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(54) **PANELS FOR FLOATING COVERS, FLOATING COVERS AND METHODS FOR MAKING THEM**

PLATTE FÜR SCHWIMMENDE ABDECKUNGEN, SCHWIMMENDE ABDECKUNGEN UND HERSTELLUNGSVERFAHREN DAFÜR

PANNEAUX POUR CHAPEAUX FLOTTANTS, CHAPEAUX FLOTTANTS ET LEURS PROCEDES DE FABRICATION

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(56) References cited:
**CA-A- 966 430**
**CA-A- 2 021 130**
**GB-A- 2 042 615**
**US-A- 3 902 239**
**US-A- 3 910 452**
**US-A- 4 189 058**
**US-A- 4 202 460**
**US-A- 4 213 280**
**US-B1- 6 193 092**



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## Description

FIELD OF THE INVENTION

**[0001]** This invention relates to panels for floating covers, floating covers and methods of forming them, particularly for use in large liquid storage tanks, for example for preventing contamination to/from the content of the tanks and evaporation losses. More specifically it relates to such covers being made from pre-fabricated sandwich panels.

BACKGROUND OF THE INVENTION

**[0002]** Storage tanks are in common use at storage terminals or processing plants where huge stockpiles of liquid raw materials are necessary for their continuous operations. These storage tanks usually employ floating covers that move as the liquid levels change, and these covers provide protection against contamination to/from the external environment or weather and against evaporation losses.

**[0003]** The covers are typically made of steel or aluminium, mainly due to their ease of welding and their availability as construction materials. However, steel covers corrode relatively easily and are costly to maintain. For aluminium covers, the initial capital outlay is high but the maintenance cost is lower than that of steel. The materials of these covers or their coatings must also be compatible with the content in the tanks.

**[0004]** These tanks are usually very large and may range from a few metres to about a hundred metres in diameter. Before construction begins, a platform supported on scaffolding is erected and the cover is then formed on the platform. Due to the size of the cover, this type of construction is invariably carried on site. Owing to the nature of work, it involves welding from both sides, and this requires welders to carry out overhead welding from below the platform. However, welding creates hazardous fumes, and the working space, especially that below the platform must be properly ventilated.

**[0005]** It has also been known to make such covers from sheets of glass fibre, which overlap at their edges and which are supported on their undersides by buoyant urethane foam frames, for instance as is disclosed in published patent document GB 983,797. This too involves construction from both sides and in almost 40 years since publication has not really caught on. CA 966 430 A discloses a floating roof cover in which panels are secured together in edge-to-edge relationship including reinforcing means both above and below the adjacent panels.

SUMMARY OF THE INVENTION

**[0006]** According to one aspect of the present invention, there is provided a generally planar buoyant panel for a floating cover according to claim 1.

**[0007]** According to a second aspect of the invention, there is provided a plurality of panels, as above, wherein the first portion of each panel has an edge generally orthogonal to the plane of the panel, and the edges of the first portions of adjacent panels abut each other.

**[0008]** According to a third aspect of this invention, there is provided a buoyant cover for a liquid storage tank comprising a plurality of panels as above.

**[0009]** According to a fourth aspect of this invention, there is provided a method of joining a plurality of generally planar buoyant panels together, according to claim 28.

**[0010]** This may be used to produce a buoyant cover as above and/or may be a method of forming a floating cover.

**[0011]** According to a fifth aspect of this invention, there is provided a method of constructing a floating cover for a liquid tank from a plurality of panels, wherein the panels are securely joined together by people working on just one side of the cover.

**[0012]** According to a sixth aspect of this invention, there is provided a method of constructing a floating cover for a liquid tank from a plurality of panels, comprising the steps of:

placing said plurality of panels on a form work;
joining said panels together; and
removing said form work;

wherein the joining step prior to the removing step is accomplished solely from one side of the cover.

**[0013]** According to a seventh aspect of this invention, there is provided a method of testing the integrity of joints in a floating cover formed by a plurality of panels, as above, comprising the steps of:

providing at least one testing port in said infill portion at a boundary between said infill portion and a panel second portion;
applying a pressure differential between the testing port or one of the testing ports and the outside of the cover;
determining if there is a leak between the one testing port or said one of the testing ports and the outside of the cover; and
if there is a leak, identifying the leak.

**[0014]** Preferably, a pump delivers air or nitrogen to the test port at a predetermined pressure. A liquid, such as a soap solution, may be used for detecting leaks from any defective portion of the cover.

**[0015]** A plurality of drain holes may be provided at the lower surface of the floating cover of one or more of the above aspects.

BRIEF DESCRIPTION OF THE DRAWINGS

**[0016]** This invention will now be described by way of

non-limitative examples, with reference to the accompanying drawings, in which:-

Fig. 1 is a cross-section illustrating a typical liquid storage tank using a floating cover of the type described in this invention;

Fig. 2 illustrates cross sectional details of a sandwich panel making up the floating cover according to an embodiment of this invention;

Fig. 3 illustrates cross sectional details where two prefabricated sandwich panels join together; and

Fig. 4 is an exploded view of the component parts of Fig. 3.

Fig. 5 illustrates a portion of the floating cover with a test port for testing if the sandwich panel joints are airtight.

Fig. 6 illustrates a portion of the floating cover with another test port and a drain port.

DETAILED DESCRIPTION

**[0017]** Fig. 1 illustrates a large storage tank 10 having a cover 12 floating on liquid 14 contained in the tank. This floating cover 12 is made up of a number of prefabricated sandwich panels joined together.

**[0018]** The cover 12 includes other components for operation of the storage tank. For example, a ring flange, with a cross-sectional shape of an inverted "L" is provided around the peripheral edge of the cover. A flexible metal seal 16 is mounted on this flange to co-operate with the internal wall of the tank to keep the content of the tank beneath the cover 12 and to prevent external contaminants from entering. A plurality of vents is equally spaced along the ring flange is to allow for expansion or contraction of vapour that may be present in the tank as its temperature varies during the day. Other types of vents may also be provided, for example a vacuum breaker vent to allow the liquid in the tanks to be emptied, when the cover is resting on the tank floor and is no longer floating. This is to prevent damage to the cover caused by negative pressure when the balance of the content is pumped out.

**[0019]** Draining or sampling points are arranged in order to allow samples of the contents of a tank to be taken. Further, a gauge pole well is also provided for determining the quantity of the content in the tank.

**[0020]** Fittings, such as a wire rope 18 fixed between the roof and floor of the tank and passing through the cover prevent the cover 12 from rotating.

**[0021]** Vertically extending legs 20 are spaced apart below the cover 12 at regular intervals. These legs are provided to support the cover 12 when the scaffolding has been removed after the cover is completed and before the tank 10 is filled with sufficient liquid for the cover 12 to float. The legs 20 also provide headroom below the cover 12 for maintenance purposes. A hatch-cover complete with seals over a man-hole is also provided for maintenance purposes.

**[0022]** These provisions for the operation of the tank, such as the vents, sampling and drain points, anti-rotation fittings, legs or man-hole hatch cover, etc mean that some of the panels have apertures or flanges to allow them to be fitted, or are formed with various components already installed.

**[0023]** A roof 22 covers the whole tank 10.

**[0024]** A prefabricated sandwich panel 30, used to make up the floating cover 12, is shown in cross-section in Fig. 2. Because each panel is very much thinner than it is long or wide, the relative depth and width is distorted in Fig. 2 and other figures. Likewise, there is a distortion in the relative thicknesses of the different layers.

**[0025]** Each panel 30 has a lower glass-fibre reinforced composite layered portion 32, an upper glass-fibre reinforced composite layered portion 34 and a honeycomb section (portion) 36, to provide buoyancy, sandwiched between the lower and upper layered portions 32,34. Each portion is preferably continuous, in that there are no holes or gaps all the way through them. The panels are joined together, with the lower layered portions 32, edge 38 to edge 38, to form the entire floating cover 12.

**[0026]** Both the lower layered portion 32 and the upper layered portion 34 are themselves composite, laminar structures of several layers, each of which contains a liquid polymerise resin such as an epoxy resin, for instance epoxy vinyl ester resin, and glass fibres. The glass fibres are orientated in different patterns or directions, at least relative to immediately adjacent layers to provide each panel with required strength and other desired mechanical properties.

**[0027]** In general composition, in this exemplary embodiment, the lower and upper layered portions 32,34 are mirror images of each other, although extending different amounts in the plane of each panel 30.

**[0028]** In the lower layered portion 32, the lowermost (outer) layer 42, is a V-layer. Above the V-layer 42 is a first mat or M-layer 44. An R-layer 46 is disposed above the first M-layer 44. A second M-layer 48, of a similar composition to the first M-layer 44 is provided on top of R-layer 46. This is the topmost layer of the lower layered portion 32 and is adjacent the underside of the honeycomb section 36.

**[0029]** The upper layered portion 34 is the inverse of the lower layered portion 32, with a V-layer 52 uppermost, above a first M-layer 54, above a R-layer 56 above a second M-layer 58, which is adjacent the topside of the honeycomb section 36. The V-layer 52, first M-layer 54, R-layer 56 and second M-layer 58 of the upper layered portion 34 have the same general composition as their corresponding layers in the lower layered portion 32.

**[0030]** The V-layers (surface veil layers) 42, 52 have a surfacing veil glass fibre mat of C glass reinforcements and have carbon (and colour pigments if desired) and

enhance the surface finish as well as providing weather protection and corrosion resistant properties. Typically they are about 90 - 95% by weight of resin and about 0.5 - 0.6 mm thick. Different V-layers within the same panel can be of differing construction.

**[0031]** The M-layers (mat layers) 44, 48, 54, 58 have a chopped strand mat of glass fibres that are of certain lengths but are randomly orientated. Typically they are about 60 - 70% by weight of resin and about 1.1 - 1.2 mm thick. The M-layers absorb relatively more resin and give relatively higher resistance to corrosion to the composite layered portions 32, 34. Different M-layers within the same panel can be of differing construction.

**[0032]** The R-layers (woven roving layers) 46, 56 have a woven roving mat of glass reinforcements that are woven in two perpendicular directions. Typically they are about 40 - 50% by weight of resin and about 1.1 - 1.2 mm thick. Due to the orientations of the reinforcement, the R-layers provide mechanical strength in two directions. The lower resin absorption of these layers increases the glass to resin ratio with consequent increased mechanical strength. Different R-layers within the same panel can be of differing construction.

**[0033]** The honeycomb layer 36 is made of a polypropylene core, with two membranes on each side. An inner membrane permanently attaches to the core and acts as a seal to prevent resin penetration into the cells of the core. An outer membrane of a nonwoven thermoplastic mat is porous and allows the resin of the composite layered portions (when wet) to penetrate and bond to the membrane's surface. The resulting bond contributes to the overall structural integrity of each panel 30.

**[0034]** This honeycomb layer 36 and its core may be substituted with other types of lightweight core materials as desired or appropriate.

**[0035]** The panels 30 are prefabricated at a factory. Each panel is typically 2.2 m square, this size being selected on a weight of about 70-80 kg per panel and general cumbersomeness. Each panel is not too heavy or large for a group of four to manhandle. As most storage tanks are cylindrical, a cover for such a tank would also be circular. This means that not all panels will be square, but some will have a rounded edge according to the overall radius of the tank.

**[0036]** Generally the composite is made in a large continuous and uniform sheet which is cut into appropriately sized panels 30. Portions of each panel are then removed around its edges to give it a stepped form, as is shown in Fig. 2. In particular, the upper layered portion 34 and honeycomb section 36 are removed from a strip around every edge, in this example the strip is 0.1m wide. Thus the lower layered portion 32 extends 0.1m beyond the upper layered portion 34 and honeycomb section 36 in an exposed portion 50 in each direction in the plane of the panel 30. Further, the top V-layer 52 is stripped back a bit further at its edges, leaving an exposed strip 40 of the top first M-layer 54. Again this strip is 0.1m wide in this example.

**[0037]** Of course the panels do not have to be formed in this way, the stepped form can be achieved in the original fabrication stage or in other ways.

**[0038]** Before installation of the cover 12, form work scaffolding is erected and a platform is provided so that the panels 30 making up the entire cover 12 can be laid out with contiguous contact between the edges of the lower layered portions 32. In the spaces above the extended edges of the lower layered portions 32, the upper, horizontal surfaces are roughened with sandpaper, emery cloth or similar abrasive (for example having a grade size of about 30), if this has not been already been done. The resulting dust is removed by vacuum cleaning, otherwise the residue may cause weak bonding and joint failure.

**[0039]** A joint between adjacent panels 30 is shown in Fig. 3. An exploded view of this is shown in Fig. 4.

**[0040]** The resin used in the V-layer is then applied to the extended facing edges 38 of the lower layered portions 32. However, rather than just filling in the gap between adjacent honeycomb structures 36 with more honeycomb, a reinforcing structure is mounted over the joints between adjacent panels 30. In particular, the gap is filled with what amounts to a narrower inverted panel with the top V-layer 52 completely removed. That is there is a reinforcing infill composite 60, having a first M-layer 62 in contact with the abutting second M-layers 48 of two abutting lower layer portions 32. Above this is a first R-layer 64, then a second M-layer 66. Atop this is a honeycomb structure 68, on top of which is a third M-layer 70, then a second R-layer 72, then a fourth M-layer 74 and finally a topmost V-layer 76.

**[0041]** Whilst it is possible to prefabricate the infill composite 60 in panels, for improved strength it is preferred that they be made in situ. In particular, a catalysed resin is applied to the exposed and roughened surfaces 50 of the second M-layers 48 and the infill composite is applied one layer at a time, either with each layer prefabricated or more preferably each layer made in situ, with some of the resin seeping down between the abutting edges 50 of the panels to help join them together. After each layer is laid down, it is compacted and air bubbles that may be present are rolled out, for example using metal rollers.

**[0042]** Before the resin bonding the infill second M-layer 66 to the infill first R-layer 64 in this lower structural infill portion 78 has hardened or cured, a catalysed resin is applied to the underside of the infill honeycomb structure 68 and this is applied to the top of the infill second M-layer 66. It is held down by weights until it has completely cured. An infill top structural infill portion 80, with the remaining layers, is then applied to the top of the infill honeycomb structure 68. Again this is done on a layer by layer basis, compressing the layers and rolling out the air bubbles each time. This completes the joint. Once all the cover joints have been completed, the top surface can be finished off with any required top coat.

**[0043]** The creation of the infill composite 60 reflects the creation of the initial composite from which the panels

are formed. Thus if there are additional or fewer processes in creating that, they could be reflected in the creation of the infill. This means that the infill has similar properties to the panels. Additionally it means that the heights of various layers of the infill correspond to heights of other layers in the panels. In particular, the top of the infill honeycomb structure 68 is level with the top of the exposed top first M-layer 54 and the infill third M-layer 70 is level with the top V-layer 52.

**[0044]** Further, the top infill structural portion 80, that is the third M-layer 70, second R-layer 72, fourth M-layer 74 and topmost V-layer 76, extend further outwards relative to the rest of the infill structure 60. It is about 0.4m wide, whilst the infill honeycomb structure 68 and lower structural infill portion are about 0.2m, or a little less wide (to allow resin between the panels 30 and the infill composite 60. This means that the top infill structural portion 80 extends as far as the exposed top first M-layer 54, the infill third M-layer 70 bonding to the top exposed surface 40 of the top first M-layer 54. The top V-layer 76 may also be extended down the exposed sides of the top structural infill portion 80, to join up with the top V-layers 52 of the panels being joined, to complete the outer protective layer.

**[0045]** After completion of the cover, the form work is removed from the underside and exposed edges on the underside are sealed and laminated with a further V-layer. This is to improve corrosion resistance, rather than being necessary for strength.

**[0046]** The construction of the cover 12 from separate panels 30 by this method can be carried out from just one side, the top side, although the preferred finishing step after completion is carried out below. This is partly due to the fact that the panels are connected edge to edge, with vertical edges next to each other and without overlap. This means that people do not have to work in cramped and badly ventilated conditions underneath, thereby improving safety. Breathing equipment is therefore not necessary, or does not need to be used so much and there are improvements in work conditions and costs.

**[0047]** With this method of construction, the prefabricated panels are joined together to form an entire cover having similar structural layers. This method provides a cover that is mainly prefabricated at the factory and minimal work is carried out on site. As the working conditions and quality at the factory is easily controlled, this means that the structural integrity of the cover thus formed is relatively superior to that if .formed on site. With this method, the entire job for completing a cover is also shorter, which means cost savings.

**[0048]** The lower and upper layered portions 32,34 are formed layer by layer in the factory to suit each application. The resins binding the fibres in each layer may also differ from the adjacent layers, and together with the glass-fibres, each layer provides the composite plate unique mechanical properties. The composition and number of layers of panels can vary from job to job, within the scope of the invention.

**[0049]** In this example, each lower and upper layered portion 32,34 is 4 mm thick and the honeycomb layer is 60 mm thick. Depending on the size of the cover, the core thickness, the spacing between the supporting legs, the self-weight of the cover, the strength of the resin and glass fibres, the rigidity of the cover, the composite plate thickness or the number of laminates may vary, all relative to each other. Similarly, the honeycomb thickness or number of honeycomb layer may be increased for greater strength or rigidity. Yet it is also possible to maintain a common composite thickness and strength by providing more supporting legs at the lower side of the cover.

**[0050]** The exposed portions in the described embodiment are 0.1m wide. The invention covers other possibilities as required. For example, they could range from 0.05 to 0.2m or to other widths. The extension of the lower layered portion 32 relative to the upper layered portion 34 and core 36, and the overlap of the top infill structural portion 80 need not be 0.1m but could be different from each other and can be varied as desired, for instance depending on the type of resin used and the shear forces induced at these joints, etc. Moreover, the steps do not need to have vertical faces, but can be sloped.

**[0051]** The materials chosen for the cover need to be compatible with the liquid in the tank.

**[0052]** The completed floating cover 12 may need to be inspected and tested to verify that the floating cover 12 formed according to the specification of work meets the industry or regulatory standards during and after commissioning. To allow testing that the bonding of the layers of the fibreglass and resin and joints are integral, testing ports 90 may be provided at the infill composite section 60 near the cut edges of the honeycomb 36, 68 as shown in Fig. 5.

**[0053]** The infill honeycomb sections 68 are generally slightly smaller than the space between two adjacent honeycomb sections 36. This is to allow for dimensional tolerances in the fabrication of the panels 30 and honeycomb sections 68. As a result there is a gap 92 in between the cut edges of the honeycomb sections 36, 68, and this gap 92 runs along the fabricated joints between the panels 30. In an integrally constructed floating cover 12, the gap 92 is sealed by the lower composite layers 32, 78, upper composite layers 34, 80 and honeycomb sections 36, 68.

**[0054]** To provide a testing port 90, a hole 94 is drilled through the upper composite layer 80 to the cut edge of the honeycomb 68. Epoxy resin such as that mixed with the catalyst used in fabricating the panels 30 is applied onto the walls of the hole 94. A sleeve 96, preselected to suit the hole 94, is inserted into the hole 94, and the gap, if any, between the hole 94 and the sleeve 96 is further filled with epoxy and catalyst so that there is no void between the hole 94 and the sleeve 96. The bonding between the composite layer 80 and the sleeve 96 can thereby be as strong as the composite layer 80 itself.

**[0055]** The sleeve 96 has a through hole with an internal thread. In the process of inserting the sleeve 96 in the hole 94, precautions are taken not to allow the epoxy to block the internal hole of the sleeve 96. The upper end of the sleeve 96 may be temporary closed with a plug 98 (which may extend all the way to the bottom of the sleeve 96).

**[0056]** A number of test ports 90, for example, are provided at spaced apart positions. One such port 90 should normally be sufficient, as the gaps 92 are all joined together. However, more than one is provided to give the tester a choice of testing positions or in case some groups of the gaps are isolated. After the sleeves 96 are bonded to the composite layer 80, all the test ports except one are plugged. A nipple 100 is attached to the test port 90 which is not plugged. The nipple 100 is screwed into the internal thread of the sleeve 96 so as to form an airtight joint. A first end of a T-joint 102 is connected to the other end of the nipple 100. The other two distal ends of the T-joint 102 are connected to a pressure gauge 104 and a shutoff valve 106. The shutoff valve 106 has a thread that is suitable for connection to a line from a pump 200.

**[0057]** During commissioning of the cover 12, the pump 200 is operated to deliver a gas, for example air or nitrogen, to the enclosed space created by the gap 92 between the panels 30 in the floating cover 12. The gas is delivered with a positive pressure, for example 0.005 bar gauge (or 50 mm water head), and the shutoff valve 106 is closed once a predetermined pressure is attained. The pressure in the enclosed space in the floating cover 12 is monitored over a period of time, for example 24 hours. If this pressure is maintained over this time period, the joints formed in the panel are airtight. If the pressure is not maintained, one or more joints is not airtight. The actual leaking joints may be detected by applying a liquid such as a soap solution to a portion of the floating cover and observing air bubbles from a defective portion of the cover 12. The defective portion of the cover can then be identified, repaired and tested again to ensure that the joints formed in the floating cover 12 are not defective.

**[0058]** To test for leaks in the joints, a vacuum pressure may be used instead of a positive pressure. Accordingly, the pressure gauge must be suitable for vacuum sensing. However, to identify the defective portion of the cover with ease, a positive pressure and a liquid such as a soap solution are used.

**[0059]** When the floating cover 12 is put into use, these testing ports 90 are plugged up to prevent entry of vapour or liquid into the cover.

**[0060]** Although the hole 94 is smooth in the above embodiment, alternatively, the hole 94 may be threaded to fit an externally threaded sleeve.

**[0061]** Another alternative is to locate the sleeve 96 in the infill composite section 60 as the infill composite section 60 is made.

**[0062]** A further alternative for the test ports is to provide the sleeve 96 with a flange 300 having an internal hole through which the sleeve 96 is positioned and to which the sleeve 96 is welded, to form a test port 91 as shown in Fig. 6.

**[0063]** The flange 300 and sleeve 96 may both be made of metal, for example, steel or aluminium. The flange 300 is toroidal, for example with an outside diameter of about 70 mm and a thickness from about 3 mm to about 5 mm. Other shapes of the flange 300 are also suitable, although preferably they can fit an inscribed circle within them, for example of at least 70 mm diameter. The sleeve 96 has an internal thread and an internal bore of 12-mm, for example, nominal diameter. In the preferred embodiment, the internal pressure is to be 0.005 bar gauge. Thus the external diameter of the sleeve may, for instance, be 25 mm. The diameter of the flange through hole matches the external diameter of the sleeve 96. Thus if a different pressure rating were required, the external diameter of the sleeve 96 might change, and so would the size of the flange through hole. The sizes of the sleeve 96 and flange 300 are not limited by these examples, and the sizes of the sleeve 96 and flange 300 are merely design choices.

**[0064]** The sleeve 96 and flange 300, which are prejoined together, are inserted during the formation of the infill composite portion 60. After the structural layers 70,72,74 of the infill composite portion 60 are formed, the hole 94 is drilled. Catalysed epoxy is applied to the walls of the hole 94 and the sleeve 96 is inserted such that there is no void between the hole 94 and sleeve 96, as done in the previous embodiment. Catalysed epoxy is also applied to the upper, lower and edge surfaces of the flange 300. With the test port 91 fully inserted, i.e. with the sleeve 96 portion pushed all the way down into the hole 94 until the flange 300 is in contact with the top M-layer 74, another set of structural fibreglass layers 70,72,74 is formed over and around the flange 300 to secure the test port 91 to the floating cover 12, and also to strengthen the structural layers of the cover 12 around the test port 91. Once all the structural work is completed, the V-layer 76 is formed over the exposed layers of the infill portion 60 to complete the finishing and protective layer 76.

**[0065]** In this embodiment as shown in Fig. 6, a plurality of drain ports 191 are provided on the lower side of the floating cover 12. These drain ports 191 are provided so that any liquid that has entered the cover 12, such as the liquid from the storage tank 10 (which entered during maintenance or repair of the floating cover 12 or otherwise) or rain water collected on the uncompleted floating cover 12 during its fabrication, can be drained out. Each drain port 191 is fabricated in the same manner as a test port 91, i.e. having a flange 302 welded to a sleeve 97.

**[0066]** After the floating cover 12 is formed and the supporting formwork is removed, a plurality of positions directly below the gap 92 are marked on the lower surface of the cover 12. These positions are spaced apart as desired. At each position, a hole 95 is drilled through the structural layers 42,44,46,48 of the cover 12. The V-layer 42 in the area around each hole 95 is removed, if not

previously done, over an area extending beyond the size and shape of the flange 302. The flange 302 is positioned on the sleeve 97 and they are prejoined together, such that when of the sleeve 99 is inserted into the hole 95 until the flange 302 is in contact with the exposed area of the outer M-layer 44 and the upper end of the sleeve 97 is about flush with the inner M-layer 48. Catalysed epoxy is applied onto the exposed area of the outer M-layer 44, onto the surfaces of the hole 95 and also on the upper, lower and edge surfaces of the flange 302. The sleeve 97 is then inserted into the hole 95 until the flange 302 is in contact with the exposed layer 44. Each drain port is mounted and secured onto the cover 12 by forming a set of structural layers of fibreglass 70,72,74 over and around the flange 300 of the drain port 191 similar to layers 70,72,74 over and around the test port 91. Once the structural work is completed, a V-layer similar to layer 42 is formed over the exposed surfaces of the newly laid structural layers 70,72,74 and the exposed area of layer 44 to complete the finishing and protective coat on the lower surface of the floating cover.

**[0067]** Of course, although this embodiment shows test ports 91 and drain ports 191 together, other embodiments may have one or more test ports 91 without any drain ports 191 and yet further embodiments may have one or more drain ports 191 without any test ports 91.

**[0068]** Further variations include providing a cover having a slight camber and/or rainwater drainage, which is particularly suitable for a tank without a roof. The cover need not be round and it may be square, rectangular, or of any shape for fitting into any storage tank or reservoir to function as a cover. Instead of forming the in-fill sandwich sections on site, these could be prefabricated at the factory.

**[0069]** While only one embodiment of a cover and method of its construction have been described and illustrated in detail, it is to be understood that many changes, modifications and variations could be made to the present invention without departing from the scope of the invention, as defined by the following claims.

## Claims

1. A generally planar buoyant panel (30) for a floating cover (12) for a liquid storage tank (10), the panel comprising first (32) and second portions (36) in contact with each other, **characterized in that**:

   the first portion (32) has an extent in the plane of the panel and a first side facing the second portion;
   the second portion (36) has an extent in the plane of the panel, which extent is less than the extent of the first portion; and
   the first portion (32) has on said first side an exposed portion (50) in each direction in the plane of the panel (30).

2. The panel according to claim 1, wherein the second portion (36) has an edge and the exposed portion (50) extends all the way around the edge of the second portion (36).

3. The panel according to claim 1 or 2, wherein the first portion (32) is a laminate structure.

4. The panel according to any one of the preceding claims, wherein the first portion (32) is a glass reinforced structure.

5. The panel according to any one of the preceding claims, wherein the second portion (36) is buoyant.

6. The panel according to any one of the preceding claims, for use with the second portion (36) being above the first portion (32).

7. The panel according to any one of the preceding claims, wherein the first and second portions (32), (36) are continuous.

8. The panel according to any one of the preceding claims, further comprising a third portion (34) in contact with the second portion (36) on the other side of the second portion (36) from the first portion (32).

9. The panel according to claim 8, wherein the third portion (34) has a first side facing the second portion (36) and an extent in the plane of the panel, which extent is the same as or less than that of the second portion (36).

10. The panel according to claim 8 or 9, wherein the third portion (34) has a laminate structure.

11. The panel according to claim 10, wherein the layers (52, 54, 56, 58) of the third portion (34) each have an extent in the plane of the panel and the extent of the layer (52) of the third portion (34) furthermost away from the second portion (36) is less than the extent of the layer (58) of the third portion (34) nearest the second portion (36).

12. The panel according to any one of claims 8 to 11, wherein the third portion (34) is a glass reinforced structure.

13. The panel according to any one of claims 8 to 12, wherein the third portion (34) has the same construction as the first portion.

14. The panel according to any one of the preceding claims, wherein the panel is generally a parallelepiped in the plane of the panel.

15. A plurality of panels, each as defined in any one of

the preceding claims, wherein the first portion (32) of each panel has an edge (38) generally orthogonal to the plane of the panel, and the edges (38) of the first portions (32) of adjacent panels abut each other.

**16.** The plurality of panels according to claim 15, further comprising a plurality of infill portions (60), each infill portion (60) extending in contact with the exposed portions (50) of two adjacent and abutting panels.

**17.** The plurality of panels according to claim 16, wherein each infill portion (60) comprises an infill first portion (78), an infill second portion (68) and an infill third portion (80), the infill second portion (68) is sandwiched between the infill first portion (78) and the infill third portion (80), and the infill second portion (68) has the same construction as a panel second portion (36).

**18.** The plurality of panels according to claim 17, wherein each infill third portion (80) has the same construction as a panel first portion (32), inverted.

**19.** The plurality of panels according to claim 17 or 18, wherein in each infill portion (60):

the infill third portion (80) has an extent in the plane of the panels between which the infill portion (60) extends and a first side facing the infill second portion (68);
the infill second portion (68) has an extent in the plane of the panels between which the infill portion (60) extends, which extent is less than the extent of the infill third portion (80); and
the extent of the infill third portion (80) not covered by the infill second portion (68) extends onto and in contact with outer surfaces (40) of the panels between which the infill portion (60) extends.

**20.** The plurality of panels according to claim 19 when dependent on at least claim 8, wherein the extent of the infill third portion (80) not covered by the infill second portion (68) extends onto and in contact with outer surfaces (40) of the panel third portions (34) of the panels between which the infill portion (60) extends.

**21.** The plurality of panels according to claim 20 when dependent on at least claim 11, wherein the extent of the infill third portion (80) not covered by the infill second portion (68) is in contact with layers (54, 56, 58) of the panel third portions (34) between which the infill portion (60) extends, other than the layer (52) of each of those panels furthermost away from the panel second portion (36).

**22.** The plurality of panels according to any one of claims 17 to 21 when dependent on at least claim10, wherein each infill first portion (78) has the same construction as a panel third portion (80) without the layer (76) furthermost away from the panel second portion (68) and inverted.

**23.** The plurality of panels according to any one of claims 16 to 22, further comprising:

one or more drain ports (91, 97) extending from a boundary between said infill portions (60) and one of said panel second portions (36).

**24.** The plurality of panels according to claim 23 when dependent on at least claim 3, wherein said one or more drain ports (97) extends from a first end thereof flush with an inner most laminate layer (48) of said laminate structure.

**25.** The plurality of panels according to any one of claims 15 to 24, wherein the panels are prefabricated before being laid and joined together where they are to be used.

**26.** The plurality of panels according to any one of claims 16 to 24 or according to claim 25 when dependent on at least claim 16, further comprising:

at least one testing port (90) extending from a boundary between the infill portion (60) and one of the panel second portions (36) to an external surface of one of the panel third portions (34).

**27.** A buoyant cover for a liquid storage tank comprising a plurality of panels according to any one of claims 15 to 25.

**28.** A method of joining a plurality of generally planar buoyant panels together, for use in forming a floating cover, wherein each panel (30) comprises first and second portions (32, 36) in contact with each other, with the first portion (32) of each panel having an extent in the plane of the panel and a first side facing the second portion (36), the second portion (36) of each panel having an extent in the plane of the panel, which extent is less than the extent of the first portion (32); and the first portion (32) having on said first side an exposed portion (50) in each direction in the plane of the panel (30), and wherein the plurality of panels are placed together, with adjacent panels abutting each other, the edges (38) of the first portions (32) of adjacent panels which are orthogonal to the planes of the panels being in contact, **characterized in that** the method comprises the step of:

inserting infill portions (60) between adjacent panels, the infill portions (60) extending in contact with the exposed portions (50) of adjacent

and abutting panels.

**29.** The method of joining a plurality of generally planar buoyant panels together, for use in forming a floating cover, wherein each panel (30) is as defined in any one of claims 1 to 14, and wherein the plurality of panels are placed together, with adjacent panels abutting each other, the edges (38) of the first portions (32) of adjacent panels which are orthogonal to the planes of the panels being in contact, the method comprising the step of:

inserting infill portions (60) between adjacent panels, the infill portions (60) extending in contact with the exposed portions (50) of adjacent and abutting panels.

**30.** The method according to claim 28 or 29, wherein the plurality of panels are prefabricated off-site before being positioned for joining together.

**31.** The method according to claim 30, further comprising the step, preceding the inserting step, of roughening exposed surfaces (50) of said panels and cleaning away dust generated thereby.

**32.** The method according to any one of claims 28 to 31, wherein the inserting step comprises:

placing a first infill layer (62) over the exposed portions (50) of adjacent and abutting panels; and
placing one or more further infill layers (64, 66) over the first infill layer (62), one at a time.

**33.** The method according to claim 32, further comprising the step of rolling each infill layer (62, 64, 66) after placing it to remove air.

**34.** The method according to claim 32 or 33, wherein at least the first infill layer (62) is a non-laminated layer.

**35.** The method according to any one of claims 28 to 34, wherein the panels are securely joined together by people working on just one side of the cover.

**36.** The method according to any one of claims 28 to 34 used to produce a buoyant cover as defined in claim 27.

**37.** The method according to any one of claims 28 to 34 being a method of forming a floating cover.

**38.** The method according to any one of claims 28 to 37, wherein the panels are securely joined together by people working on just one side of the cover.

**39.** The method according to any one of claims 28 to 37, comprising the steps of:

placing said plurality of panels on a form work;
joining said panels together; and
removing said form work;
wherein the joining step prior to the removing step is accomplished solely from one side of the cover.

**40.** A method for testing the integrity of joints in a floating cover formed by a plurality of panels according to any one of claims 16 to 24 when dependent on at least claim 8 or according to claim 25 or 27 when dependent on at least claims 8 and 16, **characterized in that** the method comprises:

providing at least one testing port (90) extending from a boundary between the infill portion (60) and one of the panel second portions (68) to the external surface of one of the panel third portions (34);
applying a pressure differential between the testing port (90) or one of the testing ports (90) and the outside of the cover;
determining if there is a leak between the one testing port (90) or said one of the testing ports (90) and the outside of the cover; and
if there is a leak, identifying the leak.

**41.** The method of testing according to claim 36, wherein applying a pressure differential comprises pumping a gas into the one testing port (90) or said one of the testing ports (90) at a predetermined pressure.

**42.** The method of testing according to claim 41, wherein said gas is air or nitrogen.

**43.** The method according to any one of claims 36 to 42, wherein applying a pressure differential further comprises sealing said one testing port (90) or said one of the testing ports (90) at a predetermined pressure.

**44.** The method of testing according to claim 43, wherein determining if there is a leak comprises detecting if there is a change in pressure over time in said one testing port (90) or said one of the testing ports (90).

**45.** The method of testing according to any one of claims 36 to 44, wherein identifying the leak comprises applying a liquid to portions of said floating cover and observing bubbles formed in the liquid due to a leak.

**46.** The method of testing according to claim 45, wherein said liquid is a soap solution.

**47.** The method of testing according to any one of claims 36 to 46, further comprising providing a sleeve (96) in said at least one testing port (90) to apply the pres-

sure differential to said at least one testing port (90).

**48.** The method of testing according to any one of claims 36 to 47, wherein there is a plurality of the testing ports (90) and all but one is sealed as the pressure differential is applied to that one.

**Patentansprüche**

**1.** Eine im Wesentlichen ebene schwimmfähige Platte (30) für eine schwimmende Abdeckung (12) für einen Flüssigkeitsspeichertank (10), bei welcher die Platte erste (32) und zweite (36) Abschnitte in Kontakt miteinander umfasst, **dadurch gekennzeichnet, dass:**

der erste Abschnitt (32) eine Ausdehnung in der Ebene der Platte und eine erste, dem zweiten Abschnitt zugewandte Seite aufweist;
der zweite Abschnitt (36) eine Ausdehnung in der Ebene der Platte aufweist, wobei diese Ausdehnung kleiner ist als die Ausdehnung des ersten Abschnitts; und
der erste Abschnitt (32) auf der ersten Seite einen freiliegenden Abschnitt (50) in jeder Richtung in der Ebene der Platte (30) aufweist.

**2.** Platte nach Anspruch 1, bei welcher der zweite Abschnitt (36) eine Kante aufweist und sich der freiliegende Abschnitt (50) über den gesamten Weg um die Kante des zweiten Abschnittes (36) erstreckt.

**3.** Platte nach Anspruch 1 oder 2, bei welcher der erste Abschnitt (32) eine Laminatstruktur ist.

**4.** Platte nach irgendeinem der vorhergehenden Ansprüche, bei welcher der erste Abschnitt (32) eine glasverstärkte Struktur ist.

**5.** Platte nach irgendeinem der vorhergehenden Ansprüche, bei welcher der zweite Abschnitt (36) schwimmfähig ist.

**6.** Platte nach irgendeinem der vorhergehenden Ansprüche zur Verwendung mit dem zweiten Abschnitt (36), der sich über dem ersten Abschnitt (32) befindet.

**7.** Platte nach irgendeinem der vorhergehenden Ansprüche, bei welcher die ersten und zweiten Abschnitte (32), (36) kontinuierlich sind.

**8.** Platte nach irgendeinem der vorhergehenden Ansprüche, weiterhin einen dritten Abschnitt (34) in Kontakt mit dem zweiten Abschnitt (36) auf der anderen Seite des zweiten Abschnitts (36) von dem ersten Abschnitt (32) umfassend.

**9.** Platte nach Anspruch 8, bei welcher der dritte Abschnitt (34) eine erste Seite aufweist, die dem zweiten Abschnitt (36) zugewandt ist, und eine Ausdehnung in der Ebene der Platte aufweist, wobei die Ausdehnung gleich oder kleiner als die Ausdehnung des zweiten Abschnitts (36) ist.

**10.** Platte nach Anspruch 8 oder 9, bei welcher der dritte Abschnitt (34) eine Laminatstruktur aufweist.

**11.** Platte nach Anspruch 10, bei welcher die Schichten (52, 54, 56, 58) des dritten Abschnitts (34) jeweils eine Ausdehnung in der Ebene der Platte aufweist, und die Ausdehnung der Schicht (52) des dritten Abschnitts (34) am weitesten entfernt von dem zweiten Abschnitt (36) kleiner als die Ausdehnung der Schicht (58) des dritten Abschnitts (34) am nächsten zum zweiten Abschnitt (36) ist.

**12.** Platte nach irgendeinem der Ansprüche 8 bis 11, bei welcher der dritte Abschnitt (34) eine glasverstärkte Struktur ist.

**13.** Platte nach irgendeinem der Ansprüche 8 bis 12, bei welcher der dritte Abschnitt (34) dieselbe Konstruktion wie der erste Abschnitt aufweist.

**14.** Platte nach irgendeinem der vorhergehenden Ansprüche, bei welcher die Platte im Wesentlichen ein Parallelepiped in der Ebene der Platte ist.

**15.** Eine Vielzahl von Platten, wobei jede nach irgendeinem der vorhergehenden Ansprüche definiert ist, bei welcher der erste Abschnitt (32) jeder Platte eine Kante (38) aufweist, die im Allgemeinen senkrecht zu der Ebene der Platte ist, und die Kanten (38) der ersten Abschnitte (32) benachbarter Platten aneinander anstoßen.

**16.** Vielzahl von Platten nach Anspruch 15, weiterhin eine Vielzahl von Füllabschnitten (60) umfassend, wobei jeder Füllabschnitt (60) sich in Kontakt mit den freiliegenden Abschnitten (50) zweier benachbarter und aneinanderstoßender Platten erstreckt.

**17.** Vielzahl von Platten nach Anspruch 16, bei welcher jeder Füllabschnitt (60) einen ersten Füllabschnitt (78), einen zweiten Füllabschnitt (68) und einen dritten Füllabschnitt (80) umfasst, wobei sich der zweite Abschnitt (68) zwischen dem ersten Füllabschnitt (78) und dem dritten Füllabschnitt (80) befindet, und der zweite Füllabschnitt (68) die gleiche Konstruktion wie ein zweiter Plattenabschnitt (36) aufweist.

**18.** Vielzahl von Platten nach Anspruch 17, bei welcher jeder dritte Füllabschnitt (80) dieselbe Konstruktion wie ein invertierter erster Plattenabschnitt (32) aufweist.

**19.** Vielzahl von Platten nach Anspruch 17 oder 18, bei welcher in jedem Füllabschnitt (60):

der dritte Füllabschnitt (80) eine Ausdehnung in der Ebene der Platten aufweist, zwischen welchen sich der Füllabschnitt (60) erstreckt und eine erste Seite dem zweiten Füllabschnitt (68) zugewandt ist;
der zweite Füllabschnitt (68) eine Ausdehnung in der Ebene der Platten aufweist, zwischen welchen sich der Füllabschnitt (60) erstreckt, dessen Ausdehnung kleiner als die Ausdehnung des dritten Füllabschnitts (80) ist; und
die Ausdehnung des dritten Füllabschnitts (80) nicht durch den zweiten Füllabschnitt (68) abgedeckt ist, der sich mit äußeren Oberflächen (40) der Platten erstreckt und in Kontakt steht, zwischen welchen sich der Füllabschnitt (60) erstreckt.

**20.** Vielzahl von Platten nach Anspruch 19, soweit er zumindest von Anspruch 8 abhängig ist, bei welcher die Ausdehnung des dritten Füllabschnitts (80), die nicht durch den zweiten Füllabschnitt (68) abgedeckt ist, sich auf und in Kontakt mit äußeren Oberflächen (40) der dritten Plattenabschnitte (34) der Platten erstreckt, zwischen welchen sich der Füllabschnitt (60) erstreckt.

**21.** Vielzahl von Platten nach Anspruch 20, soweit er zumindest von Anspruch 11 abhängig ist, bei welcher die Ausdehnung des dritten Füllabschnitts (80), die nicht durch den zweiten Füllabschnitt (68) abgedeckt ist, in Kontakt mit den Schichten (54, 56, 58) der dritten Plattenabschnitte (34) steht, zwischen welchen sich der Füllabschnitt (60) erstreckt, anders als die Schicht (52) jeder der Platten, die am weitesten von dem zweiten Plattenabschnitt (36) entfernt sind.

**22.** Vielzahl von Platten nach irgendeinem der Ansprüche 17 bis 21, soweit sie von zumindest Anspruch 10 abhängig sind, bei welcher jeder erster Füllabschnitt (78) dieselbe Konstruktion wie ein dritter Plattenabschnitt (80) aufweist ohne die Schicht (76), die am weitesten von dem zweiten Plattenabschnitt (68) entfernt ist und umgekehrt.

**23.** Vielzahl von Platten nach irgendeinem der Ansprüche 16 bis 22, weiterhin umfassend:

einen oder mehrere Abflussanschlüsse (91, 97), die sich von einer Grenze zwischen den Füllabschnitten (60) und einem der zweiten Plattenabschnitte (36) erstrecken.

**24.** Vielzahl von Platten nach Anspruch 23, soweit er zumindest von Anspruch 3 abhängig ist, bei welcher sich einer oder mehrere der Abflussanschlüsse (97) von einem ersten Ende davon bündig mit einer innersten Laminatschicht (48) der Laminatstruktur erstrecken.

**25.** Vielzahl von Platten nach irgendeinem der Ansprüche 15 bis 24, bei welcher die Platten vorproduziert werden, bevor sie ausgelegt und miteinander verbunden werden, an dem Ort, wo sie zu verwenden sind.

**26.** Vielzahl von Platten nach irgendeinem der Ansprüche 16 bis 24 oder nach Anspruch 25, soweit er von zumindest Anspruch 16 abhängt, weiterhin umfassend:

zumindest einen Testanschluss (90), der sich von einer Grenze zwischen dem Füllabschnitt (60) und einem der zweiten Plattenabschnitte (36) zu einer äußeren Oberfläche von einem der dritten Plattenabschnitte (34) erstreckt.

**27.** Schwimmfähige Abdeckung für einen Flüssigkeitsspeichertank mit einer Vielzahl von Platten nach irgendeinem der Ansprüche 15 bis 25.

**28.** Verfahren zum miteinander Verbinden einer Vielzahl, im Allgemeinen planarer, schwimmfähiger Platten zur Verwendung zum Bilden einer schwimmenden Abdeckung, wobei jede Platte (30) erste und zweite Abschnitte (32, 36) umfasst, die miteinander in Kontakt stehen, wobei der erste Abschnitt (32) jeder Platte eine Ausdehnung in der Ebene der Platte und eine erste Seite aufweist, die dem zweiten Abschnitt (36) zugewandt ist, und wobei der zweite Abschnitt (36) jeder Platte eine Ausdehnung in der Ebene der Platte aufweist, wobei die Ausdehnung geringer ist als die Ausdehnung des ersten Abschnitts (32); und der erste Abschnitt (32) auf der ersten Seite einen freiliegenden Abschnitt (50) in jeder Richtung der Ebene der Platte (30) aufweist, und wobei die Vielzahl von Platten miteinander angeordnet sind, wobei benachbarte Platten aneinander anstoßen, und wobei die Kanten (38) der ersten Abschnitte (32) benachbarter Platten, welche senkrecht zu den Ebenen der Platten sind, die in Kontakt stehen, **dadurch gekennzeichnet, dass** das Verfahren den folgenden Schritt umfasst:

Einfügen von Füllabschnitten (60) zwischen benachbarte Platten, wobei sich die Füllabschnitte (60) in Kontakt mit den freiliegenden Abschnitten (50) benachbarter und aneinander anstoßender Platten erstrecken.

**29.** Verfahren zum miteinander Verbinden einer Vielzahl von im Allgemeinen ebenen, schwimmfähigen Platten zur Verwendung zur Bildung einer schwimmen-

den Abdeckung, bei welchem jede Platte (30) nach irgendeinem der Ansprüche 1 bis 14 definiert ist, und bei welchem die Vielzahl von Platten miteinander angeordnet werden, so dass benachbarte Platten aneinander anstoßen, und die Kanten (38) der ersten Abschnitte (32) benachbarter Platten, die senkrecht zu den Ebenen der Platten sind, die in Kontakt stehen, wobei das Verfahren den folgenden Schritt umfasst:

Einfügen von Füllabschnitten (60) zwischen benachbarte Platten, wobei sich die Füllabschnitte (60) in Kontakt mit den freiliegenden Abschnitten (50) benachbarter und anstoßender Platten befinden.

**30.** Verfahren nach Anspruch 28 oder 29, bei welchem die Vielzahl von Platten nicht vor Ort vorproduziert werden, bevor sie zum miteinander Verbinden positioniert werden.

**31.** Verfahren nach Anspruch 30, weiterhin den folgenden Schritt umfassend, vor dem Einfügeschritt, die freiliegenden Oberflächen (50) der Platten aufzurauen und den dabei erzeugten Staub wegzuputzen.

**32.** Verfahren nach irgendeinem der Ansprüche 28 bis 31, bei welchem der Einfügeschritt umfasst:

Anordnen einer ersten Füllschicht (62) über den freiliegenden Abschnitten (50) benachbarter und aneinander angrenzender Platten; und
jeweiliges (einzelnes?) Anordnen von einer oder mehreren weiteren Füllschichten (64, 66) über der ersten Füllschicht (62).

**33.** Verfahren nach Anspruch 32, weiterhin den Schritt des Rollens jeder Füllschicht (62, 64, 66) umfassend, nachdem sie um Luft zu entfernen angeordnet ist.

**34.** Verfahren nach Anspruch 32 oder 33, bei welchem zumindest die erste Füllschicht (62) eine nichtlaminierte Schicht ist.

**35.** Verfahren nach irgendeinem der Ansprüche 28 bis 34, bei welchem die Platten sicher miteinander verbunden werden durch Menschen, die nur auf einer Seite der Abdeckung arbeiten.

**36.** Verfahren nach irgendeinem der Ansprüche 28 bis 34, das zum Erzeugen einer schwimmfähigen Abdeckung nach Anspruch 27 verwendet wird.

**37.** Verfahren nach irgendeinem der Ansprüche 28 bis 34 als ein Verfahren zum Bilden einer schwimmenden Abdeckung.

**38.** Verfahren nach irgendeinem der Ansprüche 28 bis 37, bei welchem die Platten sicher miteinander verbunden werden durch Menschen, die nur auf einer Seite der Abdeckung arbeiten.

**39.** Verfahren nach irgendeinem der Ansprüche 28 bis 37, umfassend die folgenden Schritte:

Anordnen einer Vielzahl von Platten auf einem Arbeitsstück;
miteinander Verbinden der Platten; und
Entfernen des Arbeitsstücks;
wobei der Verbindungsschritt vor dem Entfernungsschritt ausschließlich von einer Seite der Abdeckung durchgeführt wird.

**40.** Verfahren zum Testen der Integrität der Verbindungen in einer schwimmenden Abdeckung, die durch eine Vielzahl von Platten nach irgendeinem der Ansprüche 16 bis 24 gebildet ist, soweit sie von zumindest Anspruch 8 abhängig sind, oder nach Ansprüchen 25 oder 27, soweit sie zumindest von den Ansprüchen 8 und 16 abhängig sind, **dadurch gekennzeichnet, dass** das Verfahren umfasst:

Bereitstellen von zumindest einem ersten Testanschluss (90), der sich von einer Grenze zwischen dem Füllabschnitt (60) und einem der zweiten Plattenabschnitte (68) zu der äußeren Oberfläche von einem der dritten Plattenabschnitte (34) erstreckt;
Aufbringen einer Druckdifferenz zwischen dem Testanschluss (90) oder einem der Testanschlüsse (90) und der Außenseite der Abdekkung;
Bestimmen, ob ein Leck zwischen dem Testanschluss (90) oder einem der Testanschlüsse (90) und der Außenseite der Abdeckung besteht; und wenn es ein Leck gibt, Identifizieren des Lecks.

**41.** Verfahren zum Testen nach Anspruch 36, bei welchem das Aufbringen einer Druckdifferenz das Pumpen eines Gases in einen Testanschluss (90) oder einen der Testanschlüsse (90) mit einem vordefinierten Druck umfasst.

**42.** Verfahren zum Testen nach Anspruch 41, bei welchem das Gas Luft oder Stickstoff ist.

**43.** Verfahren nach irgendeinem der Ansprüche 36 bis 42, bei welchem das Aufbringen einer Druckdifferenz weiterhin das Abdichten des Testanschlusses (90) oder eines der Testanschlüsse (90) mit einem vordefinierten Druck umfasst.

**44.** Verfahren zum Testen nach Anspruch 43, bei welchem das Bestimmen, ob ein Leck existiert, das Be-

stimmen umfasst, ob es eine Änderung des Drucks über die Zeit in dem einen Testanschluss (90) oder in einem der Testanschlüsse (90) gibt.

**45.** Verfahren zum Testen nach irgendeinem der Ansprüche 36 bis 44, bei welchem das Identifizieren des Lecks ein Aufbringen einer Flüssigkeit auf Abschnitte der schwimmenden Abdeckung umfasst, und das Beobachten von Blasen, die sich in der Flüssigkeit aufgrund eines Lecks bilden.

**46.** Verfahren zum Testen nach Anspruch 45, bei welchem die Flüssigkeit eine Seifenlösung ist.

**47.** Verfahren zum Testen nach irgendeinem der Ansprüche 36 bis 46, weiterhin das Bereitstellen einer Hülse (96) in dem zumindest einen Testanschluss (90) umfassend, um die Druckdifferenz auf den zumindest einen Testanschluss (90) aufzubringen.

**48.** Verfahren zum Testen nach irgendeinem der Ansprüche 36 bis 47, bei welchem eine Vielzahl von Testanschlüssen (90) bestehen und alle bis auf einen abgedichtet sind, wenn die Druckdifferenz auf diesen einen aufgebracht wird.

**Revendications**

**1.** Un panneau flottable sensiblement plan (30) pour un chapeau flottant (12) pour une cuve de stockage de liquide (10), le panneau comprenant des première (32) et deuxième (36) parties en contact l'une avec l'autre, **caractérisé en ce que** la première partie (32) possède une extension dans le plan du panneau et un premier côté tourné vers la deuxième partie, la deuxième partie (36) possède une extension dans le plan du panneau, laquelle extension est inférieure à l'extension de la première partie, et la première partie (32) possède sur ledit premier côté une partie exposée (50) dans chaque direction du plan du panneau (30).

**2.** Le panneau selon la revendication 1, dans lequel la deuxième partie (36) possède un bord, et la partie exposée (50) s'étend tout autour du bord de la deuxième partie (36).

**3.** Le panneau selon la revendication 1 ou 2, dans lequel la première partie (32) est une structure stratifiée.

**4.** Le panneau selon l'une quelconque des revendications précédentes, dans lequel la première partie (32) est une structure renforcée à la fibre de verre.

**5.** Le panneau selon l'une quelconque des revendications précédentes, dans lequel la deuxième partie (36) est flottable.

**6.** Le panneau selon l'une quelconque des revendications précédentes, destiné à être utilisé en disposant la deuxième partie (36) au-dessus de la première partie (32).

**7.** Le panneau selon l'une quelconque des revendications précédentes, dans lequel les première et deuxième parties (32), (36) sont continues.

**8.** Le panneau selon l'une quelconque des revendications précédentes, comprenant également une troisième partie (34) en contact avec la deuxième partie (36) sur le côté de la deuxième partie (36) situé à l'opposé de la première partie (32).

**9.** Le panneau selon la revendication 8, dans lequel la troisième partie (34) possède un premier côté tourné vers la deuxième partie (36) et une extension dans le plan du panneau, laquelle extension est égale ou inférieure à celle de la deuxième partie (36).

**10.** Le panneau selon la revendication 8 ou 9, dans lequel la troisième partie (34) possède une structure stratifiée.

**11.** Le panneau selon la revendication 10, dans lequel les couches (52, 54, 56, 58) de la troisième partie (34) possèdent chacune une extension dans le plan du panneau, et l'extension de la couche (52) de la troisième partie (34) la plus éloignée de la deuxième partie (36) est inférieure à l'extension de la couche (58) de la troisième partie (34) la plus proche de la deuxième partie (36).

**12.** Le panneau selon l'une quelconque des revendications 8 à 11, dans lequel la troisième partie (34) est une structure renforcée à la fibre de verre.

**13.** Le panneau selon l'une quelconque des revendications 8 à 12, dans lequel la troisième partie (34) possède la même construction que la première partie.

**14.** Le panneau selon l'une quelconque des revendications précédentes, dans lequel le panneau est sensiblement un parallélépipède dans le plan du panneau.

**15.** Une pluralité de panneaux, chacun étant tel que défini dans l'une quelconque des revendications précédentes, dans laquelle la première partie (32) de chaque panneau a un bord (38) sensiblement orthogonal au plan du panneau, et les bords (38) des premières parties (32) de panneaux adjacents sont aboutés les uns aux autres.

**16.** La pluralité de panneaux selon la revendication 15,

comprenant également une pluralité de parties intercalaires (60), chaque partie intercalaire (60) s'étendant au contact des parties exposées (50) de deux panneaux adjacents et aboutés.

**17.** La pluralité de panneaux selon la revendication 16, dans laquelle chaque partie intercalaire (60) comprend une première partie intercalaire (78), une deuxième partie intercalaire (68) et une troisième partie intercalaire (80), la deuxième partie intercalaire (68) étant prise en sandwich entre la première partie intercalaire (78) et la troisième partie intercalaire (80), et la deuxième partie intercalaire (68) possédant la même construction qu'une deuxième partie de panneau (36).

**18.** La pluralité de panneaux selon la revendication 17, dans laquelle chaque troisième partie intercalaire (80) possède la même construction que la première partie de panneau (32), mais inversée.

**19.** La pluralité de panneaux selon la revendication 17 ou 18, dans laquelle dans chaque partie intercalaire (60) la troisième partie intercalaire (80) possède une extension dans le plan des panneaux entre lesquels la partie intercalaire (60) s'étend et un premier côté tourné vers la deuxième partie intercalaire (68), la deuxième partie intercalaire (68) possède une extension dans le plan des panneaux entre lesquels la partie intercalaire (60) s'étend, laquelle extension est inférieure à l'extension de la troisième partie intercalaire (80), et l'extension de la troisième partie intercalaire (80) non recouverte par la deuxième partie intercalaire (68) s'étend sur et au contact de surfaces extérieures (40) des panneaux entre lesquels la partie intercalaire (60) s'étend.

**20.** La pluralité de panneaux selon la revendication 19 lorsqu'elle est dépendante d'au moins la revendication 8, dans laquelle l'extension de la troisième partie intercalaire (80) non recouverte par la deuxième partie intercalaire (68) s'étend sur et au contact de surfaces extérieures (40) de troisièmes portions de panneaux (34) des panneaux entre lesquels la partie intercalaire (60) s'étend.

**21.** La pluralité de panneaux selon la revendication 20 lorsqu'elle est dépendante d'au moins la revendication 11, dans laquelle l'extension de la troisième partie intercalaire (80) non recouverte par la deuxième partie intercalaire (68) est en contact avec des couches (54, 56, 58) des troisièmes portions de panneaux (34) entre lesquelles la partie intercalaire (60) s'étend et qui sont autres que la couche (52) de chacun de ces panneaux la plus éloignée de la deuxième partie de panneau (36).

**22.** La pluralité de panneaux selon l'une quelconque des revendications 17 à 21 lorsqu'elles sont dépendantes d'au moins la revendication 10, dans laquelle chaque première partie intercalaire (78) possède la même construction qu'une troisième portion de panneau (80) sans la couche (76) la plus éloignée de la deuxième partie de panneau (68) et inversée.

**23.** La pluralité de panneaux selon l'une quelconque des revendications 16 à 22, comprenant également un ou plusieurs orifices d'écoulement (91, 97) s'étendant à partir d'une limite entre lesdites parties intercalaires (60) et une desdites deuxièmes parties de panneaux (36).

**24.** La pluralité de panneaux selon la revendication 23 lorsqu'elle est dépendante d'au moins la revendication 3, dans laquelle lesdits un ou plusieurs orifices d'écoulement (97) s'étendent à partir d'une première extrémité desdits panneaux, au ras de la couche de stratifié la plus intérieure (48) de ladite structure stratifiée.

**25.** La pluralité de panneaux selon l'une quelconque des revendications 15 à 24, dans laquelle les panneaux sont préfabriqués avant d'être présentés et assemblés entre eux là où ils doivent être utilisés.

**26.** La pluralité de panneaux selon l'une quelconque des revendications 16 à 24 ou selon la revendication 25 lorsqu'elle est dépendante d'au moins la revendication 16, comprenant également au moins un orifice de test (90) s'étendant à partir d'une limite entre la partie intercalaire (60) et une des deuxièmes parties de panneaux (36) jusqu'à une surface extérieure de l'une des troisièmes portions de panneaux (34).

**27.** Un chapeau flottable pour une cuve de stockage de liquide, comprenant une pluralité de panneaux selon l'une quelconque des revendications 15 à 25.

**28.** Un procédé pour assembler entre eux une pluralité de panneaux flottables sensiblement plans de façon à former un chapeau flottant, dans lequel chaque panneau (30) comprend des première et deuxième parties (32, 36) en contact l'une avec l'autre, la première partie (32) de chaque panneau possédant une extension dans le plan du panneau et un premier côté tourné vers la deuxième partie (36), la deuxième partie (36) de chaque panneau possédant une extension dans le plan du panneau, laquelle extension est inférieure à l'extension de la première partie (32), et la première partie (32) possédant sur ledit premier côté une partie exposée (50) dans chaque direction dans le plan du panneau (30), et dans lequel la pluralité de panneaux sont disposés ensemble, les panneaux adjacents étant aboutés les uns aux autres, les bords (38) des premières parties (32) de panneaux adjacents orthogonaux aux plans des pan-

neaux étant en contact, **caractérisé en ce que** le procédé comprend l'étape consistant à insérer des parties intercalaires (60) entre des panneaux adjacents, les parties intercalaires (60) s'étendant au contact des parties exposées (50) de panneaux adjacents et aboutés.

**29.** Le procédé pour assembler entre eux une pluralité de panneaux flottables sensiblement plans destinés à former un chapeau flottant, dans lequel chaque panneau (30) est tel que défini dans l'une quelconque des revendications 1 à 14, et dans lequel la pluralité de panneaux sont disposés ensemble, les panneaux adjacents étant aboutés les uns aux autres, les bords (38) des premières parties (32) de panneaux adjacents orthogonaux aux plans des panneaux étant en contact, le procédé comprenant l'étape consistant à insérer des parties intercalaires (60) entre des panneaux adjacents, les parties intercalaires (60) s'étendant au contact des parties exposées (50) de panneaux adjacents et aboutés.

**30.** Le procédé selon la revendication 28 ou 29, dans lequel la pluralité de panneaux sont préfabriqués en usine avant d'être positionnés pour être assemblés entre eux.

**31.** Le procédé selon la revendication 30, comprenant également l'étape, précédant l'étape d'insertion, consistant à rendre rugueuses les surfaces exposées (50) desdits panneaux et à éliminer la poussière ainsi produite.

**32.** Le procédé selon l'une quelconque des revendications 28 à 31, dans lequel l'étape d'insertion consiste à placer la première couche intercalaire (62) sur les parties exposées (50) de panneaux adjacents et aboutés et à placer une ou plusieurs autres couches intercalaires (64, 66) l'une après l'autre sur la première couche intercalaire (62).

**33.** Le procédé selon la revendication 32, comprenant également l'étape consistant à rouler chaque couche intercalaire (62, 64, 66) après l'avoir posée afin de chasser l'air.

**34.** Le procédé selon la revendication 32 ou 33, dans lequel au moins la première couche intercalaire (62) est une couche non stratifiée.

**35.** Le procédé selon l'une quelconque des revendications 28 à 34, dans lequel les panneaux sont solidement assemblés entre eux par des personnes qui ne travaillent que d'un seul côté du chapeau.

**36.** Le procédé selon l'une quelconque des revendications 28 à 34, utilisé pour produire un chapeau flottable tel que défini à la revendication 27.

**37.** Le procédé selon l'une quelconque des revendications 28 à 34, constituant un procédé pour former un chapeau flottant.

**38.** Le procédé selon l'une quelconque des revendications 28 à 37, dans lequel les panneaux sont solidement assemblés entre eux par des personnes qui ne travaillent que d'un seul côté du chapeau.

**39.** Le procédé selon l'une quelconque des revendications 28 à 37, comprenant les étapes consistant à placer ladite pluralité de panneaux sur un bâti porteur, à assembler les panneaux entre eux et à retirer ledit bâti porteur, l'étape d'assemblage précédant l'étape de retrait s'effectuant à partir d'un seul côté du chapeau.

**40.** Un procédé pour tester l'intégrité des joints dans un chapeau flottant formé par une pluralité de panneaux selon l'une quelconque des revendications 16 à 24 lorsqu'elles sont dépendantes d'au moins la revendication 8 ou selon la revendication 25 ou 27 lorsqu'elle est dépendante d'au moins les revendications 8 et 16, **caractérisé en ce que** le procédé consiste à ménager au moins un orifice de test (90) s'étendant à partir d'une limite entre la partie intercalaire (60) et une des deuxièmes parties de panneaux (68) jusqu'à la surface extérieure de l'une des troisièmes portions de panneaux (34), à appliquer un différentiel de pression entre l'orifice de test (90) ou un des orifices de test (90) et l'extérieur du chapeau, à déterminer s'il existe une fuite entre l'orifice de test (90) ou ledit un des orifices de test (90) et l'extérieur du chapeau et, s'il existe une fuite, à repérer la fuite.

**41.** Le procédé de test selon la revendication 36, dans lequel l'application d'un différentiel de pression consiste à injecter un gaz à une pression déterminée dans l'orifice de test (90) ou dans ledit un des orifices de test (90).

**42.** Le procédé de test selon la revendication 41, dans lequel ledit gaz est de l'air ou de l'azote.

**43.** Le procédé selon l'une quelconque des revendications 36 à 42, dans lequel l'application d'un différentiel de pression consiste également à boucher ledit orifice de test (90) ou ledit un des orifices de test (90) à une pression prédéterminée.

**44.** Le procédé de test selon la revendication 43, dans lequel la recherche d'une fuite consiste à détecter une éventuelle variation de pression avec le temps dans ledit orifice de test (90) ou dans ledit un des orifices de test (90).

**45.** Le procédé de test selon l'une quelconque des re-

vendications 36 à 44, dans lequel le repérage de la fuite consiste à appliquer un liquide sur des parties dudit chapeau flottant et à observer les bulles formées dans le liquide du fait de la fuite.

**46.** Le procédé de test selon la revendication 45, dans lequel ledit liquide est une solution savonneuse.

**47.** Le procédé de test selon l'une quelconque des revendications 36 à 46, consistant également à insérer un manchon (96) dans ledit au moins un orifice de test (90) pour appliquer le différentiel de pression audit au moins un orifice de test (90).

**48.** Le procédé de test selon l'une quelconque des revendications 36 à 47, dans lequel est ménagée une pluralité d'orifices de test (90) dont tous sont bouchés, sauf un, lorsque le différentiel de pression est appliqué à celui-ci.

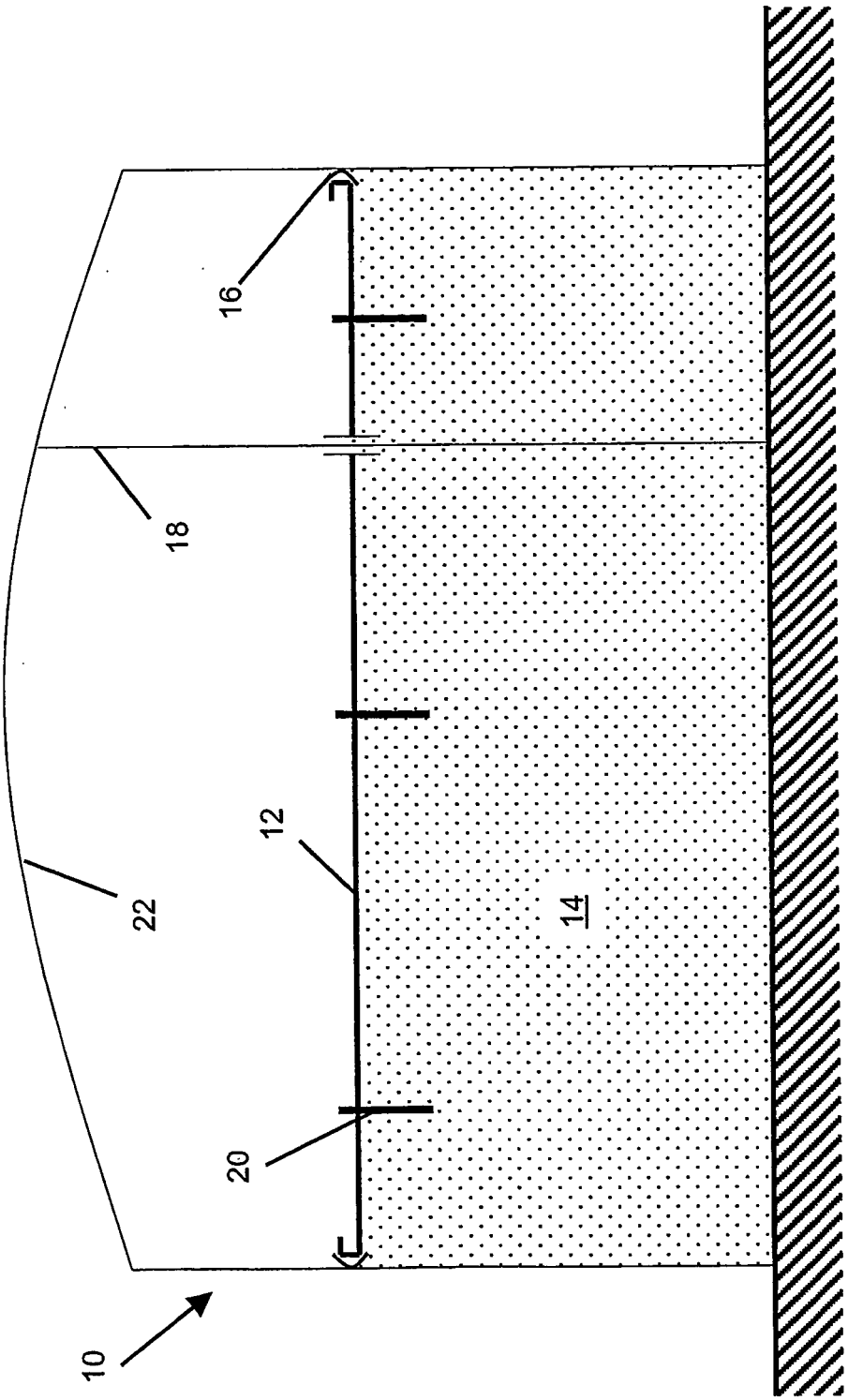


Fig. 1

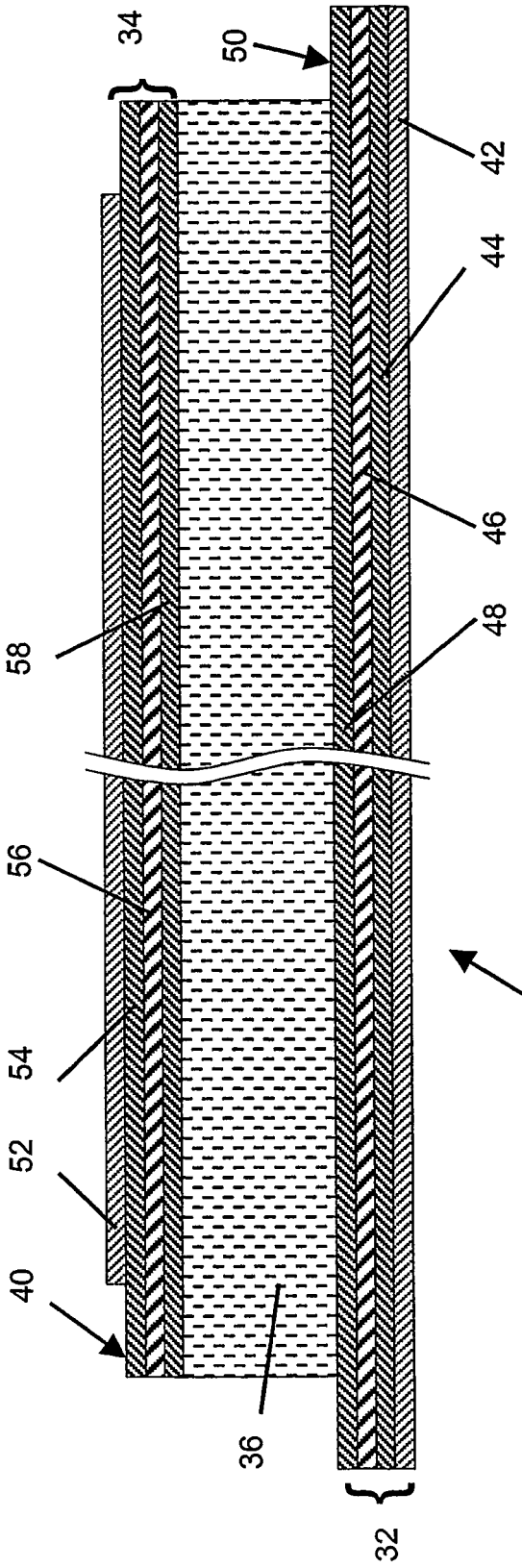


Fig. 2

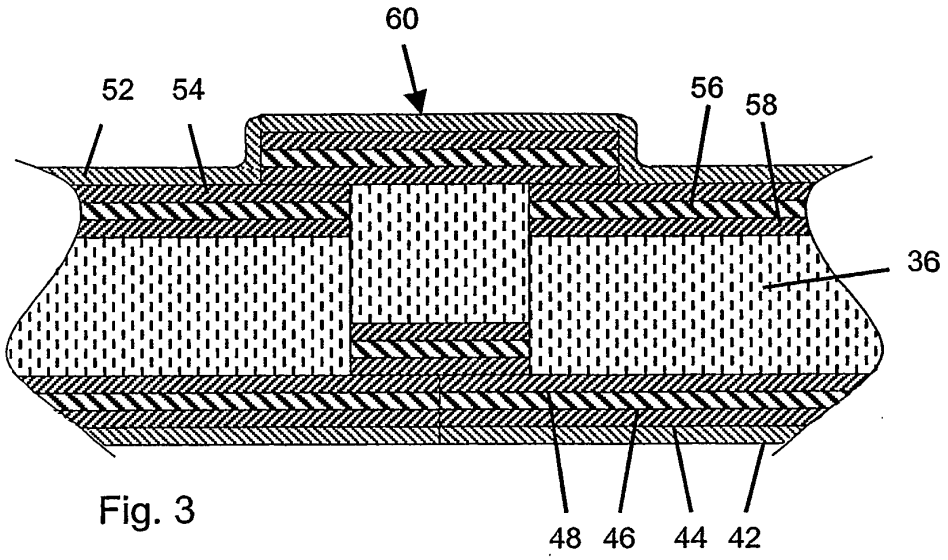
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Fig. 3

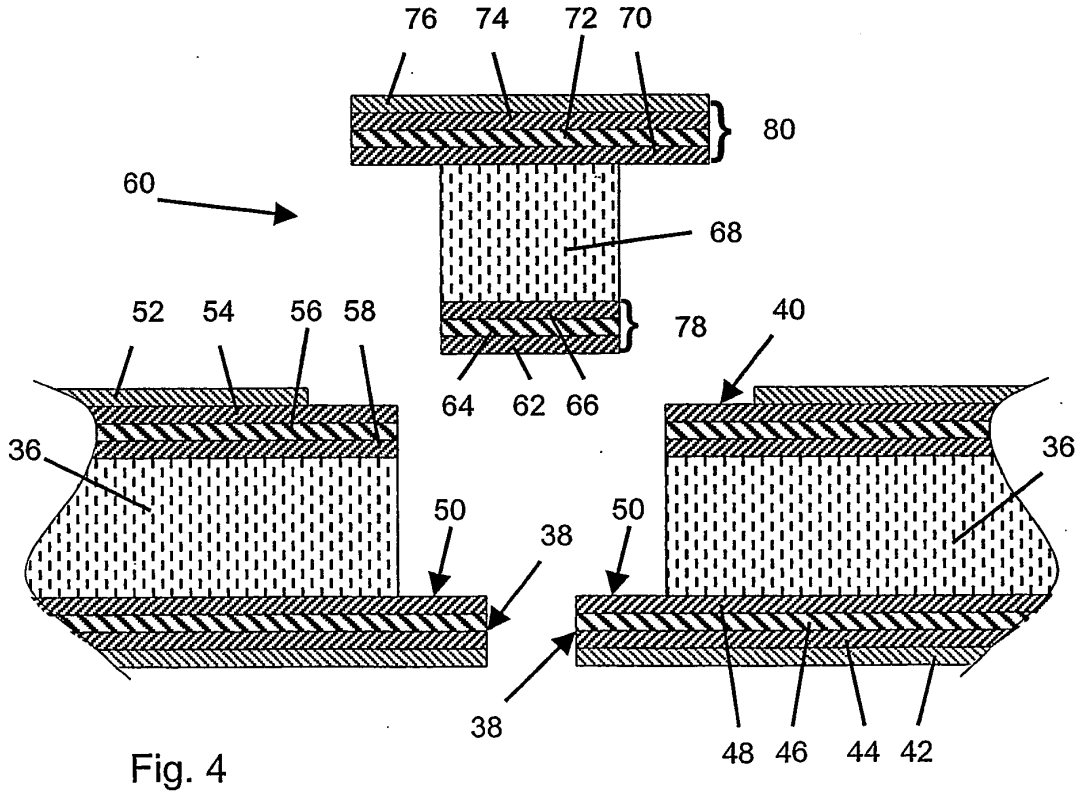
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Fig. 4

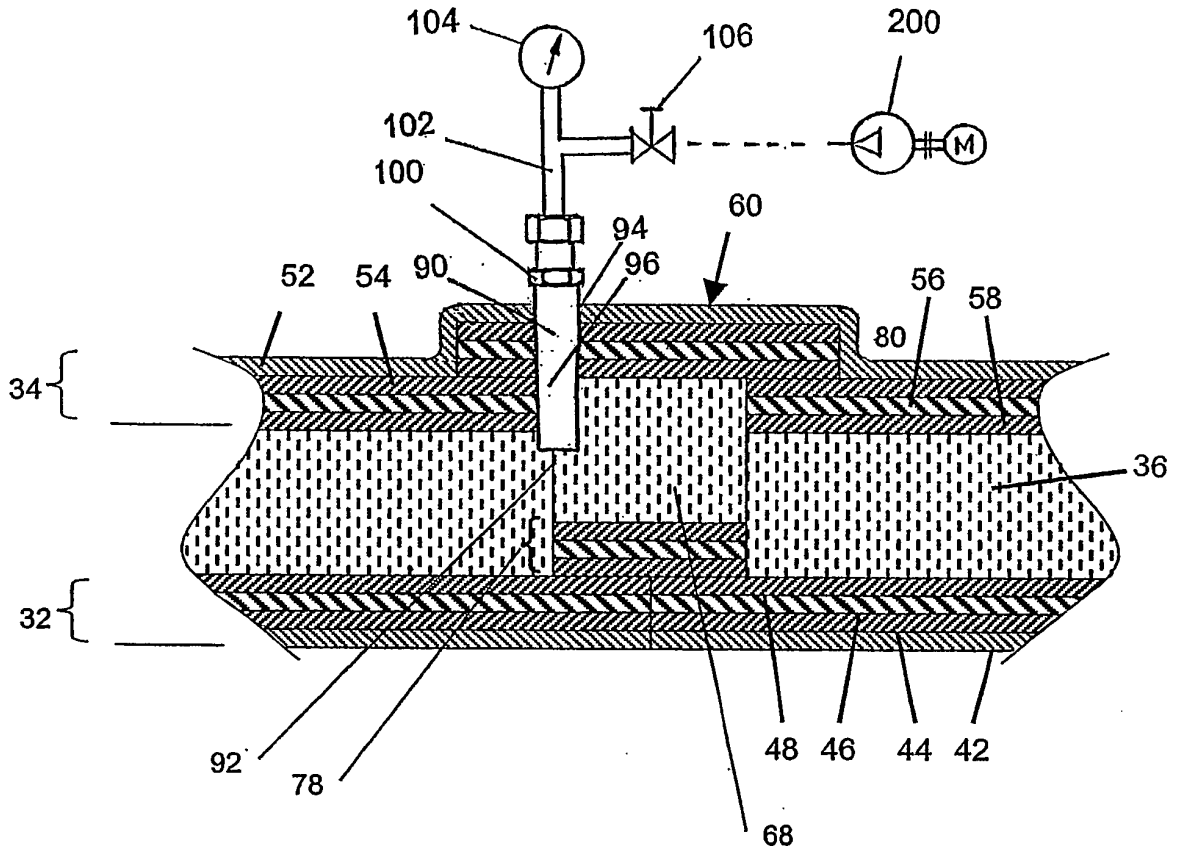
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Fig. 5

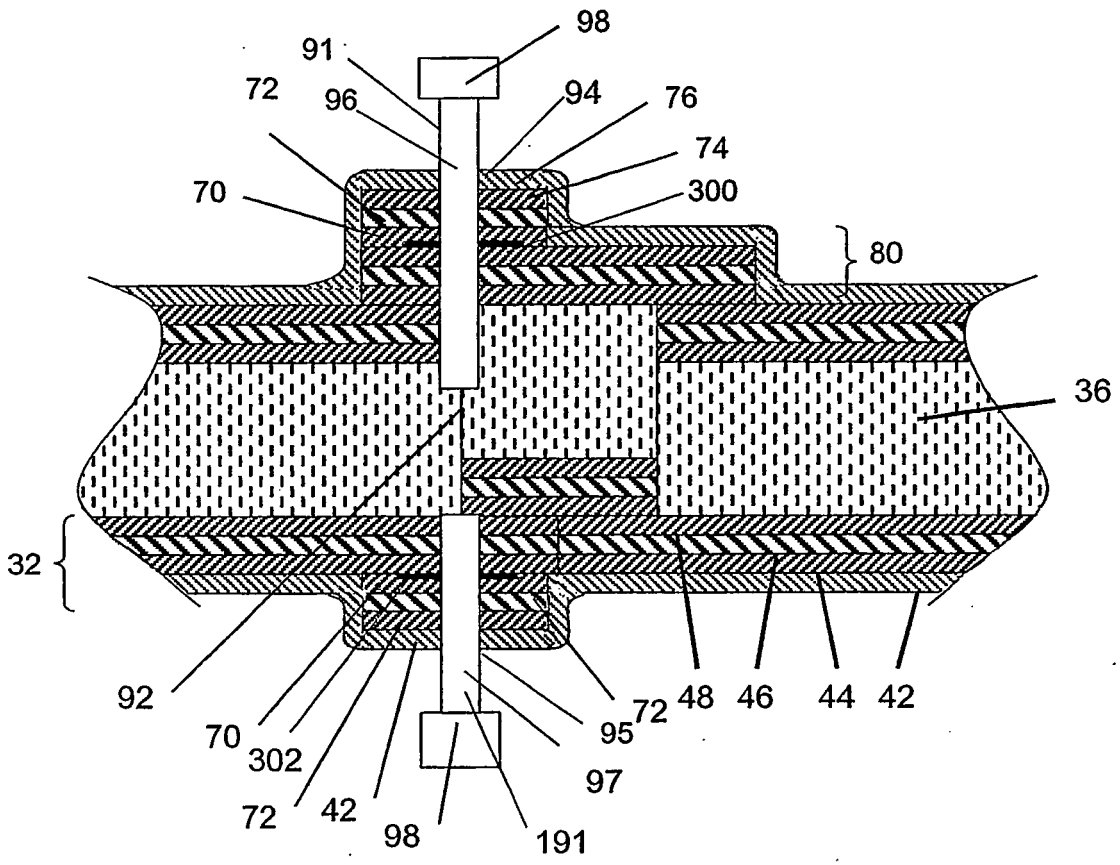
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Fig. 6

## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description


- GB 983797 A **[0005]**
- CA 966430 A **[0005]**