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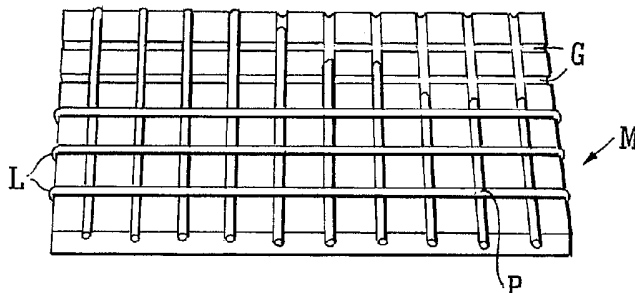
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(54) Title: FILTER SUPPORT, ESPECIALLY FOR FLUID FILTRATION



(57) Abstract: A filter comprising a filter material mounted on a support which comprises a mesh having a skeleton of hardened resin composition comprising carbon and/or polyaramid fibre. A method of making a filter comprising winding on to a former an elongate string of hardenable resin composition comprising carbon and/or polyaramid fibre so as to make the former a mesh structure having interstices then hardening the unhardened resin to form an integral structure as the filter support and then applying to the filter support a filter material. A filter comprising a filter material mounted upon a support comprising a lattice frame formed from a plurality of interconnected panels formed from a hardened resin composition comprising carbon and/or polyaramid fibre.

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## **FILTER SUPPORT, ESPECIALLY FOR FLUID FILTRATION**

The invention relates to a filter support, such as a mesh support, especially for use in fluid filtration, and in particular for the filtration of air to be directed to the air intake of an internal combustion engine, a compressor, an air conditioning unit or the like.

It is known to make a filter comprising a filter material e.g. a plastics foam. The foam is not self supporting, especially under the conditions of service, as a result of which it is mounted on a metal skeleton or frame. It is an object of the invention to provide a filter which has improved properties such as weight, strength and/or stiffness.

In one aspect the invention provides a filter comprising a filter material mounted on a support which comprises a mesh having a skeleton of hardened resin composition comprising carbon fibre and/or polyaramid fibre.

In a second aspect the invention further provides a filter comprising a filter material mounted upon a support comprising a lattice frame formed from a plurality of interconnected panels formed from a hardened resin composition comprising carbon fibre and/or polyaramid fibre.

In another aspect the invention provides a method of producing a filter according to the said one aspect comprising a filter material mounted on a support, the method comprising winding on to a former an elongate string of hardenable resin composition comprising carbon and/or polyaramid fibre so as to make on the former a mesh structure having interstices, then

hardening the unhardened resin to form an integral structure as the filter support, and then applying to the filter support a filter material.

The string used to make the mesh is preferably woven from fibres obtained from carbonised polymer such as polyacrylonitrile. The fibres can be produced by oxidising polyacrylonitrile in air at, say, 230°C whilst applying tension, and then the oxidised product can be carbonised in an inert atmosphere such as nitrogen at about 100°C. The resulting string has stiffness and can be load bearing. The string can be woven using traditional weaving technology. More than one string may be present.

Alternatively or additionally, the fibres for use in the resin composition can be synthetic polyaramid fibre, for example such fibre sold under the Trademark KEVLAR.

Filters take a variety of shapes including cylinders, domes, and the like. A support of this invention may be made in any required shape. While the support may be made integrally in one piece it may alternatively be made in several pieces which are subsequently joined e.g. interconnected together, e.g. by adhesive or welding.

The filter material may be of any known type, such as a foam e.g. of ethylene polymer such as polyethylene, urethane polymer such as polyurethanes or the like; or a flexible textile like material such as a cloth or felt which per se is not necessarily self supporting in use.

In order that the invention may be illustrated, more easily understood and readily carried into effect, embodiments of it will now be described purely by way of non-limiting example with reference to the accompanying diagrammatic drawings, in which:

Figure 1 is a perspective of a mould used in the method of making the filter of Figure 2;

Figure 2 is a perspective of one filter of the invention, parts having been removed;

Figure 3 is a perspective view of a filter frame according to a second embodiment of the invention;

Figure 4 is a perspective view of a cut-away portion of the filter frame of Figure 3 shown in detail;

Figure 5 is a perspective view of a filter frame according to a third embodiment of the invention;

Figure 6 is a perspective view of a cut-away portion of the filter frame of Figure 5; and

Figure 7 shows the cut-away filter frame portion of Figure 6 in which the exposed domed surface is covered with a layer of filter material attached to the frame.

Referring firstly to the first embodiment depicted in Figures 1 and 2, the filter frame comprises a generally tubular mesh frame F made from one or more lengths of string 'L' based on a carbon fibre composition. The string is wound e.g. by hand onto the former or mould 'M' which has grooves 'G' to guide the string to the intended positions. The string is wound to form a mesh having interstices 'I'. The composition is then cold cured e.g. by application of pressure and/or heat cured, optionally with chemical acceleration. Extra curable composition may be applied to the crossover points 'P'. An end of the frame may be

a solid wall to allow fittings to pass therethrough to hold the filter to apparatus, not shown. The formed mesh is then removed from the mould as a self supporting frame structure 'F' and trimmed as necessary. The foam, e.g. polyurethane foam A, is located on the frame 'F' by say a sliding interference fit to form the complete filter.

As an alternative to the carbon fibre reinforcing material, polyaramid fibre can be used such as that available under the Trademark KEVLAR.

Figure 3 shows a filter frame according to a second embodiment of the invention.

The filter frame 10 is of a domed rigid frame structure formed from a network of interconnected rigid spars 14, 16 of composite material comprising carbon fibre admixed with hardened resin. The base 12 of the domed frame is of a generally rectangular shape with rounded corners. The spars are interconnected at their crossing points resulting in a rigid frame in the appearance and shape of a net or cage.

As an alternative or supplement to carbon fibre, polyaramid fibre may be used.

It will be appreciated by those skilled in the art that other suitable shapes could be selected, instead of a domed 'half pillow'.

The interconnected spars 14, 16 intersect each other to form vertices 'V', the interconnected spars 14, 16 intersect perpendicular to each other, such that spars 14 are formed in a longitudinal direction and spars 16 are formed in a lateral direction. However, it will be appreciated that in alternative embodiments other angles may be chosen. The interconnected spars form a mesh having interstices 'I'.

The interconnected spars terminate at each end at, and are connected to, a base 12 which extends around the periphery of the frame. The base 12 has an 'L' shaped cross section, the interconnected spars terminate at, and are fixed to, the horizontal portion of the 'L' shaped base 12.

Suitable filter material can be placed over and cover the filter frame 10 such that a peripheral edge of the filter material would terminate at, and be secured, around the base.

It will be appreciated that the base 12 could be of an alternative structure; and in other embodiments may not be present.

The network of composite material spars could be flat, cylindrical, conical or take any three dimensional shape. The principal function of the spars is to support the filter material to prevent deformation under loads applied to it, including aerodynamic loads.

Figure 4 shows an area 'A' of the embodiment of Figure 3 in close up. It can be seen that the interconnected spars 14, 16 are of rectangular cross section, however it will be appreciated that alternative shapes could be used in other embodiments.

It can also be seen that the vertices or crossing points 'V' of the interconnected spars lie within the form of the spars at the their interconnection. The spars are aligned such that an upper and lower surface of one spar is aligned with an upper and lower surface of a second spar.

It will be appreciated that this need not be the case, in that the spars could pass one over or under the other, nor is it essential that the spars be of equal cross-section and/or shape.

Turning now to Figure 5, there is shown a third embodiment of the invention.

The filter frame 110 incorporates the same basic externally domed shape as the frame of Figure 3 and 4. The filter frame 110 has a substantially rectangular base 112, with rounded corners.

The filter frame 110 in this embodiment is a rigid structure formed from intersecting and interlinking panels 114 and 116 of composite material comprising carbon fibre within a hardened resin. Upper surfaces of the intersecting panels 114, 116 define the upper surface of the filter frame 110. The intersecting panels 114, 116 extend from the upper surface of the filter frame 110 towards the base 112 in a lattice array of open ended pockets 'P' of substantially square cross-section.

Alternatively, the composite material may comprise polyaramid fibre such as that available under the Trademark KEVLAR instead of or to supplement the carbon fibre.

The panels 114, 116 intersect and interlink at substantially 90° to one another forming longitudinal panels 114 and lateral panels 116. However, other angles are envisaged, nor is it essential that the intersecting panels form pockets of square cross-section.

The panels forming the filter frame 110 provide a rigid structure which has an influence upon the flow and direction of the flow of fluid, such as air, passing through the filter and filter frame.

The tubular structure defined by the intersecting panels tends to reduce velocity of fluid flowing in a direction transverse to the direction of filtration 'F', and to impart a directional fluid flow through the filter.

Figure 6 shows the filter frame 110 of Figure 5 where a portion of the filter frame has been cut away, such that the shape of a panel forming part of the filter frame 110 can be seen more clearly.

It can be seen that panel 116 extends throughout the cross-section of the filter frame.

The upper edges of the panels are shaped in a similar manner to the previously described embodiments, so as to form part of the support for filter material.

It can further be seen that an arcuate lower segment of the intersecting panels 114, 116 has been removed from the bottom edge, such that the intersecting panels may define a concave surface 117 within the base of the filter frame 110.

The removal of these arcuate segments from the intersecting panels 114, 116 may provide mechanical clearance when the filter is used in combination with other components. Furthermore, the removal of these sections may provide additional benefits in the fluid flow, i.e. the fluid dynamics, (in the specific case when the fluid is air), so that aerodynamics in the system in which the filter is employed may be improved by reason of the shape of parts (not shown) into which the fluid flows after passage through the filter material and support structure. Moreover, in this Figure the shape of the optional L section peripheral frame 112 may be noted.

Figure 7 shows a perspective view of the cross-section of the filter frame shown in Figure 6. A cross-section through a portion of a filter material 122 placed in contact with the upper surface of the intersecting panels 114, 116 is also shown.

The filter material 122 is secured around a peripheral edge between the upper surface of the intersecting panels 114, 116 and the vertical portion of the 'L' shape defined by the cross-section of the base 112.

Typically the fluid flow would be downwards through the filter material and then through the support structure. It is quite possible that in another arrangement, other rigid parts would be positioned above the filter material, or a smaller piece of the filter material might be placed inside each of the separate spaces formed by the panels of this type of filter support structure.

It is envisaged that fluid will flow in the direction of arrow 'F'. Thereby any pressure created by the fluid flow will not tend to separate the filter material 122 away from the filter frame 110.

It is also envisaged in alternative embodiments that the filter material 122 may be separable from the filter frame for the purpose of cleaning or replacement.

The filter may take a variety of known shapes and the frame of the invention can be moulded to make any suitably shaped support. The filter can be used to filter air, for example in the air intake of a combustion engine. In use, the air passes through e.g. filtering foam so particles of dust etc. are trapped therein. The air is then passed to the intake of an e.g. internal combustion engine. However, filtration of other fluids is also envisaged, such as, but

not limited to, fuel, oil or water. It is also envisaged that filters according to the present invention could be utilised outside the automotive industry, for example within the aircraft industry as a filter for aircraft engines.

The invention is not limited to the embodiments described and shown. The frame need not be part cylindrical as shown in Figure 2, and the frame may be present within the thickness of the foam instead of just in contact with the inside wall. The embodiments of air filter may be used in connection with any apparatus having an air intake and requiring or benefiting from air filtration.

**CLAIMS**

1. A filter comprising a filter material mounted on a support which comprises a mesh having a skeleton of hardened resin composition comprising carbon and/or polyaramid fibre.
2. A filter comprising a filter material mounted on a support, which comprises a mesh having a skeleton of hardened resin composition comprising carbon fibre.
3. A filter as claimed in Claim 1, in which the resin composition comprises fibre consisting of carbon fibre.
4. A filter as claimed in Claim 1, in which the resin composition comprises fibre consisting of polyaramid fibre.
5. A filter as claimed in Claim 2 or 3, in which the mesh is formed from strung fibres.
6. A filter as claimed in Claim 5, in which the fibres are of carbonised polymer.
7. A filter as claimed in Claim 6, in which the polymer is polyacrylonitrile.
8. A filter as claimed in Claim 7, in which the polyacrylonitrile has been oxidised in air and carbonised in an inert atmosphere.

9. A filter as claimed in any one of Claims 5 to 8, in which the strung fibres are woven.
10. A filter as claimed in any preceding claim including an at least partially domed outermost surface or region.
11. A filter as claimed in any preceding claim in which the mesh is of integral one piece construction.
12. A filter as claimed in any preceding claim in which the filter material is a foam or flexible textile material.
13. A filter as claimed in any preceding claim comprising a peripheral frame affixed to the periphery of the mesh.
14. A filter as claimed in any preceding claim which is a self supporting rigid structure.
15. A filter as claimed in any preceding claim in which the mesh is formed from a plurality of interconnected rigid spars.
16. A filter as claimed in any preceding claim in which the mesh comprises a network of interconnected spars of said hardened resin composition, including laterally extending and longitudinally extending said spars, and said spars have a cross section which is flat, rectangular, cylindrical or conical.

17. A filter as claimed in Claim 15 or 16, in which the vertices or crossing points of the interconnected spars lie within the form of the spars.
18. A method of making a filter as claimed in any one of Claims 2, 3 or 5 to 15 comprising winding on to a former an elongate string of hardenable composition comprising carbon fibre so as to make the former a mesh structure having interstices then hardening the unhardened resin to form an integral structure as the filter support and then applying to the filter support a filter material.
19. A method as claimed in Claim 18, in which the former has grooves to guide the string into intended positions.
20. A method as claimed in Claim 18 or 19, in which the composition is cold cured, heat cured or chemically cured.
21. A method as claimed of any one of Claims 18 to 20, in which additional curable composition is applied to crossover points of the string wherein the interconnections are to be formed.
22. A filter as claimed in any one of Claims 1 to 17 substantially as herein described.
23. A filter as claimed in any one of Claims 1 to 17 substantially as herein illustrated in any one of Figures 1 to 4 of the accompanying drawings.
24. A method of making a filter as claimed in any one of Claims 18 to 21 substantially as herein described or illustrated.

25. A filter comprising a filter material mounted upon a support comprising a lattice frame formed from a plurality of interconnected panels formed from a hardened resin composition comprising carbon and/or polyaramid fibre.
26. A filter as claimed in Claim 25, in which the resin composition comprises fibre consisting of carbon fibre.
27. A filter as claimed in Claim 25 or 26, wherein the frame is a rigid domed structure constructed from an array of laterally extending and longitudinally extending panels.
28. A filter as claimed in any one of Claims 25 to 27 having a substantially rectangular base with rounded corners.
29. A filter as claimed in any one of Claims 25 to 28, wherein open-ended pockets of substantially square cross section are provided within the lattice.
30. A filter as claimed in any one of Claims 25 to 29 in which, in use, the panels exert an influence upon the flow of fluid and direction of flow of fluid through the lattice.
31. A filter as claimed in any one of Claims 25 to 30 including cut away portions of and at the lowermost edges of the said panels.
32. A filter as claimed in any one of Claims 25 to 31 further including a peripheral frame or flange at its lowermost periphery.

33. A filter as claimed in any one of Claims 25 to 32 substantially as herein described.
  
34. A filter as claimed in any one of Claims 25 to 32 substantially as herein illustrated in any one of Figures 5 to 7 of the accompanying drawings.

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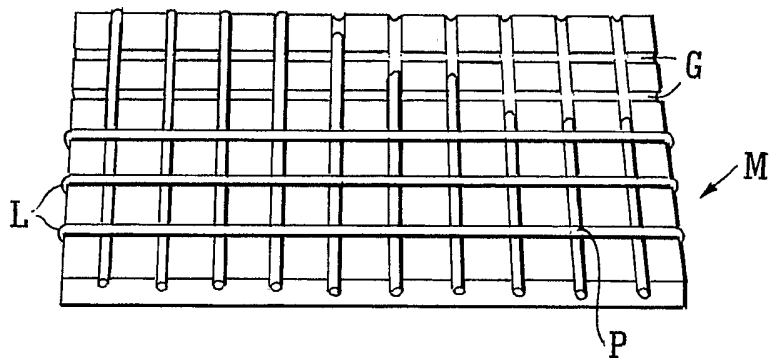


FIG. 1

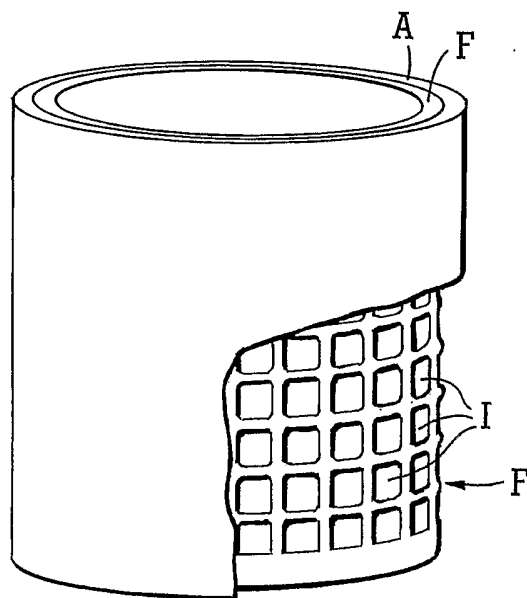


FIG. 2

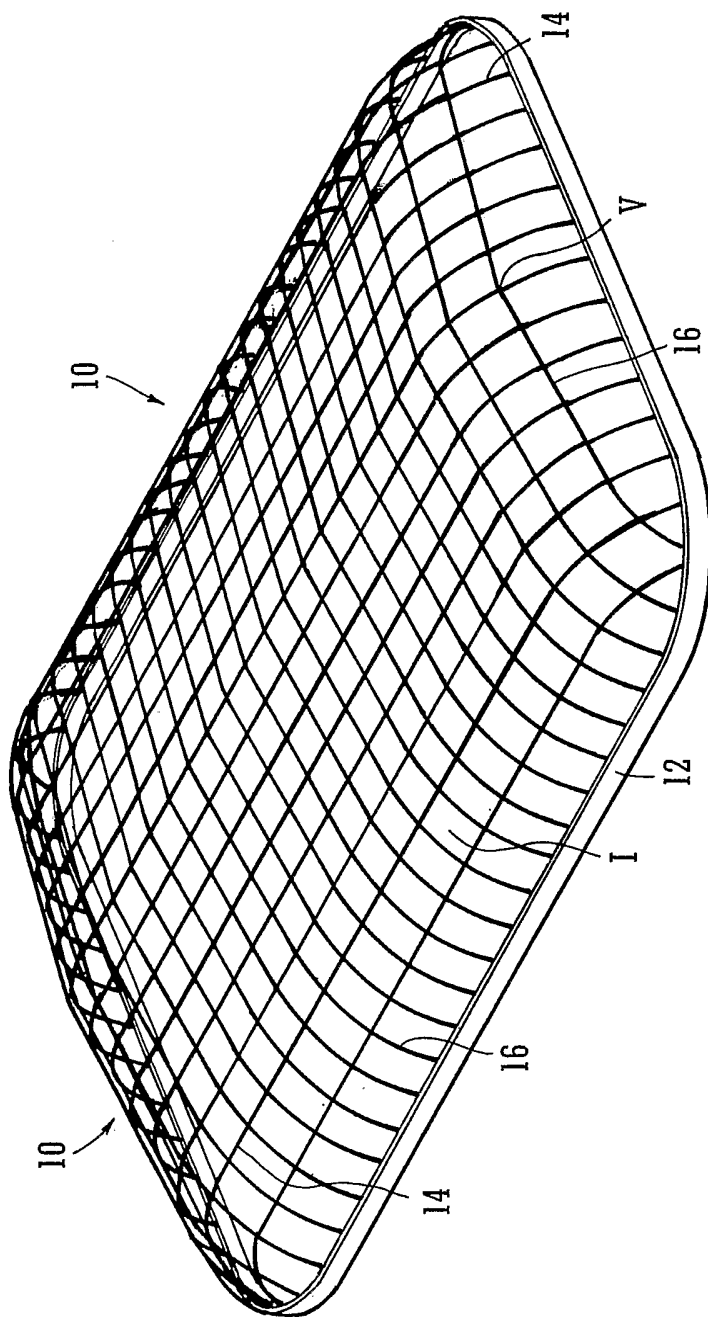


FIG. 3

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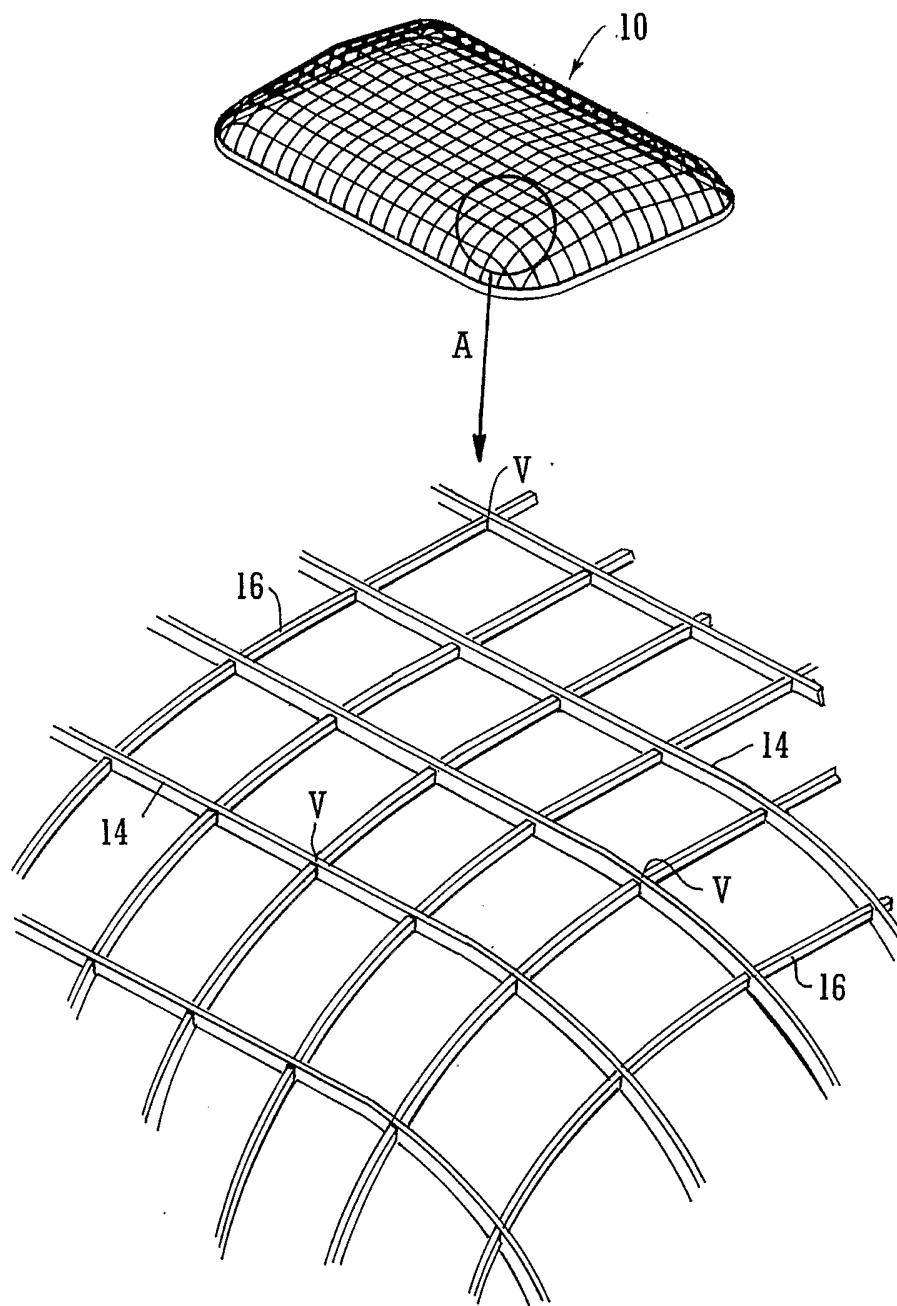


FIG. 4

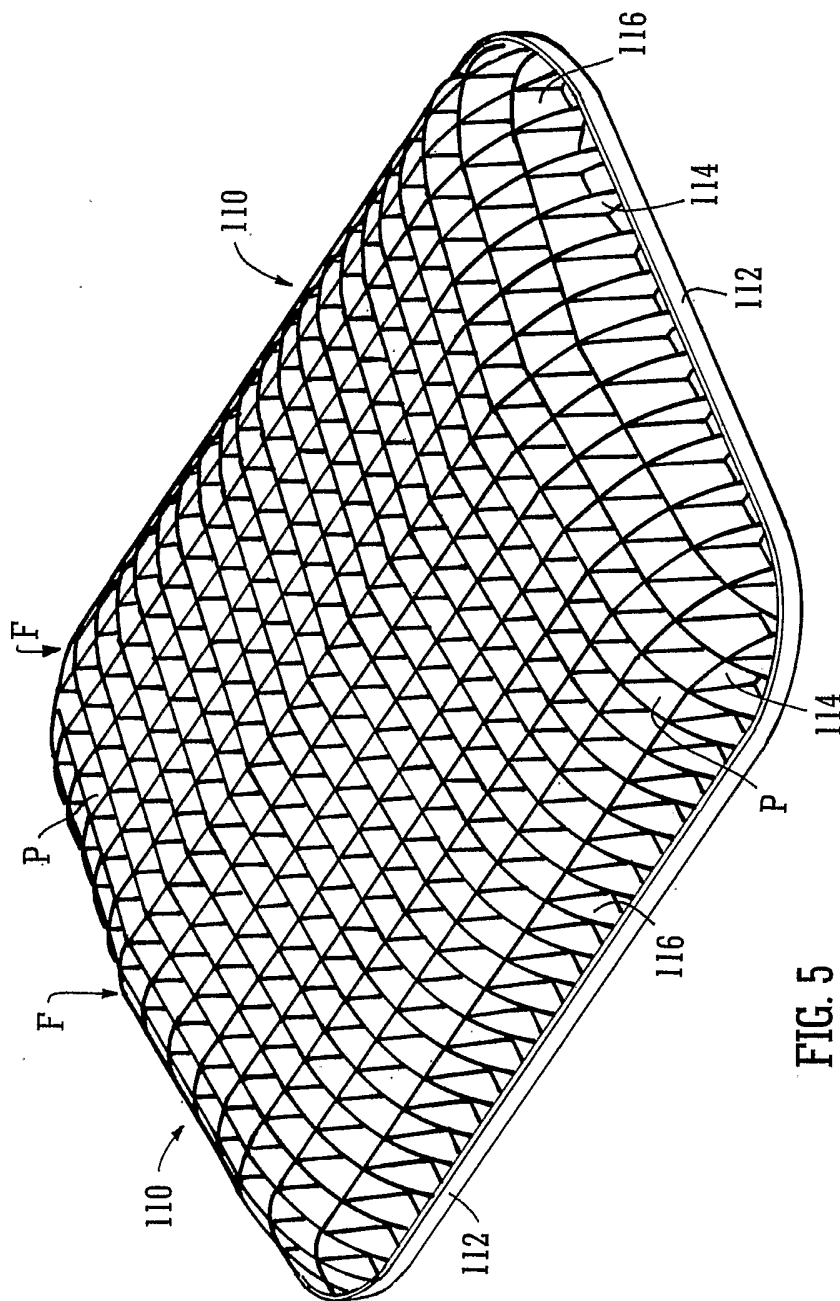


FIG. 5

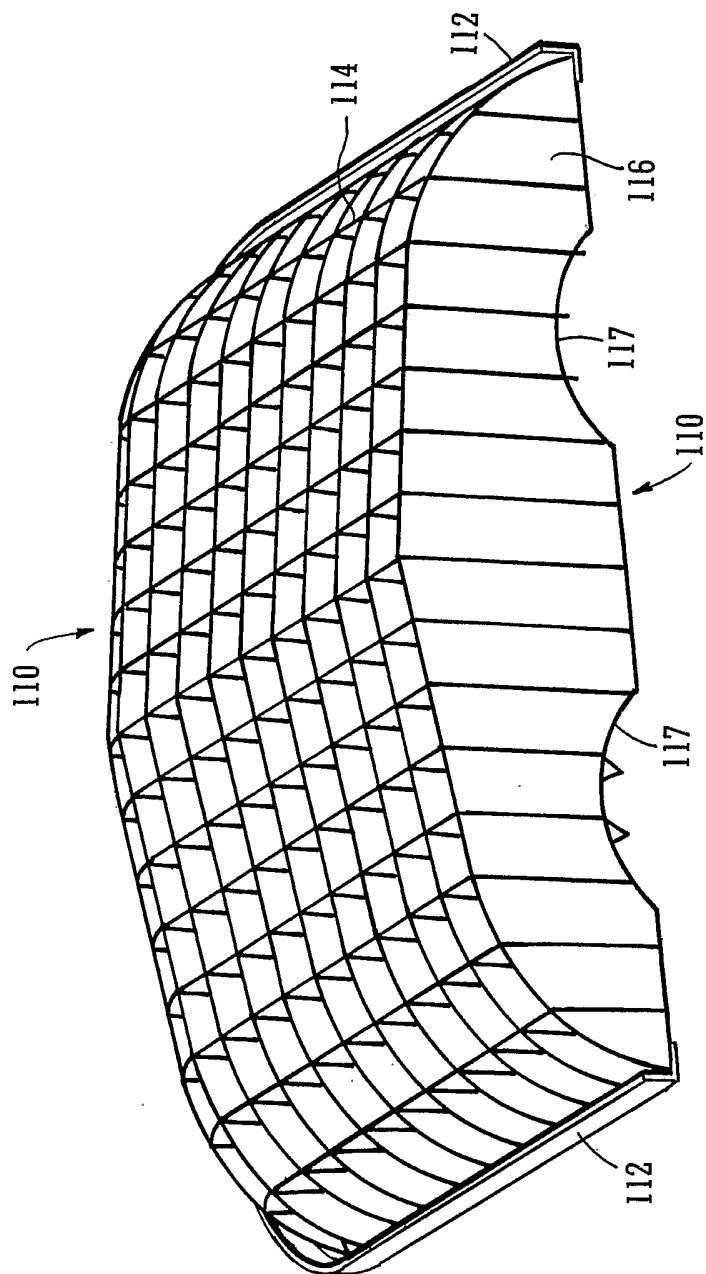


FIG. 6

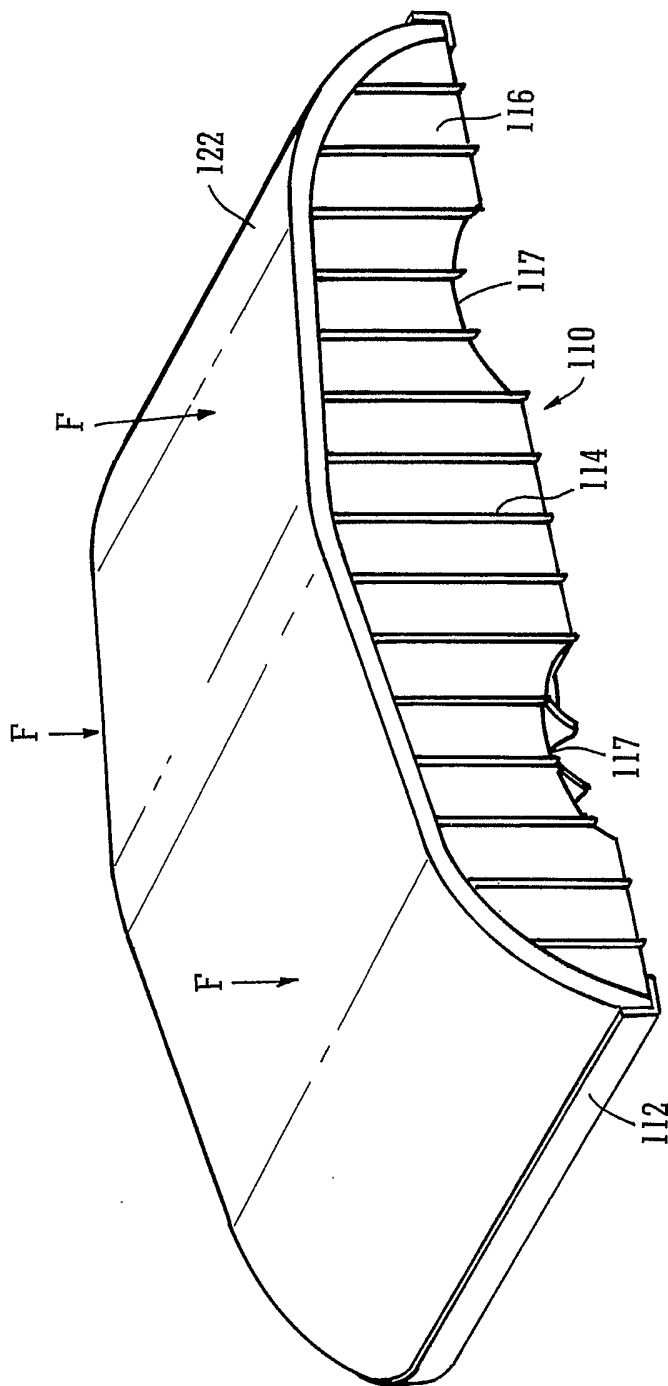


FIG. 7