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(54) **PRESSURE ADJUSTABLE FOAM SUPPORT APPARATUS**

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(57) **ABSTRACT**

The present invention concerns a mattress-like apparatus whose firmness is adjustable by the user. This goal is attained by enclosing the polyurethane foam core of the mattress within an airtight cover chamber, and varying the negative air pressure (vacuum) applied into it. As a result, the mattress is adjustable as to firmness measured in terms of Indentation Force Deflection (IFD, or spring-back force) and support (density).

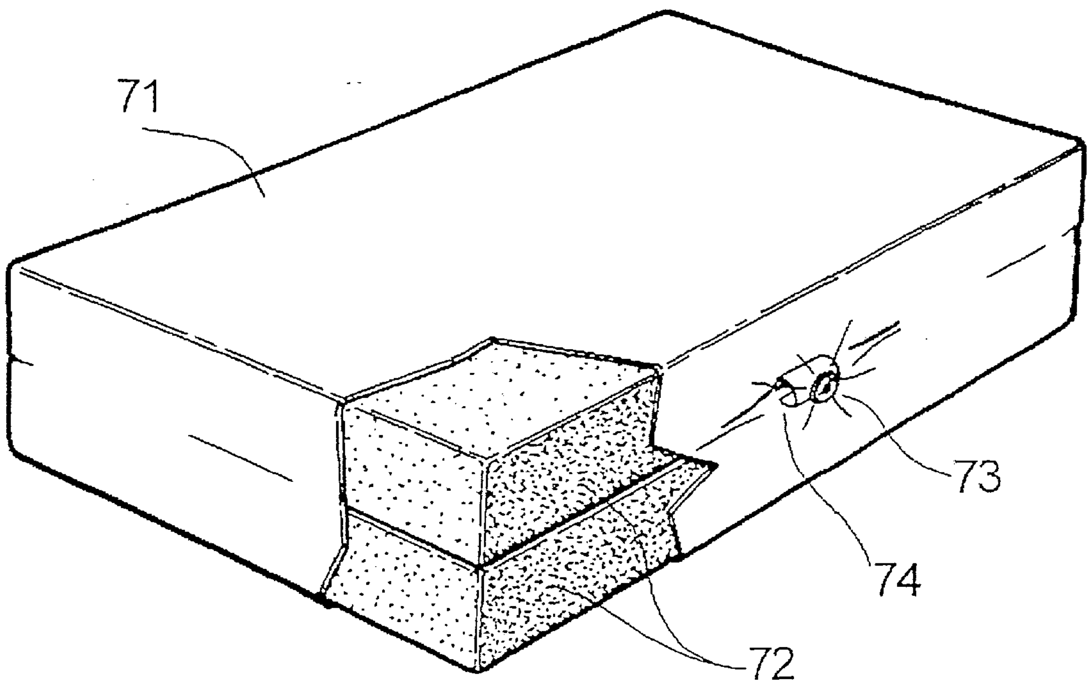

FIG.4

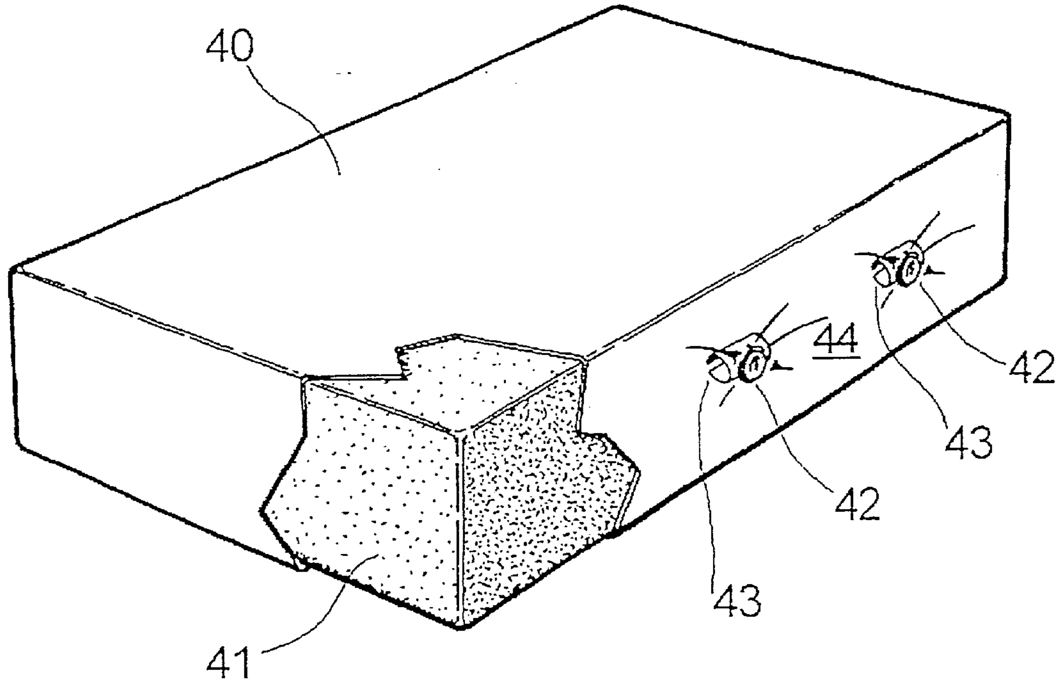

FIG.5

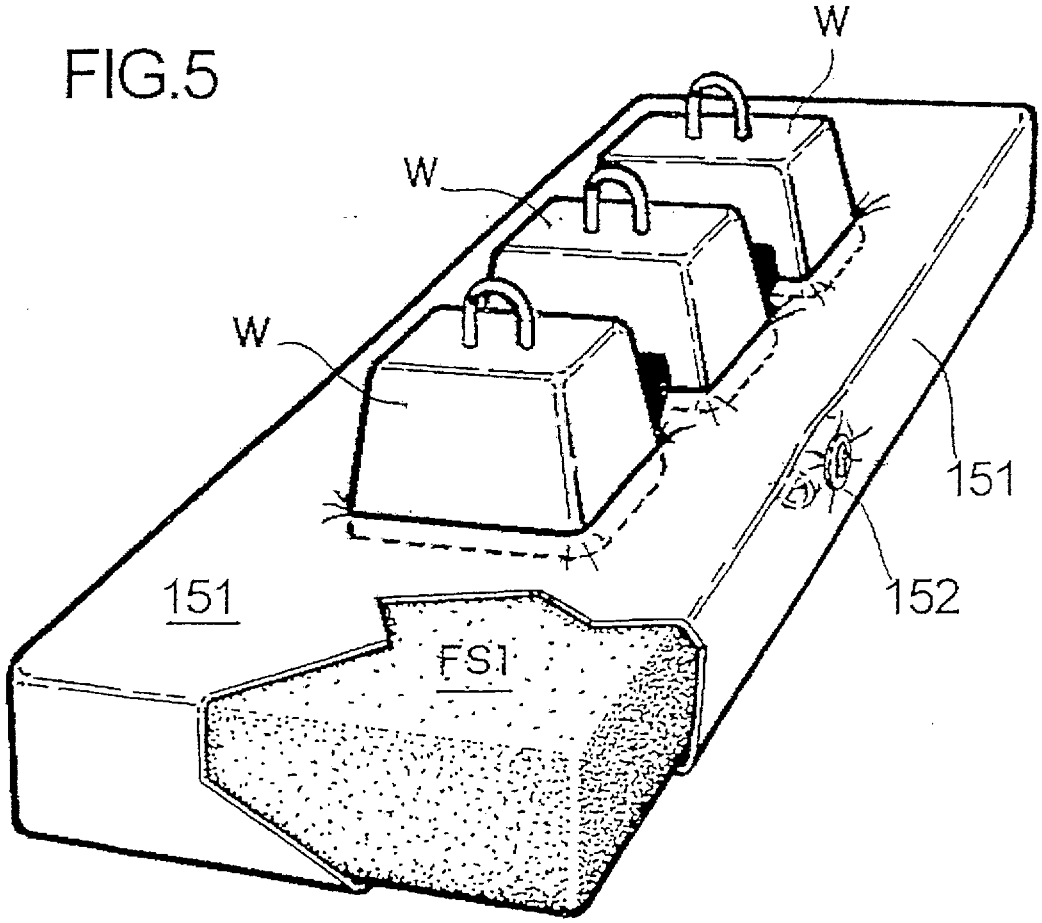

FIG.6

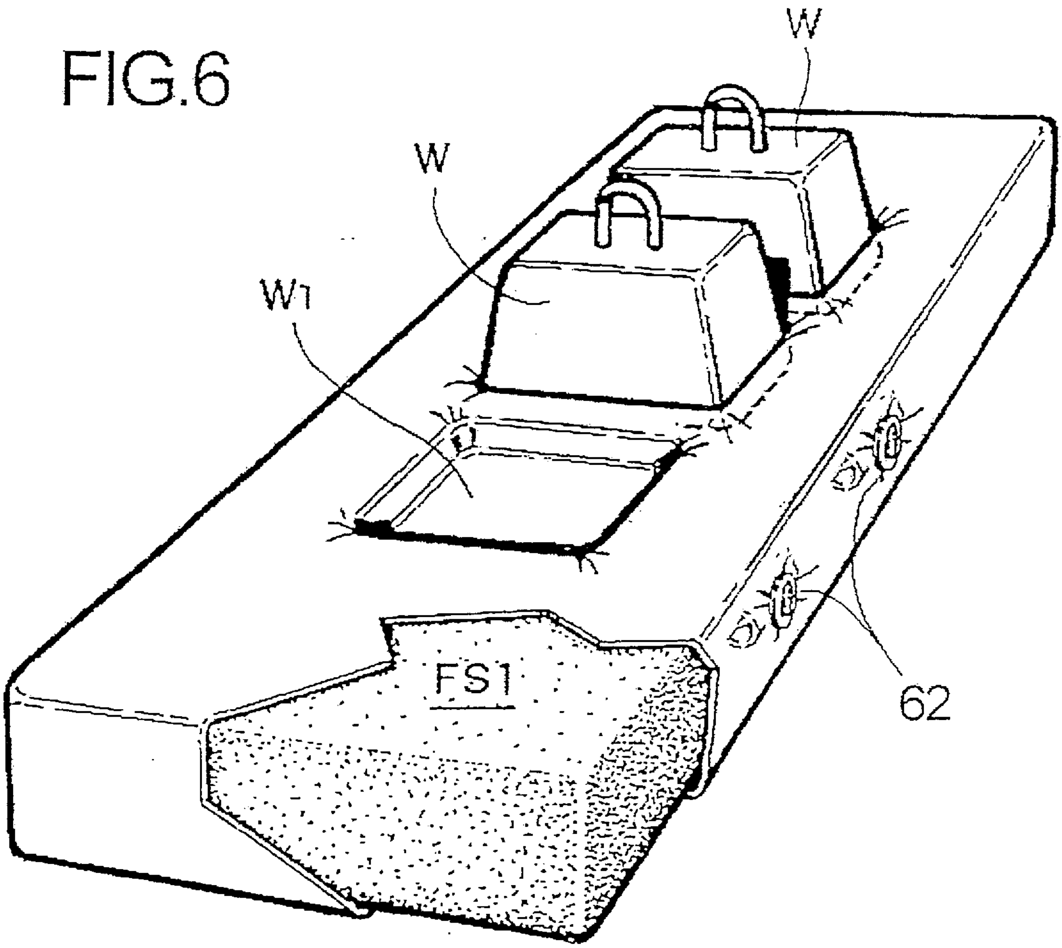

FIG.7

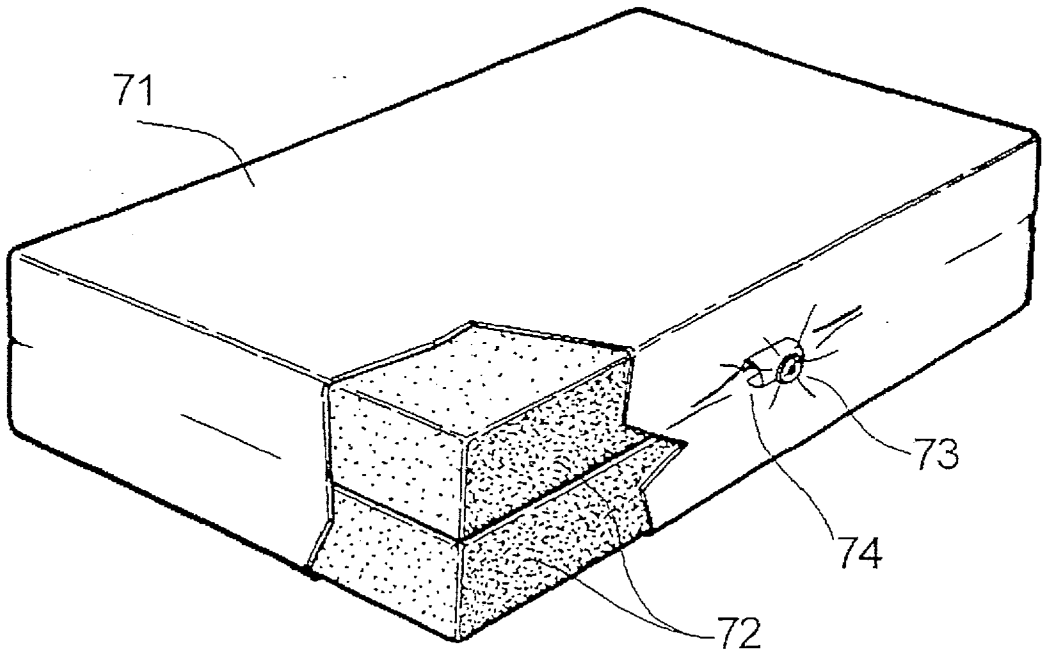

FIG.8

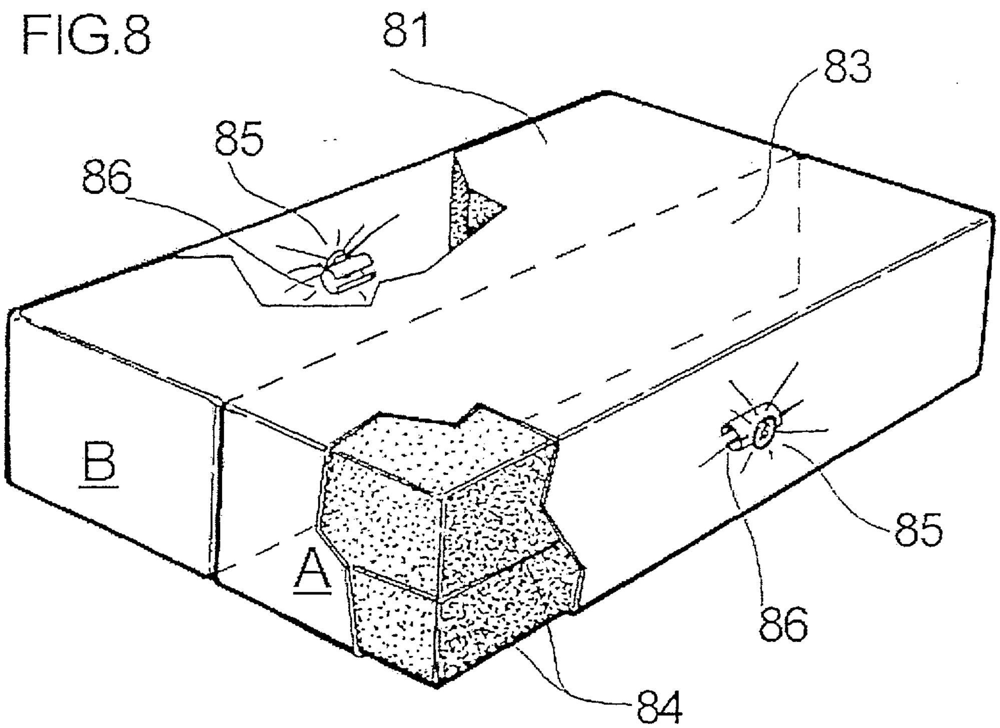

FIG.9

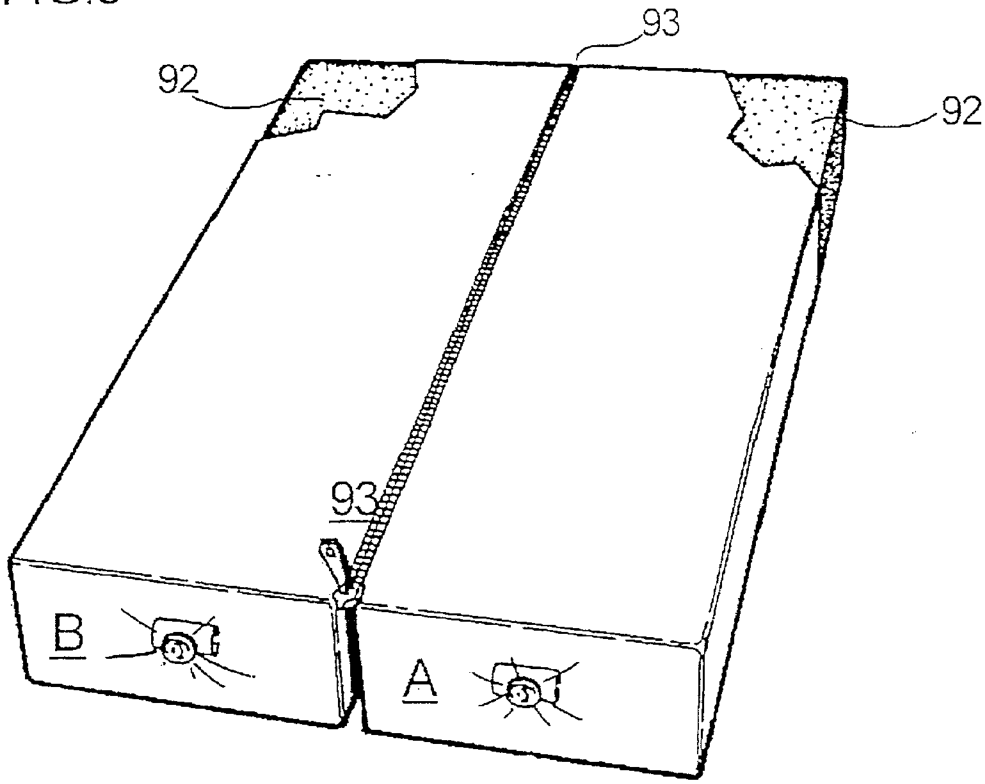

FIG. 10

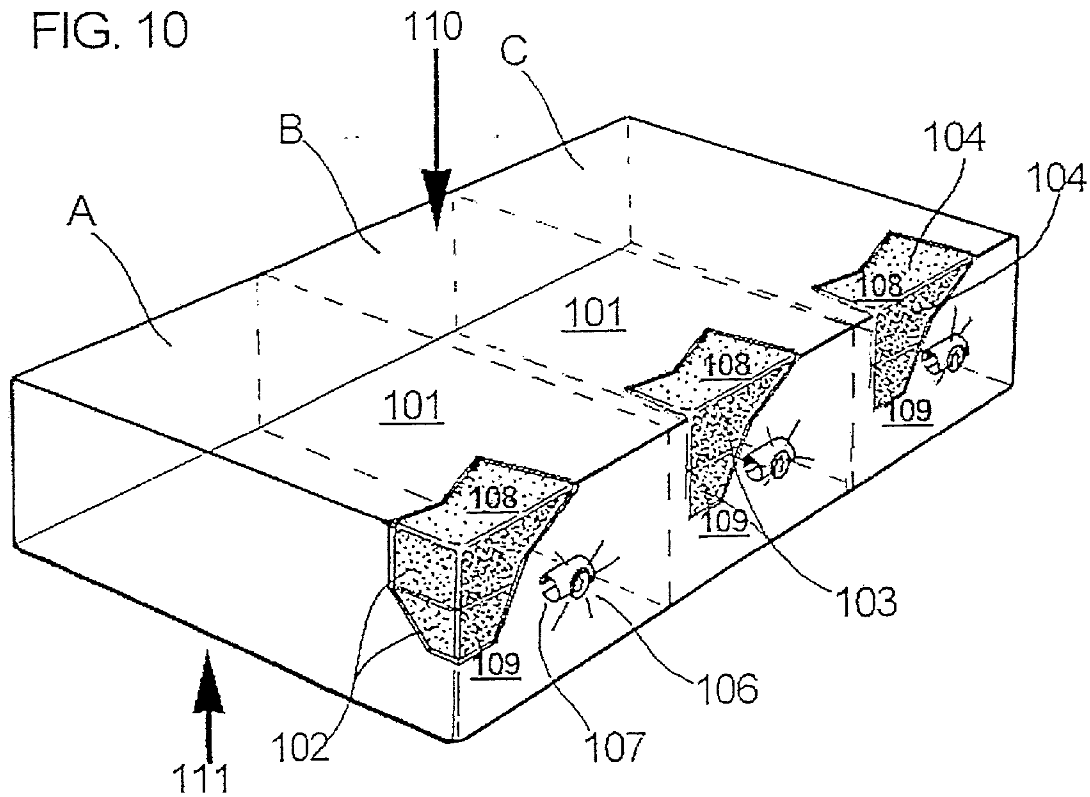
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FIG. 11

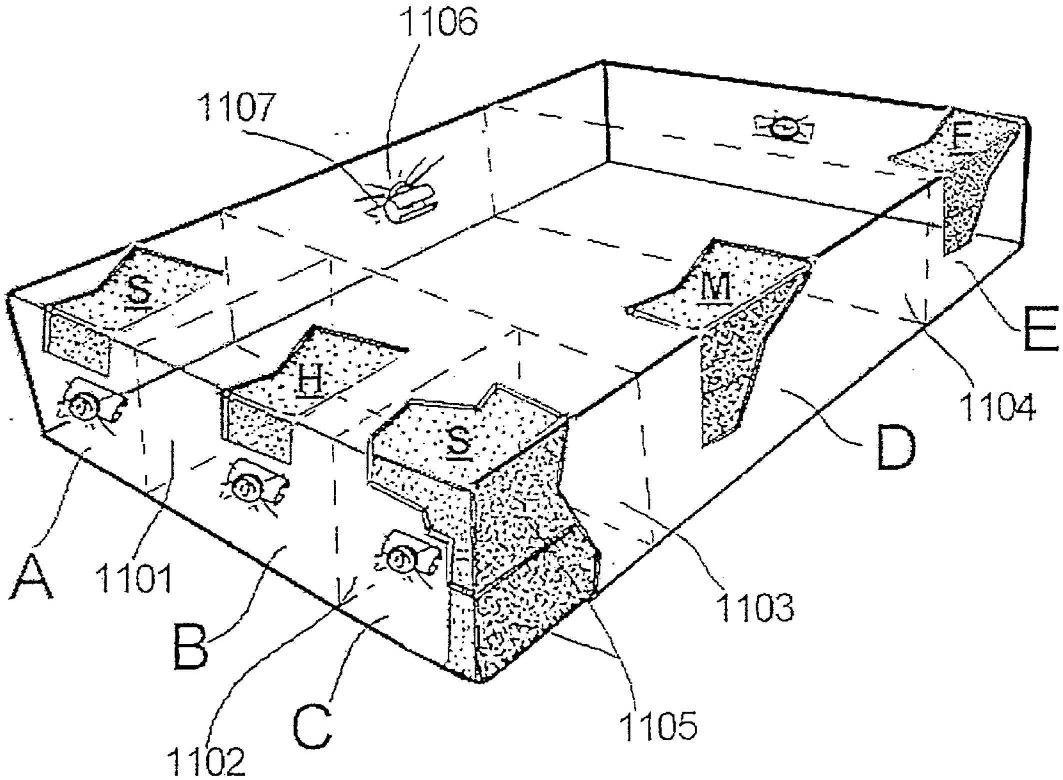


FIG.12

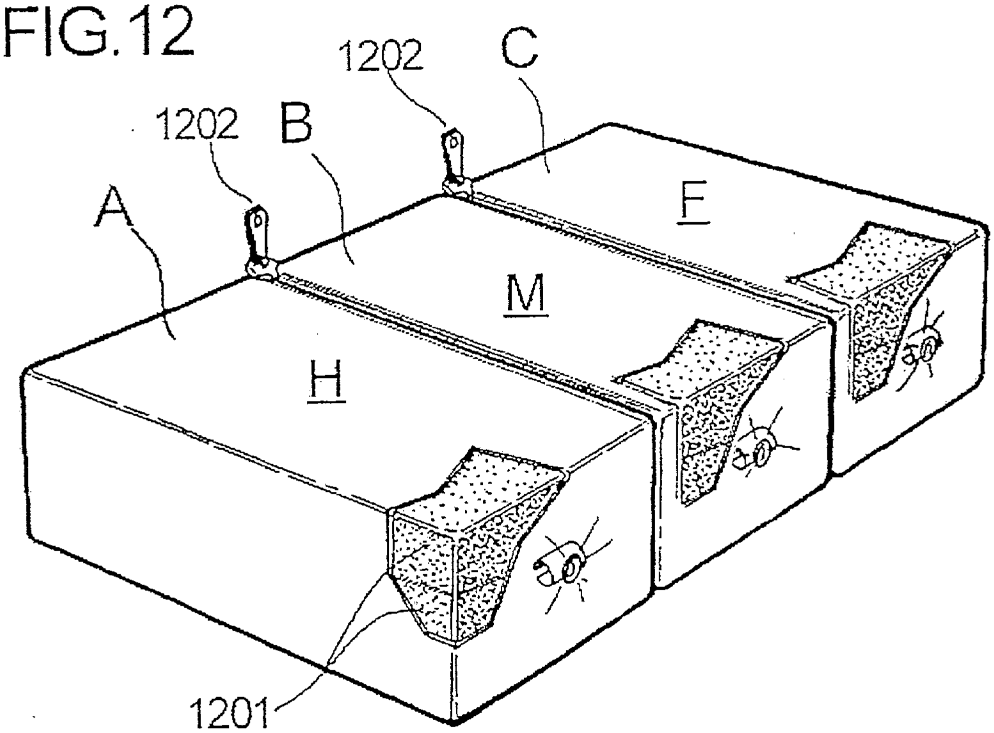


FIG. 13

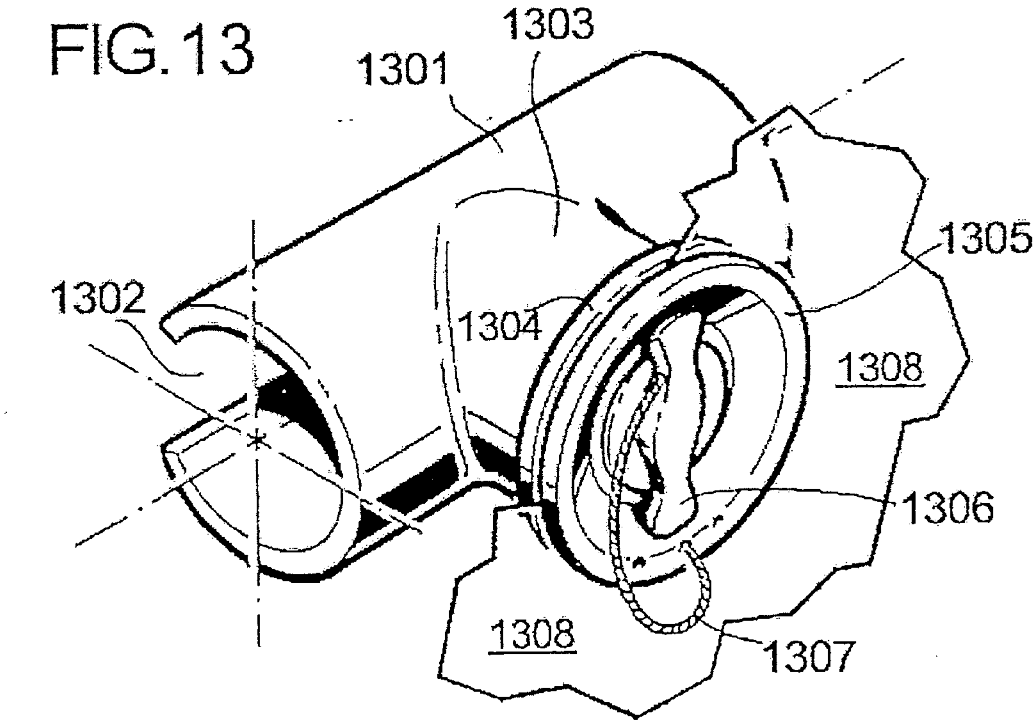
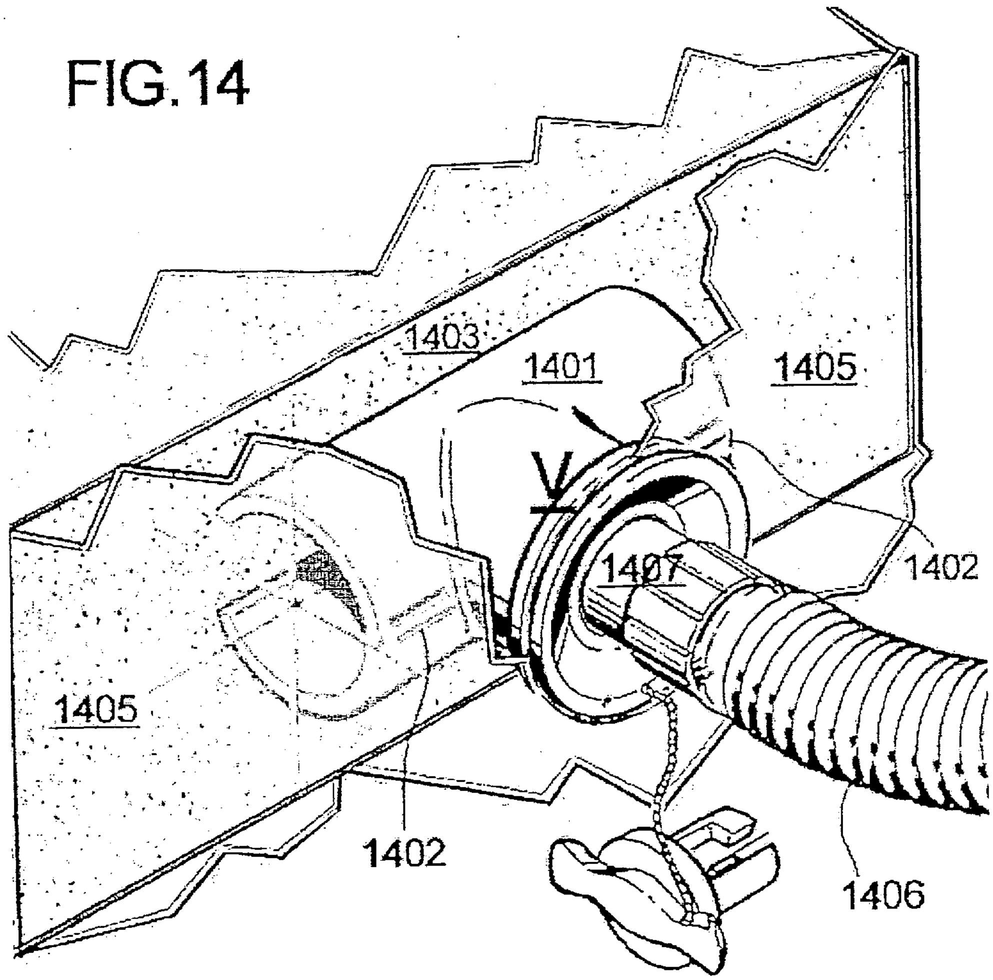


FIG. 14



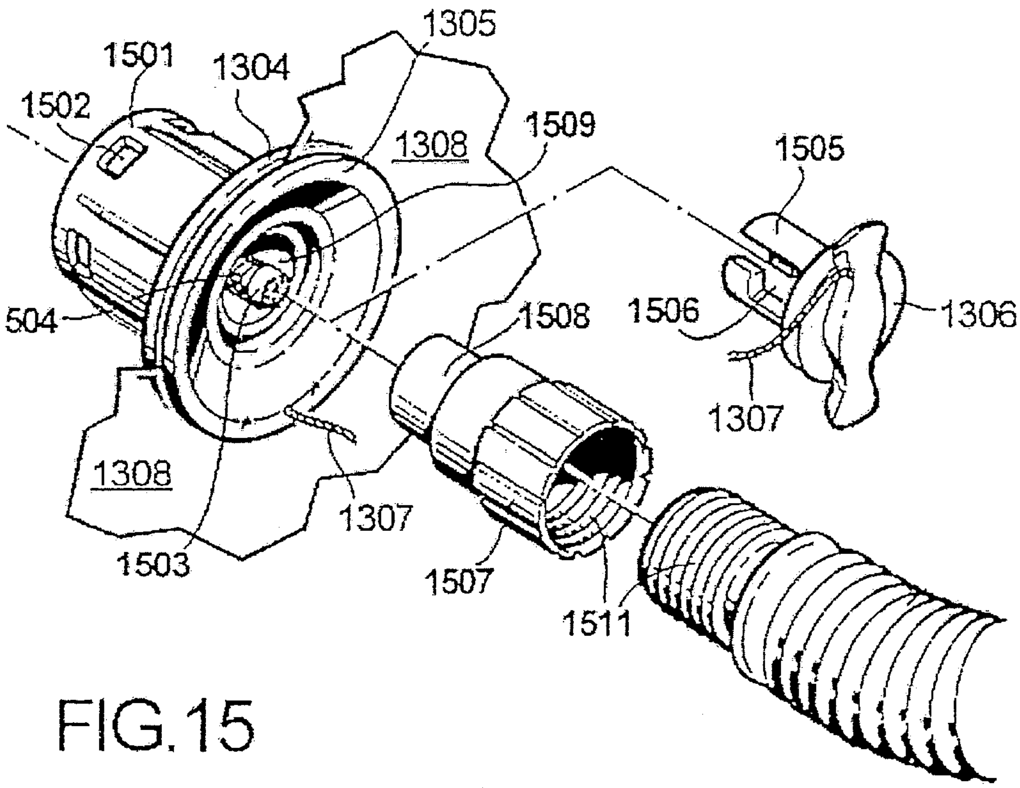

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FIG.15

PRESSURE ADJUSTABLE FOAM SUPPORT APPARATUS

FIELD OF THE INVENTION

[0001] The present invention concerns a mattress-like apparatus whose firmness is adjustable by the user. This goal is attained by enclosing the polyurethane foam core of the mattress within an airtight cover chamber, and varying the negative air pressure (vacuum) applied into it. As a result, the mattress is adjustable as to firmness, measured in terms of Indentation Force Deflection (IFD, or spring-back force) and support (density). Indentation Force Deflection is a measure of the load bearing capacity of flexible polyurethane foam. IFD is generally measured as the force (in pounds; 1 pound=0.453 kg) required to compress a 50 square inch (1 square inch=6.45 square centimeter) circular indenter foot into a four inch thick sample, typically 15 inches square or larger, to a stated percentage of the sample's initial height. Common IFD values are generated at 25 and 65 percent of initial height.

[0002] More specifically, the present invention teaches the modulation of the principal characteristics of open-cell, flexible polyurethane foam for use in support devices such as mattresses, sitting furniture, cushions and all other applications using a support apparatus. These characteristics are subjective tactile softness and bodyweight-carrying support firmness, the modulation of which is effected in a way so as to greatly enhance comfort and to offer an infinite choice of easily adjustable levels of comfort to the user at lower comparable cost. On its own, in combination with multi-chamber arrangements and also integrated with known, traditional techniques, this invention enhances the versatility of support devices, allowing for a great number of variations in the choice and adaptation of materials and mattress architecture to go together with self-inflating, modulable foam.

BACKGROUND OF THE INVENTION

[0003] Various attempts have been made to control the hardness, softness, and support of foam within a mattress. This has been achieved by adding different pieces or zones of foam within a mattress, each zone having a different density and IFD rating which corresponds to a body part such as head, shoulders, middle body, legs and feet. Yet other inventions have interchangeable foam components which the user may select and arrange as desired. This process is inconvenient, since bulky foam components have to be stored and manipulated very often to make the required changes. Another dilemma with "foam zones" having different IFD ratings for different parts of the body, is that it is difficult to give adequate support to a very soft foam component. To achieve this, mattress manufacturers use a coil, foam base, or compressed air bases which are firm and offer needed support, subsequently they layer softer foams above said firm base to offer comfort.

[0004] U.S. Pat. No. 2,779,034 to Arpin discloses a firmness adjustment for mattresses involving a standard coil spring mattress wherein standard coil springs are enclosed by a loosely fitting airtight cover. In Arpin's device, the firmness of the mattress increases while air pressure within the covered is lowered.

[0005] U.S. Pat. No. 3,872,525 and U.S. Pat. No. 4,025,974 to Lea discloses a self-inflating air mattress/mat including an airtight flexible envelope which encloses a core of resilient, open cell, lightweight foam material, substantially the entire upper and lower portions of which are bonded to the envelope. The air within can be removed by compressing the structure whereby the foam layer collapses, allowing the mat to be rolled up into a compact package.

[0006] U.S. Pat. No. 4,944,060 illustrates a mattress having a plurality of discrete, air permeable cells which are to some extent hydrophobic. The invention uses pressurized air to inflate the mattress.

[0007] U.S. Pat. No. 6,098,378 discloses a method of packaging a single mattress to a small size to be conveniently carried. In this method and apparatus, the foam mattress is compressed to fit into a hard container for shipment. At the point of sale, the mattress is extracted and expands to its original shape.

[0008] In recent years, we have seen the advent of higher density foams such as visco-elastic foam that solves the problem of support and softness combined in foam of one single piece. Visco-foam offers support because of its high density (typically over 3 pounds per cubic foot density−1 cubic foot=0.028 cubic meter) and feels soft and desirable to the user because it typically has an IFD of 15 lbs or under. However, the high cost, bulk and heavy weight of a visco-foam core remains a problem. Companies, who sell visco-foam mattresses, are obliged to deliver and install them at the customer's home.

DESCRIPTION OF THE INVENTION

[0009] The present invention addresses these difficulties through controlling softness and support of foam directly, without loss of support and without excessive weight or bulk of the resulting mattress.

[0010] The present invention teaches how to control and adjust the principal characteristics of open-cell flexible polyurethane foam in a specific integration with airtight covers and pressure valves for the use in any form of comfort support device, for instance, mattresses. The principal characteristics pertain to industry standards of subjective tactile softness in the sense of espousing body contours so as to optimally distribute pressure points of a person reclining on a planar surface, and of bodyweight-carrying support firmness. They are controlled and adjusted in a way to not only greatly enhance comfort, but particularly to offer an infinite choice of easily adjustable levels of comfort, defined as a balance between softness and firmness. This is done at lower comparable cost and weight compared to high density foam varieties such as visco-elastic foam, and in combination with known, traditional techniques, it enhances versatility, allowing for a great number of variations in the choice and adaptation of materials to go together with self-inflating, modulable foam into comfort level adjustable support devices.

[0011] The invention teaches how the Indentation Force Deflection (IFD) and density properties of a certain quality range of flexible open-cell polyurethane foam are adjusted by removing some of the air from within the foam cells and altering the cellular density of the foam core. Since high density, more expensive foams, such as visco-elastic foams, are very desirable as to comfort, the main teaching of the invention is how to modulate comparatively less expensive, lower density foam to exhibit the feel-characteristics of high density foam, and also attain support and comfort levels of a higher density, more expensive foam,- without locking the user into a single, fixed comfort level.

[0012] IFD and density adjustment are achieved by altering open-cell, flexible polyurethane foam or material of similar characteristics within a fixed framework of controllable valves and airtight bladders. This art teaches that the material is fashioned in a particular form and that it is of a structure as to permit the extraction of air in the alveolate structure in a uniform manner throughout, thus increasing material density equally uniformly. A further feature of the material is that, by virtue of its structure, particular manufacturing and finishing processes, it affords in its low IFD number modulated state a commensurably higher support stability, heretofore only associated with foam or similar material of a very much higher density and greatly higher price. Finally, it is much lighter in weight than the latter and can also be reduced in size and volume for easy transport and storage.

[0013] The application of the principles of this teaching extends to a great number of possible combinations of foam only and foam plus traditional support devices used in the architecture of, for example, mattresses, that users may adjust to their personal preference But in all its combinations, the pivotal point of the invention is that specifically fashioned types of foam will soften when air is extracted from their cell structure. Compared to its original firmness, which is indicated by the manufacturer's IFD number, its resilience will decrease to about half of its original value. The density on the other hand increases considerably to about double its original value, creating the much needed body support a mattress should have. Density of foam is its weight per cubic foot, hence the heavier a cubic foot of foam weighs, the higher will be its density rating.

[0014] The present invention teaches that removing air from a foam core reduces the volume of the core, hence increases its density without adding weight to the overall mattress, which would be undesirable for the user. One of the disadvantages of high density foams, such as visco-elastic foam, is that they are very heavy and difficult to fashion in the form of a mattress. In this invention the single foam core mattress as well as its combination with other bedding materials are much lighter of weight but yet exhibit the same comfort and support characteristics as, for instance, a visco-elastic mattress. It has the additional advantage of being adjustable. Removing air from visco-elastic foam or similar materials in the same manner is not possible, because their cellular structure is very tight and would solidify almost immediately (densification).

[0015] In the basic configuration, this invention takes the form of a mattress-like support apparatus comprising

[0016] one core of open-cell, self-inflating flexible polyurethane foam, said polyurethane foam core having an Indentation Force Deflection value within a range of 22 to 50 lbs at standard atmospheric pressure;

[0017] one airtight cover chamber enclosing said foam core, said airtight cover chamber having at least one valve arrangement for evacuating air;

[0018] characterized in that said mattress-like support apparatus is operated by the user at sub-atmospheric pressure, in that said foam core has a thickness of at least four inches at standard atmospheric pressure, and in that said Indentation Force Deflection value decreases while air pressure within said polyurethane foam core is lowered.

[0019] The apparatus may further comprise at least one vacuum pump connected to said valve or valves for evacuating air.

[0020] In another embodiment, the polyurethane foam core has a density value within a range of 1.2 to 2.5 pounds per cubic foot at standard atmospheric pressure, and said density value increases while air pressure within the polyurethane foam core is lowered.

[0021] In still another embodiment, the polyurethane foam core is vertically subdivided into at least two longitudinal or transversal core sections, and the airtight cover chamber is replaced by separate individual airtight chambers for each core section, each individual airtight chamber having at least one valve arrangement for evacuating air. In an alternative embodiment, the polyurethane foam core is vertically subdivided into at least two longitudinal or transversal core sections, and the airtight cover chamber is subdivided in individual airtight chambers for each core section by internal airtight walls, each individual airtight chamber having at least one valve arrangement for evacuating air. Each core section may have different Indentation Force Deflection values at standard atmospheric pressure -from the other core section or sections. In addition, the polyurethane foam core or core sections may comprise two or more layers of self-inflating flexible polyurethane foam. In an embodiment, at least one of the foam layers has a different Indentation Force Deflection value at standard atmospheric pressure from the other foam layer or layers.

[0022] The valve arrangement attached to the airtight cover chamber or to the individual airtight chambers may comprise one or more air permeable distancing elements, keeping any adjacent materials from obstructing airflow through said valve arrangement. Said valve arrangement may also comprises a spring-mounted mechanism that allows some air to return into the foam core and thereby prevents compression set within the foam core.

[0023] The following is a description of how a polyurethane foam core changes in this present invention, demonstrated on a sample of a twin-size mattress foam core. Such a sample typically contains a volume of about 13 cubic feet of air, has an initial density rating of 1.2 and an IFD number of 40, corresponding to a relatively firm-surface foam weighing 15.6 lbs. In comparison, visco-elastic foam of the same size would generally weigh about 58 lbs.

[0024] To effect the change in the sample, a fan-style vacuum generator is connected to an outer airtight cover, drawing approximately 0.6 cubic feet of air per second. At this rate it takes 3.5 seconds to double the foams density and to reduce the IFD value so that it feels like a 2.4 density high resilient foam with an IFD value of about 22. The vacuum pump is equipped with variable speed control and remote control memory settings, so that the user can either set or recall a previous setting of an individual comfort level at the speed and in increments which suit him. In laboratory experiments, a user was made to recline on the foam in it's original configuration. He then adjusted the density and IFD settings within the foam core. It was observed that the user's heaviest body-parts sank into the foam and were contoured progressively as the density increased and the IFD value decreased. No collapsing of the mattress, bottoming-out or hammock effect occurred. If no air were allowed to re-enter the foam core and the user were to be lifted off it, the negative mould of his body with all corresponding heavy and light pressure points would be imprinted in the foam permanently.

[0025] The second point of importance to be noted is that the foam core gains in stability when air is removed, as opposed to an air chamber which would simply deflate and become wobbly, that is, unstable. In laboratory experiments a further point has been addressed, dealing with the undesirable characteristic of open-cell flexible polyurethane foam to solidify in a full vacuum-state, the so-called 'compression set' (CS). If too much air is removed from the cellular structure of foam, it will harden in its densest state and subsequently no longer be able to self-inflate and regain its loft, even partially. CS becomes critical when foam has been compressed for an extended period of time. If, however, a residual amount of air could be left in a foam core and be controlled, it would not suffer CS nearly as much as opposed to a fully deflated foam core.

[0026] The chamber's vacuum in this example is controlled by valves which operate under spring pressure. When air is evacuated from a self-inflating foam core within a hermetically sealed cover, the foam material's cellular elasticity exerts pressure to expand to its original form by drawing air back into its open cells, developing a measurable suction force. The more air is removed from the foam cells, the higher the foam core's re-inflation force. Springs in the valve assemblies connected to the partially emptied chamber oppose the re-inflation force reciprocally. Hence a balance between the opposing forces can be established, depending on the spring force and the suction force. Tests conducted in a laboratory environment show that CS can be prevented in a totally deflated foam core if the re-inflating force is slightly greater than the closing force of the valve spring. In this manner, air is drawn back into the mattress at a very slow rate, and stops entering the mattress when the re-inflation force of the foam equals the compression force of the spring in the valve. A fixed spring-force setting, allowing foam to re-inflate to a specific degree greatly reduces the occurrence of CS and preserves the deflated product from malfunctioning when allowed to re-inflate after extended storage periods. The principle of residual air retention to off-set CS has been validated in laboratory experiments for polyurethane foam used in a wide variety of mattress architectures, be it by itself or in a combination with other arrangements. To balance the closing force of the valve spring within the valve assembly against the re-inflating force of the various foams, a great number of specific compression values are being used to adapt to foams having different IFD and density ratings.

[0027] Thus, controlling compression set forms integral part of the invention, which would not be able to perform satisfactorily over long periods of time if intentional or accidental excessive deflation took place, destroying the specific characteristics of open cell, flexible polyurethane foam, which are the basis of comfort level adjustment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] **FIG. 4** shows a hermetically sealed, modulable foam core in its simplest form, one or more valves and a distancing element.

[0029] **FIG. 5** shows the effect of pressure on a chamber containing a self-inflating foam core;

[0030] **FIG. 6** shows the effect of removing weight from the core in **FIG. 5**

[0031] **FIG. 7** shows one autonomous airtight chamber two foam cores, a single valve and a distancing element;

[0032] **FIG. 8** shows two airtight individual chambers, one or more foam cores, an internal airtight wall, two valves and two distancing elements;

[0033] **FIG. 9** shows two separate individual airtight chambers, one or more foam cores an outer attachment, two valves and two distancing elements;

[0034] **FIG. 10** shows three airtight individual chambers, one or more foam cores, two internal airtight walls, three valves and three distancing elements;

[0035] **FIG. 11** shows five airtight individual chambers, one or more cores of foam in each chamber, four internal airtight walls, five valves and five distancing elements;

[0036] **FIG. 12** shows three separate individual airtight chambers, a fastening element, one or more foam cores, three valves and three distancing elements;

[0037] **FIG. 13** shows an overall valve assembly installed in a chamber wall;

[0038] **FIG. 14** shows a vacuum hose engaged in a valve with an air permeable distancing element behind the valve, and a foam core with an exploded outer cover;

[0039] **FIG. 15** shows an exploded view of the valve subassembly in combination with a vacuum hose;

DETAILED DESCRIPTION OF THE DRAWINGS

[0040] **FIG. 4** shows one airtight cover chamber **(40)** and one foam core **(41)**. Chamber **(40)** contains a self-inflating foam core **(41)** and is fitted with one or more valves **(42)**, penetrating wall **(44)** of the chamber. The valves, when opened, either serve to let the core self-inflate rapidly or to evacuate some air, contracting the foam core**(41)** in a uniform manner and changing both its density and IFD values as the cellular volume of the foam cells changes. Air can be extracted with a vacuum pump (not shown) connected to the valves **(42)** which contain an air permeable distancing element **(43)**. This element is essential to the proper functioning of the mattress and keeps wall **(44)** and valve **(42)** distanced from the foam core **(41)**, hence permitting an effective airflow to and from the foam core.

[0041] As to the vacuum pump, no particular specifications are put forward for such an apparatus other than that it has to be efficient in extracting the air contained in the foam core. The utilization of a vacuum pump is stated here once and not repeated in subsequent descriptions of mattress configurations, but implied.

[0042] **FIG. 5** shows the advantage of modulating a self-inflating, open-cell, flexible polyurethane foam core in support structures such as mattresses when weight is placed upon it. Compared to traditional mattress architecture with coils and air chambers, the weights (V) are causing a quite different reaction or counter pressure. When they are placed on a partially deflated foam core (FS1), which is enclosed in a chamber (**51**) fitted with a valve (**52**), through which air can be evacuated selectively and uniformly, the foam core resists the pressure of the weights W without sagging (hammock-effect) and deforms at local pressure points only. If more air is evacuated from the core, the weights slowly sink deeper into the surface, still confined locally and precisely in the area where they are exerting downward pressure, without deforming adjacent areas. Because of an increase in density and a decrease of the IFD value within the foam, the surface will become softer and offer continuous support—unlike standard coil spring mattresses, where any weight deposited on the surface tends to tension and harden the coil springs, which want to return to their original, more relaxed state.

[0043] **FIG. 6** demonstrates the effect with reference to **FIG. 5**. Foam core (FS1) is enclosed in a hermetically sealed chamber (as is shown in **FIG. 4**), from which some air has been uniformly removed, and the valve or plurality of valves (**62**) were then closed. The depressions on the top surface, where one of the weights (W1) has been removed, can still be seen, because the self-inflating foam recovers slowly, reacting to the reduction in pressure by rearranging the internal air distribution with a flow through its open-cell structure towards the indented area. If additional air were to be removed from the foam core, the depression (W1) would remain, because the resilience force of the foam cells in the depressed area would not be strong enough to extract air from the open-cell structure of the adjacent foam cells for an even distribution. In this state the foam core has a very reduced IFD and a greatly increased density, thus adopting the properties of a visco-elastic memory foam. This example can be translated directly to the effect of a person reclining on top of the foam core, as air is removed uniformly from the chamber. The heaviest pressure points of the body are modulated first, provided the foam core is fully enclosed. Any evacuation of air out of the core will result in a softer surface behaving in the manner shown in **FIG. 6**. For the invention at hand to perform in a satisfactory manner, foam cores should be at least **4** inches thick.

[0044] **FIG. 7** illustrates a mattress consisting of one airtight cover chamber (**71**) with two self-inflating pieces of foam (**72**) placed inside, one on top of the other, forming a single foam core. At least one valve (**73**) with air permeable distancing element (**74**) is fitted to the outer wall of chamber (**71**), through which air can be exhausted or admitted. When the valve is opened, air can be withdrawn from the chamber by means of a vacuum pump, which will change the air volume within the foam core. When the foam pieces (**72**) are compressed, their surfaces will soften as a result of decreasing IFD. Provided foam pieces are used with different factory pre-set density and IFD values, their characteristics will change differentially upon air evacuation. A harder pre-set foam on the bottom will soften less and provide more stability, while a softer pre-set foam on top will soften more readily under the conditions of an identical partial vacuum. More comfort modulation levels are thus provided to the user. The foam core in each chamber can be subdivided into two or more core pieces, each piece of foam may or may not have a different pre-set foam density. All foam pieces within the same core and in the same chamber will react differently on extraction of air.

[0045] Additionally, having multiple and diverse factory-preset foam pieces within a chamber, signifies that the user can choose which surface of the mattress he prefers to recline upon before any modulation takes place. Versatility is thus increased. Using, for example in the two chamber configuration, one or more foam pieces per chamber, it is possible to achieve a comfort modulation level of very soft to softer in the first chamber, and hard to very firm in the second chamber. For clarity's and brevity's sake, the possibility of using multiple core foam pieces per chamber and multiple chambers is implied in the subsequent descriptions of chamber configurations, and not limited to the present examples.

[0046] **FIG. 8** shows a mattress (**81**) comprising an airtight cover chamber subdivided in two individual airtight chambers (A and B) by an internal airtight wall (**83**), each containing one or more self-inflating foam pieces (**84**). The chambers (A&B) are both fitted with one or more valves (**85**) to exhaust air selectively and independently from within the foam cores. The valves penetrate the wall (**81**) to the interior of their respective chamber and both have an air permeable distancing element (**86**) attached to their inward end to prevent foam or cover material from clogging the air passage. When the air is exhausted from the chambers selectively, the two cores increase in density, so there is no loss of support, and they will soften because of a decrease in IFD. They will do so differentially when foam types of a different factory pre-set density and IFD value are used, so that the foam in chamber (A), for example, can be independently modulated to give a harder surface feeling than the lower piece of foam or vice versa. On the other hand, when only the air is evacuated from the foam core of chamber (A), only this chamber will be rendered softer because the core (B) will remain unaffected. This mattress combination can be used on both sides, and is intended for use by two users who wish to modulate their own side of the bed selectively.

[0047] **FIG. 9** shows a mattress comprising two individual airtight chambers (A and B), both containing one or more foam pieces (**92**). Both chambers (A and B) are removably connected by an exterior element (**93**) such as a zipper or hook and loop. Although the modulation capabilities of this mattress are identical to the previous in **FIG. 8**, it has the added advantage of separating into two mattresses which can be used in a different location.

[0048] **FIG. 10** shows a mattress comprising an airtight cover chamber subdivided in three individual airtight chambers (A,B,C) with two internal walls (**101**). Each individual airtight chamber contains one or more foam pieces (**102**, **103**, **104**) to form three foam cores within the three chambers which may or may not contain foams of similar IFD and density ratings. Three chambers thus organized, represent a comfort zone for the head (A), middle body (B), and feet (C). Each section may be modulated by removing some air through the valves (**106**) (one shown) which each contains an air permeable distancing element (**107**) (one shown) directly behind it, to prevent any occlusion and to increase airflow to and from the chambers. The top foam pieces in chambers (A,B and C) (**108**) may be softer IFD factory-preset rated foam, and the bottom pieces (**109**) may be firmer factory-preset rated foams. In this manner, the user may chose to recline on either side of the mattress (arrows **110,111**), before modulation with a vacuum pump is commenced.

[**0049**] **FIG. 11** shows a mattress comprising an airtight cover chamber subdivided in five individual airtight chambers (A,B,C,D and E) with four internal walls (**1101-1104**). Each individual airtight chamber contains one or more foam pieces (**1105**) (only one foam core shown) to form five foam cores within the five chambers which may or may not contain foams of similar IFD and density ratings. Five chambers thus organized represent comfort zones for the head (H) and shoulders (S), middle body (M), and feet (F). Each chamber may be modulated by removing some air through the valves (**1106**) (one shown) which contains a permeable distancing element (**1107**) (one shown) directly behind it, to prevent any occlusion and to increase airflow to and from the chamber. As in **FIG. 10**, the top foam pieces in chambers (A,B C,D and E) may be softer IFD factory-preset rated foam, and the bottom pieces may be firmer. In this manner, the one may use the mattress on either side.

[**0050**] **FIG. 12**. shows a mattress comprising three individual airtight chambers (A, B and C), each containing one or more foam pieces (**1201**) (only one core shown). All three chambers (A, B and C) are removably connected by an exterior element (**1202**) such as a zipper or hook and loop at the edges of the chambers. As with previous foam combinations, this mattress can be modulated by removing some air through the valves from either chamber resulting in a higher density, lower IFD more desirable foam feel. The chambers are zoned for head (H), middle body (M) or feet (F), and have the added advantage of separating into three sections. Moreover, both foot and head sections may be inclined at different angles if placed on an adjustable bed frame.

[**0051**] **FIG. 13** shows an example of valve assembly as installed in the walls of any of the chambers referenced above, with an air permeable distancing element behind the valve. To this end, chamber wall (**1308**) is placed between two elements (**1304**-and **1305**) of the overall valve assembly. The flange (**1304**) is a truncated, inverted cone. Flange (**1305**) is also a truncated, but outward facing cone, which exactly matches inverted cone (**1304**). Once these elements are screwed together they will securely clamp the chamber wall. Welding or gluing can also be used, while a clamped valve could be taken apart again for servicing, if necessary. Also shown is a lateral cylindrical extension (**1303**) which interconnects to the valve and acts as an air-permeable distancing element (**1301**). The element has an air-permeable opening (**1302**), essential for the modulation of the foam core, since air can pass to and from the foam core. When air is rapidly evacuated through the assembly, foam and outer cover material is prevented from occluding or touching the valve, because the air-permeable distancing element keeps the foam and outer cover material at a distance from the inner valve. When not in use, the valve assembly can be closed by a plug (**1306**) which is inserted into the interior of the valve assembly. The plug is attached to the valve housing by a loss-prevention cord (**1307**). It also prevents any undesirable foreign particles or liquids from entering.

[**0052**] **FIG. 14** shows the air-permeable distancing element (**1401**) that may contain additional frontal openings (**1402**). When the vacuum is activated, air is drawn through the valve (V) and from within the foam core (**1403**). This causes the valve, distancing element (**1401**), and outer cover (**1405**) to be drawn towards the foam core (**1403**). By contrast, air also passes through openings (**1402**) from within the distancing element (**1401**), thus sucking the outer cover (**1405**) through the openings (**1402**) only in that area. The outer cover wall (**1405**) is pulled towards the openings (**1402**) and because of this vacuum effect the outer cover (**1405**) pulls the distancing element and the valve back towards itself. The two opposing forces (the valve and distancing element being pulled towards the foam, and the outer cover pulling these components back) allow for a perfect vacuuming effect to be formed and they create a perfect airflow. Thanks to this functionality the airflow within a vacuum pump is more efficient, causing less heat and fatigue to the electrical motor. It also increases the speed at which a mattress can be modulated. When a vacuum pump is activated to remove some air without an air-permeable distancing element, valve (V) and outer cover (**1405**) would be drawn towards the foam wall (**1403**) and form a counter vacuum whereby very little air would be removed from the foam core. Also shown in **FIG. 14** is a vacuum hose (**1406**) and nipple (**1407**), which can be disengaged from the valve, or may be permanently attached to the valve extending towards a vacuum pump (not shown), and may be removably connected to that vacuum pump.

[**0053**] **FIG. 15** shows the structure of the example valve assembly in an exploded view. The chamber material is clamped between flanges (**1304**) and (**1305**). Flange (**1304**) is connected to a cylindrical extension (**1501**), which has lateral air apertures (**1502**) so that the air being evacuated can easily enter the inner valve assembly. The cylindrical extension (**1501**) fits tightly within the air-permeable distancing element and extends laterally (**1401**). Behind the valve stem-head (**1503**) is a compression spring (**1504**) and a protective plug (**1306**), which has a forward cylindrical extension (**1505**) with a locking slot (**1506**), allowing plug (**1306**) to be engaged into interior receptacle (**1509**). When air is evacuated from any of the chambers referenced above, plug (**1306**) is removed from the valve assembly and nipple (**1507**) is being inserted into the interior receptacle (**1509**) with its forward end (**1508**) in a press fitting manner. A vacuum hose (**1510**) is attached to the nipple (**1507**) by way of screw threads (**1511**).

1-11. (cancelled).

12. A mattress-like support apparatus comprising

a core of open-cell, self-inflating flexible polyurethane foam, said polyurethane foam core having an Indentation Force Deflection value within a range of 22 to 50 at standard atmospheric pressure; and

an airtight cover chamber enclosing said foam core, said airtight cover chamber having at least one valve arrangement for evacuating air;

characterized in that said mattress-like support apparatus is operated by the user at sub-atmospheric pressure, in that said foam core has a thickness of at least four inches at standard atmospheric pressure, and in that said Indentation Force Deflection value decreases while air pressure within said polyurethane foam core is lowered.

13. The apparatus of claim 12, wherein said polyurethane foam care has a density value within a range of 1.2 to 2.5 lbs per cubic foot at standard atmospheric pressure, and wherein said density value increases while air pressure within said polyurethane foam core is lowered.

14. The apparatus of claim 12 wherein said polyurethane foam core is vertically subdivided into at least two longitudinal or transversal core sections, and wherein said airtight cover chamber is replaced by separate individual airtight chambers for each core section, each individual airtight chamber having at least one valve arrangement for evacuating air.

15. The apparatus of claim 12, wherein said polyurethane foam core is vertically subdivided into at least two longitudinal or transversal core sections, and wherein said airtight cover chamber is subdivided into individual airtight chambers for each core section by internal airtight walls, each individual airtight chamber having at least one value arrangement for evacuating air.

16. The apparatus of claim 14, wherein at least one of the core sections has a different Indentation Force Deflection value at standard atmospheric pressure from the other core section or sections.

17. The apparatus of claim 15, wherein at least one of the core sections has a different Indentation Force Deflection value at standard atmospheric pressure from the other core section or sections.

18. The apparatus of claim 12, wherein said polyurethane foam core comprises two or more layers of self-inflating flexible polyurethane foam.

19. The apparatus of claim 14, wherein said polyurethane foam core sections comprise two or more layers of self-inflating flexible polyurethane foam.

20. The apparatus of claim 18, wherein at least one of the foam layers has a different Indentation Force Deflection value at standard atmospheric pressure from the other foam layer or layers.

21. The apparatus of claim 19, wherein at least one of the foam layers has a different Indentation Force Deflection value at standard atmospheric pressure from the other foam layer or layers.

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