

June 10, 1969

R. HELLER

3,448,551

STRESSED SKIN PANEL CONSTRUCTION

Filed Nov. 13, 1967

Sheet 1 of 2

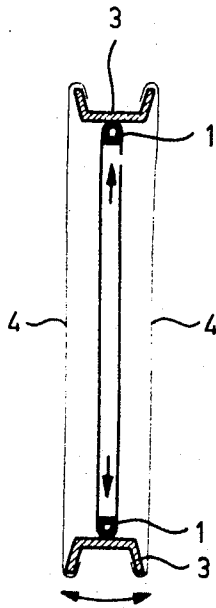


Fig. 1

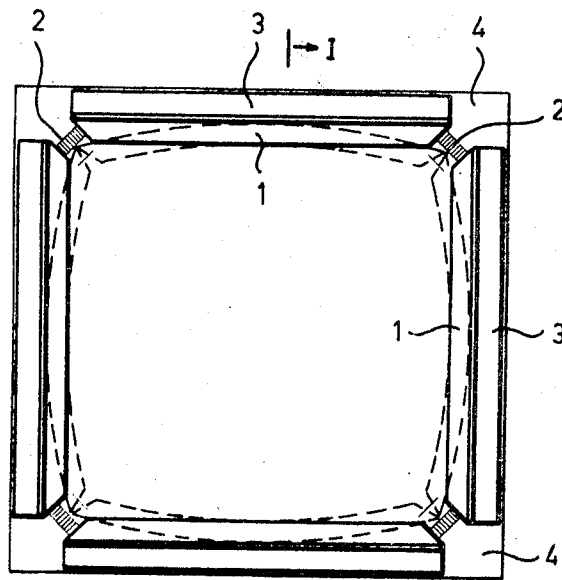


Fig. 2

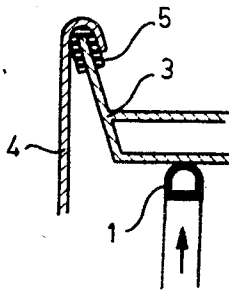


Fig. 3

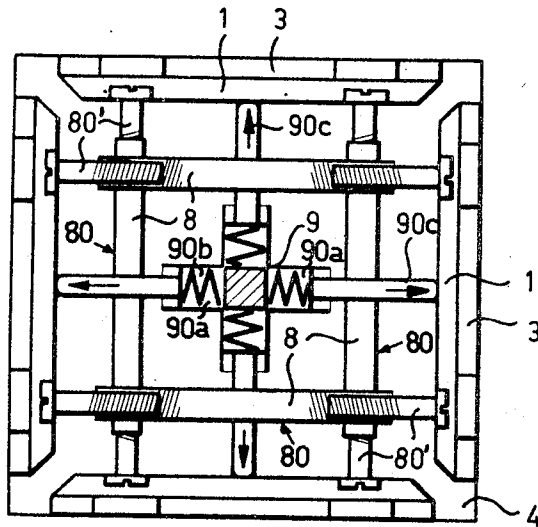


Fig. 4

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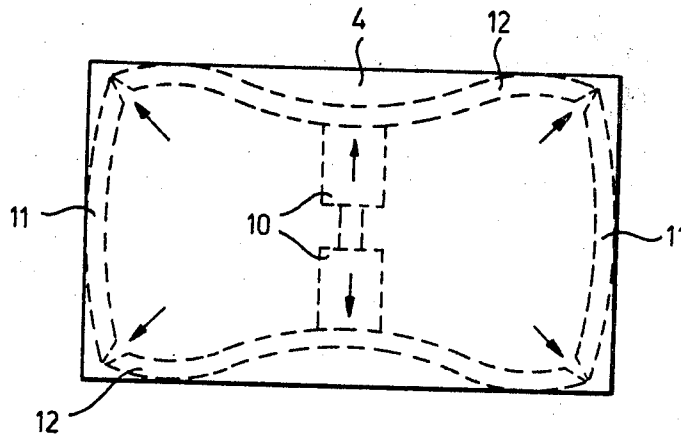


Fig. 5

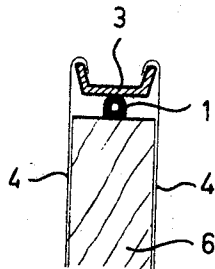


Fig. 6

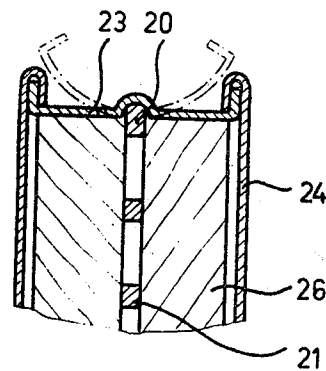


Fig. 8

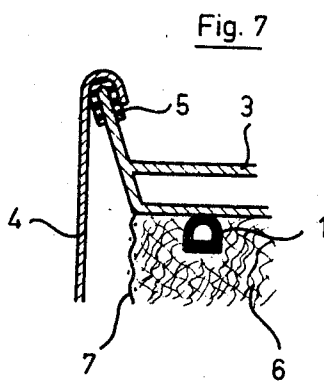
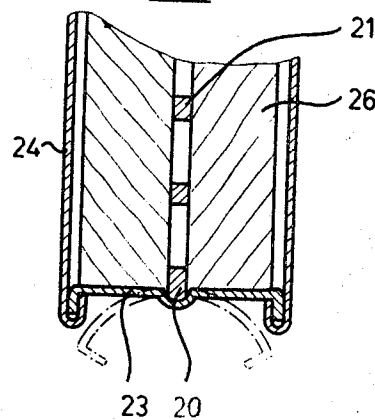


Fig. 7



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STRESSED SKIN PANEL CONSTRUCTION

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U.S. Cl. 52—222

14 Claims

ABSTRACT OF THE DISCLOSURE

A panel includes two sheet-material members arranged in spaced parallel planes. A prestressed frame connects the two members located intermediate the same and is operative to permit limited movement of the members with reference to one another and in the respective plane of the members, to thereby compensate for different thermal expansion or contraction of the two members.

Background of the invention

The present invention relates to panels in general, and more particularly to panels for structural and architectural purposes. Still more specifically, the present invention relates to panels which are particularly suitable for covering the outer sides of exterior building walls and similar structures.

In modern architecture the use of such panels is becoming increasingly common, not only for aesthetic reasons, but also to afford good thermal insulation at minimum possible specific weight. Of course, such panels are expected to carry a certain amount of load and also to have maximum possible shape-retaining ability.

The panels which are known for this purpose from the prior art include compound panels whose major surfaces are covered with sheets of metal or layers of other strong and inextensible material. However, these constructions are possessed of a major disadvantage, namely the fact that their inner and outer sides are subjected to highly significant temperature differentials, for instance as a result of strong sunlight on the outer sides and/or of high external temperature, or of extremely low external temperature with the inner side being subjected to heating by heat emanating from the building. Such temperature differences between the inner and outer sides of these panels may reach 50° C. and more and of course strong heating or cooling will result in thermal expansion or contraction of the sheet material member in question. Evidently, this will result in deformation of the panels and, if adjoining panels are rigidly connected with one another or with a frame, undesired pressures and/or tensile forces develop. If the panels are secured only locally the deformations are not checked at all and the exposed sides of the panels, that is the sheet material members, become wavy as a result of these developing forces and will present an aesthetically displeasing appearance.

Summary of the invention

The present invention provides a panel which is not subject to the aforementioned disadvantages.

More particularly, the present invention provides a panel wherein differential heating and/or cooling of the sheet-material members forming the major surfaces of the panel will result only in dimensional changes in the respective members as a result of thermal expansion or contraction, but will not cause other deformations of the respective members.

In accordance with one feature of my invention I provide, in a panel of the type here under discussion, a pair of sheet-material members arranged in spaced parallel

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planes and being subject to differential changes of dimension in the respective planes upon exposure to differential thermal conditions, and means connecting the sheet-material members and tensioning the same in their respective planes, the means being operative to effect independent compensation for dimensional changes of either of said members in the respective plane thereof to thereby maintain both of said members tensioned irrespective of the dimensional changes.

The panel according to the present invention may, for instance, utilize a prestressed frame which, in accordance with one aspect of my invention, may consist of a plurality of U-profiled members located intermediate the spaced parallel sheet-material members connected to the same and supported on the prestressed members of an inner frame in such a manner that they are tiltable about a central plane of symmetry extending intermediate and in parallelism with the planes in which the sheet-material members are located.

Other embodiments will be discussed subsequently, but regardless of the embodiment used, I have found it advantageous if one or more layers of light weight thermally insulating material are disposed intermediate the respective sheet-material members, but are not bonded thereto in surface-to-surface contact to avoid influencing the prestressing which has been applied to the sheet-material members. Such insulating material will advantageously consist of inflammable inorganic material, such as rock wool, glass wool, or other material which may be admixed with a binder if desired. Various different materials may be used as the sheet-material members and I have found it very advantageous to utilize surface improved metal foils consisting of aluminum alloys and having a thickness of substantially 0.4 to 0.6 mm., or else of non-rusting steel. The use of such materials for the sheet-material members provides a highly aesthetic appearance on structures equipped with my novel panels, and the attractive appearance thus provided will remain unchanged and will not be influenced by changes in weather and/or temperature conditions because of the constant tensioning of the sheet-material members which is assured in accordance with my present invention.

In case of fire in a structure equipped with my novel panels it could ordinarily be expected that the shape-retaining ability or form stability of the novel panels, together with their load-supporting ability and the connection to a concrete or steel wall skeleton would be weakened, particularly in cases where readily meltable aluminum foils are used as sheet-material members. To guard against these problems I have found it advantageous to construct the frame members and the connecting members of material which is more highly heat-resistant than aluminum, for instance steel, and to secure eventually inserted fire-retarding layers by means of wire netting or of sheet metal constructions which similarly consist of highly heat-resistant materials and which secure the fire-retarding layers to the frame members.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings.

Brief description of the drawing

FIG. 1 illustrates a somewhat schematic section taken on the line I—I of FIG. 2;

FIG. 2 is a somewhat schematic plan view of the embodiment illustrated in FIG. 1;

FIG. 3 is a detail view of FIG. 1 on a considerably enlarged scale;

FIG. 4 is a view similar to FIG. 2, but illustrating another embodiment of the invention;

FIG. 5 is also similar to FIGS. 2 and 4, but illustrates yet an additional embodiment of the invention;

FIG. 6 is a view similar to FIG. 1 illustrating another embodiment of the invention;

FIG. 7 is a detail view similar to FIG. 3 but illustrating yet a further embodiment of the invention; and

FIG. 8 is a transverse section through an additional embodiment of the invention, shown in fragmentary form.

Description of the preferred embodiments

Discussing now the drawing in detail, and firstly FIGS. 1-3 thereof, it will be seen that I have illustrated there a panel structure which, as pointed out earlier, is particularly suitable for covering exposed sides of wall structures in buildings and the like, but which has general application for the construction of panel members. FIG. 2 shows most clearly that I provide an inner supporting frame consisting of four individual members 1 of steel or similarly elastically shape-retaining and heat-resistant material. The members 1 are connected to one another at their respective joints by double screws 2 which are inclined at a 45° angle and which are well known in the art. Actuation of the screws 2 will push the adjoining members 1 away from each other. FIG. 1 shows clearly that the outwardly directed sides of the members 1 are rounded, and FIG. 2 shows in dotted lines that each of the members 1 is initially of arcuate outline.

A plurality of members 3, each of U-profiled cross-section, constitute together an outer frame. Each of the members 3 is supported with its base or bottom wall portion on the curved side of an associated one of the members 1 so as to be tiltable about the respective member 1 in the direction indicated by the double-headed arrow shown in FIG. 1, namely about a central plane of symmetry located between and in parallelism with the respective major surfaces of the panel.

To assemble the panel illustrated in FIGS. 1-3 the members 3 are arranged within an outer assembly frame (not illustrated). The members 1 are arranged inwardly of the members 3 and, when the screws 2 are operated, the members 1 are elastically deflected out of the initial positions which are illustrated in FIG. 2 with dashed lines until they assume the full-line positions illustrated in the same figure. Of course, as this takes place they are pressed against the members 3 which latter are prevented from yielding to such pressure by the assembly frame which is outwardly adjacent to them. Thus, the dual frame consisting of the members 1 and 3 is placed into a prestressed condition.

Once this is accomplished the sheet material members 4 are secured on opposite sides of the dual frame. These members 4 may consist of metal, for instance of surface improved aluminum sheets or non-rusting steel sheets having a thickness of 0.5 mm., for example, and securing of the members 4 to the arms of the U-profiled members 3 is effected by bending the edge portions of the members 4 over the edges of the arms, as evident in FIGS. 1 and 3, this connection to be improved if necessary or desired by spot welding or bonding. The main point to remember is that the members 4 must be as taut as possible so as to be stretched in their respective planes. Upon removal of the thus completed panel from the assembly frame the outwardly directed tensioning forces generated by the members 1 are equally distributed via the tiltable arranged U-profiled members 3 to the sheet-material members 4. It will be clear that if temperature differentials develop between the two sheet material members 4 of a panel constructed in accordance with my invention, that is if, for example, one of the members 4 expands more strongly than the other, wrinkling of the more strongly expanding member 4 is impossible and the member 4 thus

expanding will remain tautly stretched because the developing slack will be taken up by the outwardly acting stresses generated by the prestressed members 1 which act to outwardly deflect the U-profiled members 3 to the extent to which this has been made possible by the expansion of the sheet-material member 4 in question. Of course, it being assumed that only one of the sheet-material members 4 has expanded to this extent whereas the other has expanded less or not at all, the U-profiled members 3 will tilt slightly about the supporting members 1 in the direction towards the non-expanded or less strongly expanded sheet-material member 4. It will be clear that, if the converse takes place so that one of the sheet-material members 4 is cooled to a greater degree than the other, and is therefore subjected to thermal contraction greater than that which takes place in the other of the sheet material members 4, the increased stretching of the more strongly cooled sheet-material member 4 will be transmitted to other member 4 by tilting of the U-profiled members 3.

FIG. 3 illustrates that for static reasons it is advantageous to have the bottom wall of the members 3 configured as a tubular profile, advantageously of quadratic or rectangular cross-section. It is also shown in FIG. 3 that insulating tapes or strips 5 of synthetic plastic material are arranged between the arms of the members 3 and the bent-over edge portions of the sheet-material members 4 to eliminate thermal bridging at these points and to also reduce the development and transmission of noise.

FIGS. 6 and 7 show constructions which essentially are the same as that shown in FIGS. 1-3. The difference in FIG. 6 is the use of a thermally insulating layer or plate 6 which is disposed intermediate the sheet material members 4. A similar layer 6' is shown in FIG. 7. In both cases the layers 6 or 6' are advantageously constructed of non-flammable material which should have at least a certain stability, and for this purpose I have found rock wool or expanded mica which is compressed into plate-shape with sodium silicate, to be advantageous although other materials are of course usable. FIG. 7 differs from FIG. 6 in the manner in which FIG. 3 differs from FIG. 1, namely in the construction of the members 3 and in the provision of the members 5, and further in that the layer 6' is supported by wire mesh 7, or similar heat-resistant supporting members, which are secured to the members 3 and which are intended to insure that the novel panel has sufficient stability to prevent collapse even if the sheet-material members 4 should be destroyed, for instance in case of a fire.

Coming now to the embodiment illustrated in FIG. 4 it will be seen that this differs from FIGS. 1-3 in the arrangement employed for prestressing of the frame. In FIG. 4 there are provided adjusting organs 8 located within the confines of the members 1 outwardly adjacent of which the members 3 are arranged. Each of the adjusting organs 8 comprises a tubular member 80 and a pair of screws 80' threaded into the opposite open ends of the tube 80. There is further provided a member 9 having the configuration of a cross and comprising four tubular portions 90a each of which has arranged therein a spring 90b. Received in each of the extensions 90a is a supporting arm or rod 90c which is urged outwardly in the direction of the arrows associated with the respective arms 90c. It is clear from a construction of FIG. 4 that the screws 80' serve to pull the opposite ends of the members 1 inwardly and to elastically deform them against the action of the arms 90c. If, upon affixing of the sheet-material members 4, the screws 80' are again relieved, the now prestressed members 1 will serve to maintain the members 4 in the desired stretched condition in the manner in which this has been outlined earlier.

A further embodiment in accordance with the present invention is illustrated in FIG. 5 in somewhat schematic form. It will be seen that the sheet material members 4

have again been identified with the same reference numeral as previously, whereas the U-profiled members 3 have been omitted for the sake of clarity. In place of the members 1, the embodiment of FIG. 5 employs an inner frame which consists of two arcuately curved end pieces 11 and two arcuately but inwardly curved side pieces 12. A screw-type pressure-applying arrangement 10 of well-known construction is arranged intermediate the side pieces 12 and, when operated, exerts thereupon pressure in the direction of the dual arrows associated with the arrangement 10, thus prestressing the members 12 and thereby the members 11 and providing the desired prestressing which has been discussed with reference to FIGS. 1-3 earlier.

Coming, finally, to the embodiment illustrated in FIG. 8, it will be seen that this illustrates yet a further approach in accordance with my invention. In FIG. 8 the sheet-material members are identified with reference numerals 24. They are arranged, as in all other embodiments, in two spaced parallel planes. Located intermediate these planes in a central plane of symmetry which is in parallelism therewith is an inner frame 20 which is stiffened by the members 21 which are parallel bars. Members 23 having a U-shaped profile and consisting of spring steel are supported on the frame 20 in such a manner that their arms extend in outward direction. In their non-tensioned state the members 23 have the configuration illustrated in dot-dash lines in FIG. 8, it being noted that they are provided with a central longitudinal depression in which the edge of the frame 20 is received as clearly visible in FIG. 8. To effect assembly of the embodiment illustrated in this figure the members 23 are deflected from the dot-dash line position into the full-line position, whereupon the sheet-material members 24 are secured to them by bending the edge portions of the members 24 over the arms of the members 23 and/or otherwise effecting a connection, for instance by means of spot welding, bonding or the like. In any case, the permanent tendency of the members 23 to return from their full-line position into their normal position in which they are relaxed and have the configuration shown in dot-dash lines, will permanently stretch the members 24 and keep them taut. Of course, the members 23 are tiltable about the edge of the frame 20 received in the groove in these members 23, and this is for the purposes which have been outlined earlier. Arranged intermediate the sheet-material members 24 are two layers or plates 26, one disposed on each side of the frame 20, consisting of thermally insulating material and/or non-flammable or fire retarding material. These layers 26 are advantageously secured to the members 21 of the frame 20.

The advantages of the present construction will have become obvious already. It will therefore suffice to merely point out once more that the panel in accordance with the present invention is of light weight while exhibiting great form stability and load-carrying ability. Such panels are very well suited for covering the exposed sides of building walls, whether solid or skeleton wall constructions, and the fact that they have very good thermally insulating properties make them particularly suitable for such applications. Inasmuch as a large variety of different materials can be used for the sheet-material members which constitute the major surfaces of the panels makes it possible to select the sheet-material according to the specific requirements of a situation, for instance by using surface treated chrome-nickel steel or the like, and it is clear that this makes it possible to provide a building covered with my novel panel with an aesthetically pleasing appearance which will always remain attractive and unchanged, regardless of changing weather and/or temperature conditions.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of structures differing from the types described above.

While the invention has been illustrated and described

as embodied in a panel structure, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims.

1. A panel, particularly for covering the exposed sides of a wall construction on buildings and the like, comprising a pair of sheet-material members arranged in spaced parallel planes and being subject to differential changes of dimension in the respective planes upon exposure to differential thermal conditions; and means connecting said sheet-material members and tensioning the same in their respective planes, said means including pretensioned frame means interposed between said members and comprising an outer frame having a first pair of spaced parallel frame portions and a second pair of spaced parallel frame portions loosely extending intermediate said first frame portions, and a pretensioned inner frame located within the confines of said outer frame engaging said frame portions and urging the same outwardly away from one another, said members being connected to said frame portions and being tensioned by being operative to effect independent compensation for dimensional changes of either of said members in the respective plane thereof to thereby maintain both of said members tensioned irrespective of dimensional changes in either of said members individually or in both of said members together.

2. A panel as defined in claim 1, wherein said frame portions are each engaged and supported by said pretensioned frame for tilting movement transversely of a central plane of symmetry of said panel which is located between and parallel to said planes.

3. A panel as defined in claim 2, wherein said frame portions are of profiled cross-sectional configuration.

4. A panel as defined in claim 2, wherein said frame portions are of substantially U-shaped cross-section and each have a bight and a pair of arms, and wherein the bights of each pair of frame portions face inwardly towards one another.

5. A panel as defined in claim 1; and further comprising at least one layer of thermally insulating material interposed between said members.

6. A panel as defined in claim 5, wherein the material of said layer is non-combustible.

7. A panel as defined in claim 6; and further comprising at least one reinforcing support element supporting said layer and connecting the same to said frame means.

8. A panel as defined in claim 7, wherein said support element consists of a material having a resistance to heat greater than that of said sheet-material members.

9. A panel as defined in claim 8, wherein said support element is a wire-mesh element.

10. A panel as defined in claim 1; and further comprising at least one layer of lightweight thermally insulating material interposed between said members.

11. A panel as defined in claim 1, wherein said second pair of frame portions extends between but is separate from said first pair, said frame portions each being of substantially U-shaped cross-section with the bights of the portions of the respective pairs facing one another, said frame portions consisting of spring steel having a permanent tendency to flex outwardly about a line of symmetry extending longitudinally of the respective bight intermediate the respective arms, and said members being

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connected to said arms and maintaining said frame portions against such flexing, said means further comprising rigid support means extending between and engaging the bight of the frame portions of the respective pairs and being operative for maintaining said frame portions of the respective pairs in predetermined spaced relationship with one another.

12. A panel as defined in claim 1, wherein said outer frame is of outwardly open substantially U-shaped cross-sectional configuration and said frame portions are transversely spaced arm portions provided with oppositely directed side faces, said members each overlying one of said side faces and having respective edge portions each connected to one of said arm portions.

13. A panel as defined in claim 12; and further comprising elements of elastomeric material interposed between the respective arm portions and members associated therewith.

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14. A panel as defined in claim 13, wherein said elastomeric material is a thermally insulating material.

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U.S. Cl. X.R.

52—475, 573, 619; 160—374.1