

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
29 June 2006 (29.06.2006)

PCT

(10) International Publication Number
WO 2006/066773 A1

(51) International Patent Classification:
D02G 3/44 (2006.01) A61B 5/113 (2006.01)

(21) International Application Number:
PCT/EP2005/013446

(22) International Filing Date:
14 December 2005 (14.12.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
MI2004A002430
20 December 2004 (20.12.2004) IT

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

(71) Applicant (for all designated States except US): FONDAZIONE DON CARLO GNOCCHI - ONLUS [IT/IT]; Piazzale Rodolfo Morandi, 6, I-20121 Milano (IT).

(72) Inventors; and

(75) Inventors/Applicants (for US only): DIRIENZO, Marco [IT/IT]; Viale Campania, 30, I-20133 Milano (IT). GILARDI, Giovanni [IT/IT]; Via Marigone, 1/F, I-13897 Occhieppo Inferiore (IT).

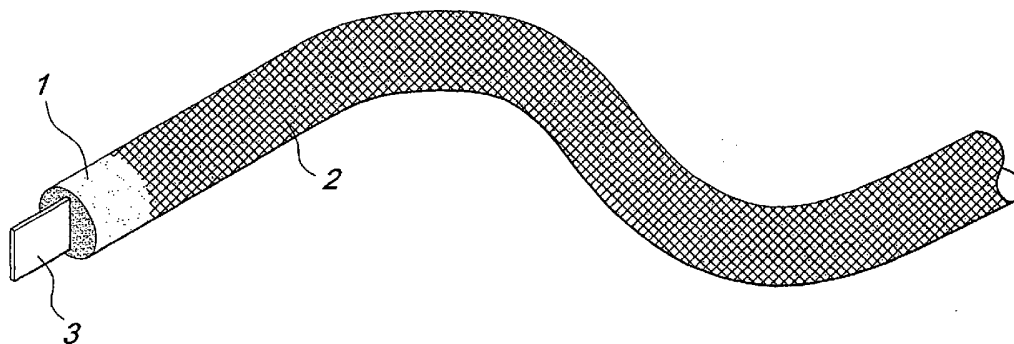
(74) Agent: MODIANO ALAGEM, S., Lara; Modiano & Associati, Via Meravigli, 16, I-20123 Milano (IT).

Published:

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: ELASTIC CONDUCTOR, PARTICULARLY FOR PROVIDING VARIABLE-DISTANCE ELECTRICAL CONNECTIONS



(57) Abstract: A conductor particularly for the electrical connection to each other of two distant points whose distance can vary over time, comprising a body (1) made of elastic material on which conducting fibers (2) are wound.

WO 2006/066773 A1

ELASTIC CONDUCTOR, PARTICULARLY FOR PROVIDING VARIABLE-DISTANCE ELECTRICAL CONNECTIONS

Technical Field

The present invention relates to an elastic conductor, particularly for
5 providing electrical connections between two points whose distance is
variable.

Background Art

As is known, the need can occur to connect electrically two points
whose distance is variable. For example, in the case of items of clothing in
10 which sensors for biological signals, for example an ECG sensor, are sewn
or integrated, it is necessary to detect biological signals, which must then be
sent to an apparatus which must plot the ECG of the person wearing the
item of clothing provided with the sensors.

In this case, the use of known types of conductors, which have a
15 constant length, is not satisfactory.

Moreover, in the general case in which it is necessary to have
electrical connections between two points whose distance can vary over
time, the use of known types of conductors, whose length cannot change in
any way during use, is not suitable.

20 Disclosure of the Invention

The aim of the present invention is to provide a conductor which
allows to electrically connect to each other two points whose distance can
vary over time.

Within this aim, an object of the present invention is to provide a
25 conductor which can be used in items of clothing in which sensors for
detecting biological signals are integrated.

Another object of the present invention is to provide a conductor
whose electrical resistance varies as a function of the distance between the
two points to be connected electrically by means of the conductor.

30 Another object of the present invention is to provide a conductor

which is highly reliable, relatively simple to provide, and at competitive costs.

This aim and these and other objects, which will become better apparent hereinafter, are achieved by a conductor particularly for the electrical connection to each other of two distant points whose distance can vary over time, characterized in that it comprises a body made of elastic material on which conducting fibers are wound.

Brief Description of the Drawings

Further characteristics and advantages of the invention will become better apparent from the description of a preferred but not exclusive embodiment of a conductor according to the invention, illustrated by way of non-limiting example in the accompanying drawings, wherein:

Figure 1 is a perspective view of the conductor according to the invention in a first embodiment;

Figure 2 is a perspective view of the conductor according to the invention in a second embodiment.

Ways of carrying out the Invention

With reference to Figure 1, the conductor according to the invention, illustrated by way of example as a cord, comprises a body 1 made of elastic material, around which a fabric which comprises conducting fibers is arranged.

More particularly, the elastic body 1 is covered with a sheath 2 made of conducting textile fibers, which therefore allows to connect electrically two points to which the cord can be connected, with the advantage that the body 1, by being elastic, allows the two connected points to vary their mutual distance.

The elastic body is of course not necessarily a single body, but can be provided by means of a plurality of elastic elements, for example ribbons or bands, arranged substantially in parallel to each other along the longitudinal direction of the element, woven together, or braided or linked by means of

conducting and/or non-conducting fibers.

When the elastic body or core 1 of the conductor is extended due to an increase in the distance between the two points connected electrically to each other by means of the conductor according to the invention, the
5 resistance of the conductor changes and therefore the current that flows through the body of the conductor changes, thus providing an indication of the variation of the distance between the two electrically connected points.

In general, the element thus conceived can act as a piezoresistive transducer. The fact of being able to have an indirect measurement of the
10 distance variation allows to use the conductor according to the invention also, for example, as a strain gage.

Substantially, the conductor according to the invention can be used for example by integrating it in an item of clothing provided with sensors in order to detect the heartbeat or other physiological signals, therefore
15 combining also a function for respiration measurement, i.e., chest extension measurement.

By arranging for example a portion of a conductor according to the invention horizontally at the chest, as a consequence of the breathing that the person performs while wearing the item of clothing, the cord or
20 conductor extends and then resumes its original length as a consequence of the expiration step. The change in resistance produced by this extension gives an indication of the depth of respiration, i.e., of the expansion of the chest, and therefore of the pulmonary capacity of the person.

Conveniently, the conductor according to the invention can be
25 provided, at at least one end, with a metallic terminal 3, in order to provide an electrical connection.

The terminal 3 is connected to the sheath made of conducting fabric.

Obviously, the shape of the conductor according to the invention may be different from the one shown; for example, the conductor can be shaped
30 like a ribbon and the like.

Figure 2 illustrates a different embodiment, which is likewise shown by way of non-limiting example and in which fibers 2 made of conducting material are wound in turns around the elastic body 1. The turns are preferably interleaved between non-conducting fibers or fibers arranged at a sufficient distance from each other so that they are not in contact one another.

In this manner, the conducting fibers 1 constitute a solenoid, the total length of which varies over time depending on the extension of the elastic body on which it is wound.

10 When the solenoid is crossed by a current, it becomes therefore possible to detect the impedance across it, which therefore varies depending on the extension of the elastic body on which it is wound.

Likewise, it is possible to utilize the magnetic field generated by the solenoid for applications that require this kind of property.

15 In practice it has been found that the conductor according to the invention fully achieves the intended aim and objects, since it allows to electrically connect to each other two distant points whose distance can vary over time.

20 The elasticity of the conductor, particularly of the core of the conductor, allows to maintain the electrical connection, and at the same time the sheath made of conducting fabric which is arranged externally with respect to the conducting body is also extended, accordingly varying the electrical resistance of the conductor.

25 The variation in electrical resistance allows several applications, as explained earlier. For example, it can provide an indirect measurement of the elongation undergone by said conductor if a table has been prepared which allows to establish a relation between a given percentage of elongation of the conducting body and a given variation of the resistance of said conductor.

30 Moreover, by interleaving elastic conductors and non-elastic

conductors it is possible to provide local or point-like detectors.

Similar considerations apply with reference to embodiments which allow to detect impedance and its variation across a solenoid.

The conductor thus conceived is susceptible of numerous
5 modifications and variations, all of which are within the scope of the
appended claims; all the details may further be replaced with other
technically equivalent elements.

In particular, it is possible to cover the conductor with insulating
material, for example liquid rubber or latex, in order to improve the
10 conductivity of the conducting fibers and minimize the risk of interference
with other electrical signals or noise signals.

The insulation can of course be full or partial. For example, it is
possible to leave some points of the conductor exposed in order to provide
electrical terminals or nodes to which other conductors can be connected.
15 The exposed parts can also act as detectors.

The person skilled in the art clearly understands that the innovative
characteristics of a conductor thus configured, while being described mainly
in this document by means of examples of operation in terms of signal
detection, allow uses which are diversified also as regards active use. This
20 means, for example, the possibility to vary the length of the exemplifying
conductor of Figure 2 in order to generate a magnetic field which is suitable
for the intended application, said magnetic field being also optionally
variable if a mechanical movement of extension and release of the elastic
body of the conductor is forced.

25 Similar considerations apply for example if the conductor is used as a
resistor with variable resistance, which can be obtained by extending or
releasing the elastic body, or as a solenoid which can be used with various
values of impedance according to requirements.

Finally, in practice the materials used, as well as the contingent
30 shapes and dimensions, may be any according to requirements and to the

state of the art.

The disclosures in Italian Patent Application No. MI2004A002430 from which this application claims priority are incorporated herein by reference.

CLAIMS

1. A conductor particularly for the electrical connection to each other of two distant points whose distance can vary over time, characterized in that it comprises a body (1) made of elastic material on which conducting
5 fibers (2) are wound.

2. The conductor according to claim 1, characterized in that said conducting fibers (2) constitute a sheath made of conducting textile fibers which is arranged around the body made of elastic material.

3. The conductor according to claim 1, characterized in that it
10 comprises, at at least one end of said body, a metallic terminal (3) which is connected to said conducting textile fibers (2) arranged around said conducting body (1).

4. The conductor according to one or more of the preceding claims, characterized in that said conductor is shaped like a cord.

15 5. The conductor according to one or more of the preceding claims, characterized in that said conductor is ribbon-like.

6. Use of a conductor according to one or more of the preceding claims, characterized in that it is used as a strain gage.

7. An item of clothing with biological signal sensors integrated
20 therewith, characterized in that it comprises at least one conductor according to one or more of claims 1 to 5, said conductor being connected to said item of clothing.

1/1

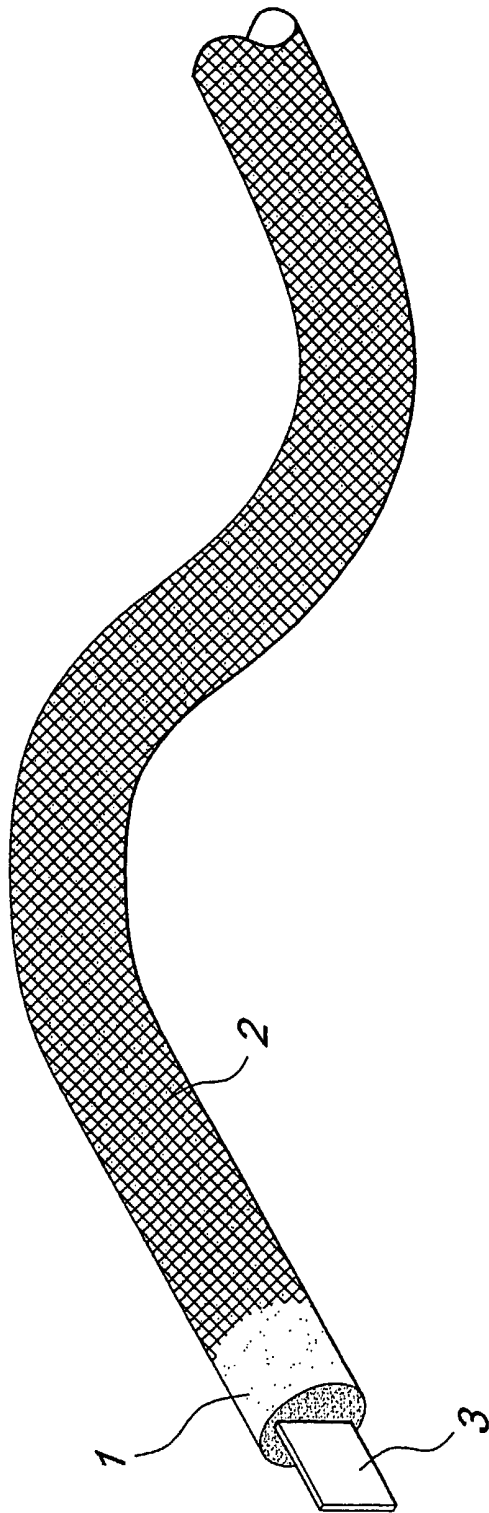


Fig. 1

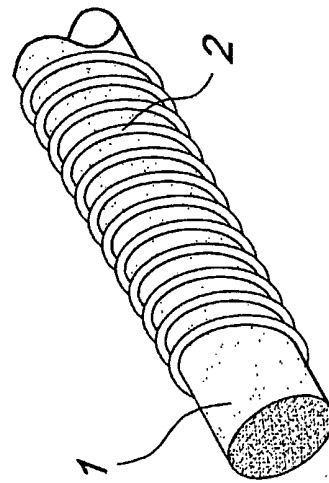


Fig. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2005/013446

A. CLASSIFICATION OF SUBJECT MATTER
D02G3/44 A61B5/113

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)
D02G A61B

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)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2004/027132 A (W. ZIMMERMANN GMBH & CO. KG; NUSKO, ROBERT; PARZL, ADI; MAIER, GEORG) 1 April 2004 (2004-04-01) abstract page 10, line 28 - line 30 -----	1, 3, 4, 6
X	WO 2004/097089 A (INVISTA TECHNOLOGIES S.A.R.L.; KARAYIANNI, ELENI) 11 November 2004 (2004-11-11) page 10, line 7 - line 10 page 4, line 8 - line 10 page 5, line 8 - line 11 -----	1, 3, 4, 7
X	US 2003/124349 A1 (DEANGELIS ALFRED R ET AL) 3 July 2003 (2003-07-03) paragraphs [0006] - [0008] -----	1-5
	-/--	

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

* Special categories of cited documents :

<p>*A* document defining the general state of the art which is not considered to be of particular relevance</p> <p>*E* earlier document but published on or after the international filing date</p> <p>*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)</p> <p>*O* document referring to an oral disclosure, use, exhibition or other means</p> <p>*P* document published prior to the international filing date but later than the priority date claimed</p>	<p>*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</p> <p>*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</p> <p>*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.</p> <p>*Z* document member of the same patent family</p>
--	--

Date of the actual completion of the international search 30 March 2006	Date of mailing of the international search report 18/04/2006
---	---

Name and mailing address of the ISA/ 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	Authorized officer Knüpling, M
---	--

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2005/013446

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 290 977 A (COATS & CLARK, INC) 17 November 1988 (1988-11-17)	1,3,4
Y	abstract	6,7
Y	----- ROSSI DANILO ET AL.: "Electroactive Fabrics and wearable biomonitors devices" AUTEX RESEARCH JOURNAL, vol. 3, December 2003 (2003-12), pages 180-185, XP002374913 page 180, paragraph 2 page 181, paragraph 2 page 182, paragraph 4 -----	6,7

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2005/013446

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2004027132 A	01-04-2004	AU 2003299049 A1	08-04-2004
		CA 2493145 A1	01-04-2004
		CN 1671901 A	21-09-2005
		DE 10342787 A1	13-05-2004
		EP 1537264 A1	08-06-2005
		JP 2005538270 T	15-12-2005
		US 2005282009 A1	22-12-2005
WO 2004097089 A	11-11-2004	AU 2004235297 A1	11-11-2004
		CA 2523421 A1	11-11-2004
		EP 1631711 A1	08-03-2006
US 2003124349 A1	03-07-2003	AU 9113701 A	02-04-2002
		BG 107742 A	30-04-2004
		BR 0114019 A	22-07-2003
		CA 2422227 A1	28-03-2002
		CN 1461364 A	10-12-2003
		CZ 20031087 A3	15-10-2003
		EE 200300115 A	15-04-2005
		EP 1322812 A2	02-07-2003
		HU 0302952 A2	29-12-2003
		JP 2004510067 T	02-04-2004
		MX PA03002308 A	24-06-2003
		NO 20031283 A	20-03-2003
		NZ 524756 A	29-08-2003
		PL 360628 A1	20-09-2004
		WO 0224988 A2	28-03-2002
		US 6497951 B1	24-12-2002
		EP 0290977 A	17-11-1988
US 4776160 A	11-10-1988		