YIELDABLE WALL ASSEMBLY FOR CONTAINERS FOR THE TRANSPORTATION OF LOW-TEMPERATURE FLUIDS

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10 Claims

ABSTRACT OF THE DISCLOSURE

A yieldable wall assembly adapted to be mounted via load-supporting insulation and thermally insulating bolt constructions upon the rigid wall of a tank in which the wall is formed by laterally and longitudinally contiguous coplanar sheet-metal main plates of relatively large area whose corners are cut at a bias of 45° to accommodate relatively small-area square corner plates, all of the plates having upwardly turned flanges welded together to form flanged seamless with gussets being provided in the flanged seams of the main plates at the junctions of these flanged seams with the corners of the auxiliary or corner plates. The gussets are formed by bending the flanges of the welded seam alternately inwardly and outwardly so that the upper edge of an outer fold of the flange of one main plate bears upon and is welded to the inwardly bent flange portion of a laterally or longitudinally contiguous main plate.

Our present invention relates to a container for the transportation of low-temperature fluids and, more particularly, to a tank or compartment in a seagoing vessel for the transportation of liquefied gases (e.g. methane) at low temperatures.

In the commonly assigned copending applications Ser. No. 664,066, filed Aug. 29, 1967, now Pat. No. 3,459,158 (entitled "Tank for Liquefied Gases"); Ser. No. 721,042 filed Apr. 12, 1968 and entitled "Yieldable Wall Assembly for the Transportation of Low-Temperature Fluids" and application Ser. No. 721,043 filed Apr. 12, 1968 and entitled "Yieldable Wall Assembly for the Transportation of Low-Temperature Fluids," there are disclosed tankships for the transportation of liquefied gases (e.g. liquid hydrocarbons) such as methane, ethane or propane, or air-refracting products (such as nitrogen or argon) with rigid hulls forming holds containing a plurality of tanks thermally insulated from the hull and having fluid-containing compartments which may be separated from the rigid wall by a continuous sheet-metal skin.

The skin, which may flex in response to temperature fluctuations is, as described in applications Ser. No. 664,066, now Pat. No. 3,459,158, composed of plates welded together in fluid-tight relationship along their peripheries at upstanding flanges so that the welded peripheries of the trys or plates form expansion joints or folds accommodating thermal expansion and contraction of the skin.

Between the sheet-metal skin and the hull of the ship, there is provided a filling of one or more layers of thermal insulation preferably of load-supporting or relatively incompressible character.

An earlier application, Ser. No. 663,577, filed Aug. 28, 1967 and also assigned to the owner of the present invention, describes an improvement in which insulating bolt assemblies attach the sheet-metal outer wall of a double-wall container to the hull of the ship via an intervening layer of load-supporting thermal insulation. As pointed out there, a further layer of insulation, preferably of the non-supporting type, may be interposed between the inner wall of the vessel and the intermediate sheet-metal layer. The bolt assembly comprises a bolt head welded sealingly to the sheet-metal layer and having a shank threaded into a cylindrical post of thermally insulating material, the post being threaded in a sleeve upstanding from and welded to the rigid wall or hull of the vessel.

In such arrangements, using an intermediate skin adapted to yield with temperature variations, plasticity is gained and stress is reduced by providing the sheet-metal wall of a plurality of plates in contiguous relationship, the plates having upturned flanges at the peripheries which are welded together at the corners of the plate to form individual pans or trays therefrom. The flanges of adjacent trays, which diverge upwardly are welded inwardly or outwardly turned lips to form a continuous partition or wall precluding passage of fluid therepast. The flanges, when welded together, form folds in the continuous wall which, like accordion plates, permit expansion and contraction of the sheets or trays in the plane thereof in response to the high-temperature fluctuations sustained by the walls upon filling of the tank with a low-temperature fluid or upon discharging the cargo.

Additional stress reduction is provided in accordance with the further improved description in application Ser. No. 721,043, filed Apr. 5, 1968 and entitled "Yieldable Wall Assembly for the Transportation of Low-Temperature Fluids." In that system, the stress developed in the individual plates, which are preferably welded together in contiguous relationship to form the continuous fluid-tight partition mentioned earlier, is relieved by offsetting the junctures between the plates, from plate to plate, along the continuous skin. This is accomplished by imparting to the plates a geometric configuration which corresponds substantially to a double trapezoidal joint at the corresponding small base. More specifically, the plates are provided with a pair of parallel end edges and a pair of inwardly directed lateral edges and are joined together in an interlocking overlapping relationship so that the juncture between a pair of end-aligned plates is located substantially intermediate the ends of the neighboring side-aligned plates. Thus the plates of the last-mentioned application are connected end-to-end in adjacent rows which are offset substantially by about half the length of the plates and each plate is widest at its end and narrowest at an intermediate region corresponding to the location of closest approach of the inwardly turned lateral sides. Preferably, this intermediate location lies at the center of the plate. A single bolt assembly (e.g. as described in copending application Ser. No. 721,042, entitled "Tank Assembly for the Transportation of Low-Temperature Fluids") secures each plate to the rigid wall at the center of the plate.

In the flexible sheet-metal skin arrangement of the character described, problems may remain with respect to the corner junctions of the several plates. Thus it appears that arrangements in which the flanges, upon welding together, form relative rigid sets restrict expansion and contraction in both mutually perpendicular directions in the plane of this wall with particular stressing at the corners. Furthermore, this phenomenon is all the more significant when the trys are generally rectangular.

An object of the present invention is, therefore, to provide a corner junction for the plates of a yieldable wall assembly for the purposes indicated which reduces the stress applied to the wall upon thermal dimensional fluctuations.

In the commonly assigned, concurrently filed application Ser. No. 729,049 filed by Rudiger von Saldern, one of the present joint inventors, and entitled "Yieldable Wall Assembly for Containers for the Transportation of
Low-temperature Fluids," there is described an arrangement whereby it is possible to describe the stresses arising from the arrangement of the plates or trays which are contiguous connected into the thermally expansive and contractible wall assembly. That system provides, at each intersection point of the orthogonally welded flanged seams, a corner junction which includes one or more gussets in the seam of at least one portions of the main plates and has its upturned flanges welded at their upper extremities to the welded seams of the adjoining flanges of the plates. Each of the corner plates, according to the invention, serves as the means for affixing the yieldable wall assembly to a rigid wall (e.g. the tankshell hull) and can be provided with a bolt construction of the type described in application Ser. No. 721,042. Thus, the present assembly can be considered to comprise a multiplicity of laterally and longitudinally contiguous main plates having edge flanges turned upwardly at angles of less than 90° as previously described and welded together to form mutually orthogonal arrays of welded flanged seams at the junctions of which square corner plates are disposed so that their diagonals are aligned with the flanged seams of the respective arrays, a plug-and-socket type of bolt construction being disposed at the intersection of these diagonals. The upturned flanges of the corner plates, which are also bent upwardly at angles of less than 90°, may be welded together to constitute the corner plates respective plates of the character described. Best results are obtainable when the square plates have sides of 100–300 mm. In length and are joined to the flanged seams of the main plates via prismatic or arcuate gussets as previously discussed. The bias edges of the main plates are welded to the sides of the corner plates over substantially the entire length thereof.

The above and other objects, features and advantages of the present invention will become more readily apparent from the following description, reference being made to the accompanying drawing in which:

FIG. 1 is a plan view illustrating a corner junction of a flexible wall assembly in accordance with the present invention;

FIG. 2 is a cross-sectional view taken generally along the line II—II of FIG. 1;

FIG. 3 is a detail view, drawn to an enlarged scale, of the corner construction at the junction between a corner plate and a main plate in accordance with this invention;

FIG. 4 is a cross-sectional view taken along the line IV—IV of FIG. 3.

FIG. 5 is a plan view of a larger portion of the flexible wall assembly illustrating the relationship of corner plates to main plates;

FIG. 6 is a vertical cross-sectional view through the bolt assembly of FIG. 2 illustrating its construction in greater detail; and

FIG. 7 is a cross-sectional detail view of a gusset (partly broken way) similar to that used in FIG. 1.

Referring first to FIG. 5, in which we show the overall construction of the yieldable wall assembly in plan view, it can be observed that the wall comprises a multiplicity of longitudinally contiguous plates 10, 11 and 12 whose opposite longitudinal ends are formed with upturned flanges 10′, 11′, 11″ and 12′. The flange 10′ at one end of plate 10 is welded to the flange 11′ at the opposite longitudinal side of the plate 11 along the weld seam 13 extending laterally. Similarly a lateral weld seam 13′ is formed between the opposite end flanges 11″ and 12′ of the plates 11 and 12. The longitudinal plate array 10, 11 and 12 is laterally welded to adjoining longitudinal array 10a, 11a and 12a on one side and 10b, 11b and 12b on the opposite side of the array 10, 11, 12. A further array of main plates is shown at 10c, 11c and 12c. At their laterally contiguous edges, the plates 10, 11 and 12 have flanges 14 and 14′ joined to the flanges 10a and 10b′, for example, by weld seams 15 and 15′ running in the longitudinal direction. Thus, the main plates are joined together by orthogonal arrays of laterally extending flanged seams 13, 13′, etc. and arrays of flanged seams 15, 15′, etc. extending in the lateral direction (upwards in FIG. 5.) The arrays of flanged seams would, in accordance with earlier practice, intercept at corner junctions which may be made flexible as described in the commonly assigned concurrently filed co-pending applica-
tion Ser. No. 729,049 or would have been relatively rigid. However, we have found that it is possible to eliminate such rigidity by cutting the corners of the main plates 10–10c, 11–11c and 12–12a at a bias as shown at the corners 16a, 16b, 16c and 16d of the plate 11. The cut is made at an angle α to the respective side of the main plates which, although shown to be square in FIG. 5, may also be rectangular. At each of these bias-cut corners, at which the angle α is preferably 45°, we provide an upwardly flanged 16a', 16b', 16c' and 16d' which adjoins the previously described flanges 11', 11'' at gussets 16 described in greater detail in connection with FIGS. 1–4. The bias-cut flanges 16a–16c are welded to the side of flanges 17, for example, of corner plates 17a, 17b, 17c and 17d at each of the corners of the main plate 11. The corner plates, which are square and have a side length of 100–300 mm., are provided with bolt assemblies generally represented at 20a, 20b, 20c and 20d at the intersection of the diagonals 18 and 19 of the corner plates (see corner plate 17b). The diagonals 18 and 19 are aligned with the seams 16 and 13 respectively.

Each bolt assembly is, according to this invention, of the type described in the copending application Ser. No. 721,042 and, as shown in FIG. 6, connects the sheet-metal skin via the respective corner plate 17a to the rigid wall 21 of the ship. A layer 22 of load-supporting thermal insulation, as described in application Ser. No. 664,066, is disposed between the sheet-metal skin and the wall 21 of the vessel to form a thermal barrier preventing heat loss from the tank compartment defined by the sheet-metal skin to the wall of the vessel. A typical insulating material is Ferrozel which is shear-resistant and compression-resistant glass fiber reinforced phenolic resin (see French Pat. 1,490,834). Each bolt assembly comprises an upwardly flanged internally threaded sleeve 23 which has a height equal only to a small fraction of the spacing of the plates 17a, etc., from the hull 21 and is welded peripherally to the latter along a seam 24. A post 25 of load-supporting material of poor thermal conductivity (e.g. Ferrozel or a ceramic thermal insulator) has a threaded portion 26 screwed into the sleeve 23 so that the outer periphery of the post 25 is flush with the outer periphery of this sleeve. The post 25 is formed with a stepped bore whose large-diameter portion 27 joins the small-diameter portion 28 at a shoulder 29 serving to anchor the head 30 of a pin 31 extending upwardly through the small-diameter portion 28 and having a frustoconical end 32. Each of the corner plates 17a, 17b, etc., is provided with a respective aperture 33 at the intersection of the diagonals 18 and 19, registering with the bore 27, 28 and with the internal cavity 34 of a cap 35 mounted upon the corner plate at this intersection. At its lower end, the cap 35 is formed with an outwardly extending annular flange 36 lying flat against the sheet metal of the corner plate 17a, 17b, etc. and preferably welded thereto at 37. Within the interior 34 of the cap 35, there is provided an inwardly open peripheral groove 38 which receives a spring ring 39 adapted to be wedged outwardly by the frustoconical upwardly extending end 32 of the bolt 31 until the cap 35 is thrust over this bolt. Behind the frustoconical end 32, the bolt or pin 11 is formed with an outwardly open circumferential groove 40 adapted to receive part of the ring 39 when the latter springs back after it has been wedged outwardly. To support the bolt 31, there is provided a cylindrical backing block 41 which fills a large portion 27 of the bore of post 25 as it is seated against the hull 21 of the vessel.

As has been described in application Ser. No. 721,042 and as can be seen from FIG. 6 of the present case, the frustoconical end 32 of the pin 31 has an outer diameter which is less than the inner diameter of the ring 39 in its relaxed position. After the cap 35 is welded in place upon its corner plate 17a, 17b, etc., these plates may be placed with their apertures 33 over the pins 31 and set by relatively light hammer taps upon the caps 35. The taps drive the caps 35 over the frustoconical tapers 32 of the pins 31 until the rings 39, which initially are spread outwardly, spring back into the respective grooves 40, thereby retaining the plates upon the pins. An externally rapid rate of assembly is thus permitted.

In FIG. 7, we have shown in somewhat greater detail the basic elements of the flanged seams of a yieldable wall assembly for tankships and the like adapted to carry low-temperature fluid such as methane.

The main plate 11 and the corner plate 17a thus have upwardly extending peripheral flanges which are represented in detail in FIG. 7 at 50 and 51 and are welded together about the periphery of each plate so as to impart a tray-like configuration to the plates. These flanges 50 and 51 have lips 52 and 53 which are turned generally toward one another (parallel to the plane of the plates 11 and 17a) and are welded together along seams 54. The flanges 50 and 51 diverge somewhat outwardly, having been folded up through angles β of less than 90°, and thus converge in the direction of a respective perpendicular plane P extending along the weld seam 54 perpendicularly to the plane of the plates 11 and 17a. The seam illustrated in FIG. 7 (in which the perpendicular plane P is shown to be vertical and orthogonal to the plane of the drawing) is designated at 55 and corresponds to the seams formed along each of the edges of the rectangular plates 11, etc. and 17a, etc. This seam is of triangular section and has an upper edge formed at 54 by the actual weld junction.

Upon shrinkage of the plates 11 and 17 (arrows 56 and 57), the flanges 50 and 51 are flattened somewhat as fully described in the commonly assigned copending application Ser. No. 721,043, entitled 'Yieldable Wall Assembly for the Transportation of Low-temperature Fluids.' According to the principles of the present invention, each of the weld seams 55 between each pair of laterally and longitudinally contiguous plates is provided, at its opposite ends with gussets 16, the gussets being geometrically similar to one another and of triangular prismatic or arcuate configuration, as described in greater detail in connection with FIGS. 1–4.

From FIGS. 1 and 2, it will be seen that each main plate is provided along its periphery with upwardly bent flanges 2 whose lips are welded together at 2'2 contiguously and in both lateral and longitudinal directions (see FIG. 5). The upwardly bent flanges 3 along the biased cut corners of the main plates are provided at their junctions with flanges 2 whose gussets 16 are here represented as consisting of outwardly bent portions 4 of one flange and inwardly bent portions 5 of the contiguous flange. In the gap between the upper edges 3' of the biased cut edges of the plates, the square corner plate 6 is inset so that its bent flanges 7 are welded at their upper edges or lips to the contiguous edge flanges 3 of the main plates. The corner plates 6 are attached by the bolt assemblies 8 of low-thermal conductivity to the rigid outer wall of the ship (see FIG. 6), the bolt assembly being located at the center of the corner plates 6. The gussets 16 at the corners of the junctions between the main plates 1 and the corner plates 6 increase the elasticity along the weld seams and provide direct stress along the latter. The stress is substantially uniformly distributed along the corner plates 6. As shown in FIGS. 3 and 4, the outer edges 4' and 5' are bent outwardly and inwardly in arcuate configuration and are welded along the bend to form a gusset 16 (FIG. 3). In this case, the stresses which otherwise might be concentrated along angular junctions are distributed more uniformly over the curved seam.

We claim:

1. A yieldable wall assembly for containers used in the transportation of low-temperature fluids, comprising a plurality of laterally and longitudinally contiguous octagonal sheet metal main plates each with two pairs of parallel main edges, each pair of edges being perpendicular to
the edges of the other pair, each of said plates having upwardly turned flanges along said edges, the distal edges of the flanges of adjacent plates being welded together along respective mutually orthogonal arrays of flanged seams forming main-edge junctions between the adjacent plates, and secondary edges of substantially less length than said main edges alternating with the main edges, said secondary edges being formed by the truncated corners of each plate and being disposed at a bias of 45° to said main edges; and a corner-junction structure wherein each of the truncated corners of the main plates are joined to the truncated corners of adjacent main plates, such junction being formed by providing each of the respective truncated secondary edges with an upwardly turned flange, said corner-junction structure also including a square corner plate of an area less than that of the main plates and having each of its edges of substantially the same length as each of said secondary edges and provided with an upwardly turned flange welded to the distal edge of an upwardly turned flange of said main-plate secondary edges along weld seams connecting said flanged seams, said upwardly turned flanges of each main plate being joined into a continuous peripheral flange, said main plates being arranged in straight rows at right angles to each other.

2. The assembly defined in claim 1 wherein said corner plate has sides of a length of 100 to 300 mm.

3. The assembly defined in claim 1 wherein each of said plates has a planar central portion surrounded by the respective flanges, said upwardly turned flanges being bent upwardly from the planar central portion of the respective plates to include an angle greater than 90°.

4. The assembly defined in claim 1, further comprising a gusset formed in each of the flanged seams of said main plates in the region of said corner plate for accommodating shrinkage of the wall assembly longitudinally of the flanged seams associated with the respective gussets.

5. The structure defined in claim 4 wherein each gusset is formed in a respective one of the flanged seams formed by a pair of said main plates and has an outer bend of the flange of the one plate of said pair and an inner bend of the adjoining flange of the plate of said pair whereby said one of said flanged seams has a respective perpendicular plane and the flanges thereof are welded together along a weld line bent alternately away from said plane and toward said plate at the gusset.

6. A yieldable wall assembly for containers used in the transportation of low-temperature fluids, comprising a plurality of laterally and longitudinally contiguous octagonal sheet metal main plates each with two pairs of parallel main edges, each pair of edges being perpendicular to the edges of the other pair, each of said plates having upwardly turned flanges along said edges, the distal edges of the flanges of adjacent plates being welded together along respective mutually orthogonal arrays of flanged seams forming main-edge junctions between the adjacent plates, and secondary edges of substantially less length than said main edges alternating with the main edges, said secondary edges being formed by the truncated corners of each plate and being disposed at a bias of 45° to said main edges; and a corner-junction structure wherein each of the truncated corners of the main plates are joined to the truncated corners of adjacent main plates, such junction being formed by providing each of the respective truncated secondary edges with an upwardly turned flange, said corner-junction structure also including a square corner plate of an area less than that of the main plates and having each of its edges of substantially the same length as each of said secondary edges and provided with an upwardly turned flange welded to the distal edge of an upwardly turned flange of said main-plate secondary edges along weld seams connecting said flanged seams, said upwardly turned flanges of each main plate being joined into a continuous peripheral flange, said main plates being arranged in straight rows at right angles to each other, said assembly further comprising a bolt assembly of low thermal conductivity connecting said corner plate with a rigid support wall.

7. The assembly defined in claim 6 wherein a layer of load-supporting thermal insulation is disposed between said yieldable wall assembly and said rigid wall and said bolt assembly includes a load-supporting post secured to said rigid wall and extending toward said corner plate, a pin anchored in said post and extending therebeyond away from said rigid wall, and a cap anchored to said corner plate for receiving an end of said pin projecting beyond said post.

8. The assembly defined in claim 7 wherein said cap is located substantially at the intersection of the diagonals of said corner plates and said corner plate is provided at said intersection with an aperture aligned with said cap, said cap and said pin being formed with spring-ring means for locking said cap onto said pin upon insertion of said pin into said cap.

9. The assembly as defined in claim 8 wherein said cap is formed with an inward open peripheral groove, said spring means including a resilient ring received in said groove, said end of said pin having a frustoconical configuration and being receivable in said ring to expand same, said pin being provided with an outwardly open circumferential groove behind said end to receive said ring upon its expansion by said end of said pin.

10. The assembly as defined in claim 9 wherein said post is composed of load-supporting thermal insulation.

References Cited

UNITED STATES PATENTS

3,184,094 5/1965 French et al. .................. 220—9
3,302,358 2/1967 Jackson ........................ 220—9

FOREIGN PATENTS

1,370,087 7/1964 France.
1,171,684 6/1964 Germany.

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