

Jan. 23, 1968

B. G. BENGTTSSON

3,364,644

EXPANSIBLE WALL STRUCTURE AND METHOD OF ERECTING SAME

Filed Feb. 19, 1965

3 Sheets-Sheet 1

FIG. 1

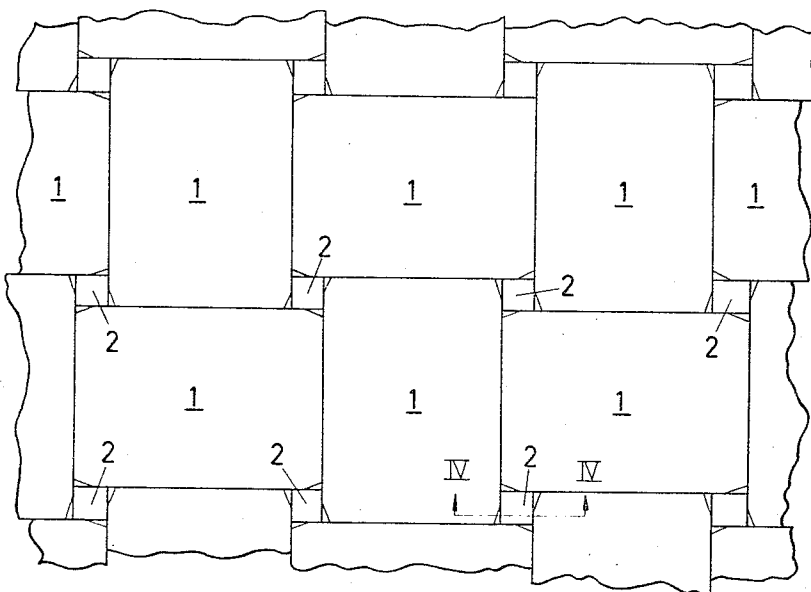
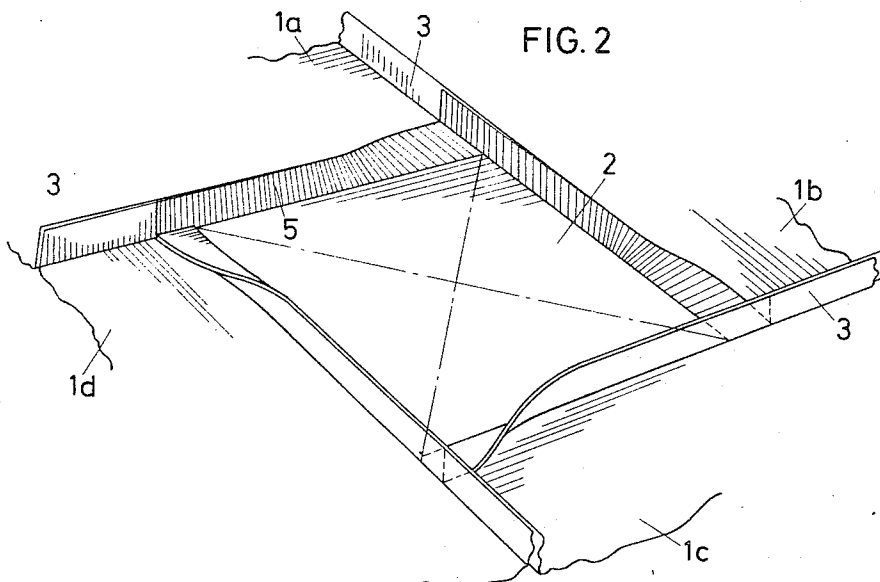


FIG. 2



INVENTOR.

Bengt Gunnar Bengtsson

BY

Pierre Scheffler & Parker
Attorneys

Jan. 23, 1968

B. G. BENGTTSSON

3,364,644

EXPANSIBLE WALL STRUCTURE AND METHOD OF ERECTING SAME

Filed Feb. 19, 1965

3 Sheets-Sheet 2

FIG. 3

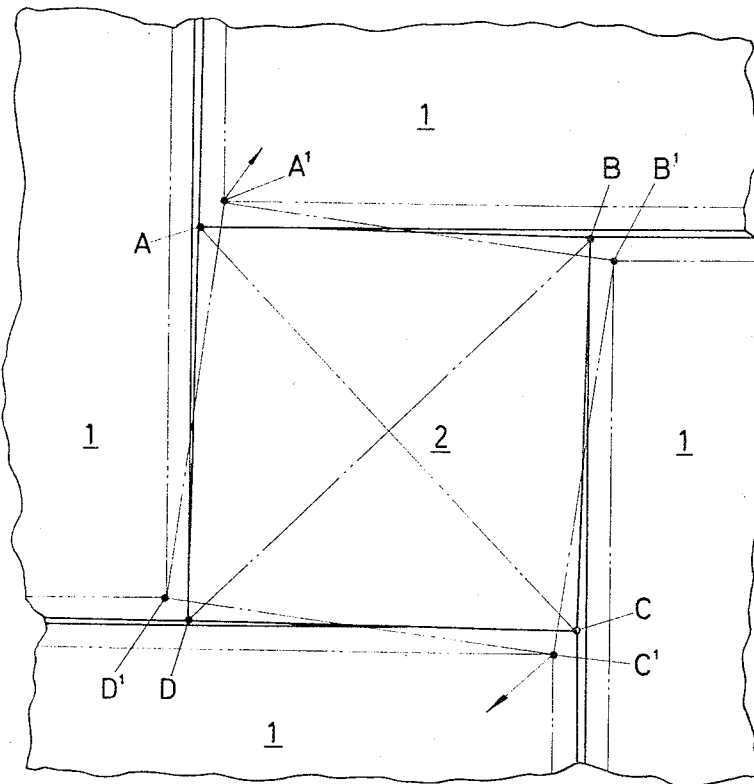
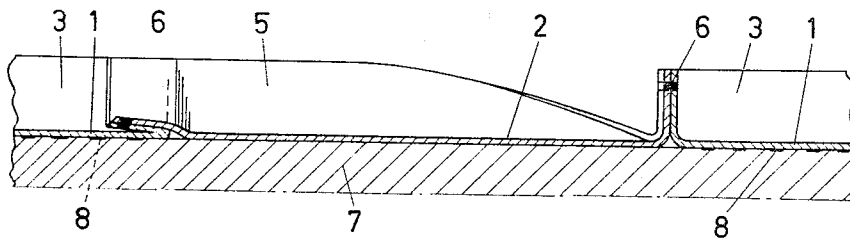


FIG. 4



INVENTOR.

Bengt Gunnar Bengtsson

BY

Pierre Scheffler & Parker
attorneys

Jan. 23, 1968

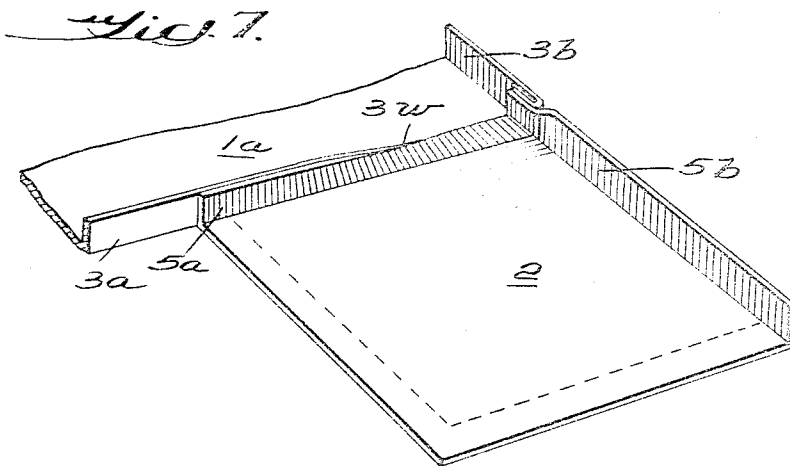
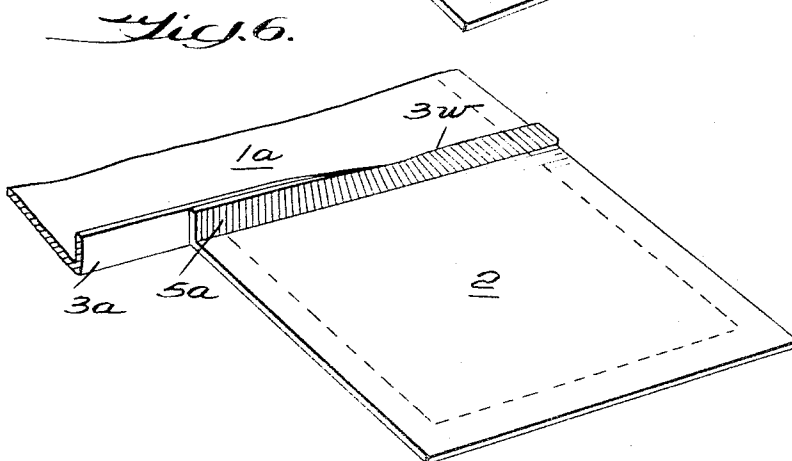
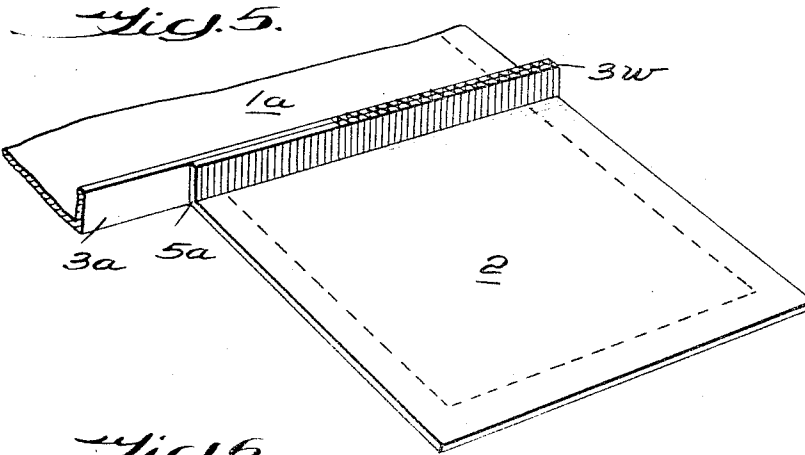
B. G. BENGTSSON

3,364,644

EXPANSIBLE WALL STRUCTURE AND METHOD OF ERECTING SAME

Filed Feb. 19, 1965

3 Sheets-Sheet 3



INVENTOR
BENGT GUNNAR BENGTSSON,

BY *Pierce, Schaffler & Parker*
ATTORNEYS

1

2

3,364,644

EXPANSIBLE WALL STRUCTURE AND METHOD OF ERECTING SAME

Bengt Gunnar Bengtsson, Goteborg, Sweden, assignor to Aktiebolaget Gotaverken, Goteborg, Sweden, a corporation of Sweden

Filed Feb. 19, 1965, Ser. No. 434,027

Claims priority, application Sweden, Mar. 7, 1964, 2,902/64

2 Claims. (Cl. 52—506)

ABSTRACT OF THE DISCLOSURE

In an expansible wall structure for tanks or containers composed of rectangular main plates and interposed square fitting plates, interconnected along their upturned rims the improved manner of fitting the wall structure to a support structure, which comprises arranging the main plates in a regular pattern in which a short side of one main plate abuts the long side of an adjacent main plate and bonding the main plates to the support structure while keeping the fitting plates free therefrom.

The transportation of large quantities of deeply cooled condensed gas in ships implies many difficulties of which the contraction and the expansion of the materials in the container are dominating factors. In practical use the container or tank—which beside staying or stabilizing members is detached and uninsulated—is surrounded by a cold space—a cofferdam—which is intended to receive gas possibly leaking from the container and also to facilitate an inspection of the walls of the container. The outside of the cofferdam is usually defined downwards by the double bottom and to its sides by an inner hull of the ship and above the tank by the deck. An insulating wrapping is usually attached to the surfaces of the container defining the space outwardly. In order to prevent cold gas, which possibly may leak from the container into the cofferdam from coming into direct contact with the insulation and with the steel plates of the ship the insulating wrapping is provided with a gas and liquid tight lining, usually called a "secondary barrier." As the tank is uninsulated this barrier will have essentially the same temperature as the tank and its content.

The lining may consist of thin sheets of a metal which is not brittle at low temperatures. This lining is usually not sufficiently rigid to be self-supporting. It is then carried by the insulating wrapping or by a support structure built thereinto. In practice it is very difficult to arrange the lining as a free layer on the insulation so that it may contract and expand freely. Major difficulties will be encountered below the tank, where the lining will be locked by the supports carrying the tank. A definite desideratum is therefore that the lining over the larger part of its surface shall be bonded to the supporting structure and further that it shall form a continuous receptacle having bottom and sides covering also the insulation below the tank. In such a design the lining must not during cooling down be subjected to high temperature strains, which may tend to tear the lining free from the support. The barrier shall of course at all temperatures be able to prevent the leakage of cold liquids, even if the tank is so damaged that it completely loses its carrying capacity.

Hitherto known wall structure adapted for this purpose have all suffered from the disadvantage that the "expansion bellows" in the lining, which take care of temperature movements, consist of complicated pleated members fitted between plane plates. These members, which often are broad and high make the wall expensive and difficult to manufacture. The expansion bellows must also be designed

in such a manner that they will stand the statical pressure of a fluid filled cofferdam.

It has also been proposed to increase the possibilities of thermal movements in the plane of a wall by making a large number of impressions in the surface of the plate which lessen the rigidity thereof. Such plates are, however, very expensive and only adapted to take care of moderately large temperature movements. It is impossible completely to avoid strains in the plate and after a number of temperature changes cracking of the material is likely to occur. Furthermore impressions or pleating of the material always means a weakening of the material.

One object of the invention is to design the component parts of the wall in such a manner that the wall is cheap in manufacture and easy to assemble.

A further object of the invention is to produce a wall structure which as a lining may be attached to a support structure and where only a small part must be free to move in relation to the support.

A still further object is to instruct in the method for erecting such walls.

In the drawings:

FIGURE 1 shows a plan view of a wall according to the invention adapted to be utilized in connection with insulating against cold.

FIGURE 2 is a perspective view of a fitting plate between some wall plate elements.

FIGURE 3 shows the same detail in a schematic view as seen from above.

FIGURE 4 is a section along line IV—IV in FIG. 1.

FIGS. 5, 6 and 7 are perspective views showing, in sequence, steps in securing together a wall plate and a fitting plate.

The lining according to FIG. 1 is composed of a number of rectangular main plates 1 of equal size, which are arranged in such a manner that the long sides of each plate abut short sides of other plates. The proportion between the long and the short sides of a plate is preferably so chosen that half the difference between the length and the breadth is essentially smaller than the breadth. By arranging the plates in a regular pattern with the short sides of some plates intermediate the ends of the long sides of other plates square spaces are obtained between the corners of the plates. These spaces are covered by fitting plates 2. The plates 1 as well as the fitting plates 2 are provided on all four sides with rim portions 3, 5, respectively, turned up essentially at right angles to the plane of the plate. The plates are arranged with their rim portions in contact with each other and a continuous seam welded or a series of closely arranged spot welds are made along the abutting edges of the rim portions in such a manner that the plates will be connected gas- and liquid-tight. A movement at right angles to the joint is possible as the walls of the pleat between the plates will open when the plates contract. For a wall adapted for heated containers the rim portions are folded at less than 90° in such a manner that the pleat may close when the plates expand. Both plates 1 and 2 are rectangular and the rims including the corners thereof are continuous.

As mentioned above the lining is composed in part of rectangular main plates 1 which are provided with up-turned rim portions 3, as indicated at 3a in FIG. 5. The fitting plates 2 will also be provided with similar up-turned rim portions 5, as more particularly shown at 5a in FIGS. 5, 6 and 7. The first step during mounting of a fitting plate 2 consists of bringing the up-turned rim portion 5a thereof into contact with the corresponding up-turned rim portions 3a of the long side of a first main plate element 1a (FIG. 2), with the edge of a short side of the plate 1 in alignment with a free edge of the fitting plate. Thereupon the rims 3 and 5 are welded together along about half the length of the side of the fitting plate start-

ing from the middle thereof and working towards a free end, as more particularly shown at 3w in FIG. 6.

Thereupon this joined portion is folded down against plate 1a in such a manner that these edge portions will come close to the adjacent still flat rim portion of the short side of plate 1a, as shown in FIG. 6. Thereafter the rim portion 3b of the short side of plate 1a is turned upwards together with the already connected parts of the long side thereof and of the fitting plate as shown in FIG. 7. The next step consists in bringing the upturned rim portion of a second main plate 1b towards the upturned edge 3b, 5b thus obtained for connection therewith.

It is to be noted that the aforesaid upturned edge 3b, 5b, constituting a first joint, includes also that portion of the joint between plate 1 and fitting plate 2 lying in the plane of said upturned portions.

Thereupon, a second main plate 1b is provided with an upturned rim portion along a long side of said plate 1b and this upturned rim portion is brought into contact with the aforesaid first joint 3b, 5b and with a free edge of plate 1b in alignment with a free edge of the fitting plate 2. The edges of the confronting rim portions of the main plate 1b and fitting plate 2 are then welded together along the full length of the side of the fitting plate 2, forming a second joint.

The so-joined portion between 1b and 2 (i.e., said second joint) is folded down against plate 1b in that part thereof adjacent the aligned free edges of 1b and 2, so that the extreme edge portion of said second joint overlies the adjacent rim portions of plate 1b and fitting plate 2. Then, the rim portions of plate 1b and fitting plate 2 which are contiguous with the just-mentioned folded-down second joint, are upturned, along with said jointed portion, and an upturned rim portion along the long side of a third main plate 1c is caused to abut against said upturned rim portions, with a free edge of the plate 1c in alignment with a free edge of fitting plate 2. The edges of the confronting upturned rim portions are then welded together along the full length of the side of fitting plate 2, thereby producing a third joint.

The main plate element 1d is connected to the fitting plate 2 in the same manner as plates 1b and 1c with the exception that before the rim portions of main plate element 1d are connected with the corresponding rim portions of the fitting plate, thereby forming a fourth joint, the rim portion of plate 1a is first completely folded down against the fitting plate 2. Hereafter the common rim portions of plates 1a, 1d and the fitting plate are folded back upwards and their confronting edges are welded together whereby simultaneously the remainder of aforesaid first joint along the first side of the fitting plate is closed.

The fourth joints along the sides of the fitting plate will thus not provide a continuous "ridge," but each seam changes character from vertical at one end to horizontal at the other. This means that at each corner of a fitting plate there is full possibility of expansion in one direction at one side whereas movement in the same direction at the other side of the same corner is limited.

The flexibility of the wall structure acts in the following manner, whereby it is presupposed that the fitting plates are free whereas the rectangular main plates are fixed in relation to a carrying support 7. This fixing of the plates may for instance be done by glueing 8. It is also presupposed that the connection to the support will not prevent a considerable temperature deformation of the plates, and the temperature deformation of the support will be uniform and not essentially change the center point of each plate. FIG. 3 shows the behaviour at the connection point (fitting plates 2) when the lining—which is fitted at normal temperature—contracts during heavy cooling. By the contraction of the separate plates 1 the corners A-D will move in the direction towards the center point of the cor-

responding plates to position A¹-D¹. The sides of the plates will be parallel before as well as after the contraction, even if the connection to the support should not keep this relationship. The fitting plates 2 which are free from the support must, due to their connection to the plates 1 perform a turning movement, which together with the flexibility obtained at the upturned rim portions guarantees that the plates may contract freely and without risk of cracking or leakage.

The wall structure above described, which in the embodiment shown has the character of a secondary barrier, may of course also be utilized for the container proper.

What I claim is:

1. A method for erecting an expansible wall structure for tanks or containers comprising a number of similar rectangular main plates of equal size and a number of square fitting plates of equal size having a side measure corresponding to half the difference between the length and the breadth of the main plates, said main plates and said fitting plates being made of a material with a high thermal coefficient and provided with upturned mutually interconnected rim portions and arranged in such a manner that a short side of one main plate abuts a long side of another plate, one fitting main plate being inserted at the meeting corners of every four main plates, comprising the steps of: placing an upturned rim portion of a long side of a first main plate in close relation to an upturned rim portion of a fitting plate with an edge of a short side of said first main plate in alignment with a free edge of said fitting plate adjacent the upturned rim portion thereof; welding the edges of the pertaining rim portions together starting from about the middle of the joint and working toward the aforesaid aligned edges thereby forming a partial first joint; folding the resulting partial first joint down in the plane of said first main plate; folding the outermost part of said folded down partial first joint upwards together with the adjacent rim portions of said first main plate and said fitting plate which include said aligned edges of the pertaining parts at right angles to said partial first joint; placing an upturned rim portion of a long side of a second main plate in close relation to the upturned rim portions of said fitting plate and short side of said first main plate with a free edge of said second main plate in alignment with a free edge of said fitting plate and welding the edges of the pertaining rim portions together to form a second joint at right angles to the partial first joint; folding the joined rim portions constituting the said second joint down in the plane of the second main plate; folding the outermost portion of said folded down second joint upwards together with the aligned edges of the second main plate and fitting plate at right angles to said second joint; placing an upturned portion of a long side of a third main plate in close relation to the upturned rim portions of said second main plate and fitting plate with an edge of a short side of said third main plate in alignment with a free edge of said fitting plate; welding the adjacent edges of the confronting rim portions together to form a third joint; folding the resulting joined rim portions down in the plane of the third main plate; folding the outermost part of said folded down third joint upwards together with aligned free edges of the third main plate and said fitting plate to form a continuous upturned rim portion; placing an upturned rim portion of a long side of a fourth main plate in close relation to said continuous upturned rim portion and with a free edge thereof overlying a bent-down rim portion of said first main plate; welding the confronting edges of said continuous rim portion and of the upturned rim portion of said fourth main plate to form a fourth joint; folding down the outermost part of said fourth joint in the plane of said fourth main plate, whereby a portion of said fourth joint overlies the adjacent rim portion of said fourth main plate and a folded down rim portion of said first main plate; folding said folded down outermost part of said fourth joint upwards together with the associated

5

rim portions of said first main plate and said fitting plate and said fourth main plate; and welding the opposed edges of said rim portions together to complete said first joint.

2. An expansible wall structure for tanks or containers comprising an insulating support structure and a lining therefor made of a material with a high thermal coefficient, said lining consisting of a number of similar rectangular main plates of equal size provided with upturned rims, said main plates being arranged in a regular pattern in such a manner that a short side of one main plate abuts the long side of another main plate,

a number of square fitting plates of equal size also provided with upturned rims and having a side measure corresponding to half the difference between the length and the breadth of the main plates,

one fitting plate being inserted at the meeting corners of every four main plates and said main plates and associated fitting plates being liquid-tightly joined by weld seams along confronting edge portions of said upturned confronting rims on each fitting plate and four associated main plates whereby four ex-

6

pansible accordion pleats surround each fitting plate, each said accordion pleat being upright at one end thereof and gradually being bent to one side until its opposite end lies in a plane parallel to and immediately adjacent the confronting main plate and with its terminal edge folded into the upright end of the pleat normal thereto; and means bonding said main plates to said insulating support structure while the fitting plates are free therefrom.

References Cited

UNITED STATES PATENTS

1,799,234	4/1931	Huff	52—573 X
2,331,140	10/1943	Schmidt	52—573 X
2,736,400	2/1956	Gay et al.	52—573 X
3,184,094	5/1965	French et al.	220—5 X
3,215,301	11/1965	Armstrong	52—573 X

FRANK L. ABBOTT, *Primary Examiner.*

ALFRED C. PERHAM, *Assistant Examiner.*

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,364,644

January 23, 1968

Bengt Gunnar Bengtsson

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 24, "plate, one fitting main plate" should read -- main plate, one fitting plate --.

Signed and sealed this 9th day of December 1969.

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

WILLIAM E. SCHUYLER, JR.

Commissioner of Patents