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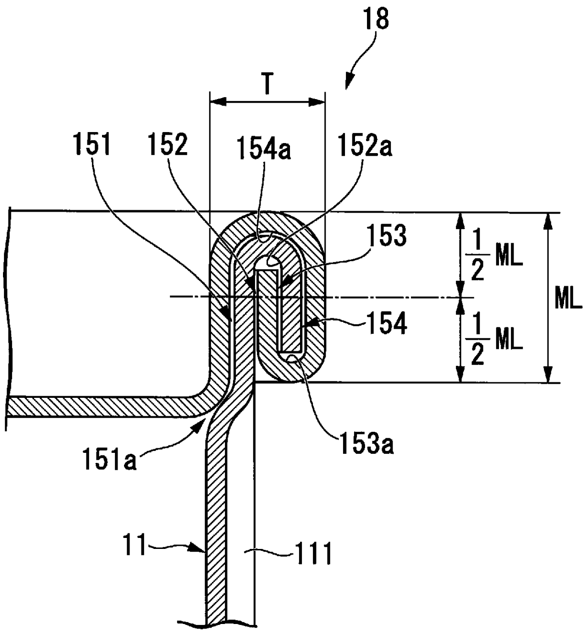
(54) FLOATING BODY

(57) A floating body which is accommodated in a float chamber of a floating roof of a floating roof-type tank includes a main body made of a metal in which an opening is formed in at least one location and which has an internal space, and a lid made of a metal which covers the opening and has an edge portion attached to the opening by a seaming. Between the opening and the edge portion, a first gap which allows a communication between an external space and the internal space of the main body, and permits a movement of an approach and separation between the main body and the lid is provided, and a first contact portion which blocks the first gap when the lid is closest to the main body is provided.

FIG. 5



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Description

Technical Field

[0001] The present invention relates to a floating body which is used for a floating roof of a floating roof-type storage tank for storing petroleum products, such as crude oil or gasoline.
Priority is claimed on Japanese Patent Application No. 2011-005735, filed January 14, 2011, the content of which is incorporated herein by reference.

Background Art

[0002] As a tank which stores combustible liquid, such as petroleum, a floating roof-type storage tank is generally known. This type of floating roof-type storage tank has a structure in which a floating roof formed of a steel sheet or the like is floated on the liquid so as to cover the liquid surface of the combustible liquid, such as the petroleum, stored in the tank. The floating roof has a pontoon with a cavity (float chamber) therein, and the entire floating roof is floated on the liquid by buoyancy of the pontoon. The floating roof moves up and down to follow change in the liquid level caused by an increase/decrease in the liquid stored in the tank, and a state where the liquid surface of the stored liquid is covered with the floating roof is constantly maintained.
[0003] On the other hand, in this floating roof-type storage tank, a welded portion or the like of the pontoon of the floating roof formed of a steel sheet may be broken due to vibration caused by sloshing (liquid surface vibration) or the like. For example, Patent Document 1 and Patent Document 2 suggest a configuration in which a floating body (envelope, float) is accommodated in the pontoon so as to maintain adequate buoyancy even if the pontoon gets broken and the liquid in the tank enters the pontoon. In this way, the floating body is accommodated in the pontoon, whereby, for example, even if the liquid enters the pontoon, a state where the entire floating roof is floated on the liquid in the tank is maintained by buoyancy of the floating body itself.

Related Art Document

Patent Document

[0004]

[Patent Document 1] Japanese Unexamined Utility Model Application, First Publication No. S58-24867
[Patent Document 2] Japanese Unexamined Patent Application, First Publication No. 2006-143291

Summary of Invention

Technical Problem

[0005] In a floating roof-type tank which stores petroleum or the like, even if a fire breaks out, during the time (for example, approximately 48 hours) needed for fire extinction, it is necessary that a state where the floating roof is floated on the liquid surface of the liquid stored in the tank can be maintained. However, since a floating body which is used in a conventional floating roof is formed in a bag shape of rubber, resin, or the like, the floating body is lacking in fire resistance and is unable to endure high temperatures during a fire emergency. For this reason, if the pontoon gets broken during the fire emergency of the tank, it is not possible to maintain a state where the floating roof is floated on the liquid surface of the liquid stored in the tank.
[0006] Since the conventional floating body has a sealed structure, internal gas may expand due to heating during the fire emergency, may cause breakage of the floating body, and may contract due to cooling after fire extinguishment. For this reason, the conventional floating body may not maintain adequate buoyancy when there is change in temperature during the fire emergency.
[0007] The invention has been accomplished in consideration of this situation, and an object of the invention is to provide a floating body which is excellent in the fire resistance, and can maintain the adequate buoyancy even if there is change in temperature of surrounding environment.

Solution to Problem

[0008] The invention employs the following aspects so as to solve the above-described problems and to attain the concerned object.

(1) An aspect according to the invention provides a floating body which is accommodated in a float chamber of a floating roof of a floating roof-type tank, the floating body including: a main body made of a metal in which an opening is formed in at least one location and which has an internal space; and a lid made of a metal which covers the opening and has an edge portion attached to the opening by a seaming, wherein, between the opening and the edge portion, a first gap which allows a communication between an external space and the internal space of the main body, and permits a movement of an approach and separation between the main body and the lid is provided, and a first contact portion which blocks the first gap when the lid is closest to the main body is provided.

(2) In the floating body according to (1), the main body may be a cylinder in which a number of the opening is two, the lid may be provided for each opening of the cylinder by the seaming, and the first gap and the first contact portion may be provided between one lid and one opening to which the one lid is attached and between the other lid and the other opening.

(3) In the floating body according to (1) or (2), the floating body may be a square can made of a metal in which the cylinder has a square shape and the lid has a rectangular shape.

(4) In the floating body according to any one of (1) to (3), when a portion at the seaming is viewed by a cross section including a direction of the approach and separation, the opening of the main body and the edge portion of the lid may be engaged with each other.

(5) In the floating body according to any one of (1) to (4), the first contact portion may be a line contact portion which is formed in a ring shape along the opening between the opening and the edge portion.

(6) In the floating body according to any one of (1) to (5), the number of turns of the seaming may be equal to or greater than two.

(7) In the floating body according to (6), when a portion at the seaming between the opening and the edge portion is viewed by a cross section including a direction of the approach and separation, the first gap may have a plurality of linear gap portions along the direction of the approach and separation, and folded gap portions which are folded to connect the linear gap portions, and when each of the linear gap portions is viewed at an intermediate position in a length direction thereof and by a cross section intersecting the direction of the approach and separation, an average gap size of the linear gap portions may be equal to or greater than 100 μm and equal to or smaller than 175 μm.

(8) In the floating body according to any one of (1) to (7), a sheet thickness of the main body may be in a range of 0.20 mm to 0.32 mm, and a sheet thickness of the lid may be in a range of 0.20 mm to 0.32 mm.

(9) In the floating body according to any one of (1) to (8), the main body may be formed by a folding of a rectangular metal sheet in a cylindrical shape and by a bonding of two sides which are opposite each other, and the bonding may be made by a seaming, wherein, between the two sides which are seamed, a second gap which allows a communication between the internal space and the external space of the main body, and permits a movement of an approach and separation between the two sides may be provided, and a second contact portion which blocks the second gap when the two sides are closest to each other may be provided.

(10) In the floating body according to (9), the number of turns of the seaming between the two sides may be equal to or greater than two.

(11) In the floating body according to (10), the second contact portion may be a line contact portion between the two sides.

(12) Another aspect of the invention provides a floating body which is accommodated in a float chamber of a floating roof of a floating roof-type tank, the floating body including: a main body which is formed by a folding of a rectangular metal sheet in a cylindrical shape and by a bonding of two sides which are opposite each other; and a lid which is fixed to cover an opening of the main body, wherein the bonding is made by a seaming, and wherein, between the two sides which are seamed, a third gap which allows a communication between an internal space and an external space of the main body, and permits a movement of an approach and separation between the two sides is provided, and a third contact portion which blocks the third gap when the two sides are closest to each other.

(13) In the floating body according to (12), the number of turns of the seaming between the two sides may be equal to or greater than two.

(14) In the floating body according to (12), the third contact portion may be a line contact portion between the two sides.

Advantageous Effects of Invention

[0009] According to the floating body described in (1) of the aspect, the floating body is excellent in fire resistance, and can maintain adequate buoyancy even if there is change in temperature of surrounding environment.
This will be described. Since the floating body according to the aspect is made of a metal, fire resistance is incomparably more excellent compared to a conventional resin floating body. Moreover, it is necessary to take care that merely forming a metal floating body instead of a conventional resin floating body is not enough to solve the above-described problems.

Specifically, when it is assumed that a metal floating body is merely filled with air and sealed so as to obtain buoyancy, and when a fire breaks out and the metal floating body is heated by the fire for example, the sealed air is heated and the internal pressure unavoidably increases. In a metal floating body in which the degree of deformation when the internal pressure is applied is restricted compared to a resin floating body, when the internal pressure exceeds an allowable value, the floating body may be broken.
On the other hand, in the floating body according to the aspect, since the first gap which permits the movement of the approach and separation between the main body and the lid is provided, when an excessive increase in the internal space occurs, the lid can be slightly separated from the main body using the internal pressure so as to secure the first gap. An excessive internal pressure in the internal space of the floating body can be released toward the external space through the first gap. Since this adjustment function can be attained only with the seaming without using an extra component, such as a safety valve, this contributes to a production at low cost and a reduction in weight of the floating body itself.
In the floating body according to the aspect, even if an excessive increase in the internal pressure by heating does not occur, the liquid acts on the floating body as an external pressure when the liquid enters the float chamber. The lid to which the external pressure is applied performs a slight approach movement as being pressed against the main body, and as a result, the first gap is automatically blocked in the first contact portion. Therefore, since the air is sealed in the internal space of the floating body, sufficient buoyancy can be obtained.

[0010] According to a floating roof using the floating body described in the aspect, a plurality of floating bodies, in which the fire resistance is excellent, the deformation such as expansion or contraction is suppressed as compared to the conventional one even if the temperature changes to a required extent, and the adequate buoyancy can be maintained, are accommodated in the float chamber. Therefore, even if the float chamber gets broken by a fire or the like, a state where the floating roof is floated on the liquid stored in the floating roof-type tank can be maintained due to the buoyancy of the floating body.

Brief Description of Drawings

[0011]

FIG 1 is a longitudinal sectional view showing a floating roof in which a floating body according to an embodiment of the invention is accommodated in a pontoon and a floating roof-type tank.
FIG. 2 is a longitudinal sectional view showing a state where a liquid storage material stored in a floating roof-type tank shown in FIG 1 enters a pontoon of a floating roof.
FIG 3A is an exploded perspective view showing a main body and a lid which constitute the floating body according to the embodiment.
FIG 3B is a front view of the floating body.
FIG 4A is a diagram showing an opening of a cylinder and an edge portion of a lid before seaming of the floating body and is an enlarged sectional view showing a portion corresponding to a portion A of FIG 3B.
FIG 4B is a diagram showing an opening of a cylinder and an edge portion of a lid after seaming of the floating body and is an enlarged sectional view of the portion A of FIG. 3B.
FIG 4C is a diagram showing the shape of an opening of a cylinder after seaming of the floating body and is an enlarged sectional view of the portion A of FIG. 3B.
FIG 4D is a diagram showing the shape of an edge portion of a lid after seaming of the floating body and is an enlarged sectional view of the portion A of FIG. 3B.
FIG 5 is a diagram showing a gap which allows communication between an internal space and an external space of the floating body and is an enlarged sectional view of the portion A of FIG 3B.
FIG 6A is a diagram showing a state of a gap when an external pressure is applied to a cylinder and is an enlarged sectional view of a portion corresponding to the portion A of FIG 3B.
FIG 6B is a diagram showing a state of a gap when an internal pressure is applied to a cylinder and is an enlarged sectional view of a portion corresponding to the portion A of FIG. 3B.
FIG 7A is a plan view before a lid is attached to a cylinder of the floating body.
FIG. 7B is a diagram showing a state of a gap when an internal pressure is applied to a cylinder and is an enlarged sectional plan view of a portion corresponding to a portion B of FIG. 7A.
FIG 7C is a diagram showing a state of a gap when an external pressure is applied to a cylinder and is an enlarged sectional plan view of a portion corresponding to the portion B of FIG 7A.

Description of Embodiments

[0012] Hereinafter, although respective embodiments according to the invention will be described in detail referring to the drawings, it should be noted that the invention is not limited to the configuration of the following embodiments, and various alterations may be made without departing from the scope of the invention. In the drawings which are used in the following description, in order to easily understand the features of the invention, for convenience, a main part may be enlarged, and the dimension ratios or the like between respective constituent elements are not necessarily equal to the actual ratios.

[First Embodiment]

[0013] FIG 1 is a longitudinal sectional view showing a floating roof 200 in which a floating body 10 according to a first embodiment of the invention is accommodated in a pontoon 220 and a floating roof-type tank 100. In FIG 1, reference sign CL denotes a center axis line of the floating roof-type tank 100.

[0014] As shown in FIG 1, a liquid storage material OL, such as a petroleum product, is stored in the floating roof-type tank 100 according to the embodiment which has a cylindrical shape and has a bottom, and the floating roof 200 is floated on the liquid surface of the liquid storage material OL.

The floating roof 200 is formed of a steel sheet, and has a roof main body 210 having a disc shape, and a pontoon 220 which is formed in a ring shape along a top surface edge of the roof main body 210 and has a gradually increasing height outward from the center of the ring in a longitudinal sectional view.

The pontoon 220 includes an outer wall 220a having a cylindrical shape which is welded and fixed to the roof main body 210 so as to rise steeply upward in a vertical direction from the edge, an inner wall 220b having a cylindrical shape which is arranged so as to be concentric inside the outer wall 220a and which is welded and fixed so as to rise steeply upward in the vertical direction from the top surface of the central portion of the roof main body 210, and an upper wall 220c having a ring shape which is welded and fixed to the upper edges of the outer wall 220a and the inner wall 220b so as to close a space between the outer wall 220a and the inner wall 220b. The pontoon 220 has a float chamber E therein which is a cavity having a ring shape, and air sealed in the float chamber E can generate buoyancy. Accordingly, the entire floating roof 200 is floated to cover the top surface of the liquid storage material OL stored in the floating roof-type tank 100 by the buoyancy of the pontoon 220.

[0015] A predetermined gap G is provided between an outer circumferential surface 222 of the pontoon 220 and an inner circumferential surface 101 of the floating roof-type tank 100. A seal 221 having a ring shape is provided so as to be inserted in the gap G, and the gap G is filled, whereby the sealability of the upper opening of the floating roof-type tank 100 is maintained. For example, the seal 221 has a structure in which a cover sheet, such as nitrile butadiene rubber (NBR) or fluororubber, is formed in a floating tube and fixed to the outer circumferential surface 222 of the floating roof 200 (pontoon 220). The cover sheet has compressed urethane foam therein.

[0016] Multiple floating bodies 10 are accommodated in the float chamber E of the pontoon 220. In the embodiment, as the floating bodies 10, an 18-liter can which is made of a metal and which has a square shape (a rectangular parallelepiped shape) is used. The floating bodies 10 having the square shape are accommodated in the float chamber E of the pontoon 220 in a state of being plurally arranged and plurally stacked. In this way, the floating bodies 10 having the square shape are used and stacked without gap, whereby the multiple floating bodies 10 can be accommodated in the float chamber E in a state where spatial loss is less. As a result, even when the liquid storage material OL enters the float chamber E, the buoyancy of the floating roof 200 can be sufficiently secured.

[0017] Each floating body 10 moves into or out of the float chamber E through a manhole 223 formed on the upper wall 220c of the pontoon 220 for example, whereby installation into the float chamber E or extraction from the float chamber E for maintenance is possible. When installing each floating body 10 in the float chamber E of the pontoon 220, the floating bodies 10 may be merely stacked and installed, or may be bound each other so that the arrangement is not collapsed. Each floating body 10 after binding may be fixed to the inner wall, such as the bottom wall of the float chamber E. However, since binding or fixing is not essential in exhibiting the buoyancy of the floating body 10, in the embodiment, a configuration in which binding or fixing is not performed is illustrated.

Although the multiple floating bodies 10 are accommodated in the float chamber E of the pontoon 220, since the floating body 10 itself is hollow and lightweight, the buoyancy of the pontoon 220 as a whole can be maintained. A specific structure of the floating body 10 will be described below.

[0018] FIG 2 is a longitudinal sectional view showing a state where the seal 221 gets broken and lost due to vibration caused by sloshing (liquid surface vibration) or the like in the floating roof-type tank 100 shown in FIG. 1, a welded portion or the like of the pontoon 220 gets broken, and the liquid storage material OL enters the float chamber E from the broken portion.

[0019] As shown in FIG 2, when the liquid storage material OL enters the pontoon 220 until a liquid level So of the liquid storage material OL in the floating roof-type tank 100 and a liquid level Si in the pontoon 220 are substantially aligned with each other, the multiple floating bodies 10 which sink in the liquid storage material OL are floated together by the buoyancy thereof in the pontoon 220. The multiple floating bodies 10 which are floated in the liquid storage material OL entering the pontoon 220 hit the bottom surface of the upper wall 220c of the pontoon 220 and are supported from the below. As a result, since the weight of the floating roof 200 can be supported by the buoyancy of each floating body 10, even if the liquid storage material OL enters the pontoon 220, a state where the floating roof 200 is floated on the liquid storage material OL can be maintained. Specifically, even if the liquid storage material OL enters the pontoon 220, the substantially entire liquid surfacel of the liquid storage material OL can be kept covered with the floating roof 200 excluding the portion of the gap G

[0020] As described above, in a state where the liquid storage material OL enters the pontoon 220, when a fire breaks out and ignites the liquid storage material OL, air in the float chamber E is heated to a high temperature. As a result, with the high-temperature air, each floating body 10 in the pontoon 220 is heated from the periphery. In this case, each floating body 10 is not broken, such as molten, due to the fire resistance of the metal floating body 10 itself, and the buoyancy is maintained. As a result, even if a fire breaks out, a state where the floating roof 200 is floated on the liquid storage material OL stored in the floating roof-type tank 100 as a whole can be maintained.

[0021] As described above, even if the pontoon 220 gets broken due to sloshing or the like, and the liquid storage material OL enters the float chamber E, it is necessary for the floating roof 200 to be floated while covering the top surface of the liquid storage material OL stored in the floating roof-type tank 100. In this state, when a fire breaks out, it is necessary for the floating roof 200 to be floated while covering the liquid level of the liquid storage material OL stored in the floating roof-type tank 100. In order to satisfy the demands, the airtightness needs to be compatible with the fire resistance in the floating body 10 itself which is accommodated in the float chamber E of the pontoon 220.

[0022] Subsequently, a structure of the floating body 10 according to the embodiment will be described below in detail. As shown in FIG. 3A, the floating body 10 (metal can) is made of a metal thin sheet (for example, a tin plate, tin-free steel, or the like), and has a structure in which a rectangular cylinder 11 (a metal cylinder forming a main body) with curves in four corner portions and a pair of lid sheets 12 and 13 (metal end sheets forming a lid) made of a metal thin sheet are combined as a unit.

[0023] The lid sheets 12 and 13 have the same shape, and have a rectangular shape in which four corners are curved so as to match the shape of openings 11x of the rectangular cylinder 11. The lid sheet 12 is bonded so as to close the upper opening 11x of the rectangular cylinder 11, and the lid sheet 13 is bonded so as to close the lower opening 11x of the rectangular cylinder 11. In this way, the upper and lower openings 11x of the rectangular cylinder 11 are closed by the lid sheets 12 and 13, whereby air can be sealed in the floating body 10.

[0024] In each of four sidewall surfaces 11y of the rectangular cylinder 11, a pair of vertical reinforcing beads 111 which are formed between both the upper and lower openings 11x, a pair of horizontal reinforcing beads 112 which extend in a direction intersecting the reinforcing beads 111, and a rectangular reinforcing portion 113 (commonly called a frame) which is formed so as to be surrounded by the vertical reinforcing beads 111 and the horizontal reinforcing beads 112 are formed by pressing. With the formation of the vertical reinforcing beads 111, the horizontal reinforcing beads 112, and the rectangular reinforcing portion 113, the four sidewall surfaces 11y are reinforced, and as a result, the entire rectangular cylinder 11 is structurally reinforced.

[0025] The rectangular cylinder 11 and the lid sheet 12 are bonded together, for example, by seaming shown in FIGS. 4A and 4B. Although bonding of the other lid sheet 13 is not particularly described, the lid sheet 13 is bonded to the rectangular cylinder 11 by double seaming similar to the lid sheet 12.

[0026] The seaming will be described. Before seaming, as shown in FIG 4A, a flange 11a is formed so as to extend while being curved gently from the inside toward the outside in one opening 11x of the rectangular cylinder 11. In an edge portion 12x of the lid sheet 12, an inclined portion 12x1 which rises obliquely upward along the inner surface of the flange 11a, a parallel portion 12x2 which is contiguous to the inclined portion 12x1 and is substantially parallel to the central portion of the lid sheet 12, and a curled portion 12x3 which is contiguous to the parallel portion 12x2 and is bent in an arc shape so as to extend from the top of the flange 11a toward the bottom are formed.

[0027] When forming the flange 11a in the opening 11x of the rectangular cylinder 11, the vertical reinforcing beads 111 (see FIG 3A) whose tip potion reaches the opening 11x as the end edge of the rectangular cylinder 11 are deformed so that a concave shape thereof returns to a flat surface in the tip portion of the flange 11a.

In a state where the flange 11a of the rectangular cylinder 11 is covered with the curled portion 12x3 of the edge portion 12x in the lid sheet 12, the lid sheet 12 is set in one opening 11x (end edge portion) of the rectangular cylinder 11. Then, double seaming is performed by a double seamer, which is not shown, in a state where the edge portion 12x including the curled portion 12x3 of the lid sheet 12 and the flange 11a of the rectangular cylinder 11 are stacked as a unit.

FIG. 4B shows a state after double seaming is performed in this way. As shown in FIG 4B, a seamed portion 18 is formed in the bonded portion of the opening 11x of the rectangular cylinder 11 and the edge portion 12x of the lid sheet 12. The portions of the vertical reinforcing beads 111 in the seamed portion 18 further return to flat due to pressing during seaming. Accordingly, in the vertical reinforcing beads 111, both tip portions are deformed to be flat by forming the flange 11 a and seaming, and a portion between both flat ends, specifically, a portion other than the seamed portion maintains the original concave shape, whereby a function as the vertical reinforcing beads 111 for reinforcement is exhibited.

[0028] The edge portion 12x of the lid sheet 12 and one opening 11x of the rectangular cylinder 11 are seamed by the double seamer using a double seaming method, and have a shape shown in FIG. 4B.

This shape will be described in detail. As shown in FIG 4C, the opening 11x of the rectangular cylinder 11 after double seaming includes an inclined portion 11x1 which is inclined obliquely from the inside of the rectangular cylinder 11 toward the outside, a first linear portion 11x2 which is contiguous to the inclined portion 11x1 and is formed in a linear shape along the longitudinal direction (up-down direction) of the rectangular cylinder 11, a first folded portion 11x3 which is contiguous to the first linear portion 11x2 and is folded in a U shape from the inside of the rectangular cylinder 11 toward the outside, and a second linear portion 11x4 which is contiguous to the first folded portion 11x3 and is formed in a linear shape along the longitudinal direction (up-down direction).

[0029] As shown in FIG. 4D, the edge portion 12x of the lid sheet 12 after double seaming includes a second folded portion 12x4 which is folded from the central portion of the lid sheet 12 toward the longitudinal direction (up-down direction) of the rectangular cylinder 11, a third linear portion 12x5 which is contiguous to the second folded portion 12x4 and is formed in a linear shape along the longitudinal direction, a third folded portion 12x6 which is contiguous to the third linear portion 12x5 and is folded in a U shaped from the inside of the rectangular cylinder 11 toward the outside, a fourth linear portion 12x7 which is contiguous to the third folded portion 12x6 and is formed in a linear shape along the longitudinal direction (up-down direction), a fourth folded portion 12x8 which is contiguous to the fourth linear portion 12x7 and is folded in a U shape from the outside of the rectangular cylinder 11 toward the inside, and a fifth linear portion 12x9 which is contiguous to the fourth folded portion 12x8 and is formed in a linear shape along the longitudinal direction (up-down direction).

[0030] Seaming is performed in the above-described shape in a state where the edge portion 12x of the lid sheet 12 and one opening 11x of the rectangular cylinder 11 are stacked, whereby the seamed portion 18 shown in FIG. 4B is formed. In general, double seaming refers to a method of winding of the curled portion 12x3 of the lid sheet 12 around the flange 11a of the rectangular cylinder 11, and of performing crimping and bonding. The lid sheet 12 and the rectangular cylinder 11 are respectively doubled, and this method is thus called double seaming.

In the seamed portion 18, one opening 11x (end edge portion) of the rectangular cylinder 11 which is folded so as to have a sectional U shape is engaged with the edge portion 12x of the lid sheet 12 which is folded twice and formed in a spiral shape. As a result, as shown in FIG. 5, in the seamed portion 18, a gap channel which includes four gaps 151, 152, 153, and 154 communicating with each other is formed between one opening 11x of the rectangular cylinder 11 and the edge portion 12x of the lid sheet 12 which are engaged with each other.

[0031] The gap channel will be described in detail. As shown in FIG. 5, the gap channel includes a gap 151a which directly communicates with the internal space of the rectangular cylinder 11 and has a curved shape, a linear gap 151 which is contiguous to the gap 151a and extends along the longitudinal direction (up-down direction) of the rectangular cylinder 11, a gap 154a which is contiguous to the gap 151 and is folded in a U shaped from the inside of the rectangular cylinder 11 toward the outside, a linear gap 154 which is contiguous to the gap 154a and extends along the longitudinal direction, a gap 153a which is contiguous to the gap 154 and is folded in a U shape from the outside toward the inside, a linear gap 153 which is contiguous to the gap 153a and extends along the longitudinal direction, a gap 152a which is contiguous to the gap 153 and is folded in a U shape from the outside toward the inside, and a linear gap 152 which is contiguous to the gap 152a, extends along the longitudinal direction, and directly communicates with the external space of the rectangular cylinder 11.

[0032] When the pontoon 220 gets broken and the liquid storage material OL enters the float chamber E, as shown in FIG 6A, the floating body 10 receives an external pressure P1 by the liquid storage material OL filling the external space from the periphery. The external pressure P1 is applied to the outer surface of the lid sheet 12, and the edge portion 12x of the lid sheet 12 is thus pressed against the opening 11x of the rectangular cylinder 11. For this reason, a line contact along the shape of the opening 11x occurs in a part (contact portions 161 and 162 in the drawing) of the gap channel, and as a result, the gap channel is blocked. With this blocking, since it is possible to sufficiently prevent the liquid storage material OL filling the periphery of the floating body 10 from entering the internal space of the floating body 10, the buoyancy of the floating body 10 is maintained.

[0033] On the other hand, for example, when a fire breaks out and the floating body 10 is heated from the periphery, as shown in FIG. 6B, air sealed in the internal space is heated and a rise in pressure (internal pressure P2) occurs. Since the internal pressure P2 makes the edge portion 12x of the lid sheet 12 be slightly separated from the opening 11x of the rectangular cylinder 11, a gap is formed in a location (locations of the reference signs 161 and 162) where the gap channel is blocked. As a result, the gap channel which has a substantially spiral shape and allows communication between the internal space and the external space of the floating body 10 is formed, whereby a rise in pressure in the internal space can be reliably release (be exhausted) to the external space. Therefore, the floating body 10 can maintain buoyancy without being broken. For example, even if size of the gap channel is small, since air (gas) has viscosity lower than the liquid storage material OL (liquid), aeration can be facilitated.

As described above, the edge portion 12x of the lid sheet 12 approaches to and is separated from the opening 11x of the rectangular cylinder 11, whereby the gap channel is opened or blocked.

[0034] When manufacturing a metal can as a general can container, after a seal material is put in the portions corresponding to the inclined portion 12x1, the parallel portion 12x2, and the curled portion 12x3 of the lid sheet 12, the lid

sheet 12 and the rectangular cylinder 11 are seamed, and the seal material is filled in the four gaps 151 to 154 which are formed in the seamed portion 18, whereby sealability increases. The reason for the use of the seal material is that, if leakage of a liquid stored in the metal can occurs, a function as a container may not be exhibited fully, and a structure without a seal material is improbable.
When manufacturing a metal can as the floating body 10 according to the embodiment, conversely, it is not preferable that a seal material is put in the inclined portion 12x1, the parallel portion 12x2, and the curled portion 12x3 of the lid sheet 12. This is because, if the seal material is put, the gaps 151 to 154 after seaming are buried by the seal material. Since a metal can is usually used as a container, a seal material is essential. Meanwhile, in the floating body 10 according to the embodiment, conversely, a configuration in which the gaps are positively formed without using a seal material, specifically, a configuration which may not be conceived from conventional knowledge is used.

[0035] The gap size of each of the four gaps 151 to 154 can be adjusted by an increase/decrease in seaming pressure by the double seamer. When the seaming pressure increases, the seaming thickness T (hereinafter, referred to as T size) of the seamed portion 18 shown in FIG 5 decreases, and the gap size of each of the four gaps 151 to 154 also decreases. When the seaming pressure decreases, the T size of the seamed portion 18 increases, and the gap size of each of the four gaps 151 to 154 also increases. The four gaps 151 to 154 in the seamed portion 18 becomes a channel of ventilation of gas (air) between the internal space and the external space of the floating body 10 forming a metal can. For this reason, if the gap size of each of the gaps 151 to 154 is set to an appropriate value, it is possible to sufficiently reduce the internal entering of the liquid storage material OL (liquid) (while maintaining the buoyancy), and to sufficiently suppress the deformation of expansion and contraction of the floating body 10 by heating during fire emergency of the floating roof-type tank 100 and cooling after fire extinguishment.

[0036] Hereinafter, the results when the floating body 10 is practically manufactured and a water immersion test and a heating-cooling test are performed will be described below. The floating body 10 (18-liter square can) as a square can made of a metal of the following size was manufactured by double seaming (the number of turns is two) using the rectangular cylinder 11 having the sheet thickness of 0.27 mm and provided with a pair of openings 11x and the lid sheets 12 and 13 having the sheet thickness of 0.32 mm. The T size in the seamed portion 18 of the floating body 10 was changed, and a water immersion test and a heating-cooling test of the floating body 10 were performed.

- the external size of three sides of the floating body 10: 350.0 mm x 238.0 mm x 238.0 mm (a tolerance of each side is within ±1.0 mm)
- the mass of the floating body 10: 1019 g
- the volume of the internal space of the floating body 10: 19.5 L (liter)

[0037] The average gap size (thickness) of the gaps 151, 152, 153, and 154 in a plane cross section at an intermediate position in a length direction along the direction of the approach and separation of the seamed portion 18 (referring to FIG. 5, when the length of the seamed portion 18 is ML, a position of 1/2 x ML from the end portion of the seamed portion 18) is defined as follows. When the sheet thickness of the rectangular cylinder 11 is S_1 in a unit of mm, the sheet thickness of the lid sheets 12 and 13 is S_2 in a unit of mm, the thickness of the seamed portion 18 is T in a unit of mm, and the number of turns of the seamed portion 18 is R, the average gap size (thickness) G is defined by a following Expression (1) in a unit of μm.

$$G = 1000 \times \{T - S_1 \times R - S_2 \times (R + 1)\} \div 2R \ldots \text{(Expression 1)}$$

[0038] First, the water immersion test of the floating body 10 will be described.
The thickness T of the seamed portion 18 was changed by 0.10 mm within a range of 1.70 mm to 2.70 mm. The floating body 10 was submerged in water and held for 48 hours. The amount of water entering the internal space of the floating body 10 after 48 hours was measured. The tests were carried out five times and the average value was obtained as the amount of leaked water. Table 1 shows the thickness T of the seamed portion 18, the average gap size G which is calculated from the Expression 1, and the amount of leaked water.

[0039] As shown in Table 1, in the floating bodies 10 having T = 1.70 mm (G = 50 μm) and T = 1.80 mm (G = 75 μm), the amount of leaked water was smaller than 30 ml. In the floating bodies 10 having T = 1.90 mm (G = 100 μm), T = 2.00 mm (G = 125 μm), T = 2.10 mm (G = 150 μm), and T = 2.20 mm (G = 175 μm), the amount of leaked water was approximately 100 ml. In the floating bodies 10 having T = 2.30 mm (G = 200 μm), T = 2.40 (G = 225 μm), and T = 2.50 mm (G = 250 μm), the amount of leaked water was approximately 200 ml to 300 ml. In the floating bodies 10 having T = 2.60 mm (G = 275 μm) and T = 2.70 mm (G = 300 μm), the amount of leaked water was 113 ml and 33 ml.

[0040] Table 2 shows the relationship between a water filling amount into the internal space of the floating body 10 and a submergence depth of the floating body 10 for confirmation. The submergence depth of the floating body 10 represents the degree of sinking when the floating body 10 with an arbitrary amount of water filled in the internal space is standing under water, and represents how depth the longest side (350.0 mm) from among the three sides of the floating body 10 is submerged from the water surface. As shown in Table 2, the submergence depth of the floating body 10 with 500 ml of water filled (leaked) is substantially the same as that of the floating body 10 with no water filled. Specifically, the water filling amount (amount of leaked water) of approximately 500 ml does not affect the buoyancy of the floating body 10, whereby the floating body 10 can maintain sufficient buoyancy.

[0041] Accordingly, it can be determined that all the floating bodies 10 having the thickness T of 1.70 mm to 2.70 mm in the seamed portion 18 shown in Table 1 have sufficient buoyancy. In particular, the floating bodies 10 having the thickness T equal to or smaller than 2.20 mm (the average gap size G is equal to or smaller than 175 μm) in the seamed portion 18 are preferable because water immersion can be sufficiently reduced while maintaining buoyancy.

[0042]

[Table 1]

NO.	T SIZE (mm)	AVERAGE GAP SIZE (μm)	AMOUNT OF LEAKED WATER (ml/48H)
1	1.70	50	6
2	1.80	75	27
3	1.90	100	98
4	2.00	125	108
5	2.10	154	97
6	2.20	175	100
7	2.30	200	213
8	2.40	225	318
9	2.50	250	291
10	2.60	275	113
11	2.70	300	33

[0043]

[Table 2]

SUBMERGENCE DEPTH OF FLOATING BODY (mm)	WATER FILLING AMOUNT (ml)
350	19000 (COMPLETELY SUBMERGED)
335	18000
315	17000
300	16000
285	15000
265	14000
250	13000
230	12000
215	11000
195	10000
180	9000
165	8000
145	7000
130	6000
115	5000

(continued)

SUBMERGENCE DEPTH OF FLOATING BODY (mm)	WATER FILLING AMOUNT (ml)
90	4000
75	3000
60	2000
45	1000
35	500
20	EMPTY CAN

[0044] The heating-cooling test of the floating body 10 was further performed, and the following test result was obtained.

(1) Test 1

[0045] The floating bodies 10 having T = 1.7 mm (G = 50 μm) and T = 1.9 mm (G = 100 μm) were heated to 750°C using an electric furnace and held for 8 hours and 30 minutes. Thereafter, slow cooling was carried out to 80°C over 16 hours in the furnace. After reaching 80°C, the floating bodies 10 were taken from the electric furnace and were cooled rapidly in the air. As a result, contraction deformation of the floating bodies 10 has slightly occurred. However, the contraction deformation is not contraction by which the buoyancy of the floating bodies 10 is decreased.

(2) Test 2

[0046] The floating body 10 having T = 1.8 mm (G = 75 μm) was heated to 750°C using an electric furnace and held for 8 hours and 30 minutes. Thereafter, slow cooling was carried out to 30°C over 40 hours in the furnace. After reaching 30°C, the floating body 10 was taken from the electric furnace. As a result, contraction deformation of the floating bodies 10 has not occurred.

(3) Test 3

[0047] The floating body 10 having T = 2.0 mm (G = 125 μm) was increased in temperature to 750°C using an electric furnace. Immediately after reaching 750°C, a heater of the electric furnace was turned off, and cooling was carried out to 300°C over 30 minutes in the furnace. After reaching 300°C, the floating body 10 was taken from the electric furnace and cooled in the air. As a result, while contraction deformation has not occurred in the floating body 10 when the floating body 10 was taken from the electric furnace (floating body temperature of 300°C), contraction deformation of the floating bodies 10 has slightly occurred during the cooling in the air. However, the contraction deformation is not contraction by which the buoyancy of the floating body 10 is decreased.

(4) Test 4

[0048] The floating bodies 10 having T = 2.1 mm (G = 150 μm) and T = 2.2 (G = 175 μm) were increased in temperature to 750°C using an electric furnace. Immediately after reaching 750°C, a heater of the electric furnace was turned off, and cooling was carried out to 300°C over 30 minutes in the furnace. After reaching 300°C, the floating body 10 was taken from the electric furnace and cooled in the air. As a result, contraction deformation of the floating bodies 10 has not occurred.

(5) Ring Fire Experiment of Pontoon 220 having Actual Size

[0049] The floating body 10 having T = 1.8 mm (G = 75 μm) was accommodated in the pontoon 220 having actual size, and a fire experiment was performed. The pontoon 220 was combusted for 12 hours in a ring shape along the outer circumferential portion. At this time, the highest end-point temperature of the floating body 10 inside the pontoon 220 became 750°C. After the pontoon 220 was naturally extinguished, the top sheet of the pontoon 220 was water-cooled, and the top sheet of the pontoon 220 was opened to rapidly cool the inside of the pontoon 220 in the air. As a result, while rapid cooling was carried out by 400°C for approximately 9 minutes which was from the time point of natural fire extinguishment (floating body temperature of 700°C) to the time point of the opening of the top sheet of the pontoon 220 (floating body temperature of 300°C), contraction deformation of the floating body 10 has not occurred. On the other hand, while the top sheet of the pontoon 220 was opened to rapidly cool the inside of the pontoon 220 in the air, contraction deformation of the floating body 10 has slightly occurred. However, the contraction deformation is not contraction by which the buoyancy of the floating body 10 is decreased.

[0050] The following was understood from the above-described results.

(1) All the floating bodies 10 having T = 1.7 mm (G = 50 μm), T = 1.8 mm (G = 75 μm), T = 1.9 mm (G = 100 μm), T = 2.0 mm (G = 125 μm), T = 2.1 mm (G =150 μm), and T = 2.2 mm (G = 175 μm) are not broken during heating to 750°C.
(2) In so far as the floating bodies 10 are gradually cooled after heating, contraction deformation (depression) does not occur in the floating bodies 10.
(3) In the floating bodies 10 having T = 2.1 mm (G = 150 μm) and T = 2.2 mm (G = 175 μm), contraction deformation (depression) does not occur even if rapid cooling after heating is performed.
(4) In the floating bodies 10 having T = 1.7 mm (G = 50 μm), T = 1.8 mm (G = 75 μm), T = 1.9 mm (G = 100 μm), and T = 2.0 mm (G = 125 μm), while contraction deformation occurs due to rapid cooling after heating, the contraction deformation is not contraction by which the buoyancy of the floating body 10 is decreased.

[0051] In general, as the seaming thickness T of the seamed portion 18 is large, the average gap size (thickness) G in the seamed portion 18 increases, and the channel of ventilation of gas (air) between the internal space and the external space of the floating body 10 is widened. For this reason, during heating and cooling, expansion and contraction deformation of the floating body 10 is suppressed. On the other hand, as the T size is small, the average gap size (thickness) G decreases, and sealability of the floating body 10 increases. For this reason, the entering of a liquid from the external space of the floating body 10 is suppressed, whereby the buoyancy of the floating body 10 can be adequately maintained over a long period of time.

[0052] Specifically, it is preferable that appropriate T size and average gap size G are set according to whether performance required for the floating body 10 is placed importance on the buoyancy (sealability) or on expansion and contraction deformation (aeration property) during heating and cooling. All the floating bodies 10 used in the tests satisfy performance relating to the buoyancy (sealability) and the expansion and contraction deformation (aeration property) required for the floating body 10. However, when either the sealability or the aeration property is placed importance, the T size and the average gap size G of the floating body 10 may be appropriately set according to the demand. As a result, deformation, such as expansion or contraction, due to change in temperature during fire emergency is further reduced, and adequate buoyancy can be maintained over a long period of time.

[0053] From the results of the water immersion test and the heating-cooling test, in the floating body 10 (18-liter square can) used in the tests, in order to further reduce the amount of immersion of a liquid while securing aeration of gas (air) to some extent, it is preferable that the T size is equal to or greater than 1.90 mm and equal to or smaller than 2.20 mm, specifically, the average gap size G is equal to or greater than 100 um and equal to or smaller than 175 μm. In particular, during fire emergency of the floating roof-type tank 100, in order to adequately maintain the buoyancy of the floating body 10 by sufficiently suppressing the expansion and contraction deformation of the floating body 10 and by suppressing the entering of a liquid into the floating body 10, it is preferable that the T size is equal to or greater than 2.1 mm and equal to or smaller than 2.2 mm, specifically, the average gap size G is equal to or greater than 150 μm and equal to or smaller than 175 μm.

[0054] While the preferred range of the T size is a value which changes depending on the sheet thickness of the rectangular cylinder 11 and the lid sheets 12 and 13 used in the floating body 10 and depending on the number of turns, the preferred range of the average gap size G is the average size (thickness) of the gaps and is thus a value which does not depend on the sheet thickness of the floating body 10 and the number of turns. Accordingly, when the floating body 10 having a sheet thickness and the number of turns other than those used in the tests is used, the average gap size G of the floating body 10 may be controlled to become within the above-described preferred range.

[0055] Although, in the above-described tests, a metal can (18-liter square can) is used as the floating body 10, the invention is not limited thereto, and a metal main body and a metal lid having fire resistance may be seamed so that the internal space is hollow.

Although, in the above-described tests and the above-described embodiment, the floating body 10 in which the rectangular cylinder 11 (metal cylinder) and the lid sheets 12 and 13 (metal end sheets) are double-seamed (the number of turns is two) is used, the number of turns of the floating body 10 is not limited thereto, the number of turns may be changed as necessary.

[0056] In the above-described tests and the above-described embodiment, the two openings 11x of the rectangular cylinder 11 are seamed to the lid sheets 12 and 13 using the rectangular cylinder 11 having a pair of openings 11x and the lid sheets 12 and 13 in order to form the floating body 10. However, the number of seaming locations in the floating body 10 is not limited to two, an opening may be formed in at least one location, and a main body having an internal space and a lid may be seamed. In this case, since the entire length of a gap formed in a ring shape along the opening

11x of the floating body 10 is changed, the average gap size G may be controlled according to the change.

[0057] The sheet thickness of each of the rectangular cylinder 11 and the lid sheets 12 and 13 is not limited to the sheet thickness (the sheet thickness of the cylinder of 0.27 mm and the sheet thickness of the lid sheet of 0.32 mm) used in the above-described tests, and may be changed as necessary. However, it is preferable that the sheet thickness of each of the rectangular cylinder 11 and the lid sheets 12 and 13 is 0.20 mm to 0.32 mm. If a material having the sheet thickness within this range is used, the rectangular cylinder 11 and the lid sheets 12 and 13 can be seamed to manufacture the floating body 10 using a manufacturing apparatus for an existing can manufacturing process. For this reason, it is possible to suppress capital investment costs and to reduce manufacturing costs.

[0058] Although, in the above-described tests and embodiment, the floating body 10 having a square shape (rectangular parallelepiped shape) is used, the shape of the floating body 10 is not limited thereto. The shape of the floating body 10 may be a circular shape (a cylindrical shape, such as a drum) or other shapes. However, as described above, if the floating body 10 has a square shape, a plurality of floating bodies 10 can be accommodated in the float chamber E of the pontoon 220 in a state where spatial loss is less. For this reason, a greater buoyancy of the pontoon 220 can be preferably secured.

[0059] The floating body 10 according to the embodiment described above will be summarized below.

(1) The floating body 10 according to the embodiment is accommodated in the float chamber E of the floating roof 200 of the floating roof-type tank 100 and used. The floating body 10 includes the metal rectangular cylinder 11 (main body) in which the openings 11x are formed in two locations and which has an internal space, and the metal lid sheets 12 and 13 (lid) which cover the openings 11x and have the edge portions 12x attached to the openings 11x by the seaming. Moreover, between the openings 11x and the edge portions 12x, the gap channels (first gap) which allow the communication between the external space and the internal space of the rectangular cylinder 11 (main body), and permit the movement of the approach and separation between the rectangular cylinder 11 (main body) and the lid sheets 12 and 13 (lid) are provided, and the contact portions 161 and 162 (first contact portion) which block the gap channels (first gap) when the lid sheets 12 and 13 (lid) are closest to the rectangular cylinder 11 (main body) are provided.

[0060] (2) The rectangular cylinder 11 (main body) is the cylinder in which the number of the opening is two. The lid sheets 12 and 13 (lid) are respectively provided for the openings 11x of the cylinder by the seaming. The gap channels (first gap) and the contact portions 161 and 162 (first contact portion) are provided between the lid sheet 12 and one opening 11x to which the lid sheet 12 is attached and between the lid sheet 13 and the other opening 11x to which the lid sheet 13 is attached.

[0061] (3) The floating body 10 according to the embodiment is the square can made of the metal in which the cylinder 11 has the square shape and the lid sheets 12 and 13 (lid) have the rectangular shape.

(4) When the seamed portions 18 (portion at the seaming) are viewed by the cross section of FIG 5 including the direction of the approach and separation, the openings 11x of the rectangular cylinder 11 (main body) and the edge portions 12x of the lid sheets 12 and 13 (lid) are engaged with each other.

(5) The contact portions 161 and 162 (first contact portion) are the line contact portions which are formed in the ring shape along the openings 11x between the openings 11x and the edge portions 12x.

(6) The number of turns of the seaming is two. As described above, the number of turns of the seaming may increase as necessary.

[0062] (7) When the seamed portion 18 (portion at the seaming) between the openings 11x and the edge portions 12x are viewed by the cross section of FIG. 5 including the direction of the approach and separation, the gap channels (first gap) have the four gaps 151, 152, 153, and 154 (linear gap portions) along the direction of the approach and separation, and the three gaps 154a, 153a, and 152a (folded gap portions) which are folded to connect the gaps 151, 152, 153, and 154 (linear gap portions). When the gaps 151, 152, 153, and 154 (linear gap portions) are viewed at the intermediate position in the length direction thereof and at the position of 1/2 x ML of FIG 5 which is the position of the cross section intersecting the direction of the approach and separation, the average gap size of the gaps 151, 152, 153, and 154 (linear gap portions) is in the range which is equal to or greater than 100 μm and equal to or smaller than 175 μm.

[0063] (8) The sheet thickness of the rectangular cylinder 11 (main body) is in the range of 0.20 mm to 0.32 mm. The sheet thicknesses of the lid sheets 12 and 13 (lid) are in the range of 0.20 mm to 0.32 mm.

[Second Embodiment]

[0064] Subsequently, a floating body 10 according to a second embodiment of the invention will be described below. In the embodiment, since the structure of the rectangular cylinder 11 (main body) is particularly different from that in the first embodiment, description will be provided focusing on the difference. Other configurations are the same as those in the first embodiment, and an overlapping description will not be repeated here.

[0065] Although the rectangular cylinder 11 of the first embodiment has the structure in which the rectangular metal sheet is folded and molded in the rectangular square shape and two sides which are opposite each other are superimposed and welded, as shown in a portion B of FIG. 7A, in the embodiment, seaming is used instead of welding. This will be described below referring to FIGS. 7B and 7C.

[0066] As shown in FIGS. 7B and 7C, the rectangular cylinder 11 is a cylinder having a pair of openings 11x by connecting two sides 19x and 19y, which are opposite each other, of a rectangular metal sheet 19. The connection is seaming. Moreover, between the two sides 19x and 19y which are seamed, a cylinder gap 20 which allows a communication between the internal space and the external space of the rectangular cylinder 11, and permits a movement of the approach and separation between the opposing two sides 19x and 19y is provided, and cylinder contact portions 211 and 212 which block the cylinder gap 20 when the opposing two sides 19x and 19y are closest to each other is provided. Although it is preferable that the number of turns of the seaming is equal to or greater than two, in the embodiment, double seaming is illustrated. The number of turns of the seaming may be changed as necessary.

[0067] In the floating body 10 according to the embodiment, in addition to seaming between the openings 11x of the rectangular cylinder 11 and the edge portions 12x of the lid sheets 12 and 13, similarly, the rectangular cylinder 11 itself has a seamed structure in which a gap is provided without seal material. With this additional structure, it is possible to more reliably exhaust the air pressure of the internal space due to heating during fire emergency.

Specifically, as shown in FIG 7B, for example, when the pontoon 220 gets broken and the liquid storage material OL enters the float chamber E, the floating body 10 receives an external pressure by the liquid storage material OL filling the external space from the periphery. With this external pressure, since the two sides 19x and 19y, which are seamed, of the rectangular cylinder 11 are pressed, a line contact along the longitudinal direction of the rectangular cylinder 11 occurs in a part (the cylinder contact portions 211 and 212 in the drawing) of the cylinder gap 20, and as a result, the communication between the internal space and the external space of the rectangular cylinder 11 is blocked. With this blocking, since it is possible to sufficiently prevent the liquid storage material OL filling the periphery of the floating body 10 from entering the internal space of the floating body 10, the buoyancy of the floating body 10 is maintained.

As shown in FIG. 7C, for example, when a fire breaks out and the floating body 10 is heated from the periphery, air sealed in the internal space is heated and a rise in pressure occurs. Since the internal pressure makes the two sides 19x and 19y, which are seamed, of the rectangular cylinder 11 be slightly separated from each other, a gap is formed in the blocked location (locations of reference signs 211 and 212). As a result, the cylinder gap 20 which substantially has a spiral shape and allows the communication between the internal space and the external space of the floating body 10 is formed, whereby a rise in pressure in the internal space can be reliably release (be exhausted) to the external space. Therefore, the floating body 10 can maintain buoyancy without being broken. For example, even if size of the separation distance is small, since air (gas) has viscosity lower than the liquid storage material OL (liquid), aeration can be facilitated.

[0068] The floating body 10 according to the embodiment described above has the following configuration, in addition to the configuration according to the first embodiment.

(9) The rectangular cylinder 11 (main body) is formed by the folding of the rectangular metal sheet 19 in the rectangular cylinder shape and by the bonding of the two sides 19x and 19y which are opposite each other. The bonding is made by the seaming. Moreover, between the two sides 19x and 19y which are seamed, the cylinder gap 20 (second gap) which allows the communication between the internal space and the external space of the rectangular cylinder 11 (main body), and permits the movement of the approach and separation between the two sides 19x and 19y is provided, and the cylinder contact portions 211 and 212 (second contact portion) which block the cylinder gap 20 (second gap) when the two sides 19x and 19y are closest to each other are provided.

(10) The number of turns of the seaming between the two sides 19x and 19y is two. As described above, the number of turns of the seaming may increase as necessary.

(11) The cylinder contact portions 211 and 212 (second contact portion) are the line contact portions between the two sides 19x and 19y.

[0069] As a modification of the floating body 10 according to the embodiment described above, the floating body 10 may have a configuration in which bonding between the openings 11x of the rectangular cylinder 11 and the edge portions 12x of the lid sheets 12 and 13 is made by the welding, and the rectangular cylinder 11 may have a configuration in which bonding between the two sides 19x and 19y, which are opposite each other, of the rectangular metal sheet 19 is made by the seaming. In this case, performance relating to the buoyancy (sealability at the time of entering of a liquid into the pontoon) of the floating body 10 and to the suppression of the expansion and contraction deformation (aeration property at the time of heating from the periphery) is satisfied by the cylinder gap 20 which permits a relative movement of the approach and separation between the two sides 19x and 19y which are opposite each other and by the cylinder contact portions 211 and 212 which block the cylinder gap 20 when the two sides 19x and 19y which are opposite each other are closest to each other.

[0070] Specifically, in the modification, the following configuration may be used.

(12) The floating body 10 according to the modification is accommodated in the float chamber E of the floating roof 200 of the floating roof-type tank 100 and used. The floating body 10 includes the rectangular cylinder 11 (main body) which is formed by the folding of the rectangular metal sheet 19 in the rectangular cylindrical shape and by the bonding of the two sides 19x and 19y which are opposite each other, and the lid sheets 12 and 13 (lid) which are fixed to cover the

openings 11x of the rectangular cylinder 11 (main body). Moreover, the bonding is made by the seaming. Moreover, between the two sides 19x and 19y which are seamed, the cylinder gap (third gap) which allows the communication between the internal space and the external space of the rectangular cylinder 11 (main body), and permits the movement of the approach and separation between the two sides 19x and 19y is provided, and the cylinder contact portions 211 and 212 (third contact portion) which block the cylinder gap 20 (third gap) when the two sides 19x and 19y are closest to each other.

(13) The number of turns of the seaming between the two sides 19x and 19y is equal to or greater than two. As described above, the number of turns of the seaming may increase as necessary.

(14) The cylinder contact portions 211 and 212 (third contact portion) are the line contact portions between the two sides 19x and 19y.

Industrial Applicability

[0071] According to the aspects of the invention, since it becomes possible to provide a floating body which is excellent in fire resistance and can maintain adequate buoyancy even if there is change in temperature of surrounding environment, industrial applicability is high.

Reference Signs List

[0072]

10:	floating body (floating body, metal square can)
11:	rectangular cylinder (main body, cylinder)
11a:	flange
11x:	opening
12, 13:	lid sheet (lid)
12x:	edge portion
12x1:	inclined portion
12x2:	parallel portion
12x3:	curled portion
151, 152, 153, 154:	gap (linear gap portion, first gap)
152a, 153a, 154a:	gap (folded gap portion, first gap)
161, 162:	contact portion (first contact portion)
18:	portion at seaming
19:	metal sheet
19x, 19y:	two sides which are opposite each other
20:	cylinder gap (second gap, third gap)
211, 212:	cylinder contact portion (second contact portion, third contact portion)
100:	floating roof-type tank
200:	floating roof
210:	roof main body
220:	pontoon
221:	seal
223:	manhole
E:	float chamber
T:	seaming thickness

Claims

1. A floating body which is accommodated in a float chamber of a floating roof of a floating roof-type tank, the floating body comprising:

    a main body made of a metal in which an opening is formed in at least one location and which has an internal space; and
    a lid made of a metal which covers the opening and has an edge portion attached to the opening by a seaming, wherein, between the opening and the edge portion,
    a first gap which allows a communication between an external space and the internal space of the main body,

and permits a movement of an approach and separation between the main body and the lid is provided, and a first contact portion which blocks the first gap when the lid is closest to the main body is provided.

2. The floating body according to claim 1, wherein the main body is a cylinder in which a number of the opening is two, the lid is provided for each opening of the cylinder by the seaming, and the first gap and the first contact portion are provided between one lid and one opening to which the one lid is attached and between other lid and other opening.

3. The floating body according to claim 1, wherein the floating body is a square can made of a metal.

4. The floating body according to claim 1, wherein, when a portion at the seaming is viewed by a cross section including a direction of the approach and separation, the opening of the main body and the edge portion of the lid are engaged with each other.

5. The floating body according to claim 1, wherein the first contact portion is a line contact portion which is formed in a ring shape along the opening between the opening and the edge portion.

6. The floating body according to claim 1, wherein a number of turns of the seaming is equal to or greater than two.

7. The floating body according to claim 6, wherein, when a portion at the seaming between the opening and the edge portion is viewed by a cross section including a direction of the approach and separation, the first gap has a plurality of linear gap portions along the direction of the approach and separation, and folded gap portions which are folded to connect the linear gap portions, and when each of the linear gap portions is viewed at an intermediate position in a length direction thereof and by a cross section intersecting the direction of the approach and separation, an average gap size of the linear gap portions is equal to or greater than 100 μm and equal to or smaller than 175 μm.

8. The floating body according to claim 1, wherein a sheet thickness of the main body is in a range of 0.20 mm to 0.32 mm, and a sheet thickness of the lid is in a range of 0.20 mm to 0.32 mm.

9. The floating body according to any one of claims 1 to 8, wherein the main body is formed by a folding of a rectangular metal sheet in a cylindrical shape and by a bonding of two sides which are opposite each other, and the bonding is made by a seaming, and wherein, between the two sides which are seamed, a second gap which allows a communication between the internal space and the external space of the main body, and permits a movement of an approach and separation between the two sides is provided, and a second contact portion which blocks the second gap when the two sides are closest to each other is provided.

10. The floating body according to claim 9, wherein a number of turns of the seaming between the two sides is equal to or greater than two.

11. The floating body according to claim 10, wherein the second contact portion is a line contact portion between the two sides.

12. A floating body which is accommodated in a float chamber of a floating roof of a floating roof-type tank, the floating body comprising:

a main body which is formed by a folding of a rectangular metal sheet in a cylindrical shape and by a bonding of two sides which are opposite each other; and
a lid which is fixed to cover an opening of the main body,
wherein the bonding is made by a seaming, and
wherein, between the two sides which are seamed,

a third gap which allows a communication between an internal space and an external space of the main body, and permits a movement of an approach and separation between the two sides is provided, and
a third contact portion which blocks the third gap when the two sides are closest to each other.

13. The floating body according to claim 12,
wherein a number of turns of the seaming between the two sides is equal to or greater than two.

14. The floating body according to claim 12,
wherein the third contact portion is a line contact portion between the two sides.

FIG. 1

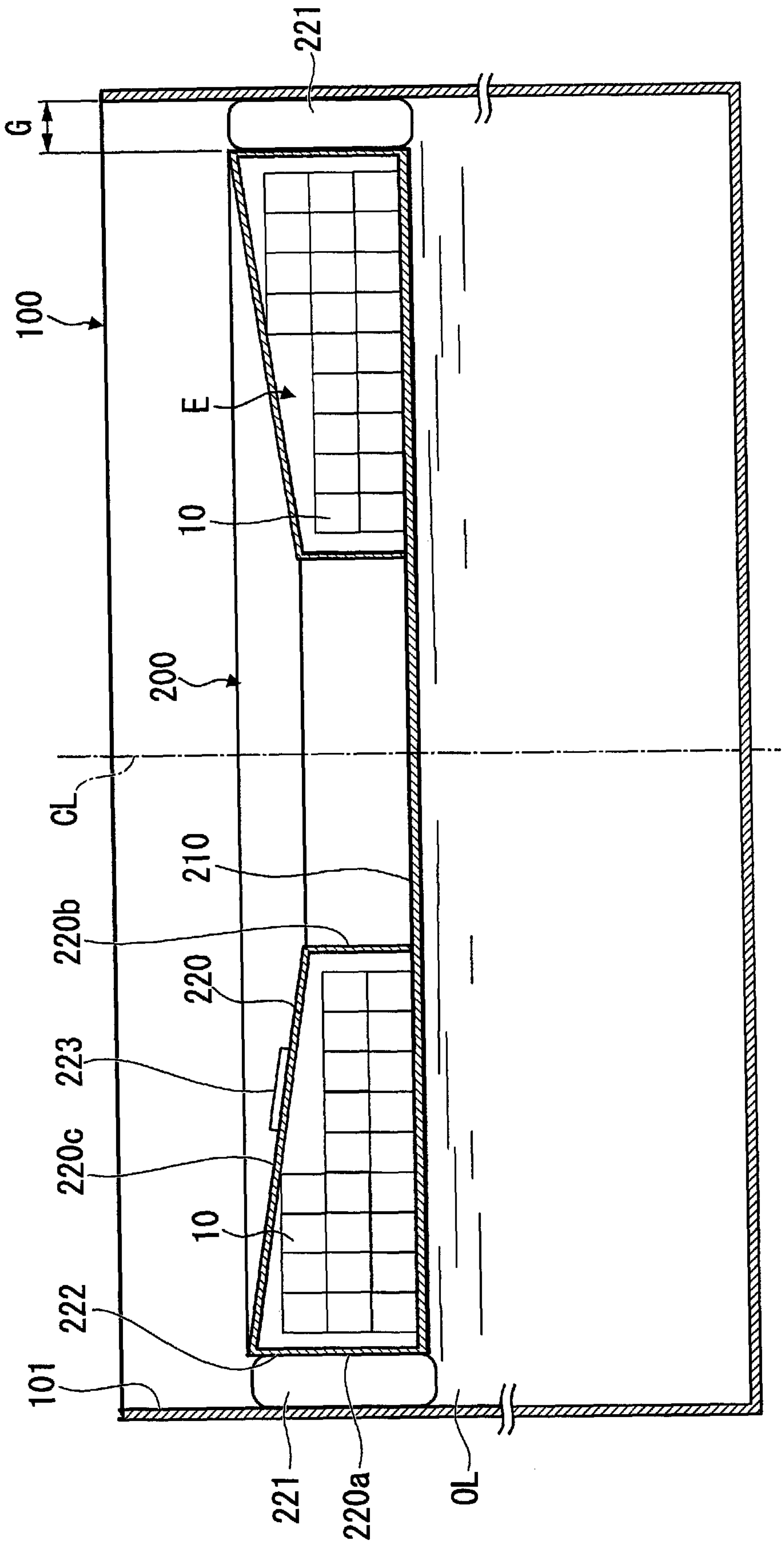


FIG. 2

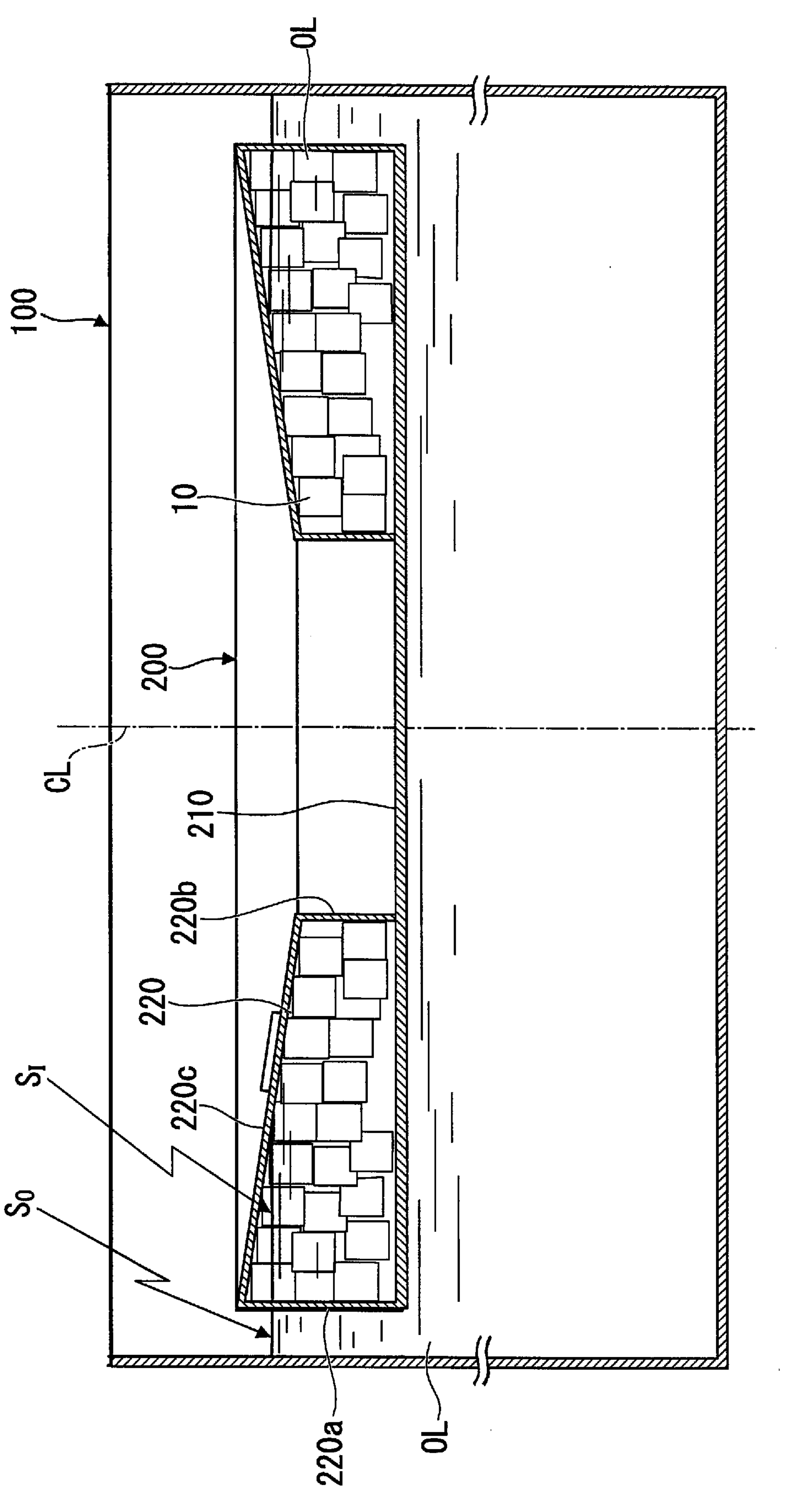


FIG. 3A

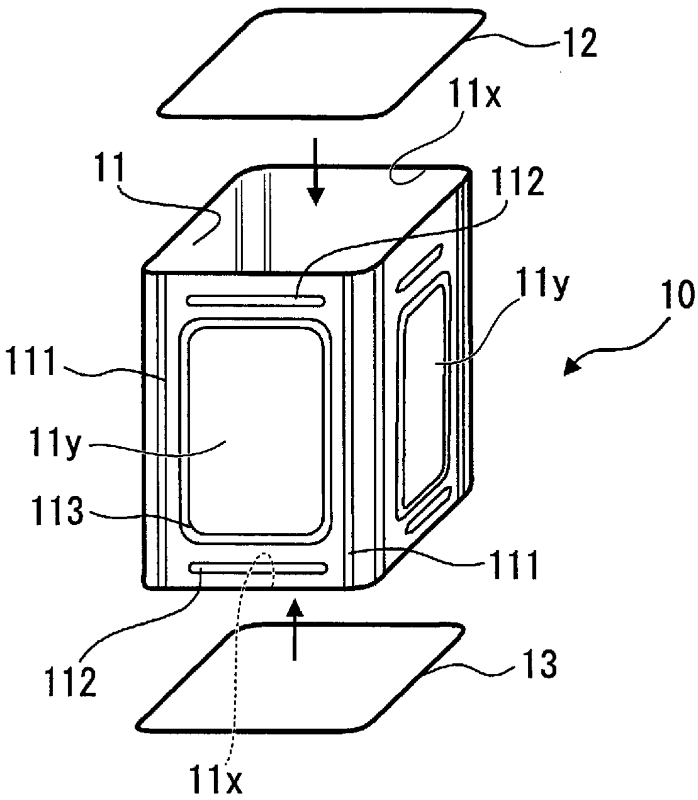


FIG. 3B

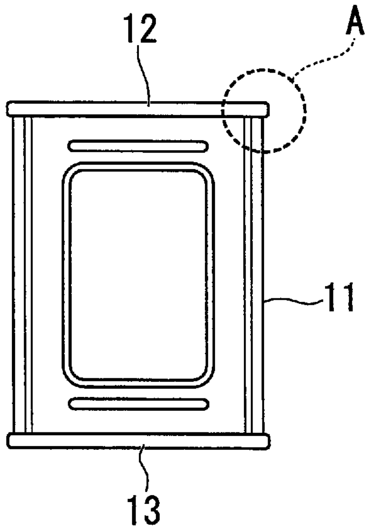


FIG. 4A

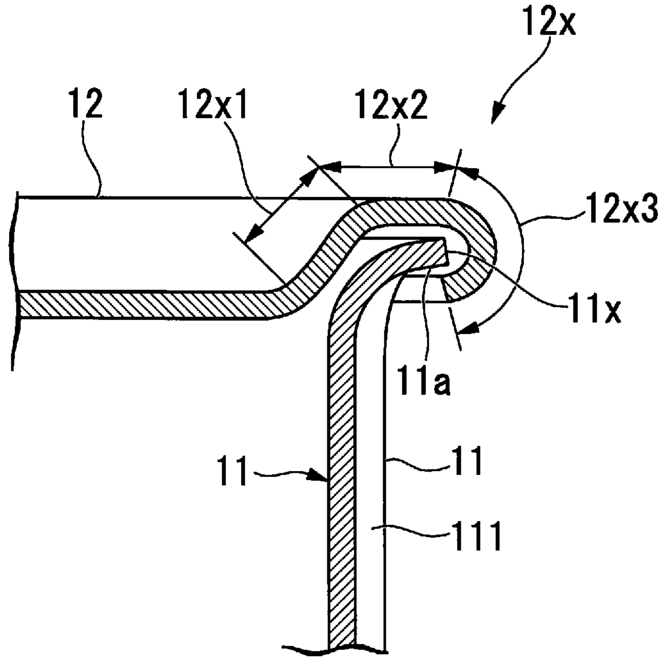


FIG. 4B

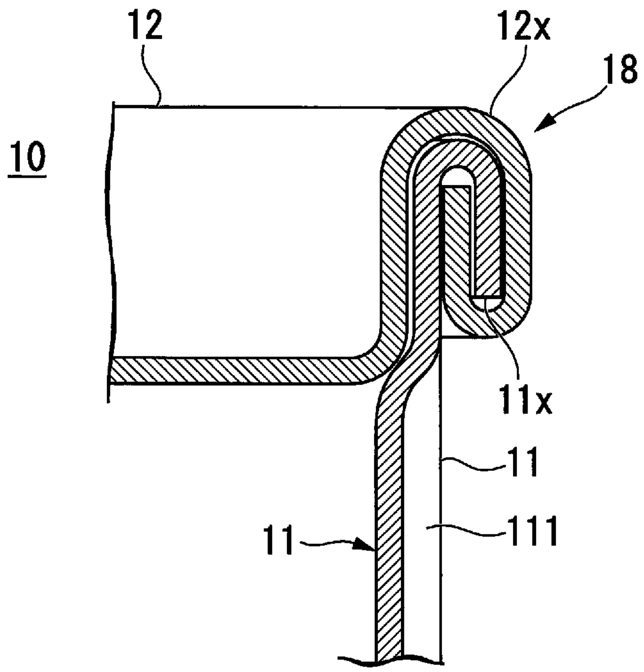


FIG. 4C

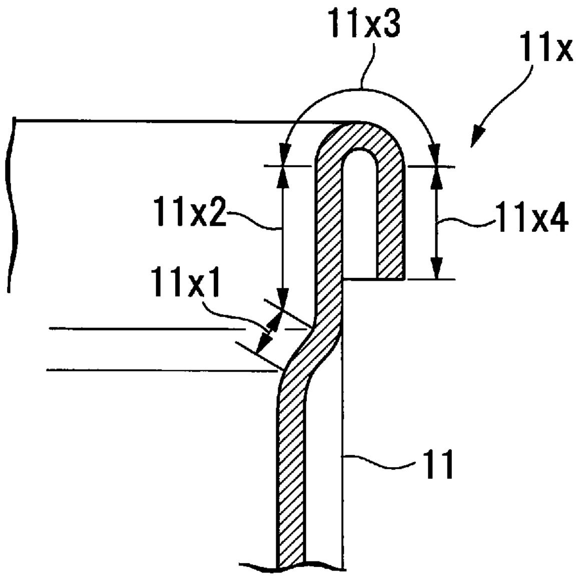


FIG. 4D

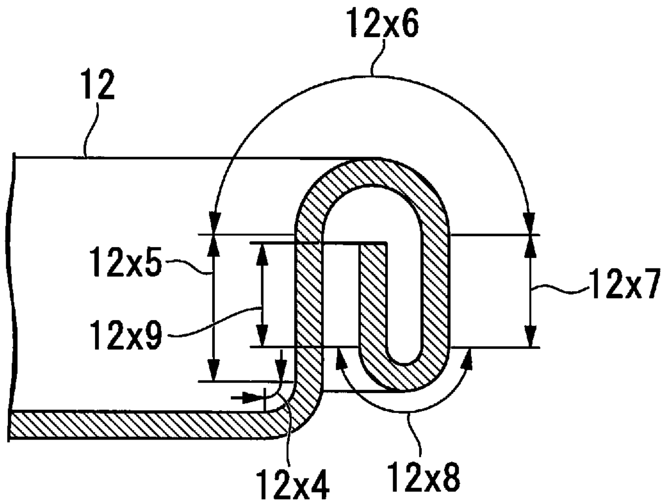


FIG. 5

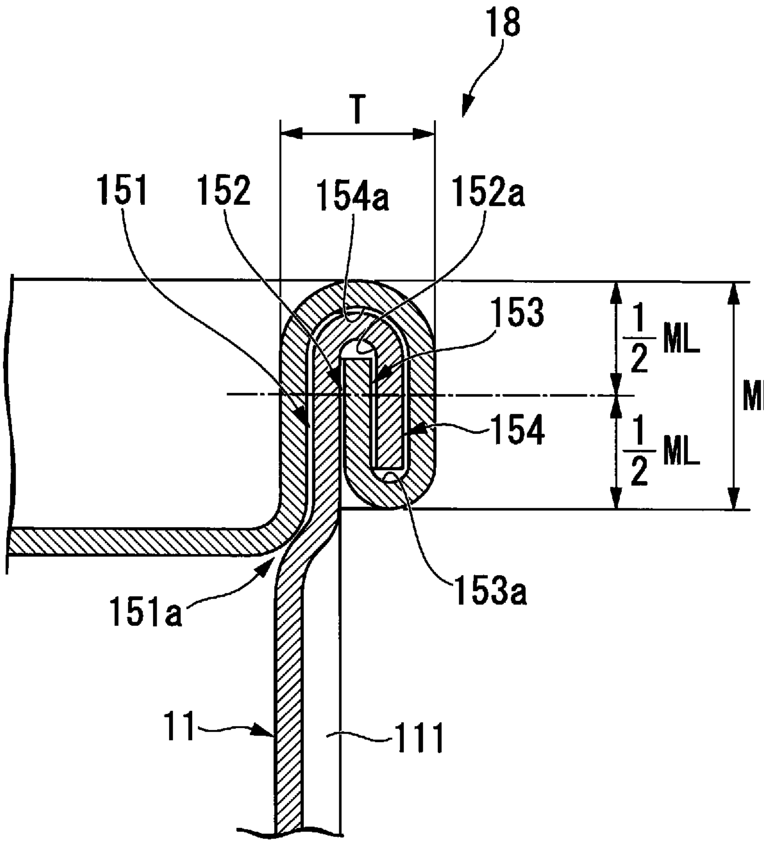


FIG. 6A

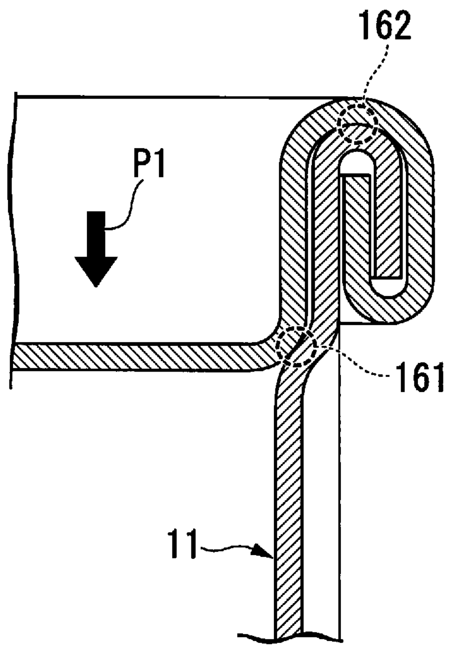


FIG. 6B

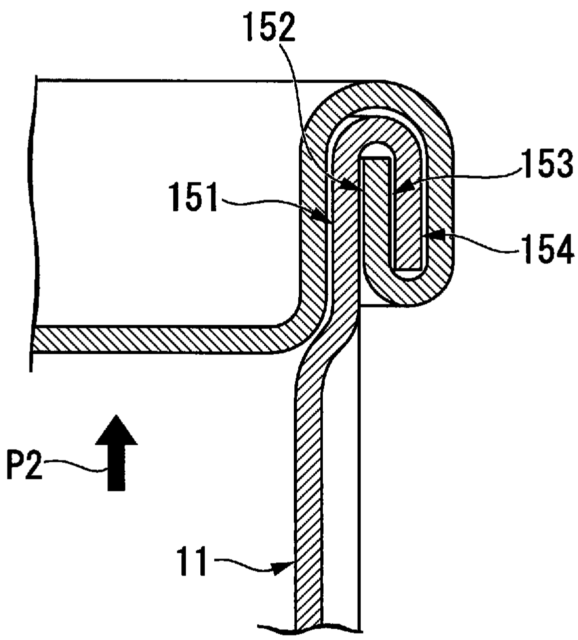


FIG. 7A

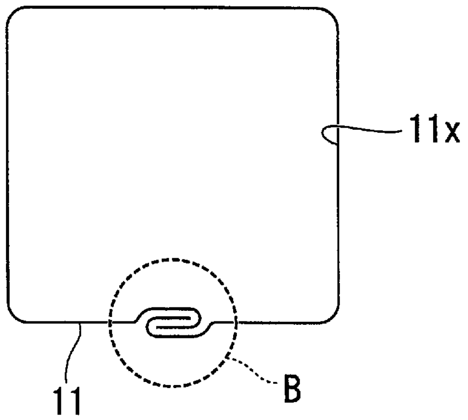


FIG. 7B

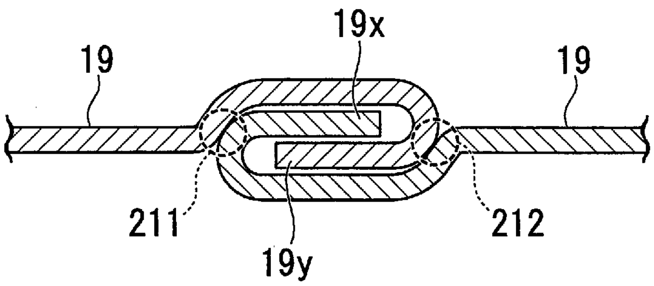
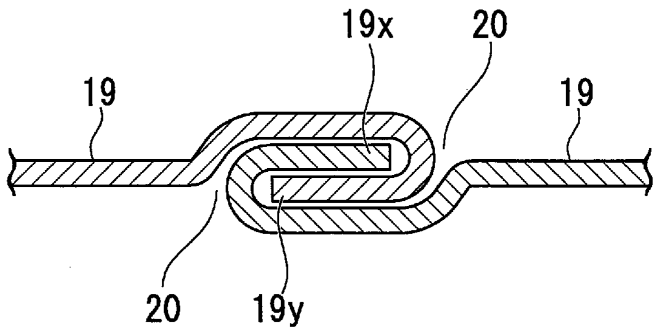


FIG. 7C



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/050446

A. CLASSIFICATION OF SUBJECT MATTER
B65D88/34(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B65D88/34

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2012
Kokai Jitsuyo Shinan Koho	1971-2012	Toroku Jitsuyo Shinan Koho	1994-2012

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 4229235 B2 (Kabushiki Kaisha Ishii Tekkosho), 25 February 2009 (25.02.2009), entire text; fig. 1 to 4 (Family: none)	1-6,8-14 7
Y A	JP 4172846 B2 (Fujita Corp.), 29 October 2008 (29.10.2008), paragraph [0010]; fig. 2, symbol 12 (Family: none)	1-6,8-14 7
Y A	JP 2006-26638 A (Honshuseikan Co., Ltd.), 02 February 2006 (02.02.2006), entire text; fig. 1 to 9 (Family: none)	1-6,8-14 7

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search
09 April, 2012 (09.04.12)

Date of mailing of the international search report
17 April, 2012 (17.04.12)

Name and mailing address of the ISA/
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/050446

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 54-39800 B1 (Toyo Seikan Kaisha, Ltd.), 29 November 1979 (29.11.1979), page 1, column 1, lines 25 to 30; fig. 1 to 4 (Family: none)	9-14 7
A	JP 4-11991 Y2 (Japan Insulation Co., Ltd.), 24 March 1992 (24.03.1992), entire text; fig. 1 to 9 (Family: none)	1-14
A	JP 4-239489 A (Misawa Homes Co., Ltd.), 27 August 1992 (27.08.1992), entire text; fig. 1 to 9 (Family: none)	1-14

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2011005735 A **[0001]**
- JP S5824867 B **[0004]**
- JP 2006143291 A **[0004]**