has a conductor and an insulation sheath covering the conductor, the insulation sheath being made of a fire-retardant resin composition containing 100 parts by weight of a base resin and 70-200 parts by weight of a metal hydrate fire-retardant additive, wherein the base resin contains (A) 70-90 parts by weight of a polypropylene resin and (B) 30-10 parts by weight of an olefin or a styrene thermoplastic elastomer, and the metal hydrate fire-retardant additive is halogen free, and surface-treated with a fatty acid including unsaturated bond or with a silane treatment agent.

(A) The polypropylene resin is, for example, propylene homopolymer, block copolymer of crystalline polyolefin and amorphous rubber, and copolymer of

ethylene/propylene/butene. The crystalline polyolefin is, for example, homopolymer or nonelastomer copolymer of ethylene, propylene, butene-1, hexene-1, and 4-methylpentene-1. It is preferable that the polypropylene resin contains a number of kinds. Among them, it is necessary to contain a polypropylene resin modified with maleic acid, that is, modified polypropylene resin. The modified polypropylene resin can be manufactured with melt process or solution process. The modified amount is 0.5-6.0 wt%, more preferably, 2-3 wt%. The amount of the maleic acid modified resin is 5-30 parts by mass, preferably, 15-20 parts by mass. When the amount of the maleic acid modified resin is less than the lower limit, wear resistance is reduced. When the amount of the maleic acid modified resin is more than the upper limit, elongation property is reduced. Also, it is suitable that polypropylene resin other than the maleic acid modified resin has elastic coefficient of 1,000-2,000 MPa.

(B) The olefin thermoplastic elastomer is, for example, a mixture of non-crystalline polyolefin and amorphous olefin copolymer rubber, propylene/ethylene random copolymer, propylene-α-olefin random copolymer, and propylene/ethylene-α-olefin random copolymer. The amorphous rubber is, for example, ethylene/propylene copolymer rubber (EPM), ethylene/1-butene copolymer rubber (EBM), ethylene/propylene/butene copolymer rubber, and

ethylene/propylene/non-conjugated diene copolymer rubber. Styrene thermoplastic elastomer besides the amorphous rubbers is block copolymer or random copolymer containing aromatic series vinyl polymer block (hard segment) and conjugated diene polymer block (soft segment). The aromatic series vinyl compound is α-alkyl substitute styrene (e.g., styrene, α-methylstyrene, α-ethylstyrene, α-methyl-p-methylstyrene), and nuclear alkyl substitute styrene (e.g., o-methylstyrene, m-methylstyrene, p-methylstyrene, 2,4-dimethylstyrene, ethylstyrene, 2,4,6-trimethylstyrene, o-t-butylstyrene, p-t-butylstyrene, p-cyclohexylstyrene). The conjugated diene compound is, for example, butadiene, isoprene, and methylpentadiene. The other rubber component is, for example, styrene-butadiene rubber (SBR), nitrile rubber, and butyl rubber (IIR).

(C) The metal hydrate fire-retardant additive is magnesium hydroxide, aluminum hydroxide and calcium hydroxide, and metal hydroxide such as hydrotalcite, talc, or clay, surface-treated with the fatty acid including the unsaturated bond or with the silane treatment agent.

The fatty acid including the unsaturated bond is oleic acid, linolenic acid, crotonic acid, mitoleic acid, palmitoleic acid, elaidic acid, vaccenic acid, linoleic acid, eleostearic acid, stearidonic acid, gadoleic acid, eicosapentaenoic acid, erucic acid, clupanodonic acid, docosahexaenoic acid, and nervonic acid.

The silane treatment agent for surface-treating the magnesium hydroxide, the aluminum hydroxide, the calcium hydroxide, and the metal hydroxide such as hydrotalcite, talc, or clay, is vinyltrichlorosilane, vinyltrimethoxysilane, vinyltriethoxysilane, vinyltris(β-methoxyethoxy)silane, β-(3,4-epoxycyclohexyl)ethyltrimethoxysilane, γ-glycidoxypropyltrimethoxysilane.

The surface coating treatment on the metal hydroxide particles with the silane treatment agent (silane coupling agent) is achieved with the conventional wet process or dry process. The wet process includes the steps of preparing a slurry of the magnesium hydroxide particles, adding a liquid or emulsion silane treatment agent to the slurry, and mechanically mixing the mixed slurry up to a temperature of about 100 degrees C. The dry process includes the steps of stirring the magnesium hydroxide particles with a mixer, adding the liquid, emulsion, or solid silane treatment agent to the particles, and fully mixing with heat or without heat.

In addition to the above essential components, the present invention can contain fire-retardant additive, fire-retardant auxiliary agent, anti-oxidizing agent, metal inactive agent, anti-aging agent, lubricant, filler and reinforcing material, UV absorbent, stabilization agent, plasticizing material, pigment, dye, coloring agent,

antistatic agent, and effervescent agent as long as they are not hindrance to the advantageous effects of the present invention.

Brief Description of the Drawings

FIG. 1 shows compounding ratios, and evaluation results of fire-retardancy, elongation property and wear resistance of Examples 1-11;

FIG. 2 shows compounding ratios, and evaluation results of fire-retardancy, elongation property and wear resistance of Examples 12-15;

FIG. 3 shows compounding ratios, and evaluation results of fire-retardancy, elongation property and wear resistance of Comparative Examples 1-12; and

FIG. 4 is a sectional view of a sheathed electrical cable of the present invention.

Best Mode for Carrying out the Invention

Embodiments of a sheathed electrical cable for motor vehicle of the present invention are explained in detail below.

Sheathed Electrical Cable for Motor Vehicle:

FIG. 4 is a sectional view of an embodiment of a fire-retardant electrical cable 1 of the present invention. The fire-retardant electrical cable 1 has a plurality of conductors 2, and an insulation sheath 3, which is made of

a fire-retardant resin composition, covering the conductors 2. It is apparent that the electrical cable 1 may include a single conductor 2.

Fire-Retardant Resin Composition:

The fire-retardant resin composition of the present invention contains 100 parts by weight of a base resin and 70-200 parts by weight of a metal hydrate fire-retardant additive. The base resin contains (A) 70-90 parts by weight of a polypropylene resin and (B) 30-10 parts by weight of an olefin or a styrene thermoplastic elastomer. The metal hydrate fire-retardant additive is a halogen-free metal hydrate surface-treated with a fatty acid containing an unsaturated bond or a silane treatment agent. All resins utilized here are non-cross linking type.

The polypropylene resin is, for example, propylene homopolymer, block copolymer of crystalline polyolefin and amorphous rubber, and copolymer of ethylene/propylene/butene. The crystalline polyolefin is, for example, homopolymer or nonelastomer copolymer of ethylene, propylene, butene-1, hexene-1, and 4-methylpentene-1. It is preferable that the polypropylene resin contains a number of kinds. Among them, it is necessary to contain a polypropylene resin modified with maleic acid, that is, modified polypropylene resin. The modified polypropylene resin can be manufactured with melt process or solution process. The modified amount is 0.5-6.0

wt%, more preferably, 2-3 wt%. The amount of the maleic acid modified resin is 5-30 parts by mass, preferably, 15-20 parts by mass. When the amount of the maleic acid modified resin is less than the lower limit, wear resistance is reduced. When the amount of the maleic acid modified resin is more than the upper limit, elongation property is reduced. Also, it is suitable that polypropylene resin other than the maleic acid modified resin has elastic coefficient of 1,000-2,000 MPa.

The olefin thermoplastic elastomer is, for example, a mixture of non-crystalline polyolefin and amorphous olefin copolymer rubber, propylene/ethylene random copolymer propylene-α-olefin random copolymer, and propylene/ethylene-α-olefin random copolymer. The amorphous rubber is, for example, ethylene/propylene copolymer rubber (EPM), ethylene/1-butene copolymer rubber (EBM), ethylene/propylene/butene copolymer rubber, and ethylene/propylene/non-conjugated diene copolymer rubber (EPDM).

Styrene thermoplastic elastomer is block copolymer or random copolymer containing aromatic series vinyl polymer block (hard segment) and conjugated diene polymer block (soft segment). The aromatic series vinyl compound is α-alkyl substitute styrene (e.g., styrene, α-methylstyrene, α-ethylstyrene, α-methyl-p-methylstyrene), and nuclear alkyl substitute styrene (e.g., o-methylstyrene, m-

methylstyrene, p-methylstyrene, 2,4-dimethylstyrene, ethylstyrene, 2,4,6-trimethylstyrene, o-t-butylstyrene, p-t-butylstyrene, p-cyclohexylstyrene). The conjugated diene compound is, for example, butadiene, isoprene, and methylpentadiene. The other rubber component is, for example, styrene-butadiene rubber (SBR), nitrile rubber, and butyl rubber (IIR).

The metal hydrate fire-retardant additive is magnesium hydroxide or aluminum hydroxide surface-treated with the fatty acid containing the unsaturated bond such as oleic acid, linolenic acid and the like, or surface-treated with the silane treatment agent.

The resin composition of the present invention has a high fire-retardancy, and also high mechanical properties such as wear resistance and elongation property. The fire-retardant resin composition is thus utilized for the insulation sheath of the electrical cable 1 of the motor vehicle because of a high reliability.

The embodiment of the sheathed electrical cable 1 of the present invention has the insulation sheath 3 with a thickness of 0.2-0.9 mm, which gives the improved wear resistance for use in the motor vehicle. The electrical cable 1 having the insulation sheath 3 with the thickness of 0.2-0.9 mm corresponds to the product names of CHFUS-0.13~1.5sq, HFSS-0.35~2f, and HF-3~8sq. The insulation sheath 3 with the thickness more than 0.9 mm increases its

own volume and reduces the fire-retardancy. The increase of the thickness reduces heat absorption of the conductors 2 when the insulation sheath 3 burns. The thick insulation sheath 3 retards the heat transfer to the central conductors 2. The standard electrical cable 1 for motor vehicle usually has the insulation sheath 3 with the thickness of more than 0.2 mm. The insulation sheath 3 with the thickness less than 0.2 mm exposes the conductors 2 when the insulation sheath 3 wears out, and is thus not adapted for the electrical cable of the motor vehicle.

Examples:

Examples and Comparative Examples of the present invention are explained by referring to FIGS. 1-3.

Materials Utilized for Examples and Comparative Examples:

(A) Polypropylene resin

The polypropylene resin was a polypropylene homopolymer of PS201A (Product of SunAllomer Ltd.). The modified polypropylene resin is Umex 1010 (Product of Sanyo Chemical Industries Ltd.).

(B) The olefin or the styrene thermoplastic elastomer was Q200f (Product of SunAllomer Ltd.).

(C) The metal hydrate fire-retardant additive was KISUMA-5P (Product of Kyowa Chemical Industry Co., Ltd.).

Beside the above materials,

(D) A supplemental agent (MD-1024: Product name of Ciba

Specialty Chemicals) for metal and (E) An anti-oxidizing agent (Irganox 1010: Product name of Ciba Specialty Chemicals) may be added.

Evaluation:

The evaluation of the fire-retardancy had the following steps of extrusion-forming the fire-retardant resin composition around the conductor, cutting the sheathed electrical cable for motor vehicle by a length of 600 mm, holding the sheathed electrical cable in a no-wind tank with an angle of 45 degrees, exposing a portion distant about 200 mm ± 5 mm from an upper end of the sample cable to a reducing flame of a Bunsen burner for 15 seconds, gently removing the flame, and measuring a time when the flame of the electrical cable disappears. The target value is at most 70 seconds. When the measured time is within 70 seconds, the electrical cable is evaluated as "acceptable, denoted by a circle", and the measured time is more than 70 seconds, the electrical cable is evaluated as "not acceptable, denoted by X".

The evaluation of the elongation property was achieved in accordance with JIS B 7721. The evaluation had the following steps of cutting the sheathe electrical cable by 150 mm, removing the conductors from the sheathed electrical cable to form a cylindrical shaped test piece of the insulation layer, indicating marks spaced 50 mm each other, attaching each end to an associated chuck of a

tension tester at a room temperature, pulling the insulation sheath by 25-500 mm/min, and measuring a distance between the marks. The insulation sheath is evaluated as "acceptable, denoted by the circle" when the extension is at least 500 percents and "not acceptable, denoted by X" when the extension is less than 500 percents.

The evaluation of wear resistance was achieved with the scrape wear resistance tester. The evaluation had the following steps of mounting the sheathed electrical cable of about 1 m on a sample holder, holding the electrical cable with a clamp, preparing a plunge having a piano wire of 0.45 mm, abutting the plunge to the end of the sheathed electrical cable, press-reciprocating the plunge with a total load of 7 N to the sheathed electrical cable by a distance of 14 mm, measuring a reciprocating cycle until the piano wire of the plunge reaches the conductors of the electrical cable due to the wear of the insulation layer. The insulation sheath is evaluated "acceptable, denoted by the circle" when the cycle is at least 300 and "not acceptable, denoted by X" when the cycle is less than 300.

Embodiments of the present invention are explained below, and Examples and Comparative Examples are compared. FIGS. 1-3 show the respective parts by weight of the associated compounding of Examples 1-11 and Comparative Examples 1-13. Each compounding material is melt-mixed at a temperature of 200 degrees C and extrude-formed with an

extruder to form the sheathed electrical cable as shown in FIG. 4. The test examples (Examples and Comparative Examples) of the sheathed electrical cables are the same as the standard CHFUS-1.0sq and HFSS-2f. All of Examples 1-12 and Comparative Examples 1-6 contain 1 part by weight of the anti-oxidant agent. FIGS. 1-3 also show the test results of the fire-retardancy, the elongation property and the wear resistance.

Examples 1-11:

Examples 1-12 contain 100 parts by weight of the base resin (A+B) and 70-200 parts by weight of the metal hydrate fire-retardant additive (C). The base resins (A+B) contain (A) 70-90 parts by weight of polypropylene and (B) 30-10 parts by weight of olefin or styrene thermoplastic elastomer. The metal hydrate fire-retardant additive is magnesium hydroxide surface-treated with oleic acid.

Comparative Examples 1-13:

Comparative Examples 1-6 contain 100 parts by weight of the base resin (A+B), and 65 or 205 parts by weight of the metal hydrate fire-retardant additive (C). The base resins (A+B) contain (A) 70-90 parts by weight of polypropylene and (B) 30-10 parts by weight of olefin thermoplastic or styrene thermoplastic elastomer. The metal hydrate fire-retardant additive (C) is magnesium hydroxide surface-treated with oleic acid.

Referring to FIGS. 1-3, it is apparent that the fire-

retardant resin compositions containing 100 parts by weight of the base resin and 70-200 parts by weight of the metal hydrate fire-retardant additive satisfy the required properties.

Comparison between Examples 1-4 and Comparative Examples 1-3 indicates that Examples 1-4 containing 70 parts by weight of the metal hydrate fire-retardant additive provided good results about the fire-retardancy, the elongation property and the wear resistance. Comparative Examples 1-3 containing 65 parts by weight of the metal hydrate fire-retardant additive were not acceptable (X) with respect to the fire-retardancy. Accordingly, it is preferably to contain at least 70 parts by weight of the metal hydrate fire-retardant additive in the fire-retardant resin composition.

Comparison between Examples 10-12 and Comparative Examples 4-6 indicates that the fire-retardant resin compositions containing 200 parts by weight of the metal hydrate fire-retardant additive provided good results about the fire-retardancy, the elongation property and the wear resistance, and that Comparative Example 4 was not acceptable (X) about the elongation property and the wear resistance and Comparative Examples 5, 6 were not acceptable (X) about the wear resistance. Accordingly, it is preferably to contain at most 200 parts by weight of the metal hydrate fire-retardant additive in the fire-retardant

resin composition.

The fire-retardant resin composition includes the base resin and the metal hydrate fire-retardant additive. The metal hydrate fire-retardant additive is magnesium hydroxide or aluminum hydroxide single or combination surface-treated with the fatty acid including the unsaturated boding such as oleic acid or linolenic acid, or with the silane treatment agent. The resultant fire-retardant resin compositions provide the required fire-retardancy while keeping the variety of mechanical properties such as the wear resistance and the elongation property.

Industrial Applicability

The present invention provides a highly reliable sheathed electrical cable for motor vehicle having a fire-retardancy while keeping a mechanical property such as a wear resistance.

Claims

1. A sheathed electrical cable for motor vehicle, having a conductor and an insulation sheath covering the conductor, the insulation sheath being made of a fire-retardant resin composition containing 100 parts by weight of a base resin and 70-200 parts by weight of a metal hydrate fire-retardant additive,

wherein the base resin contains (A) 5-30 parts by weight of a modified polypropylene resin and 40-85 parts by weight of a polypropylene resin and (B) 30-10 parts by weight of an olefin or a styrene thermoplastic elastomer, and the metal hydrate fire-retardant additive is halogen free, and surface-treated with a fatty acid including unsaturated bond or with a silane treatment agent.

2. The sheathed electrical cable as claimed in claim 1, wherein the insulation sheath has a thickness of 0.2-0.9 mm.

EXAMPLE	1	2	3	4	5	6	7	8	9	10	11
MODIFIED POLYPROPYLENE RESIN	5	15	20	30	5	20	30	5	15	20	30
POLYPROPYLENE RESIN	85	70	60	40	85	60	40	85	70	60	40
OLEFIN THERMOPLASTIC ELASTOMER	10	15	20	30	10	20	30	10	15	20	30
METAL HYDRATE FIRE-RETARDANT ADDITIVE	70	70	70	70	100	100	100	120	120	120	120
FIRE-RETARDANCY	○	○	○	○	○	○	○	○	○	○	○
ELONGATION PROPERTY	○	○	○	○	○	○	○	○	○	○	○
WEAR RESISTANCE	○	○	○	○	○	○	○	○	○	○	○

FIG.1

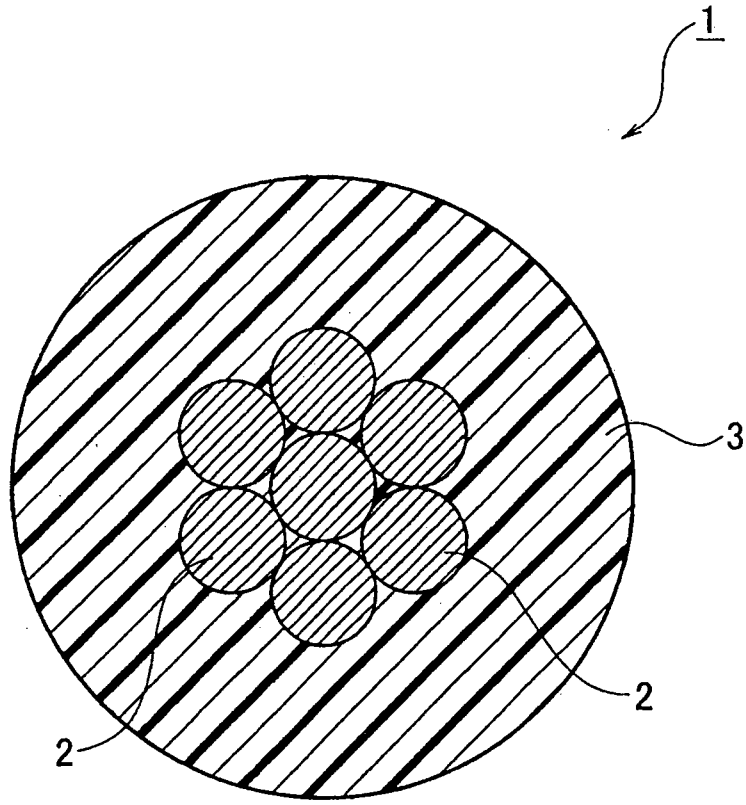
EXAMPLE	12	13	14	15
MODIFIED POLYPROPYLENE RESIN	5	15	20	30
POLYPROPYLENE RESIN	85	70	60	40
OLEFIN THERMOPLASTIC ELASTOMER	10	15	20	30
METAL HYDRATE FIRE-RETARDANT ADDITIVE	200	200	200	200
FIRE-RETARDANCY	○	○	○	○
ELONGATION PROPERTY	○	○	○	○
WEAR RESISTANCE	○	○	○	○

FIG.2

COMPARATIVE EXAMPLE	1	2	3	4	5	6	7	8	9	10	11	12
MODIFIED POLYPROPYLENE RESIN	5	20	30	5	20	30	10	4	0	31	40	15
POLYPROPYLENE RESIN	85	60	40	85	60	40	70	86	90	39	50	76
OLEFIN THERMOPLASTIC ELASTOMER	10	20	30	10	20	30	20	10	10	30	10	9
METAL HYDRATE FIRE-RETARDANT ADDITIVE	65	65	65	205	205	205	205	100	100	100	100	100
FIRE-RETARDANCY	×	×	×	○	○	○	○	○	○	○	○	○
ELONGATION PROPERTY	○	○	○	×	×	×	○	○	×	×	×	×
WEAR RESISTANCE	○	○	○	×	○	○	×	×	×	○	○	○

FIG.3

FIG.4



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/053880

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl. H01B7/295, C08K3/00, C08K9/04, C08L9/06, C08L23/00, C08L23/10, H01B3/00, H01B3/44, H01B7/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2011
Registered utility model specifications of Japan 1996-2011
Published registered utility model applications of Japan 1994-2011

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2002-212354 A (SUMITOMO WIRING SYSTEMS, LTD.)	1, 2
Y	2002.07.31, claim 1-4, 9, 【0001】, 【0017】-【0024】, Example 1, 3 (no family)	1, 2
X	JP 2002-167480 A (SUMITOMO WIRING SYSTEMS, LTD.)	1, 2
Y	2002.06.11, claim 1, 3, 【0001】, 【0012】, 【0017】-【0020】, Example 1, 2 & US 2002/0099122 A1 & EP 1213324 A1 & DE 60114126 D & DE 60114126 T	1, 2
X	JP 2002-138173 A (SUMITOMO WIRING SYSTEMS, LTD.)	1, 2
Y	2002.05.14, 【0001】, 【0029】, 【0040】, 【0041】, 【0046】, 【0061】, Example 1, 6 (no family)	1, 2

☑ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13.05.2011	24.05.2011

Name and mailing address of the ISA/JP	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/053880

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2008-195933 A (Mitsubishi Chemical Corporation) 2008.08.28, 【0058】, 【0088】,【0102】, 【0122】 - 【0124】, Example 3 (no family)	1 1, 2
Y	JP 2006-199923 A (Furukawa Electric Co., Ltd.) 2006.08.03, 【0092】, 【0093】, 【0098】 - 【0101】, Example 9 & WO 2006/068304 A1 & DE 112005003235 T & CN 101080456 A	1, 2
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