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HEATER FABRIC
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22 Claims

ABSTRACT OF THE DISCLOSURE

A heater wherein electrical conductors are provided in a conventional fabric permitting electrical current to be passed therethrough for providing heat energy. The electrical conductors are defined by a metal fiber yarn wherein in the diameter and number of filaments are preselected so that the physical characteristics of the yarn are similar to those of the fabric fibers to maintain the hand of the fabric substantially unaffected by the disposition of the metal conductors therein.

This invention relates to textile materials and in particular to heater fabrics.

In conventional heater fabrics, electrical conductor wires are provided in the fabric for providing thermal energy as a result of the resistance to electrical current flow thereof. Such known electrical heater fabrics have the serious disadvantage of having the characteristics of the textile material changed by the provision of the heater wires therein. In the textile field, the general characteristic of such textile material is commonly referred to as the “hand” of the material with reference to the way that the fabric feels to a person’s hand. The hand characteristic takes into consideration a number of factors such as the drapability, flexibility, the compliance, the softness, compressibility, compressional resilience, and the surface texture of the fabric. The change in the hand of the textile fabric by the provision therein of the conventional electrical conductor wires is highly undesirable as, for example, in a seat pad structure where portions of a person’s body are urged thereagainst. The present invention comprehends an improved heater fabric arranged and constructed of textile yarns which function as resistance heaters so that the hand of the fabric is substantially unaltered by the inclusion of the heater conductors therein. Wherein certain textile yarns such as carbon and graphitic yarns can function as resistance heaters, the relative low abrasion resistance, flex life and shear strength thereof substantially limit their performance in textile structures which include the present invention. The present invention is based on the use of metallic yarns composed of filaments of fine enough diameter to meet the performance requirements of a textile and which have been demonstrated to have high flex life, abrasion resistance and shear strength.

Thus, a principal feature of the present invention is the provision of a new and improved heater fabric.

Another feature of the invention is the provision of such a heater fabric wherein the heater conductors comprise yarn having physical characteristics simulating that of the other yarns of the fabric to maintain the hand of the fabric substantially unaffected by the disposition of the metal yarn therein.

A further feature of the invention is the provision of such a heater fabric wherein the metal yarn conductor is bare.

Still another feature of the invention is the provision of such a heater fabric wherein the metal yarn conductor is covered.

A yet further feature of the invention is the provision of such a heater fabric wherein the metal yarn conductor is provided integrally in the fabric as one of the yarns thereof.

Still another feature of the invention is the provision of such heater fabric defining carpet material wherein the metal yarn conductors are provided in the backing thereof.

A further feature of the invention is the provision of such a heater fabric defining a seat pad.

Still another feature of the invention is the provision of such heater fabric defining drapery material in which the metal yarn conductors are integrally incorporated into the warp and/or the filling.

Still another feature of the invention is the provision of such a heater fabric in which the metal yarn conductors are integrally incorporated in a fabric defining a heated wall, ceiling or floor covering.

Still another feature of the invention is the provision of such a heater fabric defining a garment; illustratively the fabric may define an outer garment or an undergarment, it may be formed as cold weather gear, sport or casual clothing, foot, hand or head garments, and the like.

Still another feature of the invention is the provision of such a heater fabric defining bedding fabrics such as blankets, sheets, mattress covers, mattress pads, pillows, and the like.

Another feature of the invention is the provision of such a heater fabric defining an insert in another structure such as heating panels in vehicles or furniture.

Yet another feature of the invention is the provision of such a heater fabric defining flexible compliant structures such as for use in laboratory or industrial vessels, tanks, retorts, and the like.

Still another feature of the invention is the provision of such a heater fabric defining a seating means as for aircraft surfaces, microwave apparatus, power unit components and like structures which may be exposed to low temperature conditions.

Other features and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawing wherein:

FIGURE 1 is a perspective view of a length of metal yarn conductor for use in a heater fabric embodying the invention;

FIGURE 2 is a perspective view of a length of modified metal yarn conductor having an organic filament, roving, or yarn cover;

FIGURE 2A is a perspective view of another modified yarn embodying the invention;

FIGURE 3 is a perspective view of a further modified form of a metal yarn conductor having a core spun organic fiber boucle cover;

FIGURE 4 is a perspective view of another form of such a metal yarn conductor having a core spun organic fiber bulked cover;

FIGURE 5 is a perspective view of still another form of metal yarn conductor having a resin sheath;

FIGURE 6 is a perspective view of yet another form of metal yarn conductor having a resin sheath and a surrounding organic fiber overwrap;

FIGURE 7 is a perspective view of another form of metal yarn conductor having a resin sheath filled with short metal fibers;
FIGURE 8 is a fragmentary plan view of a heater fabric embodying the invention including a woven fabric of organic fibers and a plurality of metal yarn conductors extending in the warp direction therethrough.

FIGURE 9 is a fragmentary plan view of a heater fabric generally similar to that of FIGURE 8 and further including a plurality of metal yarn conductors disposed in the organic fiber fabric in the filling direction an electrically connected to the warp conductors for providing facilitated connection of the fabric to a source of electricity.

FIGURE 10 is a fragmentary enlarged plan view of a heater fabric embodying the invention wherein the organic fiber fabric is formed of a leno fabric.

FIGURE 11 is a fragmentary plan view of a heater fabric embodying the invention wherein the organic fiber fabric and metal yarn conductors are provided in the form of a weft knit fabric construction.

FIGURE 12 is a fragmentary plan view of a heater fabric embodying the invention wherein the organic fiber fabric and metal yarn conductors are provided in the form of a warp knit fabric construction.

FIGURE 13 is a fragmentary perspective view of the interior of an automobile provided with a carpet structure and a heat pad structure defining heater fabrics embodying the invention.

FIGURE 14 is a transverse vertical section of the carpet material illustrated in FIGURE 15; and

FIGURE 15 is a transverse section of a modified form of carpet material.

As shown in FIGURE 1 of the drawing, the present invention comprehends the provision of an improved metal yarn conductor generally designated 10 for use in heater fabrics and the like. More specifically, the conductor 10 is preferably formed of extremely fine diameter filaments 11 which while being formed of metal have, by virtue of their extremely small diameters, substantial similarity in flexibility to organic fibers and filaments. Thus, the yarn 10 may be utilized in fabrics formed primarily of conventional dielectric textile materials such as natural or synthetic organic fiber yarns or glass or asbestos yarns without substantially changing the hand thereof. The filaments 11 preferably have a diameter of under approximately one mil and in the illustrated embodiment have a diameter of approximately 12 microns. The yarn 10 illustratively may be formed of a metal such as stainless steel with a sufficient number of filaments 11 being provided therein to form a conventional yarn configuration, in the illustrated embodiment 90 filaments 11 are provided therein. A twist of approximately five turns per inch may be provided in the filaments for improved yarn performance. As will be obvious to those skilled in the art, other suitable metals may be employed in forming the yarn 10. The diameter and number of filaments may correspondingly be varied as desired by the user to maintain the compatibility of the characteristics of the yarn 10 with that of the other yarns of the fabric in which the yarn is to be provided. The filaments 11 illustratively may be formed by multiple end forming processes such as disclosed in Webber et al. United States Letters Patent 3,277,564 and Roberts et al. application for United States Letters Patent Ser. No. 348,326, filed Mar. 3, 1964, now Patent No. 3,392,213 providing improved, low cost, small diameter metal filaments simulating organic fiber and filament characteristics.

As desired, the metal yarn conductor may be provided in the form of bare yarn 10 or as a covered yarn as exemplified in the yarns shown in FIGURES 2 through 7. Thus, for example, the metal yarn conductor may comprise a covered yarn 10c wherein the bare metal yarn 10 is covered with a wrapping 12 of natural or synthetic organic fiber or glass. As shown in FIGURE 3, the metal yarn conductor may comprise a yarn 10b having a core 10 covered with a spun boucle 13 formed of natural or synthetic organic or glass fibers. Another form of metal yarn conductor 10c is shown in FIGURE 4 to comprise a core 10 covered with bulked natural or synthetic organic or glass fibers 14. In FIGURE 5, a metal yarn conductor 10d is shown to comprise a core 10 having a resin coating 15 thereof, and in FIGURE 6, a metal yarn conductor 10e is shown to comprise a core 10 having a resin coating or sheath 15 thereon with an outer covering 16 comprising a wrapped or core spun overlap of natural or synthetic organic or glass fibers. In FIGURE 7, a metal yarn conductor 10f is shown to comprise a core 10 having a coating or sheath 17 formed of resin with a plurality of short length metal fibers 18 dispersed therein.

In FIGURE 2A, another metal conductor embodying the invention is shown to comprise an organic or glass fiber core 11a which may be bare or sheathed as desired, and having a metal yarn overwound thereon and bulked or appropriately twisted in such a way as to balance the moduli of the core and metal yarn. Covering of the yarn may be effected to achieve any given visual characteristics of the fabric and metal yarn conductor as desired. As indicated briefly above, the metal yarn conductors are provided in integral association with the organic or glass fiber yarn fabrics to provide essentially 78 watts per square foot of heater fabric having substantially the same hand as the organic or glass fiber fabric alone. Illustratively, in FIGURE 8, a woven fabric 19 formed of natural or synthetic organic or glass yarns is provided with a plurality of metal yarn conductors spaced in the direction of the filling and extending in the warp direction of the fabric to define a heater fabric 20. The metal yarn conductors are illustrated in FIGURE 8 as comprising the bare metal yarn conductors 10, it being understood that any of the metal yarn conductors comprehended by the invention may be utilized in forming the heater fabrics of the invention.

Illustratively, the fabric 19 may comprise a weave of continuous filament, 260 denier nylon, with the conductors 10 being spaced apart approximately one-half inch. A heater pad 21 may be formed of the fabric 20 by providing at the opposite edges thereof cross-conductors 22 which are electrically connected to the opposite ends of the warp conductors 10 to provide electrical connections thereto at the opposite edges of the pad. The filling conductors 22 may be formed of multifilament metal yarns, and in the illustrated embodiment, the conductors 22 comprise yarns formed of 300 stainless steel filaments of 25 micron diameter such as stainless steel.

A heater fabric such as heater fabric 21 may be employed, for example, as a seat pad 23 as shown in FIGURE 13 wherein a pair of such seat pads 23 are disposed on the rear seat 24 of a conventional automobile. Illustratively, the seat pads may have an over-all size of approximately 17 inches by 30 inches, with the electrical conductors 10 being spaced approximately one-half inch apart in the filling direction. Where the stainless steel is a 304 stainless steel material and the yarn comprises 90 filaments of 12 micron diameter, it has been found that in such a seat pad construction an applied voltage of 12 volts to the terminal conductors 22 at the opposite ends of the conductors 10 provides approximately 6.5 amperes therethrough, or approximately 75 watts.

Referring now to FIGURES 10 through 12, other heater fabric configurations embodying the invention are shown to include a leno fabric generally designated 25 wherein the conductors 10 are woven in combination with the warp organic or glass yarns 26 to maintain the spacing of the open leno weave fabric. In FIGURE 11, a heater fabric 27 is shown to comprise a warp knit fabric 28 formed of natural or synthetic organic or glass fiber yarns, with the metal yarn conductors 10 being provided as alternate warp yarns therein. In FIGURE 12, a heater fabric 29 embodying the invention is shown to comprise a weft knit fabric 30 of natural or synthetic organic or glass fiber yarns wherein the electrical conductors 10 comprise alternate weft yarns.
Illustratively, the fabrics of FIGURES 10 through 12 may be used as drapery materials wherein relatively large heating areas may be provided. One specific example of such a drape material is that wherein the material is formed as shown in FIGURE 10 to define a leno weave wherein the metal yarn conductors comprise core spun boucle covered conductors 106 with the filaments having a diameter of approximately 12 microns and the yarn having approximately 90 filaments therein, and where the leno fabric may comprise a glass boucle fabric.

Another application of the heater fabric structural concept embodying the invention is illustrated in FIGURES 13 wherein a carpet 31 is provided in the automobile A wherein the carpet 31 for an approximately 9 ounces, 16 square jute backing and wherein the metal yarn conductors are woven in at approximately one-quarter inch spacing. The tufting of the carpet 31 may be of any conventional construction and herein, illustratively, comprises tufting of 80 percent viscose, 20 percent nylon blend, as is sometimes employed in automobile carpeting. Where such a carpet is made to have an approximately 24 inch by 30 inch size, it has been found that by utilizing such yarn formed of 90-12 micron diameter 304 stainless steel filaments that approximately 13 amperes will be produced by a 12 volt power supply, or slightly over 150 watts.

Illustratively, as shown in FIGURE 14, the carpet may be formed with the metal yarn conductors 10 provided as warp threads in the burlap 32 of the carpet material. Alternatively, as shown in FIGURE 15, the carpet may comprise a carpet material generally designated 33 wherein the metal yarn conductors are provided in the facing 34 thereof. When used in the facing portion of the carpeting, the metal yarn conductors are preferably insulatedly covered and, thus, for example, may comprise metal yarn conductors 10e.

The invention comprehends the provision of a weft knit structure in which a jersey or any other knit stitch is employed to coordinate continuous filament metallic yarns in a compliant structure adapted to conform to spherical, cylindrical, or odd shaped laboratory or industrial vessels in which the metallic yarn function and form a resistance heater for imparting controlled, uniformly distributed heat energy thereto. A wide range of knit geometries is available to accomplish these ends, including variations in filament diameter, number of filaments per yarn, twist, yarn elasticity, stitch tension control, stitch size, and fashioning. A continuous filament yarn, insulatingly covered as in FIGURE 5 or FIGURE 2A, plated or otherwise blended with elastic organic yarns, may be provided to define an elastic bandage or heating wrap. A still further application of the inventive concept is one in which the above mentioned forms of yarns may be used as heater elements in narrow fabrics or tapes which may be sewn or otherwise incorporated in textile structures as heating elements.

Also, textile structures formed of the above disclosed yarns or fabrics may be employed as components of apparel including garments or parts thereof such as hand, head or foot coverings, undergarments, outer garments or interlinings. Further, the yarns or fabrics may be incorporated as heating elements in bedding components, such as blankets, sleeping bags, mattress covers, mattress pads, and the like.

Thus, the invention comprehends an improved heater fabric wherein the metal yarn conductors are formed as an integral part of the fabric without changing the hand thereof by virtue of the similarity of the textile yarn characteristics of the metal filaments thereof to those of the conventional organic fiber textile fabrics.

While we have shown and described certain embodiments of our invention, it is to be understood that it is capable of many modifications. Changes, therefore, in the construction may be made without departing from the spirit and scope of the invention as defined in the appended claims.

We claim:
1. A heater fabric comprising:
   a. fabric formed of dielectric fibers defining an area from which heat is to be delivered, said fabric having a preselected hand;
   b. a yarn formed of metal fibers having a diameter of less than approximately one mil extending in said fabric across said area to define a continuous electrical conduction having a substantially maintained pre-selected resistivity for developing heat energy therein as a result of a current flow thereathrough, said metal fibers being preselected to define a yarn having physical characteristics simulating that of said dielectric fibers of said fabric to maintain the hand of the fabric substantially unaffected by the disposition of said yarn therein; and
   means at spaced portions of said yarn for passing an electrical current through said yarn whereby the fabric effectively defines an electrical heating element.
2. The heater fabric of claim 1 wherein said yarn is bare.
3. The heater fabric of claim 1 wherein an insulating cover is provided on said yarn.
4. The heater fabric of claim 3 wherein said cover is formed of a fiber material.
5. The heater fabric of claim 3 wherein said cover is formed of organic yarn.
6. The heater fabric of claim 1 wherein said yarn is core spun with an organic boucle material.
7. The heater fabric of claim 1 wherein said yarn is core spun with an organic bulked material.
8. The heater fabric of claim 1 wherein said yarn is provided with an insulating cover of resin.
9. The heater fabric of claim 1 wherein said yarn is provided with an insulating cover of resin and an overlying wrap formed of organic fibers.
10. The heater fabric of claim 1 wherein said yarn is provided with an insulating cover of resin having short metal fibers dispersed therein.
12. The heater fabric of claim 1 wherein said fabric comprises a woven fabric and said yarn comprises a warp yarn therein, and said means for passing electrical current through said yarn comprises a filling yarn of metal filaments in said fabric electrically connected to said warp yarn.
15. The heater fabric of claim 1 wherein said fabric comprises a weft knit fabric.
17. The heater fabric of claim 1 wherein said fabric comprises a burlap fabric and a plurality of tufts standing therefrom to form a carpet material.
18. The heater fabric of claim 1 wherein said fabric is formed to define an automobile seat pad.
19. A heater fabric comprising:
   a. a carpet fabric having a backing and tuft portion standing from said backing; and
   a yarn of metal filaments having a diameter of less than approximately one mil arranged in a tuft configuration on said backing substantially similar to the configuration of the tuft portion of the carpet fabric and are provided with an insulating cover similar to the carpet tuft material.
20. The heater fabric of claim 1 wherein the yarn comprises filaments.
21. The heater fabric of claim 1 wherein the yarn comprises a blend with dielectric fiber.
22. The heater fabric of claim 1 wherein the yarn comprises a spun yarn.

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