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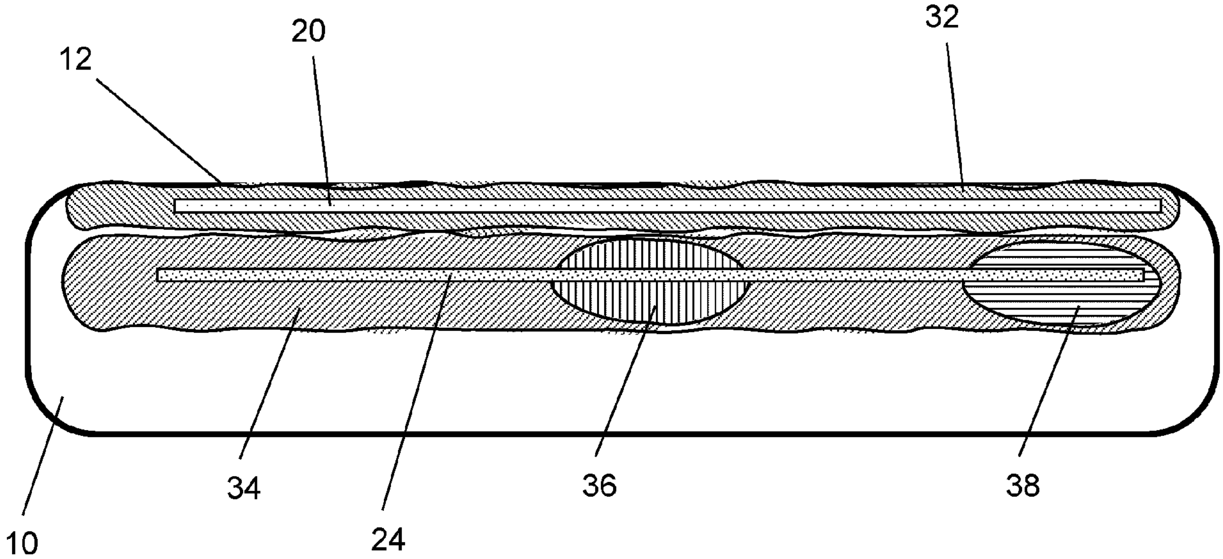
(54) MULTI-ZONE COOLING FOR A FOAM PADDING

(57) A foam padding (10) has at least one upper section (32) and at least one lower section (34). The foam padding (10) comprises at least one absorber (20) that is embedded in the upper section (32), the at least one absorber (20) for absorbing thermal energy from the upper section (32). The foam padding (10) further comprises at least one band (24) that is embedded in the lower section (34), the at least one band (24) configured for transferring thermal energy within the lower section (34) from a sub-section with excess thermal energy (36) to at least one sub-section with-out excess thermal energy (38). The at least one sub-section with-out excess thermal energy (38) is located at the edges of the foam padding (10).

FIG. 1



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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims benefit of and priority to Luxembourg patent application LU500685 filed on 24 September 2021. The entire disclosure of LU500685 is hereby incorporated by reference.

FIELD OF THE INVENTION

[0002] The field of the invention relates to a foam padding for e.g., a mattress.

BACKGROUND OF THE INVENTION

[0003] There is a growing trend in the mattress industry to employ new types of materials for a mattress which create a cooling effect for users. Examples of these new type of materials include phase change materials (PCMs) or cooling gels. These phase change materials and cooling gels are included in foams in the upper section (near-surface region) of the mattress. These new types of materials seek to alleviate overheating during use or provide a more comfortable environment for users who may suffer from medical conditions which cause excess heat production.

[0004] The comfortable temperature window during sleep is relatively narrow as the body must try to maintain its core body temperature of around 98.6°F (or 37°C). It has been reported that an optimal insulating sleep system should ensure a bed temperature between 28°C and 32°C which should allow the contact temperature between the body and bed to stabilize between 30°C and 35°C. A too high bed insulation will result in a temperature rise of the body which leads to excess sweating and an increase in relative humidity. On the other hand, if the insulation is too low, the body will cool off which may cause shivering and similar issues with sleep disturbance. These insulating properties of the mattress are mainly dependent on the core materials of the mattress and its design. The cores made of latex or polyurethane, for instance, will have higher insulation values than a spring mattress. Aside from the core, the contact temperature itself is mainly dependent on the top layer of the mattress and its ability to hold air.

[0005] There are not many solutions to this challenge for designing the mattress. Since 'feeling hot' is a feeling of temperature, designers are looking for methods to reduce temperature. The designers are looking for cooling solutions which may be active or passive. This leads to solutions with an air conditioner combined with a mattress, with ventilators, materials with high thermal connectivity blended into the foam padding or with channels cut into foam materials running along the mattress. These methods are either expensive (air conditioner), noisy (ventilator) or not working at all (blending thermal conducting materials into foam, channels).

[0006] For example, international Patent Publication No. WO2015/034528 (Tempur-Pedic) teaches a support cushion or mattress for prolonged cooling that includes a region with a phase change material and an underlying copper layer connected to another region of phase change material. The phase change materials are fibers or flexible foams that are coated with or include substances having a high heat of fusion. One example of such as substance is paraffin wax which melting at certain predetermined temperature and thereby absorbing thermal energy. During melting, this phase change material feels 'cool'. The phase change material is after melting no longer able to absorb thermal energy.

[0007] The Tempur-Pedic patent application also teaches an attempt to extend the duration of the melting phase by transporting thermal energy away from the phase change material by connecting this phase change material with the copper layer or band located under the bottom of this phase change material. According to the teachings of the Tempur-Pedic patent application, the body heat is absorbed into the phase change material from the top of the phase change material. The phase change material can absorb only up to 9kJ/kg. It is known that the body emits about 230 KJ of thermal energy during an eight-hour period. The phase change material will have melted after before the end of an eight-hour period. After the phase change material has completely melted, the construction of the mattress is substantially insulating, not providing any more cooling.

[0008] Commonly assigned Luxembourg Patent Application No. LU100834 discloses a foam padding having hollow volumes and a flexible band with an electrically conducting layer. The flexible band with an electrically conducting layer can transport excess thermal energy from the hollow volumes in the foam padding and its surrounding material, thereby allowing a reduction of temperature in certain sections of a body resting on said padding. Typically, these sections are 4 - 5 cm below the surface of a padding. Transporting thermal energy from certain sections by the band provides a long-lasting cooling effect. This effect starts to be felt once the body heat of the user of the padding reaches these sections, which takes typically about 10 - 20 minutes from the beginning of the usage of the padding.

[0009] US patent application US 2019/344688 A1 (Faurecia Automotive Seating LLC) describes a vehicle seat including a thermal comfort system including an air duct in a foam cushion, a thermoelectric device, a heat sink extending inside the air duct from the thermoelectric device, and an air mover that causes air to flow from the passenger cabin, through the seating surface, along the air duct and heat sink, and back out of the seat.

[0010] US patent application US 2003/006633 A1 (Thermal Solutions Inc) describes an induction heatable body that quickly heats to a desired temperature, retains heat long enough to be used in almost any application, and develops no "hot spots" even when heated by a heating source having an uneven magnetic field distribution.

[0011] The foam paddings described in the prior art do not provide instant cooling as soon as the user starts to use the padding as well as long-lasting cooling during the use of the padding.

SUMMARY OF THE INVENTION

[0012] The invention describes a foam padding that provides instant cooling as well as long-lasting cooling. According to one aspect of the invention, a foam padding is provided having at least one upper section and at least one lower section. At least one absorber is embedded in the upper section. The absorber can absorb the thermal energy from the upper section. The foam padding further comprises a band embedded in the lower section and can transfer the thermal energy within the lower section.

[0013] The band is configured for transferring the thermal energy within the lower section from a sub-section with the excess thermal energy to at least one sub-section without the excess thermal energy. The at least one sub-section without excess thermal energy is located at the edges of the foam padding.

[0014] The location of the sub-sections without the excess thermal energy at the edges of the foam padding leads to a higher difference of the thermal energy between the two types of the sub-sections and therefore to a higher thermal energy flow.

[0015] The upper section is located between the lower section and a surface of the foam padding and can have a substantially homogeneous temperature distribution. The lower section has an inhomogeneous temperature distribution.

[0016] The absorber can further comprise at least one conducting layer and a plurality of conducting strips that are connected together by a conducting connecting band. The connecting band is more flexible than the plurality of conducting strips.

[0017] The band can further comprise a continuous conducting layer that extends from within the at least one sub-section with excess thermal energy to the at least one sub-section without excess thermal energy. The absorber can further have a higher thermal capacity than the band. The conducting layer can have a thickness of 0.5mm to 2.00mm and/or a width of 30mm to 70mm and can be made of graphite. The absorber and/or the band can further be laminated with a lamination layer on one or both sides of polyethylene, polyurethane, or other stabilizing materials, such as aluminum foils, and can further be punctured and/or perforated. The lamination layer must be thin and will have a thickness of, for example, between 10 μm and 35 μm. The thickness must not be too large in order to not hinder the transfer of the thermal energy through the lamination layer.

[0018] The lower section can have a temperature distribution that is inhomogeneous in a direction parallel to the surface of the padding. Alternatively, the lower section can have a temperature distribution that is inhomogeneous in a direction perpendicular to the surface of the padding. The padding can be in the form of a mattress or a seat.

DESCRIPTION OF THE FIGURES

[0019]

FIG. 1 shows a cross sectional view of a padding according to a first aspect of the invention.
FIG. 2 shows a cross sectional view of a padding according to a second aspect of the invention.
FIG. 3 shows an absorber according to the invention in a schematic illustration.
FIG. 4 shows a band according to the invention in a schematic illustration.
FIG. 5 shows a lower section of the padding according to a third aspect of the invention in a schematic illustration.
FIG. 6 shows the lower section of the padding according to a fourth aspect of the invention in a schematic illustration.
FIG. 7 shows the lower section of the padding according to a fifth aspect of the invention in a schematic illustration.
FIG. 8 shows the test set up of a test described.
FIG. 9 shows the test results comparing settings with and without gel-infused foams.
FIG. 10 shows the test results comparing settings with and without flexible bands.

DETAILED DESCRIPTION OF THE INVENTION

[0020] The invention will now be described on the basis of the figures. It will be understood that the embodiments and aspects of the invention described herein are only examples and do not limit the protective scope of the claims in any way. The invention is defined by the claims and their equivalents. It will be understood that features of one aspect or embodiment of the invention can be combined with a feature of a different aspect or aspects and/or embodiments of the invention.

[0021] The following description discloses a mattress as an aspect of the foam padding. The thermal comfort of a mattress enables a comfortable experience for the use of the mattress.

[0022] The temperature of any material is the result of

$$T\ (Mat@t) = T\ (Mat@t\text{-}1) + E(therm\text{-}inflow) - E(therm\text{-}outflow)$$

With T (Mat@t) being the temperature of a given material at a given time t, T (Mat@t-1) being the temperature of this material before this given time t, E(therm-inflow) being the thermal energy reaching the material between t-1 and t and E(therm-outflow) being the thermal energy leaving the material between t-1 and t. Based on this assumption a change of the temperature is not done by changing the temperature of the material itself but rather analyzing and optimizing the thermal energy flows affecting the materials.

[0023] In order to lower the temperature in a material permanently the inflow of the thermal energy has to be lowered or the outflow of the thermal energy has to be raised. In a typical mattress, most inflow of the thermal energy is from the impact of body heat of a person on the mattress. The body during sleep emits a heat flux of 40W/m2 skin, approx. 70-80 W/person which translates to an inflow of the thermal energy of 230 kJ per night. Additional inflow of the thermal energy can be heating devices used, or the thermal energy used in conjunction with dynamic foams. There is no realistic method to reduce the inflow of the thermal energy into the mattress, and the quantity of this inflow of the thermal energy is obviously high.

[0024] The distribution of the thermal energy within a padding of a mattress needs to be further considered when designing the padding in addition to analyzing the thermal energy flows. The upper section of the padding of a mattress (0 - 3 cm below the surface that is in contact with the body of the user of the padding, depending on the foam structure/shape) has typically a very even temperature from the center to the edges. The body heats substantially only one section of the mattress, but the body heat is distributed across the surface by the comforter/duvet. This upper section does not have a significant temperature gradient.

[0025] The section below this upper section of a mattress (lower section) is characterized by the body heat being relatively stable collected in the foam of the padding in this lower section in an area just below the body. The lower section starts 3 cm to 7 cm below the surface of the padding that is in contact with the body of the user of the padding and reaches up to 15 cm below the surface, depending on the foam structure/shape. A temperature gradient within the lower section occurs as the temperature of the foam of the padding around this body-heat-affected area is more like room temperature and not body temperature. The lower section of the padding of a mattress therefore has a temperature gradient in directions substantially parallel to the plane of the surface of the padding.

[0026] The reasons for the distribution of thermal energy loads in the padding of a seat are different to the abovementioned reasons for the distribution of the thermal energy in the padding of a mattress. On the seat padding, the body touches about 80% to 90% of the surface of the seat padding during use. The thermal energy load is therefore spread rather more equally across the surface in the upper section. In the lower section below the upper section the thermal energy level is equally distributed in directions substantially parallel to the plane of the surface but diminishing with increasing depth within this lower section of the padding. This lower section of the padding of the seat therefore has a temperature gradient in a direction substantially perpendicular to the plane of the surface of the padding. The concepts described for the mattress in this document can be applied to the padding of the seat in a similar manner taking into account this difference between the distribution of the thermal energy in the lower section of the padding of the seat and of the mattress.

[0027] In order to provide the user of the padding with a substantially instant but long-lasting experience of cooling, different approaches for cooling are applied to the upper section and to the lower section of the mattress. The differences in the distribution of the thermal energy within the lower section and the upper section allow to use different cooling approaches. As the mattresses are used for long periods of up to 10 hours, the thermal energy must be transported away to provide the long-lasting cooling effect. The long-lasting cooling effect can be provided by transporting the thermal energy away to sub-sections where the user of the padding does not feel the heat. The temperature gradient in the lower section allows this transportation of the thermal energy to those subsections where the heat is not felt by the user. The effect of the body heat being transported away starts to be felt once the body heat reaches this sub-section in the lower section. This duration for this cooling effect to occur is typically 10 - 20 minutes, so the cooling effect caused by the transportation of the thermal energy is not felt instantly.

[0028] To provide the substantially instant cooling effect, the body heat can be absorbed by an electrically conducting absorber in the upper section of the mattress. This instant cooling effect starts about 20 seconds after the user of the padding lies down on the surface of the padding. Depending on the thickness and the material of the absorber and the quantity of the body heat emitted, the thermal energy level of the absorber rises, until this level is the same level as the thermal energy level of the surrounding foam. This is typically the case after 20 to 45 minutes of use. After this time, the absorber does not absorb any more of the thermal energy.

[0029] Around this time, the body heat starts to accumulate in the lower section and the cooling by transporting the thermal energy within the lower section starts to perform. The lower section has substantial temperature gradients, as the lower section is only the area just below the body in which the thermal energy is accumulated.

[0030] The effect of transporting the thermal energy is continuous during use of the mattress. As long as the body emits heat, the resulting temperature gradient in the lower section will drive the transport of the thermal energy.

[0031] The materials are flexible and used to raise the transport of the thermal energy within the lower section. The materials can therefore be incorporated in a padding of a mattress or seat without reducing the comfort feeling. The materials are not using energy and are not transporting the excess thermal energy upwards, as warmer air would do. Therefore, the materials can be used to transport the excess thermal energy to the edge or bottom of a padding or to any sub-section not felt by the user.

[0032] For cooling the lower section, the material utilizes a property of modern - mostly foam based - paddings that the thermal energy is not distributed evenly within this lower section. Polyurethane foam typically has many hollow volumes (usually called cells), which are either open (connected to each other) or closed (not connected to each other). These hollow volumes contain air which gradually becomes warmer with use. Even with open cell foams the movement of this air is very restricted and the air would move upwards towards the user, but not away from the user. The foam material itself could be a transport medium for the thermal energy additionally to the air as a transport medium for the thermal energy within the mattress. The foam has a low thermal conductivity. The foam material cannot transport the thermal energy very well or rather not at all.

[0033] In case of the lower section, this material transports the thermal energy to sub-sections within the lower section with the hollow volumes at which sub-section, the thermal energy is not felt by the user, or to the outside air using a band, as this is a form which is flexible in both dimensions. Even though an electrically conducting layer is used, the band is usually bent only in one direction (along the length) as the width is too short to bend the band. The band can also affect larger sub-sections within the mattress, as several of the bands can be used with a distance between the several bands, so that moisture or humidity can pass easily between the several bands.

[0034] The band has an electrically conducting layer and has therefore a high thermal conductivity. Usually, materials with carbon content are preferred, like graphite, but also other material, such as but not limited to copper or aluminum, could be used. The thickness of the electrically conducting layer needs to be reduced to below 0.5mm to achieve a degree of flexibility, but higher thickness is also allowed as long as a certain flexibility is achieved.

[0035] This electrically conducting layer within the band must be uninterrupted, meaning thickness, composition and width need to be above the minimum values along the whole length of the band.

[0036] The band must be positioned in a way that the band touches the hollow volumes in sub-sections with the excess thermal energy i.e., directly under the body or any heating device and at the same time also touches without any interruption of the conducting layer at least one hollow volume in a sub-section with the normal or reduced thermal energy. These sub-sections can be found in any mattress, e.g., in the lower section towards or at the edges of the mattress.

[0037] The sub-sections of lower thermal energy are at the edges, e.g., the left side and right side of the mattress, or the feet portion. If the mattress is placed on a surface allowing air to reach the lower side of a mattress (i.e., slated frame, spring box) also this lower side can be used as a sub-section of lower thermal energy. There are two principles driving the transport of the thermal energy within the lower section.

1. The higher the difference of the thermal energy between both sub-sections the higher the thermal energy flow. The amount of the thermal energy below the body is rather fixed and thus it is worthwhile to search for sub-sections with lower values of the thermal energy carefully. Some of the aspects described below are based on the idea of lowering the thermal energy level in those sub-sections.
2. The larger the area of the band in the sub-section of the mattress with the lower thermal energy in relation to the area of the band in the sub-section of the mattress with the excess thermal energy the higher the thermal energy flow. At least 30% of the band is in the sub-section with lower thermal energy, but 50% would be preferred, in the case of a lower temperature difference.

[0038] The effects of the described transport of the thermal energy in the lower section can be measured. Figure 8. describes a test setting used. A user of the mattress was placed on the mattress containing the padding with the bands having a continuous electrically conducting layer. The bands were running along the length of the mattress. Three foam layers were placed on each other. The first foam layer 1 is on the top. The second foam layer 2 is located in the center and the third foam layer 3 is at the bottom of the mattress. The bands were placed between the second foam layer 2 and the third foam layer 3. Temperature sensors were placed around two locations. A first location is a hip zone on top of the first foam layer 1 just beneath the body. The second location is a hip zone between the first foam layer 1 and the second foam layer 2. The sensors were located between the body and the bands which were positioned one foam layer below. Temperature values were taken for every minute during a full night with the user sleeping on top. Tests were done with a first test setting described above, a second test setting without the bands, a third test setting in which the first foam layer 1 was gel-infused foam (with and without the bands). The tables in Figures 9-11 show the change in temperature values always comparing two test settings with each other.

[0039] Figure 9 compares a setting with the conventional foams to a setting where the first foam layer 1 is made of gel-infused foams. The upper solid line are the average delta values of the sensors atop the first foam layer 1. The lower dotted line is the average delta values of the sensors between the first foam layer 1 and the second foam layer 2. The x-axis is in minutes and the γ- axis is delta Temperature in Kelvin. Negative values denote that the gel-infused foam has lower temperature values compared to the conventional foam mattress. The result demonstrates that the gel-infused foams indeed lead to lower temperature values compared to the conventional foam - but only in the first hour. After that time the thermal capacity of the gel is filled, and the temperature rises again. The temperature values after two hours are even higher with gel-foam compared to conventional foam.

[0040] Fig. 10 compares a setting with the conventional foam with the flexible bands to a setting in which the conventional foams do not contain the flexible bands. The upper solid line are the average delta values of the sensors atop the first foam layer 1. The lower dotted line is the average delta values of the sensors between the first foam layer 1 and the second foam 2. The x-axis is in minutes and the γ- axis is delta Temperature in Kelvin. Negative values denote that the foam with the bands below has lower temperature values compared to the conventional foam mattress without bands. It can be seen that, apart from a small increase of temperature in the beginning, the values are much lower with the bands than without the bands through the full night. The effect increases even with time, as the normal foam mattress becomes warmer. The effect is significant with -2°K after 6 hours.

[0041] The band itself is small and therefore not a block to humidity passing through the mattress. The band can be punctured well with holes in regular patterns to enable humidity to pass through the bands. The thermal energy flow will pass around these holes and not be interrupted. The holes can be so dense that it is similar to a perforation. It is recommended to keep the holes as small as possible.

[0042] A band being flexible and comprising electrically conducting material will typically be sensitive to punctual impact and react by breaking. The break should be especially avoided as this break creates an interruption of thermal energy flow. It has been found that a laminating of a very thin polyethylene layer (< 0,18mm thickness) is enough to prevent the break of the band. This thin lamination layer can, of course, also be applied on both sides of the band, but usually this is not necessary. Other material adding stability can be applied as the lamination layer to the band as long as the band is flexible i.e., polyurethane.

[0043] The band connecting the two sub-sections with excess and without excess thermal energy can pass through or end within a section of the mattress filled with gel infused foam. Gel infused foam ("Gelfoam") is usually used to prevent the user from feeling too hot. Typically, the transport of the thermal energy within the lower section described in this document creates a much higher thermal energy flow than gel infused foam. This combination adds up the thermal capabilities of the gel infused foam and of the band described in this document.

[0044] A further variation is based on the observation that the thermal energy level in the sub-section with the lower thermal energy should be as low as possible. It might be that, based on the specific shape of the mattress, even this sub-section is penetrated by thermal energy from the body. So, any thermal shield (insulating layer) between the sub-section and the body would lower the thermal energy level in that sub-section, increases the thermal energy difference between the sub-section and the sub-section of the excess thermal energy and therefore increases flow of thermal energy within the band.

[0045] The band can be positioned purely within the mattress, but the band can also be positioned so that the band runs from the sub-section of the excess thermal energy outside the body, i.e., along a side or the lower edge of the mattress or completely outside (i.e., from the mattress into a spring box below). Typically, the outside thermal energy level is determined by room temperature. This room temperature is typically much lower than the temperature of the sub-sections of the excess thermal energy. It could be observed that this difference in thermal energy level is large enough to create a superior flow of the thermal energy through the band. A section of the band of 20% outside the mattress or along the edge of the mattress is more than enough to increase the flow of thermal energy.

[0046] The band described should have a thickness between 0.1mm to 0.5mm. A thin band is more flexible but also more sensitive to break whereas a thicker band is the opposite. The capacity of the band to absorb and transport the thermal energy can be affected by the thickness of the band.

[0047] The band was observed to fit well into the mattress if the width is between 4cm to 10 cm, though also smaller or wider dimensions are allowed. In case wider dimensions are used the puncturing or perforating variation is preferred as not to reduce humidity flow within the mattress.

[0048] A good thermal effect of the band was observed when using graphite as the electrically conducting layer. The graphite comes in very different variations and good results were achieved using graphite with a carbon content greater than 99% and/or a content of ash lower than 1% and /or a density of greater than 1g/cm^3 and/or a content of sulfur lower than 1.800 ppm.

[0049] There are very different types of graphite available. The type called highly oriented pyrolytic graphite (HOCG) is very capable to transport thermal energy based on the special molecular structure. Highly oriented pyrolytic graphite

(HOPG) is a highly pure and ordered form of synthetic graphite. This form of graphite is characterized by a low mosaic spread angle, meaning that the individual graphite crystallites are well aligned with each other. The best HOPG samples have mosaic spreads of less than 1 degree. It had been found that this graphite type is generating very good results in transporting thermal energy.

[0050] In another aspect of the invention the electrically conducting layer is made from graphene. This material is an allotrope of carbon in the form of a two-dimensional, atomicscale, hexagonal lattice in which one atom forms each vertex. It is the basic structural element of other allotropes, including graphite, charcoal, carbon nanotubes and fullerenes. It can also be considered as an indefinitely large aromatic molecule, the ultimate case of the family of flat polycyclic aromatic hydrocarbons. The graphene has a thermal conductivity of greater than 1.000 W/mK and can be much smaller than the flexible band with an electrically conducting layer of normal graphite having the same thermal performance.

[0051] In case of the upper section of the padding, it is feasible to absorb the thermal energy to provide an instant cooling effect. An absorber consisting of at least one electrically conducting strip (further also referred to as conducting strip) with a high thermal capacity is used to absorb the thermal energy in the upper section according to a first aspect of the invention. The thermal energy will not flow in these conducting strips as there is no temperature gradient driving the flow of the thermal energy. The thermal energy emitted by the body is spreading from the surface of the padding into the foam and is absorbed by the absorber. A low heat transfer resistance of the material used for the absorber to the foam is of advantage. Typically, the conducting strips consist of 0.5mm to 2.00 mm graphite foil, with a width of 3 cm to 7 cm. This foil should be laminated to prevent damage during use. The graphite foil of this thickness is not extremely flexible but acceptable especially if the width is lower. The absorber might be separated into several conducting strips of shorter length to increase flexibility.

[0052] The absorber could also be made of any other material as described above for the bands in the lower section.

[0053] To increase the effect of thermal energy intake, thicker parts of the electrically conducting material like graphite foil of 1.0 mm thickness can be attached to a connecting band of thinner electrically conducting material like graphite foil of 0.2mm thickness. With this method, the absorber stays flexible though still having a rather high thermal capacity to absorb the thermal energy. The thinner portions of this absorber help to distribute the thermal energy from the thicker portions of the absorber to another thicker portion of the absorber in case both of the thicker portions are adjacent to each other and have a different load of the thermal energy.

[0054] The conducting strips might be perforated with holes to increase breathability and the passage of humidity. Several of these conducting strips can be used, especially in the hip zone and the shoulder zone.

[0055] The absorber in the upper section will start to absorb the body heat faster compared to the surrounding foam. The thermal energy level in the foam therefore drops and with this the temperature in the foam of the upper section.

[0056] The absorber in the upper section, which is loaded with thermal energy does not hinder the transfer of the thermal energy to the lower section, because the thermal resistance will always be lower than that of the foam.

[0057] In case the user of the padding does not use a comforter/duvet, the distribution of thermal energy in the first section is similar as described for the second section. The absorber is then able to provide a long-lasting cooling effect due to transport of thermal energy as described for the band within the second section.

EXAMPLES

[0058] FIG. 1 shows a cross sectional view of a padding 10 according to a first aspect. The padding 10 has a surface 12 which is in contact with a user of the padding. The padding according to this aspect is a mattress and the user of the mattress is lying on the surface 12. An upper section 32 is located below the surface 12 of the padding 10. The upper section 32 does not have a substantial temperature gradient as the body heat from the user lying on the padding 10 is distributed across most of the surface 12 by a comforter/duvet.

[0059] A lower section 34 is located below the upper section 32. The lower section 34 comprises a temperature gradient as the heat of the user of the padding 10 accumulates below the body of the user in a sub-section with excess thermal energy 36. The lower section 34 comprises a sub-section without excess thermal energy 38 in addition to the sub-section with excess thermal energy 36. The sub-section with excess thermal energy 36 is further referred to as the first sub-section 36. The sub-section without excess thermal energy 38 is further referred to as the second sub-section 38. The second sub-section 38 can be located e.g., towards or at the edges of the padding, as the edges of the padding 10 are not affected by the body of the user and the emittance of the thermal energy. Therefore, these edges and their vicinity are sub-sections without excess thermal energy 38. In the case of a mattress for more than one user, the second sub-section 38 can also be located between the users.

[0060] An electrically conducting absorber 20 is located in the upper section 32 to absorb the thermal energy emitted by the user of the padding 10. The absorber 20 has the shape of a flexible band and extends across the upper section 32. Alternatively, more than one absorber 20 can be positioned in the upper section 32 to increase the amount of the thermal energy that can be absorbed.

[0061] The lower section 34 comprises an electrically conducting band 24 to transport the thermal energy within the lower section 34. The electrically conducting band 24 extends from within the first sub-section 36 to within the second sub-section 38. The electrically conducting band 24 can transport the thermal energy from the first sub-section 36 to the second sub-section 38. The electrically conducting band 24 is further described in figures 4 to 7.

[0062] FIG. 2 shows a cross sectional view of the padding 10 according to a second aspect of the invention. The absorber 20 comprises two conducting strips 21 of electrically conducting materials. The two conducting strips 21 are connected by an electrically conducting connecting band 23 so that the thermal energy can be transported between the conducting strips 21. The conducting strips 21 are thicker compared to the connecting band 23.

[0063] FIG. 3 shows the absorber in a schematic illustration. The absorber 20 comprises an electrically conducting layer 22 being laminated by a polyethylene-layer 28 along the whole length and width of said absorber 20 to stabilize the electrically conducting layer 22. Such an absorber 20 may be implemented in the previous aspects.

[0064] FIG. 4 shows the band 24 in a schematic illustration. The band 24 comprises a continuous electrically conducting layer 26 being laminated by a polyethylene-layer 28 along the whole length and width of said band 24 to stabilize the continuous electrically conducting layer 26. Such a band 24 may be implemented in the previous aspects.

[0065] FIG. 5 shows the lower section 34 of the padding according to the first and second aspect in a schematic illustration. Fig. 5 demonstrates the general concept of the transfer of the thermal energy in the lower section 34 of the padding 10. The padding 10 is illustrated having several hollow volumes 40 and 42. Usually such a padding 10 will be partly occupied on top by the user and a thermal gradient can be present within the padding 10. Under such a situation it is possible that some of the hollow volumes 40, 42 contain the excess thermal energy, whereas other ones of the hollow volumes 40, 42 do not. In the illustrated aspect, a flexible conducting band 24 having a continuous electrically conducting layer 26 is extending such that the flexible conducting band 24 extends into at least two hollow volumes 40, 42 such that a thermal gradient can be smoothened. The flexible conducting band 24 is illustrated as ending in one of the hollow volumes 40, 42. It is to be noted that the flexible conducting band 24 may extend beyond the hollow volumes 40, 42, provided that the extension is at least such that several or at least two of the hollow volumes 40, 42 are connected with each other, allowing thermal energy transfer beyond the limits of one single hollow volume 40, 42 or from one of the hollow volumes 40, 42 towards another one of the hollow volumes 40, 42. The flexible conducting band 24 is thus provided and configured to allow improvement of a padding 10 having a plurality of the sub-sections. The sub-sections covering at least one of the hollow volumes 40, 42 of the padding 10. Indeed, the flexible conducting band 24 is flexible and elongated for transferring the thermal energy from the first sub-section 36 with the hollow volume 40 in the event of excess thermal energy towards the at least one second sub-section 38 with the hollow volume 42 in the padding 10 not containing excess thermal energy. Since the flexible conducting band 24 is having a continuous electrically conducting layer 26 with a defined area extending from within the at least one first sub-section 36 to another different second sub-section 38 a thermal gradient within the padding 10 can be smoothened and the comfort for the user using such a padding 10 can be drastically improved without substantially impairing other comfort characteristics of the padding 10. The flexible conducting band 24 is a passive thermal element not requiring any additional elements such as a power supply, a fluid driving device, or the like. It is to be noted that in practice the sub-sections 36, 38 will include a plurality of the hollow volumes 40, 42. It is furthermore to be noted that it is not excluded that one or more of the hollow volumes 40, 42 may extend in either sub-section 36, 38.

[0066] FIG. 6 shows the lower section 34 of the padding 10 according to a third aspect of the invention in a schematic illustration. Within the lower section 34 of the padding 10 is a sub-section with excess thermal energy 36, e.g., the section where the hip of the user sleeping is located. Therefore, this second sub-section 36 has several hollow volumes 40 also containing excess thermal energy. The edges of the padding 10 are not affected by the body of the user and the emittance of the thermal energy. Therefore, these edges are the sub-sections without the excess thermal energy 38 and will have one or more hollow volumes 42 without the excess thermal energy. Two of the flexible conducing bands 24 having a continuous electrically conducting layer 26 are positioned crossing each other at the sub-section with the excess thermal energy 36. Both of the flexible conducting bands 24 run from edge to edge connecting at least the one first sub-section 36 including a first hollow volume with the excess thermal energy 40 with the at least a second sub-section 38 including at least another hollow volume without the excess thermal energy 42. Using such a configuration enables increased thermal dissipation as the crossing flexible conducting bands 24 are used. The double layer in section 36 with the hollow volumes 40 with the excess thermal energy has two of the flexible conducting bands 24 to absorb the excess thermal energy and four different directions to transport this energy. The section 38 with the hollow volumes 42 with the lowest thermal energy load will generally receive the most thermal energy in such a configuration like this.

[0067] FIG. 7 shows the lower section 34 of a padding 10 according to a fourth aspect in a schematic illustration. The padding 10 has a section made from gel-infused foam 50 being part of the padding 10. The flexible conducting band 24 having the continuous electrically conducting layer 26 runs through the sub-section with the excess thermal energy 36 having the hollow volumes with the excess thermal energy 40 through the section made from gel-infused foam 50. This section 50 with the gel-infused foam 50 is the sub-section without the excess thermal energy 38 having the hollow volumes without excess thermal energy 42.

Reference numerals

[0068]

10	Padding
12	Surface
20	Absorber
21	Conducting strip
22	Conducting layer
23	Connecting band
24	Band
26	Continuous conducting layer
28	Lamination
32	Upper section
34	Lower section
36	Sub-section with excess thermal energy
38	Sub-section without excess thermal energy
40	First hollow volume (with excess thermal energy)
42	Second hollow volume (without excess thermal energy)
50	Section of mattress with Gel-infused foam

Claims

1. A foam padding (10) having edges, and at least one upper section (32) and at least one lower section (34), the foam padding (10) comprising:

at least one absorber (20) embedded in the upper section (32), the at least one absorber (20) for absorbing thermal energy from the upper section (32); and
at least one band (24) embedded in the lower section (34), the at least one band (24) configured for transferring thermal energy within the lower section (34) from a sub-section with excess thermal energy (36) to at least one sub-section without excess thermal energy (38),
wherein the at least one sub-section without excess thermal energy (38) is located at the edges of the foam padding (10).

2. The foam padding (10) according to claim 1, wherein
the upper section (32) is located between the lower section (34) and a surface (12) of the foam padding (10).

3. The foam padding (10) according to any one of claims 1 to 2, wherein
the upper section (32) has a substantially homogeneous temperature distribution, and/or the lower section (34) has an inhomogeneous temperature distribution.

4. The foam padding (10) according to any one of claims 1 to 3, wherein
the absorber (20) comprises at least one conducting layer (22).

5. The foam padding (10) according to any one of claims 1 to 4, wherein
the absorber (20) comprises a plurality of conducting strips (21) connected together by a conducting connecting band (23), wherein the connecting band (23) is more flexible than the plurality of conducting strips (21).

6. The foam padding (10) according to any one of claims 1 to 5, wherein
the band (24) comprises a continuous conducting layer (26) extending from within the at least one sub-section with excess thermal energy (36) to the at least one sub-section without excess thermal energy (38).

7. The foam padding (10) according to any one of claims 1 to 6, wherein
the absorber (20) has a higher thermal capacity than the band (24).

8. The foam padding (10) according to any one of claims 4 to 7, wherein
the conducting layer (22) has a thickness of 0.5mm to 2.00 mm and/or a width of 30mm to 70mm.

9. The foam padding (10) according to any one of claims 4 to 8, wherein the conducting layer (22) is made of graphite.

10. The foam padding (10) according to any one of claims 1 to 9, wherein the absorber (20) and/or the band (24) are laminated on one or both sides with polyethylene (PE), polyurethane (PU), or other stabilizing materials (28).

11. The foam padding (10) according to any one of claims 1 to 10, wherein the absorber (20) and/or the band (24) are punctured and/or perforated.

12. The foam padding (10) according to any one of claims 1 to 11, wherein the lower section (34) has a temperature distribution that is inhomogeneous in a direction parallel to the surface (12) of the padding (10).

13. The foam padding (10) according to any one of claims 1 to 11, wherein the lower section (34) has a temperature distribution that is inhomogeneous in a direction perpendicular to the surface (12) of the padding (10).

14. The foam padding (10) according to any one of claims 1 to 13, wherein the foam padding (10) is in the form of a mattress or a seat.

FIG. 1

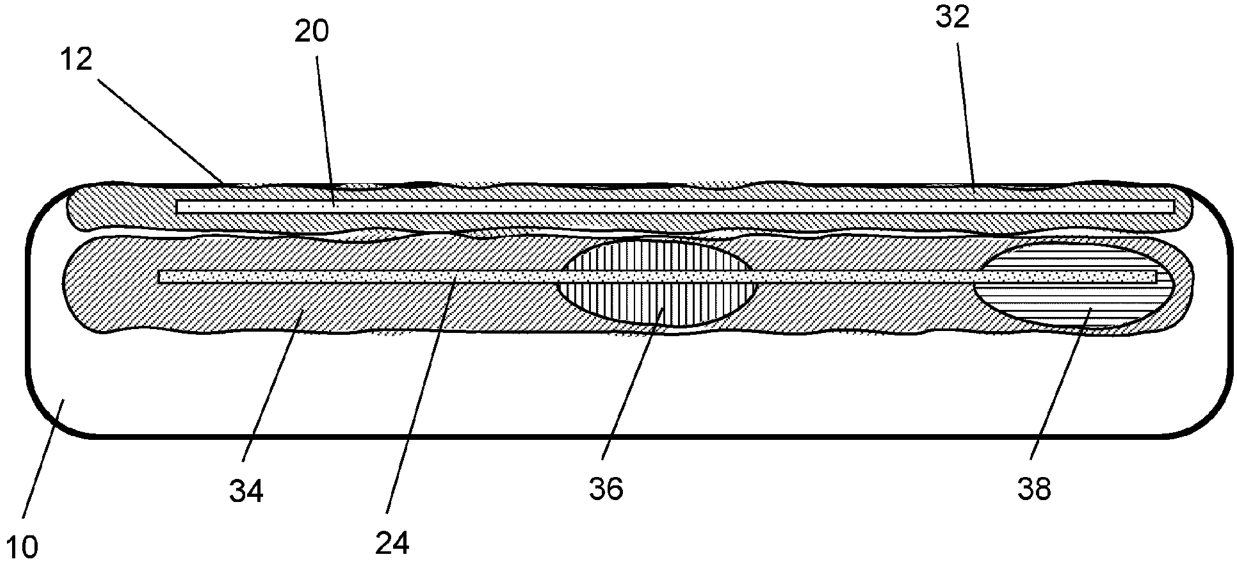


FIG. 2

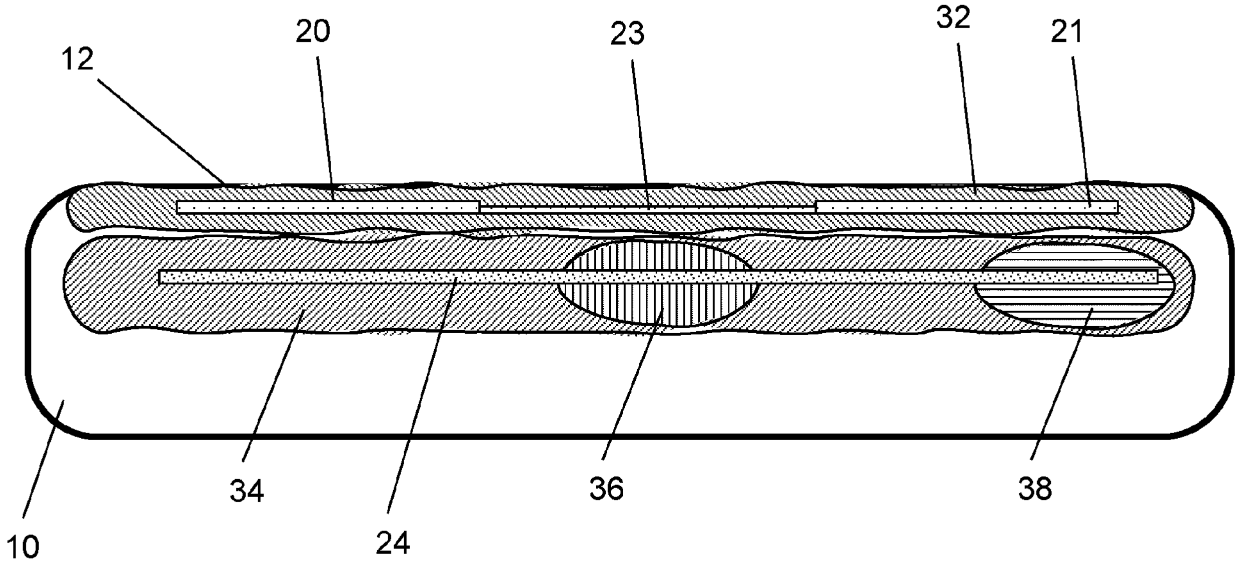


FIG. 3

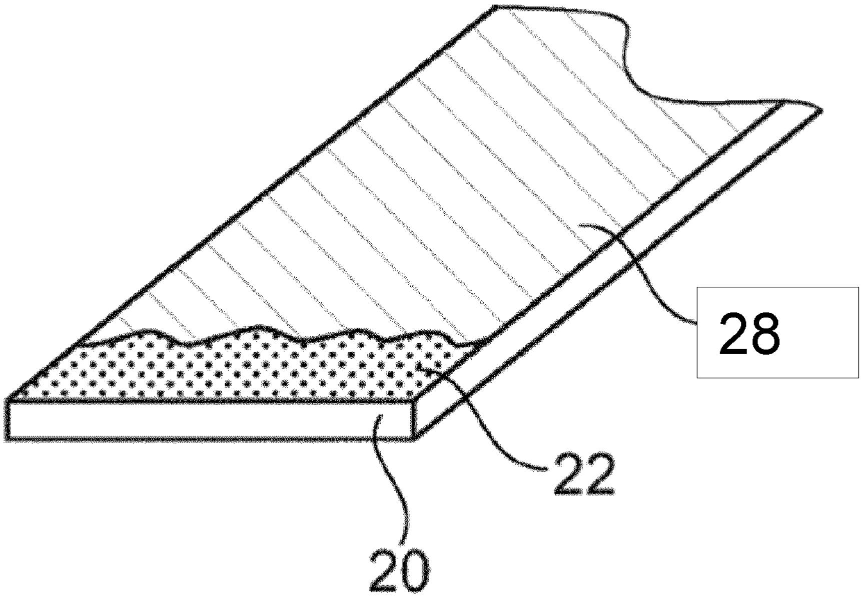


FIG. 4

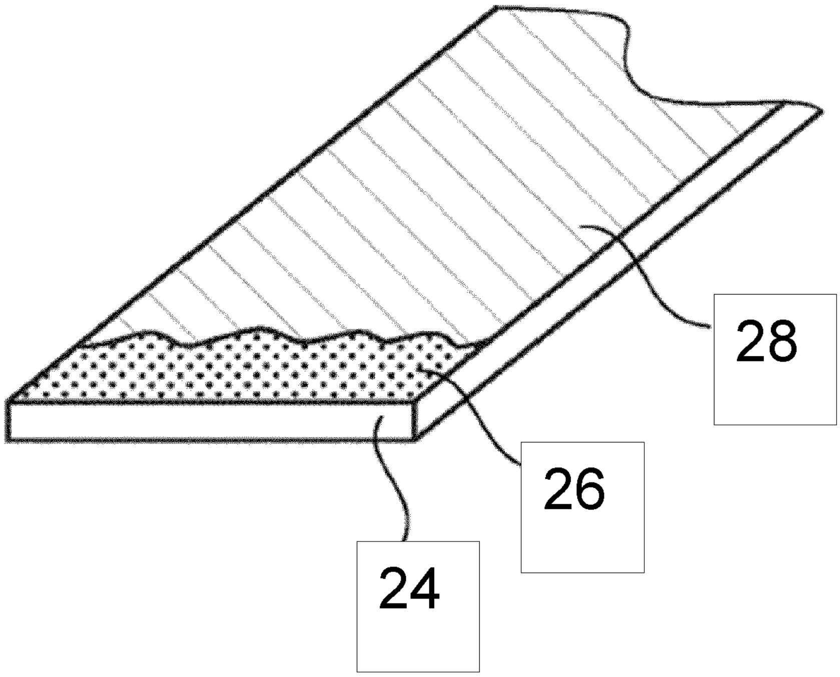


FIG. 5

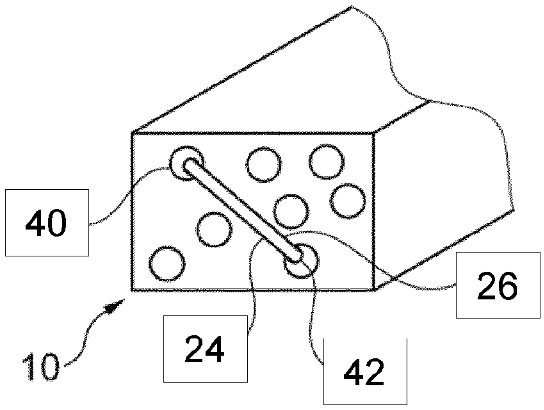


FIG. 6

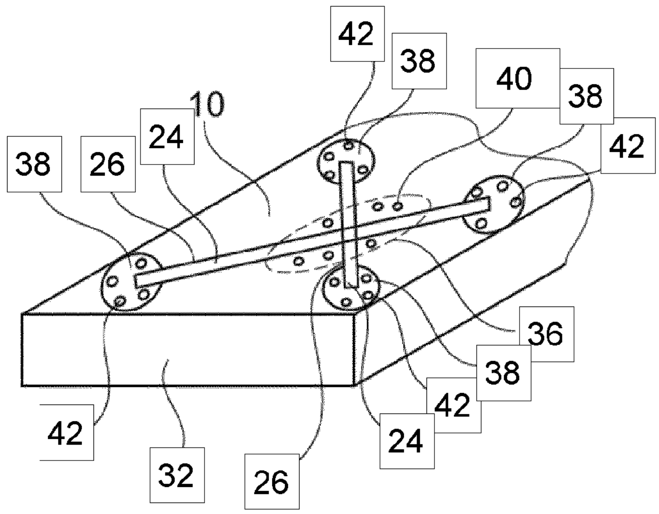


FIG. 7

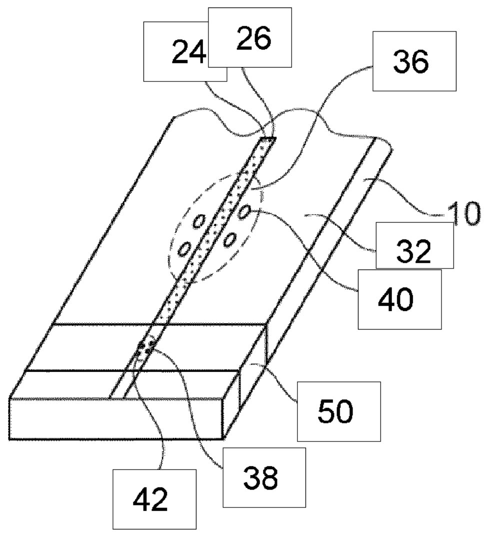


FIG. 8

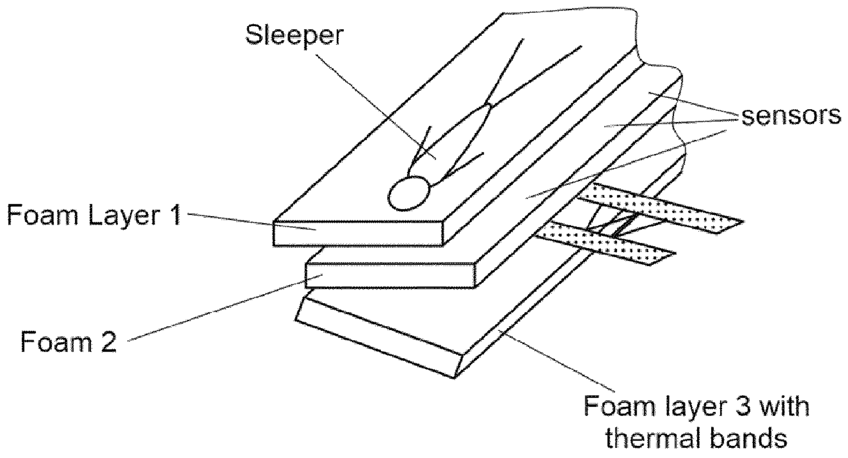


FIG. 9

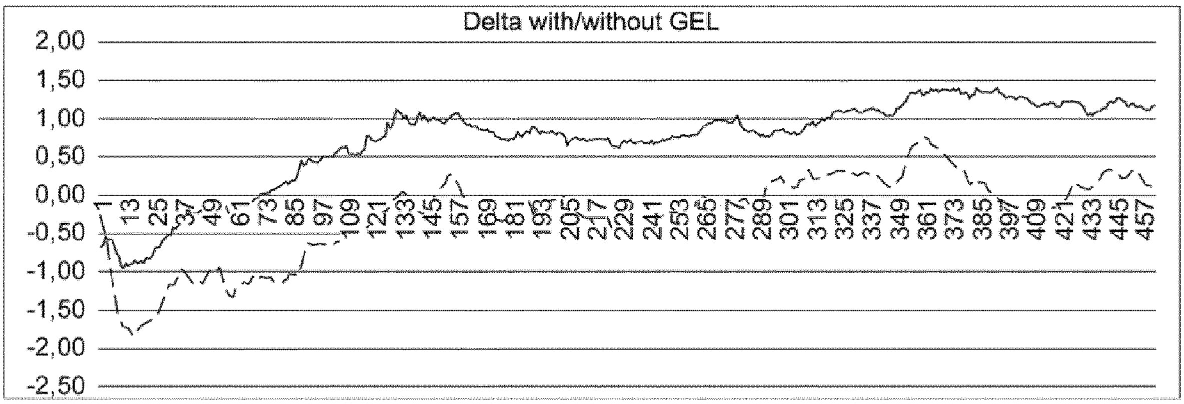
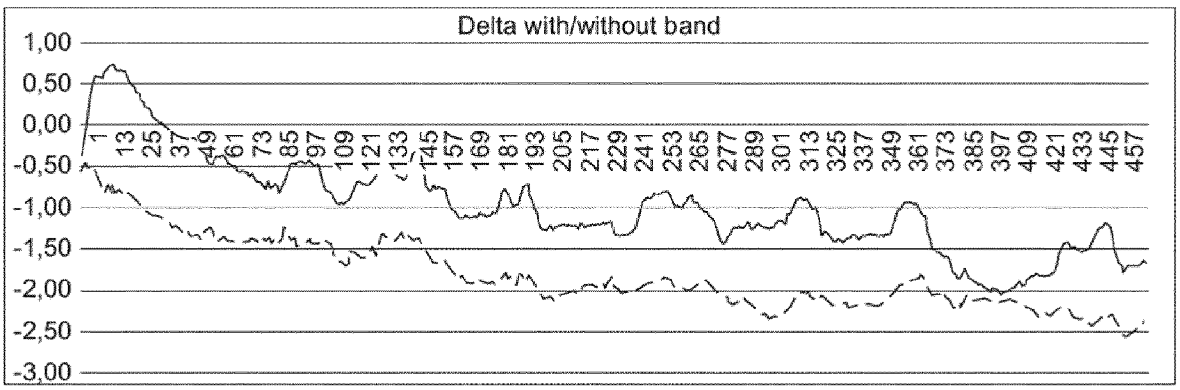


FIG. 10



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Application Number
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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	24 January 2023	Kis, Pál

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