

March 3, 1942.

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2,274,840

ELECTRICALLY CONDUCTIVE FABRIC

Filed June 7, 1941

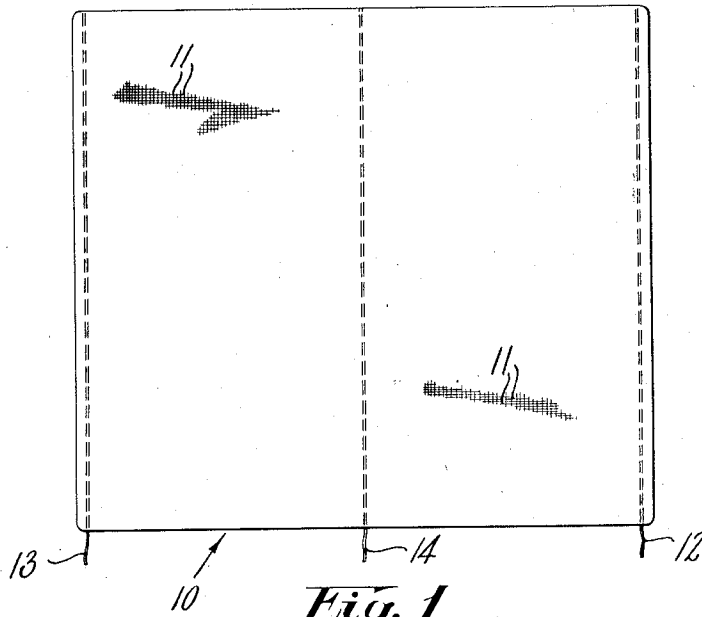


Fig. 1

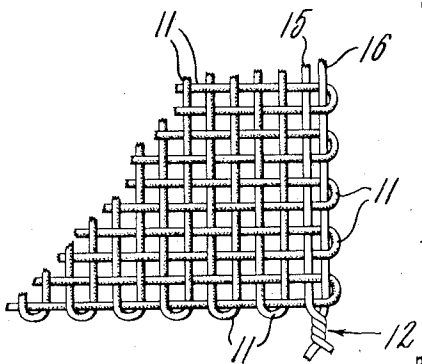


Fig. 2

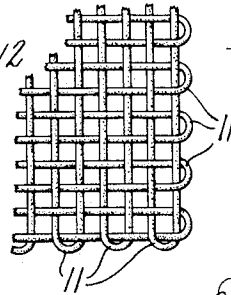


Fig. 3

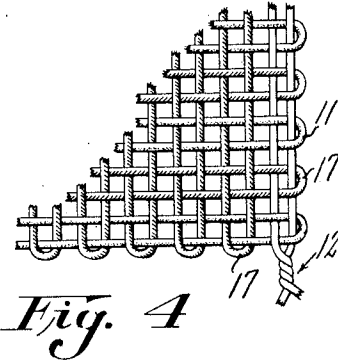


Fig. 4

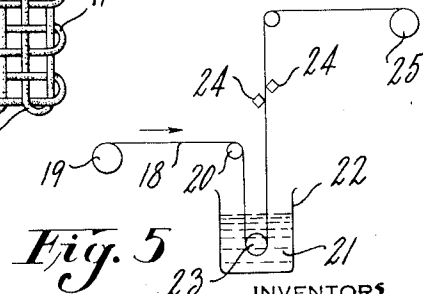


Fig. 5

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2,274,840

ELECTRICALLY CONDUCTIVE FABRIC

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Application June 7, 1941, Serial No. 397,090

15 Claims. (Cl. 219—46)

This invention relates to electrically conductive fabrics employing in their construction electrically conductive textile threads capable of individually conducting electric current and to a heating unit formed of such fabric.

The present invention contemplates a textile fabric which may be woven or otherwise constructed and which has embodied therein textile threads that serve in the fabric as individual conductors of electric current.

These conductor threads may constitute ordinary textile threads which have been treated with electrically conductive rubber to render them conductors. The fabric herein contemplated may be formed entirely of such conductive textile threads, or these threads may be embodied in the fabric with non-conductive threads. The present conductive threads may extend longitudinally of the fabric or transversely thereof, or both longitudinally and transversely, and may be disposed side by side in the fabric or separated from each other by non-conductive threads.

In many cases, but not in all uses of the conductive fabric of the present invention, it may be desirable to provide conductor wires or other metal conductors along one or more marginal edges of the fabric to thereby supply electric current to or conduct it from the threads of such fabric, and if the conductive fabric used is a relatively wide sheet it may be desirable to provide additional metal conductors extending along the fabric between its marginal edges.

An electrically conductive fabric such as herein contemplated and which is not provided with the abovementioned conductor wires, may be used for electrically shielding purposes upon electrical apparatus, also to carry off or disperse static electric charges from such nonelectric objects as the upholstered parts of an automobile and wearing apparel. In many cases however where a static charge is to be dispersed or carried off it is desirable to provide the conductive fabric with the abovementioned conductor wires.

The present invention further contemplates a heating unit formed of the above described conductive fabric having conductor wires secured thereto for supplying the heating current to the fabric. Such a heating unit may have the feel, flexibility and other characteristics of a sheet of woven textile fabric and is well adapted for use as the heating element for an electrically heated garment, and in other fields where only a moderately high temperature is desired.

In carrying out the present invention the yarns or threads which are to be rendered electrically

conductive are treated with a current conductive plastic material such as an electrically conductive rubber cement before these threads are embodied in the fabric.

- 5 The conductivity of the conductive textile thread herein contemplated will be only a fraction of that of a wire of corresponding size. Therefore a fabric may be formed entirely of these conductive textile threads without imparting to such fabric higher conductive properties than is desired when the fabric is to be employed in an electrical heating unit using a source of energy of only a few volts. As a result of the present invention no part of the heating unit need be heated to a temperature high enough to burn the hand if touched, whereas when wires are used as the heating element they have to be operated at a much higher temperature than the present threads.

- 20 The above and other features of the present invention will be more fully understood from the following description when read in connection with the accompanying drawing, wherein:

- 25 Fig. 1 is a plan view of one type of electrical heating unit constructed in accordance with the present invention;

- Fig. 2 on an enlarged scale is a plan view of a small portion of Fig. 1 showing both the warp and weft threads as formed of the conductive

- 30 textile threads herein contemplated.
- Fig. 3 is a view similar to Fig. 2 showing a modified construction in which the current conductive threads are employed in the warp alone or in the weft alone;

- 35 Fig. 4 is a view similar to Fig. 3 showing a further modification in which the non-conductive threads run in one direction, and rows of non-conductive and conductive threads are woven in the fabric at right angles thereto;

- 40 Fig. 5 is a diagrammatic view of apparatus for applying current conducting material to a yarn or thread; and

- Fig. 6 is a plan view showing the construction of Fig. 2 with the conductor wires 15, 16 omitted.

- 45 The weave of the fabric is shown in Figs. 2, 3, 4 and 6 as much more open than will probably be used in practice.

- In carrying out the present invention the entire fabric may be woven, braided or otherwise constructed of the current conductive threads alone or such fabric may be formed of both conductive and non-conductive threads as desired, depending largely upon the amount of conductivity or heating effect desired in the fabric.

- 50 When the present fabric is to be used for heat-

ing purposes it is necessary, in order to secure the heating action to maintain spaced portions of the conductive fabric at a different electric potential. This may be done by securing the above-mentioned metal conductors or conductor wires along the fabric transversely of the conductor threads at spaced intervals, and such metal conductors may be woven into the fabric as shown in the drawing and as will be further described.

These metal conductors or conductor wires, may be spaced from each other anywhere from an inch or less to several feet depending upon the voltage, electrical resistance of the conducting material, amount of heat to be generated and other conditions.

In many constructions, the conductive fabric will operate in the desired manner if one metal conductor is provided at one side edge of the fabric and another metal conductor is provided at the opposite side edge of the fabric. When, however, the current conductive fabric is relatively wide it may be desirable to provide intermediate metal conductors to thereby decrease the distance between such conductors.

In the embodiment of the invention shown in Fig. 1 there is provided a relatively wide woven fabric 10 which may be formed entirely of current conducting threads or yarns 11 extending warp wise and weft wise as better shown in Fig. 2 wherein it will be seen that both the warp and weft are formed of the treated threads. The current conducting fabric of Fig. 1 is shown as provided with a metal conductor 12 at one side edge thereof, a second metal conductor 13 at the opposite side edge thereof and a third metal conductor 14 extending along the central portion of the fabric, so that the desired heating effect of the fabric may be secured by maintaining the central wire 14 at one electric potential and the side wires 12 and 13 at a different electric potential.

In practice it is found desirable to secure the metal conductors, such for example, as 12 to the fabric by providing the wires 15 and 16 which are woven into the fabric transversely of the current conducting threads as shown, in Figs. 2, 3, and 4. By providing two wires 15 and 16 that are similarly woven into the fabric a better balanced construction is secured than if a single conductor wire is woven in the fabric, and good contact between these wires and the threads 11 is secured.

In the embodiment of the invention shown in Fig. 3, the conductor threads 11 extend warp wise of the fabric or weft wise as desired and the non-conductor threads 17 are woven in the fabric at right angles thereto.

The embodiment of the invention shown in Fig. 4 is substantially the same as in Fig. 3 except that in Fig. 4 the threads extending in one direction consist of rows of conductor threads 11 and non-conductor threads 17, which are interwoven with non-conductor threads 17 extending at right angles thereto. The conductor threads may also be used in weftless, knitted or other types of fabrics.

The conductor threads may be formed of any desired textile filaments such as cotton, wool, silk, rayon or where higher temperatures are desired non-combustible threads or filaments may be used. These filaments may be rendered conductive by depositing upon them a conductive cement, suspension or dispersion, for example, as shown in Fig. 5 where the filament 18 to be treated is led from a source of supply 19

about a guide 20 and then downwardly into a bath of conductive cement 21 contained within the receptacle 22 so that this filament will pass about a pulley or guide 23 in the receptacle as shown. It then passes upwardly between doctor bars or the like 24 adapted to remove the excess cement whereupon the treated filament may be dried and wound onto the package 25. However, in place of this dipping method of treating the textile threads they may have the conductive cement sprayed, spread or otherwise provided thereupon.

The textile threads may be rendered conductive by treating them with a plastic material containing current conductive carbon but are preferably treated with rubber containing such carbon, and the following is an example of one practical type of conductive rubber cement that may be used.

	Parts by weight
Rubber	100.
Acetylene black	85.
ZnO	15.
Antioxidant	.75
Accelerator	2.00
Deodorant	.10
Softener	7.00
Vulcanizing agent	.75
Solvent (gasolene)	1500.

It will be apparent from the foregoing that by employing the construction of the present invention an electrical heating fabric or unit is secured which is free from metal wires except at the side edges of the fabric where they serve as current supply conductors rather than as heating filaments, and as a result a textile heating fabric is secured.

In the construction of Fig. 2 in which the fabric is formed entirely of the conductor threads 11 a more uniform heating effect will be produced over the surface of the fabric than when the construction of Fig. 3 or of Fig. 4 is used.

It is found in practice that if the space between adjacent conductor wires, such as 12 and 14, is not more than ten inches, 12 volts will be sufficient to heat the fabric between such wires to a temperature of approximately 115° F. in a room at normal room temperature. If a higher temperature is desired or the current supply wires are spaced from one to several feet apart then a higher voltage will be needed.

An important advantage of using a low voltage, such as 12 volts, to operate the electrical heating unit resides in the safety from electrical shock to persons using the same. Other advantages reside in the light weight, high flexibility, and textile feel of the heating unit, and in the uniform heating effect whereby no part of the heating unit need be hot enough to burn the hand when the same is touched.

The present electrical unit is well adapted to heat any portion of the human body and for this purpose may be embodied in a garment or used as a heating sheet or pad. It may also be used in many other fields where its heating action is desired.

While the embodiment of the invention shown in Figs. 1 to 4 inclusive has been designed primarily for use as an electrical heating unit, it is also well adapted for use as a static discharge sheet in which case the wires 12 may constitute a sufficient body to absorb the static charge, or they may contact larger bodies into which the static may be discharged.

Where it is desired to employ a conductive fabric formed of conductive threads, as herein shown and described, as a static discharging sheet or static dispersing means the conductor wires 12, 13 and 14 may be omitted since the conductive property of the threads 11 will serve to disperse static charges. Such a construction is shown in Fig. 6 wherein the fabric is or may be woven entirely of the current conducting threads or yarns 11 but the conductor wires 15 and 16 of Fig. 2 are omitted.

The construction of Fig. 6 is well adapted for use for electrically shielding purpose upon such electrical apparatus as radios and amplifiers, as it is believed a conductive fabric sheet will be superior to the metal shields used heretofore as it has greater electrical absorbing properties than a metal shield. It may also be used in various fields to disperse static charges, and to carry off static or other electrical charges when the fabric is grounded or contacts a large conducting body.

By forming the electrically conductive fabric as herein contemplated by weaving or otherwise embodying therein the individual conductive textile threads, a fabric is produced that is porous or pervious to the air, which is desirable when the same is worn in a garment or used adjacent the human body.

Having thus described our invention, what we claim and desire to protect by Letters Patent is:

1. An electrically conductive fabric employing in its construction electrically conductive textile threads that render the fabric conductive, said threads having individually deposited thereon so as not to form a film from one thread to another an electrically conductive rubber cement, whereby an air pervious fabric having said conductive threads substantially throughout its area to enable the fabric to conduct current is provided.

2. An electrically conductive fabric employing in its construction electrically conductive and non-electrically conductive textile threads, said conductive threads having deposited thereon so as not to form a film from one thread to another an electrically conductive rubber, whereby a conductive fabric having said conductive threads substantially throughout its area is provided.

3. An electrically conductive fabric employing in its construction electrically conductive textile threads that render the fabric conductive, said threads having deposited individually thereon so as not to form a film from one thread to another an electrically conductive rubber, whereby an air pervious fabric is provided having said conductive threads embodied in the fabric at the desired positions to render the fabric conductive.

4. An electrically conductive fabric woven of electrically conductive and non-electrically conductive textile threads, said conductive threads having deposited thereon so as not to form a film from one thread to another an electrically conductive rubber cement, whereby a conductive fabric is formed having said conductive threads embodied therein wherever the fabric is to be rendered conductive.

5. An electrically conductive fabric employing in its construction electrically conductive textile threads that render the fabric conductive, said threads having deposited individually thereon so as not to form a film from one thread to another an electrically conductive rubber, whereby an air pervious fabric is provided having said

conductive threads embodied in the fabric at the desired positions to render the fabric conductive, and conductor wires embodied in the fabric at one or more edges thereof.

6. An electrically conductive fabric woven of electrically conductive and non-electrically conductive textile threads, said conductive threads having deposited thereon so as not to form a film from one thread to another an electrically conductive rubber cement, whereby a conductive fabric is formed having said conductive threads embodied therein wherever the fabric is to be rendered conductive, and conductor wires woven in the fabric at one or more edges thereof.

7. An electrically conductive fabric employing in its construction electrically conductive textile threads treated with conductive rubber to thereby render these threads conductors of electric current and embodied in the fabric so that they extend in the same general direction, and metal conductors secured along the fabric in spaced relation to each other and transversely of said threads to conduct electric current to or from said threads.

8. An electrical heating unit, comprising an electrically conductive fabric employing in its construction electrically conductive textile threads, said conductive threads having deposited individually thereon so as not to form a film over the fabric an electrically conductive rubber, and metal conductors secured along two opposite edges of said fabric in contact with the opposite ends of said threads, whereby an electric current will flow along said threads and heat the fabric when a different potential is maintained between said conductors.

9. An electrical heating unit, comprising a woven electrically conductive fabric embodying in its construction electrically conductive textile threads, said conductive threads having deposited individually thereon so as not to form a film over the fabric an electrically conductive rubber, and conductor wires woven along two opposite edges of the fabric in contact with the opposite ends of said conductive threads, whereby an electric current will flow along said threads and heat the fabric when a different potential is maintained between said wires.

10. An electrical heating unit, comprising a sheet of woven fabric containing textile threads treated with conductive rubber to thereby render them conductors of electric current and woven in the fabric as electrically contacting warp and weft threads, and metal conductors secured along said fabric transversely of one set of said threads and in spaced relation to each other whereby an electric current will flow along said threads and heat the fabric substantially uniformly over its surface when a different potential is maintained between said metal conductors.

11. An electrical heating unit, comprising a sheet of textile fabric having textile threads treated with conductive rubber to thereby render them conductors of electric current and embodied in the fabric in parallel relation to each other, and metal conductors secured along said fabric transversely of said threads and in spaced relation to each other, whereby an electric current will flow along said threads and heat the fabric when a different potential is maintained between said metal conductors.

12. An electrical heating unit, comprising a sheet of textile fabric having textile threads treated with a plastic containing current conducting carbon black to thereby render these

threads conductors of electric current and embodied in the fabric in parallel relation to each other, and metal conductors secured along said fabric transversely of said threads and in spaced relation to each other, whereby an electric current will flow along said threads and heat the fabric when a different potential is maintained between said metal conductors.

13. An electrical heating unit, comprising a sheet of fabric having non-metallic threads treated with a plastic containing a current conducting non-metallic material to thereby render these threads conductors of electric current and embodied in the fabric in parallel relation to each other, and metal conductors secured along said fabric transversely of said threads and in spaced relation to each other, whereby an electric current will flow along said threads and heat the fabric when a different potential is maintained between said metal conductors.

14. An electrical heating unit, comprising a sheet of fabric having textile threads treated with conductive rubber to thereby render these threads conductors of electric current and embodied in the fabric so that they extend in the same general direction, and metal conductors secured along said fabric transversely of said threads and in spaced relation to each other, whereby an electric current will flow along said threads and heat the fabric when a different potential is maintained between said metal conductors.

5 15. An electrical heating unit, comprising a sheet of fabric having textile threads treated with conductive rubber to thereby render these threads conductors of electric current and embodied in the fabric so that they extend in the same general direction and the adjacent threads are in electrical contact with each other at numerous points in the fabric, and metal conductors secured along said fabric transversely of said threads and in spaced relation to each other, whereby an electric current will flow along said threads and heat the fabric when a different potential is maintained between said metal conductors.

10 15 20 15. An electrical heating unit, comprising a sheet of fabric having textile threads treated with conductive rubber to thereby render these threads conductors of electric current and embodied in the fabric so that they extend in the same general direction and the adjacent threads are in electrical contact with each other at numerous points in the fabric, and metal conductors secured along said fabric transversely of said threads and in spaced relation to each other, whereby an electric current will flow along said threads and heat the fabric when a different potential is maintained between said metal conductors.

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