PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 :		(11) International Publication Number:
H01B 1/04, D01F 9/145, 9/15 **H01B 1/24**	**A1**	**WO 94/05017**
		(43) International Publication Date: 3 March 1994 (03.03.94)

(21) International Application Number: PCT/NL93/00170

(22) International Filing Date: 12 August 1993 (12.08.93)

(30) Priority data:
9201447 12 August 1992 (12.08.92) NL

(71) Applicant *(for all designated States except US):* A.J. VAN DEN HUL B.V. [NL/NL]; Eperweg 14, NL-8167 LH Oene (NL).

(72) Inventor; and
(75) Inventor/Applicant *(for US only) :* VAN DEN HUL, Aalt, Jouk [NL/NL]; Eperweg 14, NL-8167 LH Oene (NL).

(74) Agent: BOELSMA, Gerben, Harm; Octrooibureau Polak & Charlouis, Laan Copes van Cattenburch 80, NL-2585 GD The Hague (NL).

(81) Designated States: BR, CZ, HU, JP, KP, PL, SK, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.
In English translation (filed in Dutch).

(54) Title: ELECTRICALLY CONDUCTING CABLE WITH ONE OR MORE CORES, IN PARTICULAR FOR SIGNAL TRANSFER

(57) Abstract

The invention relates to an electrically conducting cable with one or more cores, in particular for signal transfer. According to the invention, the conductor of at least one core comprises a carbon filament obtained by dehydrogenating a cyclic hydrocarbon C_xH_y. With such a core the signal tranfer is improved significantly, in particular at the lower signal levels, whereas a core on basis of such a carbon filament has a higher resistance against mechanical loads, such as bending and the like.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	**FR**	France	**MR**	Mauritania
AU	Australia	**GA**	Gabon	**MW**	Malawi
BB	Barbados	**GB**	United Kingdom	**NE**	Niger
BE	Belgium	**GN**	Guinea	**NL**	Netherlands
BF	Burkina Faso	**GR**	Greece	**NO**	Norway
BG	Bulgaria	**HU**	Hungary	**NZ**	New Zealand
BJ	Benin	**IE**	Ireland	**PL**	Poland
BR	Brazil	**IT**	Italy	**PT**	Portugal
BY	Belarus	**JP**	Japan	**RO**	Romania
CA	Canada	**KP**	Democratic People's Republic of Korea	**RU**	Russian Federation
CF	Central African Republic			**SD**	Sudan
CG	Congo	**KR**	Republic of Korea	**SE**	Sweden
CH	Switzerland	**KZ**	Kazakhstan	**SI**	Slovenia
CI	Côte d'Ivoire	**LI**	Liechtenstein	**SK**	Slovak Republic
CM	Cameroon	**LK**	Sri Lanka	**SN**	Senegal
CN	China	**LU**	Luxembourg	**TD**	Chad
CS	Czechoslovakia	**LV**	Latvia	**TG**	Togo
CZ	Czech Republic	**MC**	Monaco	**UA**	Ukraine
DE	Germany	**MG**	Madagascar	**US**	United States of America
DK	Denmark	**ML**	Mali	**UZ**	Uzbekistan
ES	Spain	**MN**	Mongolia	**VN**	Viet Nam
FI	Finland				

Title: Electrically conducting cable with one or more cores, in particular for signal transfer.

The invention relates to an electric conducting cable with one or more cores, in particular for signal transfer, in which the conductors are embedded in a sheath comprising synthetic material.

For the transmission of electric signals, according to the usual prior art, cables with conductors of an electrically good conducting metal, are generally used.

In general, such conductors are considered as a homogeneous transfer medium and the flow of electrons therein is considered as the flow of a liquid.

It is known, that the quality of music reproduced by apparatus of high quality will be affected to a considerable extent or will reduce in the long term due to the type of cable which connects the various parts of the music reproducing apparatus. In particular, it is known, that chemical attacks from the environment may seriously harm the quality of the cable as a signal transferring medium. A proven remedy against such attacks is electrolytically coating the conductor with a protection layer consisting of for example tin or silver.

Up to now, as criterium for expressing the differences between various conductors of electrical cables the specific resistance (ohm.cm), therefore the electrical attenuation, is generally used as a measure. Nevertheless, in practice, differences in sound effect are experienced with cables in sound reproducing apparatus, which differences cannot be explained by differences in the conductor material used or by differences in electrical attenuation.

The aim of the invention is to provide an improvement of the usual conductors in transmission cables and in particular to improve the transfer properties at the lower signal levels.

The underlying insight in aiming this improvement, is that the usual metal conductor cannot be considered at all as a homogeneous medium and that much more significance should be given to the circumstance that in a metal conductor it is in fact a matter of a not reproducible grouping of metal crystals substantially established along mechanical way, with contaminance and boundary areas therebetween, which form barriers for an optimal transfer at low signal levels. Even protecting layers consisting of for example tin or silver cannot avoid that the impurity of the conductor (at the long term) increases by for example absorption of gas and oxidation and also the

barriers against an optimum signal transfer will increase, so that the quality of the conductor reduces continuously.

It should be noted, that the usual way of fabricating (by pulling) the known metal conductors is beneficial to the occurrence of dislocations with a similar barrier effect. During the electrolytical coating process as well as during normal use, in which the conductor is subject to distortions such as bending, such dislocations and an associated deterioration of the signal transmission may occur.

Tests and measurements on metal conductors at lower signal levels, at which the number of higher harmonics in the output signal showed a significant increase, support this insight. Against the background of this insight, the observed deterioration of the transfer of the lower signal levels with the known metal conductors might be described as being the result of a phenomenon, which could be indicated with "cross-crystal distortion", that could be compared with the known phenomenon "cross-over distortion" in amplifiers of lower quality.

The improvement according to the invention is achieved in that the conductor of at least one core comprises a carbon filament obtained by dehydrogenating a cyclic hydrocarbon C_xH_y.

It should be noted, that manufacturing a carbon filament by extrusion of a carbon black obtained by dehydrogenating a hydrocarbon is on itself known in general. However, these carbon filaments are generally used as reinforcement in synthetic material.

Furthermore, it is known that the carbon fiber is very flexible, chemically inert, strong and has a good electric conductivity. However, the electric conductivity depends to a great extent on the degree of order of the carbon atoms. However, this degree of order of carbon atoms forms a very uncertain factor in the carbon black (obtained by dehydrogenating of a hydrocarbon) as basic material for the carbon fiber.

The invention has surprisingly shown that, when using a carbon black obtained by dehydrogenating a cyclic hydrocarbon as basic material in the fabrication of carbon fibers, the cyclic molecular structure has evidently a strong arranging effect on the reorientation of the carbon atoms taking place during the extrusion or spinning process of the fiber.

It may be assumed, that in the thus obtained carbon fiber the original cyclic structure is maintained and that in the fiber it is a

matter of a linear structure of partially overlapping "loops" of double bonds and the purity of the carbon fiber guarantees an unobstructed transfer of electrons in the longitudinal direction. In particular it was surprisingly, that measurement of the impedance on a large number of individual carbon fibers, having a thickness of 7 micron, by known fiber extrusion or spinning techniques from a carbon black obtained by dehydrogenating benzene as well as a large number of conductors according to the invention with a diameter of 1 mm and composed of about 12000 carbon filaments having a thickness of 7 micron, resulted in surprisingly low and hardly fluctuating values of approximately 400 Kohm.m and 35 ohm.m, respectively.

According to a further characteristic of the invention it has been found, that the arranging effect of the original cyclic structure can be enhanced by applying an electric field in the extrusion and spinning process of the fibers and that as a result the above mentioned values and the fluctuations may be further lowered.

By applying an alternating magnetic field perpendicular to the production direction (and therefore also perpendicular to the electric field) a still stronger arranging effect can be obtained. In terms of analogy this could be compared with the premagnetising process through a bias signal in magnetising of tape as is known from the recording technique. By a correct tuning of the direct current field in the production direction with the alternating magnetic field perpendicular thereto, an additional arranging effect results, which reveals itself in a further decreasing resistance of the final product.

As a result of the small thickness (in the order of 10 micron) of the (individual) carbon fibers distorsions such as effected by bending in using, will not result in dislocations, in contrast to the known metal conductors, which would lead to a deterioration of the signal transmission at lower levels, whereas as a result of the purity of the carbon fiber and the chemical inertness thereof the life span in all respects is nearly unlimited.

In a practical application, the conductor according to the invention will consist of a bundle of carbon filaments described above. As is the case with a cable comprising metal conductors, this bundle of carbon filaments will be embedded in a sheath of synthetic material, for which in case of the invention, the synthetic materials polyethylene, polypropylene and polytetrafluorethylene are specifically suitable.

To obtain an optimal advantage of the high chemical stability and purity of the carbon fiber, in this case it is advisable to provide each fiber with an insulating layer (e.g. by immersion) in the course of the fabrication process, so that the transport of electrons may only take place in the longitudinal direction of the conductor and therefore no undesirable "cross traffic" may occur.

Thereby, it is practical to choose a protection layer or lacquer layer, that is soluble in a solvent such as aceton. This offers the possibility to remove by immersion in aceton a certain length of the insulating layers from the bundle of conductors insulated from each other by the insulating layers, which conductors need to be finished with a connecting element (connector) thereby resulting in a desired effective contact in cross direction between the individual carbon fibers at the conductor end, which is necessary for diverting the electron flows of all fibers to a connecting sleeve or sleeve forming part of the connector, which has to be attached to the thus "internally stripped" conductor end through mechanical way.

The invention also relates to a method of manufacturing a carbon fiber adapted to be used as conductor in an electrical conductive cable by extruding or spinning a carbon black obtained by dehydrogenating a hydrocarbon C_xH_y. A first characteristic of the method according to the invention consists therein, that during the extrusion and spinning process an electric field is applied to the extrusion and spinning area respectively, while preferably a cyclic hydrocarbon is used as hydrocarbon. As mentioned above, the application of an electric field in manufacturing the carbon fiber has an arranging effect on the arrangement of atoms during the creation phase of the carbon fiber, whereas the cyclic molecule structure of the cyclic hydrocarbon has also an arranging effect on the arrangement of atoms in the developing carbon fiber.

Furthermore, a particular aspect of the invention relates to processing a residu of cables and unusable cables.

At present, unusable cables with metal conductors are generally processed by burning. As is known, such way of processing is considered to be extremely damaging to the environment and an increasing opposition against this way of processing exists.

In this respect a transmission cable according to the invention, of which all the conductors consist of carbon fibers, offers other possibilities of processing, which does not damage the environment.

A preferable way of processing the (residu of) cables according to the invention consists in that the cables and the residu of the cables are chopped up into small pieces, which are then melted together by heating to produce a coating mass suitable to be reused as a conductive shield for electrical conductors. This coating mass is a synthetic material homogeneously mixed with carbon and is therefore electrically conductive, of which coating mass the basis mass is formed by the insulating sheath of the (carbon) conductors in the cable.

The invention is applicable to all types of cables with one or more cores, including so called coax cables, in which a central conductor consisting of carbon fibers according to the invention, is surrounded or shielded by an outer conductor consisting of a web of carbon fibers.

Briefly, the invention provides the possibility to maximize the electrically conducting properties of carbon fibers in a reproducable way and therefore make the carbon fibers suitable for utilization as electrical conductor in transmission cables, of which especially the signal transmission on the lower levels is of great significance.

When used with music reproducing apparatus of high quality, a transmission cable according to the invention contributes to music, which distinguishes itself to experts by a remarkable "three-dimensionality", just because of the excellent transmission properties on the lower levels.

C L A I M S

1. Electrically conductive cable with one or more cores, in particular for signal transfer, in which the conductors are embedded in a sheath comprising synthetic material, characterised in that the conductor of at least one core comprises a carbon filament obtained by dehydrogenating a cyclic hydrocarbon C_xH_y.

2. Cable according to claim 1, characterised in that the core consists of a bundle of carbon filaments.

3. Cable according to claim 2, characterised in that the individual filaments or fibers are surrounded by an insulating coating layer.

4. Cable according to claim 3, characterised in that the coating layer has a thickness in the range of 0,5-2 micron.

5. Cable according to claims 3-4, characterised in that the coating layer consists of a material soluble in a solvent, such as aceton.

6. A method of manufacturing a carbon fiber adapted to be used as conductor in an electrically conductive cable by extruding or spinning a carbon black obtained by dehydrogenating a hydrocarbon C_xH_y, characterised in that during the extrusion or spinning proces an electric field is applied to the extrusion or spinning area.

7. Method according to claim 6, characterised in that a cyclic hydrocarbon is used as the hydrocarbon.

8. Method of processing cables and the residu of cables according to claims 1-5, of which all cores consist of carbon filaments (fibers), and which may be considered as waste, characterised in that the cables and the residu of cables are chopped up into small pieces, which are then melted together by heating to produce a coating mass suitable to be reused as a conductive shield for electrical conductors.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NL 93/00170

A. CLASSIFICATION OF SUBJECT MATTER
IPC 5 H01B1/04 D01F9/145 D01F9/15 H01B1/24

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)
IPC 5 H01B D01F

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

Electronic data base consulted during the international search (name of data base and, where practical, 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.
Y	EP,A,0 306 067 (NEDERLANDS OMROEPPRODUKTIE BEDRIJF) 8 March 1989 see the whole document	1
Y	PATENT ABSTRACTS OF JAPAN vol. 11, no. 192 (C-429)19 June 1987 & JP,A,62 011 795 (CHIYODA CHEM ENG) see abstract	1
A		6,7
Y	WO,A,91 04563 (KABELWERKE REINSHAGEN) 4 April 1991 see the whole document	1
A		2,3
Y	EP,A,0 283 844 (TOSHIBA) 28 September 1988 see the whole document	8

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in 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 document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"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

1

Date of the actual completion of the international search	Date of mailing of the international search report
7 December 1993	22. 12. 93

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Drouot, M-C

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP,A,0 131 067 (TOSHIBA) 16 January 1985 see the whole document ---	8
Y	DATABASE WPI Section Ch, Week 32, Derwent Publications Ltd., London, GB; Class A85, AN 92-260011 & DD,A,298 857 (UNIV CHEMNITZ) 12 March 1992 see abstract -----	8

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/NL 93/00170

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
EP-A-0306067	08-03-89	NL-A-	8702102	03-04-89
		NL-A-	8801535	03-04-89
		AU-A-	2154088	09-03-89
		CN-A-	1034087	19-07-89
		JP-A-	1097381	14-04-89
		US-A-	4972046	20-11-90
WO-A-9104563	04-04-91	DE-A-	3930496	21-03-91
		DE-U-	8914352	15-02-90
		EP-A-	0442990	28-08-91
		US-A-	5159157	27-10-92
EP-A-0283844	28-09-88	JP-A-	63218309	12-09-88
		JP-A-	63218310	12-09-88
		JP-C-	1610220	15-07-91
		JP-B-	2037120	22-08-90
		JP-A-	63227000	21-09-88
		JP-C-	1712159	11-11-92
		JP-B-	2012986	03-04-90
		JP-A-	63235368	30-09-88
		JP-C-	1712160	11-11-92
		JP-B-	2012987	03-04-90
		JP-A-	63238162	04-10-88
		JP-C-	1712161	11-11-92
		JP-B-	2012988	03-04-90
		JP-A-	63238163	04-10-88
		JP-A-	1198665	10-08-89
		US-A-	4882227	21-11-89
EP-A-0131067	16-01-85	JP-A-	60018314	30-01-85
		JP-A-	60018315	30-01-85
		DE-A-	3375248	11-02-88
		US-A-	4530779	23-07-85