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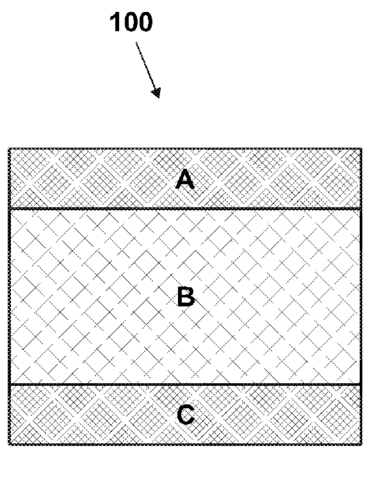


**Fig. 4**

(57) **Abstract:** Method for manufacturing a textile temperature sensor (100), said method comprising the steps of arranging a linear knitting machine comprising at least one first thread-guide and a second thread-guide; arranging a conductive insulated wire (120) on the first thread-guide, said conductive insulated wire (120) having a first end (121) and a second end (122); meshing the conductive insulated wire (120) for making a mesh portion B having not conductive surface. The method comprises then the steps of arranging an electric resistance measuring device configured to measure a variation of electric resistance R(T), said electric resistance R(T) being function of the temperature T, said step of measuring device phase of the electric resistance comprising a first electric cable (201) and a second electric cable (202); electric connection of the first electric cable (201) to the first end (121) and of the second electric cable (202) to the second end (122); arranging a control unit arranged to receive from the device the variation of electric resistance R(T) in order to calculate excursions of temperature T at the lead wire (120).

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TITLE

Method for producing a textile sensor

DESCRIPTION

Field of the invention

The present invention relates to the field of thermistors, i.e. of the temperature sensors that exploit the variation of the resistivity of some materials at temperature variation.

In particular, the invention relates to a textile thermistor.

Description of the prior art

A thermistor, or resistance thermometer, is a temperature sensor that exploits the variation of the resistivity of some materials at temperature variation.

As well known, the resistance $R$ generated by a conductive wire when current is passing is related to the resistivity of the material $\rho$ according to the law $R = \rho * \frac{l}{A}$, where $l$ e $A$ are, respectively, length and section of the conductive wire.

Furthermore, for metals exists a linear equation that links resistivity and temperature:

$$\rho(T) = \rho_0 * [1 + \alpha(T - T_0)]$$

Wherein:

$T$ is the temperature;

$\rho(T)$ is the resistivity of the material to the temperature $T$;

$\rho_0$ is the resistivity of the material to the temperature $T_0$;

$\alpha$ is a coefficient that depends upon the material.

It is therefore possible to write:

$$R(T) = \rho(T) * \frac{l}{A} = \rho_0 * \frac{l}{A} * [1 + \alpha(T - T_0)]$$

From which, known the geometric parameters and known the material, it is possible to determine the temperature excursion $(T - T_0)$ starting from the resistance $R(T)$ measured on conductive wire.

As evident by the previous equation, for the same material ($\rho_0$ and $\alpha$ constant), higher is the ratio $\frac{l}{A}$ the greater is the value of $R(T)$ generated by a same temperature excursion $(T - T_0)$. Then, by increasing $l$ and reducing $A$, there is a higher sensitivity of the thermistor.

The remarkable versatility and precision of thermistors has allowed in the last years a big development of this technology, especially in industry.

In particular, by inserting a resistive metal wire in a tissue, it is possible to exploit the technology of thermistor for making a flexible and wearable element that allows to measure the surrounding temperature.

In the thesis "*Development of temperature sensing fabric*" presented to the University of Cambridge in the

2012, Muhammad Dawood Husain presents a heat-resistant fabric where the resistive metal fibers are inserted directly by the textile machine that produces the fabric itself. In this case, the textile machine is a linear knitting machine that produces a flat knit fabric. With reference to Fig. 1, the introduction of the metal fibers is carried out by weaving, i.e. interposing the metal wire 20 between the knitting rows 10 of the fabric. This way, the metal wire 20 remains in embedded in the fabric and, once connected its ends to the resistance measuring instrument, it is possible to measure the temperature at which the textile sensor is subjected.

However, this exemplary embodiment has some drawbacks.

Firstly, it has a limited wire length $l$. In fact, despite the wire is stretched in the fabric by crossing many times, the maximum wire length is equal to $n * W_s + L_a$, where $n$ is the number of fabric knitting rows, $W_s$ is the fabric width and $L_a$ is the fabric.

Secondly, there is a limitation on the number of inserts per unit of surface. One of the methods that could be used for increasing the length of the wire is to decrease the length of the knitting rows, thus increasing the number of rows for length unit of the fabric. Such method however is not obtainable if the wire is not enameled with an insulator since, in the use of the fabric, the woven branches of conductive wire could contact each other and causing short circuits, and then false measurements. The platinum wire is not in fact available enameled, whereas the wire copper is. The replacement of the platinum wire with an enameled wire brings cost benefits, but it introduces drawbacks concerning sensitivity, since the coefficient of temperature of the copper is much lower than the platinum.

Another drawback is the limitation on the diameter of the conductive wire. In the thesis above cited, the structure of the fabric is done by horizontal weaving. This means that the metal wire, not meshed, is located between two knitting rows. When the fabric is subjected to traction, the textile wire is resiliently deforms, whereas the metal wire is much rigid and, if the section of the wire $A$ is too small, the wire may break, irreversibly damaging the thermometer.

Furthermore, always owing to the different elasticity between fabric and metal wire due to the weaving, you have problems also immediately after generating the fabric. Once formed the fabric, in fact, it tends to retreat in the direction of the weft, whereas the metal wire doesn’t. With reference to Fig. 2A, there are formed therefore side slots 25 of metal wire 20 that protrude from the fabric texture, that, in addition to provide an imperfection, can also cause a break of the wire if the side slot is engages in some object during the use of the fabric.

Finally, there is a difficulty to connect the end of the conductive wire to a conductive cable of larger diameter, which can be used for connecting the device to a data acquisition card.

## Summary of the invention

It is therefore a feature of the present invention to provide a method for manufacturing a textile temperature sensor which allows to increase the length of the wire and to decrease the section with respect to the prior art, so as to obtain a better sensitivity in temperature detection..

It is also a feature of the present invention to provide such a method that makes it possible to obtain a fabric more resilient and deformable with respect to the prior art.

These and other objects are achieved by a method for manufacturing a textile temperature sensor, said method comprising the steps of:

- arranging a linear knitting machine comprising at least one first thread-guide and a second thread-guide;
- arranging a conductive insulated wire on the

first thread-guide, said conductive insulated wire having a first end and a second end;

- meshing the conductive insulated wire for making at least one mesh portion B having not conductive surface;
- arranging an electric resistance measuring device configured to measure a variation of electric resistance $R(T)$, said electric resistance $R(T)$ being function of the temperature $T$, said electric resistance measuring device comprising a first electric cable and a second electric cable;
- electric connection of the first electric cable to the first end and of the second electric cable to the second end;
- arranging a control unit arranged to receive from the device the variation of electric resistance $R(T)$ in order to calculate excursions of temperature $T$ at the conductive wire.

whose main feature is that it also comprises the steps of:

- arranging a not conductive insulated wire on the second thread-guide;

- meshing simultaneously the conductive insulated wire with a not conductive insulated wire for making two mesh portions A and C, said mesh portions A and C having conductive surfaces;
- connecting the conductive insulated wire with the not conductive insulated wire for connecting electrically the first end to the mesh portion A and the second end to the mesh portion C.

and that the step of electric connection of the first electric cable to the first end and of the second electric cable to the second end is carried out connecting, respectively, the first electric cable to the mesh portion A and the second electric cable to the mesh portion C.

Advantageously, are also provided the steps of:

- arranging a textile wire on a third thread-guide the linear knitting machine;
- meshing simultaneously the textile wire with the conductive insulated wire at the at least one mesh portion B.

Owing to the meshing technique with which the conductive insulated wire and the textile wire are woven, the thermoresistive sensor of the present invention has relevant advantages with respect to prior art, where the wires were instead woven by means of weaving technique.

Firstly, thermistor has a much higher sensitivity. In fact, owing to the meshing the wires, the conductive insulated wire is substantially overlapped to the textile wire in all the mesh portion, and it has then a length $l$ much higher than the fabric of the prior art. Furthermore, just because the wires follow the same path, the conductive insulated wire is better supported by the textile wire, which can withstand the strains caused by any deformations or tissue traces. Such determines a cross section $A$ of the conductive insulated wire smaller than the prior art. As previously mentioned, increasing $l$ and decreasing $A$, there is an increase of the sensitivity of the thermoresistive sensor.

Secondly, there is the removal of the side slots that are formed in the woven tissue of the prior art, owing to the retraction of the fabric.

Finally, there is an overall increase of the elasticity of the fabric in the direction of the weft, due to the fact that the conductive insulated wire is arranged according to the knots of the mesh, creating slots, and it is not woven parallel to the direction of the weft. In case of tension of the fabric in the direction of the weft, the side slots extend allowing the yielding of the fabric and its subsequent return to the original shape once the mechanical stress has been completed.

Advantageously, the insulated wire has a diameter set between $10\mu m$ and $150\mu m$.

The conductive wire is, for example, made of copper.

The textile wire is, for example, made in polyester. Alternatively, the textile wire is made with a polymer adapted to high temperatures.

In particular, the step of electric connection of an electric resistance measuring device comprises the steps of:

- welding the first electric cable to the mesh portion A for connecting it electrically to the first end;
- welding the second electric cable to the mesh portion C for connecting it electrically to the second end.

Advantageously, a step is also provided of arranging an auxiliary conductive insulated wire on a fourth thread-guide of the linear knitting machine, said auxiliary conductive insulated wire having an auxiliary first end and an auxiliary second end.

In particular, are also provided the steps of:

- meshing simultaneously the auxiliary conductive insulated wire with the not conductive insulated wire and the conductive insulated wire at the mesh portion A;

- meshing simultaneously the auxiliary conductive insulated wire with the textile wire and the conductive insulated wire at the mesh portion B;
- meshing simultaneously the auxiliary conductive insulated wire with the not conductive insulated wire for making a mesh portion E, said mesh portion E having conductive surface;
- connecting by welding the conductive insulated wire with the auxiliary conductive insulated wire at the mesh portion A for connecting electrically the first end to the auxiliary first end;
- connecting by welding the auxiliary conductive insulated wire with the not conductive insulated wire at the mesh portion E for connecting electrically the auxiliary second end to the mesh portion E.

In particular, the step of electric connection of an electric resistance measuring device comprises the steps of:

- welding the first electric cable to the mesh portion C for connecting it electrically to the second end;

- welding the second electric cable to the mesh portion E for connecting it electrically to the auxiliary second end.

This way, the length of the conductive insulated wire is doubled, further increasing the sensitivity to the resistance variations.

In particular, a step is also provided of meshing simultaneously the auxiliary conductive insulated wire with the textile wire for making a mesh portion D having electric not conductive surface, said mesh portion D located between the mesh portions C and E for electrically insulating them to each other.

Advantageously, a step is also provided of meshing simultaneously a heating wire in the mesh portion B of the textile temperature sensor, said heating wire arranged to generate heat for Joule effect.

This way, knowing the temperature in still air reached by th sensor when it is heated by the heating wire, it is possible to know the temperature excursion owing to the convection caused by the fluid that crosses the sensor and, consequently, it is possible to know the speed of the fluid itself. The temperature sensor can thus work also by anemometer.

Brief description of the drawings

Further characteristic and/or advantages of the present invention are more bright with the following description of an exemplary embodiment thereof, exemplifying but not limitative, with reference to the attached drawings in which:

- Fig. 1 shows the weaving technique used in a textile sensor of the prior art;
- Fig. 1A shows the side slots which may form in the sensor of Fig. 1;
- Fig. 2 shows a block diagram of the method, according to the present invention, used to generate an exemplary embodiment of the temperature sensor of Fig. 4;
- Fig. 3 shows the meshing technique used in the method according to the present invention to overcome the difficulties of the prior art;
- Fig. 4 shows a first exemplary embodiment of the temperature sensor made with the method according to the present invention;
- Fig. 5 shows a second exemplary embodiment of the temperature sensor where the conductive wire has doubled length;
- Fig. 6 shows a third exemplary embodiment of

the temperature sensor where it is present a heating wire in parallel in order to provide a heat wire anemometer;

- Fig. 7 shows an exemplary embodiment of the temperature sensor where they are integrated strips meshed with piezoresistive wire;
- Fig. 8 shows a schematic exemplary embodiment where the temperature sensor works also as pressure sensor owing to the presence of crossed strips meshed with piezoresistive wire.

Description of some preferred exemplary embodiments

In Fig. 2 schematically shows the steps of the method necessary, according to the present invention, to generate the textile temperature sensor 100 of Fig. 4.

In particular, in a preliminary step [301] a textile wire 110, a conductive insulated wire 120 and a not conductive insulated wire are arranged on respective thread-guides of a linear knitting machine. The conductive insulated wire 120 can be, for example, an enamelled copper wire , whereas the not conductive insulated wire can be, for example, a tinned copper wire. The textile wire 110 can be, for example, a polyester wire.

Then you proceed meshing the wires. With reference to Figs. 2 and 4, following the generation of the portions from A to C, you have the following steps of meshing:

- portion A: meshing conductive insulated wire 120 and not conductive insulated wire [302];
- portion B: meshing conductive not insulated and textile wire 110 [303];
- portion C: meshing conductive insulated wire 120 and not conductive insulated wire [304].

Once made the fabric as described above, you proceed to the electric connection of the conductive insulated wire 120 and of the not conductive insulated wire at the portions A and C [305]. Such step can be made, for example, by welding, in order to dissolve locally the insulator coating the conductive insulated wire 120. Thus, the portions A and C, having conductive surface owing to the meshing of the not conductive insulated wire, can work as poles for connecting the cables 201 and 202 of an electric resistance measuring device that causes passage of current in the conductive insulated wire 120 that crosses all the portions A, B and C, and allows finally to calculate the variation of resistivity and therefore the variation of temperature.

With reference to Fig. 3, you can see the difference between the meshing technique, used in above mentioned steps, and the weaving technique, used in prior art of Fig. 1. In particular, the meshing technique makes the wires 110 and 120 substantially overlapped in all the mesh.

Owing to this there are many advantages, since it is possible to cause the conductive insulated wire 120 making a path higher than the prior art, increasing $l$ and therefore improving the sensitivity in detecting the temperature, as explained in the section of the prior art. Furthermore, the textile structure derived from this technique is much more adapted to withstand strain and tension, since the textile wire 110 and the conductive one are substantially overlapped throughout the mesh, giving them a similar elasticity, contrarily to the prior art. Such aspect, in addition to improve the elasticity and the resistance of the textile sensor, allows also to reduce the cross section $A$ of the conductive wire, further improving the sensitivity in detecting the temperature.

Furthermore, the presence of the portions A and C allows a steadier welding of the cables of the electric resistance measuring device to the conductive insulated wire 120, since the cables can be welded to an entire conductive area, rather than to the at the ends of a metal wire, as provided in prior art.

With reference to Fig. 5, for increasing further the length $l$ of the conductive insulated wire 120, it is possible to add an auxiliary conductive insulated wire 120′, to connect to the conductive insulated wire 120, to the respective ends 121 and 121′, at the mesh portion A.

In particular, following the generation of all the portions from A to E, you have the following steps of meshing:

- portion A: meshing conductive insulated wire 120, auxiliary conductive insulated wire 120′ and not conductive insulated wire;
- portion B: meshing conductive insulated wire 120, auxiliary conductive insulated wire 120′ and textile wire 110;
- portion C: meshing conductive insulated wire 120 and not conductive insulated wire;
- portion D: meshing auxiliary conductive insulated wire 120′ and textile wire 110;
- portion E: meshing auxiliary conductive insulated wire 120′ and not conductive insulated wire.

You have then a step of welding the ends 122 and 122′, respectively, in the portions C and E that become the conductive areas to which can be connected the ends of the electric resistance measuring device. Since the cables are typically connected by welding, i.e. dissolving the insulating coating of the wire insulated 120 to allow it to enter in electric connection with the not conductive insulated wire of the portion C, in this portion cannot be meshed also the auxiliary conductive insulated wire 120′, otherwise would occur a short circuit. The auxiliary conductive insulated wire 120′ must then has to be placed on the side in the portion C and then start again to be meshed by the portion D. Alternatively, the conductive insulated auxiliary 120′ can start again to be meshed directly in the portion E and the portion D can be a mesh portion only with the textile wire 110.

The portion D that has surface not conductive since there is not the not conductive insulated wire, allows instead to insulate to each other the portions C and E, avoiding short circuits.

This exemplary embodiment allows to double the conductive insulated wire, further improving the sensitivity in detecting the temperature. Furthermore, it is a solution more practical, since it determines to have connection areas for the connection of the electric resistance measuring device close to each other.

In the solution of Fig. 5, in the portions A and B are meshed three wires at the same time. In case that the machine is not adapted to operate with more than 2 thread-guide at the same time on each knitting row, it is possible to operate to alternated rows, meshing only two wires per row. For example, for portion A it is possible to alternate the following rows:

- row 1: meshing not conductive insulated wire and conductive wire 120;

- row 2: meshing not conductive insulated wire and auxiliary conductive wire 120'.

With reference to Fig. 6, in a further exemplary embodiment, it is possible to mesh a heating wire with the textile sensor shown in Fig. 4, by making a circuit parallel to that of thermoresistor.

In particular, following the generation of all the portions from X to Y, you have the following steps of meshing:

- portion X: meshing not conductive insulated wire and heating wire;
- portion X': meshing textile wire 110;
- portion A: meshing conductive insulated wire 120, not conductive insulated wire;
- portion B: meshing conductive insulated wire 120, textile wire 110 and heating wire;
- portion C: meshing conductive insulated wire 120, not conductive insulated wire;
- portion Y': meshing textile wire 110;
- portion Y: meshing not conductive insulated wire and heating wire.

To portions A and C are connected, in a way completely similar to an exemplary embodiment of Fig. 4, the cables 201 and 202 of the electric resistance measuring device. To the portions X and Y (insulated by the portions

A and C by the portions X′ and Y′ having not conductive surface) are instead connected the cables 211 and 212 of a separated supplier arranged to heat the heating wire for Joule effect.

Like what said above, the heating wire cannot be meshed in the mesh portions A and C, otherwise, at welding the cables 201 and 202, would occur an electric connection between the heating circuit and the thermoresistor circuit, which instead must act in parallel. In such portions, therefore, the heating wire is left out of the tissue and meshed only in the portion B. In the portions X′ and Y′ the heating wire can be meshed or not, according to the particular reasons, without affecting in any way the functionality of an exemplary embodiment described.

Owing to the presence of the heating circuit, knowing the temperature at which comes the sensor heated by the heating wire when the fluid has speed zero, it is possible to know the temperature excursion owing to the convection caused by the fluid that crosses the sensor and, consequently, it is possible to know the speed of the fluid itself. The temperature sensor can, thus work also by anemometer. It is possible, for example, to use this sensor on the section of a duct where air or other fluid flows to detect its speed at that point..

In Fig. 7 an exemplary embodiment is shown of the textile temperature sensor 100 of Fig. 4, wherein a plurality is provided of strips of mesh portions B alternate to strips of mesh portions Z. The mesh portions B are to each other electrically connected by the joints 130. The mesh portions Z are instead made by meshing a wire of piezoresistive material and are overlapped to corresponding strips of mesh portion Z' made by meshing not conductive insulated wire.

With reference even at Fig. 8, superimposing and arranging to 90° two exemplary embodiments of the sensor 100 of Fig. 7, it is possible to obtain a sensor 100 configured to work both from temperature sensor and pressure sensor. In fact, owing to the crossing of the strips Z and to the presence of strips Z' conductive or semiconductive it is possible to determine points of pressure $Z_i$ on which, by arranging a pressure, there is changing resistivity of the piezoresistive wire, allowing to calculate the amount of the pressures acting on the points $Z_i$ itself. This way, it is possible to analyze a map of pressures acting on the sensor 100 that, in this exemplary embodiment, then allows measuring both the temperature than the pressure.

Furthermore, both exemplary embodiment of Fig. 7 and of Fig. 8, the sensor 100 allows measuring the temperature in a way further localized, since it is possible, by means of special electric connections, to receive data of change of the resistivity by a single strip B or also by the crossing points, in Fig. 8, between strips B to each other overlapped and perpendicular.

The foregoing description some exemplary specific embodiments will so fully reveal the invention according to the conceptual point of view, so that others, by applying current knowledge, will be able to modify and/or adapt in various applications the specific exemplary embodiments without further research and without parting from the invention, and, accordingly, it is meant that such adaptations and modifications will have to be considered as equivalent to the specific embodiments. The means and the materials to realise the different functions described herein could have a different nature without, for this reason, departing from the field of the invention. it is to be understood that the phraseology or terminology that is employed herein is for the purpose of description and not of limitation.

## CLAIMS

1. Method for manufacturing a textile temperature sensor (100), said method comprising the steps of:

   - arranging a linear knitting machine comprising at least one first thread-guide and a second thread-guide;
   - arranging a conductive insulated wire (120) on said first thread-guide, said conductive insulated wire (120) having a first end (121) and a second end (122);
   - meshing said conductive insulated wire (120) for making at least one mesh portion B having a not conductive surface;
   - arranging an electric resistance measuring device configured to measure a variation of electric resistance $R(T)$, said electric resistance $R(T)$ being function of the temperature $T$, said electric resistance measuring device comprising a first electric cable (201) and a second electric cable (202);
   - electric connection of said first electric cable (201) to said first end (121) and of said second electric cable (202) to said second end (122);

- arranging a control unit arranged to receive from said device said variation of electric resistance $R(T)$ in order to calculate excursions of temperature $T$ at said lead wire (120).

**characterized in that** are also provided the steps of:

- arranging a not conductive insulated wire on said second thread-guide;
- meshing simultaneously said conductive insulated wire (120) with said not conductive insulated wire for making two mesh portions A and C, said mesh portions A and C having conductive surfaces;
- connecting said conductive insulated wire (120) with said not conductive insulated wire for connecting electrically said first end (121) to said mesh portion A and said second end (122) to said mesh portion C;

**and by that said** step of electric connection of said first electric cable (201) to said first end (121) and of said second electric cable (202) to said second end (122) is carried out connecting, respectively, said first electric cable (201) to said mesh portion A and said second electric cable (202) to said mesh portion

C.

2. The method for manufacturing a textile temperature sensor (100), according to claim 1, wherein they are also provided the steps of:

- arranging a textile wire on a third thread-guide of said linear knitting machine;
- meshing simultaneously said textile wire with said conductive insulated wire (120) at said at least one mesh portion B.

3. The method for manufacturing a textile temperature sensor (100), according to claim 1 or 2, wherein said step of connection of said conductive insulated wire (120) with said not conductive insulated wire is made by welding.

4. The method for manufacturing a textile temperature sensor (100), according to claim 1 or 2, wherein said step of connection of said conductive insulated wire (120) with said not conductive insulated wire is made by removal of an insulator said conductive insulated wire (120), said removal occurring alternatively, by means:

- chemical process;
- mechanical abrasion;
- heat abrasion, in particular by means of laser;

- a combining the previous.

5. The method for manufacturing a textile temperature sensor (100), according to claim 3 or 4, wherein said step of connection of said conductive insulated wire (120) with said not conductive insulated wire is carried out at said mesh portions A and C.

6. The method for manufacturing a textile temperature sensor (100), according to claim 1 or 2, wherein are also provided the steps of:

   - defining a length $l^*$ of conductive wire on which measuring the resistance;
   - detection of connection points $O$ and $P$ such that you have among them said length $l^*$;

and wherein said step of connection of said conductive insulated wire (120) with said not conductive insulated wire is made at said connection points $O$ and $P$.

7. The method for manufacturing a textile temperature sensor (100), according to claim 1 or 2, wherein said step of meshing said conductive insulated wire (120) for making at least one mesh portion B is arranged to create a number $n$ of mesh portions B and where they are also provided the steps of:

   - arranging a piezoresistive wire on a fourth thread-guide of said linear knitting machine;

- meshing said piezoresistive wire for making a number $n-1$ of mesh portions Z;

said $n$ mesh portions B and said $n-1$ mesh portions Z being displaced adjacent to each other and in a way alternated to each other.

8. The method for manufacturing a textile temperature sensor (100), according to claim 7, wherein a step is provided of meshing said not conductive insulated wire for making a number $n-1$ of mesh portions Z′ arranged to be overlapped to said $n-1$ mesh portions Z.

9. The method for manufacturing a textile temperature sensor (100), according to claim 1, wherein said step of electric connection of a electric resistance measuring device comprises the steps of:

- welding said first electric cable (201) to said mesh portion A for connecting it electrically to said first end (121);

- welding said second electric cable (202) to said mesh portion C for connecting it electrically to said second end (122).

10. The method for manufacturing a textile temperature sensor (100), according to claim 1 or 2, where a step is also provided of arranging an auxiliary conductive

insulated wire (120’) on a fourth thread-guide of said linear knitting machine, said auxiliary conductive insulated wire (120’) having an auxiliary first end (121’) and an auxiliary second end (122’), and where they are also provided the steps of:

- meshing simultaneously said auxiliary conductive insulated wire (120’) with said not conductive insulated wire and said conductive insulated wire (120) at said mesh portion A;
- meshing simultaneously said auxiliary conductive insulated wire (120’) with said textile wire (110) and said conductive insulated wire (120) at said mesh portion B;
- meshing simultaneously said auxiliary conductive insulated wire (120’) with said not conductive insulated wire for making a mesh portion E, said mesh portion E having conductive surface;
- connecting by welding said conductive insulated wire (120) with said auxiliary conductive insulated wire (120’) at said mesh portion A for connecting electrically said first end (121) to said auxiliary first end (121’);
- connecting by welding said auxiliary conductive

insulated wire (120’) with said not conductive insulated wire at said mesh portion E for connecting electrically said auxiliary second end (121’) to said mesh portion E.

11. The method for manufacturing a textile temperature sensor (100), according to claim 3, wherein said step of electric connection of an electric resistance measuring device comprises the steps of:

- welding said first electric cable (201) to said mesh portion C for connecting it electrically to said second end (122);
- welding said second electric cable (202) to said mesh portion E for connecting it electrically to said auxiliary second end (122’).

12. The method for manufacturing a textile temperature sensor (100), according to claim 11, wherein a step is also provided of meshing simultaneously said auxiliary conductive insulated wire (120’) with said textile wire (110) for making a mesh portion D having electric not conductive surface, said mesh portion D located between said mesh portions C and E for electrically insulating them to each other.

13. The method for manufacturing a textile temperature

sensor (100), according to any of the previous claims, wherein a step is also provided of meshing simultaneously a heating wire in said mesh portion B of said textile temperature sensor (100), said heating wire arranged to generate heat for Joule effect.

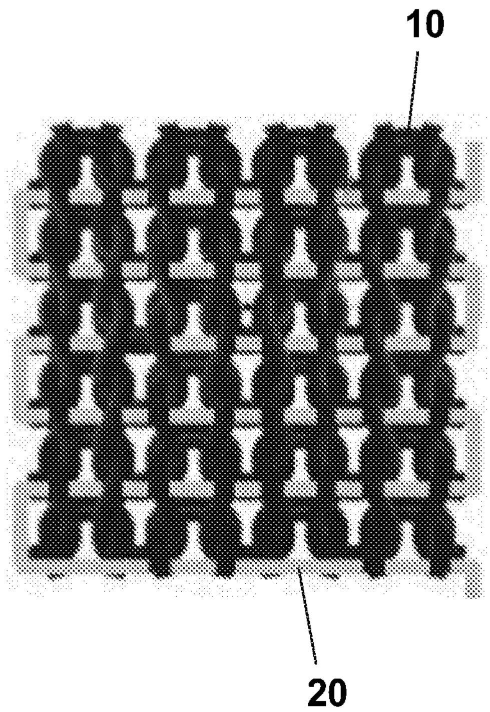



**Fig. 1**
**(prior art)**

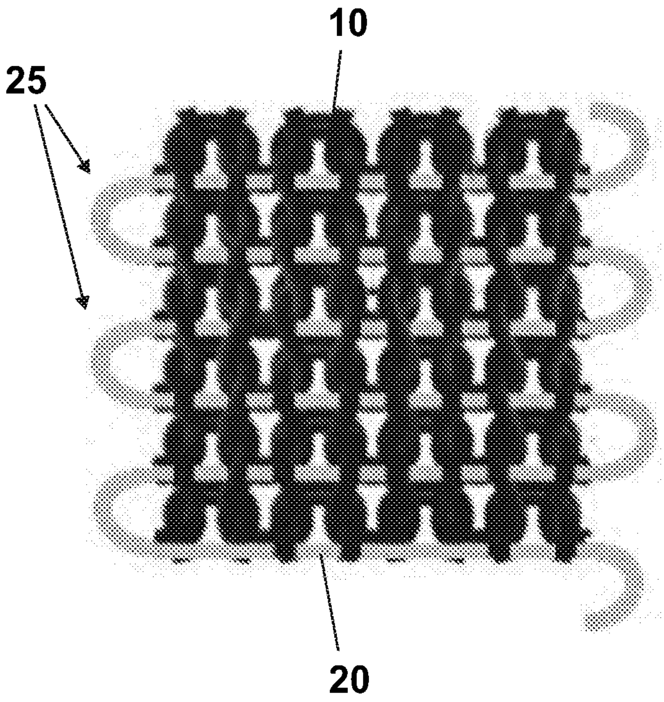
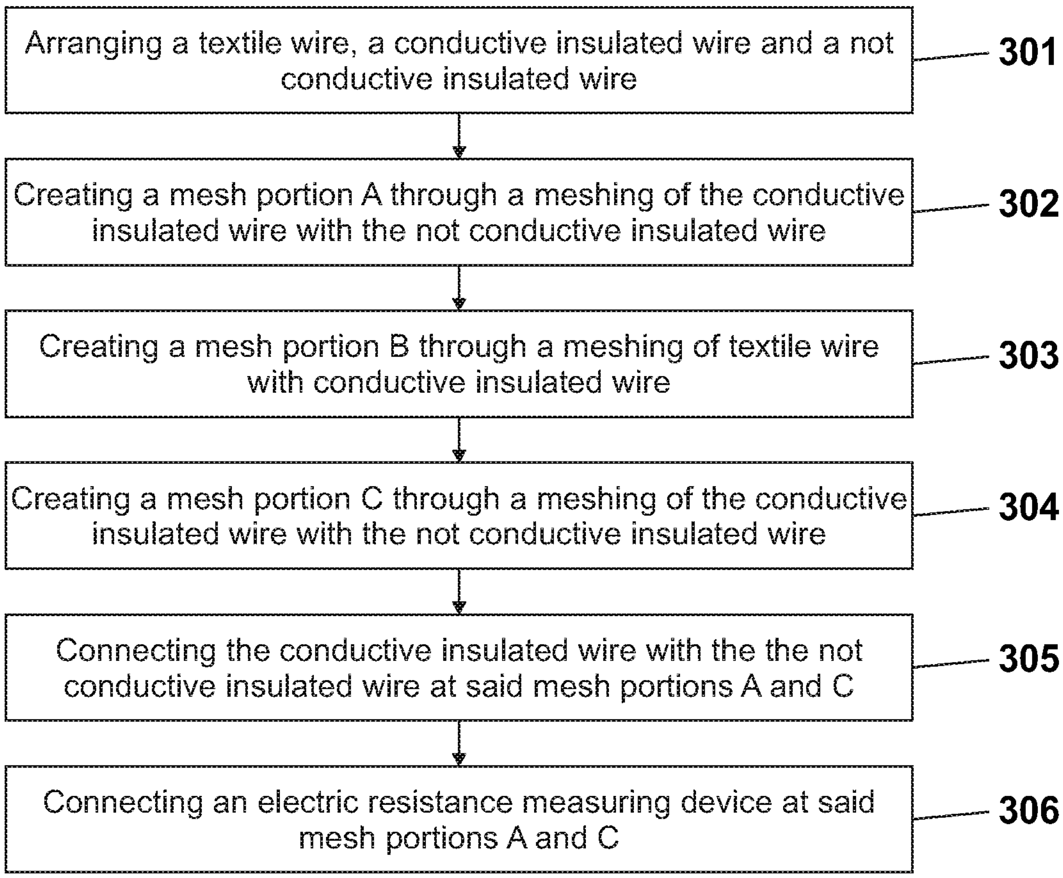



**Fig. 1A**
**(prior art)**

# Fig. 2


Arranging a textile wire, a conductive insulated wire and a not conductive insulated wire
301
Creating a mesh portion A through a meshing of the conductive insulated wire with the not conductive insulated wire
302
Creating a mesh portion B through a meshing of textile wire with conductive insulated wire
303
Creating a mesh portion C through a meshing of the conductive insulated wire with the not conductive insulated wire
304
Connecting the conductive insulated wire with the the not conductive insulated wire at said mesh portions A and C
305
Connecting an electric resistance measuring device at said mesh portions A and C
306

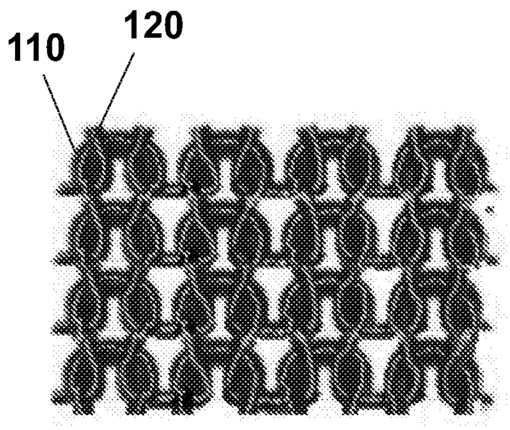



**Fig. 3**

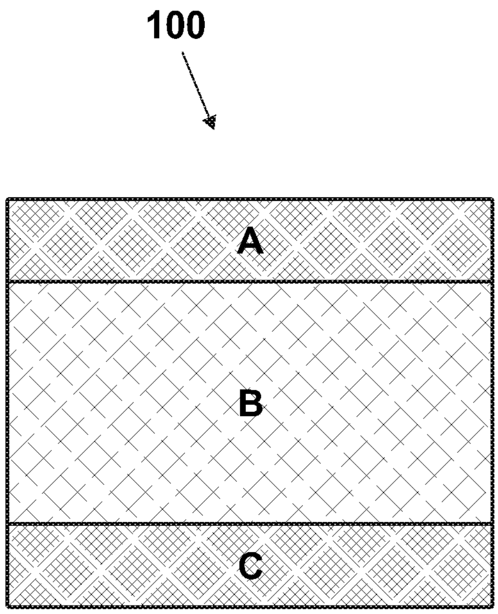



**Fig. 4**

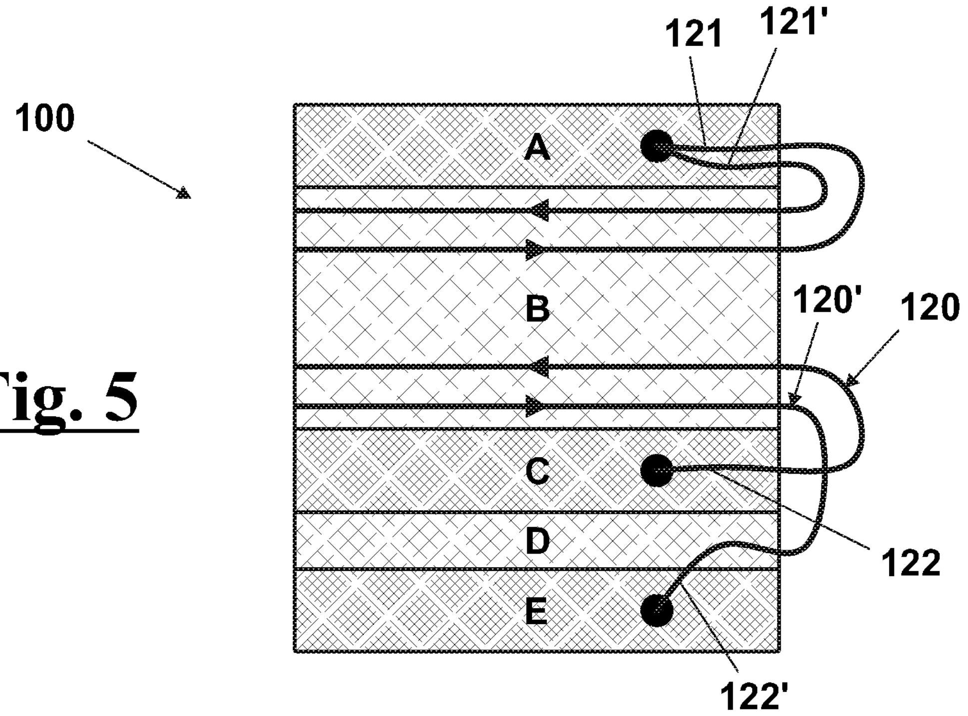



Fig. 5

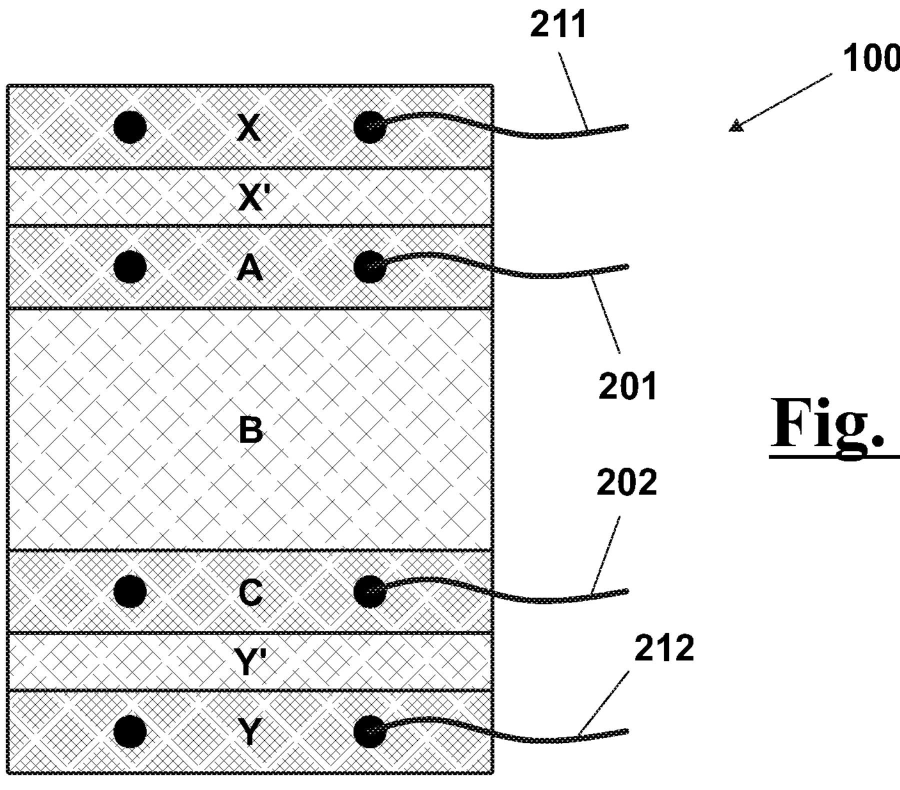



Fig. 6

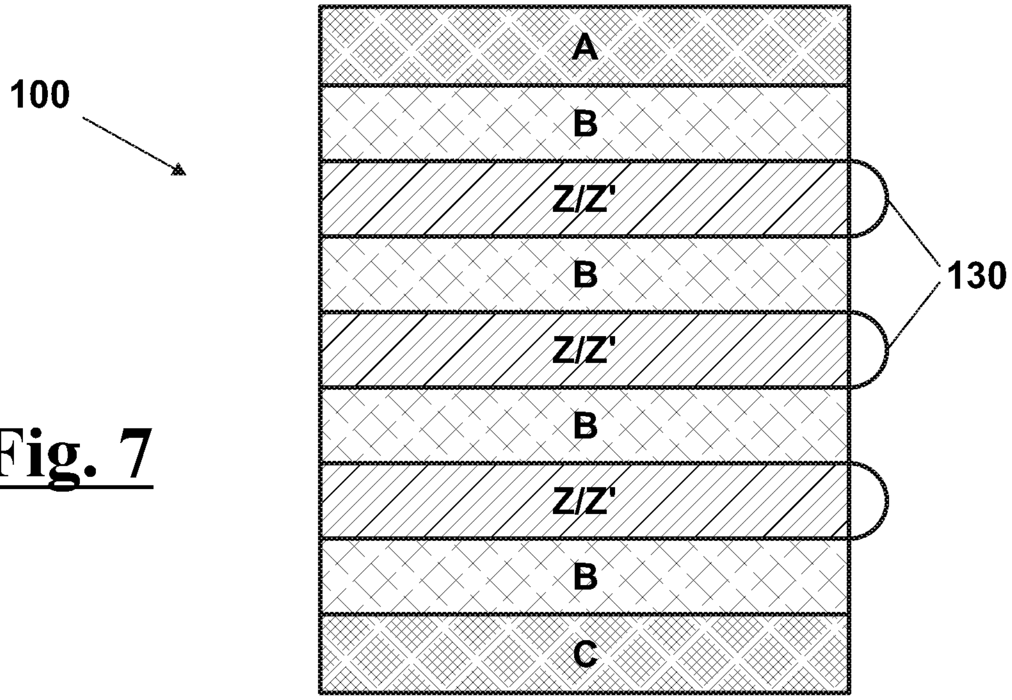



Fig. 7

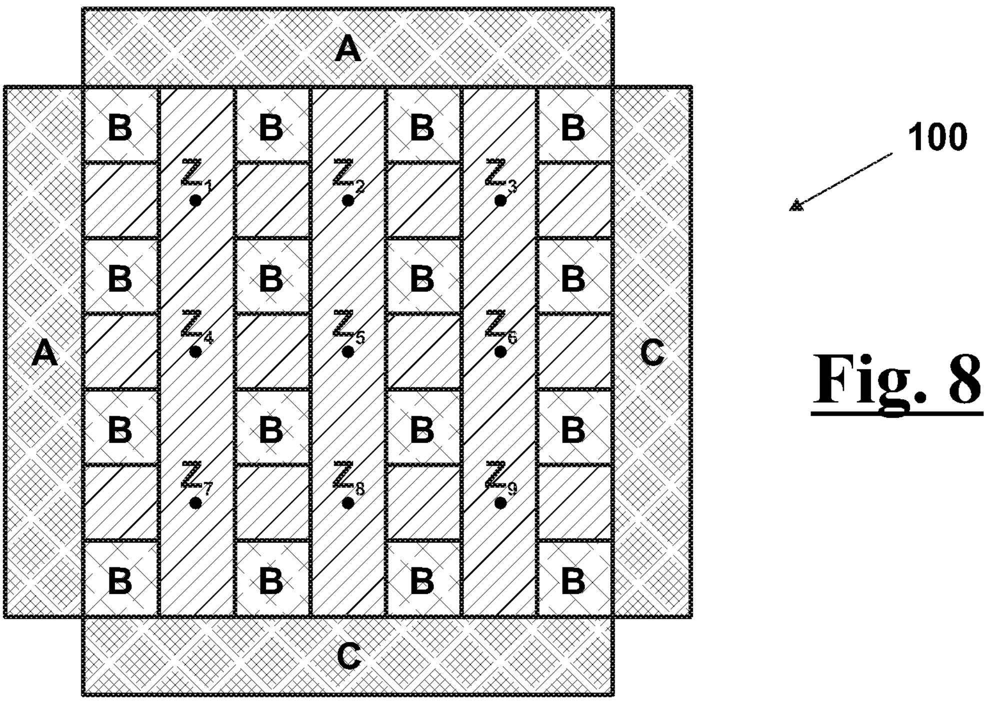



Fig. 8

# INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2017/055706

**A. CLASSIFICATION OF SUBJECT MATTER**
INV. G01K1/14 A41D13/12 D04B1/14 G01K7/18 G01K13/00
A61B5/00
ADD.

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)
G01K A41D D04B 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 practicable, search terms used)

EPO-Internal, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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| A | US 2005/062486 A1 (QI BAOHUA [US] ET AL) 24 March 2005 (2005-03-24) abstract; figure 6a paragraphs [0011], [0012], [0035], [0038] ----- | 1-13 |
| | -/-- | |

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

[X] See patent family annex.

* Special categories of cited documents :

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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

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"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 12 December 2017 | 18/12/2017 |

| Name and mailing address of the ISA/ | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040,<br>Fax: (+31-70) 340-3016 | de Bakker, Michiel |

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# INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2017/055706

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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**Information on patent family members**

International application No
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| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
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| | | | |
|---|---|---|---|
| 专利名称(译) | 纺织品传感器的制造方法 | | |
| 公开(公告)号 | EP3516357A1 | 公开(公告)日 | 2019-07-31 |
| 申请号 | EP2017787626 | 申请日 | 2017-09-20 |
| [标]发明人 | MARCHESI RICCARDO | | |
| 发明人 | MARCHESI, RICCARDO | | |
| IPC分类号 | G01K1/14 A41D13/12 D04B1/14 G01K7/18 G01K13/00 A61B5/00 | | |
| CPC分类号 | A41D1/002 A41D13/1281 A61B5/01 A61B5/6804 A61B5/6843 D04B1/14 D10B2403/02431 G01K1/14 G01K7/18 G01K13/002 D04B21/14 H01B1/124 | | |
| 优先权 | 102016000094342 2016-09-20 IT | | |
| 外部链接 | Espacenet | | |


摘要(译)

用于制造纺织品温度传感器（100）的方法，所述方法包括以下步骤：布置包括至少一个第一导纱器和第二导纱器的线性针织机;在第一导纱器上设置导电绝缘导线（120），所述导电绝缘导线（120）具有第一端（121）和第二端（122）;将导电绝缘线（120）啮合以制造不具有导电表面的网格部分B.该方法包括以下步骤：布置电阻测量装置的步骤，该电阻测量装置被配置为测量电阻R（T）的变化，所述电阻R（T）是温度T的函数，所述步骤测量电阻的装置相位包括第一电缆（201）和第二电缆（202）;第一电缆（201）与第一端（121）和第二电缆（202）与第二端（122）的电连接;设置控制单元，该控制单元设置成从装置接收电阻R（T）的变化，以便计算引线（120）处的温度T的偏移。