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

(11) Publication number: **0 120 382**
A1

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: **84102638.8**

(22) Date of filing: **10.03.84**

(51) Int. Cl.³: **H 01 B 7/02**
H 01 B 7/34

(30) Priority: **25.03.83 IT 2028283**

(43) Date of publication of application:
03.10.84 Bulletin 84/40

(84) Designated Contracting States:
BE DE FR GB LU NL SE

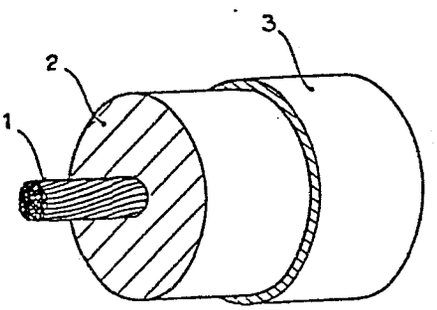
(71) Applicant: **SOCIETA' CAVI PIRELLI S.p.A.**
Piazzale Cadorna 5
I-20123 Milano(IT)

(72) Inventor: **Beretta, Germano**
Via Puglia, 15
Monza (Milan)(IT)

(74) Representative: **Mariani, Giorgio, Dr. et al,**
INDUSTRIE PIRELLI S.p.A. Direzione Brevetti Piazzale Cadorna, 5
I-20123 Milano(IT)

(54) **Low-voltage cable.**

(57) Low-voltage cable that is heat-resistent and non fire-propagating, wherein the conductor (1) is provided with a primary-covering (2) made of a thermoplastic compound based on P.V.C., circumscribed by a secondary covering (3) made of a compound based on P.V.C. cross-linked through radiation.



EP 0 120 382 A1

0120382

LOW-VOLTAGE CABLE

Specification

The present invention concerns a low-voltage cable which is resistent to heat, and which does not propagate fires - and more precisely, to an electric cable that is heat-resistent and non fire-propagating, that is included in the category of low-voltage cables that are known under the name of 'building wires'.

The greater majority of cables that come into this category known under the above name, have conductor coverings formed out of a P.V.C. based compound.

One drawback of these compounds, is that of their being thermoplastic - and hence, incapable of providing any stability in form, during the action of heat that might be applied to the conductor covering.

This is a drawback which could cause serious consequences, and for realizing this fact it is sufficient to consider the risks for the user himself, when, for example, in correspondence of a current-collector - owing to an overheating resulting from a bad connection of the cables to the latter,there is had a softening of the conductor coverings.

Moreover, in the known cables, where the conductor covering is formed out of a thermoplastic compound based on P.V.C., it is impossible to have either any notable non fire-propagating properties, or any optimization of the mechanical and insulating properties.

In fact, in order to have such non fire-propagating properties, it would be necessaryt to introduce into the compound itself, very high quantities of mineral fillers - and this is unproposable, since it would reduce the mechanical and insulating properties of the compound - and hence, of the said conductor covering, to unacceptable values.

There have besides been proposed cables having a conductor covering made of a mixture again based on P.V.C., but cross-linked through radiation. lf, in this manner, it was possible to solve the problem of providing stability of form to the conductor coverings of the cable - under the action of heat, the other problems, of non-propagating fires, were not solved, nor else the problem of the optimization of the mechanical and insulating properties of the cable.

In fact, for the cross-linking of the compounds forming the conductor covering of a cable, it was necessary to add to the compound an additive selected from divinylbenzene, polyallyl dimethacrylate esters and polyallyl trimethacrylate esters - such as, for example: trimethylolpropane-trimethacrylate.

These additives interact with the mineral fillers of the compound as well as with the P.V.C. during the cross-linking of this latter, and hence, when the quantity of mineral fillers present in the compound is increased, inevitably even the quantities increase of the additives in question.

Now, these cross-linking additives of the P.V.C., have the drawback of reducing the insulating properties of the compound if, as inevitably occurs in practice, they are still

present after the cross-linking of the P.V.C., and hence, to reduce the dielectric properties in the conductor coverings of the cable formed out of such a compound.

Therefore, for limiting the quantity of the cross-linking agents present in the compound, the quantity of mineral fillers is limited - and hence, cables that have the property of non-propagating fires are not obtainable.

The aim of the present invention is to have low-voltage cables pertaining to the 'building wires' category, having a P.V.C. base covering for the conductor in which there is encountered an optimum resistence to heat and against any propagation of fires and an optimiization both, of the dielectric characteristics as well as of the mechanical characteristics.

What forms the object of the present invention, is a low voltage cable comprising a conductor with an extruded-covering surrounding it, said extruded covering being constituted by a primary-covering that is in contact with the conductor, and by a secondary-covering surrounding the primary-covering; said coverings being made out of a P.V.C. based compound, characterized by the fact that the primary covering is of a thermoplastic compound, based on P.V.C., containing mineral fillers in quantities that are greater than 60 parts by weight with respect to 100 parts by weight of P.V.C., and that said secondary covering is a compound based on P.V.C. cross-linked through radiation.

The present invention will be better understood from the following detailed description, made solely by way of non-limiting example, with reference to the FIGURE of the

attached drawing TABLE, wherein there is shown a perspective view, with partially removed portions, of a length of cable according to this invention.

As can be seen in the figure, the cable comprises a conductor 1 - constituted by a single wire or by several layed-up wires, surrounded by a covering comprised by an extruded primary-covering 2, covered by a secondary-covering 3, said coverings being closely joined together.

The primary-covering 2 is of a thermoplastic compound based on P.V.C., and the secondary-covering 3 is made of a compound based on P.V.C. cross-linked through radiation - and hence, of a compound that, prior to being cross-linked, contains the necessary additive for said operation.

We shall now report the general characteristics that the P.V.C. based compounds must possess, for forming the primary-covering 2 and the secondary-covering 3 of a cable according to the present invention.

The compounds based on P.V.C., for the formation of the primary-covering 2, are thermoplastics and contain mineral fillers in such quantities as to endow it with the dielectric properties and properties of resistence against fire propagation, that are desired. In particular, the mineral fillers present in the compound in question - consisting of calcium carbonate, magnesium carbonate, calcined kaolin and mixtures thereof, are of a quantity that is greater than 60 parts by weight with respect to 100 parts by weight of P.V.C. Preferably, the quantity of mineral fillers present in the compound, is comprised between 60 and 120 parts by weight, with respect to 100 parts by weight of P.V.C., so as to

obtain an optimization of the dielectric characteristics for the insulation 2 and a resistence against fire propagation.

For the formation of the secondary-covering 3, the compounds based on P.V.C. contain a cross-linking agent selected from amongst the divinylbenzene, polyallyl-dimethacrylate esters and polyallyl-trimethacrylate esters such as, for example, the trimethylopropane-trimethacrylate, of a quantity not exceeding 16 parts by weight, with respect to 100 parts by weight of P.V.C., and mineral fillers in quantities not exceeding 10 parts by weight, with respect to 100 parts by weight of P.V.C.

Moreover, the mineral fillers - for the compound forming the secondary-covering 3, are constituted by calcium carbonate and by magnesium carbonate, and preferably of the type obtained through precipitation - i.e. having a high specific surface. Even mixturess of calcium carbonate and magnesium carbonate - of the types obtained through precipitation, can be utlized as fillers in the compound for the formation of the secondary covering.

We shall now give herebelow, solely by way of example, the recipes of a particular compound for the covering 2, and of a particular compound for the covering 3, of a cable according to the invention.

A compound for the formation of the primary-covering 2 of a low voltage cable according to the invention has the following recipe, whose components are expressed in parts by weight.

Parts by weight

POLYVINYL-CHLORIDE (P.V.C.)	100
PHTHALIC PLASTICISER (example: dioctylphathalate or di-isodecilphalate)	50
MINERAL FILLERS (comprised by a mixture of equal parts of calcium-carbonate and magnesium-carbonate)	80
TRIBASIC LEAD SULPHATE	5
LUBRICANT (example: stearic acid or lead-basic stearate)	0.5
ANTI-OXIDANTS (example: triphenol-A)	0.2

A compound for forming the secondary-covering 3, of a low voltage cable - according to the invention, has the following recipe - whose components are expressed in parts by weight.

	Parts by weight
POLYVINYL-CHLORIDE (P.V.C.)	100
PHTHALIC PLASTICISER (example: dioctylphathalate or di-isodecilphalate)	35
MINERAL FILLERS	5
TRIBASIC LEAD SULPHATE	5
LEAD BASIC STEARATE	0.5
BISPHENOL-A (anti-oxidant)	0.2
TRIMETYLOLPROPANE-TRIMETHACRYLATE (cross-linking agent)	8

With the particular compounds given above, a low voltage cable, according to the present invention, has been manufactured, by extruding over the conductor 1, simultaneously or with successive operations, the primary-covering 2 and the compound for forming - after the cross-linking through radiation, the secondary-covering 3.

In particular, the conductor is formed by thirty wires, each one having a diameter of 0.25 mm, layed-up together with

having a complexive section whose area is 1.5 mm2.

The primary-covering has a thickness of 0.7 mm and the superimposed layer, which - after the cross-linking through radiation, will constitute the secondary-covering 3, has a thickness of 0.1 mm and, in any case, a thickness not exceeding 15% of the thickness of the primary-covering.

The conductor, covered by the extruded layers cited above, underwent radiation by means of causing it to pass through an apparatus of a 'per se known' type, that furnished it with a dose of radiation equal to 10 M rad, so as to cross-link the secondary-covering of the cable, and the speed of production is in the same order of magnitude as that of the known cables having a conductor covering constituted entirely of a P.V.C. based thermoplastic compound.

With a cable according to the present invention, experimental tests were carried out, according to the normes CEI 20-11, for the purpose of pointing out, in the conductor covering comprised by the assembly of the primary and the secondary covering:

- the values of the insulation constant Ki at 20°C expressed in MΩ x Km;
- the resistence to thermo-compression, defined by the crushing force to be exerted upon a flat sample of conductor covering taken up to a temperature of 120°C, for reducing the thickness to a value equal to 60% of the initial thickness;
- the mechanical characteristics of the breaking load and elongation at break.

Moreover, with a cable according to the invention, experimental tests were carried out for determining the capacity of maintaining a stability in its form, at high temperatures, by suspending a cable-length inside a chamber that is heated to 200°C.

To end with, tests were carried out, according to the normes CEI 20-22, for checking the resistence against fire propagation. Tests were also carried out for determining the characteristics according to our invention, of the resistence to cable slipping, inside a duct. For this latter test, a cable-length of 50 m - according to the invention, was introduced into a rigid P.V.C. hose, shaped in the manner indicated below, with having an inner diameter of 30 mm and a length of 10 m.

The shaped hose has a configuration constituted by a broken-line of equal segments and having curved corners, formed by the assembly of an S-shape and of an L-shape. On the extremity of the cable, facing one extremity of the hose, there was applied the minimum force necessary for extracting the cable from the hose, by causing it to slide into it.

Moreover, for showing the optimum properties of a cable according to the invention, due to the simultaneous presence of a primary and a secondary cover having the above-stated characteristics, there were effectuated, for comparison purposes, the above-cited experimental tests for a cable having a conductor covering formed with only the P.V.C. based thermoplastic compound used for the primary-covering of a cable according to our invention.

Identical experimental tests were carried out for a known

cable having a conductor covering entirely formed of a P.V.C. based thermoplastic compound and for another known cable having a conductor covering entirely formed out of a P.V.C. based compound cross-linked through radiation.

The cable for comparison purposes, described previously, and both the known cables that underwent the experimental tests, had identical conductors to that of the cable according to our invention, and a thicknes for the conductor covering that was equal to the sum-total of the thicknesses of the primary and the secondary coverings of the cable according to our invention.

The results of these experimental tests are given in the following TABLE:

	Cable according to our invention	Cable for comparison purposes	Known cable having a thermoplastic sheath	Known cable having its conductor sheath cross-linked through radiation
Ki at 20°C	2000 MΩx Km	2000 MΩx Km	1000 MΩx Km	750 MΩx Km
Resistence to thermo-compression	9 N	5 N	4,5 N	4,5 N

Breaking load under traction	18 N/mm2	8 N/mm2	15 N/mm2	15 N/mm2
Elongation at break under traction	150%	100%	130%	130%
Stability of insulation-form inside furnace at temperature of 200°C	does not melt down	does not melt down	melts down	does not melt down
Fire propagation test according to standard CEI 20/22	does not spread fire	does not spread fire	spreads fire	spreads fire
Resistence to slipping inside a duct	17 N	20 N	30 N	17 N

After examining the results of the tests carried out, the following considerations can be put forward.

First and foremost, it can be realized that the presence of a secondary P.V.C. based covering cross-linked through radiation, did not bring about any reduction in the insulation constant Ki of a cable according to the present invention - as was possible to expect on observing the values of the insulation constant of a known cable having a conductor covering entirely formed out of a P.V.C. based compound, cross-linked through radiation.

It is true that the absolute values, as is possible to draw from the description of the particular form of realization described - of a cable according to the present invention, the thickness of the secondary-covering is extremely reduced, but even such a reduced thickness would have had an influence on the value of the insulation constant of the conductor covering of the cable.

The fact that what has been stated above is not verified, signifies that the secondary-covering of a cable according to this invention, has surprizingly, optimum insulation properties in spite of its being formed out of a P.V.C. based compound, cross-linked through radiation.

Moreover, from examining the results of the experimental tests that are given in the TABLE, it is found that, with a cable according to the invention, all the previously stated proposed aims are achieved.

To end with, with a cable according to the invention, there can be obtained a good production speed - in spite of the need for cross-linking the secondary covering itself through radiation.

In fact, the manufacturing speed of a cable according to our invention, expressed in metres/minutes, is in the same order of magnitude as that of the 'known' cables having a conductor covering made of a P.V.C. based thermoplastic coupound; whereas the manufacturing speed of the known cables - having a conductor covering of a P.V.C. based compound cross-linked through radiation, is generally slower by 30%.

The reason for this is due not solely to the fact that the thickness of the secondary-covering, of a cable according to our invention, is small, but it is also due to the fact that inside it, the absence, or the minute quantities of the mineral fillers present, allows for keeping to the minimum the quantity of cross-linking agents for the P.V.C. - and hence, for keeping the dose of radiation energy that has to be furnished, also to the minimum.

Although one form of realization, according to the invention, has been illustrated and described hereabove, this patent must also be understood to comprise within its ambit, all the other embodiments derived from the inventive idea, that are available to any technician of this field.

0120382

WHAT WE CLAIM IS:

1. Low voltage cable, comprising a conductor with an extruded covering surrounding it, said extruded covering being constituted by a primary-covering that is in contact with the conductor, and by a secondary-covering surrounding the primary-covering, said coverings being made out of a P.V.C. based compound, characterized by the fact that the primary covering is of a thermoplastic compound, based on P.V.C., containing mineral fillers in quantities exceeding 60 parts by weight, with respect to 100 parts by weight of P.V.C., and that the secondary-covering is a compound based on P.V.C. cross-linked through radiation.

2. Low voltage cable, according to CLAIM 1, characterized by the fact that in the P.V.C. based thermoplastic compound for forming the primary-covering, the mineral fillers are contained in a quantity comprised preferably between 60 and 120 parts by weight, with respect to 100 parts by weight of P.V.C.

3. Low voltage cable, according to CLAIM 1, characterized by the fact that the P.V.C. based compound cross-linked through radiation, forming the secondary-covering, contains - prior to the cross-linking, a cross-linking agent selected from divinylbenzene, polyallyl dimethacrylate esters and polyallyl trimethacrylate esters in quantities that do not exceed 16 parts by weight, with respect to 100 parts be weight of P.V.C.

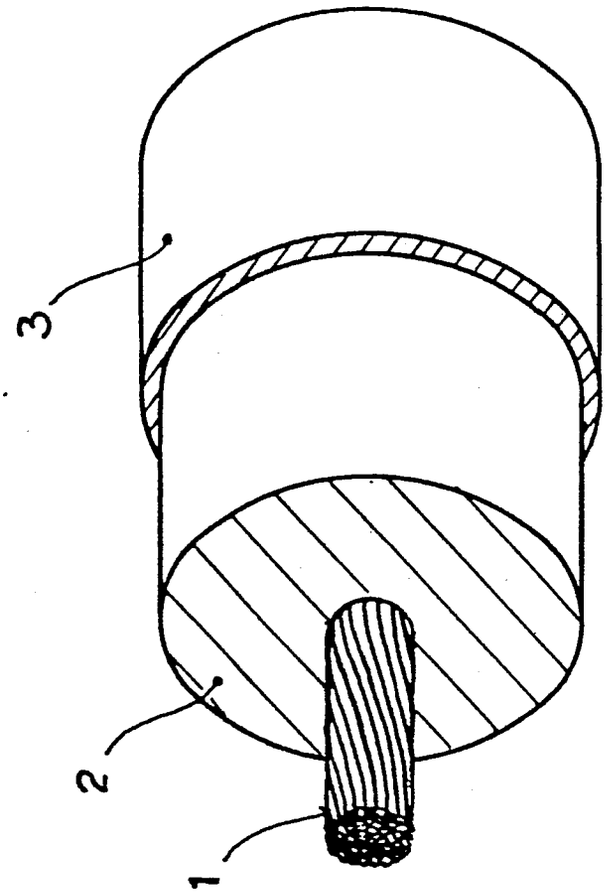
4. Low voltage cable, according to CLAIM 1, characterized by the fact that the P.V.C. based compound cross-linked through radiation, constituting the secondary-covering,

contains - prior to its being cross-linked, a cross-linking agent comprised by tri-methylolpropane-trimethacrylate.

5. Low voltage cable, according to any of the CLAIMS 1, 3 and 4, characterized by the fact that the P.V.C. based compound cross-linked through radiation, constituting the secondary-covering, contains mineral fillers in a quantity not exceeding 10 parts by weight, with respect to 100 parts by weight of P.V.C.

6. Low voltage cable, according to any of the CLAMS 1, 3, 4 and 5, characterized by the fact that the mineral fillers, contained in the P.V.C. based compound cross-linked through radiation, are precipitate mineral fillers.

7. Low voltage cable, according to any of the preceding CLAIMS, characterized by the fact that the thickness of the secondary-covering, does not exceed 15% of the thickness of the primary-covering.


3
2
1

European Patent Office

EUROPEAN SEARCH REPORT

0120382
Application number

EP 84 10 2638

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)
Y	EP-A-0 029 234 (PIRELLI) * Page 1, line 38 - page 2, line 27; figure 1 *	1	H 01 B 7/02 H 01 B 7/34
A	* Claim 10 *	7	
Y	CA-A-1 093 652 (NORTHERN TELECOM) * Page 2, line 2 - page 4, claim 4; figure *	1	
A	* Page 2, last paragraph - page 3, first, paragraph *	4	
A	US-A-4 008 368 (GUTEHOFFNUNGSHÜTTE) * Column 2, line 10 - column 8, line 47; figures 1,2 *	1,2	TECHNICAL FIELDS SEARCHED (Int. Cl. ³) H 01 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	27-06-1984	DEMOLDER J.

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

EPO Form 1503. 03.82