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(54) Title: CUSTOM CONTOURED SLEEP SURFACE AND METHOD OF MAKING SAME

(57) Abstract: The invention relates to custom beds designed for a specific purpose including features that adapt to the specific position and shape of an individual's body parts to offer relaxation and maintain the person's spine in a neutral position during long-term sleep. The bed comprises a sleep surface silhouette with a contoured shape that matches the unique body surfaces of the person. The silhouette includes various support regions for the head, shoulders, lumbar, legs, and feet. A method for making such a bed involves scanning the body surface of a subject and creating a contoured sleep surface to match. Another method for sleep ensures the spine remains in a neutral position by using a contoured surface that conforms to the subject's body in various sleeping positions.



CUSTOM CONTOURED SLEEP SURFACE AND METHOD OF MAKING SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority to United States Provisional Patent Number 63/507,078, filed June 8th, 2023, the entire disclosure of which is incorporated by reference as if fully set forth herein in its entirety.

FIELD OF THE INVENTION

[0002] The embodiments of the present invention relate to customized sleep surfaces for beds, and in particular, to custom contoured sleep surfaces that can accommodate a variety of individuals as well as methods of designing the sleep surfaces.

BACKGROUND OF THE INVENTION

[0003] According to many sleep studies, the most common sleep position is on one's side. Indeed, this position is preferred by roughly 66%, while sleeping on one's stomach is preferred by 17% of respondents, and sleeping on one's back is preferred by 18%. Moreover, as people age, people tend to prefer to sleep on their sides. Even if a person prefers to sleep on the back, as that person's body mass index (BMI) increases, there is a greater tendency to sleep on the side¹.

[0004] However, with conventional flat mattresses, side sleeping may contribute to abnormal spine curvature. Further, spinal flex can cause intraabdominal pressure which restricts breathing leading to switching positions during sleep thus decreasing restfulness. Moreover, as a flat mattress ages, it sags, resulting in a compromised spine position.

[0005] Current mattresses also suffer from a "one-size-fits-most" design mentality. They are also typically expensive for high quality, but with only five-to-ten-year lifespans. They are unnecessarily thick from being over-engineered which also makes them heavy and cumbersome to move or even to change bed linen. Considering that humans typically spend one-third of their lives attempting to get a good night's sleep², what is urgently

needed are new methods for designing custom contoured sleep surfaces that can accommodate individuals with a variety of body types and shapes.

BRIEF SUMMARY OF THE INVENTION

[0006] The following presents a simplified summary of the innovation in order to provide a basic understanding of some aspects of the invention. This summary is not an extensive overview of the invention. It is intended to neither identify key or critical elements of the invention nor delineate the scope of the invention. Its sole purpose is to present some concepts of the invention in a simplified form as a prelude to the more detailed description that is presented later.

[0007] The technology disclosed herein introduces a health revolutionizing approach to healthy sleep. In some embodiments, the sleep surfaces disclosed herein can keep a subject's spine in a healthy position during side sleep, back sleep, or stomach sleep.

[0008] In some embodiments, the techniques described herein relate to a bed designed for a purpose of keeping a subject's spine in a neutral position during sleep, the bed including: a sleep surface silhouette of the bed adapting to the specific shape of specific body parts of the subject; wherein the specific purpose is to keep a person's spine in a neutral position when the person is lying down for sleep; wherein the sleep surface silhouette is in a contoured shape that matches one or more of the unique body surfaces of the person; and wherein the contoured shape of the sleep surface silhouette matches the unique body surfaces of the person to keep the subject's spine in a neutral position when the subject is lying on the bed.

[0009] According to some aspects, the techniques described herein relate to a bed, wherein the sleep surface silhouette includes a head support region contoured to cradle the head of the person.

[0010] According to some aspects, the techniques described herein relate to a bed, wherein the sleep surface silhouette includes a shoulder support region contoured to accommodate the shoulder of the person.

[0011] In some embodiments, the techniques described herein relate to a bed, wherein the sleep surface silhouette includes a lumbar support region contoured to support the lumbar region of the person.

[0012] According to some aspects, the techniques described herein relate to a bed, wherein the sleep surface silhouette includes a leg support region contoured to support the legs of the person.

[0013] According to some aspects, the techniques described herein relate to a bed, wherein the sleep surface silhouette includes a foot support region contoured to support the feet of the person.

[0014] In some embodiments, the techniques described herein relate to a bed, wherein the bed is adjustable to accommodate different body sizes.

[0015] According to some aspects, the techniques described herein relate to a bed, wherein the bed includes a memory foam layer or a gel layer that conforms to the body of the person.

[0016] According to some aspects, the techniques described herein relate to a bed, wherein the bed includes a plurality of adjustable air chambers to adjust firmness.

[0017] In some embodiments, the techniques described herein relate to a bed, wherein the bed includes a remote control for adjusting a contour of the sleep surface silhouette.

[0018] According to some aspects, the techniques described herein relate to a bed, wherein the bed includes a heating element for providing warmth.

[0019] According to some aspects, the techniques described herein relate to a bed, wherein the bed includes a light system for providing therapeutic light therapy.

[0020] In some embodiments, the techniques described herein relate to a bed, wherein the bed is part of a sleep system that includes an environmental control unit to regulate temperature and humidity.

[0021] According to some aspects, the techniques described herein relate to a method for making a bed for keeping a subject's spine in a standing spine position or in a neutral spine position when the subject is in a sleep position or when the subject is lying down, the method including the steps of: (1) scanning a unique body surface of the subject; and (2) making a sleep surface silhouette in a contoured surface to match the unique body surface of the subject.

[0022] According to some aspects, the techniques described herein relate to a method, wherein the sleep surface silhouette includes a head support region contoured to cradle the head of the person.

[0023] In some embodiments, the techniques described herein relate to a method, wherein the sleep surface silhouette includes a shoulder support region contoured to accommodate the shoulder of the person.

[0024] According to some aspects, the techniques described herein relate to a method, wherein the sleep surface silhouette includes a lumbar support region contoured to support the lumbar region of the person.

[0025] According to some aspects, the techniques described herein relate to a method, wherein the sleep surface silhouette includes a leg support region contoured to support the legs of the person.

[0026] In some embodiments, the techniques described herein relate to a method, wherein the sleep surface silhouette includes a foot support region contoured to support the feet of the person.

[0027] According to some aspects, the techniques described herein relate to a method, wherein the bed includes a memory foam layer or a gel layer that conforms to the body of the person.

[0028] According to some aspects, the techniques described herein relate to a method, wherein the unique body surface includes a side of the subject.

[0029] In some embodiments, the techniques described herein relate to a method, wherein the unique body surface includes a back of the subject.

[0030] According to some aspects, the techniques described herein relate to a method for keeping a subject's spine in a standing spine position or in a neutral spine position when the subject is in a sleep position or when the subject is lying down, the method including the steps of: (1) obtaining a surface that is in a contoured shape to conform to a unique body surface of the subject in a lying down position; (2) positioning the surface in a plane that is about at a parallel to a horizontal surface of the Earth; and (3) positioning the subject on the contoured shape of the surface such that the unique body surface of the subject makes a contact with the contoured shape of the surface;

whereby the subject's spine is maintained in a standing spine position or in a neutral spine position when the subject is in the sleep position or is lying down.

[0031] According to some aspects, the techniques described herein relate to a method, wherein the contoured shape is operative to maintain the subject's spine in a standing spine position or in a neutral spine position for a time period of about 6 to about 8 hours, when the subject is in a sleeping state.

[0032] In some embodiments, the techniques described herein relate to a method, wherein the unique body surface of the subject is cradled so as to provide a neutral spine position.

[0033] According to some aspects, the techniques described herein relate to a method, wherein lying down is defined by a line drawn from the subject's head to the subject's ankle defining an angle of less than 90° with a horizontal line defined by a line drawn parallel to a surface of the Earth.

[0034] According to some aspects, the techniques described herein relate to a method, wherein lying down is the subject lying about parallel to the surface of the Earth.

[0035] In some embodiments, the techniques described herein relate to a method, wherein the neutral spine position is a same spine position that the subject will have when the subject is in a standing up straight position.

[0036] According to some aspects, the techniques described herein relate to a method, wherein the contoured shape conforms to the subject's body surface when the subject is sleeping on the subject's side, back, or stomach.

[0037] According to some aspects, the techniques described herein relate to a method, wherein the method is carried out over a period of longer than 1 year, longer than 2 years, or longer than 3 years, and wherein the subject's spine is kept in a neutral position during a long-term sleep of the subject so as to provide a health benefit to the subject outside of a sleeping time.

[0038] Other implementations are also described and recited herein. These and other features and advantages will be apparent from a reading of the following detailed description and a review of the associated drawings. It is to be understood that both the foregoing general description and the following detailed description are explanatory only and are not restrictive of aspects as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0039] Solely for the purpose of illustration, certain embodiments of the present invention are explained using examples in the drawings described below. It should be understood, however, that the invention is not limited to the precise arrangements, dimensions, and configurations shown. The apparatus and method disclosed below are described with reference to the accompanying drawings. In the drawings, like reference numbers can indicate identical or functionally similar elements. Additionally, the left-most digit(s) of a reference number identifies the drawing in which the reference number first appears. In the Figures:

[0040] **FIG. 1A** shows exemplary distributions of side sleep positions in the population.

[0041] **FIG. 1B** shows a 17% distribution of stomach sleep in the population.

[0042] **FIG. 1C** shows distributions of two back sleep positions, which a total of about 18%, in the population.

[0043] **FIG. 2A** and **FIG. 2B** are tables of fifteen values representing measurements of the human form, for men and women, respectively, derived from the Henry Dreyfuss³ database.

[0044] **FIG. 3A** illustrates a contoured shape or sleep surface silhouette 201 based upon values from the table of **FIG. 2A** for a fiftieth-percentile male.

[0045] **FIG. 3B**, **FIG. 3C**, and **FIG. 3D** illustrate silhouettes for small, medium and large males, respectively, based upon values from the table of **FIG. 2A**.

[0046] **FIG. 3E** shows an illustration of a rough weight distribution for a 160-pound (or about a fiftieth-percentile) male. **FIG. 3F** shows a table illustrating how 4-inch (about 10.16 cm) foam with 4-pound density (medium indentation load deflection, ILD) will compress with increasing weight.

[0047] **FIG. 4A**, **FIG. 4B**, and **FIG. 4C** are drawings of an exemplary custom contoured sleep surface according to some embodiments. **FIG. 4D** and **FIG. 4E** show illustrations of constant thickness memory foam layers with different shapes. **FIG. 4F** shows how a chamfer edge 405 can fit a complimentary chamfer edge 406 to provide a flat foam surface from two adjacent pieces.

[0048] FIG. 5A shows an illustration of hook look tape (dotted lines) that can be utilized to hold memory foam to a (contoured) rigid sleep surface, according to some aspects. FIG. 5B shows an illustration of a bolster 510.

[0049] FIG. 6A, FIG. 6B, FIG. 6C, and FIG. 6D show an exemplary embodiment of a sleep surface including a system for heating or cooling the sleeper.

[0050] FIG. 7A and FIG. 7B are illustrations of a base structure to support a sleep surface.

[0051] FIG. 8A and FIG. 8B depict a support base for one or more sleep surfaces comprising a storage cavity.

[0052] FIG. 9A, FIG. 9B, and FIG. 9C illustrate methods for obtaining a subject's form measurements with an app on a smart device, such as a smartphone.

[0053] FIG. 10 is a flowchart of an exemplary method of making a sleep surface according to some embodiments.

[0054] FIG. 11A depicts example steps of a method for making a sleep surface. FIG. 11B depicts an example method for keeping a subject's spine in a neutral position during sleep.

[0055] FIG. 12 shows exemplary measurements 1-18 on a human body that can be applied for a back sleep system.

[0056] FIG. 13 shows values (in examples of inches) for each of the measurements 1-18 illustrated in FIG. 12.

[0057] FIG. 14 shows a back sleep module shape 350 designed to keep the spine line 250 in a neutral position.

[0058] FIG. 15 shows a flowchart of another example method of making a sleep surface according to some embodiments.

[0059] It should be understood that perhaps different numbers/numbering can/are/is sometimes used in some of the figures above to describe different embodiments and different aspects of the technology, any number from any figure can be inter-combined with a numbered aspect from any other figures. All trademarks, images, likenesses, words, and depictions in the drawings and the disclosure are plainly in fair use and are provided solely for the purposes of illustration of the invention in view of an urgent need to provide better sleep to subjects as further discussed in detail below.

DETAILED DESCRIPTION OF THE INVENTION

[0060] The subject innovation is now described in some instances, when necessary, with reference to the drawings. In the following description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the present invention. It may be evident, however, that the present invention may be practiced without these specific details. In other instances, well-known structures, methods, and devices are shown in block diagram form or with illustrations in order to facilitate describing the present invention. It is to be appreciated that certain aspects, modes, embodiments, variations, and features of the invention are described below in various levels of detail in order to provide a substantial understanding of the present invention.

DEFINITIONS

[0061] For convenience, the meaning of some terms and phrases used in the specification, examples, and appended claims, are provided below. Unless stated otherwise, or implicit from context, the following terms and phrases include the meanings provided below. The definitions are provided to aid in describing particular embodiments, and are not intended to limit the claimed invention, because the scope of the invention is limited only by the claims. Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. If there is an apparent discrepancy between the usage of a term in the art and its definition provided herein, the definition provided within the specification shall prevail. In general, any chemical terminology is found in the International Union of Pure and Applied Chemistry GoldBook⁴. This disclosure is purposefully presented in commonly understood words, known to a person of skill in the art, but Merriam-Webster's Online (English) Dictionary is used, when appropriate, for terms not specifically demonstrated herein or not known in the art⁵.

[0062] As used in this specification and the appended claims, the singular forms "a," "an" and "the" include plural referents unless the content clearly dictates otherwise. For example, reference to "a cell" includes a combination of two or more cells, and the like.

[0063] As used herein, the term "approximately" or "about" in reference to a value or parameter are generally taken to include numbers that fall within a range of 5%, 10%, 15%, or 20% in either direction (greater than or less than) of the number unless otherwise stated or otherwise evident from the context (except where such number would be less than 0% or exceed 100% of a possible value). As used herein, reference to "approximately" or "about" a value or parameter includes (and describes) embodiments that are directed to that value or parameter. For example, description referring to "about X" includes a description of "X".

[0064] As used herein, the term "or" means "and/or." The term "and/or" as used in a phrase such as "A and/or B" herein is intended to include both A and B; A or B; A (alone); and B (alone). Likewise, the term "and/or" as used in a phrase such as "A, B, and/or C" is intended to encompass each of the following embodiments: A, B, and C; A, B, or C; A or C; A or B; B or C; A and C; A and B; B and C; A (alone); B (alone); and C (alone).

[0065] As used herein, the term "comprising" means that other elements can also be present in addition to the defined elements presented. The use of "comprising" indicates inclusion rather than limitation. The term "including" can be interchanged with "comprising".

[0066] The term "consisting of" refers to compositions, methods, and respective components thereof as described herein, which are exclusive of any element not recited in that description of the embodiment.

[0067] As used herein the term "consisting essentially of" refers to those elements required for a given embodiment. The term permits the presence of additional elements that do not materially affect the basic and novel or functional characteristic(s) of that embodiment of the invention. The term "consisting essentially of" can also be exemplified by plain language provided in the claims.

[0068] The term "statistically significant" or "significantly" refers to statistical significance and generally means a two-standard deviation (2SD) or greater difference.

[0069] As used herein, the term "subject" refers to a mammal, including but not limited to a dog, cat, horse, cow, pig, sheep, goat, rodent, or primate. Subjects can be house pets (e.g., dogs, cats), agricultural stock animals (e.g., cows, horses, pigs,

chickens, etc.), laboratory animals (e.g., mice, rats, rabbits, etc.), but are not so limited. Subjects particularly include human subjects in urgent need of sleep as described herein. The human subject may be a pediatric, adult, or a geriatric subject. The human subject may be of any sex.

[0070] The term “treating” includes prophylactic and/or therapeutic treatments and can include better sleep directly related to a sleep surface disclosed herein. The term “prophylactic or therapeutic” treatment is art-recognized and includes administration to the host of one or more of the subject compositions and/or application of one or more therapies or surgeries. If this is done prior to clinical manifestation of the unwanted condition (e.g., disease or other unwanted state of the host animal) then the treatment is prophylactic (*i.e.*, it protects the host against developing the unwanted condition), whereas if it is administered after manifestation of the unwanted condition, the treatment is therapeutic, (*i.e.*, it is intended to diminish, ameliorate, or stabilize the existing unwanted condition or side effects thereof).

[0071] As used herein, the terms “treat,” “treatment,” “treating,” or “amelioration” when used in reference to a disease, disorder, or medical condition, refer to therapeutic sleep surfaces or treatments for a condition, wherein the object is to reverse, alleviate, ameliorate, inhibit, slow down or stop the progression or severity of a symptom or condition. The term “treating” includes reducing or alleviating at least one adverse effect or symptom of a condition. Treatment is generally “effective” if one or more symptoms or clinical markers are reduced. Alternatively, treatment is “effective” if the progression of a condition is reduced or halted. That is, “treatment” includes not just the improvement of symptoms or markers, but also a cessation or at least slowing of progress or worsening of symptoms that would be expected in the absence of treatment. Beneficial or desired clinical results include, but are not limited to, alleviation of one or more symptom(s), sign(s), diminishment of extent of the deficit, stabilized (*i.e.*, not worsening) state of a symptom or condition, delay or slowing of onset of symptoms or indications, and an increased lifespan, with better life quality, as compared to that expected in the absence of treatment.

[0072] The terms: “decrease”, “reduced”, “reduction”, or “inhibit” are all used herein to mean a decrease by a statistically significant amount. In some embodiments, “reduce,”

"reduction" or "decrease" or "inhibit" typically means a decrease by at least 10% as compared to a reference level (e.g., the absence of a given treatment or agent) and can include, for example, a decrease by at least about 10%, at least about 20%, at least about 25%, at least about 30%, at least about 35%, at least about 40%, at least about 45%, at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 95%, at least about 98%, at least about 99%, or more. As used herein, "reduction" or "inhibition" does not encompass a complete inhibition or reduction as compared to a reference level. "Complete inhibition" is a 100% inhibition as compared to a reference level. A decrease can be preferably down to a level accepted as within the range of normal for an individual without a given disorder.

[0073] In some embodiments, the decrease in the one or more signs or symptoms is evaluated according to a specialized healthcare provider. In some embodiments, signs are observed or measured by a health care provider. Symptoms can be reported by the subject. In some embodiments, the decrease of signs or symptoms occurs in less than about 120 days, 90 days, less than about 60 days, less than about 30 days, less than about 15 days, less than about 10 days, or less than about 5 days, or less than about 3 days, or less than about 1 day. In some embodiments, the decrease of signs or symptoms occurs in less than 1 day, less than 1 week, less than 1 month, or in less than 1 year.

[0074] The terms "increased", "increase", "enhance", or "activate" are all used herein to mean an increase by a statically significant amount. In some embodiments, the terms "increased", "increase", "enhance", or "activate" can mean an increase of at least 10% as compared to a reference level, for example an increase of at least about 20%, or at least about 30%, or at least about 40%, or at least about 50%, or at least about 60%, or at least about 70%, or at least about 80%, or at least about 90% or up to and including a 100% increase or any increase between 10-100% as compared to a reference level, or at least about a 2-fold, or at least about a 3-fold, or at least about a 4-fold, or at least about a 5-fold or at least about a 10-fold increase, or any increase between 2-fold and 10-fold or greater as compared to a reference level. In the context of a marker or symptom, a "increase" is a statistically significant increase in such level.

[0075] A subject can be one who has been previously diagnosed with or identified as suffering from or having a condition in need of treatment (e.g., a lack of sleep or a related disorder) or one or more complications related to such a condition, and optionally, but need not have already undergone treatment for a condition or the one or more complications related to the condition. Alternatively, a subject can also be one who has not been previously diagnosed as having a condition in need of treatment or one or more complications related to such a condition. For example, a subject can be one who exhibits one or more risk factors for a condition, or one or more complications related to a condition or a subject who does not exhibit risk factors. A “subject in need” of treatment for a particular condition can be a subject having that condition, diagnosed as having that condition, suspected as having, or at risk of developing that condition. In another example, the subject has been brought into a treatment situation entirely without the subject’s knowledge and/or intent. For example, a subject can obviously be in need of treatment but not be responsive to a previous attempt at gaining improved sleep, and as described herein the present methods and sleep surfaces may save the subject’s life.

[0076] As discussed above, unless otherwise defined herein, scientific and technical terms used in connection with the present application shall have the meanings that are commonly understood by those of ordinary skill in the art to which this disclosure belongs. It should be understood that this invention is not limited to the particular methodology, protocols, devices, implants, and reagents, etc., described herein and as such can vary. The terminology used herein is for the purpose of describing particular embodiments only and is not intended to limit the scope of the present invention, which is defined solely by the claims. The concepts of improved sleep can extent to stress reduction, improved immunity, and better quality of life. Definitions of common terms in immunology and molecular biology can be found in The Merck Manual of Diagnosis and Therapy;⁶ The Encyclopedia of Molecular Cell Biology and Molecular Medicine;⁷ Molecular Biology and Biotechnology: a Comprehensive Desk Reference;⁸ Immunology;⁹ Janeway's Immunobiology;¹⁰ Lewin's Genes XI;¹¹ Molecular Cloning: A Laboratory Manual;¹² Basic Methods in Molecular Biology;¹³ Laboratory Methods in Enzymology;¹⁴ Current Protocols in Molecular Biology (CPMB)¹⁵; Current Protocols in Protein Science (CPPS);¹⁶ and Current Protocols in Immunology (CPI)¹⁷.

[0077] In the embodiments discussed and in any of the aspects, the disclosure described herein does not concern a process for cloning human beings, processes for modifying the germ line genetic identity of human beings, uses of human embryos for industrial or commercial purposes or processes for modifying the genetic identity of animals which are likely to cause them suffering without any substantial medical benefit to man or animal, and also animals resulting from such processes.

[0078] Reference in this entire specification to “an embodiment,” “some embodiments,” “one embodiment,” “various embodiments,” an “aspect,” “some aspects” or any variant thereof means that a particular feature or aspect described in conjunction with the particular embodiment is included in at least one embodiment. Thus, the appearance of the phrases “in one embodiment,” “in another embodiment,” or variations thereof in various places throughout the specification are not necessarily all referring to its respective embodiment.

[0079] Other terms are defined herein within the description of the various aspects of the invention. It is clearly contemplated herein that the technology can be used in surgeries in addition to a bone with a malalignment or a bone with a fracture, and the implants and techniques disclosed herein are not limited by the accurate discussion of applications in various surgeries.

A CUSTOM CONTOURED SLEEP SURFACE AND METHOD OF MAKING SAME

[0080] The custom sleep surfaces disclosed herein can accommodate any person with any body shape. The technology disclosed herein can be applied to persons having a wide variance in body dimensions, sizes, shapes, and age. For example, the technology can be applied to children, wherein the sleep surfaces are scaled down in size accordingly. In addition to the wide diversity in sizes and body dimensions, persons tend to sleep in different positions. It is contemplated that the technology can be applied to any person who sleeps in any position, even if that person changes sleep position during a sleep cycle.

[0081] People tend to think of sleeping on the back as the most common sleep position due to how common it is in media. **FIG. 1A**, **FIG. 1B**, and **FIG. 1C** show some distributions of the most common sleep positions in the population. Persons sleep on their side in sleep about 66% in all conventional flat mattresses, and these positions on

conventional flat mattresses cause abnormal spinal curvature¹⁸. **FIG. 1A** illustrates how about 6% are sleeping on the side with arms down (left), about 13% on their side with arms extended, and about 47% with legs up and arms up. **FIG. 1B** shows stomach sleep, at about 17%. This is in a way the second most popular sleep position since the back sleep 18% is made of two variations (**FIG. 1C**). In the stomach sleep (**FIG. 1B**), the neck is rotated at a wide angle to allow for breathing. This is the most common stomach sleep position. This spinal flex causes intrabdominal pressure which causes incomplete deep breaths during sleep. This also leads to switching between the 3 positions and turning at night and a less restful sleep. Turning now to **FIG. 1C**, back sleep is about 18% total with the arms and legs extended down (**FIG. 1C**, left) or the arms up and leg(s) up (**FIG. 1C**, right). This is the position most mattresses perform well for; it is also the least common sleep position. The weight of the body is distributed over a wide area with good skeletal support leading to decreased pressure points. Snoring and sleep apnea make these positions less desirable for many.

[0082] As people age, they prefer to sleep on their sides. As mattresses age, they also sink and put peoples' spines in compromised positions. Example problems with current mattresses are 1) no support for the human body, the spine is out of alignment; 2) even if the support is good, the mattress sinks over time; 3) mattress is too soft or too firm for different people; 4) limited 5-10 year lifetime with extremely high costs of \$3000+ U.S. dollars per mattress; 5) unnecessarily thick with overuse of materials; 6) extremely heavy – issues with transport, storage, and changing sheets. Finally, the environmental concerns of current flat mattresses are exemplified by the disposal problems such as commonly seeing an old mattress discarded alongside the road.

[0083] The custom sleep surfaces disclosed herein can be highly appealing once the technology is understood or is experienced in full along with each option. Exemplary custom sleep surface advantages, according to some embodiments are:

[0084] 1. A custom sleep surface to exactly match your body shape.

[0085] 2. A rigid sleep surface, that will not sink past the ideal spine aligning position.

[0086] 3. Excess padding has been replaced with a supportive custom structure with allowance for multiple sleep positions.

[0087] 4. Low-cost rigid surface combined with cheap 4" foam that is about \$130 (USD).

[0088] 5. Low cost of replacement foam for about \$130 (USD) memory foam.

[0089] 6. 30-pounds of memory foam versus 120+ pound Tempur-Pedic®.

[0090] 7. Modular rigid sleep surface that can be broken down for easy storage with lightweight memory foam.

[0091] 8. Unlimited dimensions due to modularity – potentially smaller than conventional beds for single sleepers.

[0092] 9. Heated and cooled ventilated bed.

[0093] According to some aspects, the various embodiments of the custom contoured sleep surface and their advantages can be understood by referring to the drawings. The elements of the drawings are not necessarily to scale, emphasis instead being placed upon clearly illustrating the novel features and principles of operation. In other aspects, the technology disclosed herein can be grasped by contemplating the unique variety of sleep surfaces fitting each unique person.

[0094] The ideal sleep position for all adults is to have the spine be in the same upright position it is in while standing upright. To be able to maintain this spinal alignment during side sleep the bed cannot be flat. For this, a bed that matches the contour of the specific person is necessary. To prevent the mattress from sinking over time, rigid support is necessary.

[0095] To model most of the population data from the Dreyfuss³ database, a summary table of which is shown in **FIG. 2A** and in **FIG. 2B**, is consulted. **FIG. 2A** and **FIG. 2B** are tables of fifteen values representing measurements of the human form, for men and women, respectively, derived from the Henry Dreyfuss³ database. **FIG. 2A** and **FIG. 2B** show the dimensions for male and female, respectively, for different percentiles for – XS, S, M, L, and XL sizes. These values can be extrapolated to get XXS and XXL sizes. A set of fifteen values were extracted from the database to derive five sizes to create shapes for back and side sleep.

[0096] It is clear that the human body can move in a large variety of intricate ways. This is due to the great number of joints throughout. Some of the most complex joints are in the spinal column. These joints surround some of the most critical nerves, such as the

spinal cord. While many of those joints are found in the spinal column, a person's health is intrinsically intertwined with the position of the spine because of a pinching of the spinal nerves when the spine is distorted. The spine's numerous vertebrae, or the collection of skeletal parts that stack up to create the spinal column, can each move a small amount¹⁹.

[0097] The mobility of each individual's spine is critical to having a pain-free life and for creating movements like crouching down low, rolling into a ball on the floor, twisting to look behind us, and leaning to the right or left. Keeping all of the joints in the spine mobile, is a key to performing daily activities and essential to our well-being. Thus, humans naturally seek a sleep position that is best for their spine, but until the presently disclosed technology, a sleep surface to provide this has not been available. The spine is organized with lighter, smaller vertebrae up top and larger, heavier vertebrae moving towards the tailbone. Even when a human stands up straight, the spinal vertebrae are stacked in a way that forms a series of curves. The natural curves of the spine include a slight kyphotic curve (a gentle forward "hunch") to the upper back, with curves in the opposite direction, lordotic curves, at the neck and lower back (e.g., the lumbar curvature).

[0098] A spine aligned in a way that keeps its natural curves intact is referred to as a "neutral spine." In some embodiments, a neutral spine position is a same spine position that the subject will have when the subject is in a standing up straight position.

[0099] This curvy spinal shape, in the standing up straight position (*i.e.*, the neutral position), serves a healthy purpose: Neutral curves help the parts of the spine, the bones, discs, ligaments, tendons, and muscles, carry loads efficiently and with minimal damage²⁰. Sleeping on a prior art sleep surface (e.g., a flat mattress), over time, leads to severe spine (and health) degeneration. **FIG. 3A** shows a sleep surface silhouette 201 based upon the fifteen values derived from **FIG. 2A** and **FIG. 2B**. **FIG. 3A** illustrates a silhouette based upon values from the table of **FIG. 2A** for a fiftieth-percentile male. The sleep surface silhouette 201 may be divided in a plurality of contour zones. The first contour zone, head zone 202 may be the head area and includes a length 1, representing the distance from the top of the head to the trapezius, and a depth 2, the distance from the spine, (shown as the spine line 250 in the illustration) to the ear. The neck zone 204 corresponds to the area between the neck and the outer portion of the shoulders and

includes depth 4 which is the distance from the spine line to the shoulder and length 5 from the top of the head to the shoulder. Neck zone 204 comprises a gradient descent from the neck to the shoulder.

[0100] Referring to **FIG. 3A**, the third zone or upper body zone 206 corresponds to the upper body (or shoulder) comprising depth 4 and length 6 which is the distance from the shoulder to the diaphragm. The upper body zone 206 transitions upward forming a recess. The upper body zone 206 terminates in a transition to another descent which marks the beginning of lower body zone 208. The lower body zone 208 roughly begins at the transition and comprises lengths 8, and 10, and depth 9. In some embodiments, lower body zone 208 can include a lumbar region. Length 8 is the length of the pelvis and length 10 is the distance from the widest part of the hip to the knee. Depth 9 is the spine line to the widest part of the pelvis. As can be seen in **FIG. 3A**, a depression is formed.

[0101] Continuing in **FIG. 3A**, the lower body zone 208 terminates in a transition where leg zone 210 begins. The leg zone 210 comprises depth 11 which is the distance from the spine line to the knee. The leg zone 210 also includes length 12, the distance from the knee to the ankle. The leg zone 210 is also characterized by a depression. Finally, foot zone 212 comprises length 14 which is the distance from the ankle to the bottom of the foot and preferably comprises a depression including depth 13 (ankle width from spine) and depth 15 (width of foot bottom).

[0102] **FIG. 3B**, **FIG. 3C**, and **FIG. 3D** show silhouettes 201a, 201b, and 201c for small, medium, and large sized men, respectively. As shown in the drawings, sleep surface silhouette 201 is for a man (M) reclined on the side. It will be appreciated that the silhouette may also be generated for a woman. Further, a silhouette may be developed for back and stomach sleep profiles as well.

[0103] **FIG. 3E** shows an illustration of a rough weight distribution for a 160-pound (or about a fiftieth percentile) male. Based on a weight distribution for any person, foam padding can be added to a sleep surface in different thicknesses or weights to support the weight distributions. **FIG. 3F** shows a table illustrating how 4-inch (10.16 cm) foam with 4-pound density (medium indentation load deflection, ILD) will compress with increasing weight. Based on knowledge of foam compression, different thicknesses of foam are utilized for different body areas, according to some aspects.

[0104] Referring to **FIG. 4A**, **FIG. 4B**, and **FIG. 4C**, an exemplary custom-contoured sleep surface 300 according to some embodiments is illustrated. A contoured rigid support 301 is formed from a sleep surface silhouette 201 generated from a subject's (e.g., "M") form data (length and depth measurements). Like sleep surface silhouette 201 of **FIG. 3A** and **FIG. 3B**, rigid support 301 comprises zones as described above. Rigid support 301 may be formed from any of thermoformed plastic, rotomolded plastic, prepreg fiberglass, vacuum infused composite with carbon, glass, epoxy or polyester resin, composite sandwich structure with glass or carbon skins, and foam, wood, aluminum honeycomb, aramid honeycomb, steel honeycomb for core, any suitable metal or alloy, kerfed wood, carbon fiber, or any suitable substance.

[0105] The sleep surface 300 may further comprise padding, such as a foam padding, described above in **FIG. 3F** and further described below. For example, foam padding could be memory foam. Preferably, padding is of various densities in different zones. Moreover, density of padding is preferably selected based upon the weight of the subject. In particular, padding may be selected based upon its compression due to weight of different parts of the subject's body, choosing higher density padding to support greater weight. **FIG. 3E** illustrates weight distribution for a subject M reclining on the side. It can be seen that most of the weight is comprised in the upper body and lower body areas. Consequently, padding of higher density should be selected for upper body zone 206 and/or lower body zone 208. Meanwhile, the head zone 202 and leg zone 210 could be padded with lower density padding because the weight distribution in those zones is less. Thus, depending on the weight of the person, different densities of memory foam will be selected. In an example, about 3 pound weight foam for S, 24 indentation load deflection (ILD), low density plush, 4 pound foam for M (28ILD, medium softness) and 5 pounds or more for L (32+ILD, firm high density).

[0106] Thus, referring again to **FIG. 4A**, **FIG. 4B**, and **FIG. 4C**, in head zone 202, to cushion the head, a padding 305, which may include a low-density foam is placed. Preferably, padding in this head zone 202 comprises layers of padding with a bottom layer 307 comprising a medium density foam. Since most of the subject's M weight will be distributed in upper body zone 206 and lower body zone 208, a high density padding 303 is overlaid on the rigid support 301 in those zones. Lastly, in leg zone 210 and foot

zone 212, sleep surface 300 comprises a low density padding 309. It will be appreciated that padding is shaped and dimensioned to fit the zones/contours of rigid surface 301. Padding may be any thickness. In some embodiments, padding is a foam padding having a thickness of 4 inches. In some embodiments, padding may comprise a “pillow” layer in the head zone 202 formed of a 1-inch layer of low-density foam. However, the “pillow” layer can be determined based upon keeping the spine straight.

[0107] FIG. 4D and FIG. 4E show illustrations of constant thickness memory foam layers with different shapes. In FIG. 4D, a chamfer edge 405 is provided on a foam piece. In FIG. 4E, a complimentary chamfer edge 406 is provided on another foam piece. As illustrated in FIG. 4F, the chamfer edge 405 can fit against the complimentary chamfer edge 406 to provide adjacent pieces of foam fitting against each other with a seamless flat surface.

[0108] It should be appreciated padding need not be affixed to rigid support 301. Padding may be simply overlaid on rigid support 301. On the other hand, padding may be removably or permanently attached to rigid support 301 in any suitable manner. For example, padding may be removably attached using, for example, mating hook and loop pieces (e.g., Velcro®). Alternatively, padding may be permanently affixed to rigid support 301 with an adhesive. Moreover, the various padding pieces may be adhered together to form a single piece for overlaying rigid support 301. In the alternative, if permanently attaching the padding to rigid support 301, each padding piece may be adhered to support 301 separately, then adhered together. FIG. 5A shows an illustration of hook and loop tape (dotted lines) that is utilized to hold memory foam to a (contoured) rigid sleep surface, according to some aspects. FIG. 5B shows an illustration of a bolster 510. The bolster can be utilized to keep a subject in a position. Bolsters can optionally be added near the legs in front of and behind the body, so they can be used when sleeping on both left and right sides. These will support the legs and prevent the body from rolling over and inducing a pelvic tilt. This will allow the side sleep position to be more adapted by more people.

[0109] FIG. 6A, FIG. 6B, FIG. 6C, and FIG. 6D show exemplary embodiments of a sleep surface including a system for heating or cooling the sleeper. In FIG. 6A, FIG. 6B, FIG. 6C, and FIG. 6D, another embodiment of ventilated sleep surface 310 in which rigid ventilated support 311 is configured with a plurality of air holes bored through is illustrated.

An air chamber is disposed beneath rigid ventilated support 311 and is in fluid communication with an air blower, and in some embodiments, a Peltier cooler. Padding may be perforated such that air (which may be heated or cooled) may flow from blower into air chamber, through air holes in rigid ventilated support 311, and through padding. In this manner, the subject M may be heated or cooled as desired.

[0110] FIG. 7A and FIG. 7B illustrate how a further embodiment of raised sleep surface 315 is provided with a base to raise the surface from the floor. The base may comprise a plurality of vertical base supports 701a, 701b, and 701c disposed beneath rigid support 301. Legs 703a, 703b, 703c, and 703d may be provided in pivoting connection with the vertical supports as shown. Accordingly, legs may be folded, as depicted in FIG. 7B, or extended (FIG. 7A) to offer different elevations.

[0111] FIG. 8A and FIG. 8B show another embodiment where sleep surface 300 may be combined with a base 801 in which is defined one or more cavities 802 for storage. It should be noted that a sleep surface for a back sleeper 300b is placed beside a sleep surface for a side sleeper 300a. Thus, different surfaces may be placed together for couples. In this way, couples with different sleep positions may sleep together, each having their own unique sleep position.

[0112] The sleep surfaces disclosed herein, and the various embodiments offer many advantages over conventional beds. For example, because of the contoured rigid support, the sleep surface will not sag or sink past the ideal spine aligning position. Excess padding has been replaced with supportive custom structure with allowance for multiple sleep positions. Indeed, the custom structure may be created not only for side sleepers, but it will be appreciated that the structure may be beneficial for back sleepers, and stomach sleepers. For that matter, pregnant women may benefit from the custom sleep structure as well. Furthermore, the sleep surface may be configured to be modular that can be broken down for easy storage with lightweight memory foam.

[0113] Various methods for making the custom sleep surfaces are discussed in the Examples below. FIG. 9A, FIG. 9B, and FIG. 9C illustrate methods for obtaining a subject's form measurements with an app on a smart device, such as a smartphone, a terahertz scanner, sonar, or lidar. FIG. 10 is a flowchart of an exemplary method of making a sleep surface according to some embodiments.

[0114] **FIG. 11A** depicts example steps of another method for making a sleep surface. This method or any step therein can be combined with any other embodiment herein. In step 100, the process begins with scanning a unique body surface of the subject. This step is for creating a custom-designed bed that ensures the person's spine remains in a neutral position when lying down for sleep. The scanning captures the unique body contours of the subject, which is for fabricating a sleep surface silhouette that matches these contours. The custom-designed bed is tailored to maintain proper alignment during sleep and provide a personalized fit for comfort and support. A sub-step of 100 involves the sleep surface silhouette including a head support region contoured to cradle the head of the person. This head support region is designed to provide targeted support and comfort to the person's head, ensuring that the head is properly cradled and aligned with the rest of the body. Another sub-step of 100 focuses on the shoulder support region, which is contoured to accommodate the shoulder of the person. This region provides targeted support and comfort to the person's shoulder, ensuring that the shoulder is properly supported and aligned. A sub-step addresses the lumbar support region, which is contoured to support the lumbar region of the person. This region provides targeted support and comfort to the person's lumbar area, helping to maintain the natural curve of the spine and prevent lower back pain. A sub-step involves the leg support region, which is contoured to support the legs of the person. This region provides targeted support and comfort to the person's legs, ensuring that they are properly supported and aligned with the rest of the body. A sub-step focuses on the foot support region, which is contoured to support the feet of the person. This region provides targeted support and comfort to the person's feet, ensuring that they are properly supported and aligned. Another sub-step includes the bed having a memory foam layer that conforms to the body of the person. The memory foam layer provides a conforming and comfortable surface that adapts to the person's body shape, enhancing overall comfort and support. An optional sub-step specifies that the unique body surface includes a side of the subject. This ensures that the sleep surface is contoured to fit the subject's side profile, providing proper support for side sleeping positions. For back sleepers, a sub-step indicates that the unique body surface includes a back of the subject. This ensures that the sleep surface is contoured to fit the subject's back profile, providing proper support for back

sleeping positions. Overall, the custom-designed bed, with its contoured shape and sleep surface silhouette, is crafted to match the unique body surfaces of the person. This design ensures that the person's spine is maintained in a neutral position, potentially improving sleep quality and comfort. The bed's various support regions and memory foam layer work together to provide a personalized fit, enhancing comfort and support for the person during sleep.

[0115] In one sub-step, the focus is on the head support region of the custom-designed bed. The sleep surface silhouette includes a head support region contoured to cradle the head of the person. This head support region is designed to provide targeted support and comfort to the person's head. The contoured shape of the sleep surface silhouette is intended to match the unique body surfaces of the person, ensuring a personalized fit for comfort and support. The purpose of the sleep surface silhouette with a contoured shape is to match the unique body surfaces of a person, which may provide better support and comfort during sleep. This design is part of a custom-designed bed for keeping a person's spine in a neutral position when the person is lying down for sleep. The custom-designed bed comprises a sleep surface silhouette that is in a contoured shape that matches the unique body surfaces of the person. The head support region's contoured shape is tailored to cradle the head, enhancing comfort and maintaining proper spinal alignment during sleep.

[0116] In a sub-step focusing on the shoulder support region of the custom-designed bed, the sleep surface silhouette includes a shoulder support region contoured to accommodate the shoulder of the person. This shoulder support region is designed to provide targeted support and comfort to the person's shoulder. The contoured shape of the sleep surface silhouette is intended to match the unique body surfaces of the person, ensuring that the shoulder is properly supported. The custom-designed bed aims to maintain the spine of a person in a neutral position to potentially improve sleep quality and comfort. The shoulder support region is a component in achieving this goal, as it helps to align the shoulder with the rest of the body, thereby contributing to the overall spinal alignment. The contoured shape of the shoulder support region is tailored to fit the unique body surfaces of the person, providing a personalized fit for comfort and support. The purpose of the sleep surface silhouette with a contoured shape is to match the unique

body surfaces of a person, which may provide better support and comfort during sleep. This personalized fit is for maintaining proper alignment during sleep, as it ensures that each part of the body, including the shoulder, is adequately supported. In summary, this sub-step highlights the shoulder support region in the custom-designed bed. The contoured shape of the sleep surface silhouette is designed to accommodate the shoulder of the person, providing targeted support and comfort. This personalized fit helps to maintain the spine in a neutral position, potentially improving sleep quality and comfort.

[0117] In a sub-step focusing on the lumbar support region of the custom-designed bed, the sleep surface silhouette includes a lumbar support region contoured to support the lumbar region of the person. This step is for ensuring that the bed provides targeted support and comfort to the person's lumbar region, which is for maintaining proper spinal alignment and enhancing overall comfort during sleep. The lumbar support region is designed to match the unique body surfaces of the person, ensuring that the contoured shape of the sleep surface silhouette provides a personalized fit. This personalized fit is achieved by matching the unique body surfaces of the person, which may provide better support and comfort during sleep. The purpose of the sleep surface silhouette with a contoured shape is to match the unique body surfaces of a person, which may provide better support and comfort during sleep. The custom-designed bed is intended to keep a person's spine in a neutral position when the person is lying down for sleep. This is achieved by the contoured shape of the sleep surface silhouette, which matches the unique body surfaces of the person. The purpose of the custom-designed bed is to maintain the spine of a person in a neutral position to potentially improve sleep quality and comfort. In summary, this sub-step involves the inclusion of a lumbar support region in the sleep surface silhouette of the custom-designed bed. This region is contoured to support the lumbar region of the person, providing targeted support and comfort. The contoured shape of the sleep surface silhouette matches the unique body surfaces of the person, ensuring a personalized fit that helps maintain proper spinal alignment and enhances overall comfort during sleep.

[0118] In another sub-step, the focus is on the leg support region of the custom-designed bed. The leg support region is a component of the sleep surface silhouette, which is contoured to support the legs of the person. This region is designed to match the

unique body surfaces of the person, ensuring that the legs are adequately supported during sleep. The purpose of this contoured shape is to provide a personalized fit for comfort and support, which is for maintaining the spine in a neutral position. The leg support region, as described in the claims, is included to support the legs. This action is for providing targeted support and comfort to the person's legs. The custom-designed bed's sleep surface silhouette, which includes the leg support region, is in a contoured shape that matches the unique body surfaces of the person. This design ensures that the bed adapts to the specific shape of the legs, providing tailored support that helps keep the spine in a neutral position. The specific attributes of the leg support region include its contoured shape, which is designed to match the unique body surfaces of the person. This contoured shape is part of the overall sleep surface silhouette, which is crafted to provide better support and comfort during sleep. The leg support region's purpose is to ensure that the legs are supported in a way that contributes to the overall goal of maintaining the spine in a neutral position, thereby potentially improving sleep quality and comfort. In summary, the leg support region of the custom-designed bed is a component that supports the legs by matching the unique body surfaces of the person. This contoured shape provides a personalized fit for comfort and support, helping to maintain the spine in a neutral position during sleep. The detailed design and purpose of the leg support region highlight its importance in the overall functionality of the custom-designed bed.

[0119] In a foot support sub-step, the focus is on the foot support region of the custom-designed bed. The sleep surface silhouette includes a foot support region contoured to support the feet of the person. This foot support region is designed to match the unique body surfaces of the person, ensuring that the feet are adequately supported and comfortable during sleep. The contoured shape of the foot support region is tailored to provide a personalized fit for comfort and support, which is for maintaining proper alignment and relaxation. The custom-designed bed, as described in the claims, is intended to keep a person's spine in a neutral position when the person is lying down for sleep. This is achieved through various regions of the sleep surface silhouette, each contoured to match different parts of the body. The foot support region is one such area, ensuring that the feet are supported in a way that contributes to the overall goal of spinal alignment and comfort. The foot support region, like other regions of the sleep surface

silhouette, is part of a system that adapts to the specific shape of the individual's body parts. This adaptation is for providing tailored support and enhancing the state of relaxation for the person using the bed. The contoured shape of the foot support region, along with other regions, matches the unique body surfaces of the person, ensuring that each part of the body is supported in a way that maintains the spine's neutral position. The custom-designed bed comprises a sleep surface silhouette that is in a contoured shape matching the unique body surfaces of the person. This includes the foot support region, which is specifically contoured to support the feet. The purpose of this design is to provide a personalized fit for comfort and support, contributing to the overall goal of maintaining proper spinal alignment during sleep. The foot support region's contoured shape is an embodiment of the aim to match the unique body surfaces of a person, providing better support and comfort during sleep. This region, along with other contoured regions of the sleep surface silhouette, ensures that the bed adapts to the specific position and shape of the individual's body parts, offering a state of relaxation and maintaining the spine in a neutral position.

[0120] In a customizing sub-step, the bed includes a memory foam layer that conforms to the body of the person. The memory foam layer is designed to provide a conforming and comfortable surface that adapts to the person's body shape. This feature is for ensuring that the sleep surface silhouette, which is in a contoured shape, matches the unique body surfaces of the person. The purpose of the sleep surface silhouette with a contoured shape is to match the unique body surfaces of a person, which may provide better support and comfort during sleep. The custom-designed bed is intended to keep a person's spine in a neutral position when the person is lying down for sleep. This is achieved by the memory foam layer's ability to conform to the body's contours, thereby providing a personalized fit for comfort and support. The bed's design aims to maintain proper alignment during sleep, potentially improving sleep quality and comfort. The memory foam layer's adaptability ensures that the bed can offer targeted support to various body parts, enhancing the overall state of relaxation for the person using the bed.

[0121] In consideration of the popularity of side sleep, the unique body surface can include a side of the subject. This step involves ensuring that the sleep surface is contoured to fit the subject's side profile for side sleeping positions. The custom-designed

bed is tailored to match the unique body surfaces of the person, which includes the side of the subject. This customization is for providing a personalized fit for comfort and support, ensuring that the spine remains in a neutral position during sleep. The custom-designed bed comprises a sleep surface silhouette that is in a contoured shape that matches the unique body surfaces of the person. The purpose of the sleep surface silhouette with a contoured shape is to match the unique body surfaces of a person, which may provide better support and comfort during sleep. This contoured shape is designed to adapt to the specific position of a part of an individual's body, offering a state of relaxation and enhancing comfort and relaxation for the person using the bed. The bed is designed for a specific purpose: to keep a person's spine in a neutral position when the person is lying down for sleep. This is achieved by the bed adapting to the specific shape of specific body parts, including the side of the subject. The contoured shape of the sleep surface silhouette matches the unique body surfaces of the person, ensuring that the spine is maintained in a neutral position, which is for proper alignment and potentially improving sleep quality and comfort. The custom-designed bed also includes various regions contoured to support different parts of the body, such as the head, shoulder, lumbar, leg, and foot support regions. These regions are designed to provide targeted support and comfort to the respective body parts, further enhancing the overall comfort and support provided by the bed. In summary, the side step design focuses on the unique body surface of the subject's side, ensuring that the sleep surface is contoured to fit the side profile for side sleeping positions. This customization is part of the broader design of the custom-designed bed, which aims to keep the spine in a neutral position and provide personalized comfort and support by matching the unique body surfaces of the person.

[0122] In consideration of back sleep, the unique body surface includes a back of the subject. This step is for ensuring that the custom-designed bed provides optimal support and comfort for individuals who sleep on their back. The custom-designed bed is tailored to keep a person's spine in a neutral position when the person is lying down for sleep. This is achieved through a sleep surface silhouette that is in a contoured shape matching the unique body surfaces of the person. The bed's design includes several regions contoured to support different parts of the body, such as the head, shoulders, lumbar region, legs, and feet. Each of these regions is designed to match the unique body

surfaces of the person, providing a personalized fit for comfort and support. For instance, the head support region is contoured to cradle the head, the shoulder support region accommodates the shoulder, the lumbar support region supports the lumbar region, the leg support region supports the legs, and the foot support region supports the feet. Additionally, the bed includes a memory foam layer that conforms to the body of the person, further enhancing the personalized fit and comfort. The above examples can be implemented for stomach sleep.

[0123] In some embodiments, the custom-designed bed also includes an environmental control unit to regulate temperature and humidity, creating an optimal sleeping environment. Moreover, it can be, in some embodiments, equipped with a monitoring system to track sleep patterns, which can help in analyzing and improving sleep quality. The process of creating this custom-designed bed involves scanning the unique body surface of the subject to capture their body contours. This data is then used to make a sleep surface silhouette in a contoured shape that matches the unique body surface of the subject. The contoured shape conforms to the subject's body surface when the subject is sleeping on their side, back, or stomach, ensuring that the spine is maintained in a neutral position regardless of the sleeping position. In summary, this sub-step emphasizes the importance of including the back profile of the subject in the design of the custom-designed bed. This ensures that the bed provides tailored support to the back, maintaining the spine in a neutral position and enhancing overall comfort and sleep quality. The custom-designed bed, with its contoured sleep surface silhouette and memory foam layer, offers a personalized fit that adapts to the unique body surfaces of the person, providing targeted support and comfort to various body parts.

[0124] Referring to **FIG. 11A**, in step 102, the process involves making a sleep surface silhouette in a contoured surface to match the unique body surface of the subject. This step is in the creation of a custom-designed bed that aims to keep a person's spine in a neutral position when lying down for sleep. The entities involved in this step include the custom-designed bed, contoured shape, neutral position, unique body surfaces, person's spine, sleep surface silhouette, and person. The custom-designed bed is designed for a specific purpose, which is to keep a person's spine in a neutral position when the person is lying down for sleep. This bed adapts to the specific position of a part

of an individual's body, offering a state of relaxation and tailored support to various body parts. The bed comprises a sleep surface silhouette that is in a contoured shape that matches the unique body surfaces of the person. The purpose of the custom-designed bed is to maintain the spine of a person in a neutral position to potentially improve sleep quality and comfort. The contoured shape of the sleep surface silhouette is designed to match the unique body surfaces of the person. This contoured shape is for providing a personalized fit for comfort and support, ensuring that the bed adapts to the specific shape of the person's body parts. The sleep surface silhouette includes various regions contoured to support different parts of the body, such as the head, shoulders, lumbar region, legs, and feet. Each of these regions is designed to provide targeted support and comfort to the respective body parts, enhancing the overall relaxation and spinal alignment of the person. The unique body surfaces of the person are captured through a scanning process, which ensures that the sleep surface silhouette is tailored to the individual's body shape. This customization is for maintaining the person's spine in a neutral position, as it allows the bed to provide the necessary support and alignment based on the person's unique body contours. The person's spine is a focus of the custom-designed bed, as the primary goal is to keep the spine in a neutral position during sleep. This alignment helps in reducing strain on the spine and potentially improving sleep quality and comfort. The bed's design, including the contoured shape and sleep surface silhouette, works together to achieve this goal by providing a personalized fit that supports the spine's natural curvature. The sleep surface silhouette, being in a contoured shape, matches the unique body surfaces of the person. This design ensures that the bed provides optimal support and comfort, adapting to the individual's body shape and maintaining proper spinal alignment. The contoured shape conforms to the subject's body surface when the subject is sleeping on their side, back, or stomach, providing versatile support for various sleeping positions. In summary, step 102 involves making a sleep surface silhouette in a contoured surface to match the unique body surface of the subject. This process is integral to the custom-designed bed's ability to keep a person's spine in a neutral position, offering personalized support and comfort based on the individual's unique body contours. The bed's design, including the contoured shape and sleep surface

silhouette, ensures that the person's spine is maintained in a neutral position, potentially improving sleep quality and comfort.

[0125] Turning now to **FIG. 11B**, an example method for keeping a subject's spine in a neutral position during sleep is illustrated. In step 200, the process involves obtaining a surface that is in a contoured shape to conform to a unique body surface of the subject in a lying down position. This step can include any embodiment disclosed herein. This step is for ensuring that the custom-designed bed can maintain the spine of a person in a neutral position, which is for improving sleep quality and comfort. The custom-designed bed is designed to keep a person's spine in a neutral position when the person is lying down for sleep. This is achieved through a sleep surface silhouette that is in a contoured shape that matches the unique body surfaces of the person. The contoured shape of the sleep surface silhouette is designed to match the unique body surfaces of the person, providing a personalized fit for comfort and support. This contoured shape is for maintaining proper alignment during sleep, ensuring that the spine remains in a neutral position. The purpose of the sleep surface silhouette with a contoured shape is to match the unique body surfaces of a person, which may provide better support and comfort during sleep. The custom-designed bed comprises a sleep surface silhouette that is in a contoured shape that matches the unique body surfaces of the person. This contoured shape conforms to the subject's body surface when the subject is sleeping on the subject's side, back, or stomach. This versatility ensures that the sleep surface can accommodate various sleeping positions while maintaining spinal alignment. The process of obtaining this contoured surface involves acquiring a surface that matches the subject's body shape for maintaining proper spinal alignment. This step is for ensuring that the custom-designed bed can provide the necessary support and comfort for the person using it. The contoured shape is designed to adapt to the subject's body surface in various sleeping positions, providing a versatile sleep surface that accommodates different sleeping positions while maintaining spinal alignment. Overall, step 200 is a part of the method for keeping a subject's spine in a standing spine position or in a neutral spine position when the subject is in a sleep position or when the subject is lying down. The custom-designed bed, with its contoured shape and sleep surface silhouette, ensures

that the unique body surfaces of the person are matched, providing a personalized fit for comfort and support, and maintaining proper alignment during sleep.

[0126] In a sub-step of 200, the contoured shape conforms to the subject's body surface when the subject is sleeping on the subject's side, back, or stomach. The primary component involved in this step is the contoured shape, which is a part of the custom-designed bed. The contoured shape is designed to match the unique body surfaces of the person, ensuring that the bed provides a personalized fit for comfort and support. This design is for maintaining the spine in a neutral position, which is the primary purpose of the custom-designed bed. The contoured shape is part of the sleep surface silhouette, which is tailored to match the unique body surfaces of the person. This tailoring process involves scanning the unique body surface of the subject and making a sleep surface silhouette in a contoured surface to match the unique body surface of the subject. The contoured shape is designed to adapt to the subject's body surface in various sleeping positions, including side, back, or stomach sleeping positions. This adaptability ensures that the bed provides consistent support and comfort, regardless of the subject's preferred sleeping position. The contoured shape's ability to conform to the subject's body surface is for maintaining proper spinal alignment during sleep. By matching the unique body surfaces of the person, the contoured shape helps to keep the spine in a neutral position, which can potentially improve sleep quality and comfort. The custom-designed bed, with its contoured shape and sleep surface silhouette, is thus designed to provide a personalized fit that enhances both comfort and spinal support. In summary, the sub-step involves the contoured shape conforming to the subject's body surface in various sleeping positions, ensuring that the custom-designed bed provides personalized support and maintains the spine in a neutral position. This step highlights the importance of the contoured shape in achieving the bed's primary purpose of improving sleep quality and comfort through proper spinal alignment.

[0127] Continuing to refer to **FIG. 11B**, in step 220, the process involves positioning the surface in a plane that is about parallel to a horizontal surface of the Earth. This step is for ensuring that the custom-designed bed, which is intended to keep a person's spine in a neutral position, is correctly oriented. The custom-designed bed is designed to maintain the spine of a person in a neutral position to potentially improve sleep quality

and comfort. The bed comprises a sleep surface silhouette that is in a contoured shape that matches the unique body surfaces of the person. The action of positioning the surface is to ensure that the contoured shape of the sleep surface silhouette can effectively match the unique body surfaces of the person. This alignment is for providing a personalized fit for comfort and support, thereby maintaining proper alignment during sleep. The contoured shape of the sleep surface silhouette is designed to match the unique body surfaces of a person, which may provide better support and comfort during sleep. The custom-designed bed includes various regions such as the head support region, shoulder support region, lumbar support region, leg support region, and foot support region, all contoured to match the unique body surfaces of the person. Additionally, the bed may include a memory foam layer that conforms to the body of the person, further enhancing the personalized fit and support. By positioning the surface in a plane parallel to the horizontal surface of the Earth, the bed ensures that the unique body surface of the subject makes contact with the contoured shape of the surface. This contact is for maintaining the spine in a neutral position, whether the subject is sleeping on their side, back, or stomach. The purpose of the sleep surface silhouette with a contoured shape is to match the unique body surfaces of a person, which may provide better support and comfort during sleep. In summary, step 220 involves the precise positioning of the custom-designed bed's surface to ensure that it is parallel to the horizontal surface of the Earth. This positioning is for the bed to function as intended, providing a personalized fit that maintains the spine in a neutral position, thereby enhancing sleep quality and comfort.

[0128] In step 240, the process involves positioning the subject on the contoured shape of the surface such that the unique body surface of the subject makes contact with the contoured shape of the surface. This step is for ensuring that the custom-designed bed functions as intended, maintaining the spine in a neutral position and providing personalized support and comfort. The custom-designed bed is designed to keep a person's spine in a neutral position when lying down for sleep. This is achieved through a sleep surface silhouette that is in a contoured shape matching the unique body surfaces of the person. The contoured shape of the sleep surface silhouette is tailored to the individual's body, ensuring that each part of the body receives the necessary support.

The bed includes several regions contoured to support different parts of the body: a head support region contoured to cradle the head of the person, a shoulder support region contoured to accommodate the shoulder of the person, a lumbar support region contoured to support the lumbar region of the person, a leg support region contoured to support the legs of the person, and a foot support region contoured to support the feet of the person. Additionally, the bed may include a memory foam layer that conforms to the body of the person, enhancing the personalized fit and comfort. The memory foam layer adapts to the specific shape of the body, providing a conforming and comfortable surface.

[0129] In some embodiments, the custom-designed bed is part of a sleep system that may include an environmental control unit to regulate temperature and humidity, creating an optimal sleeping environment. It may also be equipped with a monitoring system to track sleep patterns, providing insights into sleep quality and health. The process of creating this custom-designed bed involves scanning the unique body surface of the subject to capture the body contours. This data is then used to make a sleep surface silhouette in a contoured shape that matches the unique body surface of the subject. The contoured shape conforms to the subject's body surface when the subject is sleeping on their side, back, or stomach, ensuring versatile support and maintaining spinal alignment in various sleeping positions. In step 240, positioning the subject on the contoured shape of the surface ensures that the unique body surface of the subject makes contact with the contoured shape of the surface. This alignment is for optimal support and spinal alignment, providing a personalized fit for comfort and support. The purpose of the sleep surface silhouette with a contoured shape is to match the unique body surfaces of a person, which may provide better support and comfort during sleep.

[0130] The custom-designed bed is crafted to maintain a person's spine in a neutral position when lying down for sleep. This bed comprises a sleep surface silhouette that is in a contoured shape, matching the unique body surfaces of the person. The primary purpose of this design is to provide comfort and support for the spine during sleep, ensuring proper alignment and a personalized fit for enhanced comfort and support. The bed adapts to specific positions of various parts of an individual's body, offering a state of relaxation. It includes a head support region contoured to cradle the head of the person, a shoulder support region contoured to accommodate the shoulder, a lumbar support

region contoured to support the lumbar region, a leg support region contoured to support the legs, and a foot support region contoured to support the feet. Each of these regions is designed to match the unique body surfaces of the person, providing targeted support and comfort. Additionally, the bed includes a memory foam layer that conforms to the body of the person, further enhancing the personalized fit and comfort.

[0131] In some embodiments, the bed is also part of a sleep system that includes an environmental control unit to regulate temperature and humidity, creating an optimal sleeping environment. Moreover, it can be, according to some aspects, equipped with a monitoring system to track sleep patterns, which can help in analyzing and improving sleep quality. The method for making this bed involves scanning a unique body surface of the subject and making a sleep surface silhouette in a contoured shape to match the unique body surface. This ensures that the bed is tailored to the individual's body shape, providing enhanced comfort and support. The unique body surface can include the side or back of the subject, ensuring that the sleep surface is contoured to fit various sleeping positions. In summary, the custom-designed bed is a sleep solution that adapts to the specific positions and shapes of an individual's body parts, offering a state of relaxation and maintaining the spine in a neutral position. It includes various support regions, a memory foam layer, an environmental control unit, and a monitoring system, all working together to provide a personalized fit for comfort and support, and to maintain proper alignment during sleep.

[0132] The head support region is a component of the custom-designed bed, designed to cradle the head of the person. This region is part of the sleep surface silhouette, which is in a contoured shape that matches the unique body surfaces of the person. The head support region includes cradling the head, which is for providing a personalized fit for comfort and support. The purpose of this region is to ensure that the head is adequately supported, contributing to the overall goal of maintaining the spine in a neutral position during sleep. The contoured shape of the head support region is tailored to match the unique body surfaces of the person, ensuring that the head is comfortably cradled, which can help in reducing strain on the neck and promoting better sleep quality. The shoulder support region is another part of the custom-designed bed. This region is contoured to accommodate the shoulder of the person, ensuring that the shoulder is

supported in a way that matches the unique body surfaces of the individual. The shoulder support region includes accommodating the shoulder, which is for providing a personalized fit for comfort and support. By matching the unique body surfaces, this region helps in distributing the body weight evenly, reducing pressure points, and maintaining proper spinal alignment.

[0133] The contoured shape of the shoulder support region ensures that the shoulder is comfortably accommodated, which can help in preventing shoulder pain and improving overall sleep quality. The lumbar support region is designed to support the lumbar region of the person. This region is part of the sleep surface silhouette and is contoured to match the unique body surfaces of the person. The lumbar support region includes supporting the lumbar region, which is for providing a personalized fit for comfort and support. The purpose of this region is to ensure that the lower back is adequately supported, which can help in maintaining the natural curve of the spine and preventing lower back pain. The contoured shape of the lumbar support region ensures that the lumbar area is comfortably supported, which can contribute to better spinal alignment and improved sleep quality. The leg support region is contoured to support the legs of the person. This region is part of the sleep surface silhouette and is designed to match the unique body surfaces of the individual. The leg support region includes supporting the legs, which is for providing a personalized fit for comfort and support. By matching the unique body surfaces, this region helps in distributing the body weight evenly, reducing pressure points, and maintaining proper spinal alignment.

[0134] The contoured shape of the leg support region ensures that the legs are comfortably supported, which can help in preventing leg pain and improving overall sleep quality. The foot support region is designed to support the feet of the person. This region is part of the sleep surface silhouette and is contoured to match the unique body surfaces of the individual. The foot support region includes supporting the feet, which is for providing a personalized fit for comfort and support. By matching the unique body surfaces, this region helps in distributing the body weight evenly, reducing pressure points, and maintaining proper spinal alignment. The contoured shape of the foot support region ensures that the feet are comfortably supported, which can help in preventing foot pain and improving overall sleep quality. The memory foam layer is an additional feature

of the custom-designed bed, which conforms to the body of the person. This layer is part of the sleep surface silhouette and is designed to match the unique body surfaces of the individual.

[0135] The memory foam layer includes conforming to the body, which is for providing a personalized fit for comfort and support. The purpose of this layer is to ensure that the body is adequately supported, which can help in maintaining proper spinal alignment and reducing pressure points. The contoured shape of the memory foam layer ensures that the body is comfortably supported, which can contribute to better sleep quality and overall comfort. The custom-designed bed also includes an environmental control unit, which is part of the sleep system. This unit is designed to regulate temperature and humidity, creating an optimal sleeping environment. The environmental control unit includes regulating temperature and humidity, which is for maintaining proper alignment during sleep. By keeping the spine in a neutral position, this unit helps in improving sleep quality and comfort. The purpose of the environmental control unit is to ensure that the sleeping environment is conducive to restful sleep, which can help in maintaining the spine in a neutral position and preventing sleep disturbances. The monitoring system is another feature of the custom-designed bed, which is equipped to track sleep patterns. This system is designed to monitor and analyze the person's sleep patterns for health and sleep quality improvement. The monitoring system includes tracking sleep patterns, which is for maintaining proper alignment during sleep. By keeping the spine in a neutral position, this system helps in improving sleep quality and comfort. The purpose of the monitoring system is to provide insights into the person's sleep patterns, which can help in identifying any issues and making necessary adjustments to improve sleep quality.

[0136] In summary, the custom-designed bed is crafted to keep a person's spine in a neutral position when lying down for sleep. It comprises a sleep surface silhouette that is in a contoured shape, matching the unique body surfaces of the person. The head support region cradles the head, the shoulder support region accommodates the shoulder, the lumbar support region supports the lumbar region, the leg support region supports the legs, and the foot support region supports the feet. Additionally, the memory foam layer conforms to the body, the environmental control unit regulates temperature

and humidity, and the monitoring system tracks sleep patterns. All these features work together to provide a personalized fit for comfort and support, ensuring proper spinal alignment and enhancing overall sleep quality.

[0137] The shoulder support region is a component of the custom-designed bed, tailored to accommodate the shoulder of the person. This region includes a contoured shape that matches the unique body surfaces of the person, ensuring a personalized fit for comfort and support. The shoulder support region is designed to provide targeted support and comfort to the person's shoulder, which is for maintaining proper alignment during sleep. The contoured shape of the shoulder support region adapts to the specific position of the shoulder, offering a state of relaxation and enhancing the overall comfort of the bed. In the context of the claims, the shoulder support region is mentioned in claim 3, where it is described as being contoured to accommodate the shoulder of the person. This ensures that the shoulder is properly supported, preventing any discomfort or misalignment that could occur during sleep. The contoured shape of the shoulder support region is part of the sleep surface silhouette, which is designed to match the unique body surfaces of the person. This matching is for providing a personalized fit that enhances comfort and support. The shoulder support region's contoured shape is also mentioned in the method claims, specifically in claim 12, where it is included as part of the sleep surface silhouette that is made to match the unique body surface of the subject. This method involves scanning the unique body surface of the subject and making a sleep surface silhouette in a contoured shape to match the unique body surface. The shoulder support region, being part of this contoured shape, ensures that the shoulder is properly accommodated, providing targeted support and comfort. Additionally, the shoulder support region's contoured shape is designed to conform to the subject's body surface when the subject is sleeping on their side, back, or stomach. This versatility is for maintaining spinal alignment and providing support in various sleeping positions. The contoured shape of the shoulder support region ensures that the shoulder is properly supported, regardless of the sleeping position, which is for maintaining the spine in a neutral position. Overall, the shoulder support region is a part of the custom-designed bed, providing targeted support and comfort to the shoulder. Its contoured shape matches the unique body surfaces of the person, ensuring a personalized fit that enhances comfort

and support. This region is designed to accommodate the shoulder, preventing discomfort and misalignment during sleep, and is part of the sleep surface silhouette that is made to match the unique body surface of the subject. The shoulder support region's contoured shape also adapts to various sleeping positions, ensuring proper support and spinal alignment.

[0138] The lumbar support region is a component of the custom-designed bed, engineered to support the lumbar region of the person. This region is part of the sleep surface silhouette, which is in a contoured shape that matches the unique body surfaces of the person. The primary purpose of this design is to provide a personalized fit for comfort and support, ensuring that the lumbar region receives targeted support. The lumbar support region includes supporting the lumbar region and matching with unique body surfaces, which is for maintaining proper spinal alignment during sleep. In the context of the claims, the lumbar support region is mentioned in claim 4, where it is described as being contoured to support the lumbar region of the person. This contoured shape is designed to match the unique body surfaces of the person, providing tailored support to the lumbar area. The specific attributes of the lumbar support region in the claims include its contoured shape and its purpose of supporting the lumbar region, which aligns with the overall goal of the custom-designed bed to keep a person's spine in a neutral position when lying down for sleep. From the actions, the lumbar support region includes supporting the lumbar region and matching with unique body surfaces. This action is for providing a personalized fit for comfort and support, ensuring that the lumbar region is adequately supported. The purpose of this action is to provide a personalized fit for comfort and support, which is for maintaining proper spinal alignment and enhancing sleep quality. The specific attributes of the lumbar support region include its contoured shape that matches the unique body surfaces of the person. This design ensures that the lumbar region receives targeted support, which is for maintaining proper spinal alignment and enhancing sleep quality. The additional attributes highlight the importance of the contoured shape in providing better support and comfort during sleep. Implicitly, the lumbar support region works in conjunction with other regions of the sleep surface silhouette, such as the head support region, shoulder support region, leg support region, and foot support region. Each of these regions is contoured to match the unique body

surfaces of the person, providing targeted support to different parts of the body. The memory foam layer, which conforms to the body of the person, further enhances the personalized fit and comfort of the custom-designed bed. Overall, the lumbar support region is a part of the custom-designed bed, providing targeted support to the lumbar region and ensuring proper spinal alignment during sleep. The contoured shape of the sleep surface silhouette, which matches the unique body surfaces of the person, plays a role in providing a personalized fit for comfort and support. This design not only enhances sleep quality but also helps maintain the spine in a neutral position, which is for overall health and well-being.

[0139] The leg support region is a component of the custom-designed bed, which is crafted to ensure that a person's spine remains in a neutral position while they are lying down for sleep. This bed features a sleep surface silhouette that is contoured to match the unique body surfaces of the individual, thereby providing a personalized fit for comfort and support. The leg support region specifically includes supporting the legs and matching with unique body surfaces. This region is designed to provide targeted support and comfort to the person's legs, ensuring that the legs are adequately supported throughout the night. In the context of the claims, the leg support region is part of the sleep surface silhouette that includes various other regions such as the head support region, shoulder support region, lumbar support region, and foot support region. Each of these regions is contoured to match the unique body surfaces of the person, thereby providing a personalized fit for comfort and support. The leg support region, in particular, is for maintaining proper alignment of the legs, which in turn helps in keeping the spine in a neutral position. The custom-designed bed also includes a memory foam layer that conforms to the body of the person, further enhancing the personalized fit and comfort. This memory foam layer works in conjunction with the contoured sleep surface silhouette to provide a conforming and comfortable surface that adapts to the person's body shape.

[0140] The method for making this bed involves scanning a unique body surface of the subject and making a sleep surface silhouette in a contoured surface to match the unique body surface of the subject. This ensures that the bed is tailored to the individual's body shape, providing enhanced comfort and support. In summary, the leg support region, along with other contoured regions of the sleep surface silhouette, plays a role in

maintaining the spine in a neutral position, providing targeted support and comfort, and ensuring a personalized fit for the individual. The inclusion of a memory foam layer, environmental control unit, and monitoring system further enhances the functionality and comfort of the custom-designed bed.

[0141] The foot support region is an integral part of the custom-designed bed, engineered to support the feet of the person. This region is included in the sleep surface silhouette and is contoured to match the unique body surfaces of the person. The primary purpose of this design is to provide a personalized fit for comfort and support, ensuring that the feet are adequately supported during sleep. This contoured shape is for maintaining proper alignment and enhancing comfort, as it adapts to the specific shape of the feet, thereby contributing to the overall goal of keeping the spine in a neutral position. In the context of the claims, the foot support region is mentioned in claim 6, which states that the sleep surface silhouette includes a foot support region contoured to support the feet of the person. This region, like other parts of the sleep surface silhouette, is designed to match the unique body surfaces of the person, providing targeted support and comfort to the feet. The contoured shape of the foot support region ensures that the feet are cradled in a manner that promotes relaxation and proper alignment. From the actions, the foot support region includes supporting the feet and matching with unique body surfaces. This action is for providing a personalized fit for comfort and support, which is a recurring theme in the design of the custom-designed bed. The foot support region's ability to match the unique body surfaces of the person ensures that the feet are supported in a way that complements the overall contoured shape of the sleep surface silhouette. In terms of attributes, the foot support region is described as being contoured to support the feet of the person.

[0142] This specific attribute highlights the tailored nature of the support provided by this region, ensuring that the feet are comfortably cradled and supported. The contoured shape of the foot support region is a feature that aligns with the unique body surfaces of the person, contributing to the bed's overall purpose of maintaining the spine in a neutral position. The custom-designed bed, including the foot support region, is part of a comprehensive sleep system that aims to provide optimal support and comfort. The bed's design, which includes various contoured regions such as the foot support region,

is intended to match the unique body surfaces of the person, thereby enhancing comfort and promoting proper spinal alignment. This design approach ensures that each part of the body, including the feet, receives the necessary support to maintain a neutral spine position during sleep. Overall, the foot support region is a component of the custom-designed bed, playing a role in providing targeted support and comfort to the feet. Its contoured shape, which matches the unique body surfaces of the person, ensures that the feet are adequately supported, contributing to the bed's overall goal of maintaining proper spinal alignment and enhancing sleep quality.

[0143] The custom-designed bed includes a memory foam layer that conforms to the body of the person. This memory foam layer is integral to the bed's functionality, as it provides a personalized fit for comfort and support by matching with unique body surfaces. The memory foam layer's primary action is conforming to the body, ensuring that the sleep surface silhouette matches the unique body surfaces of the person. This action is for maintaining the spine in a neutral position, which is the bed's specific purpose. The memory foam layer adapts to the specific position of a part of an individual's body, offering a state of relaxation and tailored support to various body parts. This adaptation is for providing comfort and support for the spine during sleep, maintaining proper alignment, and enhancing overall sleep quality. The bed's sleep surface silhouette, which includes the memory foam layer, is designed to match the unique body surfaces of the person. This design ensures that the bed can provide targeted support to different body regions, such as the head, shoulders, lumbar region, legs, and feet. The contoured shape of the sleep surface silhouette is a feature that allows the bed to accommodate the unique body contours of the person, providing better support and comfort during sleep. The memory foam layer's ability to conform to the body enhances this feature, ensuring that the bed can adapt to various sleeping positions, whether the person is lying on their side, back, or stomach.

[0144] In addition to the memory foam layer, the custom-designed bed may include other components such as an environmental control unit and a monitoring system. The environmental control unit regulates temperature and humidity, creating an optimal sleeping environment that further enhances comfort and relaxation. The monitoring system tracks sleep patterns, providing valuable data that can be used to improve sleep

quality and maintain proper spinal alignment. Overall, the custom-designed bed, with its memory foam layer and contoured sleep surface silhouette, is engineered to provide a personalized fit for comfort and support. By matching the unique body surfaces of the person, the bed ensures that the spine is kept in a neutral position, potentially improving sleep quality and comfort. The bed's design and components work together to offer a state of relaxation, tailored support, and an optimal sleeping environment, making it a comprehensive solution for maintaining proper spinal alignment during sleep.

[0145] The custom-designed bed includes an environmental control unit and is designed to keep a person's spine in a neutral position. The environmental control unit is responsible for regulating temperature and humidity, ensuring an optimal sleeping environment. This regulation is for maintaining proper alignment during sleep, as it helps to create a comfortable and stable environment that supports the spine's neutral position. The custom-designed bed's primary purpose is to maintain the spine of a person in a neutral position to potentially improve sleep quality and comfort. This bed adapts to the specific position of a part of an individual's body, offering a state of relaxation and providing tailored support to various body parts. The bed comprises a sleep surface silhouette that is in a contoured shape, matching the unique body surfaces of the person. This contoured shape is designed to match the unique body surfaces of a person, which may provide better support and comfort during sleep. The environmental control unit is a part of the sleep system, ensuring that the temperature and humidity are regulated to create an optimal sleeping environment. This regulation is for maintaining the spine in a neutral position, as it helps to prevent discomfort and disturbances that could lead to misalignment. The custom-designed bed, with its contoured shape and sleep surface silhouette, works in conjunction with the environmental control unit to provide a personalized fit for comfort and support. The bed's design ensures that the spine remains in a neutral position, which is for preventing back pain and promoting overall health.

[0146] In some embodiments, In addition to the environmental control unit, the custom-designed bed is equipped with a monitoring system to track sleep patterns. This monitoring system is designed to maintain proper alignment during sleep by providing data on the person's sleep patterns. The data collected by the monitoring system can be used to make adjustments to the bed's settings, ensuring that the spine remains in a

neutral position throughout the night. The monitoring system is a component of the custom-designed bed, as it helps to ensure that the bed provides the necessary support and comfort for a good night's sleep. Overall, the custom-designed bed, with its environmental control unit and monitoring system, is designed to keep a person's spine in a neutral position. The bed's contoured shape and sleep surface silhouette match the unique body surfaces of the person, providing tailored support and comfort. The environmental control unit regulates temperature and humidity, creating an optimal sleeping environment, while the monitoring system tracks sleep patterns to ensure proper alignment. This combination of features makes the custom-designed bed an effective solution for improving sleep quality and maintaining spinal health.

[0147] The custom-designed bed is equipped with a monitoring system to track sleep patterns and keep the spine in a neutral position. The monitoring system is a part of the custom-designed bed, which is designed to maintain the spine of a person in a neutral position to potentially improve sleep quality and comfort. The bed adapts to the specific position of a part of an individual's body, offering a state of relaxation and comprising contoured shapes that match the unique body surfaces of the person. This ensures that the spine remains in a neutral position when the person is lying down for sleep. The monitoring system is equipped with the capability to track sleep patterns, which is for maintaining proper alignment during sleep. This system provides real-time data on the person's sleep, allowing for adjustments to be made to ensure that the spine remains in a neutral position. The custom-designed bed, with its contoured shape and sleep surface silhouette, matches the unique body surfaces of the person, providing a personalized fit for comfort and support. The bed includes various support regions, such as the head support region, shoulder support region, lumbar support region, leg support region, and foot support region, all contoured to match the unique body surfaces of the person. These regions provide targeted support and comfort to different parts of the body, ensuring that the spine remains in a neutral position. The memory foam layer conforms to the body of the person, further enhancing the personalized fit and support. Additionally, the bed is part of a sleep system that includes an environmental control unit to regulate temperature and humidity, creating an optimal sleeping environment. This unit works in conjunction with the monitoring system to ensure that the person remains comfortable

and that the spine stays in a neutral position throughout the night. In summary, the custom-designed bed, with its monitoring system, contoured shape, and various support regions, provides a solution for maintaining the spine in a neutral position during sleep. The bed's ability to adapt to the unique body surfaces of the person, combined with the real-time tracking of sleep patterns and environmental control, ensures that the person experiences improved sleep quality and comfort.

[0148] As described above and shown in the associated drawings, the present invention comprises a custom contoured sleep surface and method. While particular embodiments have been described, it will be understood, however, that any invention appertaining to the apparatus/system/method described is not limited thereto, since modifications may be made by those skilled in the art, particularly in light of the foregoing teachings. It is, therefore, contemplated by the appended claims to cover any such modifications that incorporate those features or those improvements that embody the spirit and scope of the invention. Any of the features can be combined in any physically possible way in the spirit of the invention, which is clearly to improve the sleep of persons because sleep is critical to health and takes up a major portion of lives.

[0149] According to some embodiments which can be combined with any other of the embodiments disclosed herein, an outline of a human body (or a subject's body) is scanned. For example, an outline shown in **FIG. 2A** and in **FIG. 12**. The tables in **FIG. 13** and in **FIG. 2B** represent the human body transcribed to a numerical or a digital format. In another example, a person's body is scanned (600, step 1, **FIG. 15**), resulting in a recording of a plurality of dimensions for the person's body (605, step 2). For example, shoulder width, hip width, shoulder to elbow length, and the dimensions illustrated in **FIG. 13** and in **FIG. 2B**. From the measurements, the tables can be referred to, and an assessment of small, medium, large, or unique size can be made (610, step 3). Weight percentages can be assigned (615, step 4) to each portion of the body in **FIG. 2A** and in **FIG. 12** after taking the person's weight. For example, the head will weigh a certain percent of the total weight; the torso will weigh a certain percent of total weight, and the legs will weigh a certain percent of that total weight. Each individual area of the body can be taken into consideration. In Step 5, (620) the weight percent data and proportions are utilized to pick different densities and thicknesses of foam for each body part.

[0150] Each piece of foam will, under each part of the body, compress to a certain thickness when the person is lying on the foam and on the custom bed surface under the foam. Data is stored for how much each density of foam will compress under how much weight. In Step 6, 625 (**FIG. 15**) a curve is designed based upon the scanning of the person's body and then that curve is offset by the amount of space that the foam will occupy after compression by the amount of weight for each body part, to provide a sleep surface silhouette 201 or a back sleep module shape 350, for example, which is the final shape that is now built in Step 7, 630 (**FIG. 15**). Now, after the foam is added, when the person lies on it, the foam will compress to that height, and then it perfectly matches the body. If the sleep surface silhouette 201 is built without taking into consideration an algorithm for the compression of the foam and for the offset of the sleep surface silhouette from the person's body, then the size will be too small for the sleep surface silhouette. For example, the sleep surface will be too tight in some places or too tight everywhere.

[0151] According to some aspects, the techniques described herein relate to a system, wherein the system is provided in a wearable configuration or a wearable with wireless communication configuration that monitors sleep and provides a sleep surface to accommodate and provide a better sleep experience.

[0152] In any interpretation of the claims appended hereto, it is noted that no claims or claim elements are intended to invoke or be interpreted under 35 U.S.C. 112(f) unless the words "means for" or "step for" are explicitly used in the particular claim.

[0153] In general, any combination of disclosed features, components and methods described herein is possible. Steps of a method can be performed in any order that is physically possible.

[0154] All cited references are incorporated by reference herein. Although embodiments have been disclosed, it is not desired to be limited thereby. Rather, the scope should be determined only by the appended claims.

[0155] While various embodiments of the present disclosure have been described in detail, it is apparent that modifications and alterations of those embodiments will occur to those skilled in the art. However, it is to be expressly understood that such modifications and alterations are within the scope and spirit of the present disclosure, as set forth in the following claims.

[0156] The foregoing discussion of the disclosure has been presented for purposes of illustration and description. The foregoing is not intended to limit the disclosure to the form or forms disclosed herein. In the foregoing Detailed Description for example, various features of the disclosure are grouped together in one or more embodiments for the purpose of streamlining the disclosure. This method of disclosure is not to be interpreted as reflecting an intention that the claimed disclosure requires more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive aspects lie in less than all features of a single foregoing disclosed embodiment. Thus, the following claims are hereby incorporated into this Detailed Description, with each claim standing on its own as a separate preferred embodiment of the disclosure.

[0157] Moreover, though the present disclosure has included description of one or more embodiments and certain variations and modifications, other variations and modifications are within the scope of the disclosure, *e.g.*, as may be within the skill and knowledge of those in the art, after understanding the present disclosure. It is intended to obtain rights which include alternative embodiments to the extent permitted, including alternate, interchangeable and/or equivalent structures, functions, ranges or steps to those claimed, whether or not such alternate, interchangeable and/or equivalent structures, functions, ranges or steps are disclosed herein, and without intending to publicly dedicate any patentable subject matter.

[0158] The description of embodiments of the disclosure is not intended to be exhaustive or to limit the disclosure to the precise form disclosed. While specific embodiments of, and examples for, the disclosure are described herein for illustrative purposes, various equivalent modifications are possible within the scope of the disclosure, as those skilled in the relevant art will recognize. For example, while method steps or functions are presented in a given order, alternative embodiments may perform functions in a different order, or functions may be performed substantially concurrently. The teachings of the disclosure provided herein can be applied to other procedures or methods as appropriate. The various embodiments described herein can be combined to provide further embodiments. Aspects of the disclosure can be modified, if necessary, to employ the compositions, functions and concepts of the above references and application to provide yet further embodiments of the disclosure. Moreover, due to biological

functional equivalency considerations, some changes can be made in protein structure without affecting the biological or chemical action in kind or amount. These and other changes can be made to the disclosure in light of the detailed description. All such modifications are intended to be included within the scope of the appended claims.

[0159] Specific elements of any of the foregoing embodiments can be combined or substituted for elements in other embodiments. Furthermore, while advantages associated with certain embodiments of the disclosure have been described in the context of these embodiments, other embodiments may also exhibit such advantages, and not all embodiments need necessarily exhibit such advantages to fall within the scope of the disclosure. The methods, kits, formulations, and devices disclosed herein can be combined in any way into systems to address the current public health emergency.

[0160] The methods herein can be utilized with artificial intelligence and/or with machine learning (used interchangeably). The machine learning methods and artificial intelligence methods described herein can be implemented in any suitable computing system. The computing system can be implemented as or can include a computer device that includes a combination of hardware, software, and firmware that allows the computing device to run an applications layer or otherwise perform various processing tasks. The methods described herein can be implemented in any suitable computing system. The computing system can be implemented as or can include a computer device that includes a combination of hardware, software, and firmware that allows the computing device to run an applications layer or otherwise perform various processing tasks. Computing devices can include without limitation personal computers, workstations, servers, laptop computers, tablet computers, mobile devices, wireless devices, smartphones, wearable devices, embedded devices, microprocessor-based devices, microcontroller-based devices, programmable consumer electronics, mini-computers, main frame computers, and the like and combinations thereof.

[0161] Processing tasks can be carried out by one or more processors. Various types of processing technology can be used including a single processor or multiple processors, a central processing unit (CPU), multicore processors, parallel processors, processors in a smartphone, or distributed processors. Additional specialized processing resources such as graphics (e.g., a graphics processing unit or GPU), video, multimedia,

or mathematical processing capabilities can be provided to perform certain processing tasks. Processing tasks can be implemented with computer-executable instructions, such as application programs or other program modules, executed by the computing device. Application programs and program modules can include routines, subroutines, programs, scripts, drivers, objects, components, data structures, and the like that perform particular tasks or operate on data.

[0162] Processors can include one or more logic devices, such as small-scale integrated circuits, programmable logic arrays, programmable logic devices, masked-programmed gate arrays, field programmable gate arrays (FPGAs), application specific integrated circuits (ASICs), and complex programmable logic devices (CPLDs). Logic devices can include, without limitation, arithmetic logic blocks and operators, registers, finite state machines, multiplexers, accumulators, comparators, counters, look-up tables, gates, latches, flip-flops, input and output ports, carry in and carry out ports, and parity generators, and interconnection resources for logic blocks, logic units and logic cells.

[0163] The computing device includes memory or storage, which can be accessed by a system bus or in any other manner. Memory can store control logic, instructions, and/or data. Memory can include transitory memory, such as cache memory, random access memory (RAM), static random-access memory (SRAM), main memory, dynamic random-access memory (DRAM), block random access memory (BRAM), and memristor memory cells. Memory can include storage for firmware or microcode, such as programmable read only memory (PROM) and erasable programmable read only memory (EPROM). Memory can include non-transitory or nonvolatile or persistent memory such as read only memory (ROM), one-time programmable non-volatile memory (OTPNVM), hard disk drives, optical storage devices, compact disc drives, flash drives, floppy disk drives, magnetic tape drives, memory chips, and memristor memory cells. Non-transitory memory can be provided on a removable storage device. A computer-readable medium can include any physical medium that is capable of encoding instructions and/or storing data that can be subsequently used by a processor to implement embodiments of the systems and methods described herein. Physical media can include floppy discs, optical discs, CDs, mini-CDs, DVDs, HD-DVDs, Blu-ray discs, hard drives, tape drives, flash memory, or memory chips. Any other type of tangible, non-

transitory storage that can provide instructions and /or data to a processor can be used in the systems and methods described herein.

[0164] The computing device can include one or more input/output interfaces for connecting input and output devices to various other components of the computing device. Input and output devices can include, without limitation, keyboards, mice, joysticks, microphones, cameras, webcams, displays, touchscreens, monitors, scanners, speakers, and printers. Interfaces can include universal serial bus (USB) ports, serial ports, parallel ports, game ports, and the like.

[0165] The computing device can access a network over a network connection that provides the computing device with telecommunications capabilities. Network connection enables the computing device to communicate and interact with any combination of remote devices, remote networks, and remote entities via a communications link. The communications link can be any type of communication link including without limitation a wired or wireless link. For example, the network connection can allow the computing device to communicate with remote devices over a network which can be a wired and/or a wireless network, and which can include any combination of intranet, local area networks (LANs), enterprise-wide networks, medium area networks, wide area networks (WANS), virtual private networks (VPNs), the Internet, cellular networks, and the like. Control logic and/or data can be transmitted to and from the computing device via the network connection. The network connection can include a modem, a network interface (such as an Ethernet card), a communication port, a PCMCIA slot and card, or the like to enable transmission to and receipt of data via the communications link. A transceiver can include one or more devices that both transmit and receive signals, whether sharing common circuitry, housing, or a circuit boards, or whether distributed over separated circuitry, housings, or circuit boards, and can include a transmitter-receiver.

[0166] The computing device can include a browser and a display that allow a user to browse and view pages or other content served by a web server over the communications link. A web server, sever, and database can be located at the same or at different locations and can be part of the same computing device, different computing devices, or distributed across a network. A data center can be located at a remote location and accessed by the computing device over a network. The computer system can include

architecture distributed over one or more networks, such as, for example, a cloud computing architecture. Cloud computing includes without limitation distributed network architectures for providing, for example, software as a service (SaaS).

[0167] Some features of the technology disclosed herein can be briefly summarized by the following list of features:

[0168] Feature 1: A bed designed for a purpose of keeping a subject's spine in a neutral position during sleep, the bed comprising: a sleep surface silhouette of the bed adapting to the specific shape of specific body parts of the subject; wherein the specific purpose is to keep a person's spine in a neutral position when the person is lying down for sleep; wherein the sleep surface silhouette is in a contoured shape that matches one or more of the unique body surfaces of the person; and wherein the contoured shape of the sleep surface silhouette matches the unique body surfaces of the person to keep the subject's spine in a neutral position when the subject is lying on the bed.

[0169] Feature 2: The bed of feature 1, wherein the sleep surface silhouette includes a head support region contoured to cradle the head of the person.

[0170] Feature 3: The bed of feature 1, wherein the sleep surface silhouette includes a shoulder support region contoured to accommodate the shoulder of the person.

[0171] Feature 4: The bed of feature 1, wherein the sleep surface silhouette includes a lumbar support region contoured to support the lumbar region of the person.

[0172] Feature 5: The bed of feature 1, wherein the sleep surface silhouette includes a leg support region contoured to support the legs of the person.

[0173] Feature 6: The bed of feature 1, wherein the sleep surface silhouette includes a foot support region contoured to support the feet of the person.

[0174] Feature 7: The bed of feature 1, wherein the bed is adjustable to accommodate different body sizes.

[0175] Feature 8: The bed of feature 1, wherein the bed includes a memory foam layer or a gel layer that conforms to the body of the person.

[0176] Feature 9: The bed of feature 1, wherein the bed includes a plurality of adjustable air chambers to adjust firmness.

[0177] Feature 10: The bed of feature 1, wherein the bed includes a remote control for adjusting a contour of the sleep surface silhouette.

[0178] Feature 11: The bed of feature 1, wherein the bed includes a heating element for providing warmth.

[0179] Feature 12: The bed of feature 1, wherein the bed includes a light system for providing therapeutic light therapy.

[0180] Feature 13: The bed of feature 1, wherein the bed is part of a sleep system that includes an environmental control unit to regulate temperature and humidity.

[0181] Feature 14: A method for making a bed for keeping a subject's spine in a standing spine position or in a neutral spine position when the subject is in a sleep position or when the subject is lying down, the method comprising the steps of: (1) scanning a unique body surface of the subject; and (2) making a sleep surface silhouette in a contoured surface to match the unique body surface of the subject.

[0182] Feature 15: The method of feature 14, wherein the sleep surface silhouette includes a head support region contoured to cradle the head of the person.

[0183] Feature 16: The method of feature 14, wherein the sleep surface silhouette includes a shoulder support region contoured to accommodate the shoulder of the person.

[0184] Feature 17: The method of feature 14, wherein the sleep surface silhouette includes a lumbar support region contoured to support the lumbar region of the person.

[0185] Feature 18: The method of feature 14, wherein the sleep surface silhouette includes a leg support region contoured to support the legs of the person.

[0186] Feature 19: The method of feature 14, wherein the sleep surface silhouette includes a foot support region contoured to support the feet of the person.

[0187] Feature 20: The method of feature 14, wherein the bed includes a memory foam layer or a gel layer that conforms to the body of the person.

[0188] Feature 21: The method of feature 14, wherein the unique body surface includes a side of the subject.

[0189] Feature 22: The method of feature 14, wherein the unique body surface includes a back of the subject.

[0190] Feature 23: A method for keeping a subject's spine in a standing spine position or in a neutral spine position when the subject is in a sleep position or when the subject is lying down, the method comprising the steps of: (1) obtaining a surface that is in a contoured shape to conform to a unique body surface of the subject in a lying down position; (2) positioning the surface in a plane that is about at a parallel to a horizontal surface of the Earth; and (3) positioning the subject on the contoured shape of the surface such that the unique body surface of the subject makes a contact with the contoured shape of the surface; whereby the subject's spine is maintained in a standing spine position or in a neutral spine position when the subject is in the sleep position or is lying down.

[0191] Feature 24: The method of feature 23, wherein the contoured shape is operative to maintain the subject's spine in a standing spine position or in a neutral spine position for a time period of about 6 to about 8 hours, when the subject is in a sleeping state.

[0192] Feature 25: The method of feature 23, wherein the unique body surface of the subject is cradled so as to provide a neutral spine position.

[0193] Feature 26: The method of feature 23, wherein lying down is defined by a line drawn from the subject's head to the subject's ankle defining an angle of less than 90° with a horizontal line defined by a line drawn parallel to a surface of the Earth.

[0194] Feature 27: The method of feature 23, wherein lying down is the subject lying about parallel to the surface of the Earth.

[0195] Feature 28: The method of feature 23, wherein the neutral spine position is a same spine position that the subject will have when the subject is in a standing up straight position.

[0196] Feature 29: The method of feature 23, wherein the contoured shape conforms to the subject's body surface when the subject is sleeping on the subject's side, back, or stomach.

[0197] Feature 30: The method of feature 23, wherein the method is carried out over a period of longer than 1 year, longer than 2 years, or longer than 3 years, and wherein the subject's spine is kept in a neutral position during a long-term sleep of the subject so as to provide a health benefit to the subject outside of a sleeping time.

[0198] The technology described herein is further illustrated by the following examples which in no way should be construed as being further limiting. The Examples are provided to demonstrate examples of future planned work, which in some experiments is emergency work. Although methods and materials similar or equivalent to those described herein can be used in the practice or testing of this disclosure, suitable methods and materials are described below.

EXAMPLES

[0199] The invention now being generally described with the spirit of the invention and inventive concept described and illustrated, it will be more readily understood by reference to the following examples which are included merely for purposes of illustration of certain aspects and embodiments of the present invention and are not intended to limit the invention. As can be discerned, the technology herein provides a great improvement in guiding sleep outcomes, and by helping quality of life, long-term, for patients, it is foreseen that the technology will grow.

EXAMPLE 1. PRODUCTION OF CUSTOM SLEEP SURFACES

[0200] Terahertz imaging, lidar scanning, photography, or any scan in the electromagnetic spectrum can be utilized to obtain a body shape from a subject. In a prophetic example, **FIG. 9A**, **FIG. 9B**, and **FIG. 9C** illustrate a process for obtaining length and width data from a subject using an app installed on a smartphone 901. It is important to note that 901 can represent any scanning device or acquisition device known. In **FIG. 9A** the subject is given a rectangular piece of cardstock 903 of known dimensions. In this example, using the camera on smartphone 901, the subject is photographed against a blank background holding cardstock 903. Due to distortion from phone cameras and from the photographer not holding the phone parallel to the subject, the resulting image will be warped as shown. Using the data about the user's smartphone 901 and camera, the image can be corrected for the intrinsic barrel distortion from the phone camera optics.

[0201] In **FIG. 9B**, the image taken in **FIG. 9A** is normalized to where the printed ad matches its real dimensions (note perfectly rectangular red square). This yields the final undistorted image corrected for the camera position and perspective. Lastly, in

FIG. 9C, this rendering, along with the user provided weight and height data, can be used to extract other anthropomorphic data important to the bed size like shoulder width, torso length, leg length, shoulder to elbow length, and all other bodily measurements. For example, the image processing app may be coded using python, opencv and posture analysis code.

[0202] An exemplary method 500 for making custom-contoured sleep surface 300 is described with reference to **FIG. 10** where, at Step 501, subject form (length and width) and weight data are obtained. Subject form measurements may be gathered in any suitable manner. For example, the subject may be manually measured using a measuring tape. Alternatively, subject may use an app on a smart device, described in greater detail below, wherein the app is configured to derive the appropriate length and width data from a photograph of the subject.

[0203] Referring again to **FIG. 10**, sleep surface silhouette 201 is generated based upon the form data, Step 503, and Step 505 is forming the contoured rigid support 301 based on sleep surface silhouette 201. At Step 507, padding is shaped according to the form and weight data obtained in Step 501.

EXAMPLE 2. CUSTOMER SUBSCRIPTION MODEL

[0204] In a prophetic example, a subscription model is initiated. The Rigid sleep surface and the frame/base will all have a lifetime warranty. Customers can sign up for half yearly, or yearly deliveries of the main memory foam for sleep, pillow layers, non-shift Hook/loop fitted sheets, bolsters, breathable ventilation layer. This will ensure that they always have the feeling of a brand-new bed. This recurring revenue from the subscription of add on pieces allows us to price the bed assembly competitively over time for a nominal profit.

[0205] Recycling and Lease programs: Since the memory foam is not stitched into or mixed with any other materials like springs etc. It will be very easy to recycle and reuse the memory foam. The beds can also be part of a lease and can be returned and re-claimed when moving to a different city to avoid the hassle of moving large distances. However, since the bed is much lighter and breaks down into small pieces, moving will be easy.

[0206] In addition, a Phone App Measurement method of User Anthropomorphic data using printed Ad/Coupon can be utilized.

[0207] 1. Users receive printed mail advertising/coupon (shown as box in **FIG. 9A**, **FIG. 9B**, and **FIG. 9C**) which is a predefined size square/rectangular cardstock and take a picture against a wall head to toe (they can also do a 1:1 print of ad from online and hold it up)

[0208] 2. Due to distortion from phone cameras and from the photographer not holding the phone parallel to the subject, the resulting image will be warped as shown in **FIG. 9A** .

[0209] 3. Using the data about the user's phone and camera the image can be corrected for the intrinsic barrel distortion from the phone camera optics (**FIG. 9B**).

[0210] 4. After this the image taken is warped to where the printed ad matches its real dimensions (note perfectly rectangular red square). This yields the final undistorted image corrected for the camera position and perspective.

[0211] 5. This along with the user provided weight and height data can be used to extract other anthropomorphic data important to the bed size like shoulder width, torso length, leg length, shoulder to elbow length etc. Image processing through python, opencv and posture analysis code.

[0212] For Measuring User Experience Placing orders using app:

[0213] 1. The user will open the app and enter their height and weight.

[0214] 2. They will take a picture on a simple white background.

[0215] 3. This will approximately estimate the body dimensions of the user and make recommendations for:

[0216] a. Upper body side sleep shape

[0217] b. Lower body side sleep shape

[0218] c. Upper body back sleep surface

[0219] d. Lower body back sleep surface

[0220] 4. The user will select either side sleep OR back sleep OR both to place an order.

[0221] 5. The user will be allowed to select additional optional features.

[0222] a. Back/side sleep base foams for use on existing bases

- [0223] b. Back/Side sleep base Frames for new bed build
- [0224] c. Ventilation for bed
- [0225] d. Ventilation with heating & cooling
- [0226] e. Bolsters
- [0227] 6. The user will finalize configuration and complete payment.
- [0228] In some embodiments, it is found that the methods and systems can be utilized to improve the health of a person who would otherwise not be considered to be at risk of a sleep disorder.

EXAMPLE 3. DESIGN OF A BACK SLEEP SURFACE

[0229] Some sleepers are accustomed to back sleep. In some embodiments, which can be combined with any other of the embodiments disclosed herein, an outline of a human body is scanned taking into consideration dimensions for back sleep. In one initial example, **FIG. 10** is referred to where, at Step 501, subject form (length and width) and weight data are obtained. Subject form measurements may be gathered in any suitable manner. For example, the subject may be manually measured using a measuring tape. Alternatively, the subject may use an app on a smart device, and/or a scale can be utilized. Or a photo can be utilized to derive a body outline, for example, an outline shown in **FIG. 2A** or in **FIG. 12**. For back sleep, **FIG. 12** is referred to.

[0230] The table in **FIG. 13** represents the human body transcribed to a numerical or a digital format. The person's body is scanned (600, step 1, **FIG. 15**), resulting in a recording of a plurality of dimensions for the person's body (605, step 2). For example, the measurements from the floor to the widest point of the thigh, and the spine to the back of the head (e.g., **FIG. 13**). From the measurements, the tables can be referred to (*Id.*), and an assessment of small, medium, large, or unique size can be made (610, step 3, **FIG. 15**). Weight percentages can be assigned (615, step 4, **FIG. 15**) to each portion of the body in **FIG. 2A** and in **FIG. 12** after taking the person's weight. For example, the head will weigh a certain percent of the total weight; the torso will weigh a certain percent of total weight, and the legs will weigh a certain percent of that total weight. Each individual area of the body can be taken into consideration.

[0231] In Step 5 of **FIG. 15**, (620) the weight percent data and proportions are utilized to pick different densities and thicknesses of foam for each body part. Each piece

of foam will, under each part of the body, compress to a certain thickness when the person is lying on the foam and on the custom bed surface under the foam. Data is stored for how much each density of foam will compress under how much weight.

[0232] In Step 6, 625 (**FIG. 15**) a curve is designed based upon the scanning of the person's body and then that curve is offset by the amount of space that the foam will occupy after compression by the amount of weight for each body part, to provide a sleep surface silhouette 201 or a back sleep module shape 350 as shown in **FIG. 14**, for example, which is the final shape that is now built in Step 7, 630 (**FIG. 15**). In **FIG. 14**, the back sleep module shape 350 can keep the spine line 250 in a neutral position. Now, after the foam is added, when the person lies on it, the foam will compress to that height, and then it perfectly matches the body. If the sleep surface silhouette 201 is built without taking into consideration an algorithm for the compression of the foam and for the offset of the sleep surface silhouette from the person's body, then the size will be too small for the sleep surface silhouette. For example, the sleep surface will be too tight in some places or too tight everywhere.

[0233] A similar algorithm can be utilized for stomach sleepers and for side sleepers. The algorithm can take into consideration any number of factors such as age, height, weight, bodily proportions, and sleep habits.

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[0234] All patents and other publications; including literature references, issued patents, published patent applications, and co-pending patent applications; cited throughout this application are expressly incorporated herein by reference for the purpose of describing and disclosing, for example, the methodologies described in such publications that might be used in connection with the technology described herein. These publications are provided solely for their disclosure prior to the filing date of the present application. Nothing in this regard should be construed as an admission that the inventors are not entitled to antedate such disclosure by virtue of prior invention or for any other reason. All statements as to the date or representation as to the contents of these documents is based on the information available to the applicants and does not constitute any admission as to the correctness of the dates or contents of these documents.

[0235] The foregoing written specification and figures are considered to be sufficient to enable one skilled in the art to practice the present aspects and embodiments. The present aspects and embodiments are not to be limited in scope by examples provided, since the examples are intended as a single illustration of one aspect and other functionally equivalent embodiments are within the scope of the disclosure. Various modifications in addition to those shown and described herein will become apparent to

those skilled in the art from the foregoing description and fall within the scope of the appended claims. The advantages and objects described herein are not necessarily encompassed by each embodiment. Those skilled in the art will recognize or be able to ascertain using no more than routine experimentation, many equivalents to the specific embodiments described herein. Such equivalents are intended to be encompassed by the following exemplary claims.

CLAIMS

We claim:

1. A bed designed for a purpose of keeping a subject's spine in a neutral position during sleep, the bed comprising:

a sleep surface silhouette of the bed adapting to the specific shape of specific body parts of the subject; wherein the specific purpose is to keep a person's spine in a neutral position when the person is lying down for sleep;

wherein the sleep surface silhouette is in a contoured shape that matches one or more of the unique body surfaces of the person; and wherein the contoured shape of the sleep surface silhouette matches the unique body surfaces of the person to keep the subject's spine in a neutral position when the subject is lying on the bed.

2. The bed of claim 1, wherein the sleep surface silhouette includes a head support region contoured to cradle the head of the person.

3. The bed of claim 1, wherein the sleep surface silhouette includes a shoulder support region contoured to accommodate the shoulder of the person.

4. The bed of claim 1, wherein the sleep surface silhouette includes a lumbar support region contoured to support the lumbar region of the person.

5. The bed of claim 1, wherein the sleep surface silhouette includes a leg support region contoured to support the legs of the person.

6. The bed of claim 1, wherein the sleep surface silhouette includes a foot support region contoured to support the feet of the person.

7. The bed of claim 1, wherein the bed is adjustable to accommodate different body sizes.

8. The bed of claim 1, wherein the bed includes a memory foam layer or a gel layer that

conforms to the body of the person.

9. The bed of claim 1, wherein the bed includes a plurality of adjustable air chambers to adjust firmness.

10. The bed of claim 1, wherein the bed includes a remote control for adjusting a contour of the sleep surface silhouette.

11. The bed of claim 1, wherein the bed includes a heating element for providing warmth.

12. The bed of claim 1, wherein the bed includes a light system for providing therapeutic light therapy.

13. The bed of claim 1, wherein the bed is part of a sleep system that includes an environmental control unit to regulate temperature and humidity.

14. A method for making a bed for keeping a subject's spine in a standing spine position or in a neutral spine position when the subject is in a sleep position or when the subject is lying down, the method comprising the steps of:

- (1) scanning a unique body surface of the subject; and
- (2) making a sleep surface silhouette in a contoured surface to match the unique body surface of the subject.

15. The method of claim 14, further comprising the steps of:

- (1b) recording of a plurality of dimensions for the subject's unique body surface; and
- (1c) executing an assessment of small, medium, large, or unique body sizes for one or more of each of a bodily portion of the subject.

16. The method of claim 15, further comprising the steps of:

(1d) assigning one or more weight percentages and/or bodily proportions to one or more or each part of the body of the subject; and

(1e) selecting different densities and thicknesses of foam and/or padding for each body part of the subject based upon the weight percentages, the bodily proportions, one or more sleeping positions of the subject, and/or the density and compaction propensities of the foam.

17. The method of claim 16, further comprising the steps of:

(1f) designing a sleep surface curve based upon a scanning of the subject's body curvatures and by an offsetting of the curvatures by the amount of space that the foam will occupy after a compression by the amount of weight for each body part, to provide a sleep surface silhouette design; and

(1g) fabricating the physical sleep surface silhouette shape from the designing and adding the foam pieces to the physical sleep surface silhouette.

18. The method of claim 14, wherein the sleep surface silhouette includes a head support region contoured to cradle the head of the person.

19. The method of claim 14, wherein the sleep surface silhouette includes a shoulder support region contoured to accommodate the shoulder of the person.

20. The method of claim 14, wherein the sleep surface silhouette includes a lumbar support region contoured to support the lumbar region of the person.

21. The method of claim 14, wherein the sleep surface silhouette includes a leg support region contoured to support the legs of the person.

22. The method of claim 14, wherein the sleep surface silhouette includes a foot support region contoured to support the feet of the person.

23. The method of claim 14, wherein the bed includes a memory foam layer or a gel

layer that conforms to the body of the person.

24. The method of claim 14, wherein the unique body surface includes a side of the subject.

25. The method of claim 14, wherein the unique body surface includes a back of the subject.

26. A method for keeping a subject's spine in a standing spine position or in a neutral spine position when the subject is in a sleep position or when the subject is lying down, the method comprising the steps of:

(1) obtaining a surface that is in a contoured shape to conform to a unique body surface of the subject in a lying down position;

(2) positioning the surface in a plane that is about at a parallel to a horizontal surface of the Earth;

(3) positioning the subject on the contoured shape of the surface such that the unique body surface of the subject makes a contact with the contoured shape of the surface; and

whereby the subject's spine is maintained in a standing spine position or in a neutral spine position when the subject is in the sleep position or is lying down.

27. The method of claim 26, wherein the contoured shape is operative to maintain the subject's spine in a standing spine position or in a neutral spine position for a time period of about 6 to about 8 hours, when the subject is in a sleeping state.

28. The method of claim 26, wherein the unique body surface of the subject is cradled so as to provide a neutral spine position.

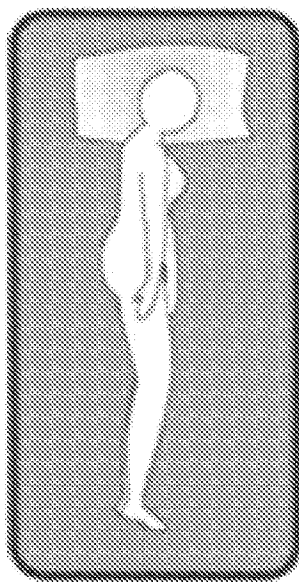
29. The method of claim 26, wherein lying down is defined by a line drawn from the subject's head to the subject's ankle defining an angle of less than 90° with a horizontal line defined by a line drawn parallel to a surface of the Earth.

30. The method of claim 26, wherein lying down is the subject lying about parallel to the surface of the Earth.

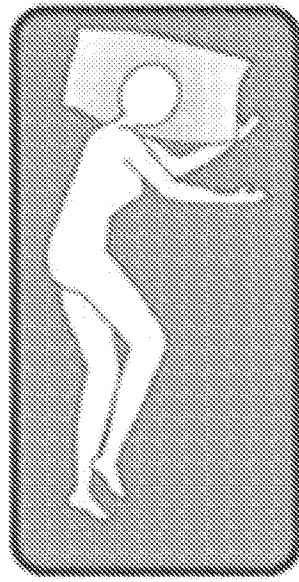
31. The method of claim 26, wherein the neutral spine position is a same spine position that the subject will have when the subject is in a standing up straight position.

32. The method of claim 26, wherein the contoured shape conforms to the subject's body surface when the subject is sleeping on the subject's side, back, or stomach.

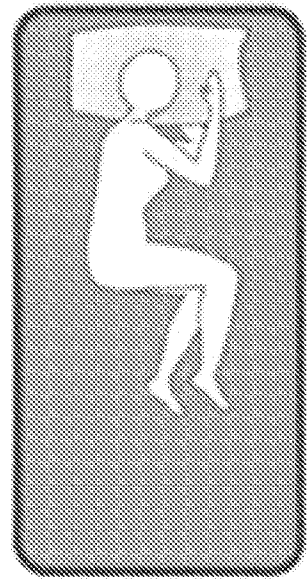
33. The method of claim 26, wherein the method is carried out over a period of longer than 1 year, longer than 2 years, or longer than 3 years, and wherein the subject's spine is kept in a neutral position during a long-term sleep of the subject so as to provide a health benefit to the subject outside of a sleeping time.



6%

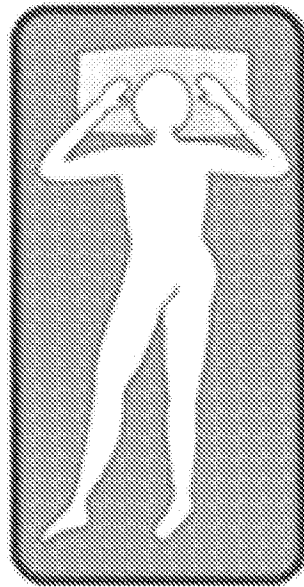


13%



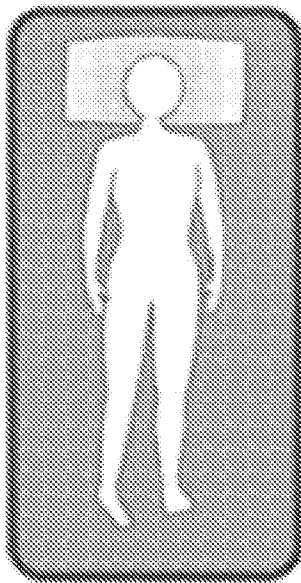
47%

FIG. 1A

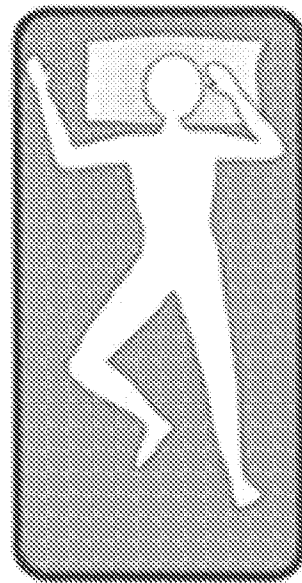


17%

FIG. 1B

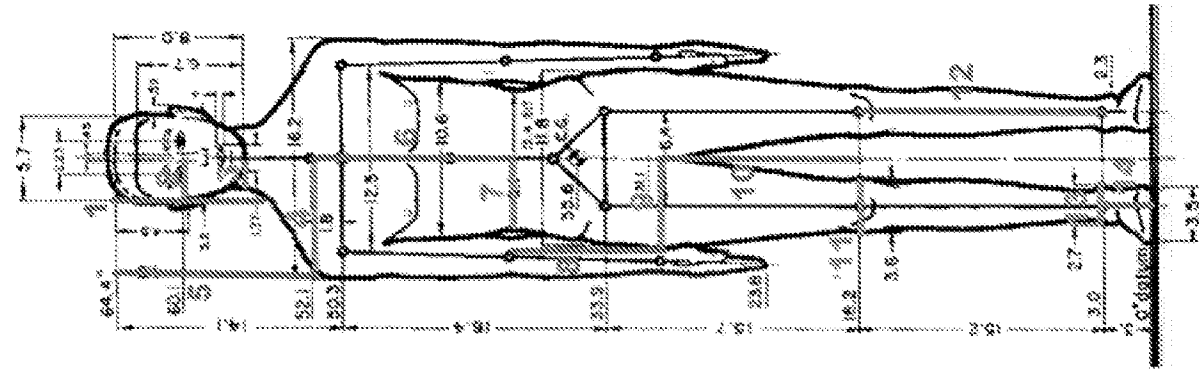


11%



7%

FIG. 1C



	V/M	XS 2.5%	S25%	M50%	L75%	XL97.5%
TOP OF HEAD TO						
1 TRAPS	V	9.5	9.75	10	10.5	11
SPINE TO EAR (HALF						
2 HEAD WIDTH	M	3	3.2	3.4	3.6	3.8
3 SPINE TO NECK	M	2.1	2.35	2.6	2.85	3.1
4 SPINE TO SHOULDER	M	8.5	9	9.5	10	10.5
TOP OF HEAD TO						
5 SHOULDER	V	12.4	12.9	13.4	13.8	14.2
SHOULDER TO RIGHT						
BELOW DIAPHRAGM	V					
6 NARROW		13	13.5	14	14.75	15.5
7 SPINE TO SIDE	M	4.55	4.925	5.3	5.825	6.35
NARROW BELOW						
DIAPHRAGM TO WIDE	V	9.7	10.75	11.8	12.4	13
8 PART OF PELVIS						
SPINE TO WIDEST OF	M	6.3	6.75	7.2	7.6	8
9 PELVIS						
WIDEST PART OF HIP	V	12.3	12.1	11.9	11.75	11.6
10 TO KNEE						
11 KNEE WIDTH	M	3.6	3.8	4	4.3	4.6
12 KNEE TO ANKLE	V	15.2	15.75	16.3	16.9	17.5
13 ANKLE WIDTH	M	2.7	2.85	3	3.15	3.3
ANKLE TO FOOT	V					
14 BOTTOM		3	3.25	3.5	3.65	3.8
15 FOOT BOTTOM WIDTH	M	3.5	3.65	3.8	4	4.2

Data from Dreyfuss

FIG. 2A

		V/H	Women				
			XS 2.5%	S25%	M50%	L75%	XL97.5%
	Weight		94lb		135lb		195lb
1	TOP OF HEAD TO TRAPS	V	8.22	8.71	9.2	9.65	10.1
2	SPINE TO EAR (HALF HEAD WIDTH	H	2.3	2.7	3.1	3.52	3.94
3	SPINE TO NECK	H	2.18	2.2	2.22	2.32	2.42
4	SPINE TO SHOULDER	H	6.97	7.525	8.08	8.23	8.38
5	TOP OF HEAD TO SHOULDER	V	10.4	11.01	11.6	11.87	12.12
6	SHOULDER TO RIGHT BELOW DIAPHRAGM NARROW	V	8.42	10.07	11.7	12.68	13.64
7	SPINE TO SIDE	H	3.44	3.995	4.55	4.9	5.25
8	NARROW BELOW DIAPHRAGM TO WIDE PART OF PELVIS	V	9.37	8.935	8.5	8.445	8.39
9	SPINE TO WIDEST OF PELVIS	H	5.9	6.45	7	7.3	7.6
10	WIDEST PART OF HIP TO KNEE	V	11.86	12.5	13.1	14.8	16.46
11	KNEE WIDTH	H	3.43	3.685	3.94	4.04	4.14
12	KNEE TO ANKLE	V	13.73	14.19	14.7	15.16	15.66
13	ANKLE WIDTH	H	1.98	2.255	2.53	2.58	2.63
14	ANKLE TO FOOT BOTTOM	V	3.33	3.33	3.33	3.33	3.33
15	FOOT BOTTOM WIDTH	H	3.2	3.52	3.84	3.99	4.14

FIG. 2B

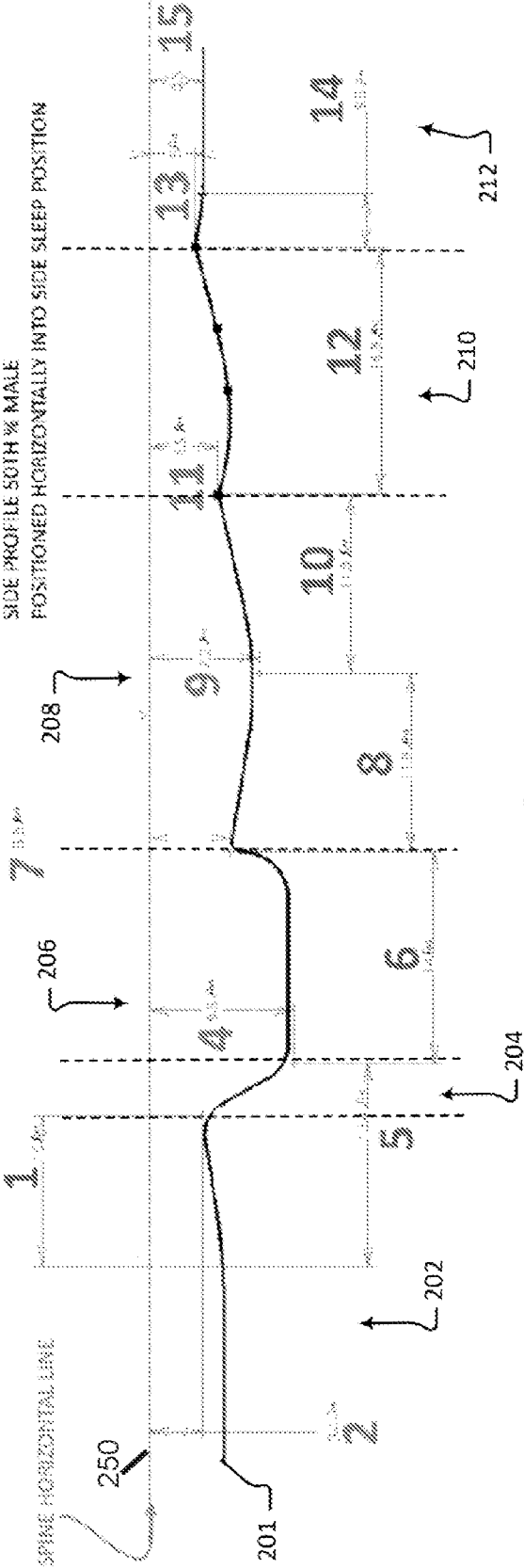
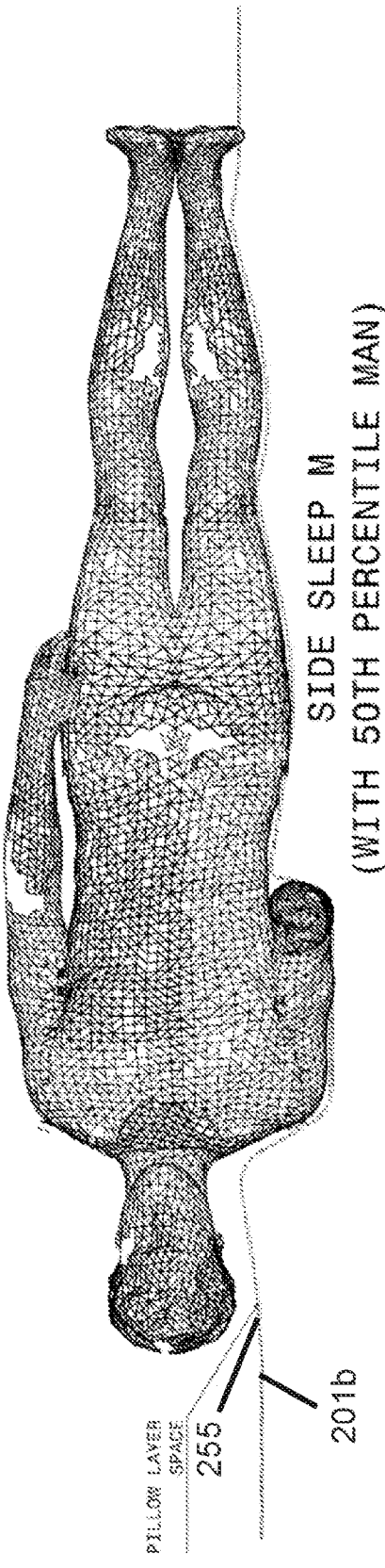
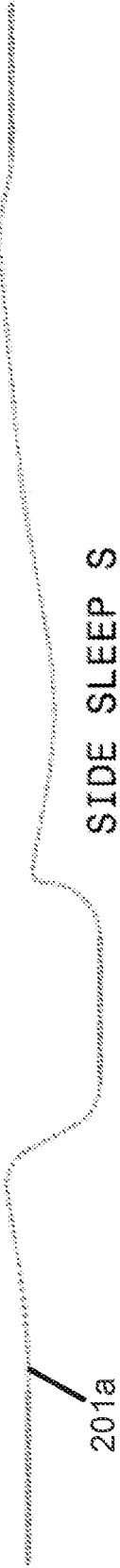


FIG. 3A



WEIGHT DISTRIBUTION OF 50TH PERCENTILE MALE
(SAME WEIGHT DISTRIBUTION IN BOTH POSITIONS, DIFFERENT
SURFACE AREA AND DIFFERENT FOAM COMPRESSION)

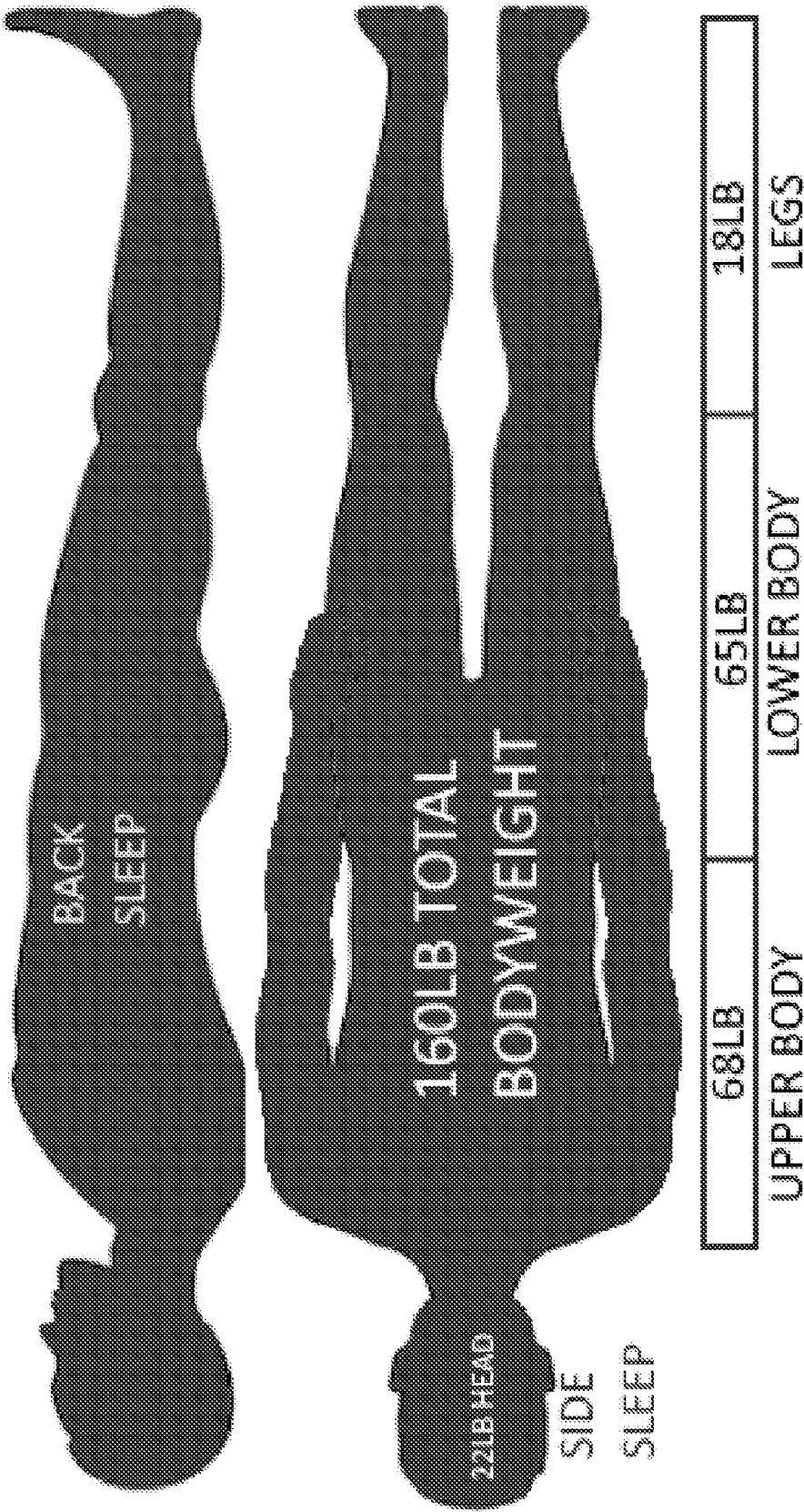
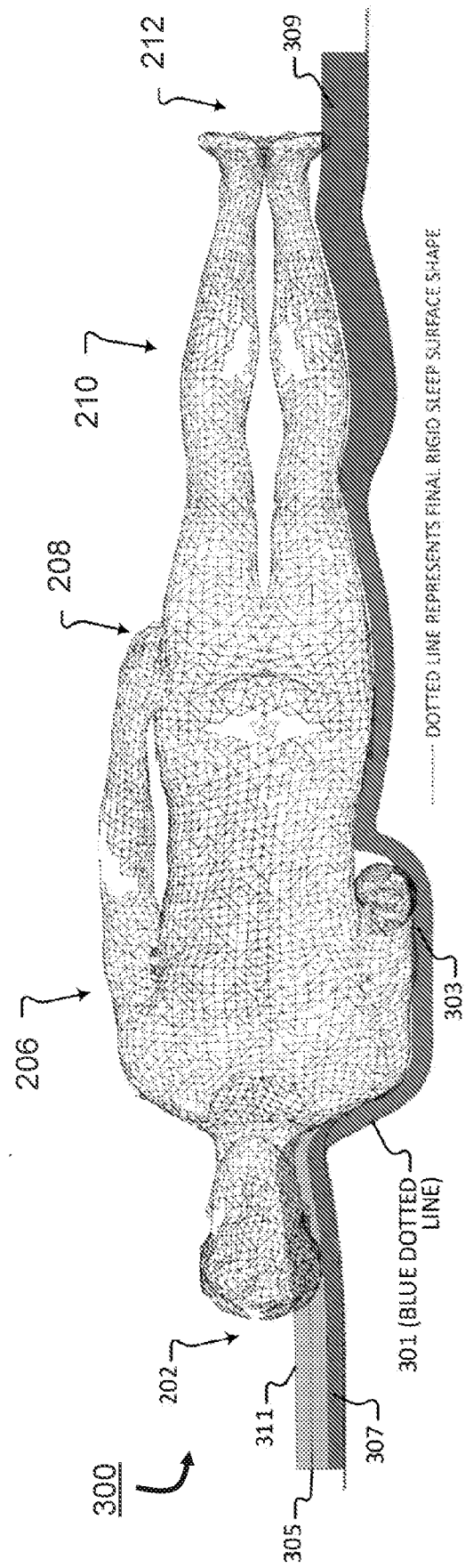
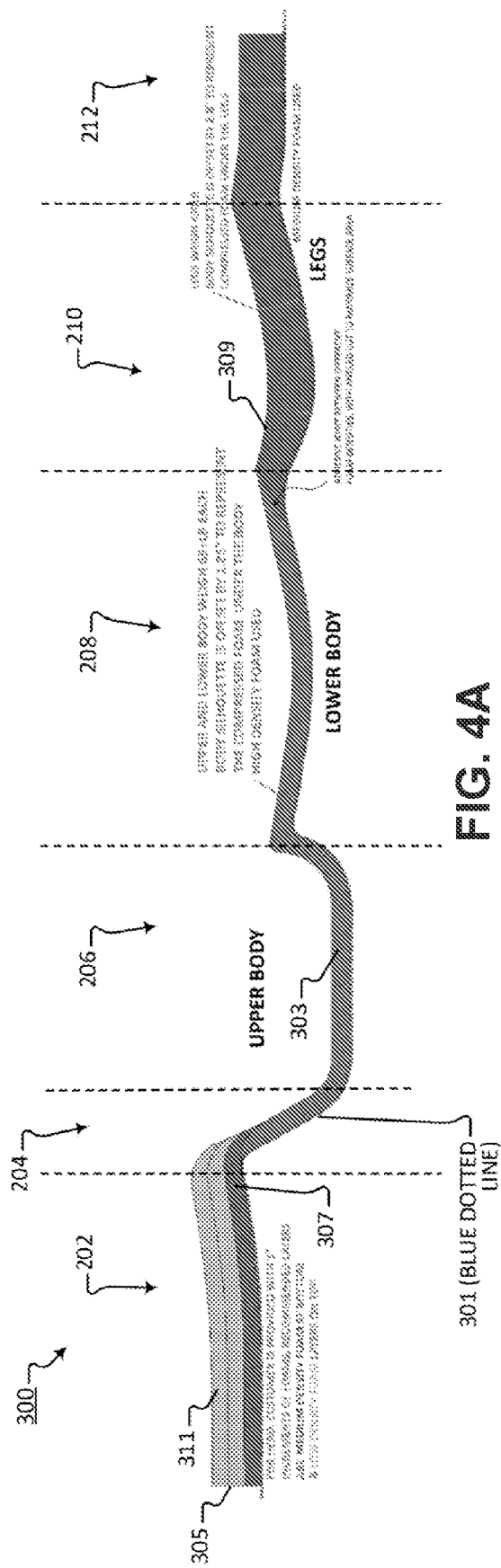


FIG. 3E

Weight	Thickness of 4" medium ILD memory foam	Compression %
0lb	4"	0%
10lb	3.7"	
20lb	3.25"	~25%
30lb	2.8"	
40lb	2"	50%
50lb	1.2"	75%

FIG. 3F



..... DOTTED LINE REPRESENTS FINAL RIGID SLEEP SURFACE SHAPE

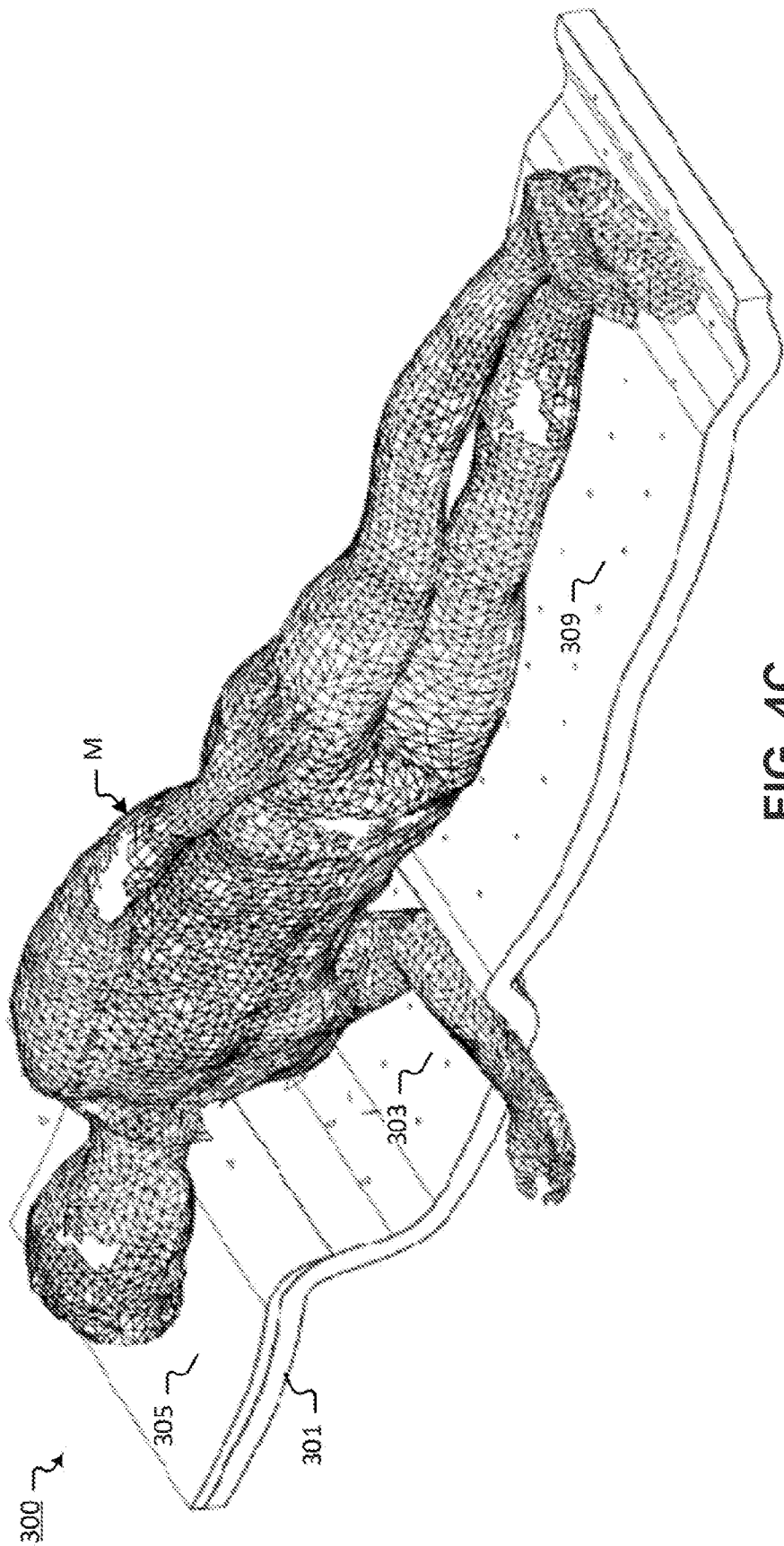


FIG. 4C

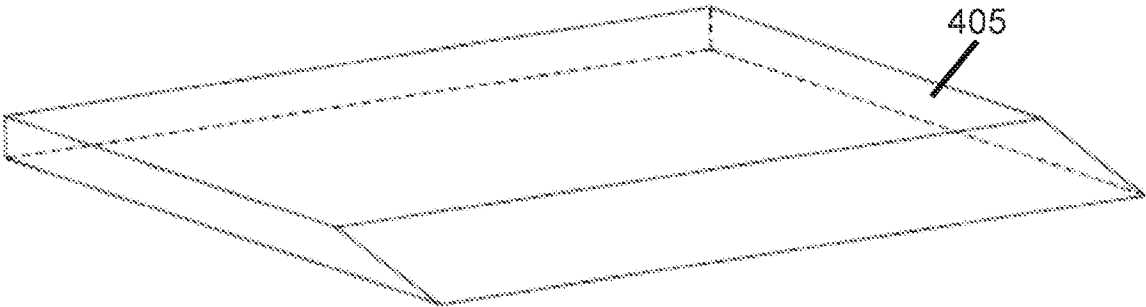


FIG. 4D

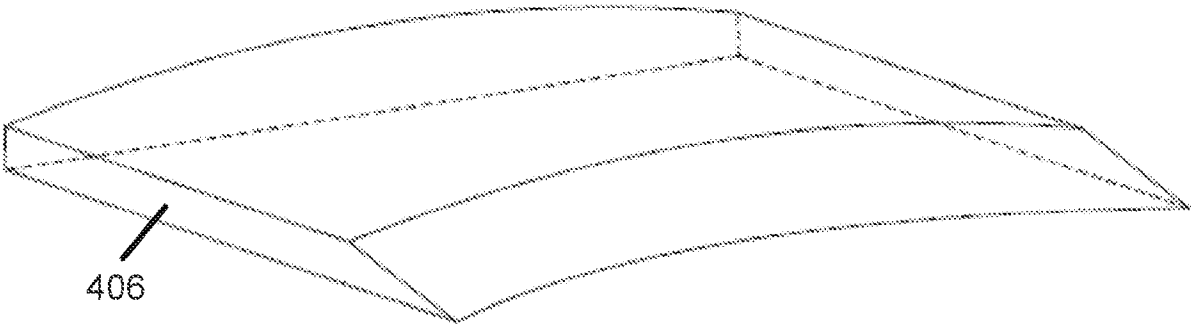


FIG. 4E

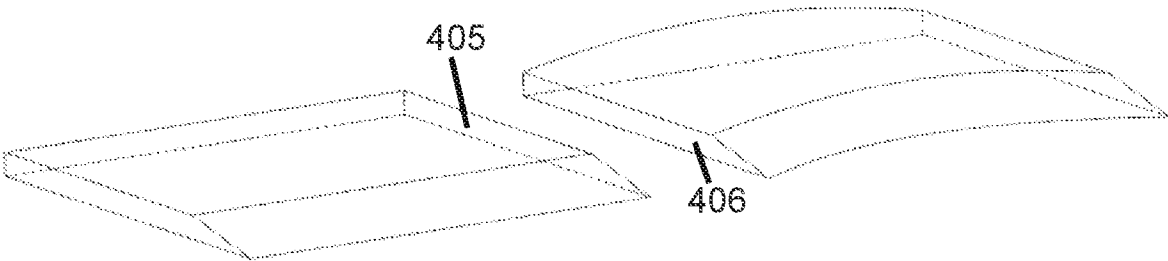


FIG. 4F

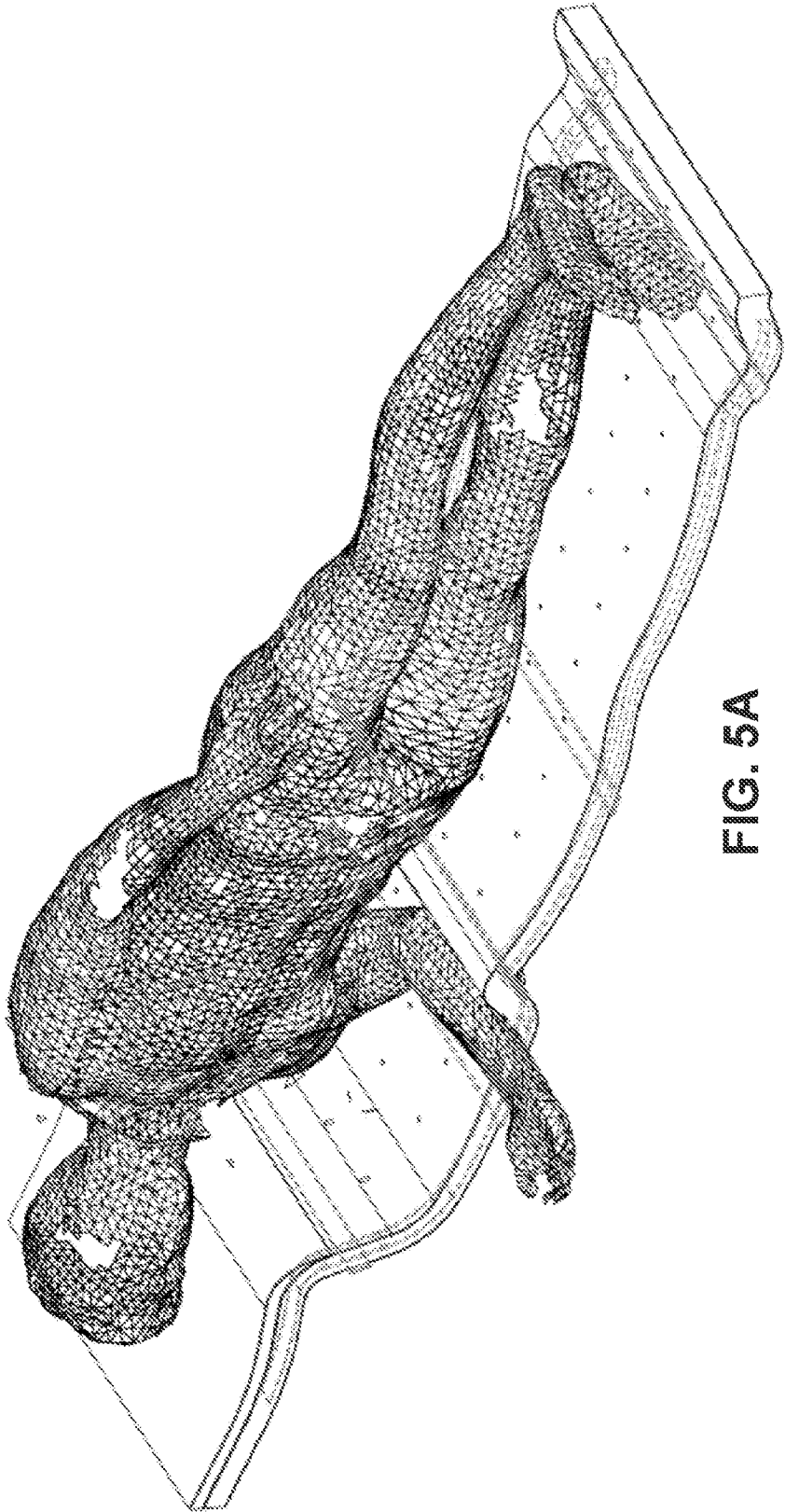


FIG. 5A

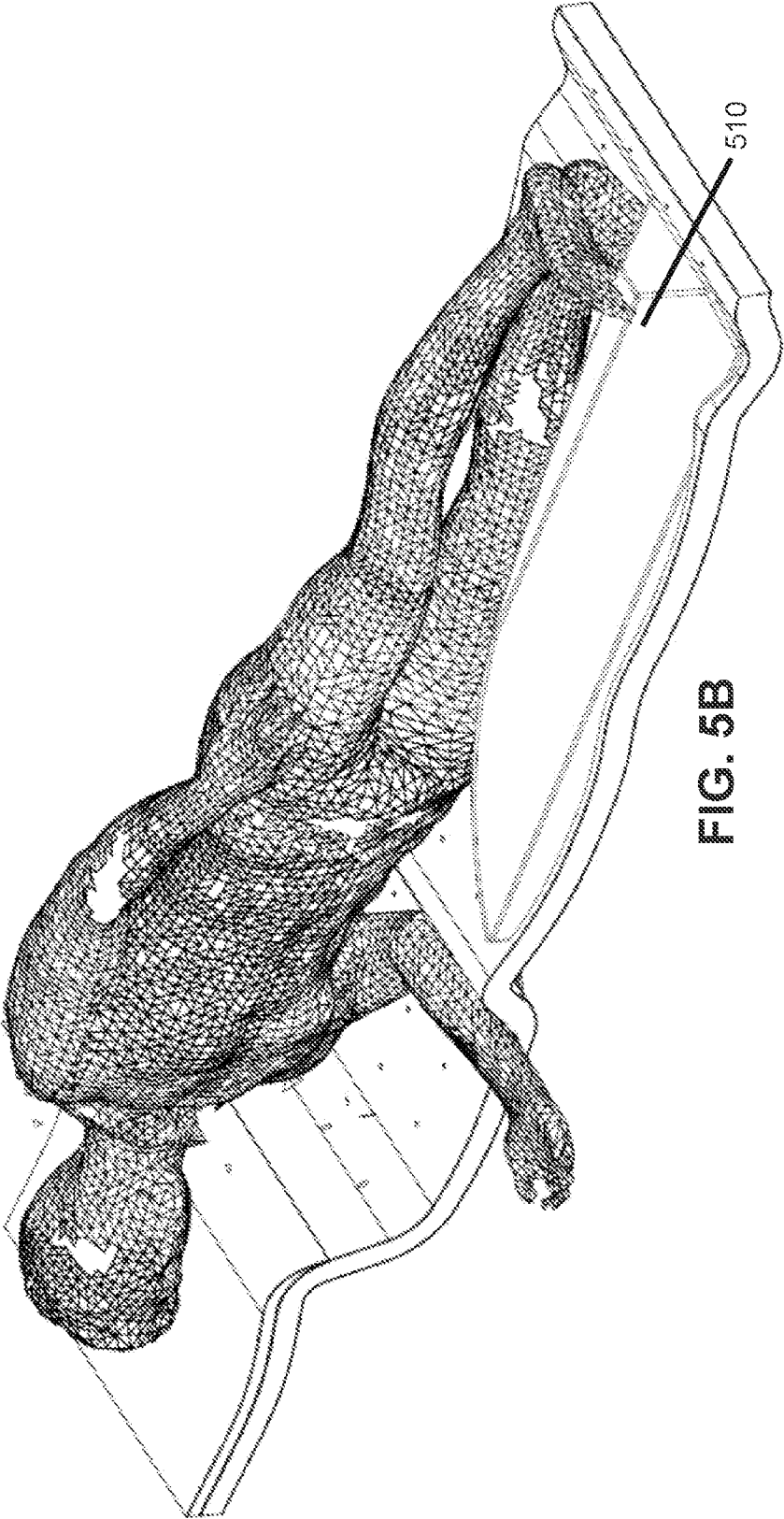


FIG. 5B

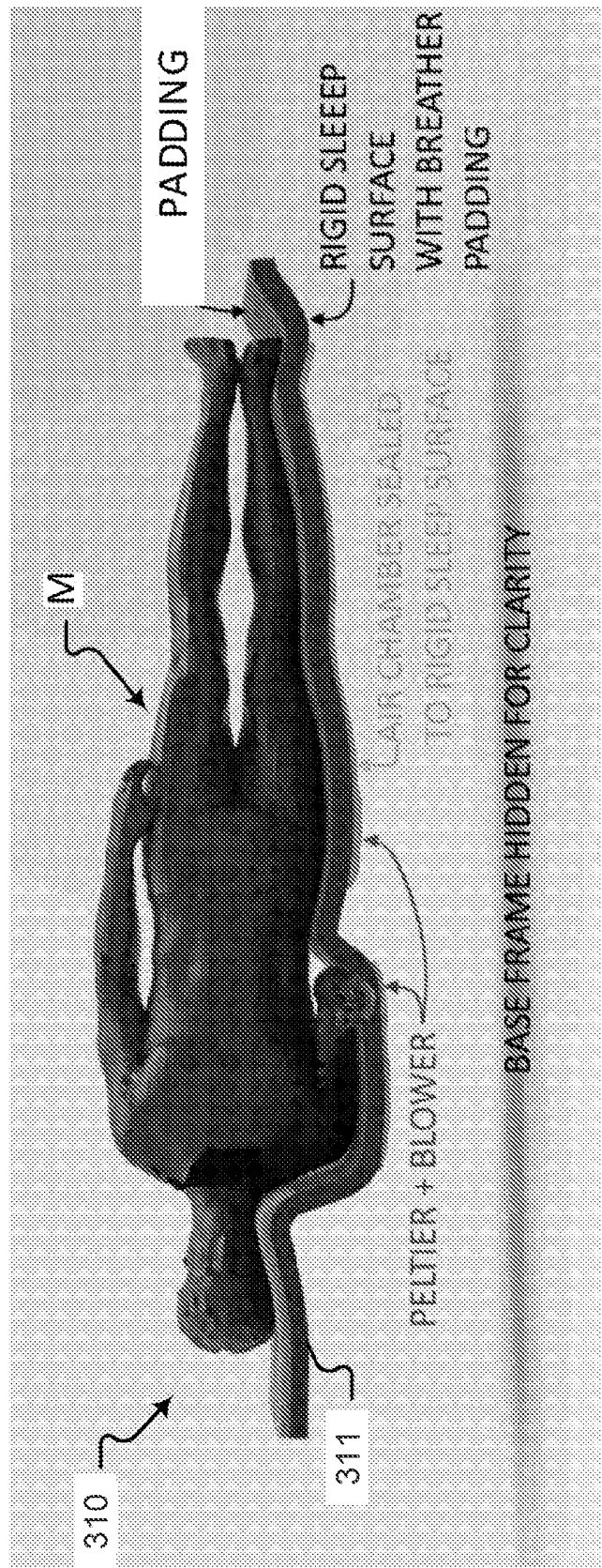
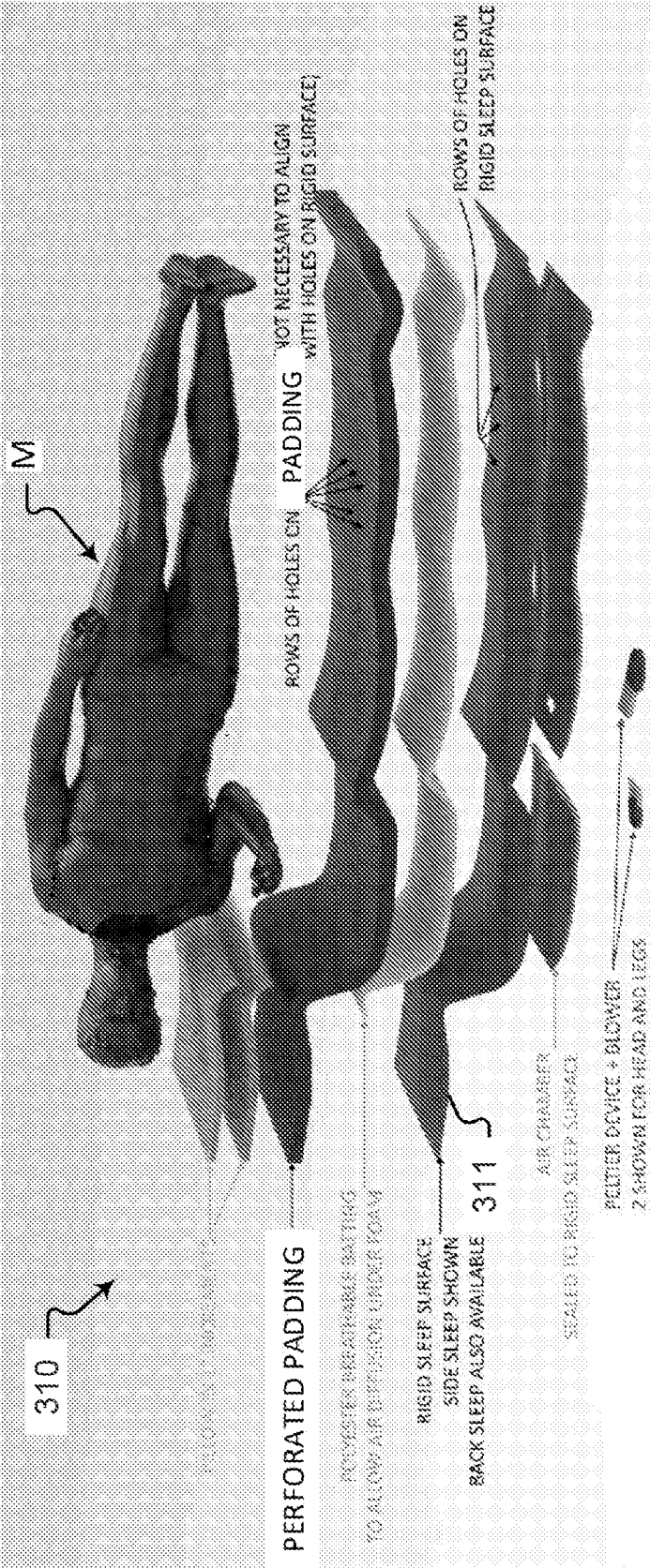


FIG. 6A



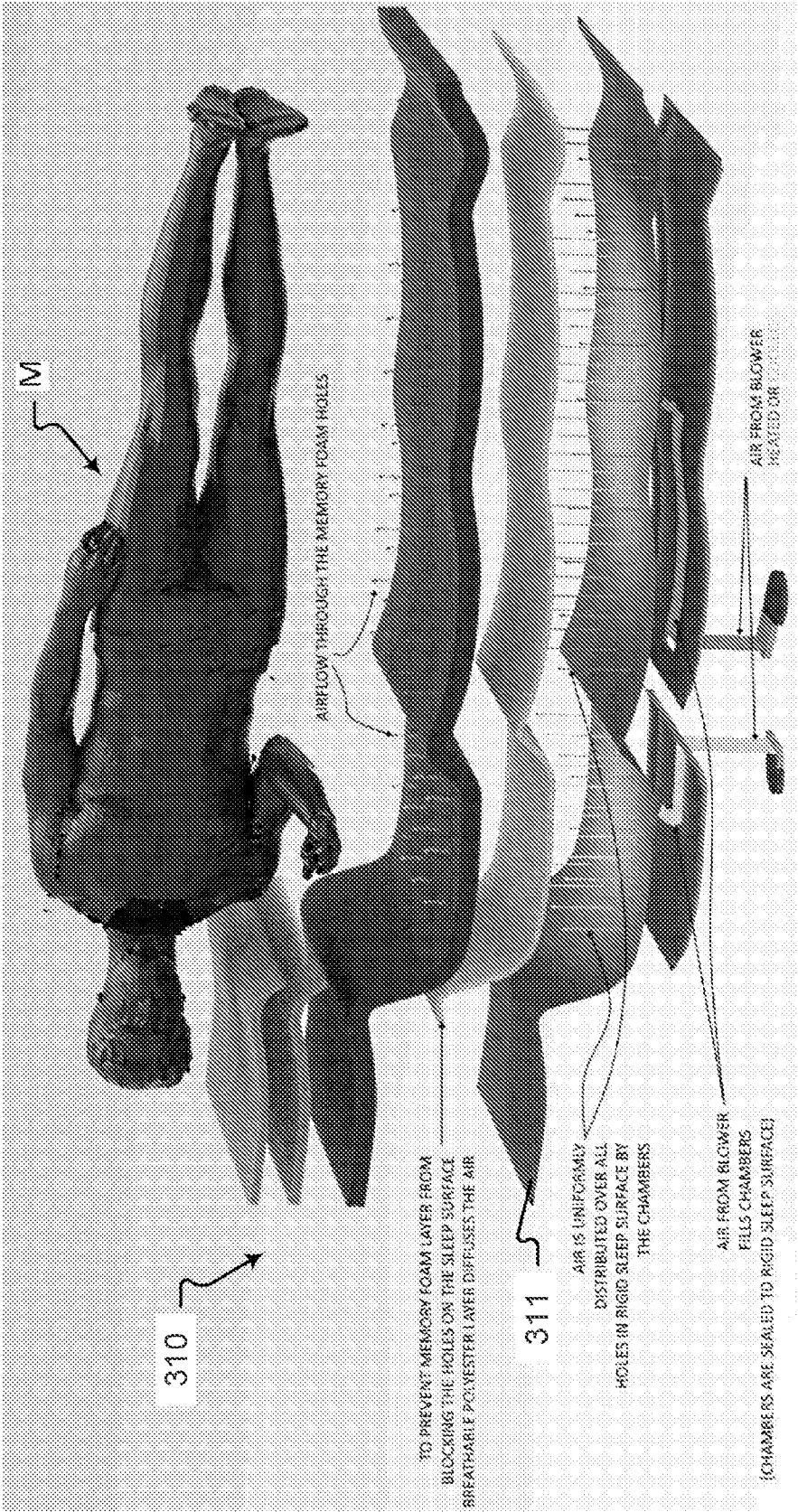


FIG. 6C

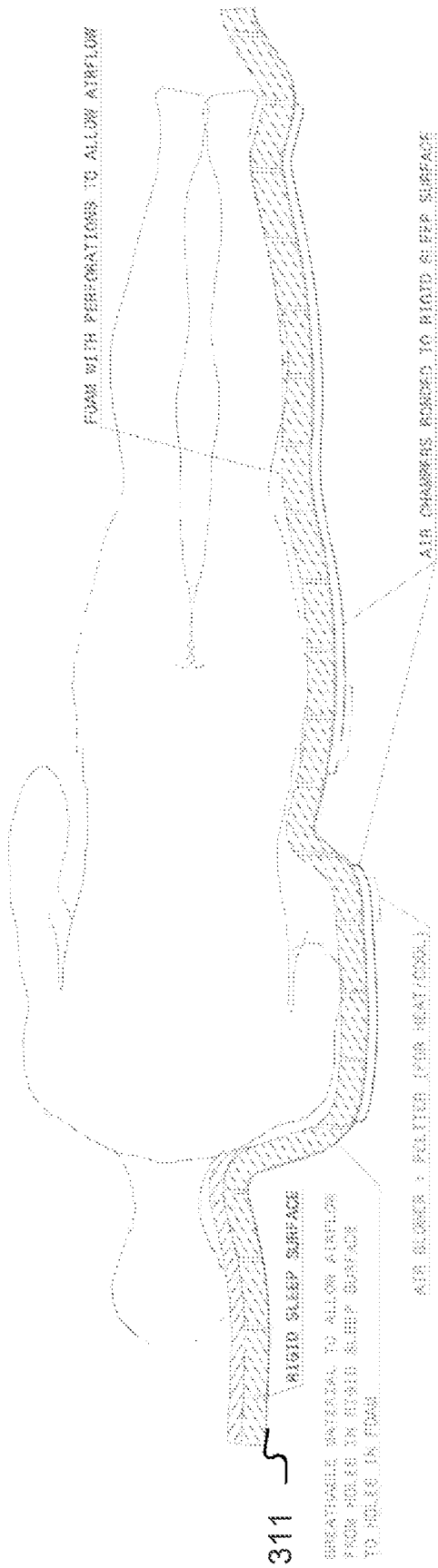


FIG. 6D

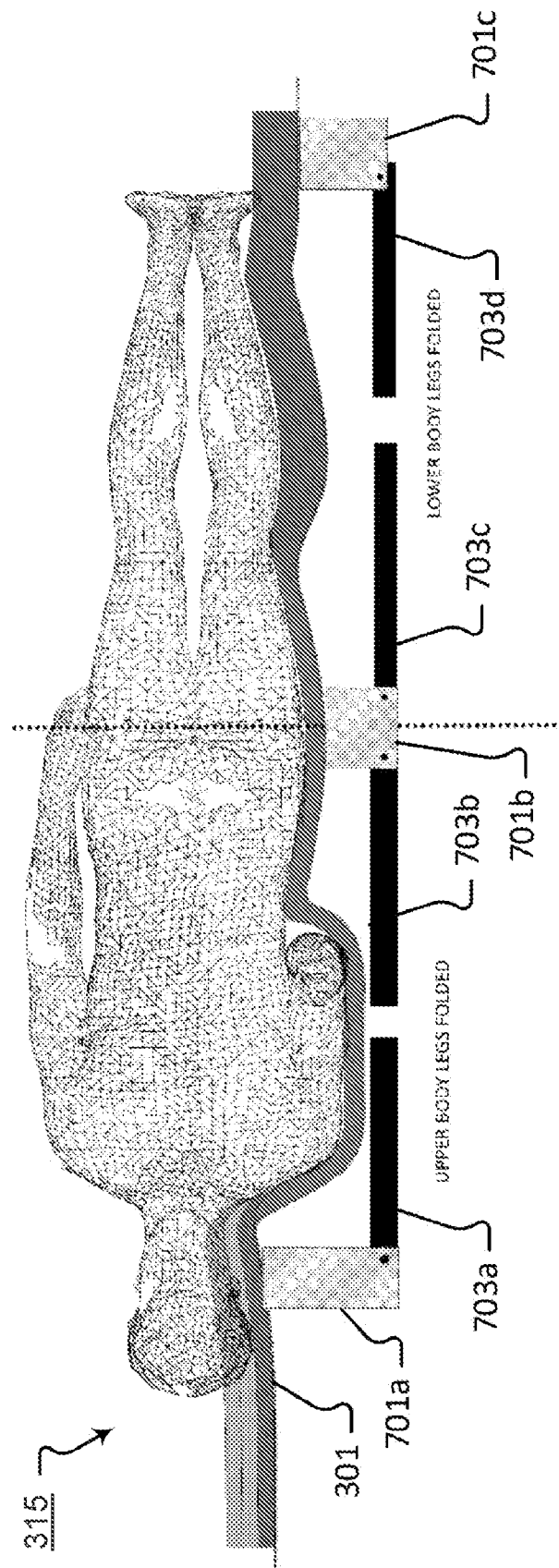


Fig. 7A

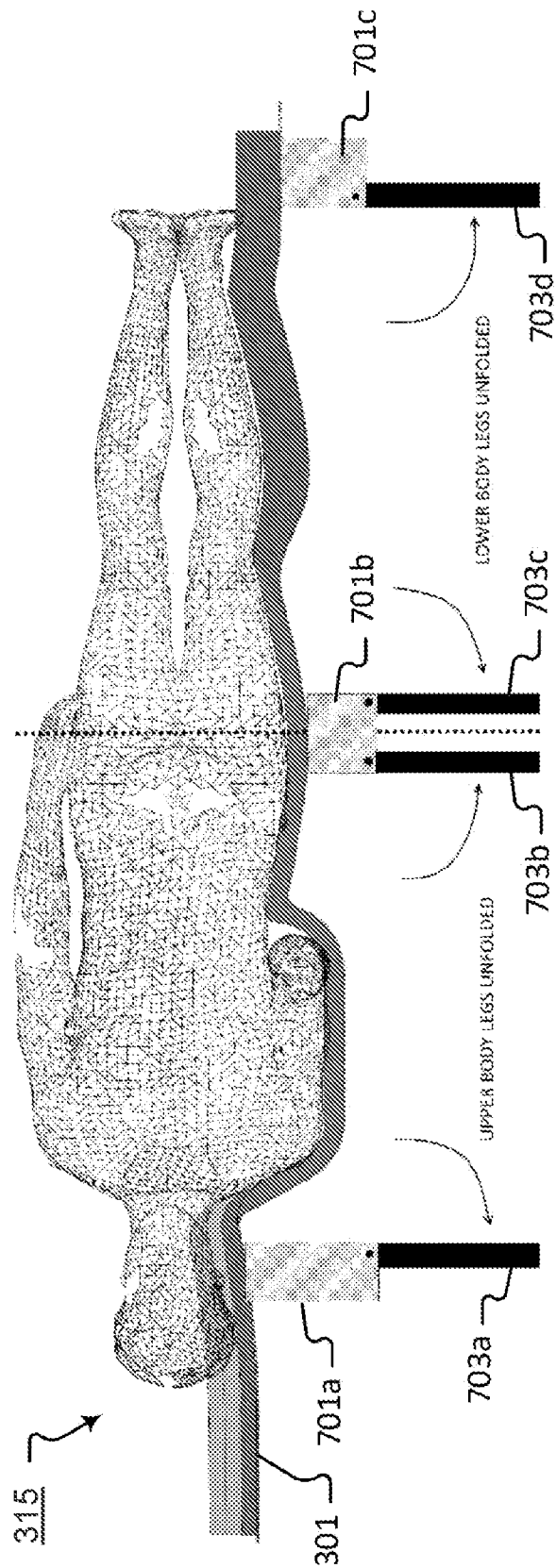


FIG. 7B

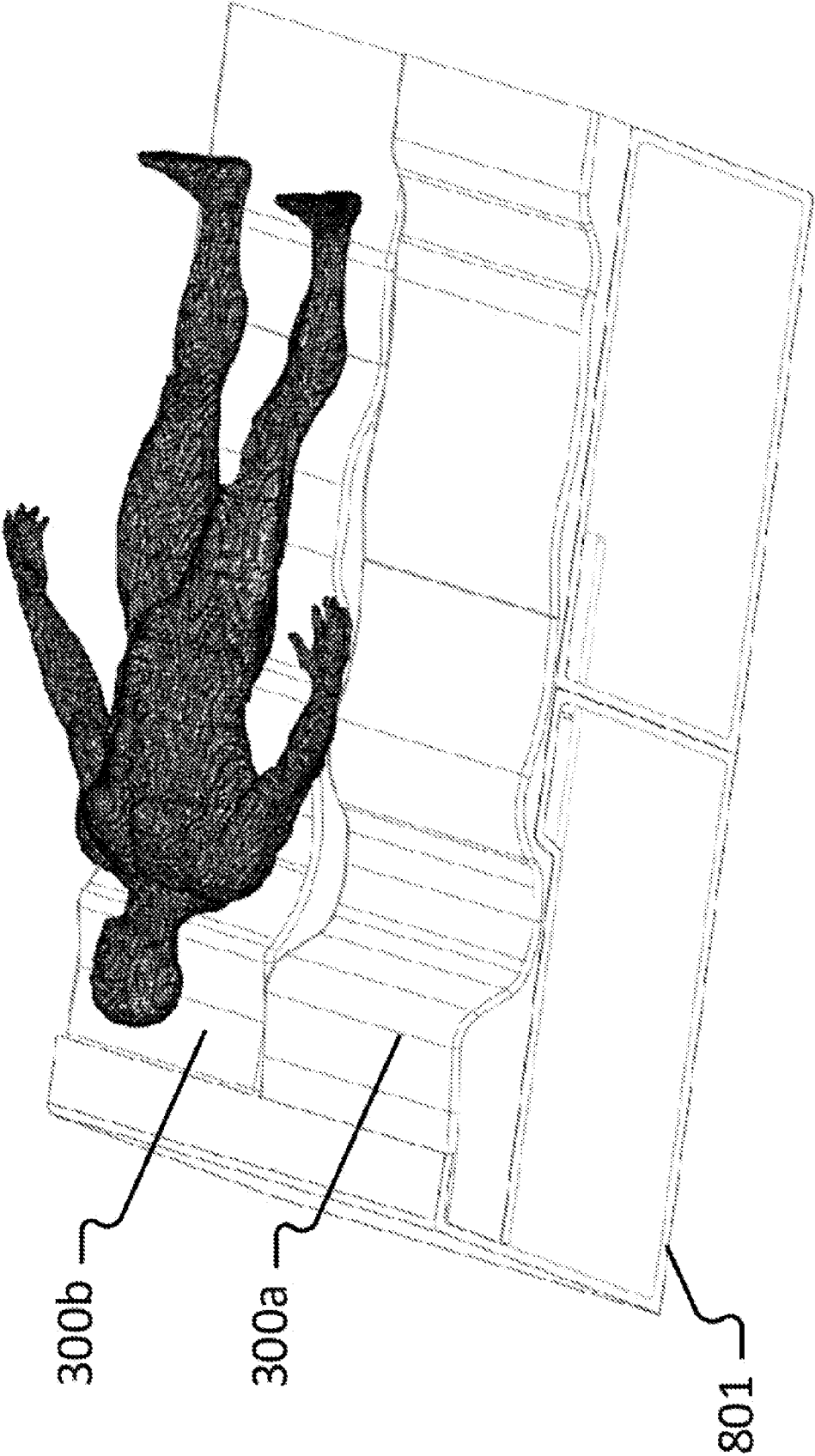


FIG. 8A

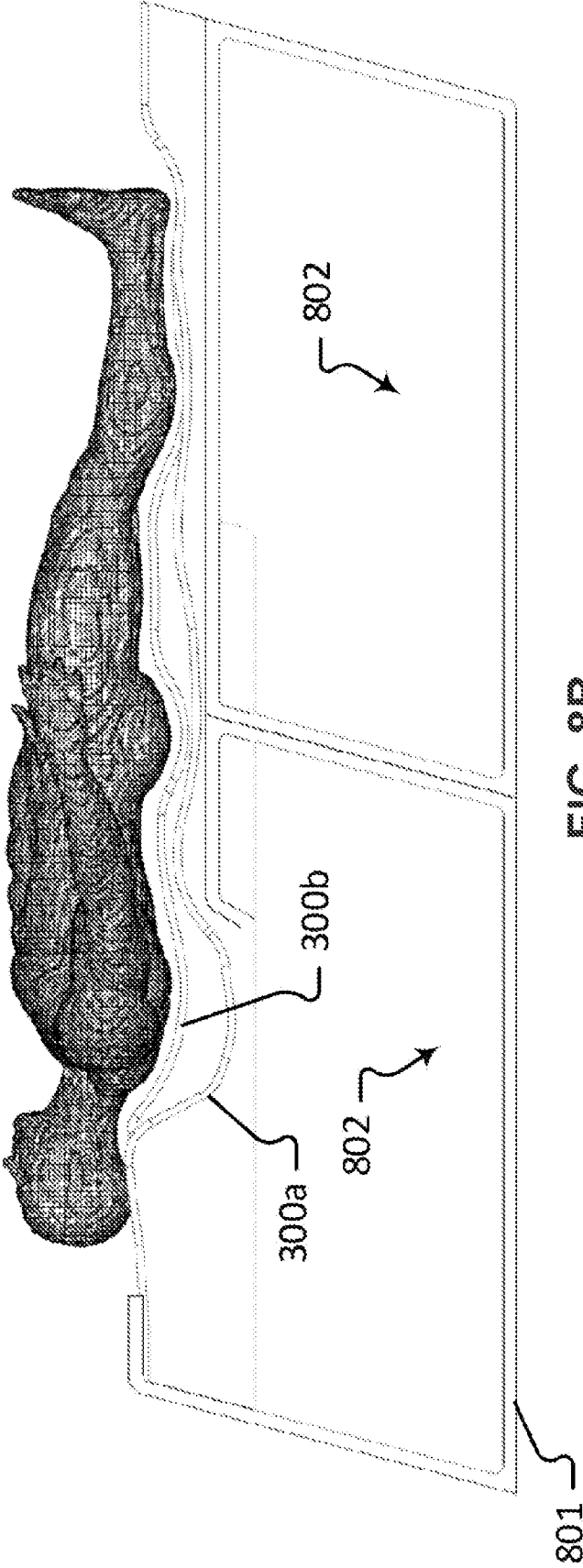
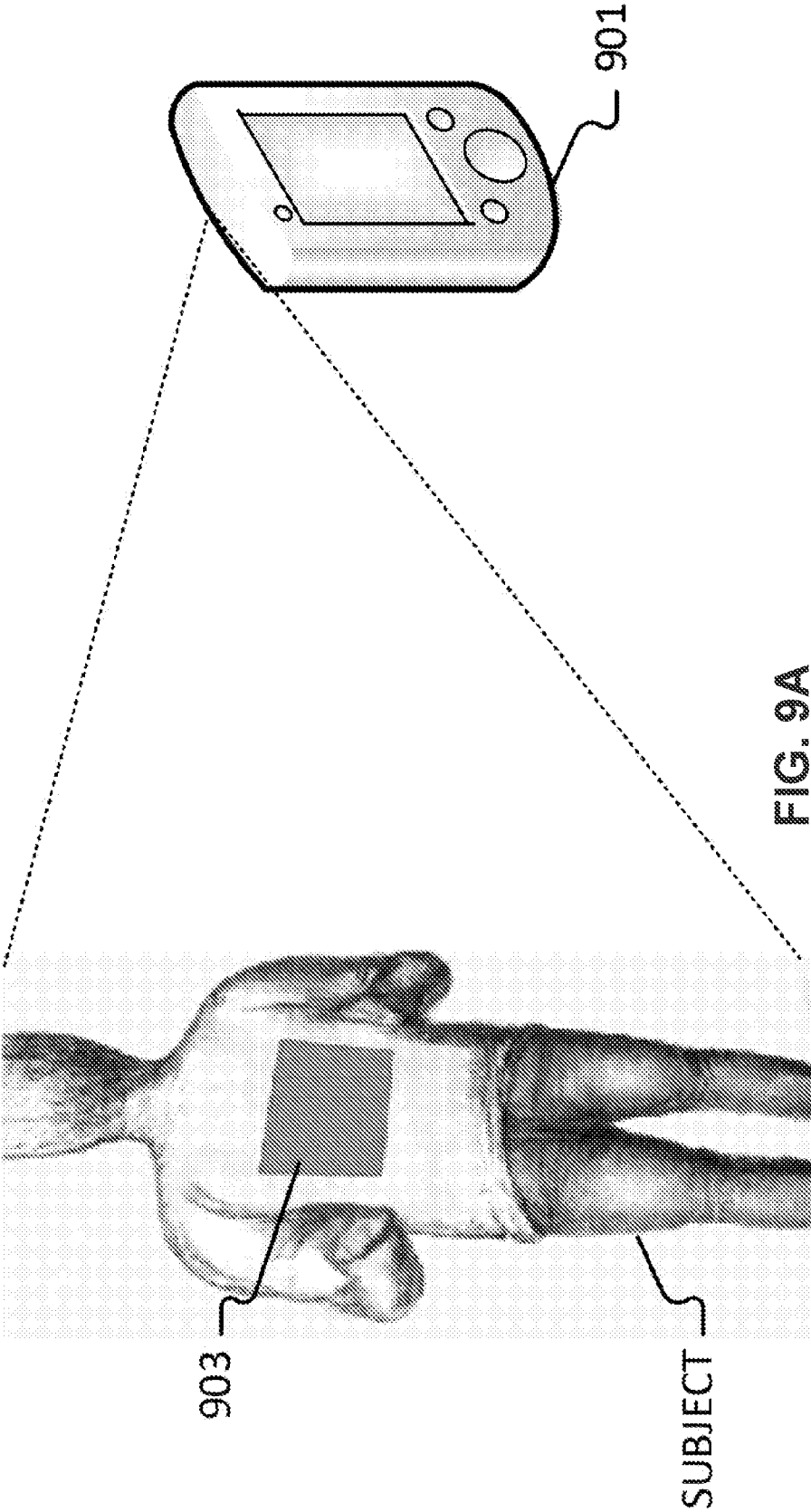


FIG. 8B



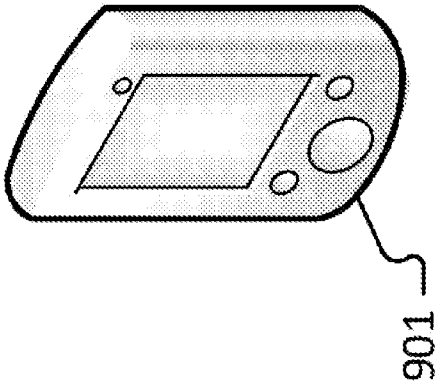
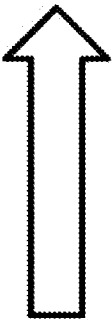
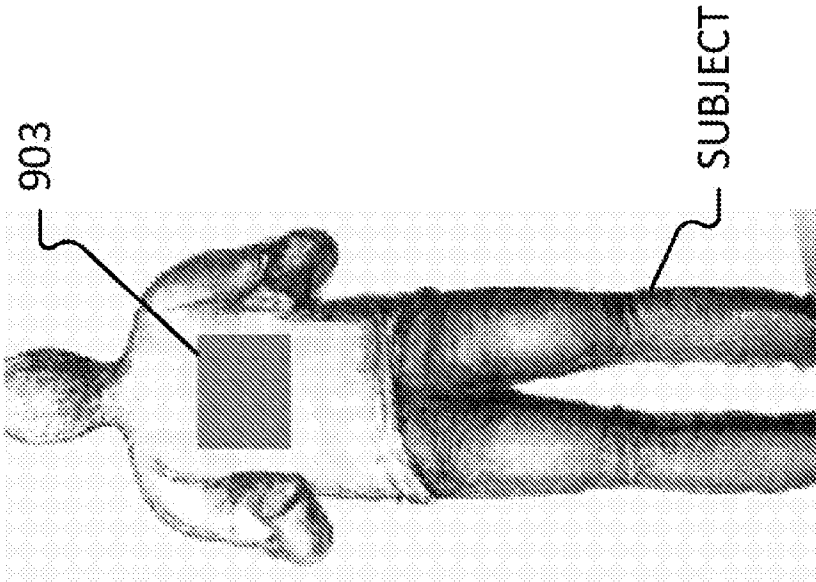


FIG. 9B

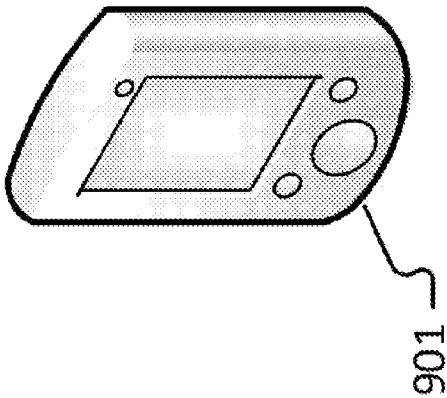
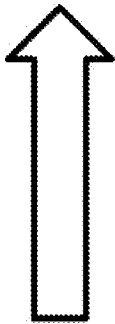
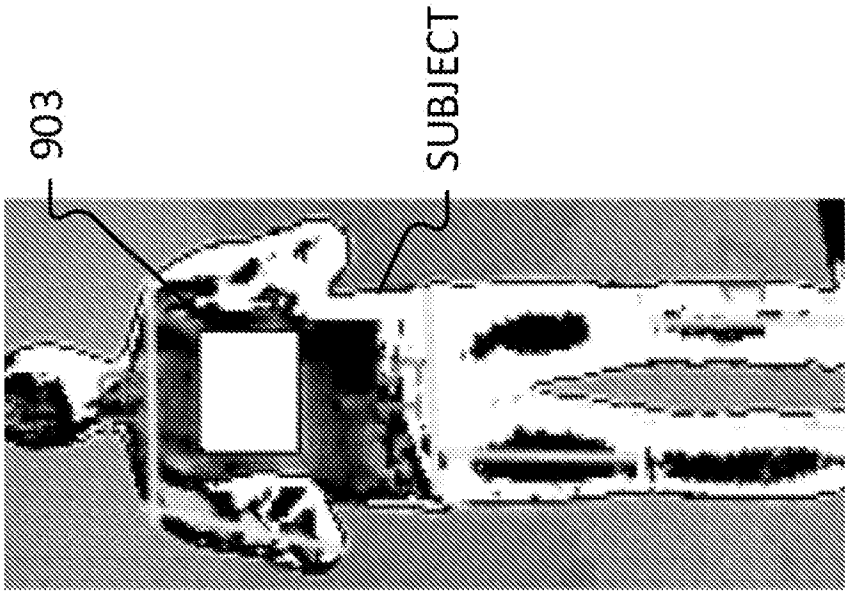


FIG. 9C

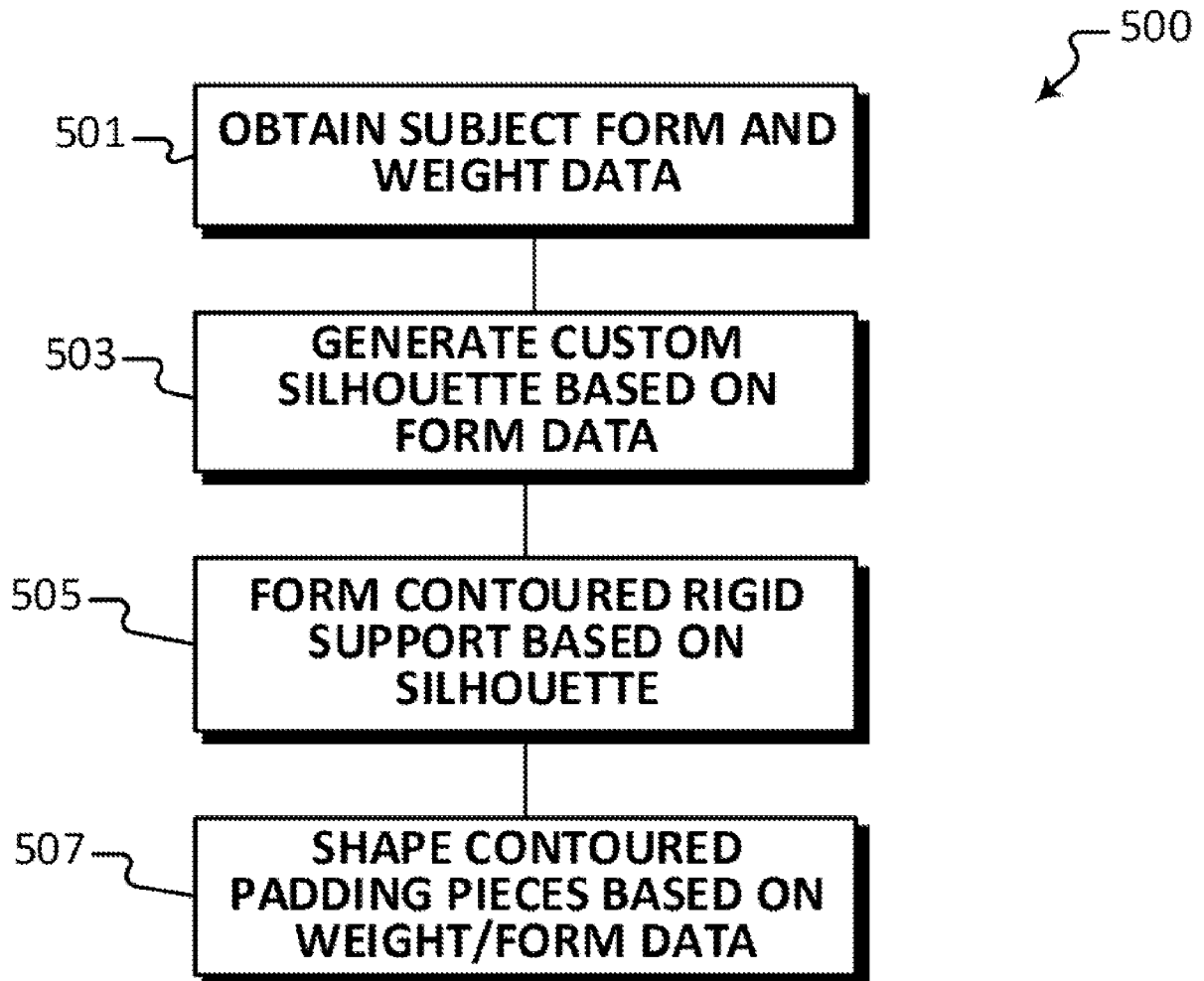
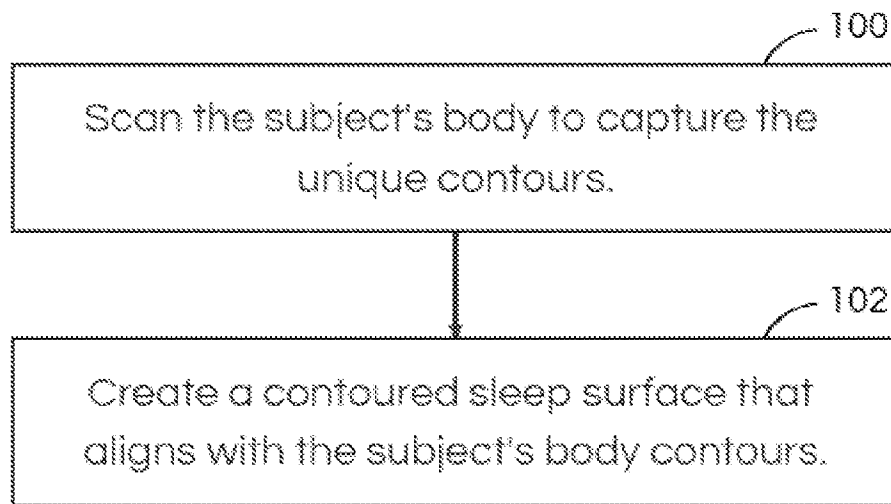
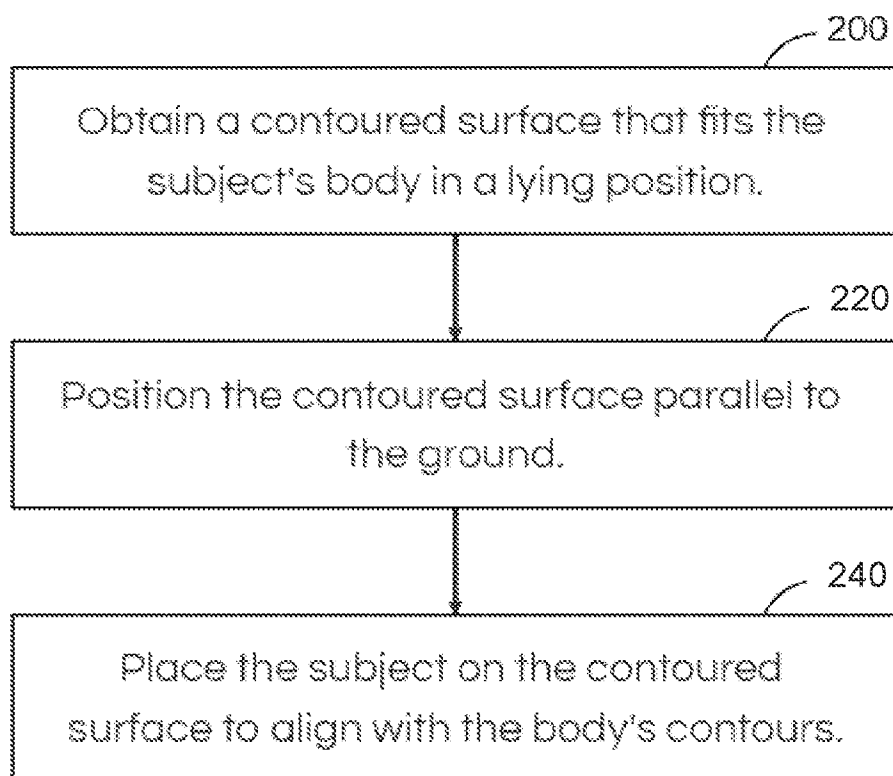
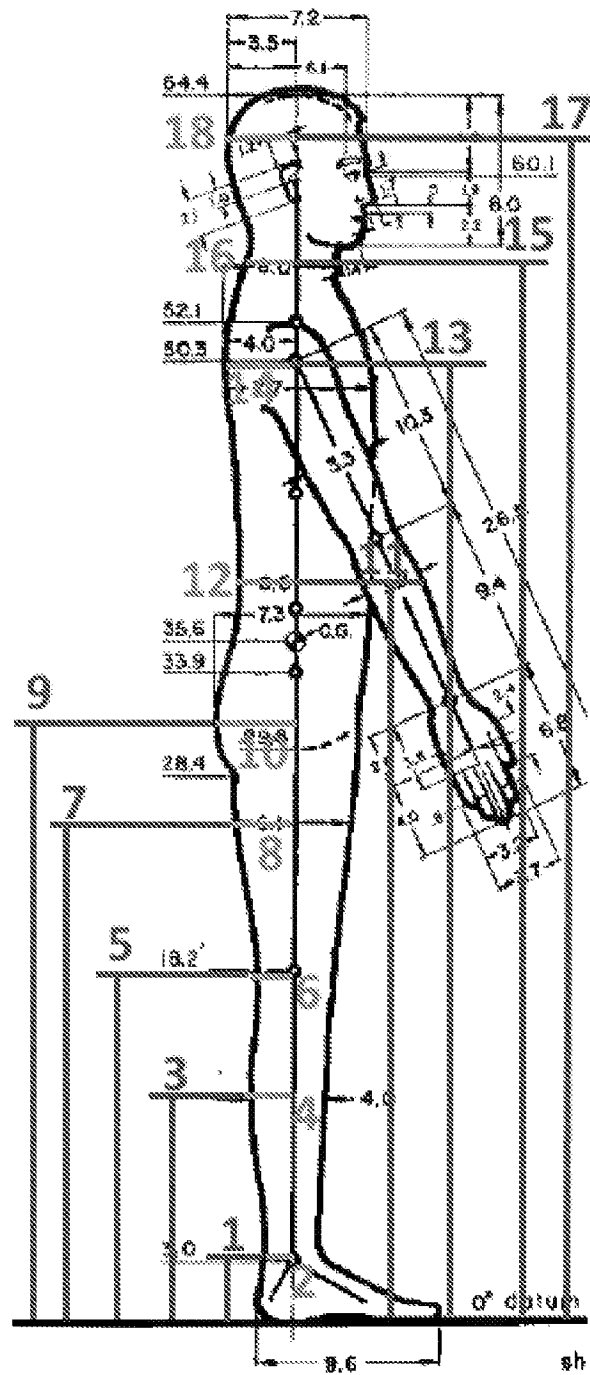


FIG. 10

**FIG. 11A****FIG. 11B**



MEASUREMENTS FOR BACK SLEEP MODULE

FIG. 12

	S 2.5%tile	M 50%tile	L 97.5%tile
1 Foot bottom to Ankle	3	3.5	3.8
2 Ankle half Width	1.6	1.8	2
3 Floor to Calf widest point	11.7	12.5	13.8
4 Calf Half width	2.2	2.5	3
5 Floor to Knee	18.2	19.7	21.2
6 Knee Half width	1.8	2	2.6
7 Floor To Thigh Widest point	26	28.8	3.8
8 Thigh Half width	3	3.5	4.1
9 Floor to gluteus	31	34.9	37.2
10 Spine to Gluteus max width	4.1	4.8	5.3
11 Floor to Narrowest back point	38.1	42	45.2
12 Spine to Narrowest back point	3	3.7	4.3
13 Floor to widest point in scapula	49.9	53.7	57
14 Spine to Back max distance	4	4.9	5.3
15 Floor to Narrowest point of Neck	55.5	59.8	64
16 Half width of Narrowest point of neck	2.4	3.1	3.4
17 Floor to widest point of skull	61.5	66.4	70.2
18 Spine to back of head	3.5	4	4.6

FIG. 13

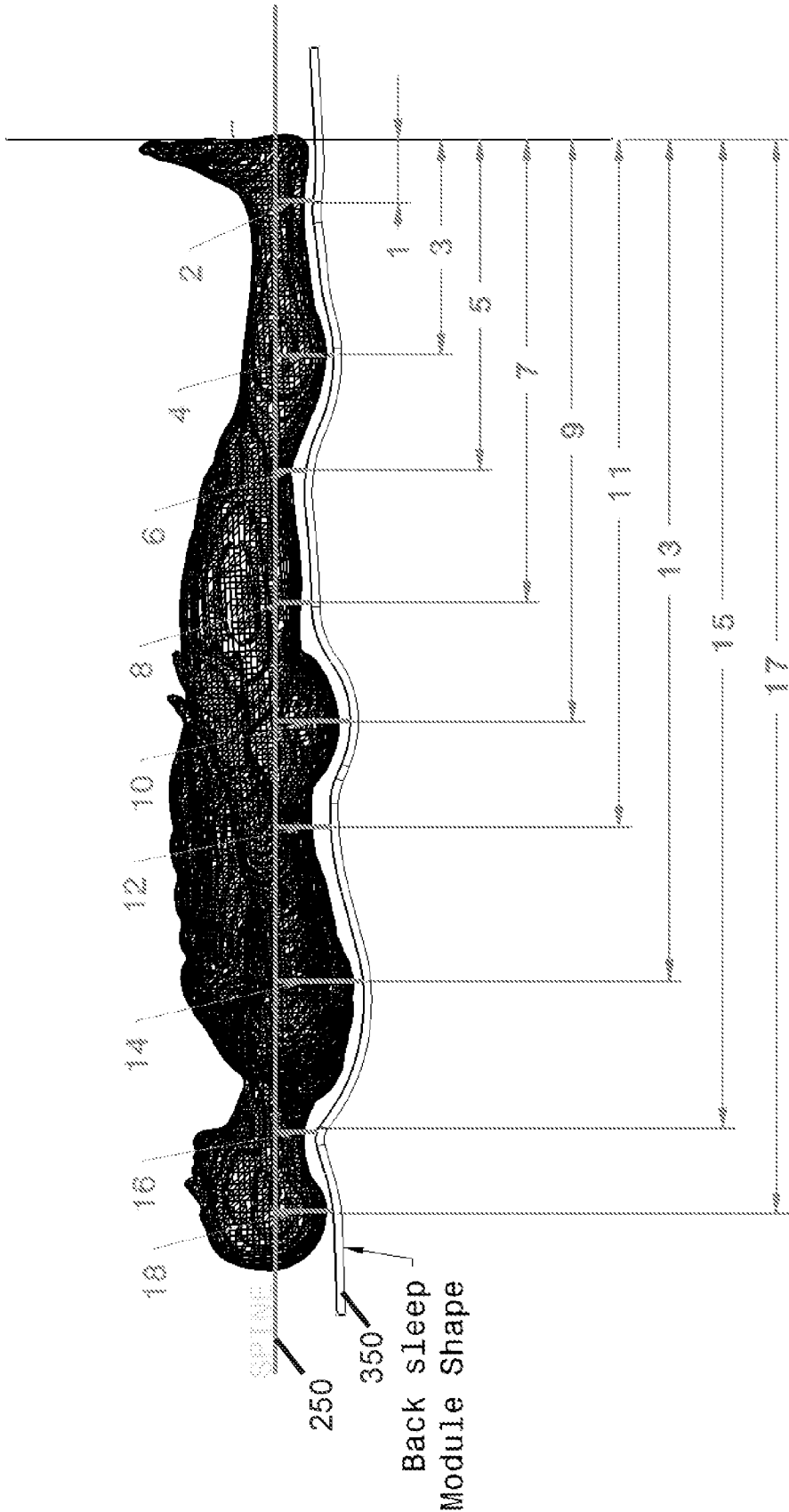
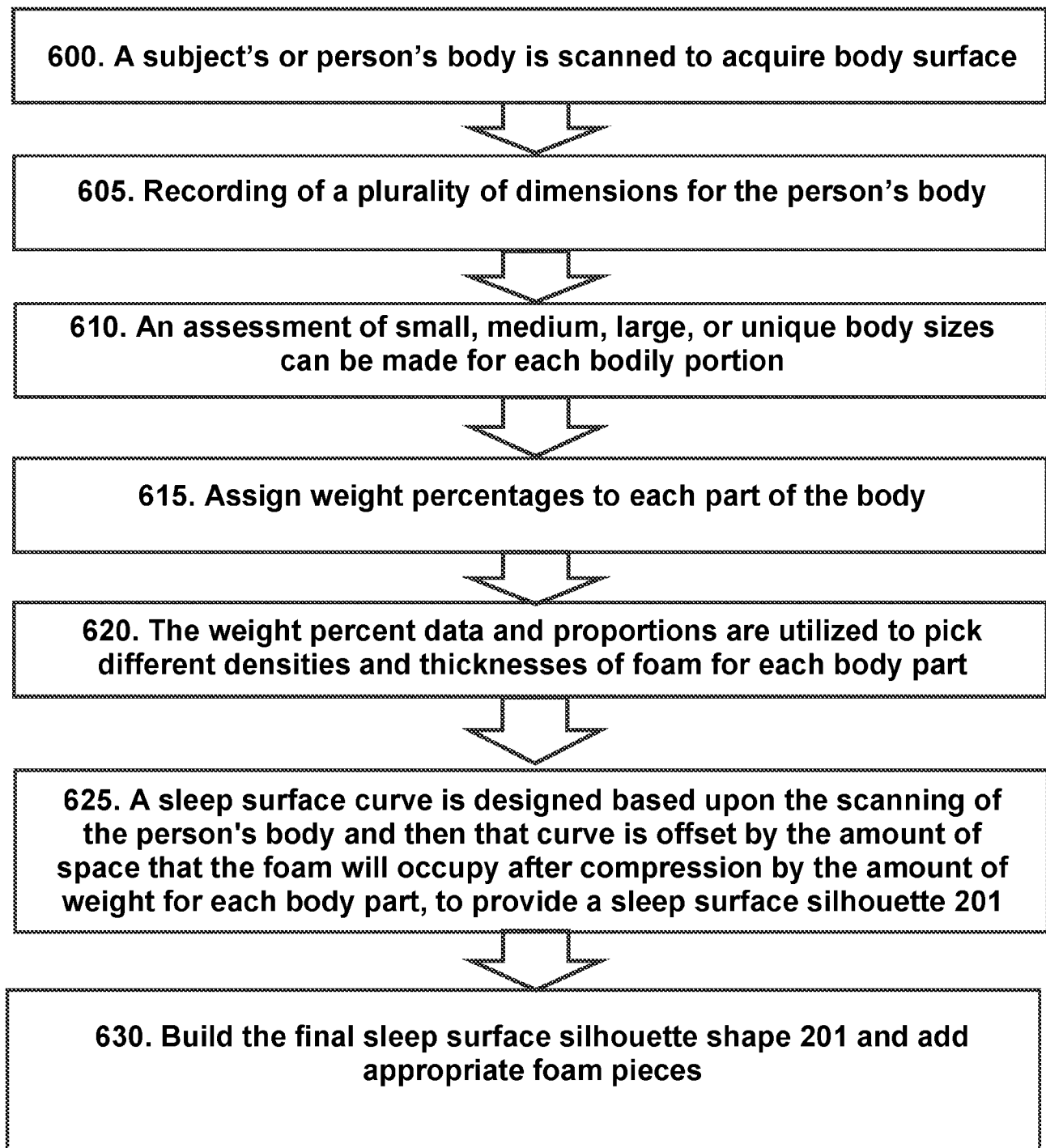


FIG. 14

**FIG. 15**