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(54) Title: SUPPORT APPARATUS WITH GEL LAYER

(57) Abstract: The invention provides a support apparatus comprising a gel layer. In one embodiment, the gel layer is overlying one or more additional support layers. The gel layer comprises a gel, such as a polyurethane gel, and optionally comprises one or more fillers, which can be a natural or synthetic material. The support apparatus includes apparatuses, such as mattresses, chairs and other furniture, and cushions.

SUPPORT APPARATUS WITH GEL LAYER

FIELD OF THE INVENTION

The present invention is generally directed to apparatuses designed for bodily support. In particular, the invention is directed to apparatuses that provide an improved level of comfort, particularly pressure relief, as well as improved control of heat transfer.

BACKGROUND

Multiple apparatuses are known in the art for providing support to the body of a user. Such apparatuses generally comprise one or more layers of padding or cushioning to provide functional support of the user's body and to provide such support while also providing a level of comfort. Similarly, such apparatuses may also comprise mechanical supports, such as coil springs.

Advances in the art are generally directed to apparatuses that provide the functional support necessary in such apparatuses but also provide increased comfort or provide a decrease in the volume of materials necessary to provide the support. For example, United States Patent No. 6,701,556 to Romano *et al.* discloses mattress or cushion structures designed to improve pressure distribution while reducing the overall thickness of the mattress or cushion. Further, U.S. Patent No. 6,804,848 to Rose discloses an air support sleep system having an upper mattress air posturizing module and an adjustable air posturizing sleep surface.

While the apparatuses commonly used for bodily support may provide functional support, they yet fail to provide a level of comfort useful for facilitating restfulness or sleep, or for providing a greatest relief of pressure for the body parts in contact with the support surface. Gel materials are generally known to provide good physical comfort and pressure relief. Further, gels are also known to exhibit a relatively high thermal conductivity. Accordingly, gels, such as polyurethane gels, are generally

regarded as having a "cool" feel to the body, as body heat is perceptibly moved away from the body when in contact with the gel.

Accordingly, there still remains a need in the field for apparatuses useful for bodily support that provide functional support to the body of the user, as well as providing comfort and, possibly, therapeutic benefit. Such properties, as well as further desirable and beneficial properties, are met by the present invention.

SUMMARY OF THE INVENTION

The present invention provides an apparatus for supporting at least a portion of the body thereon. Beneficially, the apparatus comprises a gel layer comprising a gel having a measurable hardness in a specified range. In further embodiments, the apparatus comprises a plurality of layers, and preferentially, the layers comprise at least two different types of materials, one layer of the apparatus comprising a gel. The apparatus of the invention is beneficial for improving pressure mapping and providing pressure relief, and it also provides the ability to absorb and transport heat according to various parameters, such heat capacity being adjustable depending upon the composition of the apparatus, particular the composition of the gel layer of the apparatus.

In one embodiment of the invention, the apparatus comprises a gel layer overlying one or more additional support layers. According to this embodiment of the invention, the gel layer comprises a gel having specific physical properties identified as providing increased support pressure and relief to a user, and also providing a user with an increased perception of comfort (*i.e.*, a good "feel"). The gel layer can be the outermost layer of the apparatus, therefore being in direct contact with the user. According to further embodiments, the apparatus can also comprise a covering overlying the gel layer. Preferably, the covering layer is not of structure or thickness to substantially reduce or mask the comfort and support provided by the gel layer. Non-limiting examples of coverings encompassed by the invention include a textile layer, a film layer, a coating layer, and a foam layer.

The gel used in the gel layer of the apparatus is particularly formulated to exhibit physical properties, such as hardness and elasticity, that are within a range that not only provide a good "feel", or increased comfort, to a user but also provide increased support and pressure relief beneficial to the user. In one particular embodiment, the gel used in the gel layer has a measurable hardness in the range of about 0.5 kPa to about 50 kPa. In another embodiment, the elasticity of the gel is measurable in terms of hysteresis, the hysteresis percentage of the gel being in the range of about 15% to about 80%.

The one or more additional support layers used in the apparatus can include any type of support material generally known in the art of bodily support apparatuses, particularly in the art of mattresses and seating apparatuses. For example, the one or more additional support layers may include one or more of the following: a foam layer; a spring layer; a textile layer; a gas layer, a wood layer, a metal layer, and a plastic layer. Accordingly, the apparatus of the invention finds use in a wide variety of supports. For example, the apparatus of the invention could be used for supporting the entire body or only a portion of the body. As such, the inventive apparatus finds use in home settings, such as bedding or seating, in office settings, such as chair seats, chair back rests, chair arm rests, keyboard wrist rests, and the like, in transportation, such as car seats or other interior components, medical settings, such as bedding, wheelchairs, and clothing, particularly footwear, as well as other settings wherein comfort or pressure relief are to be maximized. In one particular embodiment, the apparatus is a mattress. Non-limiting examples of further support apparatuses encompassed by the invention include seating apparatuses, pillows, mattress toppers, footwear cushions (or insoles), arm pads, and wrist pads.

According to another embodiment, the gel layer, in addition to the gel, may further comprise a content of one or more fillers. Such fillers are particularly useful in modifying the thermal conductivity of the gel used in the gel layer. As previously noted, gels are typically by a "cool" feel, in part arising from the thermal conductivity of the gel in that it transports heat away from a warmer object in contact with the gel, such as the body of a user. The fillers used in the gel layer are preferentially capable

of reducing the thermal conductivity of the gel, thereby allowing the gel to exhibit a feel to a user that is less "cool".

Various types of filler can be used according to the invention. The filler material should generally be non-reactive with the gel, or with possible derivatives of the gel or the precursors thereof (*e.g.*, isocyanates and polyols in the case of polyurethane gels). Preferably, the filler is a material capable of beneficially affecting one or more physical characteristics of the gel including, but not limited to, the thermal conductivity of the gel. In one particular embodiment of the invention, the filler material is selected from the group consisting of cork pieces, cork flour, wood pieces, wood chips, foam flakes, textile fibers, textile pieces, paraffins, hollow spheres, synthetic microspheres, mineral particles, glass beads, gasses, active agents, nanoparticles, and mixtures thereof.

In one particular embodiment, there is provided an apparatus for supporting at least a portion of the body thereon, the apparatus comprising a filled gel layer overlying one or more additional support layers. Preferentially, the filled gel layer has a thermal conductivity of less than about 0.20 W m^{-1} $^oK^{-1}$.

In another aspect of the invention, there is specifically provided a mattress. In one embodiment, the mattress comprises a gel layer overlying a foam layer. Preferably, the gel layer comprises a gel having a hardness in the range of about 0.5 kPa to about 50 kPa. In a preferred embodiment, the gel is a polyurethane gel. According to further embodiments, the mattress can comprise further support layers, such as a spring layer, and can also further comprise a covering, such as a textile layer.

In another embodiment, the mattress comprises a gel layer overlying a spring layer. Preferably, the gel layer comprises a gel having a hardness in the range of about 0.5 kPa to about 50 kPa. In a specific embodiment, the gel is a polyurethane gel. According to further embodiments, the mattress can comprise further support layers, such as a foam layer, and can also further comprise a covering, such as a textile layer.

The mattress according to this aspect of the invention can be further characterized by additional physical properties of the gel used in the gel layer. For example, in one embodiment, the gel layer comprises a gel having an elasticity such that the hysteresis of the gel is in the range of about 15% to about 80%.

In still another aspect of the invention, there is specifically provided a mattress topper. In one embodiment, the mattress topper comprises a gel layer overlying a foam layer, wherein the foam layer preferably is of a thickness that is substantially less than an average thickness of a standard mattress. In one particular embodiment, the foam layer of the mattress topper has a thickness of less than about 5 cm. In further embodiments, the mattress topper can comprise a covering overlying the gel layer. Preferably, the gel layer comprises a gel having a hardness in the range of about 0.5 kPa to about 50 kPa. In a preferred embodiment, the gel is a polyurethane gel.

In yet another aspect of the invention, there is specifically provided a pillow. In one embodiment, the pillow comprises a gel layer overlying a foam layer. In one preferred embodiment, the gel layer overlies only a portion of the foam layer. Preferably, the gel layer comprises a gel having a hardness in the range of about 0.5 kPa to about 50 kPa. In a preferred embodiment, the gel is a polyurethane gel. In still further embodiments, the pillow can comprise a covering overlying the gel layer.

DETAILED DESCRIPTION OF THE INVENTION

The present invention will be described more fully hereinafter in connection with preferred embodiments of the invention which are given so that the present disclosure will be thorough and complete and will fully convey the scope of the invention to those skilled in the art. However, it is to be understood that this invention may be embodied in many different forms and should not be construed as being limited to the specific embodiments described herein. Although specific terms are used in the following description, these terms are merely for purposes of illustration and are not intended to define or limit the scope of the invention. Like numbers refer

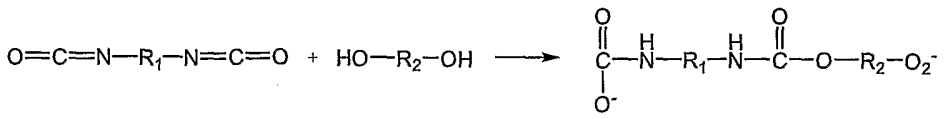
to like elements throughout. As used in this specification and the claims, the singular forms "a," "an," and "the" include plural referents unless the context clearly dictates otherwise.

The present invention provides an apparatus useful for bodily support, particularly support that, in addition to being functional, also provides increased comfort and pressure point relief for a user. The apparatus is characterized by its use of a gel material exhibiting preferred physical characteristics for providing a pleasing "feel" to a user, as well as therapeutic benefits.

The gel used in the apparatus of the invention can comprise any gel that is stable, non-toxic, and generally known to provide a cushioning effect while maintaining a degree of structural stability and support. In particular, the gel can comprise any gel material having a hardness and elasticity that are within a preferred range, as more fully described herein.

Polyurethane gels are particularly useful according to the invention. Further, other gels that are resistant to hardening over time, have limited expandability, and are resistant to substance degradation (*e.g.*, from migration of volatile agents, such as plasticizers) could also be useful as the gel in the present invention. Preferably, the gels used in the apparatus of the invention are also shock absorbent and resistant to vibration.

Polyurethanes are generally understood to be the product of the chemical reaction between a polyisocyanate compound and a polyfunctional alcohol (*i.e.*, a polyol). One example of a general reaction scheme for preparing a polyurethane compound is shown below:



wherein R_1 and R_2 can be various organic groups including, but not limited to, straight or branched chain or cyclic alkyl, alkenyl, or alkynyl groups, as well as various aryl groups. Of course, the above scheme is provided only as an example of the preparation of the polyurethane compounds useful according to the invention and is not intended to be limiting thereof. Additional examples of polyurethane gels capable of use according to the invention are disclosed in United States Patent No. 6,191,216, United States Published Patent Application No. 2004/0058163 (Application Serial No. 10/618,558) and United States Published Patent Application No. 2004/0102573 (Application Serial No. 10/656,778), which are incorporated herein by reference. Examples of other types of gels useful according to the invention are disclosed in United States Patent No. 4,404,296, United States Patent No. 4,456,642, and United States Published Patent Application No. 2005/0186436 (Application Serial No. 11/058,339), which are incorporated herein by reference.

In one embodiment of the invention, the gel used in the gel layer of the apparatus comprises a polyurethane gel. Particularly, the polyurethane gel is may be prepared using raw materials having an isocyanate functionality and a functionality of the polyol component, wherein the product of the functionalities of polyol and isocyanate is at least 5.2, but preferably at least 6.5 or 7.5. In preferred embodiments of the present invention, the polyol component for producing the gel includes a mixture of one or more first polyols having hydroxyl numbers below 112, and one or more second polyols having hydroxyl numbers in the range 112 to 600, wherein the weight ratio of the first polyols to the second polyols lies between 90:10 and 10:90, the isocyanate characteristic of the reaction mixture lies in the range from 15 to 59.81, and the product of isocyanate functionality and functionality of the polyol component is at least 6.15.

In a further specific exemplary embodiment, the raw materials for producing a gel useful according to the invention includes one or more polyisocyates, and a polyol component consisting of a first component of one or more polyols having hydroxyl numbers below 112, and a second component of one or more polyols having hydroxyl numbers in the range 112 to 600, and optionally a catalyst for the reaction

between isocyanate and hydroxyl groups, and optional fillers and/or additives which are known from polyurethane chemistry, wherein the weight ratio of first component to the second component lies between 90:10 and 10:90, the isocyanate characteristic of the reaction mixture lies in the range from 15 to 59.81, and the product of isocyanate functionality of the polyol component is at least 6.15.

The polyol component for producing the gel preferably consists of one or more polyols having a molecular weight between 1,000 and 12,000 and an OH number between 20 and 112, wherein the product of the functionalities of the polyurethane-forming components is at least 5.2, and the isocyanate characteristic lies between 15 and 60.

As isocyanates for gel production, those of the formula $Q(NCO)_n$ may preferably be used, wherein n represents 2 to 4 and Q denotes an aliphatic hydrocarbon radical having 6 to 18 C atoms, a cycloaliphatic hydrocarbon radical having 4 to 15 C atoms, or an aromatic hydrocarbon radical having 8 to 15 C atoms. The isocyanates may be used in pure form or in the form of the conventional isocyanate modifications, such as urethanisation, allophantisation or biuretisation.

Gels, such as polyurethane gels, are particularly useful in the apparatuses according to the invention due in part to the balanced pressure distribution provided by the gel. Unlike standard padding materials, which react to an applied pressure, such as a user sitting or lying of the padding, by deforming along only the axis of the applied pressure (*i.e.*, the axis perpendicular to the plane of the padding), gels tend to exhibit tri-dimensional deformation properties. In other words, the gel reacts to the applied pressure by deforming along three axes: the X and Y axes in the plane of the gel surface, as well as the Z axis that lies perpendicular to the plane of the gel surface. This leads to an even distribution of the exerted pressure, which lessens the pressure felt by the user at the pressure points. This is preferable over the standard padding materials, which allow for an uncomfortable, and possibly damaging, accumulation of pressure at the pressure points. Accordingly, in addition to providing added comfort, the gel provides health advantages, such as increased blood

circulation, encouragement of correct posture, and alleviation of pressure concentration, which can lead to serious conditions, such as bed sores, or other types of ulcerations.

Gel materials useful in the apparatus of the invention are particularly beneficial for their ability to maximize pressure distribution, which can be seen through pressure mapping. Pressure mapping is a clinical tool that measures interface pressure that occurs between a user and a support surface, such as a seat or a bed surface. With standard support cushions and paddings, pressure maps tend to reveal localized high pressure areas, which indicate an inability to evenly distribute pressure. Gels, especially polyurethane gels, and other gels useful according to the invention, are superior to standard supports because of their ability to distribute pressure away from pressure points, as demonstrated by pressure maps showing lower pressure readings at the pressure points.

Gels used according to the present invention are characterized by the specific physical properties they exhibit. Two physical properties that particularly characterize the gels of the invention are hardness and elasticity. Optimization of these two properties exhibited by the gels allows for preparation of an apparatus providing both objective and subjective comfort and support. In other words, gels according to the invention having a certain degree of hardness and a certain degree of elasticity provide therapeutic benefits (*i.e.*, objective comfort), as previously described, but also provide a user with a good "feel" (*i.e.*, subjective comfort). The ability to provide both objective and subjective comfort is particularly useful because a support apparatus designed to provide therapeutic benefit to a user may not always feel good to the user. Conversely, what feels good to a user may not always provide therapeutic benefit to the user. However, gels according to the invention having a hardness and elasticity within the presently specified ranges provide both objective and subjective comfort.

The gel used in the gel layer of the inventive apparatus is characterized by having a low degree of hardness, such hardness being measurable as the force deflection of

the gel at a specific compression. Gel hardness can be measured according to any known method, and a gel useful according to the invention can be identified as having a hardness in a specified range. One method particularly useful according to the invention for measuring gel hardness is the testing method ISO 3386-1, as designated by the International Organization for Standardization (ISO).

According to ISO 3386-1, a method is provided for the calculation of the compression stress value of various materials. The compression stress/strain characteristic is a measure of the load-bearing properties of the material, and the testing method provides two formulas for calculating the compression force deflection in kilopascals (kPa), which provides a measured hardness of the material.

Specifically, under the ISO 3386-1 standard, a gel according to the invention can be measured for a hardness determination through a compression load deflection test. In particular, a 5 cm x 5 cm x 2.5 cm gel sample is subjected to a compressive force, with a 70% maximum compression, and gel hardness is measured as the stress applied to the gel (in kPa) at 40% compression.

A gel useful according to the invention has a low measurable hardness. Preferentially, the gel has a measurable hardness that is less than 90 kPa, more preferably less than 80 kPa, still more preferably less than 70 kPa, and most preferably less than 60 kPa. In one embodiment, the gel used in the invention has a measurable hardness in the range of about 0.5 kPa to about 50 kPa. According to further embodiments, the gel has a hardness in the range of about 1 kPa to about 40 kPa, about 1.5 kPa to about 30 kPa, or about 2 kPa to about 25 kPa.

According to another embodiment of the invention, the gel used in the gel layer of the apparatus is characterized by having a measurable elasticity that is within a specified range. In solid mechanics, a material is understood to behave elastically if it changes shape due to an applied load, and when the load is removed, the material recovers its original shape. The elasticity of a material is inversely proportional to its stiffness.

One method for evaluating the elasticity of a gel for use according to the invention is through determination of the hysteresis exhibited by the gel. Hysteresis is a property of systems (usually physical systems) that do not instantly follow the forces applied to them, but react slowly, or do not return completely to their original state. Hysteresis, then, can be evaluated as the ability of a material, such as a gel, to return to its original shape after removal of a force on the gel.

In one method for determining hysteresis, a force is applied to a gel, which leads to compression of the gel. The deflection of the force by the gel at 70% compression is measured, and the external force is removed, allowing the gel to decompress. The deflection of the gel under no compression (*i.e.*, after removal of the force) is then measured. The hysteresis of the gel (evaluated as a percentage) is the difference between the two force values at the defined deflections. Accordingly, a gel exhibiting a low hysteresis percentage would be expected to be highly elastic, in other words, have a rapid and significantly complete return to its original shape. A gel exhibiting a high hysteresis percentage would be expected to be less elastic, in other words have a more delayed and less complete return to its original shape.

According to the present invention, it is beneficial for a gel for use in the gel layer to be elastic, but not exhibit physical properties that are highly temperature dependant. For example, viscoelastic foams, commonly known as "memory foam", typically exhibit a glass transition temperature (T_g) at around room temperature. In a cold environment, a memory foam product will tend to be harder and less resilient. Conversely, in a warmer environment, a memory foam product will tend to be softer and more resilient. Accordingly, the product changes in response to the surrounding temperature, including temperature changes attributable to body heat flow.

Gels useful according to the present invention, being highly elastic, do not suffer from such a drawback. Rather, the gel the gels exhibit an elasticity (or percentage hysteresis) that is not temperature dependent. In one embodiment, the gel used in the invention has a measurable hysteresis in the range of about 15% to about 80%.

According to further embodiments, the gel has a hysteresis in the range of about 20% to about 70%, about 25% to about 60%, or about 30% to about 50%.

While gels in general tend to exhibit superior pressure distribution properties to standard cushioning materials, such as foam, gels also tend to exhibit greater thermal conductivity than foam. High thermal conductivity can be a desirable gel property, such as in a warm environment where a cooling effect would be welcomed. In other situations, however, it may be more desirable to have a lower thermal conductivity in order to conserve heat near the body of the user. Accordingly, the present invention is beneficial in that the gel used in the gel layer of the inventive support apparatus can have a determinable thermal conductivity.

Thermal conductivity (λ), which is generally reported in terms of watts per meter per degree Kelvin ($W\ m^{-1}\ {}^{o}K^{-1}$), relates to the ability of a material to transmit heat under fixed conditions. The lower the value of λ, the better insulator the material will be. Conversely, the higher the value of λ, the better heat conductor the material will be.

Foam, a typical cushion material for support apparatuses, is known to be a material exhibiting good insulating properties. For example, molded foam, such as used for seat cushions, typically has a λ value of about 0.04 $W\ m^{-1}\ {}^{o}K^{-1}$, and foam used in construction and building materials typically has a λ value of about 0.022 $W\ m^{-1}\ {}^{o}K^{-1}$. When a highly insulating material, such as foam, is used in a support apparatus for human use, the heat generated by the human body, at first contact with the foam, is immediately transferred to the contact surface of the foam. With time, the transferred heat finds a high resistance to movement through the foam for dissipation. The energy (heat) produced continuously by the human body generates an increase in temperature because the foam is unable to absorb the energy and transport it away from the contact area quickly enough. In other words, while the initial warmth maintained by the contact with the foam may be of a comfortable level, an eventual heat build-up leads to discomfort for the user.

Polyurethane gels, and similar gels as described herein, exhibit different thermal properties and can generally be considered good conductors of heat compared to foam. For example, a polyurethane gel can have a λ value of about 0.20 W m^{-1} $^oK^{-1}$ or greater. Polyurethane gels also typically have a greater density than foam. For example, polyurethane gel can typically have a density in the range of about 600 to about 1,100 Kg/m^3, while expanded foam for seat cushions can generally range from about 30 to about 85 Kg/m^3. Further, polyurethane gels commonly have a high thermal capacity. This combination of increased ability to transport heat through the material, higher material mass per unit area, and high amount of energy needed to increase the material temperature makes a significant difference on the type of exchange of heat from the user to the gel over time.

The heat exchange capacity of the gels used in the gel layer according to the invention therefore further contributes to the good "feel" users desire and appreciate in a support apparatus, such as a mattress, pillow, seating apparatus, or the like. Accordingly, the presence of the gel layer allows for increased comfort not only because of the pressure distribution qualities of the gel but also because of the thermal conductivity of the gel and the corresponding ability to move heat away from the body and therefore circumvent the eventual heat buildup associated with many support apparatuses that can lead to discomfort.

Beneficially, gels useful according to the invention can have their λ values altered through addition of one or more fillers. Filled gels are useful according to the invention because they can be used in a support apparatus to provide increased comfort and pressure distribution, as previously noted, while also having a lower thermal conductivity to lessen the movement of heat away from the body of the user. Such lowering of the λ value of the gel reduces the "coolness" of the gel. This can also increase the subjective comfort of the support apparatus for users who desire a feeling of warmth.

Accordingly, in one embodiment of the invention, the gel used in the gel layer of the support apparatus further comprises one or more fillers. The filler material can be

any material capable of admixture with the gel and that is effective for altering the λ value of the gel. In a specific embodiment, the filler material is effective for lowering the λ value of the gel to at least a value indicative of a thermal conductivity wherein a perception of coolness of the gel is reduced. In yet another embodiment, the filler material is effective for lowering the λ value of the gel such that there is a perception of warmth from the gel. Accordingly, various types of materials ranging from solids to liquids may be used as filler for the gel used in the gel layer according to the invention.

In one embodiment of the invention, the filler comprises a solid material. Preferentially, the solid material comprises a particulate material. The average size of the particulate can vary depending upon the apparatus in which the filled gel is to be used and can also vary depending upon the λ value desired in the filled gel. In one embodiment, the filler can comprise coarse particles. In another embodiment, the filler can comprise fine particles (*i.e.*, powders). In yet another embodiment, the filler can comprise nanoparticles. In a particular embodiment of the invention, the filler material comprises particulates having an average diameter of about 0.05 mm to about 15 mm. In another embodiment, the particulates have an average diameter of about 0.10 mm to about 10 mm, about 0.10 mm to about 5 mm, or about 0.10 to about 1 mm.

In another embodiment of the invention, the filler material comprises hollow material, such as microspheres. Such hollow material can be natural or synthetic in origin, but are generally expected to be synthetically produced material. For example, the material can comprise synthetic microspheres. Such microspheres are preferably formed from a polymer material, such as a polyolefin, particularly an acrylonitrile copolymer or polyvinylchloride. In addition to the synthetic microspheres, other types of hollow materials having various geometries could also be used in the filled gel. For example, in addition to hollow materials that are generally spherical in nature (also described as being balloon-like), the hollow materials can also be in the form of tubular, rectangular, or other geometric shapes.

In another embodiment of the invention, the filler comprises a liquid, particularly an organic liquid. The liquid is preferably chemically inert to the gel used in the gel layer, as well as starting materials, intermediates, and by-products in the preparation of the gel (such as isocyanates and polyols in the case of polyurethane gels). Accordingly, the liquid filler is generally preferably selected from materials, such as plasticizers (including oils, resins, and hydrocarbon derivatives), hydrocarbons and fuels, alkylbenzenes, and liquid esters. More particularly, the liquid material can include amorphous or semicrystalline paraffins, naphthenic oils or resins, heavy and light fuels, alkylbenzenes, esters (preferentially products of polyhydric alcohols with monobasic carboxylic acids), alkylpolyaromatic compound, and vegetable oils, as well combinations of the above liquids.

According to a further embodiment of the invention, the filler can comprise one or more gasses. For example, the filler can comprise ambient air. In other embodiments, the gas used as the filler material can comprise substantially pure gasses, such as nitrogen gas, or another inert gas, such as argon gas. The gas can also comprise gaseous compounds, such as carbon dioxide gas.

In still another embodiment of the invention, the filler can comprise one or more active agents. As used herein, active agents are intended to refer to any additive capable of providing a therapeutic benefit to a user. For example, the active agent can include vitamins, minerals, essential oils, perfumes, and the like.

The filler generally can comprise natural or synthetic materials. For example, the filler can comprise natural materials, such as cork, wood, sponge, natural fibers (*e.g.*, cotton, wool, etc), minerals (*e.g.*, mica, or other silicates, or other metal oxides, such as aluminates), pumice, and glass (including fibers, beads, etc.). Examples of synthetic materials useful as fillers in the present invention include synthetic fibers, synthetic microspheres, and various other synthetic materials. In one particular embodiment of the invention, the filler is selected from the group consisting of cork pieces, cork flour, wood pieces, wood chips, foam flakes, textile fibers, textile pieces,

paraffins, hollow spheres, synthetic microspheres, mineral particles, glass beads, gasses, active agents, nanoparticles, and mixtures thereof.

The content of filler present in the gel can vary depending upon the apparatus in which the filled gel is to be used and can also vary depending upon the λ value desired in the filled gel. In one embodiment of the invention, the filler comprises about 5 percent to about 95 percent of the filled gel, on a volume basis. In another embodiment, the filler comprises about 10 percent to about 90 percent of the filled gel, on a volume basis. In still another embodiment, the filler comprises about 20 percent to about 80 percent of the filled gel, on a volume basis. In yet another embodiment, the filler comprises about 25% to about 75% of the filled gel, on a volume basis.

Depending upon the type of filler used in the filled gel and the content of the filler in the filled gel, the λ value of the filled gel can be altered from the λ value of the gel without the filler. Preferably, the presence of the filler in the filled gel causes the filled gel to exhibit a reduced λ value. In other words, it is preferable for the filled gel to have a thermal conductivity that is less than the thermal conductivity of the gel without the filler.

In one embodiment of the invention, the filled gel has a thermal conductivity of less than about 0.20 $W\ m^{-1}\ {}^{o}K^{-1}$. In another embodiment, the filled gel has a thermal conductivity of less than about 0.15 $W\ m^{-1}\ {}^{o}K^{-1}$. In still another embodiment, the filled gel has a thermal conductivity of less than about 0.10 $W\ m^{-1}\ {}^{o}K^{-1}$. In one particular embodiment of the invention, the filled gel has a thermal conductivity of less than or equal to about 0.08 $W\ m^{-1}\ {}^{o}K^{-1}$.

In addition to the gel layer (which may or may not include one or more fillers), the support apparatus of the invention can further comprise one or more additional support layers underlying the gel layer. The additional support layer can include any type of material generally recognized in the art as being useful for providing support to at least a portion of the body of a user. For example, the additional support layer

can comprise a layer of foam, which can take on any of the various embodiments generally useful for providing a cushioning effect or a supportive effect. The additional support layer can also comprise springs, which are recognized as being useful for providing support to the body. The layer of springs can take on any embodiment known in the art for providing effective support, while also providing comfort for the user. For example, the spring layer can comprise a series of springs that are at least partially interconnected. Furthermore, the spring layer can comprise a series of springs that are present as separate coils. Further additional embodiments of spring layers are also encompassed by the present invention, which is not intended to be limited by the examples provided above. For example, the invention also encompasses apparatuses wherein the additional support layer comprises other materials known for providing support, including gas (such as air), cushioning materials, or paddings, textile layers, and also including materials providing structure, such as wood, metal, or rigid plastics.

In one embodiment of the invention, the support apparatus comprises a gel layer and at least one additional support layer of a foam material. In another embodiment of the invention, the support apparatus comprises a gel layer and at least one additional support layer of springs. In still another embodiment of the invention, the support apparatus comprises a gel layer, at least one additional support layer of springs, and at least one additional support layer of a foam material. In one particular embodiment of the invention, the one or more additional support layers are positioned underlying the gel layer such that there are no additional support layers positioned above the gel layer.

The additional support layers and the gel layer can be integrally attached or can be separate bodies. By integrally attached is intended to mean the layers are attached one to another by means such that the two layers are not separable without at least partially damaging one or multiple layers. For example, the layers may be integrally attached, such as by gluing, stapling, sewing, welding, or the like. Further, the layers may be integrally attached through chemical bonding. For example, when the gel layer comprises a polyurethane gel and the additional support layer comprises a

polyurethane foam, both layers have free isocyanate groups prior to curing (or maturation) of the gel or foam. Accordingly, a when one layer is allowed to cure while adjacent the other layer, chemical bonding between the gel and the foam can occur.

Foam support layers are particularly useful in combination with a gel layer, not only because of ease of bonding, as described above, but also because of the various combinations provided. For example, in one embodiment, convoluted foam may be used. In another embodiment, the foam may have one or more cavities for receiving all or part of the gel layer. When such cavities are present, the cavities may be on a "top" surface of the foam, a "bottom" surface of the foam, or on both a top and bottom surface of the foam.

In specific embodiments of the invention, where the additional support layer comprises a foam layer, it can be particularly useful for the foam layer to be of a specified thickness. For example, where the apparatus is relatively large and the foam layer provides a substantial amount of the structure of the apparatus, such as in mattress, it can be beneficial for the foam layer to be of a substantial thickness. For example, in one embodiment, the additional support layer comprises a foam layer having a thickness of at least about 5 cm. In further embodiments, the foam layer has a thickness of at least about 6 cm, at least about 7 cm, at least about 8 cm, at least about 9 cm, and at least about 10 cm.

In other embodiments of the invention, it may be preferred for the additional support layer to be of a lesser thickness than as described above. For example, when the support apparatus is a shoe insert, it is desirable for the apparatus to have a minimum thickness. Likewise, in embodiments wherein the apparatus is a mattress topper, it is beneficial for the additional support layer to have a minimum thickness to avoid adding to the overall profile of the mattress topper. For example, in one embodiment, it is beneficial for the additional support layer to be a foam or textile layer having a thickness of less than about 5 cm. In further embodiments, the

additional support layer preferably has a thickness of less than about 4 cm, less than about 3 cm, and less than about 2 cm.

In addition to the gel layer and the additional support layer or layers as described above, the support apparatus of the invention also encompasses the addition of a covering overlying the gel layer. The covering can generally comprise any type of material commonly used in coverings for the various types of support apparatuses encompassed by the invention. Such coverings include natural and synthetic materials. Further, such coverings can also include padding. For example, when the support apparatus is a mattress, the covering can be a padded mattress topper. Further, any type of upholstering material can be used as the cover in the present invention. Accordingly, the presence of the gel layer in no way limits the types of covers available for use in covering the support apparatus of the invention. Furthermore, other types of coverings are also encompassed by the invention. For example, the covering can comprise a film, such as a polyurethane film, a coating, such as a polymer that is non-reactive or non-tacky in a dried or cured state, or a foam.

As with the additional support layer, in certain embodiments of the invention, it may be beneficial for the covering layer to be of a specific thickness. Generally, the covering layer should be of minimal thickness to avoid masking the therapeutic benefits and pleasing feel of the gel layer. For example, in one embodiment, the covering comprises a foam layer. According to this embodiment, it is preferable for the foam layer to have a thickness of less than about 5 cm. In further embodiments, the covering preferably has a thickness of less than about 4 cm, less than about 3 cm, and less than about 2 cm.

The presence of the gel layer in no way limits the scope of support apparatuses encompassed by the invention. Accordingly, the support apparatus of the invention can include apparatuses, such as mattresses, chairs, sofas, recliners, wheelchairs, pillows, furniture cushions, office equipment, automobile parts, mattress toppers, and the like. In one particular embodiment of the invention, the support apparatus

comprises a bed mattress. In another embodiment of the invention, the support apparatus comprises a seating apparatus. In still another embodiment, the support apparatus comprises a pillow. In still another embodiment, the support apparatus comprises a mattress topper.

The support apparatus of the invention comprising a gel layer overlying at least one additional support layer, such as a foam layer and a spring layer, derives benefit from multiple aspects of the invention. As previously noted, the gel layer provides an improved pressure mapping for the various individuals that may use the support apparatus (*i.e.*, the gel provides improved distribution of the pressure out and away from the pressure points). Furthermore, the gel has the capability to absorb and transport heat with different parameters than other known support materials, such as foam, which generally acts as an insulator and traps heat against a user. The gel layer in the apparatus of the invention, however, can further comprise one or more fillers and can therefore be made according to predefined specifications to have a ? value such that the perception of heat flow from the body of the user is optimized for comfort. In other words, the filled gel layer can provide a perception of warmth often desired by a user but not act as a heat trap, such as foam. Further, when used in combination with further layers, such as foam or springs, the various benefits of the gel layer can be provided with only a relatively thin gel layer, while the bulk of the support apparatus can comprise more conventional materials.

EXPERIMENTAL

The present invention is more fully illustrated by the following examples, which are set forth to illustrate the present invention and are not to be construed as limiting.

EXAMPLE 1

Determination of Gel Mechanical Properties

The mechanical properties of multiple polyurethane gels useful according to the present invention were determined using testing methods as described herein. The various gel samples were evaluated in terms of hardness and hysteresis, and the evaluation results are provided in Table 1.

Table 1

Gel Mechanical Properties

Sample ID	Hardness (kPa)	Hysteresis (%)	Filler	Shape	Use
1	7.6	37.4	None	Regular	Mattress
2	6.0	35.0	None	Cylinder	Mattress
3	4.4	45.7	None	Cylinder	Mattress
4	12.0	46.0	Cork	Cylinder	Mattress
5	9.7	36.0	Microspheres	Cylinder	Seat
6	7.9	71.0	None	Regular	Seat
7	11.0	63.0	None	Regular	Seat
8	41.0	47.0	None	Regular	Armpad
9	16.0	68.0	None	Regular	Armpad
10	3.1	54.5	None	Tower	Mattress
11	32.6	51.1	None	Tower	Armpad
12	92.0	63.0	None	Regular	-

For each gel sample, the sample shape, optional filler material, exemplary use, hardness (measured as force deflection at 40% compression), and percent hysteresis are provided. For sample shape, "regular" indicates a sample 5 cm wide x 5 cm long x 2.5 cm thick, "cylinder" indicates a cylindrical sample having a diameter of 5 cm and being 3 cm thick, and "tower" indicates a sample 5 cm wide x 5 cm long x 1.7 mm thick having four square projections arising from the top thereof, each being 2 cm wide x 2 cm long x 0.8 cm thick. The use provided for each sample is only provided for purposes of example and should not be construed as limiting thereof. Sample ID 12 is provided as a comparative example of a gel that would not be useful according to the invention, the hardness of the gel being outside the preferred range.

Many modifications and other embodiments of the inventions set forth herein will come to mind to one skilled in the art to which these inventions pertain having the benefit of the teaching presented in the foregoing descriptions. Therefore, it is to be understood that the inventions are not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

CLAIMS

1. An apparatus for supporting at least a portion of the body thereon, said apparatus comprising a gel layer overlying one or more additional support layers, wherein said gel layer comprises a gel having a hardness in the range of about 0.5 kPa to about 50 kPa.

2. The apparatus according to claim 1, wherein said gel exhibits a hysteresis of about 15% to about 80%.

3. The apparatus according to claim 2, wherein said gel exhibits a hysteresis of about 25% to about 60%.

4. The apparatus according to claim 1, wherein said gel has a hardness in the range of about 1.5 kPa to about 30 kPa.

5. The apparatus according to claim 1, wherein said one or more additional support layers is selected from the group consisting of a foam layer, a spring layer, a textile layer, a gas layer, a wood layer, a metal layer, a plastic layer, and combinations thereof.

6. The apparatus according to claim 1, further comprising a covering overlying said gel layer.

7. The apparatus according to claim 6, wherein said covering is selected from the group consisting of a textile layer, a film layer, a coating layer, and a foam layer.

8. The apparatus according to claim 1, wherein said apparatus is selected from the group consisting of a mattress, a seating apparatus, a pillow, a mattress topper, a footwear cushion, an arm pad, and a wrist rest.

9. The apparatus according to claim 1, wherein there are no additional support layers positioned above said gel layer.

10. The apparatus according to claims 1, wherein said gel layer comprises a polyurethane gel.

11. The apparatus according to claim 1, wherein said apparatus is a mattress comprising a gel layer overlying a foam layer, wherein said gel layer comprises a polyurethane gel having a hardness in the range of about 0.5 kPa to about 50 kPa and exhibiting a hysteresis of about 15% to about 80%.

12. The apparatus according to claim 1, wherein said gel hardness is measured according to the method of ISO 3386-1.

13. The apparatus according to claim 1, wherein said hardness represents the force deflection of a 5 cm x 5 cm x 2.5 cm sample of said gel at 40% compression.

14. The apparatus according to claim 1, wherein said gel layer is integrally attached to at least one of said one or more additional support layers.

15. The apparatus according to claim 1, wherein said one or more additional support layers comprises a foam layer.

16. The apparatus according to claim 15, wherein said foam is convoluted foam.

17. The apparatus according to claim 15, wherein said foam comprises one or more cavities for receiving said gel layer.

18. The apparatus according to claim 15, wherein said gel layer and said foam layer are chemically bonded together.

19. The apparatus according to claim 15, wherein said foam layer has a thickness of at least about 5 cm, said apparatus further comprises at least one covering overlying said gel layer, said covering being selected from the group consisting of textile layer, a film layer, a coating layer, and a foam layer, and wherein said at least one covering has a thickness of less than about 5 cm.

20. The apparatus according to claim 1, wherein said apparatus is a mattress topper comprising a gel layer overlying a foam layer, wherein said gel layer comprises a polyurethane gel having a hardness in the range of about 0.5 kPa to about 50 kPa and exhibiting a hysteresis of about 15% to about 80%, and wherein said foam layer has a thickness of less than about 5 cm.

21. The apparatus according to claim 1, wherein said gel comprises a content of one or more fillers.

22. The apparatus according to claim 21, wherein said one or more fillers are selected from the group consisting of cork pieces, cork flour, wood pieces, wood chips, foam flakes, textile fibers, textile pieces, paraffins, hollow spheres, synthetic microspheres, mineral particles, glass beads, gasses, active agents, nanoparticles, and mixtures thereof.

23. The apparatus according to claim 21, wherein said gel filled with said one or more fillers has a thermal conductivity of less than about 0.20 W ? m^{-1} ? $^{o}K^{-1}$.

24. The apparatus according to claim 23, wherein said gel filled with said one or more fillers has a thermal conductivity of less than about 0.10 W ? m^{-1} ? $^{o}K^{-1}$.

25. The apparatus according to claim 23, wherein said one or more fillers comprise about 5% to about 95% of said gel, on a volume basis.

26. An apparatus for supporting at least a portion of the body thereon, said apparatus comprising a filled gel layer overlying one or more additional support layers.

27. The apparatus according to claim 26, wherein said filled gel layer comprises one or more fillers selected from the group consisting of cork pieces, cork flour, wood pieces, wood chips, foam flakes, textile fibers, textile pieces, paraffins, hollow spheres, synthetic microspheres, mineral particles, glass beads, gasses, active agents, nanoparticles, and mixtures thereof.

28. The apparatus according to claim 26, wherein said one or more fillers comprises particulate matter have an average diameter of about 0.05 mm to about 15 mm.

29. The apparatus according to claim 26, wherein said filled gel exhibits a thermal conductivity that is less than the thermal conductivity of the gel without said one or more fillers.

30. The apparatus according to claim 26, wherein said filled gel has a thermal conductivity of less than about 0.20 W m^{-1} $^oK^{-1}$.

31. The apparatus according to claim 30, wherein said filled gel has a thermal conductivity of less than about 0.10 W m^{-1} $^oK^{-1}$.

32. The apparatus according to claim 26, wherein said one or more fillers comprise about 5% to about 95% of said gel, on a volume basis.

33. The apparatus according to claim 32, wherein said one or more fillers comprises about 20% to about 90% of said gel, on a volume basis.

34. The apparatus according to claim 26, wherein said filled gel layer comprises a gel having a hardness in the range of about 0.5 KPa to about 50 KPa.

35. The apparatus according to claim 26, wherein said filled gel layer comprises a gel exhibiting a hysteresis of about 15% to about 80%.

36. The apparatus according to claim 26, wherein said one or more additional support layers is selected from the group consisting of a foam layer, a spring layer, a textile layer, a gas layer, a wood layer, a metal layer, a plastic layer, and combinations thereof.

37. The apparatus according to claim 26, further comprising a covering overlying said filled gel layer.

38. The apparatus according to claim 37, wherein said covering is selected from the group consisting of a textile layer, a film layer, a coating layer, and a foam layer.

39. The apparatus according to claim 26, wherein said apparatus is selected from the group consisting of a mattress, a seating apparatus, a pillow, a mattress topper, a footwear cushion, an arm pad, and a wrist rest.

40. A mattress comprising a gel layer overlying a foam layer, wherein said gel layer comprises a gel having a hardness in the range of about 0.5 kPa to about 50 kPa measured according to the method of ISO 3386-1.

41. The mattress according to claim 40, wherein said gel exhibits a hysteresis of about 15% to about 80%.

42. The mattress according to claim 40, further comprising one or more spring layers.

43. The mattress according to claim 40, further comprising a covering overlying said gel layer.

44. A mattress comprising a gel layer overlying a spring layer, wherein said gel layer comprises a gel having a hardness in the range of about 0.5 kPa to about 50 kPa measured according to the method of ISO 3386-1.

45. The mattress according to claim 44, wherein said gel exhibits a hysteresis of about 15% to about 80%.

46. The mattress according to claim 44, further comprising one or more foam layers.

47. The mattress according to claim 44, further comprising a covering overlying said gel layer.

48. A mattress topper comprising a gel layer overlying a foam layer, wherein said gel layer comprises a gel having a hardness in the range of about 0.5 kPa to about 50 kPa measured according to the method of ISO 3386-1, and wherein said foam layer has a thickness of less than about 5 cm.

49. The mattress topper according to claim 48, wherein said gel exhibits a hysteresis of about 15% to about 80%.

50. The mattress topper according to claim 48, further comprising a covering overlying said gel layer.

51. A pillow comprising a gel layer overlying a foam layer, wherein said gel layer comprises a gel having a hardness in the range of about 0.5 kPa to about 50 kPa measured according to the method of ISO 3386-1.

52. The pillow according to claim 51, wherein said gel exhibits a hysteresis of about 15% to about 80%.

53. The pillow according to claim 51, further comprising a covering overlying said gel layer.

54. An apparatus for supporting at least a portion of a body thereon, said apparatus comprising a gel layer comprising a gel having a hardness in the range of about 0.5 kPa to about 50 kPa measured according to the method of ISO 3386-1 and exhibiting a hysteresis of about 15% to about 80%.

55. The apparatus according to claim 54, further comprising one or more additional support layers underlying said gel layer.

56. The apparatus according to claim 54, further comprising a covering overlying said gel layer.

57. The apparatus according to claim 54, wherein said apparatus is selected from the group consisting of a mattress, a mattress topper, and a pillow.

58. The apparatus according to claim 54, wherein said gel layer further comprises one or more fillers selected from the group consisting of cork pieces, cork flour, wood pieces, wood chips, foam flakes, textile fibers, textile pieces, paraffins, hollow spheres, synthetic microspheres, mineral particles, glass beads, gasses, active agents, nanoparticles, and mixtures thereof.

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2006/000603

A. CLASSIFICATION OF SUBJECT MATTER
INV. A47C27/08

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)
A47C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2004/058163 A1 (GANSEN PETER ET AL) 25 March 2004 (2004-03-25) paragraphs [0012], [0030], [0031], [0038], [0040]	26 1-25, 27-58
Y	US 2003/096899 A1 (PEARCE TONY M) 22 May 2003 (2003-05-22) paragraphs [0134], [0616], [0742], [0743]; figures 1-97	1-25, 27-58
Y	US 6 393 640 B1 (DALIS NINA B) 28 May 2002 (2002-05-28) column 3, line 65 - column 4, line 6; figures 1-4	1-25, 27-58

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[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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"O" document referring to an oral disclosure, use, exhibition or other means

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Date of the actual completion of the international search	Date of mailing of the international search report
16 August 2006	24/08/2006

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INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2005/050636 A1 (SETOKAWA HIROTO) 10 March 2005 (2005-03-10) paragraphs [0009], [0013], [0024], [0031], [0034], [0037], [0045], [0046]; figures 1-6	1-25, 27-58

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2006/000603

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2004058163 A1	25-03-2004	NONE	
US 2003096899 A1	22-05-2003	NONE	
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