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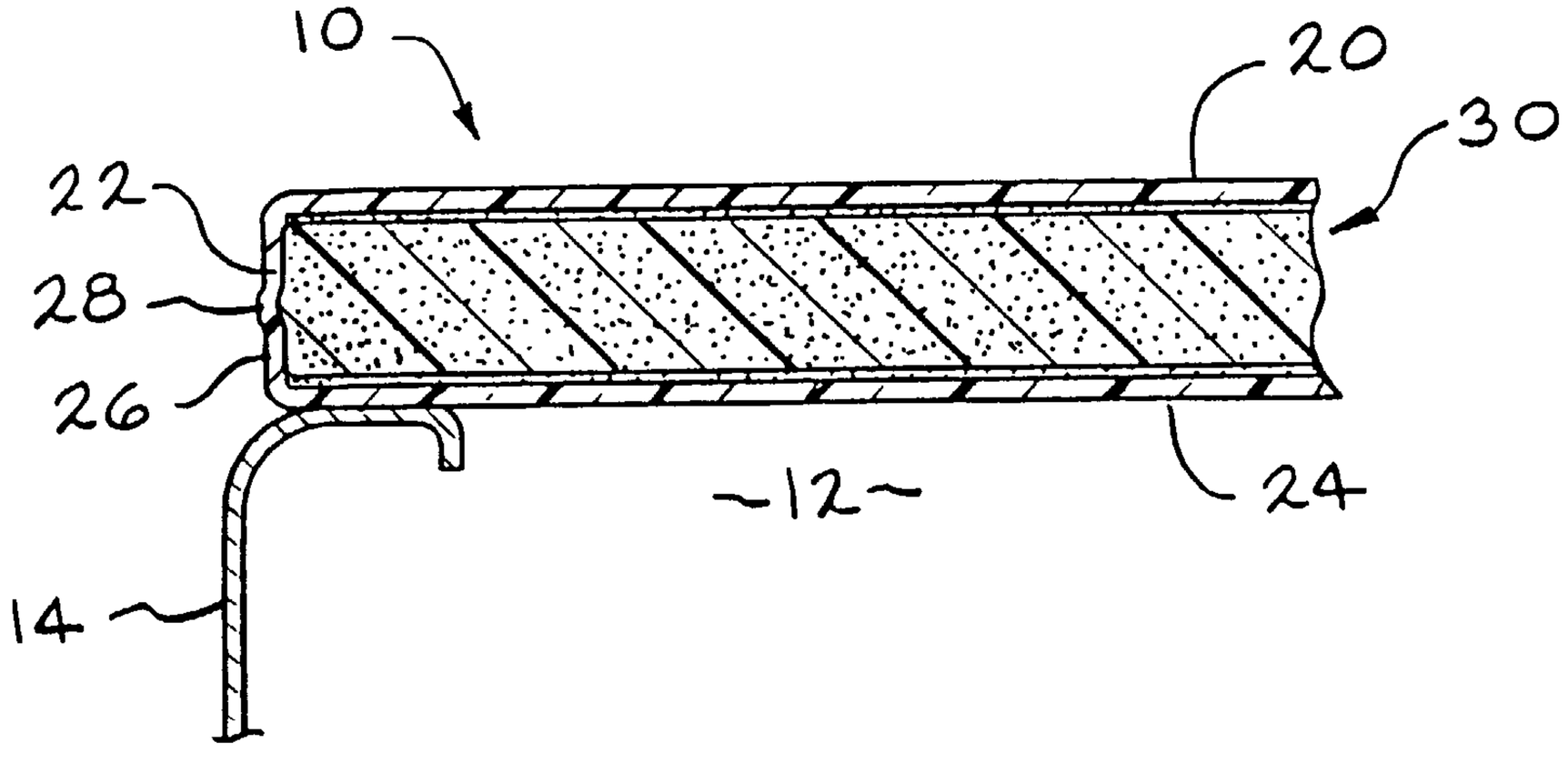
(54) Titre : STRUCTURE DE PANNEAU A NOYAU DE MOUSSE RIGIDE
(54) Title: PANEL STRUCTURE WITH RIGID FOAM CORE



(57) Abrégé/Abstract:
A panel structure (10) includes a rigid foam center core (30) sandwiched between two outer skin fiber layers (20,24). The core is preferably polyurethane, polypropylene, polystyrene and mixtures, as well as polyphenylne oxide and blends. The fiber layers (20,24) may be bi-directional fabric, a unidirectional material or a random weave mat which is impregnated with an epoxy or resin binder. The fibers themselves may fiberglass, polypropylene, Kevlar or carbon. The rigid foam core is thermoplastic polyolefin (TPO), high density polyethylene (HDPE) or acrylonitrile butadieme styrene which are molded into the skin layers (20,24) with peripheral lips (22,26). The lips (22,26) are compressed together and form a peripheral bead or seal (28).

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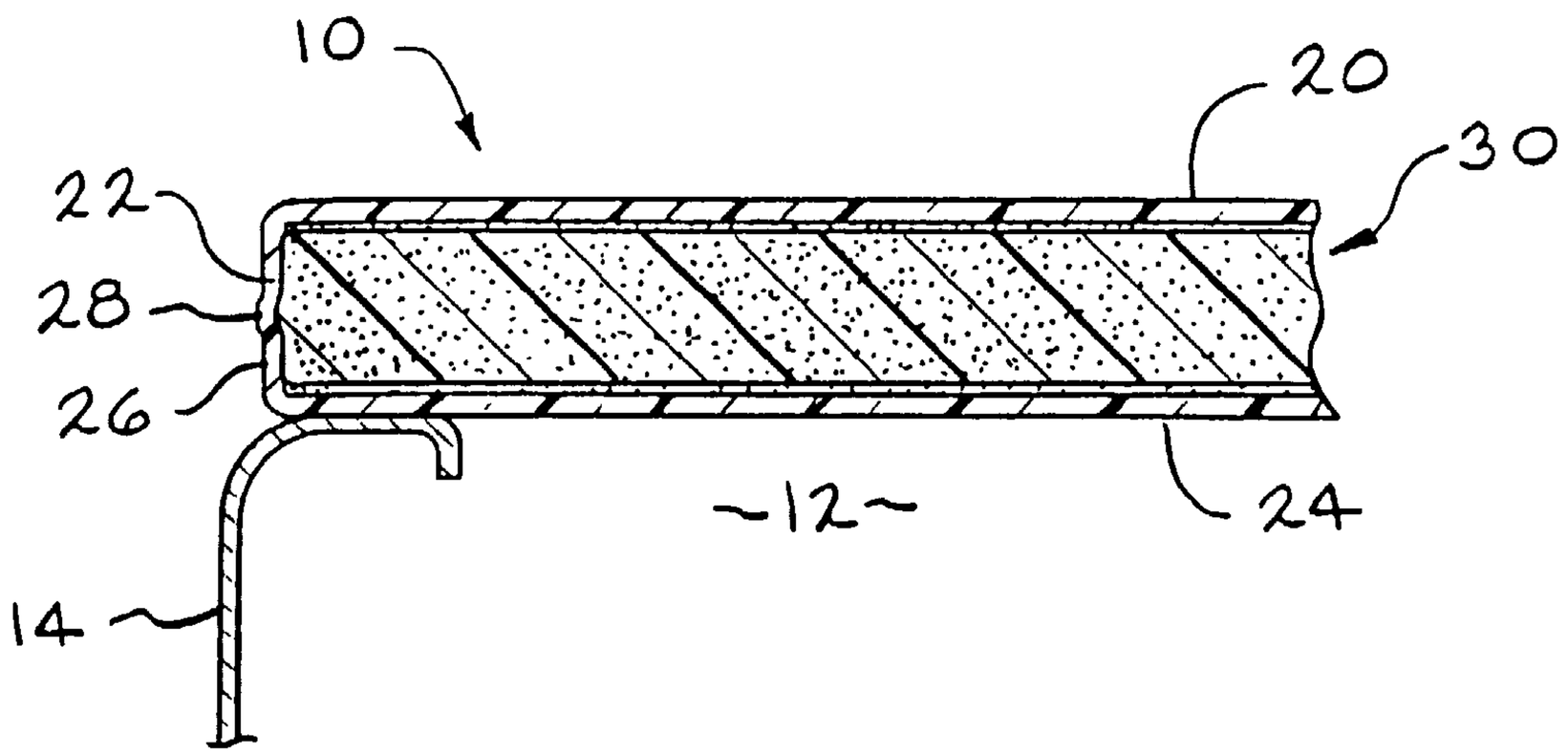

(57) Abstract: A panel structure (10) includes a rigid foam center core (30) sandwiched between two outer skin fiber layers (20,24). The core is preferably polyurethane, polypropylene, polystyrene and mixtures, as well as polyphenylne oxide and blends. The fiber layers (20,24) may be bi-directional fabric, a unidirectional material or a random weave mat which is impregnated with an epoxy or resin binder. The fibers themselves may fiberglass, polypropylene, Kevlar or carbon. The rigid foam core is thermoplastic polyolefin (TPO), high density polyethylene (HDPE) or acrylonitrile butadieme styrene which are molded into the skin layers (20,24) with peripheral lips (22,26). The lips (22,26) are compressed together and form a peripheral bead or seal (28).

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TITLE

PANEL STRUCTURE WITH RIGID FOAM CORE

BACKGROUND OF THE INVENTION

The invention relates generally to a multi-layer panel structure as well as a method of making same and more specifically to a multi-layer panel structure having an inner rigid foam core sandwiched between outer plastic skins or panels as well as a method of making this structure.

Many types of plastic composite panels have been manufactured. A wide selection of thermoplastic and thermosetting materials have been combined in multiple layers with various intermediate reinforcing materials to provide a variety of composites exhibiting specific structural characteristics intended for equally specific applications. For example, a composite having a center section of end grain balsa wood disposed between outer resin impregnated fabric layers has been found to provide exceptional strength and rigidity while exhibiting relatively low weight good sound deadening qualities.

A drawback of many such composites, particularly those constituted of only plastic and especially thermoplastic materials, is cold flow or creep. Cold flow or creep is generally defined as that tendency of a structural material which is typically under load to slowly deflect or deform. Although such deformation, to a greater or lesser extent, occurs slowly and over an extended period of time, it is generally perceived as permanent inasmuch as only exposure to a reverse load for approximately the same period of time will eliminate such deformation. At elevated temperatures, of course, such as experienced by panels or structures exposed to direct, i.e., outdoor, sunlight, creep or cold flow is significantly accelerated.

Such creep or cold flow is a significant problem and disadvantage of many components fabricated of thermoplastic or thermoset materials and frequently limits the use of such materials to applications which are not exposed to outdoor sunlight, relatively high temperatures or significant static loading. This invention is directed to minimizing this drawback of these materials.

SUMMARY OF THE INVENTION

The panel structure includes two outer skins or panels and a center rigid core assembly. The center core assembly is a sandwich having a foam center surrounded by top and bottom resin impregnated fiber layers. The center core can be a wide variety of materials but is preferably a rigid foam, such as polyurethane, polypropylene, polystyrene and mixtures as well as polyphenylene oxide (PPO) and blends. The fiber layers may be a bi-directional woven fabric, a unidirectional material or a random weave mat which is impregnated with an epoxy or resin binder. The fibers themselves may be fiberglass, polypropylene, Kevlar or carbon. The rigid foam core sandwich is surrounded with top and bottom skins or panels of moldable thermoplastic material such as thermoplastic polyolefin (TPO), high density polyethylene (HDPE) or acrylonitrile butadiene styrene (ABS) which is capable of being molded with a high quality exterior surface finish. The exterior surfaces may be smooth, textured, grained on or exhibit some other desired surface finish. The exterior surfaces may be painted, if desired.

A method of fabricating the panel structure also forms a portion of the present invention. The method includes the steps of providing upper and lower mold sections in the shape of the final product and placing a first heated, planar sheet of material such as TPO, HDPE or ABS on the lower mold and vacuum forming it. A prefabricated rigid

foam core assembly is coated on both sides with an adhesive and is disposed within the interior of the first molded panel. Then, a second, heated planar sheet of material is positioned adjacent the upper mold and it is vacuum formed. The molds are aligned and the molds and formed panels are brought together. The peripheries of the skins or panels are squeezed together and an autogenous bond or seal is created about the periphery of the panel structure. The panel structure is then removed from the mold and excess material is trimmed from its periphery.

Products incorporating these features and/or manufactured by this method are suitable as cargo and tonneau covers for light trucks and pickup trucks, for vehicle flooring, for truck beds and tailgates and other applications requiring panels having good strength, rigidity, dimensional stability and resistance to creep.

It is thus an object of the present invention to provide a panel structure having a rigid foam core.

It is a further object of the present invention to provide a panel structure having outer skins or panels with smooth, grained or painted outer surfaces and a rigid interior foam core.

It is a still further object of the present invention to provide a panel structure having outer panels or skins which surround an interior rigid foam core assembly.

It is a still further object of the present invention to provide a plastic panel structure having a rigid foam core which exhibits good creep resistance.

It is a still further object of the present invention to provide a method for fabricating a panel structure.

Further objects and advantages of the present invention will become apparent by reference to the following description of the preferred embodiment and appended drawings wherein like reference numbers refer to the same component, element or feature.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of a panel structure according to the present invention which is utilized as a tonneau cover for a pickup truck;

Figure 2 is a fragmentary, sectional view of a panel structure according to the present invention taken along line 2-2 of Figure 1;

Figure 3 is a fragmentary, sectional view of a rigid foam core assembly of a panel structure according to the present invention;

Figure 4 is a full, sectional view of a lower vacuum forming mold utilized in the fabrication of a panel structure according to the present invention with a lower skin or panel in position on the lower mold prior to forming;

Figure 5 is a full, sectional view of the lower vacuum forming mold with a formed lower panel of a panel structure according to the present invention;

Figure 6 is a full, sectional view of the lower vacuum forming mold with a formed lower panel and a rigid foam core assembly disposed on the formed lower panel;

Figure 7 is a full, sectional view of a upper vacuum forming mold utilized in the fabrication of a panel structure according to the present invention with an upper skin or panel in position on the upper mold prior to forming;

Figure 8 is a full, sectional view of the upper vacuum forming mold with a formed upper panel of a panel structure according to the present invention; and

Figure 9 is a full, sectional view of a vacuum forming mold having top and bottom panels enclosing a rigid foam core assembly during the final step of fabrication of a panel structure according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to Figures 1, 2 and 3, a panel structure according to the present invention is illustrated and generally designated by the reference number 10. The panel structure 10 in Figure 1 is configured as a rigid tonneau cover disposed over and protecting the load carrying area 12 of a bed 14 of a conventional pickup truck 16. The panel structure 10 may also be utilized for vehicle flooring, truck beds, tailgates, body panels, doors and many other vehicular and non-vehicular components.

As illustrated in Figure 2, the panel structure 10 includes a first or upper exterior skin or panel 20 having a folded or down-turned edge or lip 22 and a second or lower exterior skin or panel 24 having a folded or upturned edge or lip 26. The lips or edges 22 and 26 merge and are sealed about their peripheries at a peripheral bead or seal 28. The upper and lower panels 20 and 24 are preferably formed of a thermoplastic or thermosetting material such as thermoplastic polyolefin (TPO), high density polyethylene (HDPE) or acrylonitrile butadiene styrene (ABS). Disposed between the upper skin or panel 20 and the lower skin or panel 24 is a rigid foam core assembly 30 which is illustrated in Figure 3.

The rigid foam core assembly 30 includes a center core 32 of a dimensionally stable, rigid material such as aluminum honeycomb, polyurethane foam, polypropylene foam, polystyrene foam, blends of polystyrene, polyphenylene oxide and other materials. The rigid foam core assembly 30 also includes an upper surface layer 34 and a lower surface layer 36 preferably of epoxy or resin binder impregnated layers of fibers which may be either, bi-directional fabric of either woven or interleaved layers of fibers, unidirectional fibers or random weave material of fiberglass, polypropylene, Kevlar, carbon fiber or other materials. Kevlar is a trademark of the E.I. duPont DeNemours Co.

Typically, the rigid foam core assembly 30 will be between .5 inches (12.5 mm) and 1.5 inches (38.2 mm) thick, although it may be thinner or thicker, and the total thickness of the panel structure 10 will be between about .75 inches (19.1 mm) and 2.0 inches (50.8 mm).

Turning now to Figure 4, a method of manufacturing the planar structure 10 is illustrated. A lower mold section 40 having a conventional vacuum molding surface 42 defining a negative of the final desired lower surface of the panel structure 10 is provided. As such, the vacuum molding surface 42 may be smooth or define a textured or grained surface or other pattern as desired. The lower mold section 40 includes a continuous, peripheral raised edge or rim 44. The lower mold section 40 also includes a plurality of relatively small passageways 46 extending through the lower mold section 40 from a lower mold cavity 48 to a vacuum plenum 52 defined by a chamber or outer wall 54 which is sealed and secured to the back side of the lower mold section 40 as illustrated. A first vacuum pump 56 is in communication with the lower vacuum plenum 52 and, when activated, draws a partial vacuum in the lower plenum 52 and air through the small passageways 46.

The lower skin or panel 22 is provided to the lower mold section 40 at an elevated temperature. As utilized herein, "elevated temperature" means that temperature range at which a particular material becomes sufficiently flexible so that it is vacuum formable but does not become so flexible as to interfere with or preclude vacuum forming. Such elevated temperature may be achieved by heating the lower panel 22 by subjecting it to, for example, infra-red radiation or heated, circulating air. Alternatively, the lower panel 22 may be utilized promptly after it has been extruded from a forming station (not illustrated) and before it has had an opportunity to cool. The lower panel 22 is carried to and

placed over the mold cavity 48 by a peripheral carrier frame 58. The vacuum pump 56 is then activated.

As illustrated in Figure 5, upon application of a partial vacuum in the plenum 52 and the mold cavity 48 for a suitable period of time, the lower panel 22 is drawn into the lower mold cavity 48 and conforms to the vacuum molding surface 42 of the lower mold cavity 48.

Referring now to Figure 6, the rigid foam core assembly 30 is a prefabricated composite structure which is preferably supplied to the lower mold section 40 in a ready-to-use state. Prior to disposition within the molded lower panel 24 in the lower mold cavity 48 of the lower mold section 40, an adhesive 62 is applied to the planar faces of the foam core assembly 30. The adhesive 62 is preferably compatible with the materials used in the fabrication of the planar structure 10 and may be applied by a spray head 64 or other means such as a roller, brushes or a bath (all not illustrated).

Referring now to Figure 7, an upper mold section 70 having a conventional vacuum molding surface 72 defining a negative of the final desired upper surface of the panel structure 10 is also provided. As such, the vacuum molding surface 72 may be smooth or define a textured or grained surface or other pattern as desired. The upper mold section 70 includes a continuous, peripheral raised edge or rim 74. The upper mold section 70 also includes a plurality of relatively small passageways 76 extending through the upper mold section 20 from an upper mold cavity 78 to an upper vacuum plenum 82 which is defined by a chamber or outer wall 84 which is sealed and secured to the back side of the upper mold section 70 as illustrated. A second vacuum pump 86 is in communication with the upper vacuum plenum 82 and, when activated, draws a partial vacuum in the upper plenum 82 and air through the passageways 76.

The upper skin or panel 20 is provided to the upper mold section 70 at an elevated temperature. As noted above, such elevated temperature may be achieved by heating the upper panel 20 by subjecting it to infra-red radiation or heated, circulating air. Alternatively, the upper panel 20 may be utilized promptly after it has been extruded from a forming station (not illustrated) and before it has had an opportunity to cool. The upper panel 20 is carried to and positioned adjacent the edge or rim 74 of the upper mold section 70 by a peripheral carrier frame 88. The second vacuum pump 86 is then activated.

As illustrated in Figure 8, upon application of a partial vacuum for a suitable period of time, the upper panel 20 is drawn into the upper mold cavity 78 and conforms to the vacuum molding surface 72 of the upper mold cavity 78.

Referring now to the Figure 9, the upper mold section 70 containing the upper skin or panel 20 is positioned over the lower mold section 40 containing the lower skin or panel 24 and the rigid foam core assembly 30 and the upper mold 70 is translated into the position illustrated in Figure 9 such that the edges or rims 44 and 74 of the respective mold sections 40 and 70 compress the edges of the upper panel 20 and the lower panel 22 whereby the peripheral seal 24 is formed about the panel structure 10.

The mold sections 40 and 70 may now be separated and the panel structure 10 removed. A region of flash 90 will typically be formed which may be readily removed by sawing, sanding, grinding or filing after the panel structure 10 is removed from the mold sections 40 and 70. Fabrication of the panel structure 10 according to the present invention is now complete.

It will be appreciated that the panel structure 10 configured, for example, as a tonneau cover, exhibits excellent rigidity, surface finish and resistance to creep.

The finish on the outer surfaces of the panels 20 and 24 can be exceedingly smooth and rivals that of metal body panels and will readily accept a painted finish. Alternatively, it may be patterned or grained by suitable treatment to the vacuum molding surfaces 42 and 72 of the mold sections 40 and 70, as noted.

The foregoing disclosure is the best mode devised by the inventors for practicing this invention. It is apparent, however, that apparatus and methods incorporating modifications and variations will be obvious to one skilled in the art of panel structures and methods of making them. Inasmuch as the foregoing disclosure presents the best mode contemplated by the inventors for carrying out the invention and is intended to enable any person skilled in the pertinent art to practice this invention, it should not be construed to be limited thereby but should be construed to include such aforementioned obvious variations and be limited only by the spirit and scope of the following claims.

AMENDED CLAIMS

[received by the International Bureau on 14 January 2002 (14.01.02);
original claims 1, 8 and 15 amended; remaining claims unchanged (3 pages)]

1. A panel structure comprising, in combination,

a first panel having a planar portion and a peripheral lip, a second panel having a planar portion and a peripheral lip, said panels sealed about said peripheral lips and defining an interior space, one of said planar portions defining a surface finished to receive paint,

a rigid core disposed in and substantially filling said interior space, said rigid core including a center layer having opposed planar faces and first and second fiber layers secured to said opposed planar faces.

2. The panel structure of Claim 1 wherein material of said panels is selected from the group consisting of high density polyethylene, thermoplastic polyolefin and acrylonitrile butadiene styrene.

3. The panel structure of Claim 1 wherein said structure is a tonneau cover.

4. The panel structure of Claim 1 wherein material of said center layer of said rigid core is selected from the group consisting of aluminum honeycomb, polyurethane foam, polypropylene foam and polystyrene foam.

5. The panel structure of Claim 1 wherein said fiber layers are woven, unidirectional or random fibers.

6. The composite structure of Claim 1 wherein said fiber layers include an epoxy or resin binder.

7. The panel structure of Claim 1 further including adhesive layers disposed between said rigid core and said panels.

8. A panel structure comprising, in combination,

a first outer panel having a first, planar portion and a first peripheral lip,

a second outer panel having a second, planar portion and a second peripheral lip, said panels sealed about said peripheral lips and defining an interior space,

said first and said second planar portions defining at least one surface having a smooth finish adapted to receive paint,

a core disposed in and substantially filling said interior space, said core including a center layer having substantially parallel, planar faces and first and second fiber layers secured to a respective one of said parallel planar faces.

9. The panel structure of Claim 8 wherein said panel material is selected from the group consisting of high density polyethylene, thermoplastic polyolefin and acrylonitrile butadiene styrene.

10. The panel structure of Claim 8 defining a tonneau cover.

11. The panel structure of Claim 8 wherein material of said center layer of said core is selected from the group consisting of aluminum honeycomb, polyurethane foam, polypropylene foam, polystyrene foam and a blend of polystyrene and polyphenylene oxide foam.

12. The panel structure of Claim 8 wherein said fibers layers are woven, unidirectional or random fibers.

13. The composite structure of Claim 8 wherein said fiber layers include an epoxy or resin binder.

14. The panel structure of Claim 8 further including adhesive layers disposed between said core and said panels.

15. A method of forming a panel structure comprising the steps of,

providing upper and lower vacuum molds, at least one of said molds adapted to produce an appearance surface;

providing a first heated panel of a moldable plastic material to such lower mold and vacuum forming said first panel;

providing a preformed rigid core having a an intermediate region and first and second outer fiber layers;

applying an adhesive to such outer fiber layers;

disposing said rigid core within such formed first panel;

providing a second heated panel of a moldable plastic material to said upper mold and vacuum forming said second panel; and

disposing said upper mold adjacent said lower mold and sealing said panels together to define a peripheral seal.

16. The method of Claim 15 further including the step of trimming excess material adjacent such peripheral seal.

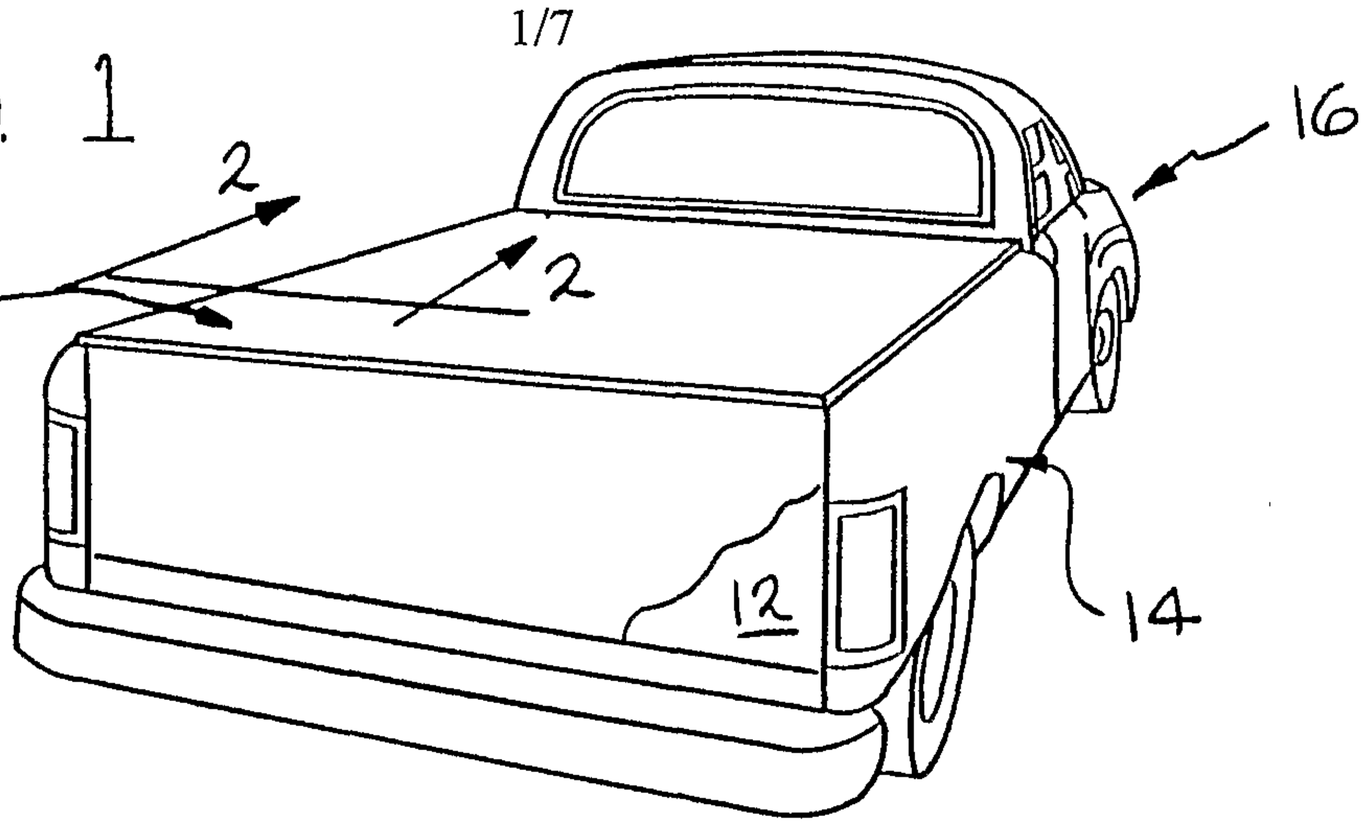
17. The method of Claim 15 wherein said adhesive is applied to said outer surface layers by spraying.

18. The method of Claim 15 wherein said panels are utilized after extrusion and before cooling.

19. The method of Claim 15 wherein said panels are thermoplastic olefin.

20. The method of Claim 15 wherein said panels are high density polyethylene.

FIG. 1



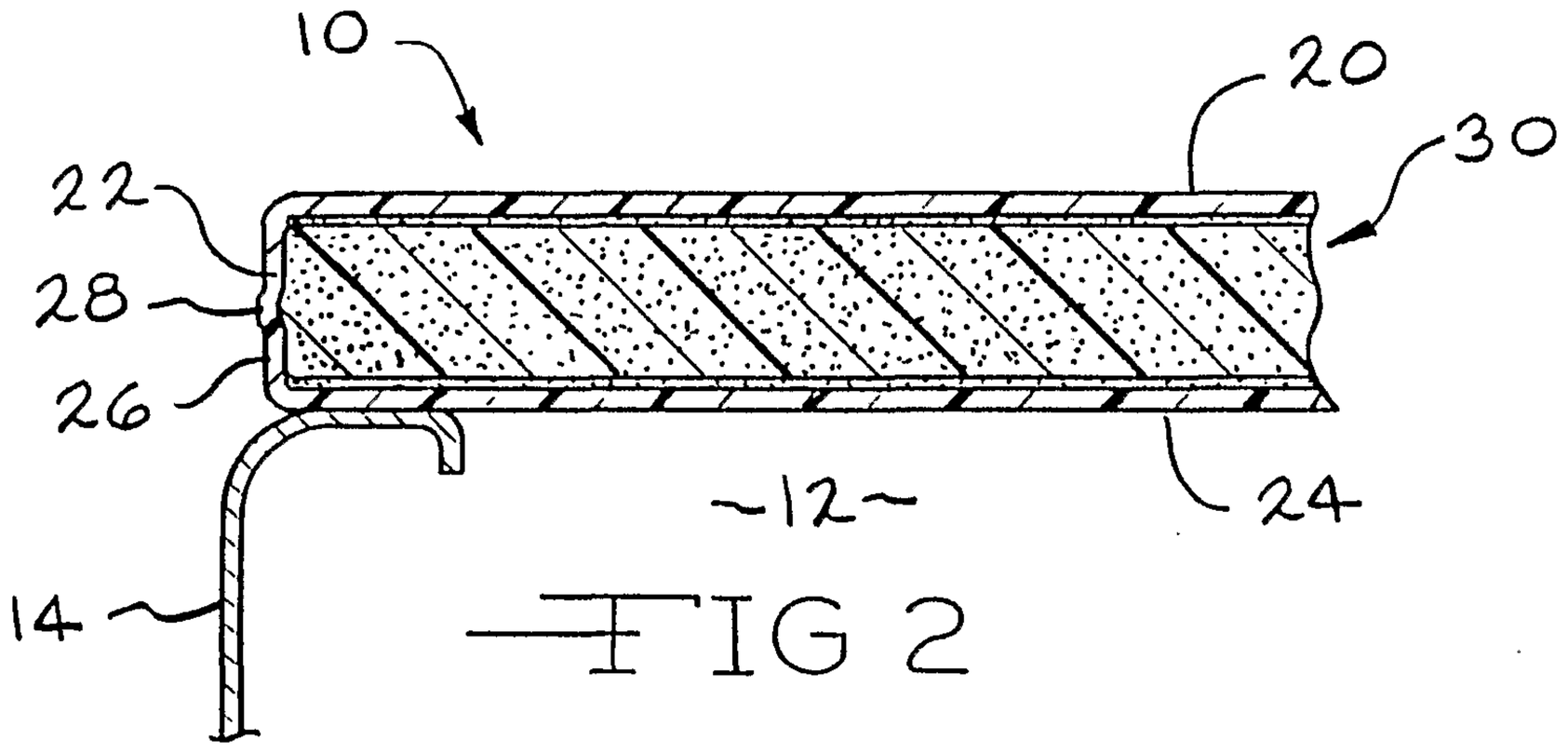


FIG 2

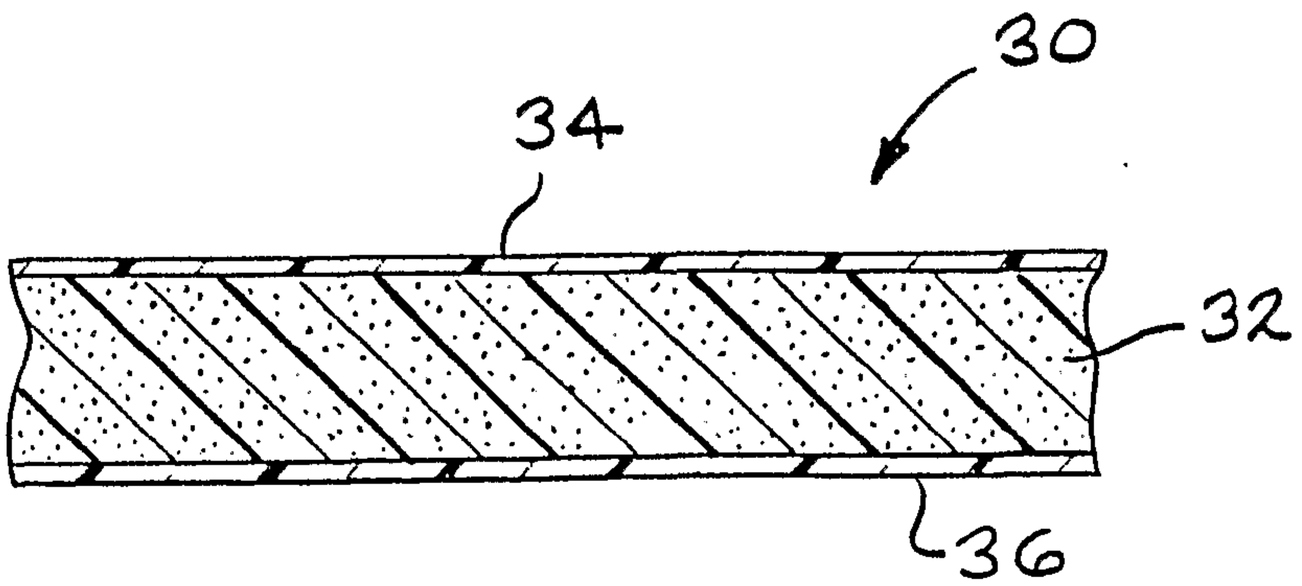


FIG. 3

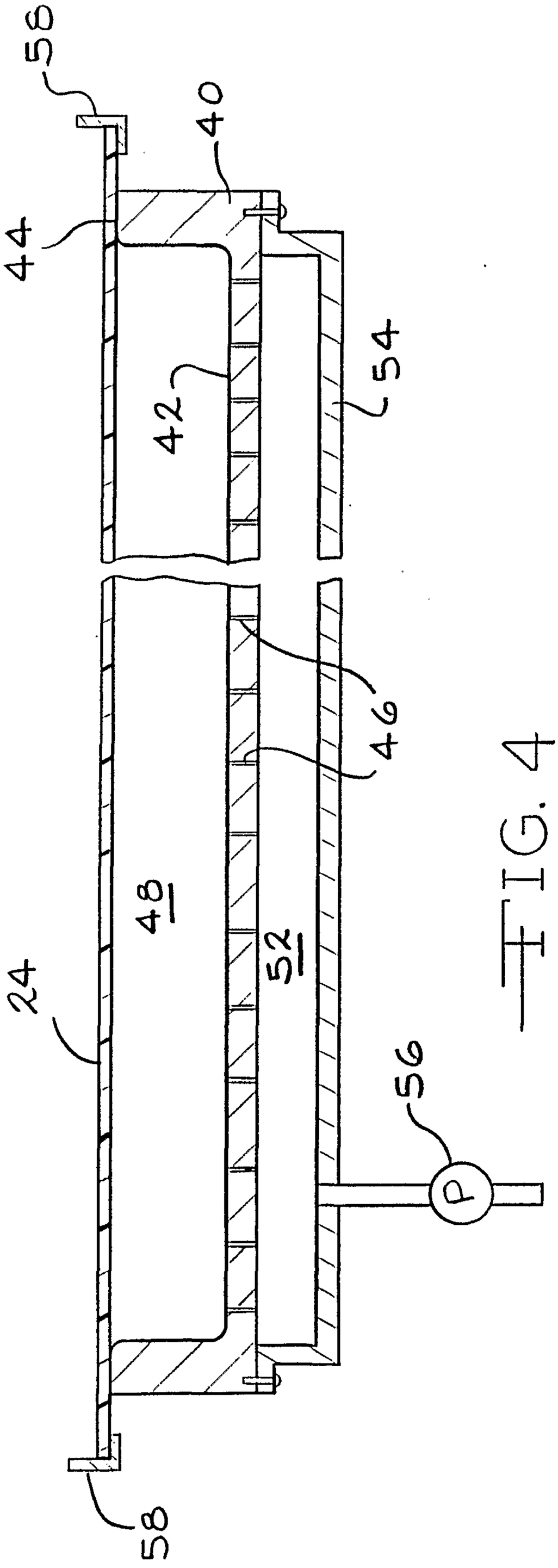


FIG. 4

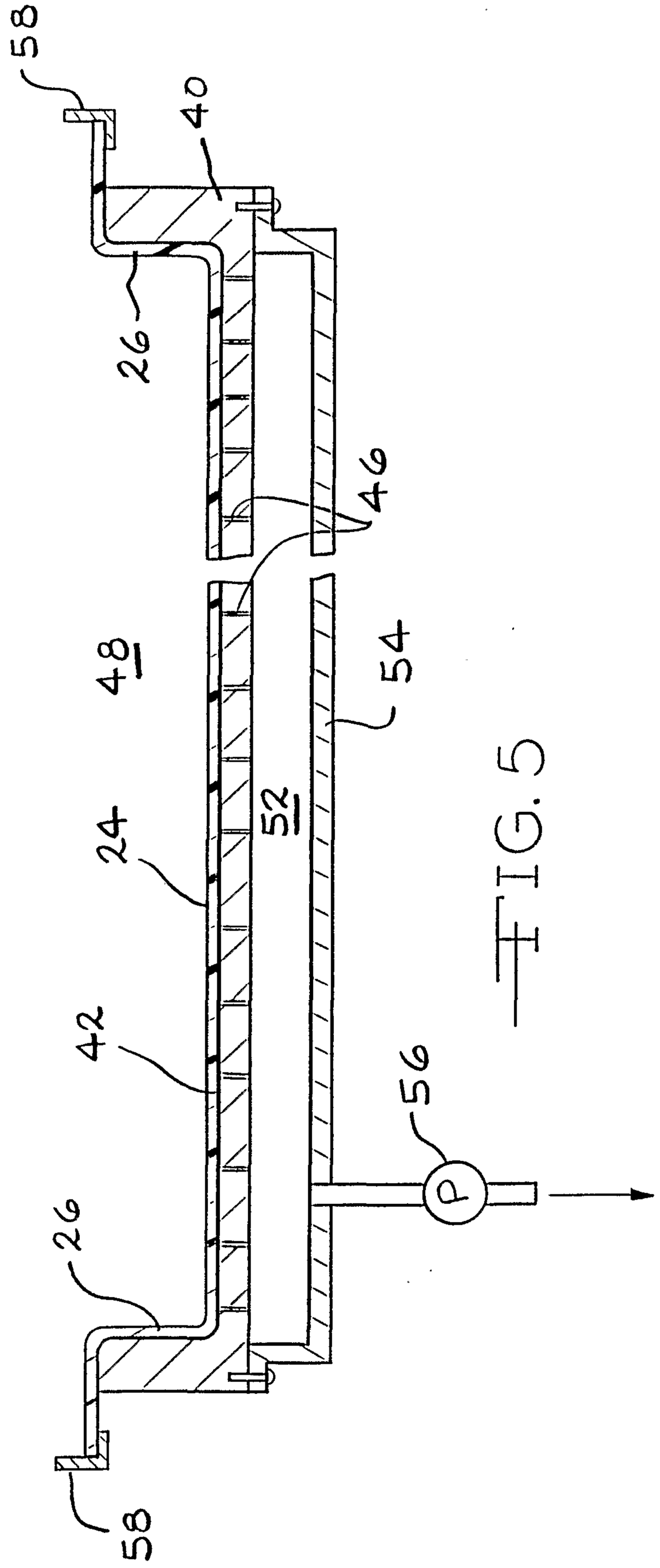


FIG. 5

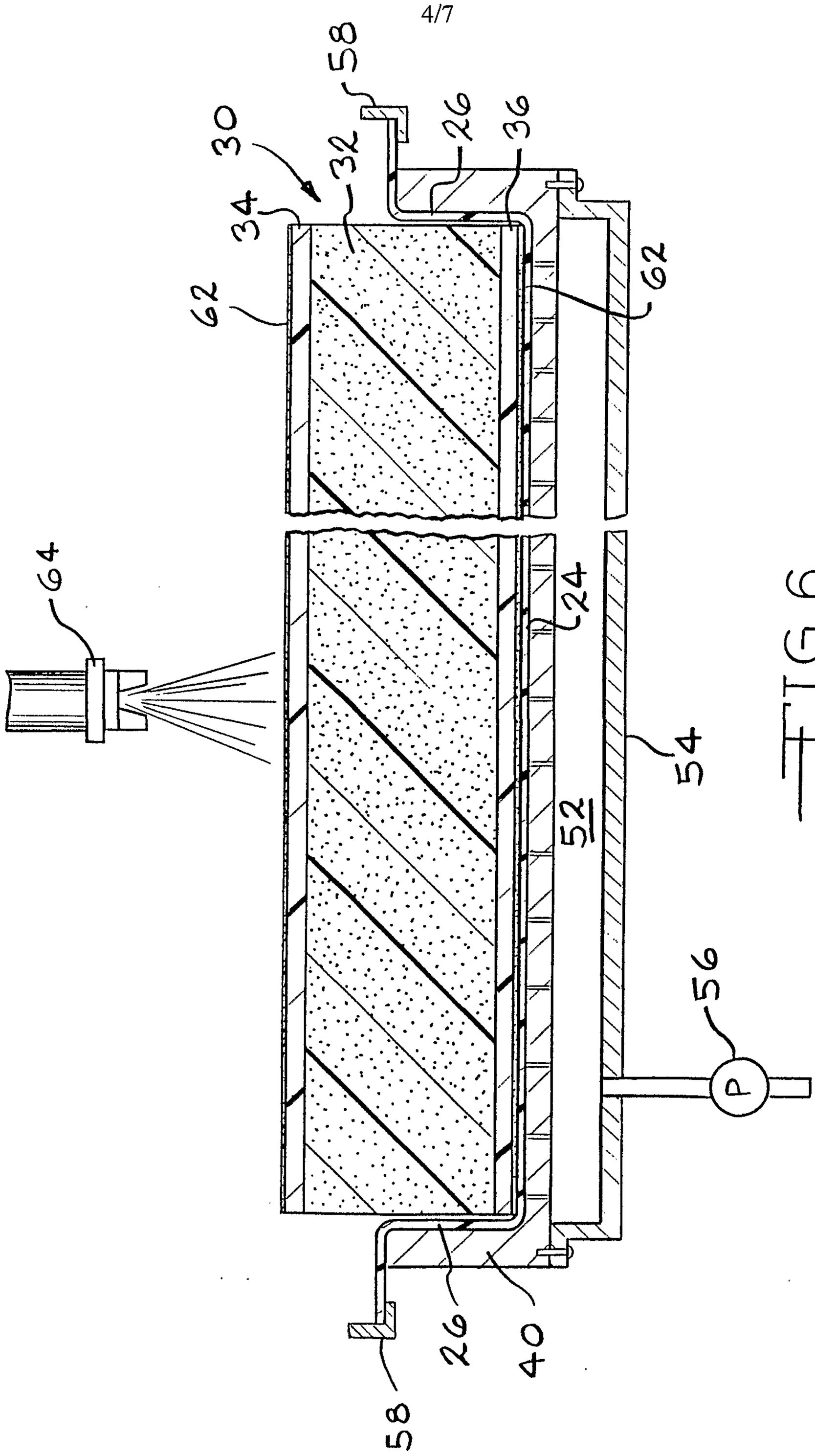


FIG 6

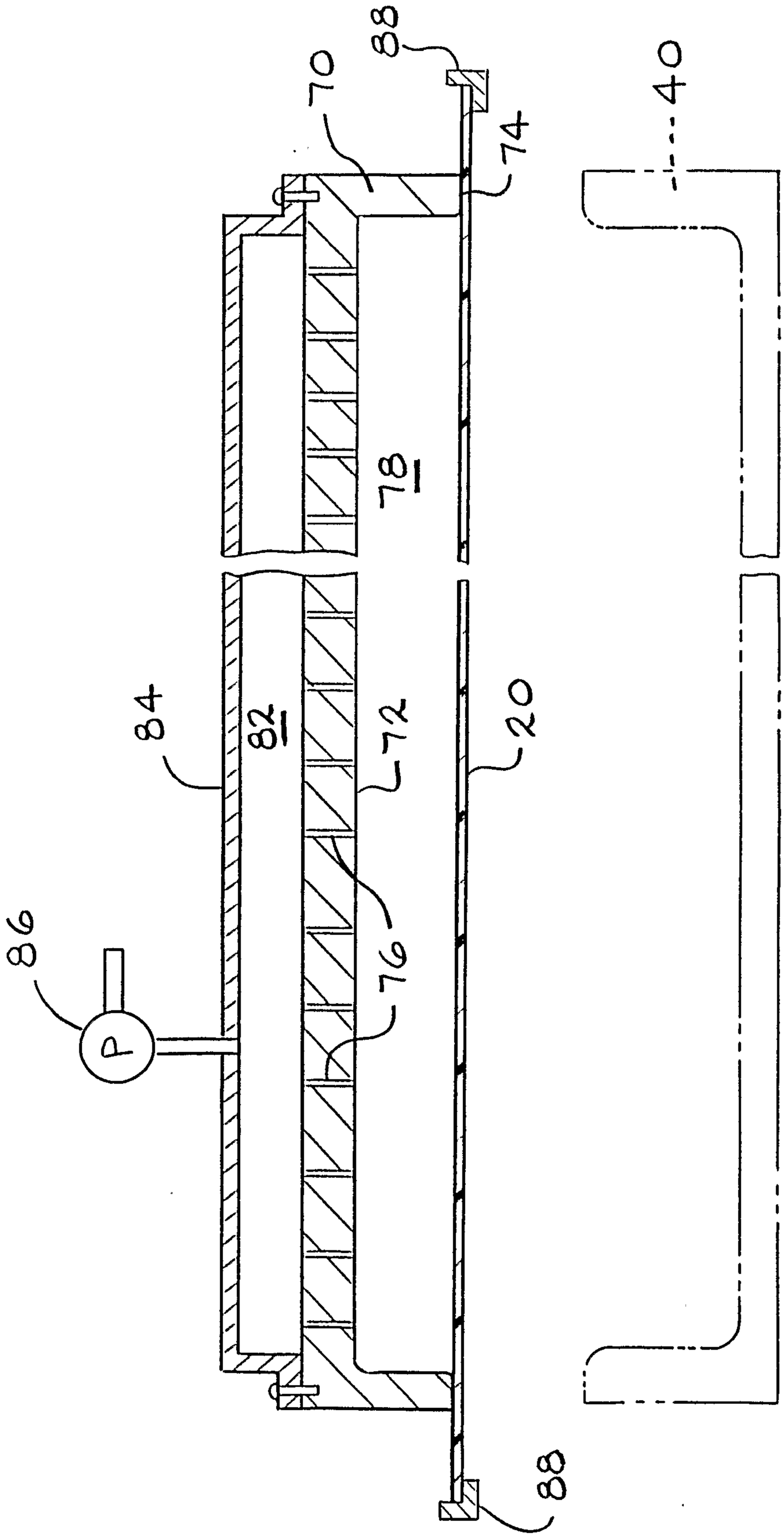


FIG. 7

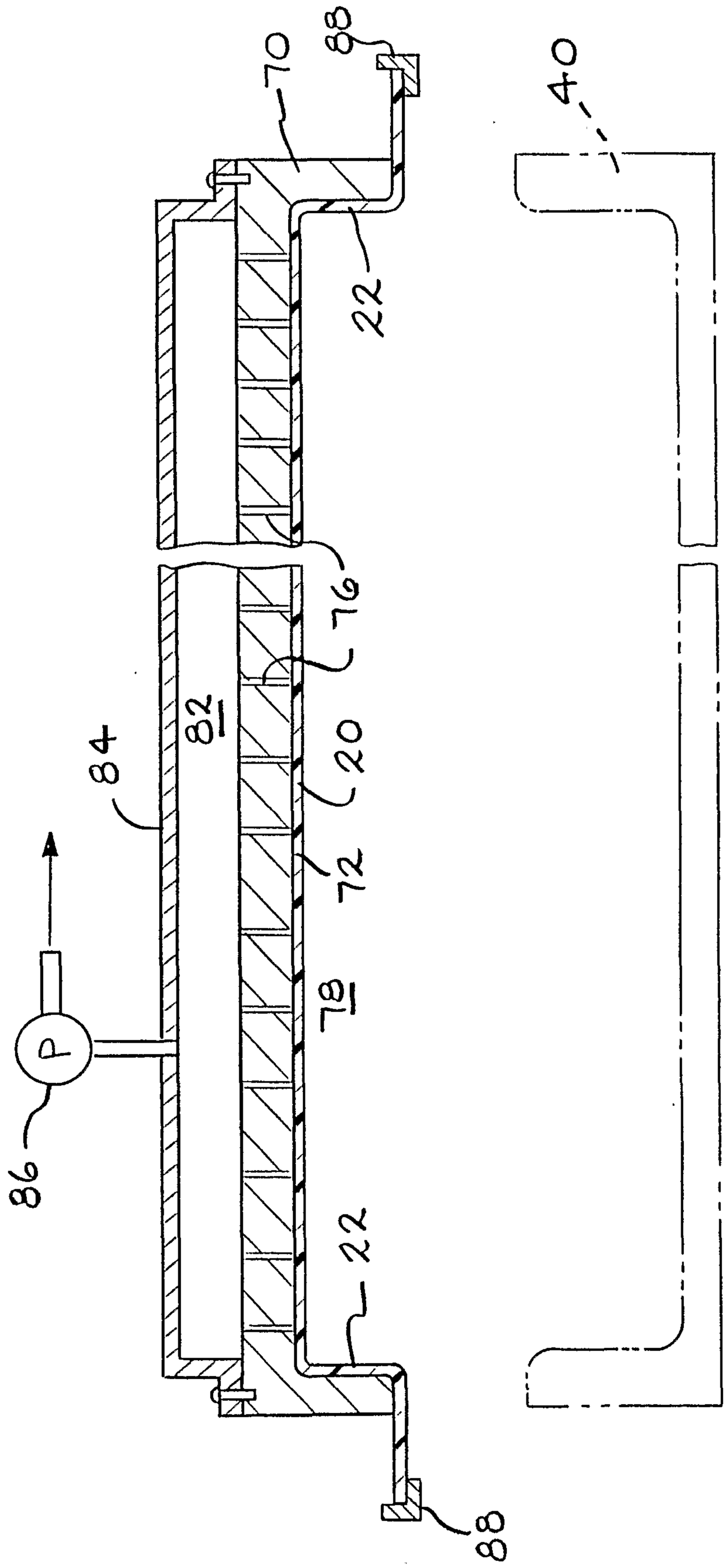


FIG. 8

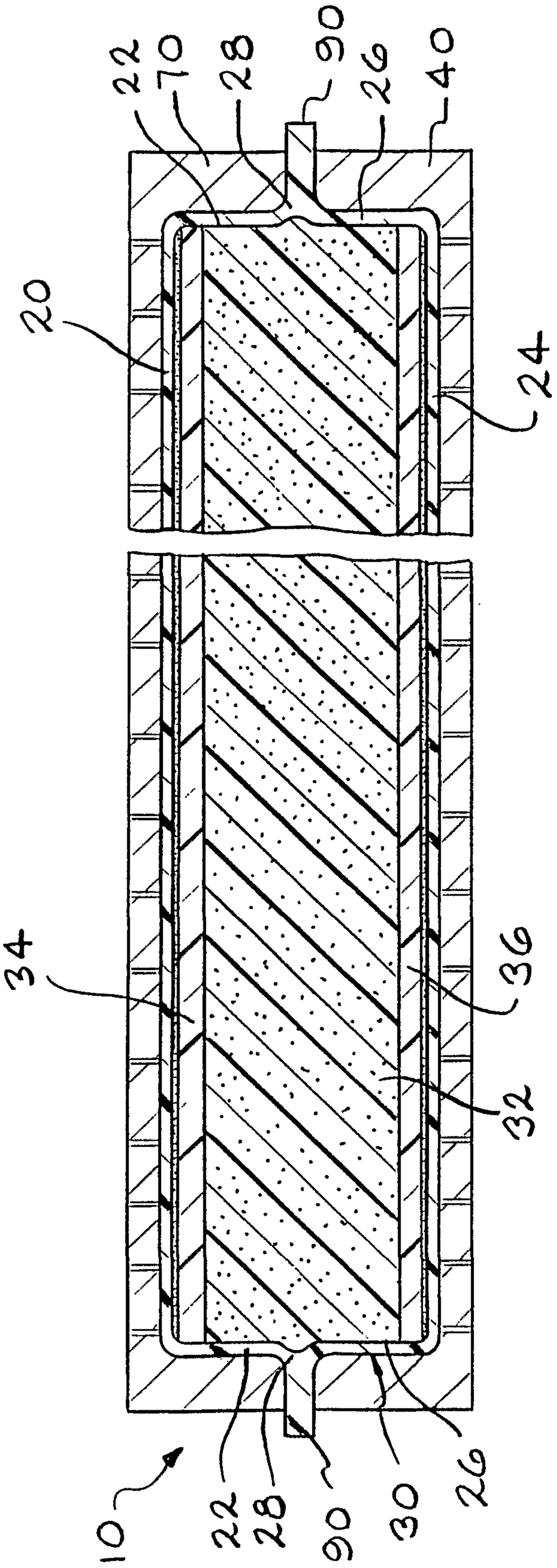
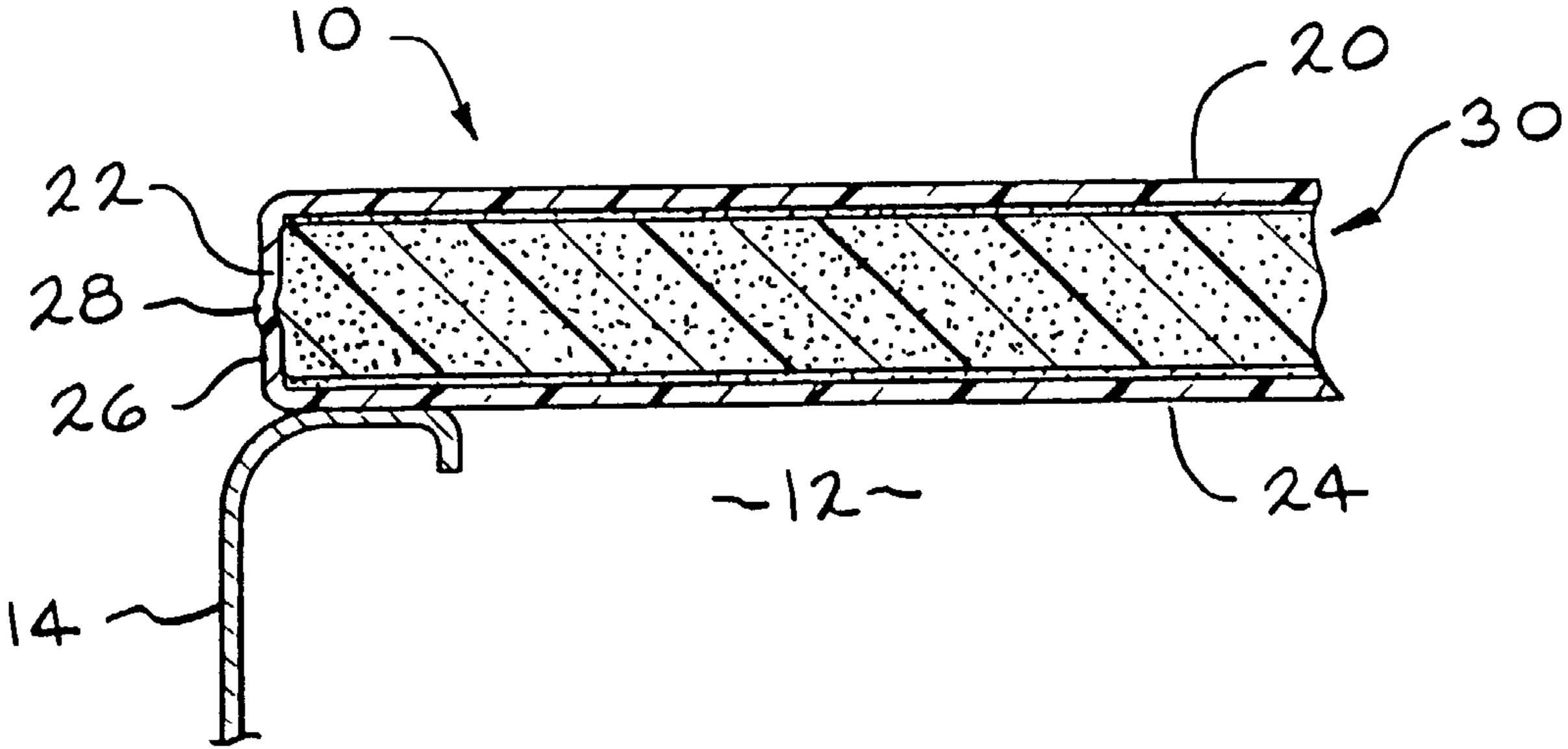


FIG. 9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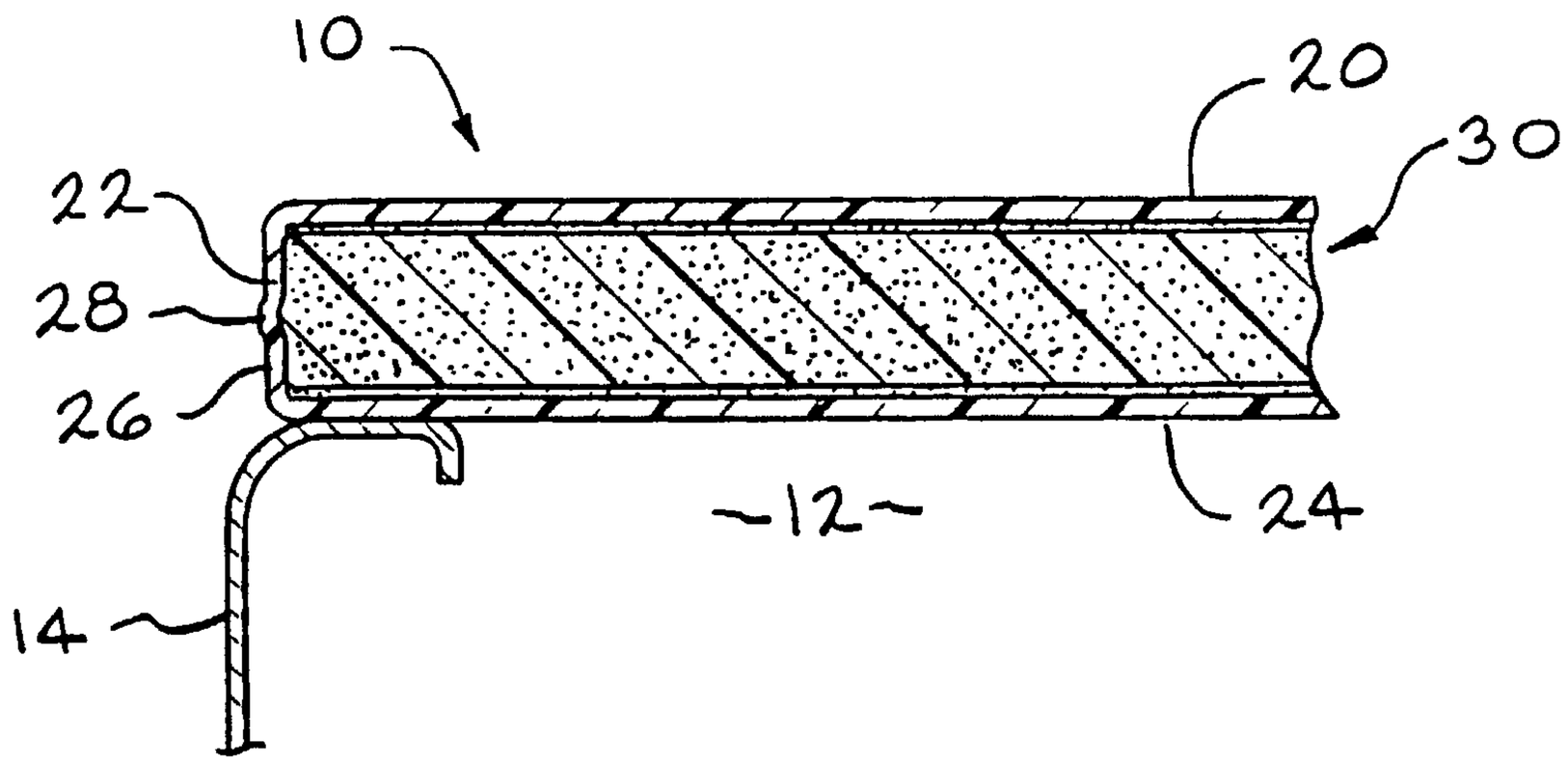
(54) Title: PANEL STRUCTURE WITH RIGID FOAM CORE



(57) Abstract: A panel structure (10) includes a rigid foam center core (30) sandwiched between two outer skin fiber layers (20,24). The core is preferably polyurethane, polypropylene, polystyrene and mixtures, as well as polyphenylne oxide and blends. The fiber layers (20,24) may be bi-directional fabric, a unidirectional material or a random weave mat which is impregnated with an epoxy or resin binder. The fibers themselves may fiberglass, polypropylene, Kevlar or carbon. The rigid foam core is thermoplastic polyolefin (TPO), high density polyethylene (HDPE) or acrylonitrile butadieme styrene which are molded into the skin layers (20,24) with peripheral lips (22,26). The lips (22,26) are compressed together and form a peripheral bead or seal (28).

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

We Claim:

1. A panel structure comprising, in combination,

a first panel having a center, planar portion and a peripheral lip, a second panel having a center, planar portion and a peripheral lip, said panels sealed about said peripheral lips and defining an interior space,

a rigid core disposed in and substantially filling said interior space, said rigid core including a center layer having opposed planar faces and first and second fiber layers secured to said opposed planar faces.

2. The panel structure of Claim 1 wherein material of said panels is selected from the group consisting of high density polyethylene, thermoplastic polyolefin and acrylonitrile butadiene styrene.

3. The panel structure of Claim 1 wherein said structure is a tonneau cover.

4. The panel structure of Claim 1 wherein material of said center layer of said rigid core is selected from the group consisting of aluminum honeycomb, polyurethane foam, polypropylene foam and polystyrene foam.

5. The panel structure of Claim 1 wherein said fiber layers are woven, unidirectional or random fibers.

6. The composite structure of Claim 1 wherein said fiber layers include an epoxy or resin binder.

7. The panel structure of Claim 1 further including adhesive layers disposed between said rigid core and said panels.

8. A panel structure comprising, in combination,

a first outer panel having a first, planar portion and a first peripheral lip,

a second outer panel having a second, planar portion and a second peripheral lip, said panels sealed about said peripheral lips and defining an interior space,

a core disposed in and substantially filling said interior space, said core including a center layer having substantially parallel, planar faces and first and second fiber layers secured to a respective one of said opposed planar faces.

9. The panel structure of Claim 8 wherein said panel material is selected from the group consisting of high density polyethylene, thermoplastic polyolefin and acrylonitrile butadiene styrene.

10. The panel structure of Claim 8 defining a tonneau cover.

11. The panel structure of Claim 8 wherein material of said center layer of said core is selected from the group consisting of aluminum honeycomb, polyurethane foam, polypropylene foam, polystyrene foam and a blend of polystyrene and polyphenylene oxide foam.

12. The panel structure of Claim 8 wherein said fibers layers are woven, unidirectional or random fibers.

13. The composite structure of Claim 8 wherein said fiber layers include an epoxy or resin binder.

14. The panel structure of Claim 8 further including adhesive layers disposed between said core and said panels.

15. A method of forming a panel structure comprising the steps of,

providing upper and lower vacuum molds;

providing a first heated panel of a moldable plastic material to such lower mold and vacuum forming said first panel;

providing a preformed core having a center region and outer fiber layers;

applying an adhesive to such outer fiber layers;

disposing said rigid core within such formed first panel;

providing a second heated panel of a moldable plastic material to said upper mold and vacuum forming said second panel; and

disposing said upper mold adjacent said lower mold and sealing said panels together to define a peripheral seal.

16. The method of Claim 15 further including the step of trimming excess material adjacent such peripheral seal.

17. The method of Claim 15 wherein said adhesive is applied to said outer surface layers by spraying.

18. The method of Claim 15 wherein said panels are utilized after extrusion and before cooling.

19. The method of Claim 15 wherein said panels are thermoplastic olefin.

20. The method of Claim 15 wherein said panels are high density polyethylene.