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(54) **PNEUMATIC FLOOR OR WALL STRUCTURE**

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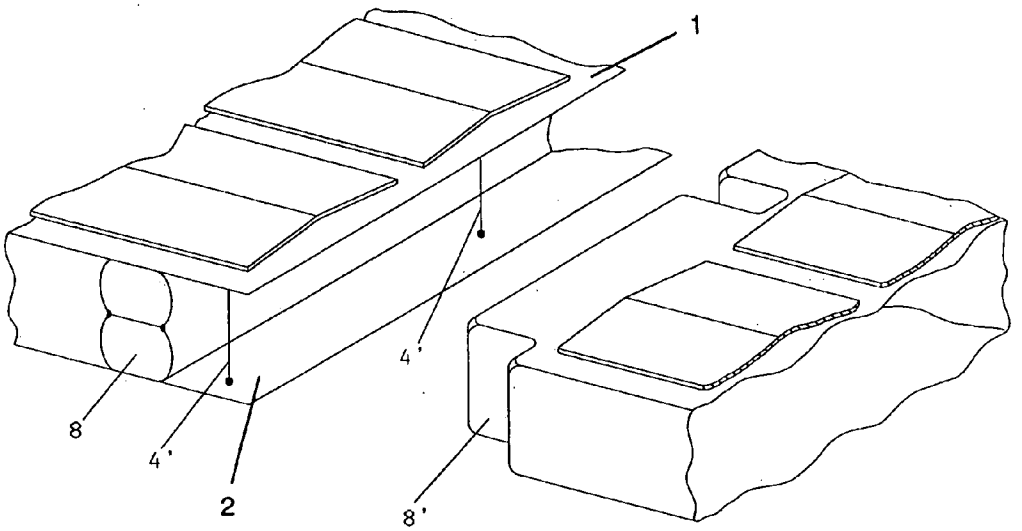
(57) **ABSTRACT**

The invention relates to an inflatable floor or wall structure for mobile buildings, which is formed by flexible boundary layers that are impermeable to air. A plurality of air chambers are formed between the boundary layers. According to the invention, one side of the pneumatic floor structure or wall structure is provided with a plurality of stiff profiled surface elements. The surface elements are mutually spaced such that the floor or wall structure can be rolled up after being deflated.



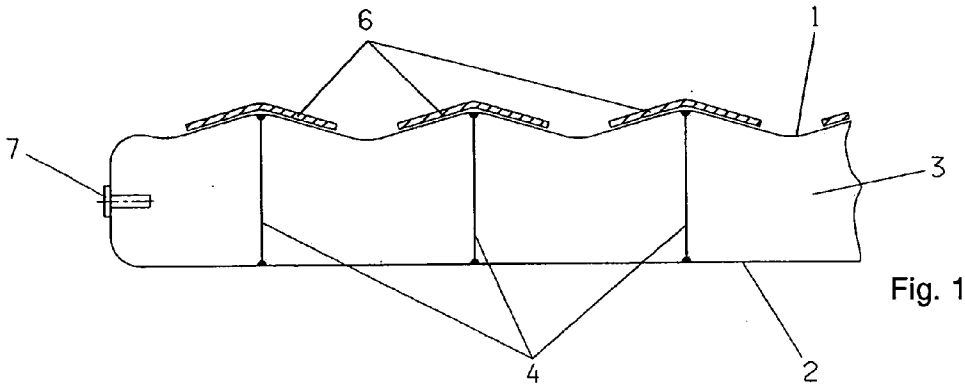


Fig. 1a

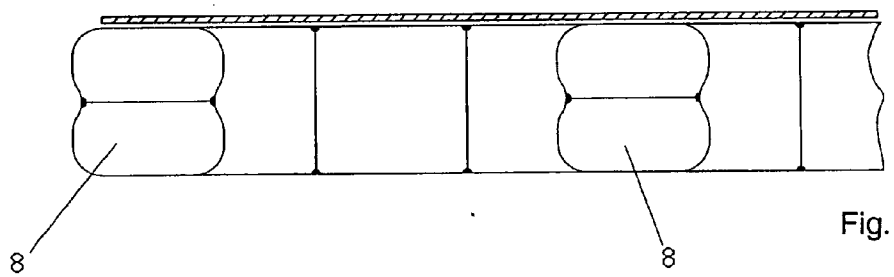


Fig. 1b

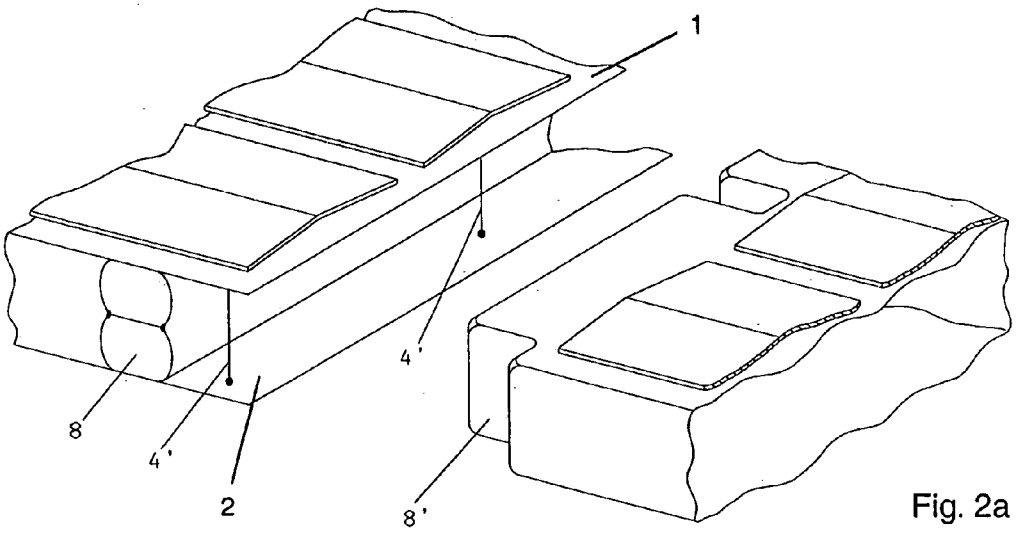


Fig. 2a

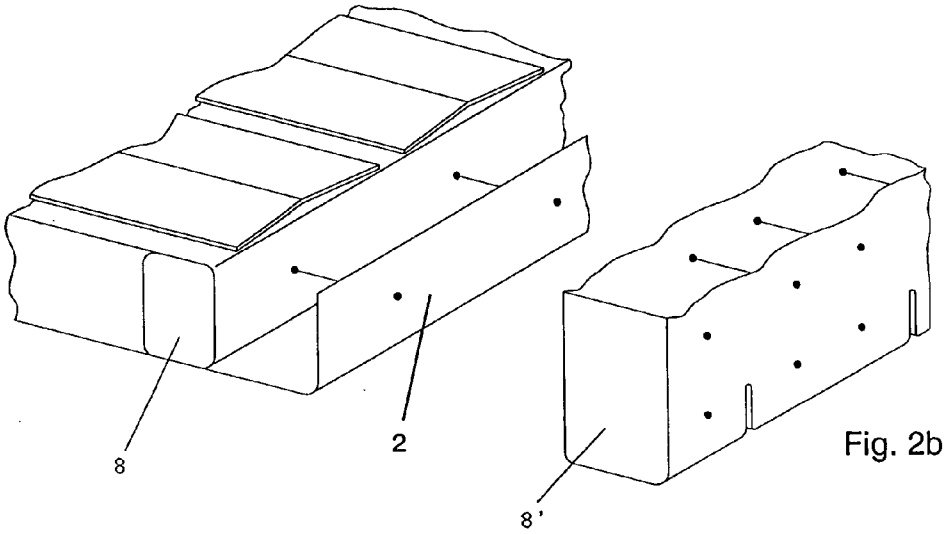


Fig. 2b

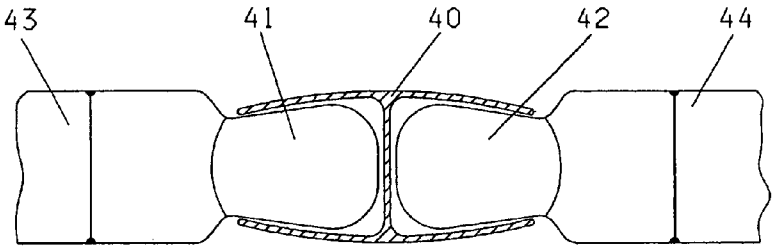


Fig. 3a

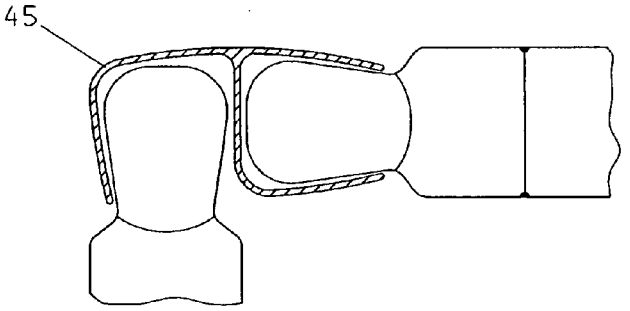


Fig. 3b

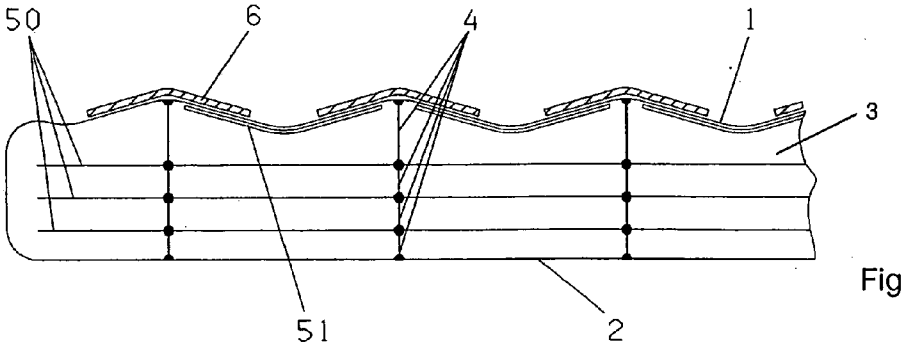


Fig. 4

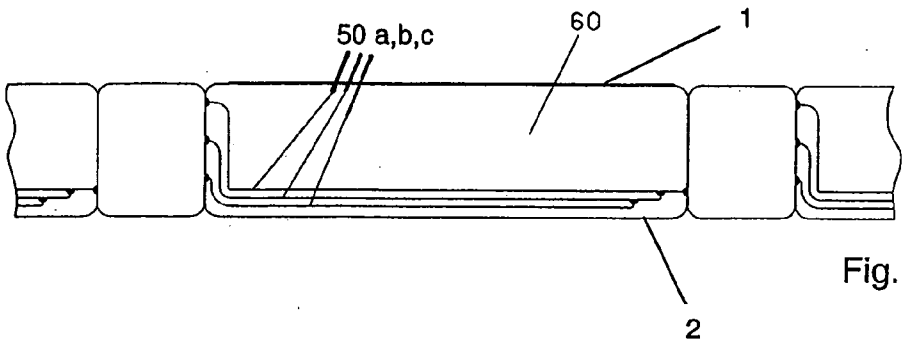


Fig. 5a

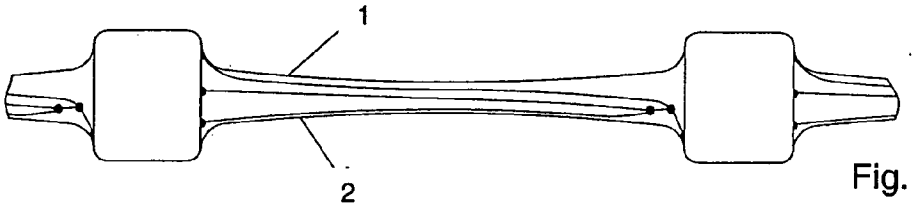


Fig. 5b

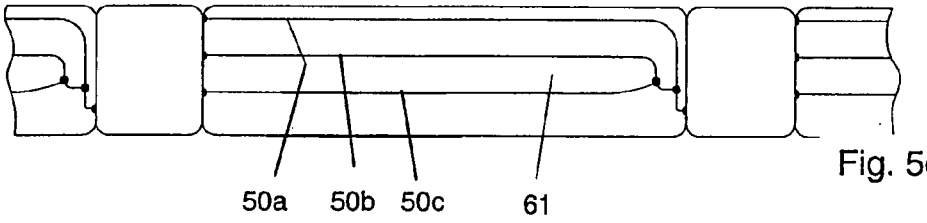


Fig. 5c

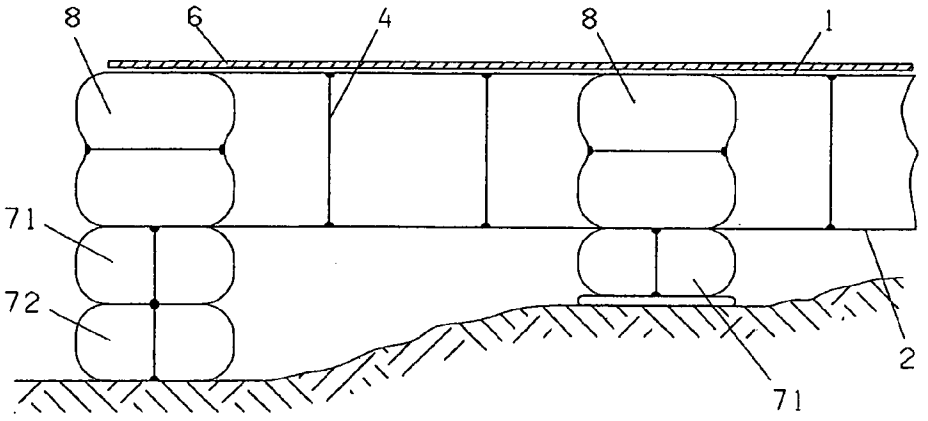


Fig. 6

PNEUMATIC FLOOR OR WALL STRUCTURE

BACKGROUND AND SUMMARY OF THE INVENTION

[0001] This application claims the priority of German Patent Document DE 1.0 2005 019 289.0-25, filed Apr. 26, 2005, the disclosure of which is expressly incorporated by reference herein.

[0002] The invention relates to a pneumatic floor or wall for a transportable structure.

[0003] As the demand for medical and technical aid rises worldwide, there is a need to rapidly supply tents and comparable mobile buildings of a simple construction, with a low packing volume and weight. As disclosed in German Patent document DE-G 93 10 671.8, floors for tents and similar mobile constructions, have been provided with pneumatic structures of the type of an air mattress. While these have a low packing volume and weight, they do not satisfy the requirements with respect to localized or concentrated loads and area loads for some applications (for example, for beds of patients of an operating room or of an intensive care unit when the tent is used as a mobile military hospital).

[0004] The creation of a stable floor suitable for walking by inserting floor plates results in a disproportionately high transport weight, and may not satisfy applicable requirements with respect to hygiene and heat insulation.

[0005] German Patent Document DE 103 06 055 B3 discloses a mobile building with a pneumatic structure, one side of which is connected at a point with stiff surface elements.

[0006] German Patent Document DE 2040 814 A, on the other hand, discloses a multipurpose house whose structural elements also consist of pneumatic elements, with stiff covering elements on both sides. The pneumatic elements may be stored and transported separately from the covering elements.

[0007] British Patent Document 2 043 737 A describes a mobile building consisting of a pneumatic roof/wall structure as well as a floor of individual parallel boards that are connected by fabric strip hinges, so that the floor can be rolled up as a whole.

[0008] One object of the present invention, therefore, is to create a lightweight structure, particularly a tent floor, which meets all of the above requirements with respect to packing volume, walkability, weight, heat insulation and hygiene, and especially permits rapid assembly and dismantling.

[0009] This and other objects and advantages of the invention are achieved by the floor or wall configuration according to the invention, which has a pneumatic structure consisting of several air chambers, and which is pressurized, according to the surface loads and concentrated loads in the range of preferably 5 kN/m^2 to 1.5 kN/dm^2 (occasionally even more). The pneumatic structure is connected with a preferably strip-shaped stiffener (such as Al, GFK [fiber-glass-reinforced plastic] CFK [carbon-fiber-reinforced plastic] profiles), which does not impair rolling it up. The profiles are individually and lastingly fixed (for example, by means of gluing together) directly on the outer covering layer. The two-layer or multilayer airtight tarpaulins are made of plastic material, fabric or, for military reasons, nylon or kevlar, with weights per unit area of from 150 to 400 g/m^2; in the inflated condition, they are held apart in a known manner by flexible thread-shaped or strip-shaped connections. Narrow pressure chambers (purlins, rafters) arranged in the direction of the rolling-off path can be used for unrolling the tent canopy, aided by compressed air; such pressure chambers can form a second redundant pressure system. For the tent floor, an optional admission of pressure to multilayer air chambers can compensate for slight inclinations of the floor surface.

[0010] An electric floor and wall radiant heating system can be provided on the wall or floor structure according to the invention, without hindering its rolling up or its transportability. However, this technique (as well as the possibility of "tempering" the compressed air—that is, cooling or heating a continuously pressurized circulating-air flow) energetically is uneconomical and not particularly meaningful, because of the heat (cold) loss to the interior and exterior.

[0011] In the civilian domain, as a rule, usage durations are longer, and there is less necessity of extremely short start-up times under all weather conditions. Accordingly, it is advantageous to adapt the tent size to applicable requirements using modular structural elements according to the present invention. This technique makes it unnecessary to provide connection elements (locks) between the so-called unit tents of different sizes. The butt joint between parallel-situated structural elements then has to be connected tightly and without a gap in a force-locking and form-locking manner, for example, using a Velcro fastener or, in a particularly advantageous embodiment, a pneumatic locking arrangement. For larger tents, and also for wall parts of lightweight containers, it may be expedient for the stiffening (to adjust for snow load, wind pressure, etc.) to insert a coupling profile (such as Al, GFK [fiber-glass-reinforced plastic] CFK [carbon-fiber-reinforced plastic]) (pneumatic mechanical locking) at the butt joint of adjacent structural elements. By a suitable construction of these profiles, units of space can be constructed which are situated at a right angle with respect to one another. This technique also permits the replacement of damaged parts and the reuse of still functional parts. On the whole, tent-type shelters of any size can thereby be constructed from prefabricated floor or wall structures and profiles, the profiles forming the supporting structure of the building.

[0012] For use not only in regions with extreme weather conditions, the heat insulation of the tent walls and of the floor represents a significant influence factor for the comfort and the operating costs of the power supply and air conditioning (heating, cooling, fresh-air supply). The arrangement of awnings is a simple measure but will be effective only if a heat accumulation is avoided by means of ventilation. U.S. Pat. No. 6,598,613 describes a structure which utilizes the prevailing fluidic and thermal conditions (convection, heat conduction and heat radiation) for the heat insulation. This system can be improved without a significant increase of the weight per unit area by providing spaced-out reflective thin metal foils within the individual air layers to reduce both the convection and radiant transmission of heat. The emission coefficient of fabric webs is, for example, 0.88; and that of aluminum, bright-rolled, is 0.049. The heat flow decreases in inverse proportion to the reflective intermediate layers. Particularly in the case of the floor, the implementation of a

low coefficient of heat transmission is a prerequisite for keeping the internal surface temperature above the dew point during the whole year.

[0013] German Patent Documents DE-AS 1 158 015, DE-AS 1 223 773 and DE-OS 1 409 994 disclose partially flexible wall structures with a pneumatically controllable transmission of light and electromagnetic radiation generally. Because the chambers are very small as a result of the function and to suppress convective heat exchange, the necessary expenditures for construction and material expenditures for equipping larger surfaces are considerable. When the function is limited to two operating modes (small and large heat transmission)—the light shielding not being relevant here anyhow—the dimensions of the air chambers can be designed in a thermodynamically more advantageous manner in that the width/thickness ratio tends to be selected to be larger. By changing the admission of pressure, the reflective intermediate layers hindering the convection either rest on one another on one side or are spread, at approximately the same spacing, parallel to the cover layers. Preferably, for the roof and the side walls, the heat transmission can also be reduced by warping down cover layers of the pneumatic structures by means of reduced pressure. The thickness of the air layer is thereby decreased to a tight packing of the cover layers and intermediate layers.

[0014] Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] **FIG. 1***a*) is a longitudinal sectional view of a pneumatic structure according to the invention, constructed as a tent floor with air chambers and covering profiles;

[0016] **FIG. 1***b*) is a cross-sectional view of a pneumatic structure according to the invention, constructed as a tent floor with air chambers and covering profiles;

[0017] **FIG. 2***a*) is a view of the pneumatic butt connection of mutually adjacent pneumatic structures in a plane;

[0018] **FIG. 2***b*) is a view of the pneumatic butt connection of mutually adjacent pneumatic structures at a right (or any) angle;

[0019] **FIG. 3***a*) is a view of coupling profiles as a connection of adjacent pneumatic structures in a plane arrangement;

[0020] **FIG. 3***b*) is a view of coupling profiles as a connection of adjacent pneumatic structures in a perpendicular arrangement;

[0021] **FIG. 4** is a view of a pneumatic structure constructed as a tent floor with several radiation foils within an air chamber as well as an electric heating foil;

[0022] **FIG. 5***a*) is a view of a pneumatic structure with several radiation foils and several air chambers for the pressure-controlled change of the heat transmission, by admitting pressure to the top chamber **60**;

[0023] **FIG. 5***b*) is a view of a pneumatic structure with several radiation foils and several air chambers for the pressure-controlled change of the heat transmission, by generating reduced pressure in the top chamber **60**;

[0024] **FIG. 5***c*) is a view of a pneumatic structure with several radiation foils and several air chambers for the pressure-controlled change of the heat transmission, by admitting pressure to the center chamber **61**; and

[0025] **FIG. 6** is a view of a pneumatic structure constructed in several layers—at least in sections—for compensating floor inclinations.

DETAILED DESCRIPTION OF THE INVENTION

[0026] The basic construction of the tent floor according to the invention is shown in **FIGS. 1***a* and **1***b*. It includes the air chamber **3** which is closed off by the cover tarpaulin **1** and the floor tarpaulin **2** and which may be constructed in several layers. Thread- or strip-shaped spacers **4** are arranged in a grid corresponding to the internal pressure that is necessary to accommodate the required surface loads and concentrated loads (as a rule, a pressure of not more than 1.5 bar). The profiled strip-shaped stiff covering profiles **6**, which compensate the floor load (and which, in this embodiment, are constructed as angled sections) are applied (for example, by gluing), to the surface of the tarpaulin **1**. The individual covering profiles **6**, which advantageously extend parallel to one another, are not connected, rather they are separated at a distance from one another, such that the entire structure can be rolled together after the evacuation of the air. If required, another foil can cover the metal cover sheets to keep them clean

[0027] Reference number **7** indicates a valve for applying internal pressure. As supporting chambers, the pressure chambers **8** extending in the longitudinal direction can also be inflated to a higher pressure, and/or can be interconnected in the manner of a redundancy in a circular arrangement, separated from the air chamber **3**. If the pressure chambers **8** form the pneumatic rafters of the side wall-roof unit, it may be useful to vary the cross-section of the pressure chamber (in a square, rectangular or circular manner) along the rafter length. By providing a smaller cross-section on both sides in proximity to the floor, a smaller radius of curvature is obtained than in the ridge area. In this manner, the tent height-to-tent width ratio can be adapted to the requirements.

[0028] Air pressure is applied to set up the tent. It can be adjusted to accommodate the demanded local surface and concentrated load, and can be controlled and automatically maintained by suitable sensors.

[0029] Relieved from pressure and rolled-up, the floor collapses to the thickness of the two air-tight fabric tarpaulins **1**, **2** and of the covering profiles **6**. The overall dimensions are preferably selected such that, for the manual mounting, a weight of 25 kg to 30 kg per roll, for example, of a width of 1.20 m, is not exceeded.

[0030] Abutting webs can be held together in a simple manner by means of a Velcro fastener, even in the case of a mutual arrangement at a right angle. As illustrated in **FIGS. 2***a,b,* in two construction examples, the more stable connection is to let the cover tarpaulins **1** and floor tarpaulins **2** protrude beyond the pressure chamber **8**, and to push the pressure chamber **8'** of the second tent floor between the spacers **4'**. The admission of pressure supplies the necessary contact pressure and thus the tightness. For the purpose of a

simpler mounting, the exposed spacers **4'** can be hung on both sides by means of wide washers.

[**0031**] The same principle of the pneumatic locking can also be used for webs arranged in an inclined manner or perpendicularly as wall elements, with the supporting structure being formed by coupling profiles **40** made of lightweight materials which are straight or curved in the longitudinal direction (**FIG. 3***a*). The pressure chambers **41** and **42** hook the wall elements **43** and **44** into the profile **40**. **FIG. 3***b* shows a corner connection with the modified profile **45**. The combination of the profile shapes **40** and **45** for achieving a connection of three webs is just as conceivable as the formation of crosspieces for the connection of four webs.

[**0032**] The quality of the heat insulation of an air layer can be increased substantially by inserting reflective foils, which, on the one hand, impede convection within a horizontal air layer, and, on the other hand (even by means of one foil), reduce radiant heat transmission by half. **FIG. 4** shows reflection foils **50** as examples. (The outer fabric webs **1**, **2** can also be covered on their interior side with a reflective foil of a thickness of a few hundredths of a millimeter.) The spacers **4** hold the foils **50** at a distance without hindering rolling-up of the entire web in the deflated condition, and pressure compensation during the inflating.

[**0033**] Reference number **51** indicates (schematically) narrow electric heating foils (for AC or DC operation). In this embodiment, they are glued to the underside of the cover layer **1**. The (by far greater) output fraction penetrates as floor heating into the space; the lost fraction disappears in the floor. An improved heat insulation is advantageous achieved by this construction.

[**0034**] Floor heating (or analogously, cooling) can also be achieved by blowing heated or cooled compressed air through the air chambers **3** and **8**, **8'**. However, such heating is thermally less efficient.

[**0035**] **FIG. 5***a* shows the position of three intermediate layers **50***a,b,c,* which results in a high heat transmission, because of the convective heat exchange in the wide air gap (within the space **60**), as well as unimpeded heat radiation. The space **60** between the upper cover layer and the uppermost intermediate layer **50***a* is acted upon by pressure. If, by means of the change-over of the compressor (delivery side/suction side) a reduced pressure is generated in space **60**, the outer boundary layers **1** and **2** (**FIG. 5***b*) arch, depending on their stiffness until they rest against one another and thereby reduce the quality of the heat insulation. Heat transmission can thus be adjusted in a targeted manner. A range of 1:8 of the heat transmission coefficients can be implemented, for example, by means of three reflective intermediate layers.

[**0036**] If pressurization is introduced into space **61** between two intermediate layers **50***b,c,* a configuration according to **FIG. 5***c* is obtained. The intermediate layers **50***b,c,* which are perforated for the purpose of distributing pressure, will spread and the overall layer thickness, with the advantage of a lower equivalent heat conduction and several radiation planes, will be divided such that the heat transmission is reduced on the order of 20%.

[**0037**] The construction according to the invention can be expanded to compensate for unevennesses and inclinations of the floor compensated, as illustrated in **FIG. 6**. Since, for reasons of stability, no expandable air chambers can be used, for example, pressure chambers can be constructed in several layers **71**, **72** above one another or side-by-side. Pressure can be introduced into these additional chambers **71**, **72** (which can also be divided into individual chambers in the longitudinal direction of the web), either by separate valve connections or by the opening of connecting conduits.

[**0038**] The foregoing disclosure has been set forth merely to illustrate the invention and is not intended to be limiting. Since modifications of the disclosed embodiments incorporating the spirit and substance of the invention may occur to persons skilled in the art, the invention should be construed to include everything within the scope of the appended claims and equivalents thereof.

What is claimed is:

1. A pneumatic bounding structure for mobile buildings, comprising:

flexible boundary layers which are impermeable to air; and

a plurality of air chambers formed between the boundary layers, wherein

one side of the pneumatic structure has a plurality of stiff profiled surface elements applied thereon; and

the surface elements are mutually spaced apart such that the floor structure can be rolled up after being relieved from pressure.

2. The pneumatic floor structure or wall structure according to claim 1, where

adjacent structures are connected by mutually overlapping boundary layers; and

the pressurization in one of the adjacent structures generates a form-locking and force-locking connection between the boundary layers.

3. The pneumatic structure according to claim 1, wherein

a coupling profile is arranged between adjacent structures;

the coupling profile interlocks air chambers of the adjacent structures upon with the admission of pressure.

4. The pneumatic structure according to claim 1, wherein

heat insulation is provided by radiation-reflecting intermediate layers, which are arranged in the air chambers in a non-contact manner, and are essentially parallel to the boundary layers.

5. The pneumatic structure according to claim 4, wherein

the air chambers are arranged in a plurality of layers; and

mutual separation between the intermediate layers can be changed by admission of pressure to individual air chambers, to adjust heat transmission of the structure in a targeted manner.

6. The pneumatic structure according to claim 1, wherein

a reduction of pressure in individual air chambers relative to ambient atmospheric pressure causes arching of the boundary layers according to their stiffness, whereby thickness of the air layer is reduced and the heat transmission is increased.

7. The pneumatic floor structure according to claim 1, further comprising electric heating foils mounted on an interior side of a boundary layer.

8. The pneumatic structure according to claim 1, wherein:

heated or cooled compressed air flows through individual air chambers for the purpose of air-conditioning a space; and

another air chamber, through which no flow takes place, is provided for heat insulation between the air chambers through which the flow takes place, and a boundary layer.

9. The pneumatic structure according to claim 1, wherein:

air chambers are arranged in a plurality of layers; and

the admission of pressure to the air chambers establishes a level compensation in the case of an uneven base.

* * * * *