

Sept. 2, 1969

YOSHIO AKITA ET AL

3,464,175

LOW TEMPERATURE LIQUID STORAGE TANK

Filed May 26, 1966

2 Sheets-Sheet 1

FIG. 1 PRIOR ART

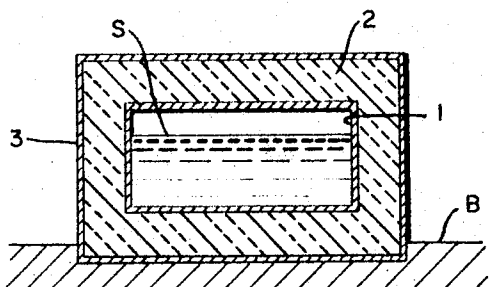


FIG. 2

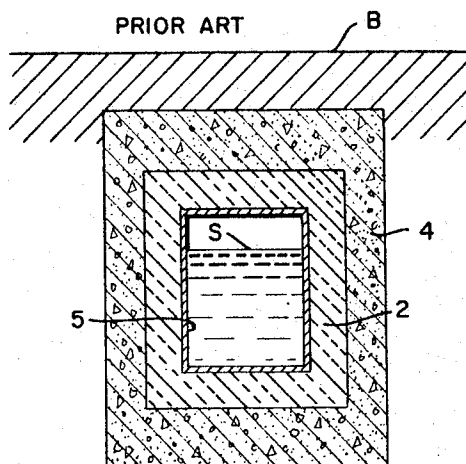


FIG. 3

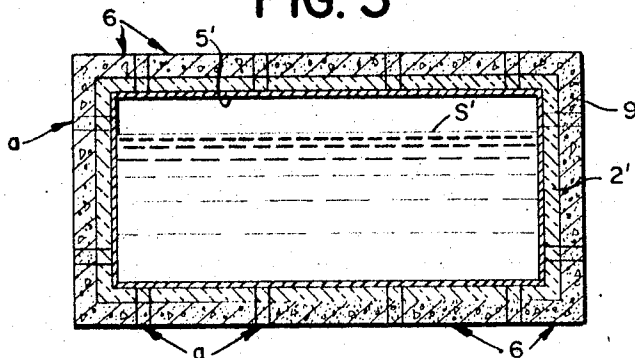
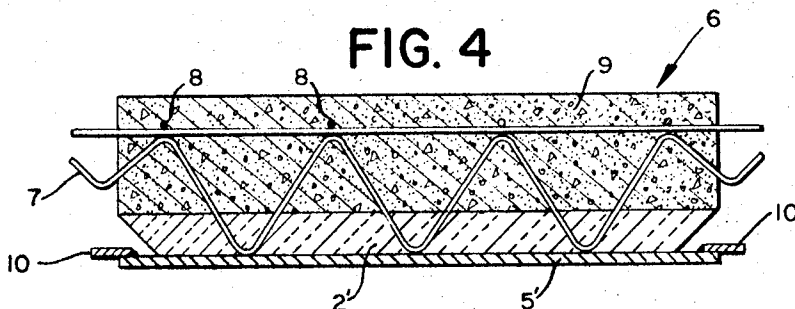


FIG. 4



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FIG. 5

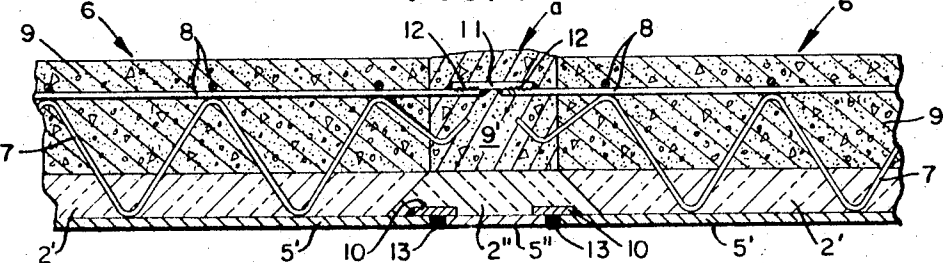


FIG. 6

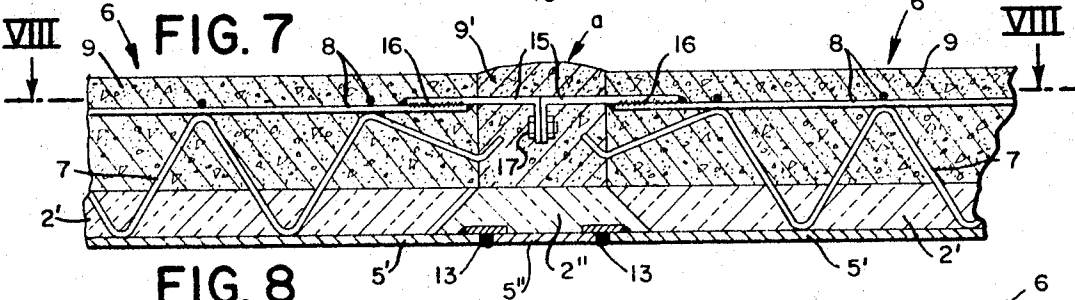
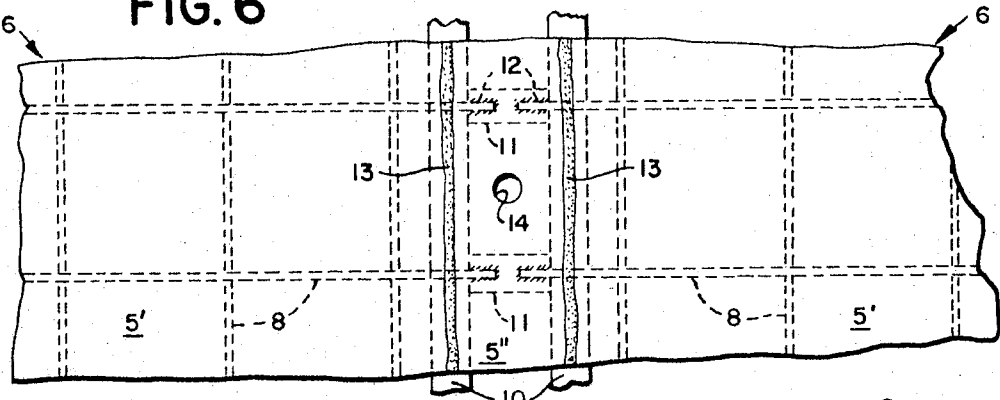
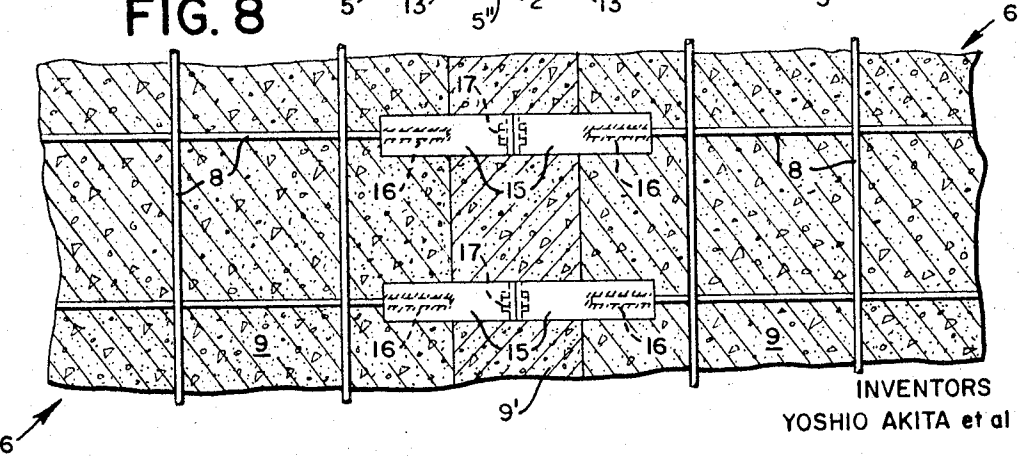


FIG. 8



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3,464,175

LOW TEMPERATURE LIQUID STORAGE TANK
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Filed May 26, 1966, Ser. No. 553,248

Claims priority, application Japan, May 31, 1965,
40/32,071

The portion of the term of the patent subsequent to
Oct. 8, 1985, has been disclaimed
Int. Cl. E04b 1/32

U.S. Cl. 52—249

9 Claims

The present invention relates to the low temperature liquid storage which is constructed by joining composite shell units (abbreviated as unit hereafter) that are in advance manufactured in a factory.

The invention disclosed and claimed herein is an improvement over that disclosed and claimed in co-pending application, Ser. No. 553,165, filed May 26, 1966, now Patent No. 3,404,500, Oct. 8 1968.

A storage containing low temperature liquid cannot in general avoid some loss of the liquid due to evaporation caused by heat from without. In order to prevent such loss as much as possible the storage must be provided with sufficient heat insulating means.

Conventionally, such a storage has been constructed on the ground. Recently, however, underground storages have gradually been increasing on account of safety and fuller utilization of the surface of the ground.

Both FIGS. 1 and 2 show the longitudinal section of an example of the conventional low temperature liquid storage, FIG. 3 the longitudinal section of the low temperature liquid storage according to the present invention, FIG. 4 the cross section of the composite shell unit, FIG. 5 the cross section of the embodiment of the invention illustrating the joining method, FIG. 6 the elevation plan of the embodiment in FIG. 5, FIG. 7 the cross section of the embodiment of another joining method, and FIG. 8 the cross section of the embodiment in FIG. 7 along the line VIII—VIII.

The following is the outline of the conventional low temperature liquid storage and its problems.

FIG. 1 shows an example of an above ground storage, where 1 refers to the inner tank, 2 to heat insulating material, 3 to the outer tank, S to stored low temperature liquid, and B to the surface of the ground, with the outside of the inner tank 1 which has a structure to stand the internal pressure being backed with heat insulating material 2 and the outer tank 3 being so constructed as to support this heat insulating material.

Weak points of this kind of a storage are that since the material comprising the inner tank 1 is subject to shrinkage due to low temperature the inner tank must usually be made of thick metallic plates reinforced with stiffener, and that since sufficient toughness of that material must be preserved at a low temperature the inner tank requires costly material such as heat treated special steel, alloyed steel, aluminium alloy, and so on. Besides, the outer tank 3 is a useless part from the view point of strength in that it has no strengthening effect with regard to the internal pressure.

FIG. 2 shows an example of an underground storage whose reinforced-concrete outer tank 4, having sufficient strength to bear the ground pressure, is backed on its inner surface with heat insulating material 2, with its inside being lined with metallic shell 5.

In the case of such an underground storage, the wall of the outer tank 4 must be considerably thick in order to prevent it from damage possibly caused by non-uniform ground pressure. Furthermore, if it happens at the

worst that negative pressure is originated in the storage the metallic shell 5 for preventing leakage of the low temperature liquids may be buckled to destruction.

Another weak point common to both the above ground storage and the underground is that heat insulating material 2 may be cracked and detached from the inner tank owing to decreasing temperature so that the low temperature liquid consequently leaks out into the outer tank, the latter may also be cracked because of thermal stress. In the case of inflammable liquid, the result of such leakage would be a serious accident such as a fire.

The purpose of the present invention is to eliminate these weak points of the conventional type of low temperature liquid storage.

The following is the explanation of the invention with reference to appended drawings.

FIG. 3 shows an embodiment of the low temperature liquid storage according to the present invention. The storage may be constructed with a number of units 6 composed in advance in a factory by joining said units at the construction fields as shown in the drawing, where each unit 6 of the given form is joined with each other at joining points *a*.

In the drawings, 2 refers to heat insulating material, 5 to shells, 9 to concrete walls.

FIG. 4 is a cross section of an embodiment of a unit 6 having a steel shear-connector 7 welded on one side of the shell 5 comprised of steel plates, steel bars 8 holding the said shear-connector 7 in it being arranged crosswise substantially parallel to said shell 5, heat insulating material 2 of adequate thickness which is adjacent to shell 5 and some concrete 9 serving as a filler. The said shear-connectors 7 and steel bars 8 are projected outwardly from said concrete, and shell 5 being welded at the edges with backing metallic plates 10 as shown in the figure. Such units can in advance be manufactured in a factory in mass production.

FIG. 5 and FIG. 6 show the method of the above-mentioned units at joining part a joining for the construction of a storage according to the present invention at the construction field. The steel bars 8 of the units 6 allocated at given places with a given interval are patched by the flat steel bar 11 by means of welding at welding part 12 and concreted as shown by 9' in FIG. 5. After the concrete 9' has been solidified a steel plate 5' having a hole 14 for pouring heat insulating material will be applied to the backing plate 10 and welded to the shell 5 along the welding line 13 and the heat insulating material 2' will be poured through said hole 14.

So far the explanation of the process of joining to be practice only on the inside of the storage. In cases where the process can be applied to both sides simultaneously, heat insulating material 2' and concrete 9' may be applied to the joining part from outside of the storage after welding of the steel plate 5' and the flat steel bar 11 is over.

Further, the backing plate 10 may be omitted by adapting conjugate two-side butt-welding of the shell 5 and the steel plate 5'.

Single-side butt-welding may be possible as well so far as the end of the shell 5 is jogged.

FIG. 7 and FIG. 8 show another embodiment of the joining method according to the invention. In this case, a section steel 15 is in advance welded to the steel round bar 8 at the welding part 16, then, in joining units at the construction field, they are bound together by means of bolts 17. This joining method has an advantage that the disposition of units is easily done.

Since each unit 6 to be joined according to these methods is tightly composed with a steel sheet and reinforced-concrete through shear-connectors, the load is shared by these two kinds of components. Consequently the strength of the low temperature liquid storage constructed with

such units is so great, that thick metal plates and stiffeners comprising the inner tank 1 of the conventional above ground storage are not required any longer, further, since steel sheets may be thin and the toughness of a steel at a low temperature increases as it is thinner, the resistance against brittle fracture will increase that much.

Furthermore, while the conventional low temperature liquid storage may require stainless steel, for example, for the inner tank, depending upon the temperature of the low temperature liquid, the storage according to the present invention requires only inexpensive materials, such as 3.5% Ni steel, for the shell 5, and also the reinforced-concrete wall can be much thinner than in the case of the conventional underground storage.

Moreover, since heat insulating material 2 of units 6 is tightly composed with the shell 5 and concrete 9 through the shear-connector 7, and can be produced in a factory in large quantities, the internal exfoliative strength of said heat insulating material is much greater in comparison with that of the conventional structure which is lined at the construction field. There will be no danger of the cracking of the storage nor exfoliation of the heat insulating material; consequently the purposes of liquid leakage prevention and heat insulation will be perfectly attained.

It should be understood that the shell, the shear connectors and the steel bars can be made of any metallic material, that plastics can be made use of as filler in place of concrete, and also some part of the structure of the storage may be constructed in combination with the conventional structure.

The storage according to the present invention has other advantages in addition to above mentioned characteristics such as: homogeneity of units, high accuracy in dimension, low cost in production, excellent heat insulating effect either in the case of an above ground low temperature liquid storage or in the case of an underground, trifle loss of the liquid due to evaporation, high degree of safety, inexpensiveness in construction, short period required for construction work, and so on.

We claim:

1. A low temperature fluid storage tank, comprising a plurality of individual units, each of said units comprising a section of insulating material, a construction layer adjacent said insulating material, a bar extending through and beyond said construction layer, and means for securing the ends of adjacent ones of said bars for joining adjacent ones of said units, to thereby form said tank.

2. A storage tank as claimed in claim 1, wherein said securing means comprise a metal section secured to each end of said bar, and means for connecting adjacent ones of said sections to one another.

3. A storage tank as claimed in claim 1, wherein each of said units further comprises a shear connector embedded in said insulating material and in said construction layer.

4. A storage tank as claimed in claim 2, wherein said construction layer is concrete.

5. A storage tank as claimed in claim 3, further comprising a metal shell secured to said shear connector and extending substantially parallel to said bar.

6. A storage tank as claimed in claim 5, wherein said securing means comprise a metal bar secured to the ends of the adjacent ends of said bars.

7. A storage tank as claimed in claim 6, wherein each of said units further comprise a backing plate secured to the edges of said metal shell.

8. A storage tank as claimed in claim 7, wherein said securing means further comprise a securing plate secured to the backing plates of adjacent ones of said units.

9. For use in constructing a low temperature fluid storage tank, a construction unit comprising an inner insulating layer, an outer concrete layer adjacent one face of said insulating layer, a metal shell secured to the other face of said insulating layer, a rod extending transversely through and extending beyond said concrete layer, and a shear connector extending between and connected to said rod and said metal shell.

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FRANK L. ABBOTT, Primary Examiner
JAMES L. RIDGILL, JR., Assistant Examiner

U.S. Cl. X.R.

52—267, 583, 612; 220—3

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,464,175 Dated Sept. 2, 1969
Inventor(s) Yoshio AKITA ET AL

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

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Column 2, line 24 , delete 2 and insert 2';
                delete 5 and insert 5';
                line 28, delete 5 and insert 5';
                line 30, delete 5 and insert 5';
                line 31, delete 2 and insert 2';
                line 32, delete 5 and insert 5';
                line 34, delete 5 and insert 5';
                line 45, delete 5' and insert 5";
                line 47, delete 5 and insert 5';
                line 48, delete 2' and insert 2";
                line 53, delete 2' and insert 2";
                line 55, delete 5' and insert 5";
                line 57, delete 5 and insert 5';
                line 58 , delete 5' and insert 5";
Column 3, line 12, delete 5 and insert 5';
                line 15, delete 2 and insert 2";
                line 16, delete 5 and insert 5';

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**SIGNED AND
SEALED
MAY 26 1970**

(SEAL)

Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents