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(54) **VISCOELASTIC FOAM PRODUCT WITH INSERTS**

(57) The current invention concerns a foam article such as a mattress or a cushion, comprising a viscoelastic foam layer, said viscoelastic foam layer has foam inserts embedded therein which elongate in the transverse direction of said article and which provide support to the body.

Fig. 1a

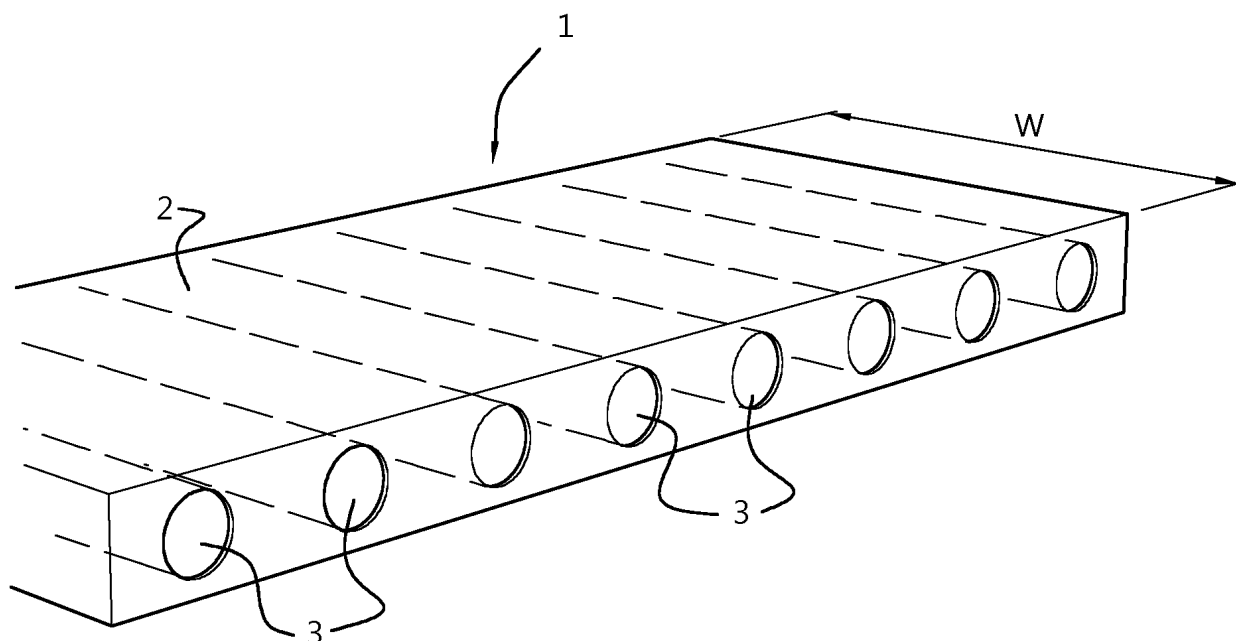
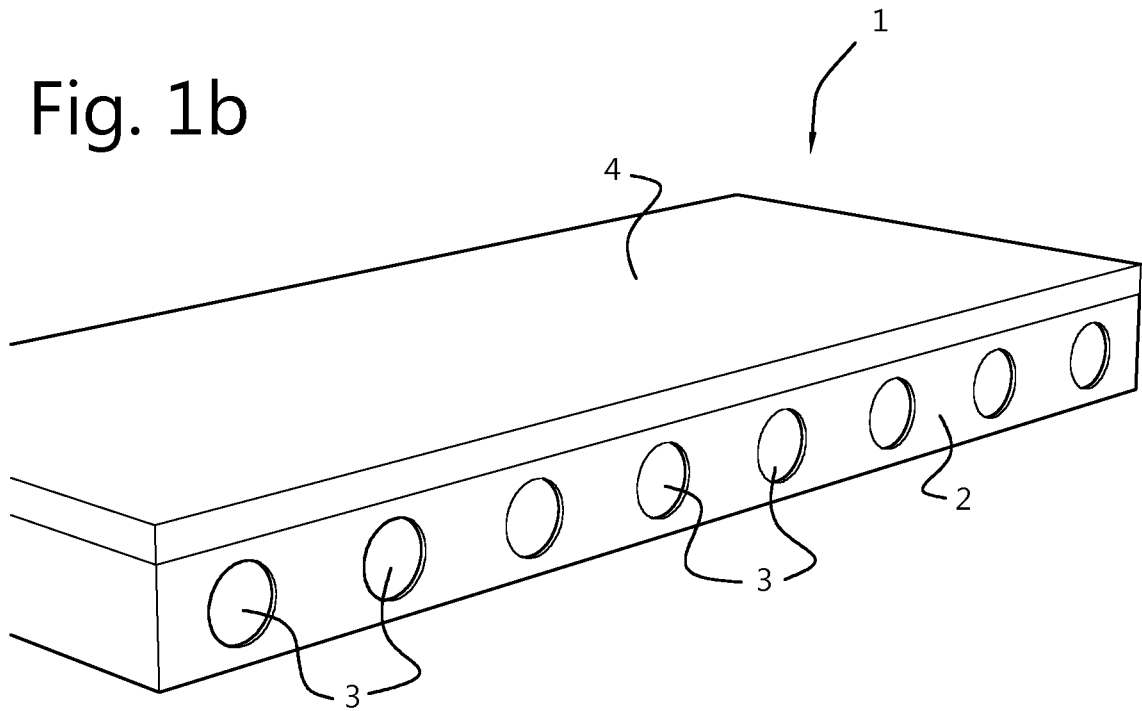


Fig. 1b



Description**TECHNICAL FIELD**

- 5 **[0001]** The invention pertains to the technical field of personalized sleeping products such as mattresses or cushions made of foam material.

BACKGROUND

- 10 **[0002]** An incorrect position during sleeping can be the cause of many problems, especially back problems. This is often due to the use of a sleeping system not adapted to the personal needs and features of the user. Moreover, when couples are sleeping together the used mattress is often not adapted to the personal shape of the users. Especially when more than one person is using the same mattress, this can give problems. Important feature for sleeping products such as mattresses and pillows are offered support and their pressure-lowering ability for certain areas.
- 15 **[0003]** Today, personalized systems are known which try to provide a product made on the requirements of the user. To that person, the user is measured and a product is proposed which offers the 'best fit', chosen from a range of standard products. In most cases, the optimal system is calculated on the length of the user, whereby the support areas are defined based on the measured length. This zoning will differ from user to user making it difficult to offer a mattress which is suited for more than one person.
- 20 **[0004]** Other systems in the prior art aim to offer a product which provides an optimal distribution of weight, rather than offering a pressure lowering solution. Mattresses and cushions made from viscoelastic or memory foam are known to offer an optimal weight distribution. These products have however drawbacks as they do not ventilate, and because the material literally encompasses the body, it will be very difficult to move or turn on such products. These are drawbacks that need to be avoided.
- 25 **[0005]** WO 2014 105 045 describes a viscoelastic foam mattress with inserts in the longitudinal direction of the mattress and which enhance the mobility of the user on the mattress. The mattress of WO 2014 105 045 does not provide a personalized tailor-made product which provides support on the required points.
- [0006]** US 2005 278 852 describes a top layer for a mattress which is comprised of a visco-elastic foam provided with support cores. Although the cores may be located in regions which accord with distinct positions of a user's body, US
- 30 **[0007]** US 2014 059 776 equally describes a foam-based mattress topper with different layers of various density. US 2014 059 776 fails however to describe a personalized mattress with inserts positioned according to distinct regions of a user's body.
- [0008]** The present invention aims to resolve at least some of the problems mentioned above. The invention aims to
- 35 provide personalized, tailor-made sleeping products such as mattresses or cushions which are pressure-lowering, yet providing enough support for the body or body parts and which have optimal ventilating capacities.

SUMMARY OF THE INVENTION

- 40 **[0009]** The present invention provides a foam article such as a mattress according to claim 1, a bed according to claim 13 and a method according to claim 15. The article according to the current invention provides an optimal and personalized sleeping.
- [0010]** The present invention may thereto be described by the following embodiments:
- 45 1. A foam article such as a mattress or a cushion, comprising a viscoelastic foam layer, said viscoelastic foam layer has foam inserts embedded in cavities of the viscoelastic foam and which elongate in the transverse direction of said article, characterized in that said inserts have a density of between 20 and 80 kg/m³.
2. Foam article according to embodiment 1, characterized in that the hardness of said inserts is between 1.5 and 6 kPa.
3. Foam article according to any one of the previous embodiments, characterized in that said inserts are of high-
- 50 resilience polyurethane foam.
4. Foam article according to any one of the previous embodiments, characterized in that said inserts have a circular, hexagonal, square or rectangular cross-sectional shape.
5. Foam article according to any one of the previous embodiments, characterized in that the article is provided with a top layer, placed above said viscoelastic foam layer.
- 55 6. Foam article according to embodiment 6, characterized in that said top layer is a polyurethane foam with imbedded gel particles.
7. Foam article according to any one of the previous embodiments, characterized in that said inserts are spaced and whereby each position of said inserts corresponds to a position on a user's body which requires support.

8. Foam article according to any one of the previous embodiments, characterized in that said inserts have the same or different densities.

9. Foam article according to any one of the previous embodiments, characterized in that said inserts extend over the entire width of said article.

10. Foam article according to any of the previous embodiments, characterized in that said inserts have a tensile strength of between 50 and 150 kPa.

11. Foam article according to any of the previous embodiments, characterized in that said resilience is between 40 and 75 %.

12. Foam article according to any one of the previous embodiments, characterized in that said inserts are positioned in the foam article based on anthropometric parameters obtained from a user.

13. Bed provided with a foam article according to embodiments 1 to 12.

14. Bed according to embodiment 13, characterized in that said article is a mattress.

15. A method for producing a foam article with non-viscoelastic inserts, comprising:

- obtaining one or more anthropometric parameters of a person intended to use said foam article;
- determining the characteristics and position of inserts in said article based on said parameters; and
- inserting said inserts in cavities of said viscoelastic layer.

16. A method for providing a personalized bedding system to an individual, said method comprising:

- determining a depth image of the body of said individual by a depth camera or depth sensor system;
- determining, based on said depth image, anthropometric parameters, age and/or sex of said individual;
- determining, based on said anthropometric parameters, the position and/or hardness of body support elements in a bedding system for said individual.

17. Method according to embodiment 1, characterized in that said depth image comprises a three-dimensional skeletal or a mesh model.

18. Method according to any of the previous embodiments, characterized in that said anthropometric parameters comprise body mass, weight, position of shoulder, loin-hip, thigh, knee, lower leg and/or feet.

19. Method according to any one of the previous embodiment, characterized in that said individual is positioned on a marked spot on a floor.

20. Method according to any one of the previous embodiments characterized in that the analysis of the obtained parameters and said determination of the body support elements in the bedding system is computer implemented.

21. Method according to any one of the previous embodiments, characterized in that said bedding system is provided with support elements which correspond to locations of the individual's body which were shown from the depth image to need support that support is needed.

22. Method according to any one of the previous embodiments, characterized in that said support elements are provided by means of transverse inserts in the bedding system, preferably tubular inserts.

23. Method according to embodiment 22, characterized in that said bedding system comprises of a viscoelastic foam layer with high resilient polyurethane foam inserts as support elements.

24. System for providing a personalized bedding system to an individual, said system comprises:

- one or more depth camera or depth sensor systems for generating a depth image of said individual, said depth camera systems are connected to
- an image system; and
- a processing device, characterized in that said processing device is provided with an algorithm to determine anthropometric parameters of said depth image and to link said parameters to a position and/or hardness of body support elements in a bedding system.

25. System according to embodiment 24, characterized in that said system further comprises a positioning mark for said individual.

DESCRIPTION OF FIGURES

[0011]

Figure 1A and B show a cross-sectional view of a foam article according to an embodiment of the current invention.

Figure 2A-C shows various embodiments of the inserts in a foam article according to an embodiment of the current invention.

Figure 3A-C shows a cross-sectional view along a longitudinal axis of various embodiments of the current invention.

Figure 4 shows a detailed view of an embodiment of a mattress according to the current invention.

Figure 5 shows a bed according to an embodiment of the current invention.

Figure 6 shows a cushion according to an embodiment of the current invention.

DETAILED DESCRIPTION OF THE INVENTION

[0012] The present invention concerns a foam article such as a mattress or a cushion which comprises a viscoelastic foam layer which has pressure-lowering capacities. In order to offer support on essential points of the body of the user, the viscoelastic foam layer comprises inserts which provide support. These inserts are placed in cavities of the foam layer on positions which coincide with certain points on the body of the user. In order to achieve the latter, the body of the user will be scanned and the exact position of the inserts in the article and the characteristics will be defined based on the obtained parameters. As such, a personalised article is provided which offers optimal support to a user.

[0013] Apart from optimal support to the body, the foam article according to the current invention equally provides for a good aeration and comfort in use.

[0014] Unless otherwise defined, all terms used in disclosing the invention, including technical and scientific terms, have the meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. By means of further guidance, term definitions are included to better appreciate the teaching of the present invention.

[0015] As used herein, the following terms have the following meanings:

"A", "an", and "the" as used herein refers to both singular and plural referents unless the context clearly dictates otherwise. By way of example, "a compartment" refers to one or more than one compartment.

[0016] "About" as used herein referring to a measurable value such as a parameter, an amount, a temporal duration, and the like, is meant to encompass variations of $\pm 20\%$ or less, preferably $\pm 10\%$ or less, more preferably $\pm 5\%$ or less, even more preferably $\pm 1\%$ or less, and still more preferably $\pm 0.1\%$ or less of and from the specified value, in so far such variations are appropriate to perform in the disclosed invention. However, it is to be understood that the value to which the modifier "about" refers is itself also specifically disclosed.

[0017] "Comprise," "comprising," and "comprises" and "comprised of" as used herein are synonymous with "include", "including", "includes" or "contain", "containing", "contains" and are inclusive or open-ended terms that specifies the presence of what follows e.g. component and do not exclude or preclude the presence of additional, non-recited components, features, element, members, steps, known in the art or disclosed therein.

[0018] The recitation of numerical ranges by endpoints includes all numbers and fractions subsumed within that range, as well as the recited endpoints.

[0019] The expression "% by weight" (weight percent), here and throughout the description unless otherwise defined, refers to the relative weight of the respective component based on the overall weight of the formulation.

[0020] In a first aspect, the current invention provides a foam article such as a mattress or a cushion, comprising a viscoelastic foam layer, whereby the viscoelastic foam layer has foam inserts embedded in cavities of the viscoelastic foam. These inserts elongate in the transverse direction of the article. For the purpose of the current invention, said transverse is to be understood as parallel to the width of the article. More specifically, transverse also has to be understood as a direction perpendicular to the longitudinal axis of a user's body.

[0021] Viscoelastic foam is known to have a pressure-lowering capacity. Mattresses and cushions of viscoelastic foam create a 'floating' experience whereby the body enters a virtual state of weightlessness when sleeping. For a long time it was found that this floating sleeping was the most optimal way to solve or prevent ergonomic problems.

[0022] The inventors of the current invention have found that the latter is not entirely correct and that there is need to break the weightlessness characteristics on certain points of the article in order to provide the necessary support to the user.

[0023] To that purpose the inventors found that the foam inserts should advantageously have a density of between 20 and 80 kg/m³, more preferably between 25 and 65 kg/m³. Said density is measured according to ISO standard 845 (reviewed in 2013). By providing inserts on several intervals in the article according to the current invention, in the transverse direction of the article, supporting points are provided for the user's body. These points enhance the ergonomic nature of the article and ensure an optimal sleeping experience. It was found that outside this range, the inserts either

provided not enough support, or that the comfort for the users declined.

[0024] In a further or separate embodiment, said inserts will have a hardness of between 1.5 and 6 kPa, more preferably between 1.8 and 5 kPa, measured according to ISO standard 1798 (reviewed in 2011). Again it was found that this range of compression stress provides the support needed for the purpose of the current invention.

[0025] In a more preferred embodiment, 5 classes of inserts can be used in the current invention, whereby the inserts are classified according to hardness. In a preferred embodiment, class I (extra soft) will have a hardness of between 1.5 and 2.5 kPa, class II (soft) will have a hardness of between 2.5 and 3.5 kPa, class III (medium) will have a hardness of between 3.5 and 3.9 kPa, class IV (firm) will have a hardness of between 4 and 4.5 and class V (fimr) will have a hardness above 4.5 to 5.5.

[0026] In yet a further or separate embodiment, the article will have tensile strength higher than 50 kPa, preferably of between 50 and 150 kPa, measured according to ISO standard 1798 (reviewed in 2011). In yet a further or other embodiment, said maximal deformation is higher than 50, preferably between 60 and 160, measured according to the same ISO standard 1798.

[0027] The resilience by ball rebound of the inserts is preferably higher than 40, more preferably between 50 and 80 % measured according to ISO standard 8307 (reviewed in 2010).

[0028] The compression of the inserts is preferably lower than 10 (measured according to ISO standard 1856. The wet compression, measured according to NFT 56 112 is by preference lower than 50.

[0029] In principle, said inserts can be produced of any suitable foam with the characteristics as described above. By preference, said foam inserts are produced of a high-resilient (HR) foam or a cold-cure foam. For the purpose of the current invention, the term HR foam is to be understood as a variety of polyurethane foam produced using a blend of polymer or graft polyols. High resilience foam has a less uniform (more random) cell structure different from conventional products. The different cell structure helps add support, comfort, and resilience or bounce. High resilience foams have a high support factor and greater surface resilience than conventional foams and are defined in ASTM D3770, now withdrawn. It was found by the inventors that the combination of viscoelastic foam with HR inserts provide the perfect combination of pressure-lowering characteristics and support.

[0030] In an embodiment, said HR foam may be non-reticulated. In another embodiment, said HR foam may be reticulated.

[0031] Many HR foams are known in the art. Suitable foams which can be used in an embodiment according to the current invention are for instance, but not limiting: HR28, HR38, HR43, HR45, HR55M, HR60.

[0032] In a preferred embodiment, the inserts will have a maximal diameter of between 3 and 6 cm, for instance around 4 cm. Diameters outside this range will either not be effective or compromise the comfort of the user. Preferably, said inserts will have a circular, hexagonal, square or rectangular cross-sectional shape. In a most preferred embodiment, said inserts are tubular. The inserts are completely embedded in the viscoelastic layer.

[0033] The inserts may be provided in a discontinuous pattern along a transverse line of the article. For instance, said insert may be a disposition of globes on regular points of such a transverse line. In another embodiment, said insert may be a disposition of cylinders, preferably same dimensions, on discrete distances along said transverse line. In yet another, most preferred embodiment, said inserts extend over the entire width of said article.

[0034] In case of a mattress, inserts may be provided in cavities, which go from one side of the mattress to the other side and whereby the inserts span the entire width of the mattress. Alternatively, for instance for a double mattress, inserts may be provided which span only half of the width of the mattress. In such case, a two person mattress may be provided which is personalized for two users, whereby on one half the inserts are positioned according to the obtained parameters of one user and the other half is adapted for a second user.

[0035] In an embodiment, said all inserts in the article will be of the same type, that is: same density, hardness, elasticity, etc. In another embodiment, each position may be provided with different inserts, whereby the term different is to be understood as different in dimension, cross-sectional shape and/or characteristics (e.g. different densities or hardness). These differences may be calculated based on the parameters obtained by a body scan or body measurement of the user. In a most preferred embodiment, said each insert will have a hardness which is defined on the basis of anthropometric parameters obtained from a user. Such parameters may be obtained via scanning of the user.

[0036] In yet another embodiment, said individual inserts may themselves be comprised of different layers of material which meet the requirements as described above. This can be necessary if for instance the body scan of the user reveals that the body of the user is in need of a very specific support on a certain location.

[0037] In general, the current invention provides a product which comprises inserts as described above, said inserts are located on positions in the product which are relative and according to specific positions and/or body parts of a user. To that purpose, the user will be measured thereby obtaining one or more anthropometric parameters, and the position and/or hardness of the inserts will be based on the parameters taken.

[0038] The viscoelastic foam layer will form the majority of the article. By preference, said foam viscoelastic has a hardness of at least about 20 N and no greater than about 80 N for desirable softness and body-conforming qualities. In other embodiments, the viscoelastic foam layer may have a hardness of at least about 30 N and no greater than about

70 N. In still other embodiments, the viscoelastic foam layer may have a hardness of at least about 40 N and no greater than about 60 N. Unless otherwise specified, the hardness of any foam material referred to herein is measured by exerting pressure from a plate against a sample of the material to a compression of 40% of an original thickness of the material at approximately room temperature (e.g., 21 -23 Degrees Celsius), wherein the 40% compression is held for a set period of time, following the ISO standard 2439.

[0039] The viscoelastic foam layer also includes a density providing a relatively high degree of material durability. The density of the viscoelastic foam layer can also impact other characteristics of the foam, such as the manner in which the viscoelastic foam layer responds to pressure, and the feel of the foam. In some embodiments, the viscoelastic foam layer 122 has a density of no less than about 30 kg/m³ and no greater than about 150 kg/m³. In other embodiments, the viscoelastic foam layer may have a density of at least about 40 kg/m³ and no greater than about 135 kg/m³. In still other embodiments, the viscoelastic foam layer may have a density of at least about 50 kg/m³ and no greater than about 120 kg/m³.

[0040] In an embodiment said viscoelastic foam may be a non-reticulated (that is, with intact cells) or a reticulated viscoelastic foam (skeletal cellular structure with open cells).

[0041] In an embodiment, the viscoelastic layer may be provided with a top layer which is positioned over the top surface of the viscoelastic layer and is supported by the latter. The top layer will be a non-viscoelastic layer. In an embodiment, the non-viscoelastic top layer can rest upon the viscoelastic layer without being attached thereto. In another embodiment, the layers may be secured to one another by adhesive or cohesive bonding material, and/or by being bonded together during formation of the layers. Tape, a hook and loop fastener material, conventional fasteners, stitches extending at least partially through the layers, or any of a number of different structures or processes may be utilized to secure the layers to each other. For example, thin adhesive strips (not shown) may be positioned between the layers. Such adhesives may extend across the entire width and length of the article, or in some embodiments may instead extend only across discrete portions of the width and/or length of the article. Such adhesive strips are flexible enough to form a softer structure than other, more conventional adhesive glues.

[0042] Both the top surface and the bottom surface of the foam layers may be substantially planar. In other embodiments, at least one of the top surface and the bottom surface may be non-planar, including without limitation surfaces having ribs, bumps, waves, and other protrusions of any shape and size, surfaces having grooves, and other apertures that extend partially or fully through the foam layers and the like.

[0043] In an embodiment, the top layer is preferably a soft polyurethane foam or a viscoelastic foam. The top layer will preferably enhance the breathability of the article. Viscoelastic foam material does not aerate or ventilate well. By adding a non-viscoelastic top layer, the breathability of the article may be further enhanced. If the article is a mattress, this will prevent the user from sweating during his or her sleep.

[0044] In a most preferred embodiment, said top layer is a water-based (polyurethane) foam containing polyols, preferably polyols of vegetative origin. More preferably, said foam is interspersed by micro gel particles which will increase the mechanical and physical features as well as the transpiration ability of the foam, making the material particularly suited for use as a top layer in the current invention. By preference, said gel particles have a size of 1 to 5 mm and comprise 5 to 20% of the total volume of the foam matrix.

[0045] The top layer will preferably have a density of between 40 and 70 kg/m³, more preferably between 50 and 60 kg/m³ such as for example 55 kg/m³ when measured by ISO standard 845.

[0046] The hardness of the top layer lies preferably between 0.5 and 1.5 kPa, more preferably between 0.6 and 1.3 kPa, such as 0.8 kPa, when measured according to ISO standard 3386.

[0047] The tensile strength of the top layer will preferably lay between 35 and 55 kPa, more preferably between 40 and 50 kPa, such as 45 kPa, when measured according to ISO standard 1798.

[0048] The resilience by ball rebound of the top layer is preferably higher than 40, more preferably between 50 and 80 % measured according to ISO standard 8307 (reviewed in 2010).

[0049] The compression of the top layer is preferably lower than 5% (measured according to ISO standard 1856).

[0050] Each of these parameters contribute to a good ventilating and comfortable top layer.

[0051] In an embodiment, the top layer has a thickness which is smaller or the same as the viscoelastic layer comprising the inserts.

[0052] In a further embodiment, a bottom layer may be provided, on which the article of the current invention resides. Such bottom layer may be provided with spring elements. The bottom layer may equally be provided with portions in foam, such as high resilient polyurethane foam.

[0053] As mentioned, the inserts are spaced, whereby each position of the inserts corresponds to a position on a user's body which requires support. To that purpose, the user is measured and body parameters are obtained. These parameters may include length, with, weight, sex, age, bone density, fat percentage, length of individual body parts, disease history, etc.

[0054] The collection of the body parameters can occur via regular ways such as questionnaires, or by more advanced technologies such as photographs and/or (3D) scanning or a combination of both.

[0055] Based on the gathered information, the required characteristics of the foam inserts are determined (density, diameter, hardness, etc.) and/or their position in the article. Subsequently a personalized article is manufactured, whereby the inserts are provided in cavities in the article.

[0056] If the article is a mattress, the inserts will be provided on regular, spaced positions in the mattress. By preference, the position of the inserts will coincide with at least one or a combination of the following points or locations of the body of a user: shoulders, chest, lower back, thighs, loin, hip, lower leg, feet, knee and/or ankle. In an embodiment, said mattress will have more than 5 inserts, such as 6, 7, 8, 9, 10, 11, 12, 13, 14 or more.

[0057] As such, the current invention equally relates to a method for producing a personalized foam article comprising a viscoelastic layer with non-viscoelastic foam inserts, comprising:

- obtaining one or more anthropometric parameters of a person intended to use said foam article;
- determining the characteristics and/or position of said inserts based on said parameters;
- inserting said inserts in cavities of said viscoelastic layer.

[0058] The current invention therefor offers a method for providing a personalized bedding system to an individual.

[0059] By preference, said anthropometric parameters are obtained via body scanning, e.g. by use of a 3D camera.

[0060] In a preferred embodiment, these anthropometric parameters will subsequently be translated by a processor towards a mass of the user. The processor will then determine the required specifics of inserts in the bedding or foam article. More specifically, the processor will calculate the preferred hardness and/or position of the inserts. The hardness of the inserts may thereby differ depending on the position in the mattress.

[0061] In a preferred embodiment of the methodology according to the current invention, a depth image of the body of said individual will be determined by a depth camera or depth sensor system comprising one or more depth cameras or depth sensors (depth information). Secondly, and based on the obtained depth image, anthropometric parameters, and optionally age and sex of the individual will be determined. In a final step, these anthropometric parameters will form the basis for determining the position and/or hardness of body support elements such as the inserts as described above in a bedding system for said individual.

[0062] In the context of the current invention, said anthropometric parameters are to be understood as those parameters which relate to the dimensions and metrics of an individual body, such as, but not limiting to height, weight, size of various body parts or organs, joints, volume, form or ratios thereof, etc.

[0063] In an embodiment, the produced parameters are correlated with a table of product design parameters to arrive at the optimum bedding product for the user according to the individual's particular body type.

[0064] In a most preferred embodiment, of the current invention, the parameters allow defining the required hardness of the inserts positioned in a position of a bedding product which coincides with specific body locations of the user.

[0065] In a preferred embodiment, 5 classes of inserts can be used in the current invention, whereby the inserts are classified according to hardness. In a preferred embodiment, class I (extra soft) will have a hardness of between 1.5 and 2.5 kPa, class II (soft) will have a hardness of between 2.5 and 3.5 kPa, class III (medium) will have a hardness of between 3.5 and 3.9 kPa, class IV (firm) will have a hardness of between 4 and 4.5 and class V (firmer) will have a hardness above 4.5 to 5.5.

[0066] For the purpose of the current invention, said depth camera system is a system comprising a depth camera or a depth sensor, suited to make a three-dimensional scan of an object, in the current case of a body.

[0067] In a further embodiment of the current invention, said depth image comprises a three-dimensional skeletal or mesh model. In a skeletal model, each body part may be characterized as a mathematical vector defining joints and bones of the skeletal model. A mesh model or polygonal model is comprised of faces, edges, and vertices.

[0068] From both models, various anthropometric parameters can be defined, which together provide an accurate model of the individual.

[0069] In a preferred embodiment, and advantageous to the current invention, said parameters comprise information on body mass, weight, position of shoulder, loin-hip, thigh, knee, lower leg and/or feet. These locations on the body are found to need additional support in order to provide an ergonomic way of sleeping.

[0070] As mentioned, the depth camera system will provide depth information which will be a depth image. The depth image may be a plurality of observed pixels where each observed pixel has an observed depth value. For example, the depth image may include a two-dimensional (2-D) pixel area of the captured scene where each pixel in the 2-D pixel area may represent a depth value such as a length or distance in, for example, centimeters, millimeters, or the like of an object in the captured scene from the capture device.

[0071] According to an example embodiment, the depth image may be an image or frame of a scene captured by, for example, the 3-D camera and/or the RGB camera of the depth camera system.

[0072] In one embodiment, upon receiving the depth image with, for example, the depth information, the depth image may be down sampled to a lower processing resolution such that the depth image may be more easily used and/or more quickly processed with less computing overhead. Additionally, one or more high-variance and/or noisy depth values

may be removed and/or smoothed from the depth image; portions of missing and/or removed depth information may be filled in and/or reconstructed; and/or any other suitable processing may be performed on the received depth information may such that the depth information may be used to generate a model such as a skeletal model, which will be described in more detail below.

5 **[0073]** According to one embodiment, upon receiving the depth image, each target in the depth image may be flood filled. For example, in one embodiment, the edges of each target such as the individual and the non-individuals in the captured scene of the depth image may be determined. As described above, the depth image may include a two-dimensional (2-D) pixel area of the captured scene where each pixel in the 2-D pixel area may represent a depth value such as a length or distance in, for example, centimeters, millimeters, or the like of an object in the captured scene from the camera. According to an example embodiment, the edges may be determined by comparing various depth values associated with, for example, adjacent or nearby pixels of the depth image. If the various depth values being compared may be greater than a predetermined edge tolerance, the pixels may define an edge. In one embodiment, the predetermined edge tolerance may be, for example, a 100 millimeters. If a pixel representing a depth value of 1000 millimeters may be compared with an adjacent pixel representing a depth value of 1200 millimeters, the pixels may define an edge of a target, because the difference in the length or distance between the pixels is greater than the predetermined edge tolerance of 100 mm.

10 **[0074]** Additionally, as described above, the capture device may organize the calculated depth information including the depth image into "Z layers," or layers that may be perpendicular to a Z axis extending from the camera along its line of sight to the viewer. The likely Z values of the Z layers may be flood filled based on the determined edges. For example, the pixels associated with the determined edges and the pixels of the area within the determined edges may be associated with each other to define a target or an object in the scene that may be compared with a pattern, which will be described in more detail below

15 **[0075]** In an example embodiment, the predetermined points or areas may be evenly distributed across the depth image. For example, the predetermined points or areas may include a point or an area in the centre of the depth image, two points or areas in between the left edge and the centre of the depth image, two points or areas between the right edge and the centre of the depth image, or the like.

20 **[0076]** According to an example embodiment, each of the flood filled targets such as the individual and the non-individuals may be matched against a pattern to determine whether and/or which of the targets in the scene include a human. The pattern may include, for example, a machine representation of a predetermined body model associated with a human in various positions or poses such as a typical standing pose with arms to each side.

25 **[0077]** According to an example embodiment, the pattern may include one or more data structures that may have a set of variables that collectively define a typical body of a human such that the information associated with the pixels of, for example, the individual and the non-individuals may be compared with the variables to determine whether and which of the targets may be a human. In one embodiment, each of the variables in the set may be weighted based on a body part. For example, various body parts such as a head and/or shoulders in the pattern may have weight value associated therewith that may be greater than other body parts such as a leg. According to one embodiment, the weight values may be used when comparing a target such as the individual and the non-individuals with the variables to determine whether and which of the targets may be human. For example, matches between the variables and the target that have larger weight values may yield a greater likelihood of the target being human than matches with smaller weight values.

30 **[0078]** Additionally, in an example embodiment, a confidence value may be calculated that indicates, for example, the accuracy to which each of the flood filled targets in the depth image corresponds to the pattern. The confidence value may include a probability that each of the flood filled targets may be a human. According to one embodiment, the confidence value may be used to further determine whether the flood filled target may be a human. For example, the confidence value may compare to a threshold value such that if the confidence value exceeds the threshold, the flood filled target associated therewith may be determined to be an individual.

35 **[0079]** In an example embodiment, the individual may be isolated and a bitmask of the individual may be created to scan for one or more body parts. The bitmask may be created by, for example, flood filling the individual such that the individual may be separated from other targets or objects in the scene elements. The bitmask may then be analysed for one or more body parts to generate a model such as a skeletal model, a mesh human model, or the like of the individual.

40 **[0080]** After a valid individual is found within the depth image, the background or the area of the depth image not matching the individual may be removed. A bitmask may then be generated for the individual that may include values of the individual along, for example, an X, Y, and Z axis. According to an example embodiment, the bitmask of the individual may be scanned for various body parts, starting with, for example, the head to generate a skeletal model of the individual.

45 **[0081]** The information such as the bits, pixels, or the like associated with the matched individual may be scanned to determine various locations that are associated with various parts of the body of the individual. For example, after removing the background or area surrounding the individual in the depth image, the depth image may include the individual isolated. The bitmask that may include X, Y, and Z values may then be generated for the isolated individual.

The bitmask of the individual may be scanned to determine various body parts. For example, a top of the bitmask of the individual may initially be determined. The top of the bitmask of the individual may be associated with a location of the top of the head. After determining the top of the head, the bitmask may be scanned downward to then determine a location of a neck of the individual, a location of the shoulders of the individual, or the like.

[0082] The bitmask may then be analysed for one or more body parts to generate a model such as a skeletal model, a mesh human model, or the like of the individual.

[0083] For example, according to one embodiment, measurement values determined by the scanned bitmask may be used to define one or more joints in a skeletal model. The one or more joints may be used to define one or more bones that may correspond to a body part of the individual.

[0084] For example, the top of the bitmask of the individual may be associated with a location of the top of the head. After determining the top of the head, the bitmask may be scanned downward to then determine a location of a neck, a location of the shoulders and so forth. A width of the bitmask, for example, at a position being scanned, may be compared to a threshold value of a typical width associated with, for example, a neck, shoulders, or the like. In an alternative embodiment, the distance from a previous position scanned and associated with a body part in a bitmask may be used to determine the location of the neck, shoulders or the like. Some body parts such as legs, feet, or the like may be calculated based on, for example, the location of other body parts. Upon determining the values of a body part, a data structure is created that includes measurement values of the body part. The data structure may include scan results averaged from multiple depth images which are provide at different points in time by the depth camera system.

[0085] In one embodiment, measurement values determined by the scanned bitmask may be used to define one or more joints in a skeletal model. The one or more joints are used to define one or more bones that correspond to a body part of an individual. One or more joints may be adjusted until the joints are within a range of typical distances between a joint and a body part of an individual to generate a more accurate skeletal model. The model may further be adjusted based on, for example, a height associated with the individual.

[0086] In yet another embodiment, points may be identified on the model of the body. The points can be joints of a skeletal model and/or other points, such as the top of the head, center of the head, tip of the hand, and tip of the foot. Subsequently the distances between the points are determined. For example, the distances can identify a shoulder width, head width, head height, arm length and body height. The method may also include the determination of ratios of the distances, such as a ratio which indicates a relative size of a head of the body, a ratio of arm length to body height, a ratio of body height to head height, and/or a ratio of head width to shoulder width.

[0087] In order to obtain an optimized model of the individual, a marked spot may be provided on the floor, e.g. of a bedding store. In an embodiment, said marked spot may be a simple indication on the floor such as a point, circle, square, etc. in another embodiment, said marked spot may be a platform. This allows perfect positioning of the individual.

[0088] In addition to obtaining data from the body scan, the individual may also be asked to provide personal information, which can be imputed in the system and which might equally serve as source for determining the personalized mattress.

[0089] In an embodiment, the analysis of the obtained parameters and the determination of the body support elements or inserts in the bedding system is computer implemented. To that purpose, an algorithm is provided to determine anthropometric parameters of said depth image and to link said parameters to a position and/or hardness of body support elements in a bedding system

[0090] In a preferred embodiment, the camera system will determine joint points as described above. By identifying the latter, the distance between two joints will be calculated. Preferably, this will result in the length of the back, neck, upper leg, lower leg, shoulder width and hip width.

[0091] The system will further determine the contours of the body and translate the latter to body volume and weight. The dimensions and location of weight dispositions on the body will be identified.

[0092] These parameters, including the total length of the person, are translated by the algorithm to different ergonomic zonings of the mattress with corresponding hardness, density and/or elasticity. The algorithm will also calculate the desired mattress length for the individual.

[0093] Advantageously, the bedding system is provided with support points such as the inserts described above which correspond to locations of the individual's body where the depth image shows support is needed (the zonings of the mattress). As mentioned, these points are often located at the shoulder, loin-hip, thigh, knee, lower leg, upper leg and feet of an individual. Based on the obtained data from the model, the required support to those locations will be calculated. This support may subsequently be translated towards specific characteristics of the support point such as density, size, hardness, elasticity, tensile strength, etc.

[0094] In a preferred embodiment, said support points are provided by means of transverse inserts in the bedding system, preferably tubular inserts. For the purpose of the current invention, said transverse is to be understood as parallel to the width of the bedding material. More specifically, transverse also has to be understood as a direction perpendicular to the longitudinal axis of a user's body when using the mattress.

[0095] Once the optimal bedding system is determined for the user, the user will be allowed to experience his or her optimal bedding system by means of a simulation device. This is necessary, as the production of the actual end product

(the bedding system) requires a specific amount of time. Such simulation device is comprised of a bedding system, e.g. a mattress, provided with hollow inserts or tubes which each may be provided at a pressure depending on the proposed foam insert. As such, the user may experience how the final bedding system (with the foam inserts) will feel. This may help in the decision process to buy the article.

[0096] By preference, the simulation device is in contact with the processor defining the characteristics of the inserts based on the anthropometric parameters obtained from the user. Once the processor has determined the characteristics of the various inserts, a signal will be transmitted to an air pressure system which will provide the required air pressure to the tubes of the bedding system. This air pressure system may be comprised of a compressor, compressed air and bellows and will allow the provision of a simulation device similar to the final bedding system.

[0097] By the method of the current invention, adequate positioning of these support elements can be determined, as well as their specific characteristics. Each support point linked to a specific location of the body may comprise a different size, different material, different hardness, elasticity, density, etc.

[0098] Under normal circumstances, a foam article such as a mattress has a lifespan of around 10 to 15 year. During that time span, the human body may undergo significant changes (e.g. weight loss or gain, pregnancy, etc.). The current invention makes it possible to adapt the foam article to the body changes of the user. In an embodiment, the inserts may be removed, and replaced, depending on alterations in the user's body.

[0099] The three different foam elements (top layer, under layer and inserts) may be formed separately and joined afterwards, or manufactured together in one piece. In another embodiment, the viscoelastic layer with the inserts may be formed simultaneously, after which they are joined to a separately manufactured top layer. In a further embodiment, a fourth or fifth layer may be provided, which encloses spring elements.

[0100] Production may occur by any suitable process such as by direct injection expanded foam molding or co-injection molding.

[0101] By way of example only, any of the features described above are applicable to mattresses, mattress toppers, overlays, futons, sleeper sofas, or any other element used to support or cushion any part or all of a human or animal body.

[0102] In a final aspect, the current invention equally relates to a bed provided with a foam article, being a mattress of a cushion according as described above. The bed may comprise of a standalone frame which is provided with a separate mattress according to an embodiment of the current invention. In another embodiment, bed and mattress are made of a combination of a bottom, such as a box spring provided with the mattress according to an embodiment of the current invention,.

[0103] The bed may be a single or double bed, or a king-size bed. In a preferred embodiment, the bed according to the current invention is a box spring whereby the top layer is a mattress according to the current invention, and provided with one or more supports. In a most preferred embodiment, said bed comprises two supports, placed central of the mattress and underlying layers, and extending towards the top and end of the mattress. By preference, said bed is adjustable in position.

[0104] The invention is further described by the following non-limiting drawings and examples which further illustrate the invention, and are not intended to, nor should they be interpreted to, limit the scope of the invention.

EXAMPLES

[0105] Table 1 provides examples of inserts which can be used for the purpose of the current invention and their characteristics.

Table 1 Characteristics of HR inserts useable for a foam article according to the current invention

	Gross density DIN and ISO 845 (kg/m ³)	Net density DIN and ISO 845 (kg/m ³)	Hardness 40% Din and ISO 3386-1 (kPa)	Elongation at break DIN and ISO 1798 (%)	Tensile strength DIN and ISO 1798 (kPa)	Resilience DIN and ISO 8307 (%)	Compression set 50%, 22h, 70°C DIN and ISO 1856 (%)	Wet compressions set RH 95%, 22h, 40°C NFT 56 112 (%)	Fire norm FMVSS 302 ISO/DIS 3795 NFP 92 504
HR28S	28	26	2,0	>140	>120	>50	<10	<45	M4
HR38H	38	36	4,0	>75	>135	>50	<7	<20	PASS/M4
HR43H	43	41	4,7	>70	>135	>50	<7	<12	PASS/M4
HR45S	45	43	3,3	>105	>130	>60	<6	<14	PASS/M4
HR55M	55	53	3,7	>100	>125	>60	<5	<6	PASS/M4
HR55H	55	53	4,5	>70	>105	>60	<6	<6	PASS/M4
HR60S	60	58	2,8	>90	>60	>65	<5	<5	PASS/M4

Description of figures

[0106] Figure 1A is a perspective view of a foam mattress 1 according to an embodiment of the current invention. The mattress 1 comprises a viscoelastic layer 2 provided with inserts 3 which are embedded in cavities in the viscoelastic layer 2. The inserts 3 may be tubular, having a round shape in cross-section. As seen on figure 1A, the inserts 3 are positioned on regularly spaced distances of each other, but these distances may also vary, depending on the measurements obtained from the user. Different inserts 3 made from different material can be used on each or some of the positions (indicated with different shading). The inserts extend in the transverse direction of the mattress, along the width W of the mattress and in a direction perpendicular to the length of the user.

[0107] As depicted in figure 1B, the mattress may be provided with a top layer 4 which is made of a non-viscoelastic material such as soft foam or alternatively, a viscoelastic material. This layer may span the entire surface of the viscoelastic layer 3 and may be attached to layer 3 by suitable attachment means (not shown on the figure). Alternatively, the top layer 4 may be loosely placed on top of the viscoelastic layer.

[0108] Figure 2A to C show various embodiments of the inserts 3 according to the current invention. The inserts may be tubular (figure 1A) but also rectangular (figure 2A), rhombic (figure 2B), hexagonal (2C) or any other suitable shape known in the art. The inserts 3 are entirely embedded into the viscoelastic layer. With reference to figure 3, a cross-section along the longitudinal axis of the mattress is shown, depicting various possibilities of the inserts 3. In the most common embodiment, the inserts will run along the entire width of the viscoelastic layer (figure 3A). Figure 3B shows an embodiment where the inserts 3 run on the both outer sides of the viscoelastic layer to the middle. This embodiment may be especially advantageous when used in a double mattress 1, whereby the inserts have to be positioned differently based on different body scans of both users. With respect to figure 3C, the inserts 3 follow a discontinuous path along the width of the viscoelastic layer 2. The inserts 3 may be positioned on discrete locations. Each of the inserts may have a different density, hardness, elasticity, etc., depending on the requirements of the user, which is depicted on the figures by different shading. In another embodiment, not shown, the height of the inserts 3 in the viscoelastic layer 2 may differ.

[0109] Figure 4 shows a detail of an advanced embodiment of the mattress 1 of the current invention. The mattress comprises of a top layer 4 which resides on the viscoelastic layer 2. The viscoelastic layer 2 is provided with a plurality of tubular inserts 3 which have different densities. The top layer 4 and viscoelastic layer 2 reside on a bottom layer of the mattress, which can be made of any suitable material such as regular foams, latex foams, etc. the bottom layer 5 can be provided with a plurality of spring elements 6 for additional comfort to the user. The mattress is by preference enveloped in a tissue

[0110] Figure 5 shows an embodiment of a bed 7 according to the current invention, provided with a mattress 1 with inserts 3 in a viscoelastic layer. The bed 7 as shown in figure 5 is of the box spring type, whereby the mattress 1 resides on a bottom layer, which is preferably provided with spring elements (6). This bottom layer may equally comprise of portions made of a high resilient foam. The combination is placed on a support substrate, which may be a wooden, metal, textile substrate or a combination of various suitable materials. The assembly provides for a sleeping surface for a user. The assembly is placed on a double support 8, comprising two feet 10, 101, which is positioned in the middle of the assembly and whereby the feet 10, 101 extend towards the top and end of the mattress.

[0111] Figure 6 shows a cushion 11 according to the current invention, made of viscoelastic foam 1 and provided with inserts 3.

Features on the figures**[0112]**

- 1: mattress
- 2: viscoelastic layer
- 3: inserts
- 4: top layer
- 5: bottom layer
- 6: spring elements
- 7: bed
- 8: support
- 9: support substrate
- 10, 101: feet
- 11: cushion

Claims

1. A foam article such as a mattress or a cushion, comprising a viscoelastic foam layer, said viscoelastic foam layer has foam inserts embedded in cavities of the viscoelastic foam and which elongate in the transverse direction of said article, **characterized in that** said inserts have a density of between 20 and 80 kg/m³.
2. Foam article according to claim 1, **characterized in that** the hardness of said inserts is between 1.5 and 6 kPa.
3. Foam article according to any one of the previous claims, **characterized in that** said inserts are of high-resilience polyurethane foam.
4. Foam article according to any one of the previous claims, **characterized in that** said inserts have a circular, hexagonal, square or rectangular cross-sectional shape.
5. Foam article according to any one of the previous claims, **characterized in that** the article is provided with a top layer, placed above said viscoelastic foam layer.
6. Foam article according to claim 5, **characterized in that** said top layer is a polyurethane foam with imbedded gel particles.
7. Foam article according to any one of the previous claims, **characterized in that** said inserts are spaced and whereby each position of said inserts corresponds to a position on a user's body which requires support.
8. Foam article according to any one of the previous claims, **characterized in that** said inserts have the same or different densities and/or hardness.
9. Foam article according to any one of the previous claims, **characterized in that** said inserts extend over the entire width of said article.
10. Foam article according to any of the previous claims, **characterized in that** said inserts have a tensile strength of between 50 and 150 kPa.
11. Foam article according to any of the previous claims, **characterized in that** said inserts have a resilience is between 40 and 75 %.
12. Foam article according to any one of the previous claims, **characterized in that** said inserts are chosen based on anthropometric parameters obtained from a user.
13. Bed provided with a foam article according to claims 1 to 12.
14. A method for producing a foam article with non-viscoelastic inserts, comprising:
 - obtaining one or more anthropometric parameters from a person intended to use said foam article;
 - determining the characteristics and/or position of inserts in said article based on said anthropometric parameters; and
 - inserting said inserts in cavities of said viscoelastic layer.
15. Method for defining the hardness of inserts to be placed in a foam article, comprising:
 - obtaining one or more anthropometric parameters from a person intended to use said foam article via a 3D body scan or camera;
 - correlating said parameters with a required hardness and position in said article.

Fig. 1a

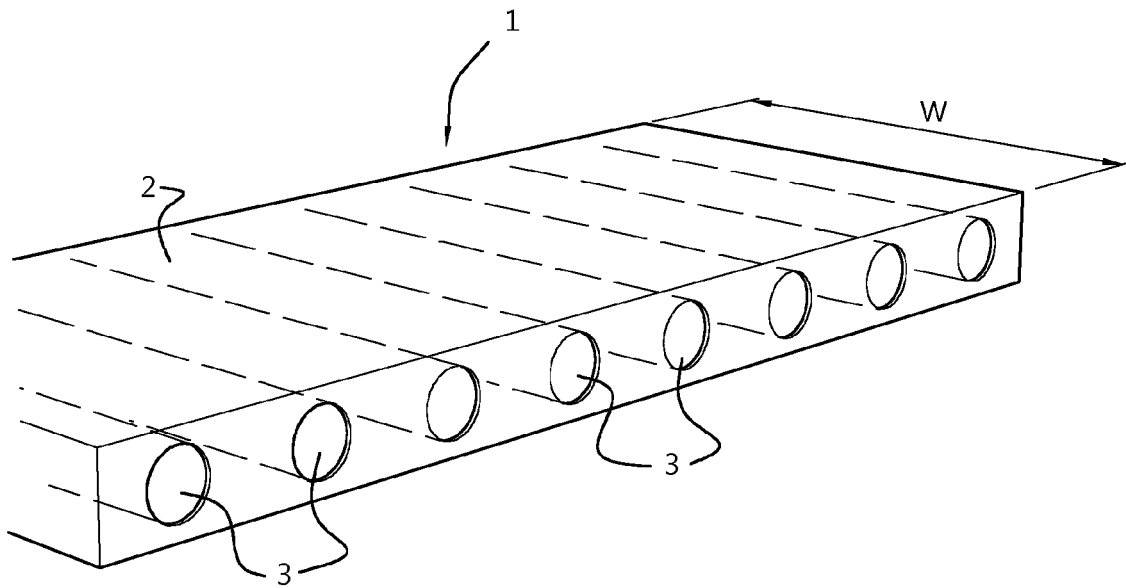


Fig. 1b

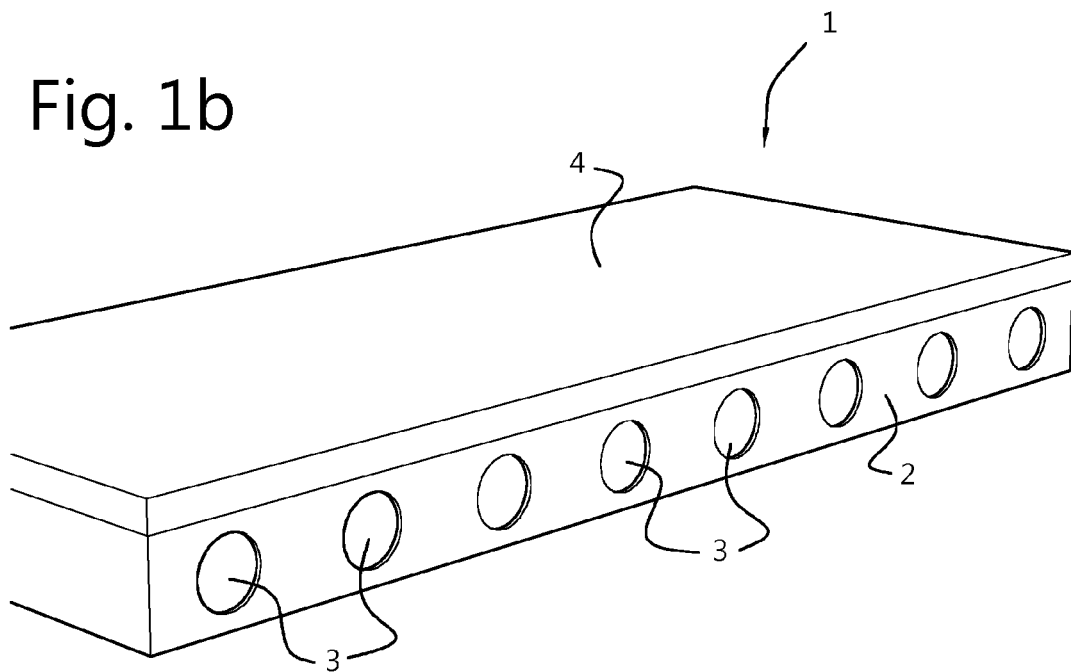


Fig. 2a

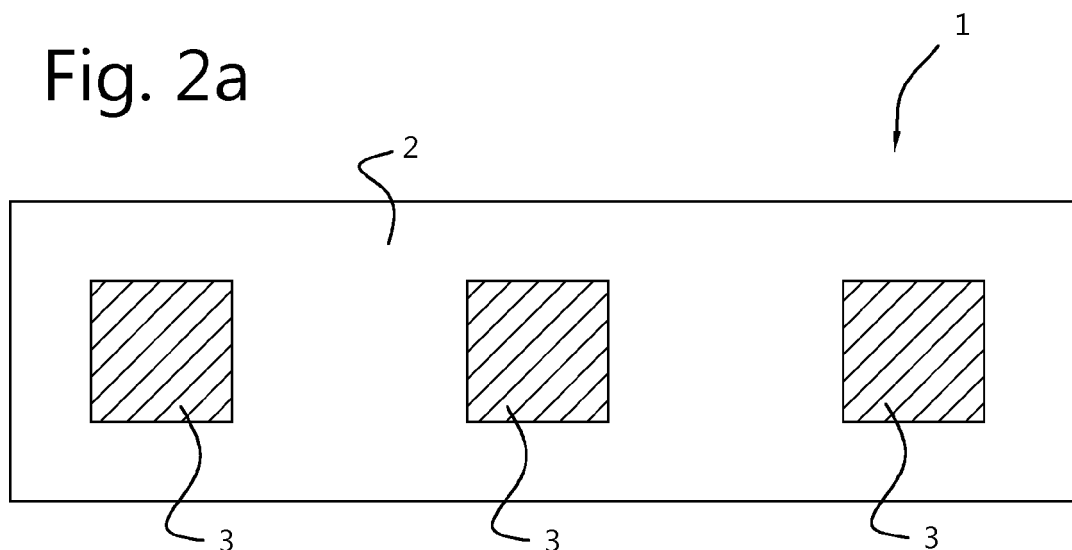


Fig. 2b

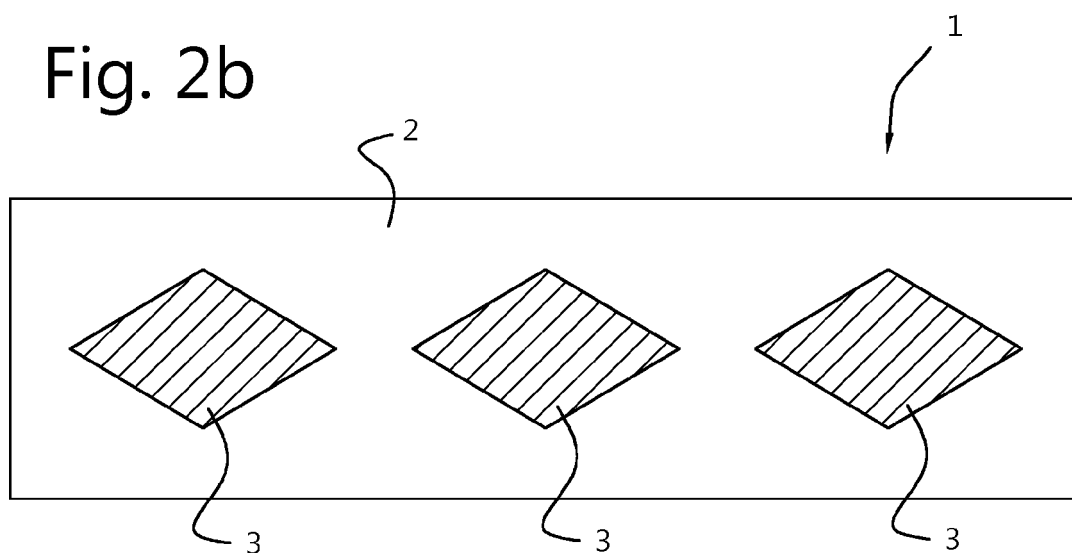
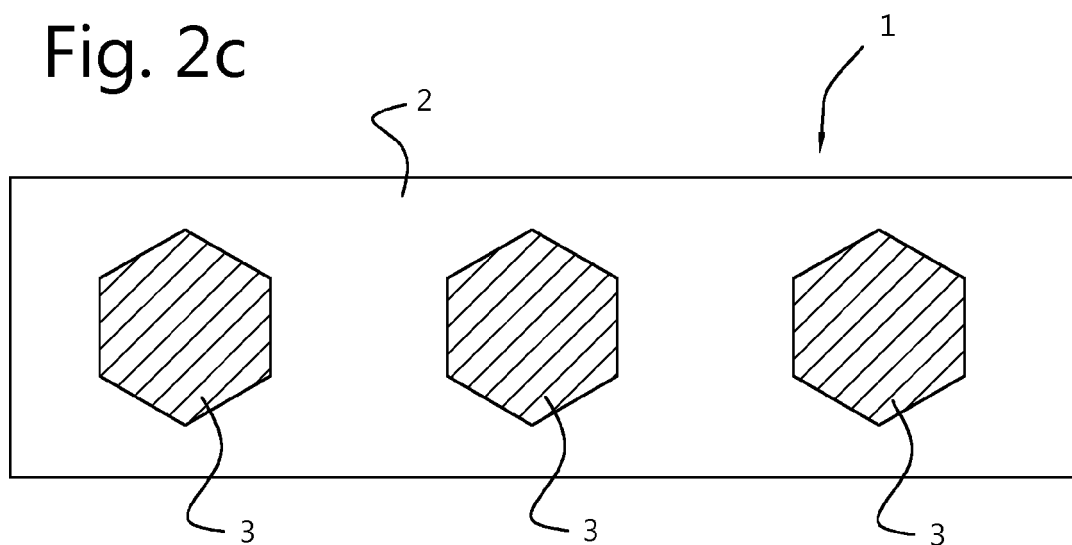


Fig. 2c



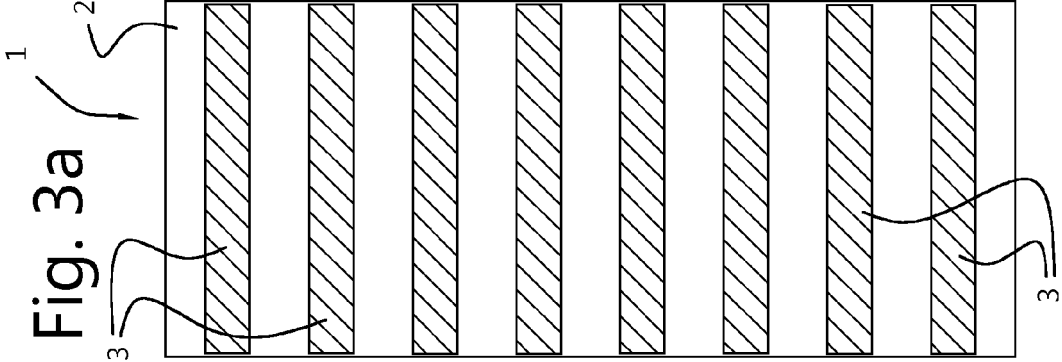
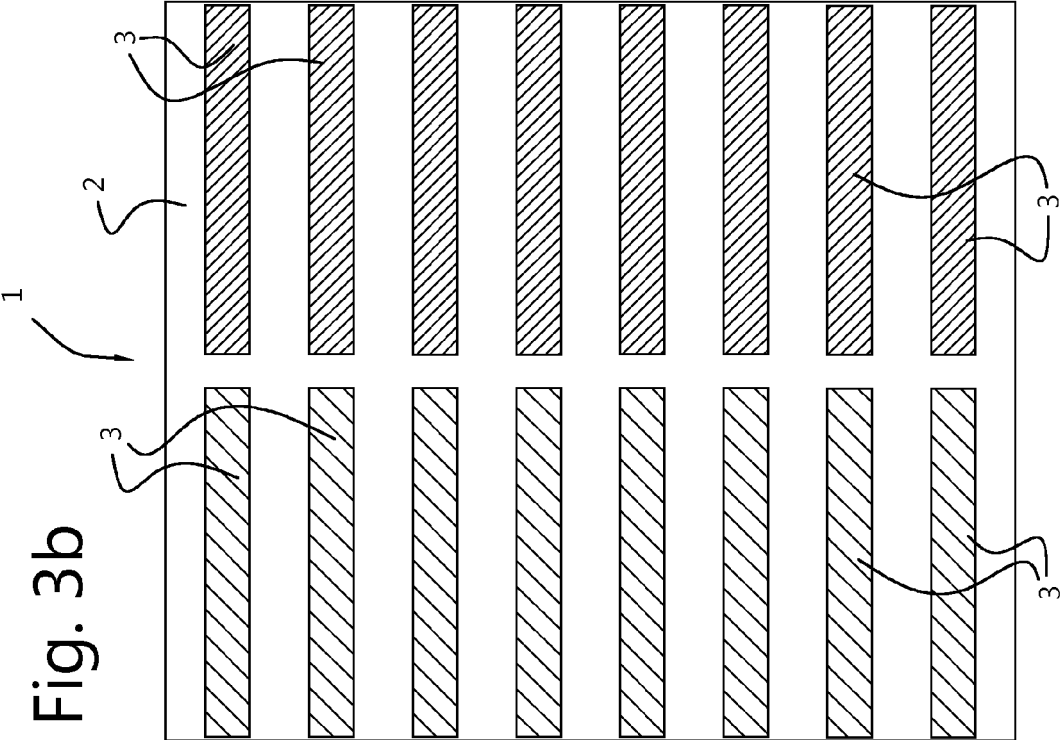
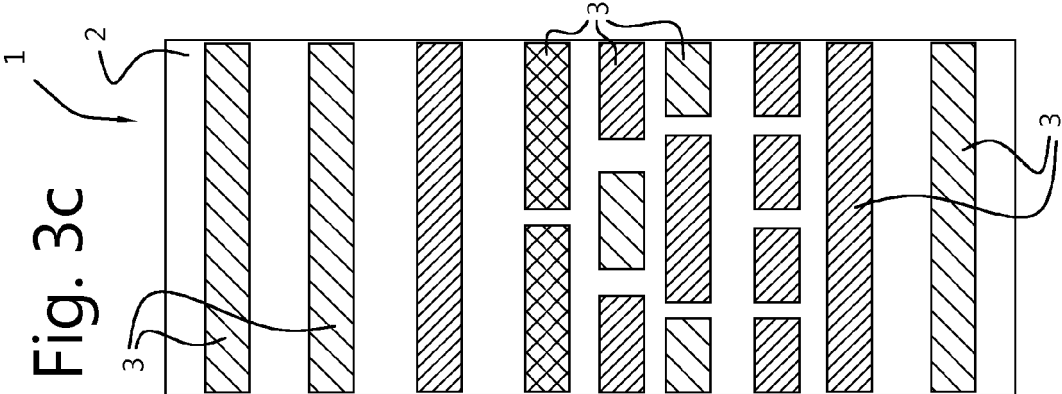


Fig. 4

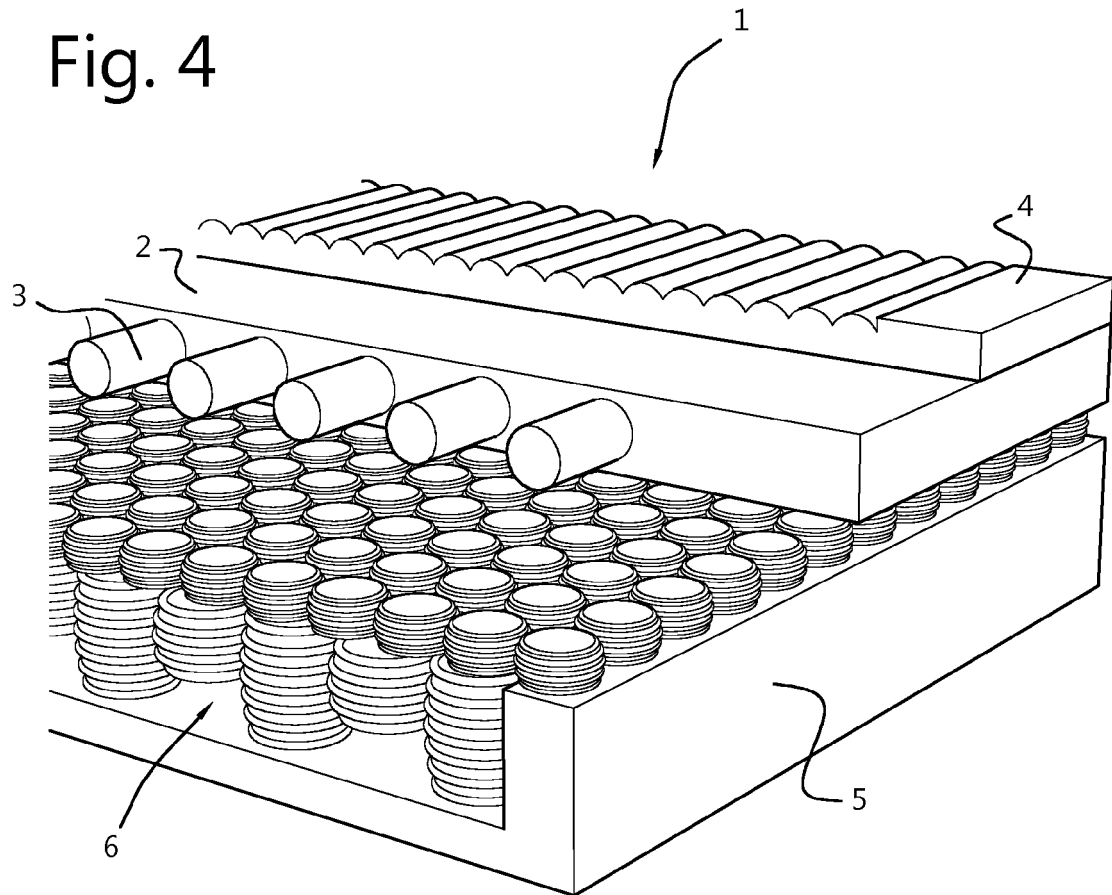


Fig. 5

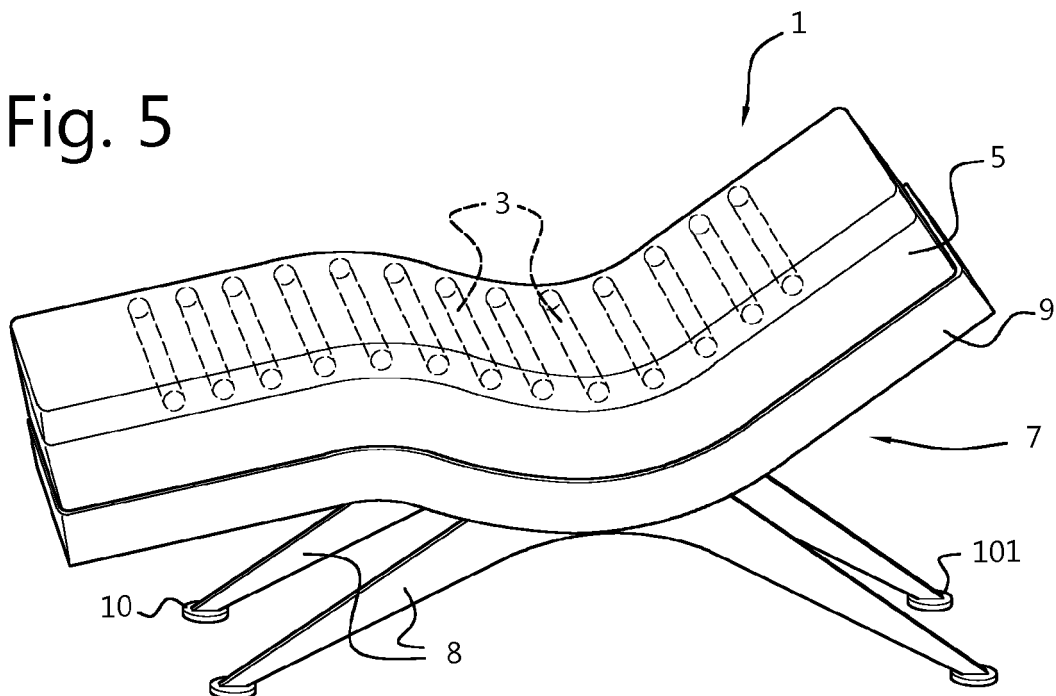
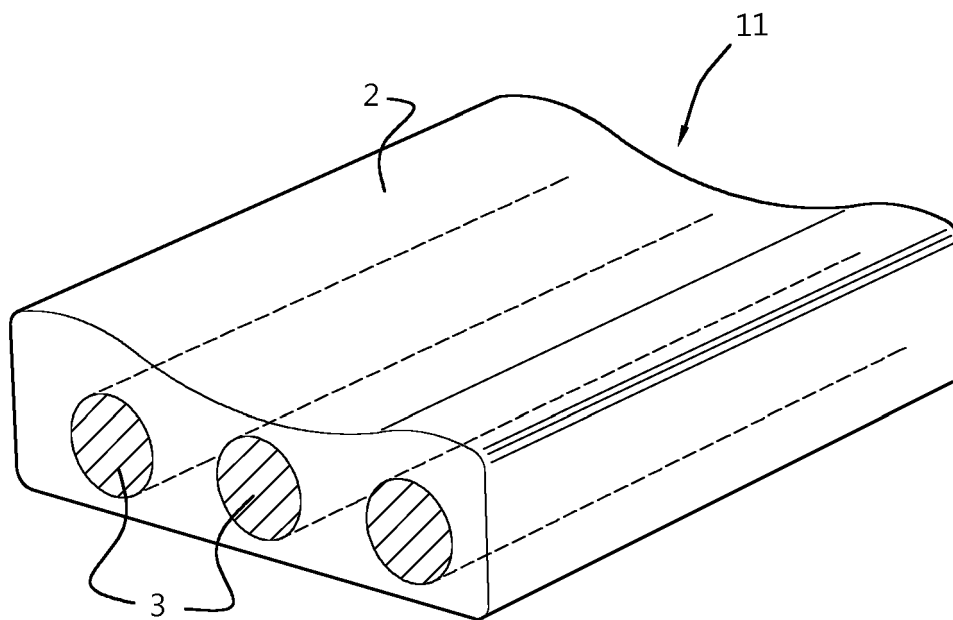


Fig. 6



REFERENCES CITED IN THE DESCRIPTION

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