Sept. 3, 1968 HIROSHI TAKEMORI 3,400,254

ELECTRIC HEATING DEVICE FOR MOUNTING INSIDE A FABRIC COVERING

Filed July 18, 1966 2 Sheets-Sheet 1

Fig. 1

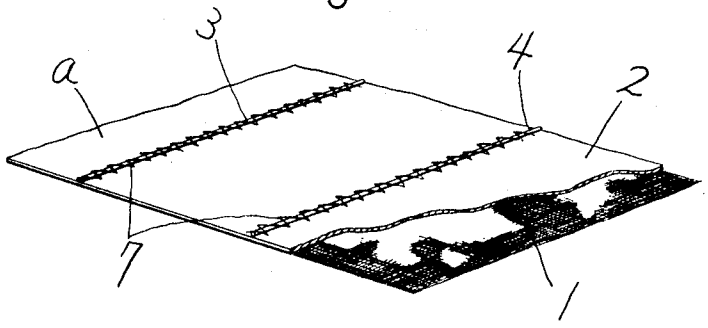


Fig. 2

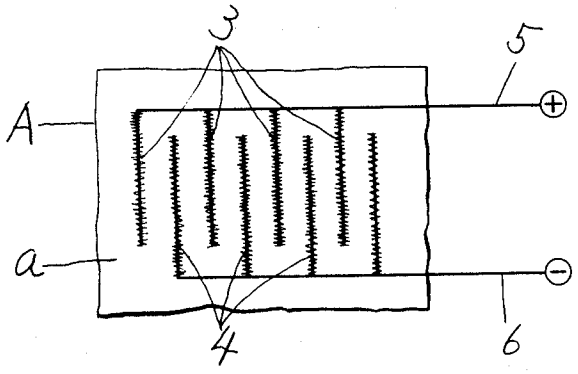
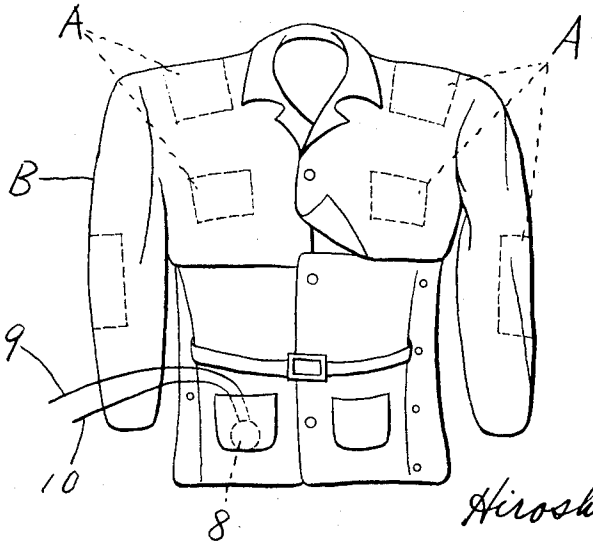


Fig. 3



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ELECTRIC HEATING DEVICE FOR MOUNTING INSIDE A FABRIC COVERING

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Fig. 4

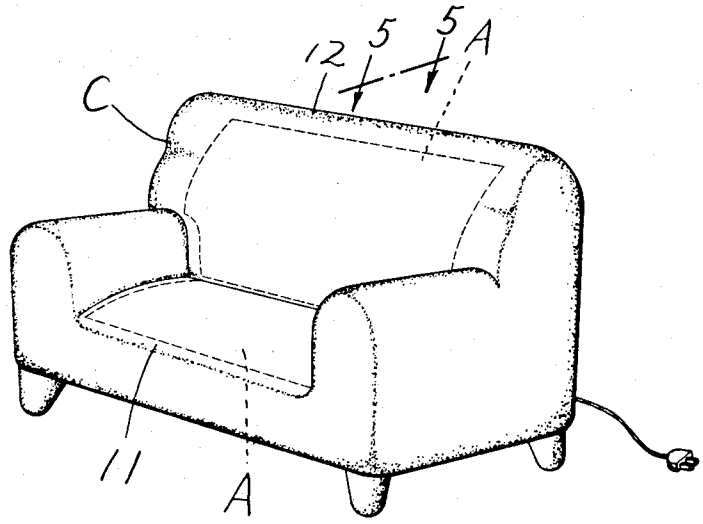
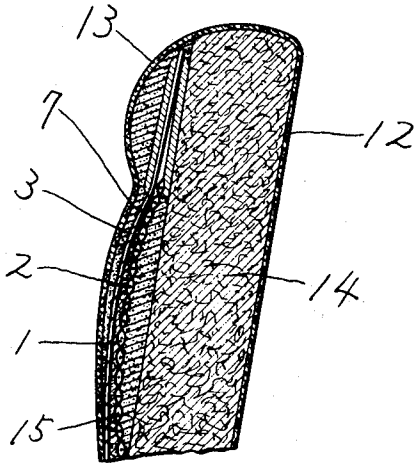


Fig. 5



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ELECTRIC HEATING DEVICE FOR MOUNTING INSIDE A FABRIC COVERING

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6 Claims. (Cl. 219—549)

ABSTRACT OF THE DISCLOSURE

A heating means for mounting inside a fabric covering. It consists of a base cloth of a material which is electrically insulating and also heatproof. A layer of conductive and flexible polymer is provided thereon which has from 45 to 55 parts of graphite having a particle size less than 10 microns, and 100 parts of a polymer forming material. Positive and negative wires are fixed to the conductive cloth at regular intervals, and common leads are connected to the respective wires. When current is supplied to the leads, the conductive layer develops heat due to the electric resistance thereof.

This invention is related to a heating device to be built in inside clothes, blankets, carpets, chairs, bed-clothes, building materials, cooking utensils and other articles of daily use, and medical appliances for heating.

The aim of this invention is to keep the human body and foodstuffs warm with utmost ease, by applying an electric current to the above-mentioned built-in heating device.

Another aim of this invention consists in the use of a thin fabric-like heat generator, unlike the traditional one in which a resistance heating wire is used. Hence, this invention is applicable to heating of a large area, for instance, blankets and carpets, and moreover this thin heat generator is not only easy to fold up but not subject to damage even when folded up, so that the clothes, blankets, carpets and the like containing the built-in heater of this invention inside them can be folded up compactly for convenience of storing.

A third aim of this invention consists in the following mechanism. This thin fabric-like heat generator has heat resistance and is coated with chemically inert and electrically conductive layer. It is made of insulated and heatproof cloth, such as glass cloth and Terylene cloth, the surface of which is coated with conductive and flexible polymer. A considerable quantity of electric current, either of high or low tension, can be supplied to this heat generator to obtain a satisfactory heating effect, and this conductive cloth has good surface resistance to any mechanical pressure, such as elongation, bending and plying, and is permanently free from deterioration, and moreover it has heat resistance, which is increased depending on the rise of heat. Furthermore, since this conductive cloth can be cut, sewn and bored at will, it can be made into heating appliances of any required shape.

The accompanying drawings show some embodiments of this invention. FIG. 1 is a perspective view showing a partial section of the heating device of this invention. FIG. 2 is a plan view showing a part of the heating device of this invention. FIG. 3 is a front view of a coat with the heating device of this invention built therein. FIG. 4 is an oblique view of a chair having the heating device of the invention built into it. FIG. 5 is a partially enlarged sectional view of the back of the chair taken along line 5—5 in FIG. 4.

As FIGS. 1 and 2 show, the heating device of this invention is a thin fabric-like heat generator *a* consisting of the insulating and heatproof base cloth **1**, made of glass cloth, Terylene cloth or glass fiber-Terylene fiber blended cloth, the surface of which is coated with a liquid compound made by mixing a binder, such as gum, synthetic resin and the like, and an appropriate quantity of pulverized carbon and metals, so as to form the conductive layer **2**.

Terylene of the Terylene cloth used as the base cloth is a trademark, and it is a kind of polyester, i.e. polyethylene terephthalate, or polyester of ethlene glycol and terephthalic acid.

The conductive layer is a flexible resistor composed of conductive carbon mixed with a synthetic resin binder. In this invention, the conductive layer is made by either of the following two methods; 45 parts of artificial graphite pulverized below 10 microns and 100 parts of 20% neopren solution prepared by dissolving neopren gum in toluene as a binder are mixed, dried, hot-pressed into a sheet with a roller and then fixed to the base cloth of glass cloth or Terylene cloth; or 100 parts of 40% water emulsion of acrylate methyl ester resin and 55 parts of artificial graphite pulverized below 10 microns are mixed, made into paste and then spread on the base cloth.

Alternatively, a water emulsion or organic solvent for synthetic resins can be utilized as the binder.

The conductive layer obtained in the above-mentioned embodiment of this invention has the following characteristics.

Specific gravity of resistance mixture (g./cc.)	1.5–1.7
Thickness of sheet (mm.)	0.3–0.6
Surface resistance (Ω/dm.²)	200–400
Cubic resistance of polymer (specific resistance) (Ω/cm.)	4–7
Functioning heat (°C.)	40–60
Functioning voltage (v.)	0–100
Output (watts/dm.²)	3–12

On the said heat generator *a* are placed the terminals **3**, **4** and **3**, **4** in parallel and at appropriate intervals, the terminals **3**, **3** being connected at one end to one of the leads **5**, while the other terminals **4**, **4** are connected at one end to the other lead **6**, the lead **5** being connected to the plus side and the lead **6** to the minus side, the electric current flowing from the terminals **3**, **3** to the terminals **4**, **4**. In the accompanying drawings, the terminals **3**, **4** are illustrated as two wires each, but they can be increased appropriately according to the dimension of the conductive layer **2**.

In this case, when the voltage is definite, the space between the plus and minus terminals can be figured out, by determining the output in watts per square foot according to the following formula.

$$X^2=\frac{144V^2}{W.R}$$

R=surface resistance of conductive layer in terms of ohms per 100 sq. ft.
W=watts required per sq. ft.
V=functioning voltage in terms of volts
X=space between terminals in terms of inches

The terminals **3**, **4** are sewn by zigzag stitches to the heat generator *a* by means of the thread **7**, and the ends of the fixed leads **5**, **6**, though not illustrated in the drawing, are connected to the power source through a power switch, transformer and the like.

When the length of the terminal wire for the heat generator *a* is known, the required current for the terminal can be worked out as follows. In this case, the functioning voltage has nothing to do with this calculation.

$$I=\frac{L}{2}\sqrt{\frac{W}{R}}$$

L=length of terminal in terms of feet
W=watts required per sq. ft.

R=surface resistance of conductive layer in terms of ohms per 100 sq. ft.

I=current in terms of amperes

The thin fabric-like heat generator *a* has different characteristics, according to whether its base cloth is made of glass cloth or Terylene cloth, as follows.

	Glass cloth	Terylene cloth
Weight of cloth (oz./sq. yd.)	3.4	2.5
Weight of coating (oz./sq. yd.)	3.5-4.0	3.0-3.5
Surface resistance (ohm/100 sq. ft.), percent	300±10	400±10
Cubic resistance of polymer (ohms/cm.)	5	5
Maximum functioning temperature (° C.)	150	120
Functioning voltage (v.)	0.250	0.250
Thickness (inches)	0.008	0.008
Maximum output (watts/sq. ft.)	150	150

The heating device A of this invention consists of the mechanism as mentioned above.

FIG. 3 shows the arrangement of the heating device A of this invention built inside the coat B to be worn for protection against cold. As illustrated by the figure, the thin fabric-like heat generators *a* are regularly distributed, being connected to each other by means of the leads **5**, **6**. The said leads **5**, **6** connecting the said heat generators *a* to each other are connected to the power source, such as a battery or the like, by means of the leads **9**, **10** through the power switch **8**.

In this case, it goes without saying that the heat generators *a* have the terminals **3**, **4** which are connected to the leads **5**, **6** respectively and fixed in parallel onto the said heat generators *a* by means of the thread **7**.

In the instance of the coat illustrated in FIG. 3, when the current is applied to the leads **5**, **6**, it runs between the terminals **3**, **4**, spreading uniformly through the conductive layer **2** of the heat generator *a*, and the conductive layer is heated by means of its own electric resistance.

As a result, each of the heat generators *a* placed at appropriate parts of the coat B is heated, making the said coat B warm enough.

The coat is thus heated by means of the heat generators *a* which are distributed appropriately and develop heat by means of application of power, so that, if the current is turned on beforehand, the coat will be warm enough to be worn readily.

The same objective can also be attained by applying this device to suits, working clothes and the like besides the above-mentioned coat for protection against cold.

FIG. 4 shows the heating device of this invention built in inside the seat and a back of the chair or the like. As FIG. 5 shows, the heating device A is inserted inside the outer cover **13** of the seat **11** or the back **12** or both parts.

FIG. 5 shows the heating device A of this invention built inside the outer cover **13** of the back **12**. Between the buffer material **15** on the core material **14** and the outer cover **13** is inserted the said heating device A integrally consisting of the terminals **3**, **4** placed in parallel and at regular intervals on the conductive layer **2** of the base cloth **1** and the leads **5**, **6** respectively connected to the said terminals **3**, **4**. When the leads **5**, **6** of the heating device A are connected to a power source and the current is applied to the heat generator *a* of the heating device A, the conductive layer **2** develops heat by means of its own electric resistance, the current being uniformly distributed throughout the said conductive layer **2**, thus heating the surface of the back **12** of the chair.

Unlike the traditional heat generator which is so devised that it will develop heat by means of the resistance heating wire, the heating device of this invention consists of a thin fabric-like heat generator, so that not only will its heating cover a very wide range but also it can be installed with ease. Moreover, even when the heating area is large, uniform heat can be obtained effectively, the current being distributed evenly between the terminals **3**, **4**.

This invention, therefore, makes it no longer necessary to apply an electrothermal cushion to the seat or the back of the chair for the sake of warmth, and completely removes the inconvenience of the cushion being disarranged according to the bodily movement. In case of heating the seats of a carriage and the like, this invention has the advantage that not only can the seat itself be heated but the back thereof can be warmed at the same time.

Each embodiment of this invention is illustrated as an instance of application of the built-in heating device inside the clothes and the chair. This invention, however, can also be applied to blankets, carpets, cooking utensils, building materials and other articles of daily use as the built-in heating device. And besides these daily necessities and furniture of everyday use, this invention can be applied to medical heating apparatus as well, for instance, a pocket warmer, which can be conveniently used as an effective curative means against chilly constitution and neuralgia, without the trouble of refilling the heating fuel, such as gasoline and the like, unlike the case of the traditional pocket warmer. This pocket warmer will be found handy and useful even by a healthy person, as he can warm himself by putting it in his pocket, connected either with a battery or with house power.

While preferred embodiments have been described in detail above, it will be understood that numerous modifications might be resorted to without departing from the scope of the invention as defined in the following claims.

I claim:

1. A heating means for mounting inside a fabric covering, consisting of a base cloth of a material which is electrically insulating and heatproof, and a layer of conductive and flexible polymer having a thickness of from 0.3–0.6 mm. and a surface resistance of from 200–400 ohms per dm.^{2} fixed to the said base cloth, said conductive layer being composed of 45 parts of artificial graphite having a particle size less than 10 microns and 100 parts of a 20% neopren solution consisting of neopren gum dissolved in toluene, the said two ingredients being mixed, dried, and hot-pressed into a sheet, a plurality of positive and negative wire fixed alternatively to the said conductive cloth at regular intervals and substantially equidistantly spaced from each other and common leads connected to the respective wires, whereby when current is supplied to said common leads, the conductive layer develops heat by means of the electric resistance thereof.

2. A heating means a claimed in claim **1** in which the interval X in inches between the wires for an output of W watts per square foot at a voltage V in volts is according to the expression

$$X^2=\frac{144V^2}{W.R}$$

where R is the surface resistance of the conductive layer in ohms per 100 square feet.

3. A heating device as claimed in claim **1** in which the current I for an output of W watts per square foot for lead wires of length L is according to the expression

$$I=\frac{L}{2}\sqrt{\frac{W}{R}}$$

where R is the surface resistance of the conductive layer in ohms per 100 square feet.

4. A heating means for mounting inside a fabric covering, consisting of a base cloth of a material which is electrically insulating and heatproof, and a layer of conductive and flexible polymer having a thickness of from 0.3–0.6 mm. and a surface resistance of from 200–400 ohms per dm.^{2} fixed to the said base cloth, said conductive layer consisting of 100 parts of a 40% water emulsion of acrylate methyl ester resin and 55 parts of artificial graphite having a particle size below 10 microns, the said two ingredients being mixed, made into paste and spread on the base cloth, a plurality of positive and negative wires fixed alternatively to the said conductive cloth at regular

intervals and substantially equidistantly spaced from each other and common leads connected to the respective wires, whereby when current is supplied to said common leads, the conductive layer develops heat by means of the electric resistance thereof.

5. A heating means as claimed in claim 4 in which the interval X in inches between the wires for an output of W watts per square foot at a voltage V in volts is according to the expression

$$X^2=\frac{144V^2}{W.R}$$

where R is the surface resistance of the conductive layer in ohms per 100 square feet.

6. A heating device as claimed in claim 4 in which the current I for an output of W watts per square foot for lead wires of length L is according to the expression

$$I=\frac{L}{2}\sqrt{\frac{W}{R}}$$

where R is the surface resistance of the conductive layer in ohms per 100 square feet.

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