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PATENT SPECIFICATION

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(54) LIQUID STORAGE TANKS MADE OF PANELS

(71) We, NORTHERN ENGINEERING INDUSTRIES LIMITED, Nei House, Regent Centre, Newcastle-upon-Tyne NE3 3SB do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

The invention relates to liquid storage tanks made of panels composed of reinforced synthetic plastic material.

A liquid storage tank according to the invention has walls and a floor made from reinforced synthetic plastic material each panel comprising a wall of generally rectangular shape the periphery of which has adjacent sides joined by portions which are generally inclined to those sides and the wall having at the periphery a flange integral therewith extending away therefrom at right angles to the general plane thereof and the wall having at least one stiffening formation integral therewith, the panels being arranged with the flanges of adjacent panels in a wall or in the floor having their flanges adjacent one another and with said portions of the panel peripheries defining spaces in which auxiliary members are located, a seal or seals being arranged between the adjacent flanges and between said portions and adjacent auxiliary members and between flanges at the margins of the walls and floor of the tank and elongate members, said adjacent flanges and said elongate members and said flanges adjacent thereto being held together by fastening means engaging the respective flanges and the respective flanges and elongate members to compress the respective seal therebetween and also to compress the respective seal between said auxiliary members and adjacent portions of the respective panel peripheries, at least some of the auxiliary members each having a sub-member inside the tank to which a stay or brace is secured, said auxiliary members being shaped so as to interlock

with adjacent panels to prevent relative movement of auxiliary members and panels transversely of the panels.

Preferably, said portions of said wall of each panel are at 45° to said adjacent sides.

The panel is usually a square panel, but oblong panels are also feasible.

Preferably, the or each stiffening formation is a dished, preferably circular portion.

The stiffening formation may protrude in the same direction as the flange extends away from the wall; and in that case there is an advantage for certain purposes if the formation protrudes no further than the flange. The stiffening formation may, however, protrude in the opposite direction to that on which the flange extends away from the wall.

The stiffening formation may be pyramidal, for example of four-sided types. Alternatively, the formation, or each formation, may be a rib; or the formation may be of cruciform shape; or the formation may be of star or flower shape.

The panels are preferably moulded and made of glass-reinforced synthetic plastic material, generally known as "GRP". A particularly suitable material for example is one selected from the range of polyester sheet moulding compounds available from British Industrial Plastics Limited of Warley, West Midlands, with glass reinforcement.

The flange may have holes to receive bolts for securing flanges together and whilst this is the preferred way of joining flanges other methods are feasible and may not necessitate holes in the flanges; for example clamps may be used to join flanges.

The auxiliary members or at least some of them may each have a sub-member which can be secured to a stay or brace, or any other other component as required, which component is needed to stiffen, reinforce or otherwise form part of the structure.

The auxiliary members may be of three kinds.

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The first being able to fit within the space within the four portions of the peripheries of four adjacent coplanar panels;

The second being able to fit within the space within two adjacent portions of the peripheries of two adjacent coplanar panels and an adjacent elongate member; and

The third being able to fit within the space defined by a portion of the periphery of a panel and two adjacent elongate members.

The second type of auxiliary member can be made by cutting an auxiliary member of the first type into two similar parts at a diagonal plane.

The third type of auxiliary member can be made by cutting an auxiliary member of the second type into two similar parts at a plane normal to and central of, the hypotenuse face of the second type of auxiliary member.

However, it is preferred to mould all three types of auxiliary member rather than cutting up members. A preferred material for the auxiliary members is glass-filled nylon synthetic plastic material which for tanks is of a water-resistant grade.

Panels, auxiliary members, tanks and methods of making them will now be described by way of example to illustrate the invention with reference to the accompanying drawings, in which:—Figure 1 is a schematic three-dimensional view of a structure in the form of a water storage tank;

Figure 2 is a plan of a first embodiment of panel;

Figure 3 is a side elevation of the panel shown in Figure 2 as seen in the direction of the arrow 'T';

Figure 4 is a section on the line IV - IV in Figure 2;

Figure 5 is a corner detail view of the panel shown in Figure 2;

Figure 6 is a corner detail view as seen in the direction of the arrow 'B' in Figure 5;

Figure 7 is a corner detail view as seen in the direction of the arrow 'C' in Figure 6;

Figure 8 is a section on the line VIII - VIII in Figure 5;

Figure 9 is a side elevation of an auxiliary member;

Figures 10 and 11 are respectively views as seen in the direction of the arrow 'A' and 'B' in Figure 9;

Figure 12 is a section on the line XII - XII in Figure 9; and

Figures 13 and 14 respectively are a plan and a section on the line XIV - XIV in Figure 13 showing a second embodiment of panel.

The tank shown in Figure 1 is made up of square panels 10 typically of 1 metre side length.

The upright corners of the tank comprise elongate members 12 being lengths of edge angles to which the adjacent flanges are secured. The horizontal corners comprise members 13 of edge angles.

Internal strengthening and bracing is provided by lengths of edge angle 14, 16, 20 which are secured to auxiliary member 50 described below.

The panels 10 shown in Figure 1 are shown in detail in Figures 2 to 8.

Each is moulded from GRP and comprises a partly flat wall 30 the central portion 32 of which is dished (being convex towards the viewer in Figure 2).

The diameter of the portion 32 is 870 millimetres and at the centre the portion is 50 mm proud of the general plane of the flat part of the wall 30, having a radius of curvature at its concave surface of 1917 mm.

The periphery of the panel 10 is relieved at each corner, the portion 34 of the periphery there being at 45° to the adjacent side periphery.

The panel 10 has integral therewith a flange 36 which extends away from the wall 30 at right-angles thereto (towards the view in Figure 2). The flange 36 has holes 38 to receive securing bolts (not shown), the holes being equally pitched at each side.

The flange extends 80 mm from the remote face of the panel (i.e. from the face remote from the view in Figure 2). Thus, the dished convex portion 32 protrudes less than the flange 36 from the general plane of the panel wall 30. This is useful where the panels are required to be laid on a surface (e.g. to form the base of a tank such as is shown in Figure 1). The load on each panel is thus borne by the flange edge rather than by the apex of the dished portion 32 where the flanges are downwardly extending.

Of course, the panels 10 may be laid on the surface 'other way up' so that the wall 30 engages the surface and the dished portion 32 and the flanges 36 extend upwardly.

The tank shown in Figure 1 may be constructed with all the dished portions and flanges facing inwardly instead of outwardly.

The flange 36 has four shallow slots 40 each extending over the whole of the respective corner position of the flange and extending slightly and equally over each of the two respective adjacent side portions of the flange (see Figures 5 to 8).

The panel 10 has four rebates 42 (see Figure 5 to 8) generally opposite the respective slots 40.

The corner flange portion 44 between the slot 40 and the rebate 42 has a dimension of 65 mm at 'X' as shown in Figures 6 and 8.

When panels 10 as shown in Figures 2 to 8 are assembled to make tanks as indicated generally in Figure 1 or in similar manner the presence of the relieved corner peripheral portions 34 on each panel gives rise to spaces where panel corners come together.

The invention provides auxiliary members 50 which will now be described and which can be assembled with the panels 10 in such

spaces to complete the structure.

The principal type of auxiliary member is shown in Figures 9 to 12; further types will be described but are not illustrated in detail.

- 5 They are shown in Figure 1 as half-portions or quarter portions of the principal type of member.

- 10 The principal auxiliary member 50 is moulded from glass-filled nylon of a water-resistant grade, as are the other types.

- 15 The member 50 has a block shaped core 52 with integral generally square flanges 54, 56. The flanges 54, 56 have extensions 58 at their corners. The flanges 45, 56 are spaced apart 65 mm so as to be capable of receiving the corner portions 44 of a panel 10 in close fitting relationship.

- 20 The member 50 has an integral lug 62 housing four holes 64 each passing through respective upstanding bosses 66 at each face of the lug 62.

- 25 A second type of auxiliary member is made by cutting a member 50 into two similar parts at the plane Y-Y in Figure 11, or by cutting a member 50 into two similar parts at the plane ZZ in Figure 11.

- 30 A third type of auxiliary member is made by cutting a second-type member into two similar parts at the plane Z-Z or Y-Y respectively in Figure 11 and by removing the lug 62 at the plane W-W in Figure 9.

- 35 The auxiliary members of the first and second type may be modified by removing the lug 62 by cutting at the plane W-W in Figure 9 for use as plug-type members where no lug is required (see items P2 and P3 in Figure 1).

- 40 In making a water-storage tank similar to that shown in Figure 1 it is necessary to make the joints between panels and between panels and/or auxiliary members and edge angles water-tight. This is done by wrapping round the outside of each flange a length or two or more lengths side-by-side of adhesive water-proof tape before the panel is positioned. When the nuts and bolts are tightened the tape is compressed in place to give a very good water-tight seal, as indicated at S in Figure 1. Also, each auxiliary member may have tape similarly wrapped around its central block; and each edge angle may have a length or lengths placed along its flanges before assembly. It may be convenient to omit the tape from the auxiliary members and edge angles, however. The tape used may be that sold under the name 'Inseal' by Industrial Sealants Limited, Borehamwood, Hertfordshire, England.

- 50 The panels are held together by bolts passed through the holes 38 and through holes in the flanges of the edge angles where required and secured by nuts with washers. The bolts may be mainly type M10 Sheradized to fit 12 mm holes with some type M12 similar to fit 14 mm holes as required. Stainless steel nuts and washers may be used if preferred.

The assembly is easily made and personnel erecting tanks or other structures have no difficulty lifting panels up into place. Each panel weighs some 15 Kgs (33 lbs).

70 The panel 10 is stiffened by the dished formation at 32. Different stiffening formations may be used as mentioned at the introduction of this specification, or several circular or other formations may be formed in the panel. However, the formation shown facilitates moulding of the panel and reduces the risk of stress concentration in the panel.

75 An alternative form of panel may have the stiffening formation or each formation protruding in the opposite direction to the flange (see Figures 13 and 14); or the formation or each of them may be shaped so as to protrude beyond the flange.

80 In yet another modification the stiffening formation or each formation may protrude at both faces of the panel; or some formations may protrude at one face and others at the other face and the degree of protrusion may be less than equal to or greater than the degree of protrusion of the flange in any or all of the cases mentioned above.

85 In a tank, for example, the panels may be arranged with the stiffening formations protruding all inwardly; or all outwardly; or some inwardly and some outwardly.

90 A tank need not be made up of only one pattern of panel; and in some cases square and oblong panels may be used in the same structure; or panels of different sizes but similar shape.

95 As an alternative to securing the panels by nuts and bolts, clamps may be used engaging the flanges, or other fasteners may be used whether extending through holes or otherwise.

100 Figures 13 and 14 show a second embodiment of panel 100 in which the partly flat wall 130 has a central circular portion 132 which is dished oppositely to the panel 10 so that the convex side of the portion 132 protrudes oppositely to the flange 136. The panel 100 is used in a manner exactly analogous to the panel 10 to make up tanks or for other purposes.

105 The panels 100 are made of GRP and have corner details similar to the panels 10.

110 The panels may be made using other reinforcing material (for example using carbon fibre reinforcing material) and using other kinds of polyester or other resin material, or using other synthetic plastic material.

115 The preferred method of making the panels is by hot press moulding, which is known technique and need not be described here. The shape of panel described above is ideally suited to moulding while at the same time giving excellent mechanical and aesthetic properties in the finished panel and in structures made from the panels. The panels may readily be coloured as desired by colour-

ing the material from which they are moulded.

The design of the panel is such as to enable the advantages of modern factory moulding techniques to be realised to the full. In particular, the panel has accurately shaped and dimensioned surfaces ensuring correct and accurate fitting together of panels, thus simplifying and speeding erection of tanks and other structures. Such panels can be readily produced in large numbers all of required standard.

Such accuracy and simplicity also leads to a simple and advantageous sealing technique using the simplest of seal elements a mere adhesive tape compressed between panels or between panel and auxiliary or other member. Such technique is vastly superior to the very difficult situation arising where steel panels are used which requires very skilled assembly and sealing operations for success.

It is to be noted that prior theoretical proposals referred to above using plastic panels for tank construction are wholly silent on the matter of sealing or postulate impractical bonding of panels one to another without the use of a seal element.

The present invention achieves a unique simplicity of construction which is nowhere taught by any prior proposals nor achieved in any practical structure.

Tanks constructed according to the invention have bracing loads applied to the integral flanges 36 of the panels. No holes pass through the panel wall 30 so that no bolt or other securements apply load to the wall and no leakage through such holes can arise. All bracing loads pass through the auxiliary members 50 and relative panel movement transversely to the plane of the wall or floor is prevented by the inter-engagement of auxiliary members and flanges 36 at the extensions 58.

WHAT WE CLAIM IS:

1. A liquid storage tank having walls and a floor comprising panels made from reinforced synthetic plastic material each panel comprising a wall of generally rectangular shape the periphery of which has adjacent sides joined by portions which are generally inclined to those sides and the wall having at the periphery a flange integral therewith extending away therefrom at right angles to the general plane thereof and the wall having at least one stiffening formation integral therewith, the panels being arranged with the flanges of adjacent panels in a wall or in the floor having their flanges adjacent one another and with said portions of the panel peripheries defining spaces in which auxiliary members are located, a seal or seals being arranged between the adjacent flanges and between said portions and adjacent auxiliary members and between flanges at the margins of the walls and floor of the tank and elongate

members, said adjacent flanges and said elongate members and said flanges adjacent thereto being held together by fastening means engaging the respective flanges and the respective flanges and elongate members to compress the respective seal therebetween and also to compress the respective seal between said auxiliary members and adjacent portions of the respective panel peripheries, at least some of the auxiliary members each having a sub-member inside the tank to which a stay or brace is secured, said auxiliary members being shaped so as to interlock with adjacent panels to prevent relative movement of auxiliary members and panels transversely of the panels.

2. A tank according to claim 1, in which said portions of said wall of each panel are at 45° to said adjacent sides.

3. A tank according to claim 1 or claim 2, in which each panel the or each stiffening formation is a dished portion.

4. A tank according to claim 1, 2 or 3, in which each panel the or each stiffening formation protrudes in the same direction as said flange.

5. A tank according to claim 4, in which the or each stiffening formation protrudes no further than said flange.

6. A tank according to claim 1, 2 or 3, in which in each panel the or each stiffening formation protrudes in the opposite direction to said flange.

7. A tank according to any preceding claim, in which in each panel the or each stiffening formation is a dished circular portion.

8. A tank according to any preceding claim, in which each panel is square and in which the stiffening formation is centred on the centre of the panel.

9. A tank according to any preceding claim, in which each panel is moulded from glass reinforced synthetic plastics material.

10. A tank according to claim 10, 11 or 12, in which a single first-type auxiliary member occupies the space defined by four adjacent portions of the peripheries of four adjacent co-planar panels of the tank, in which a single second-type auxiliary member occupies the space defined by two adjacent portions of the peripheries of two adjacent co-planar panels and an adjacent elongate member and in which three third-type auxiliary members occupy the space defined by a portion of a periphery of a panel and two elongate members at a corner of the tanks.

11. A liquid storage tank according to claim 1 substantially as herein described with reference to Figures 2 to 8 of the accompanying drawings.

12. A liquid storage tank according to claim 1 comprising panels substantially as herein described with reference to Figures 13 and 14 of the accompanying drawings.



ing the material from which they are moulded.

The design of the panel is such as to enable the advantages of modern factory moulding techniques to be realised to the full. In particular, the panel has accurately shaped and dimensioned surfaces ensuring correct and accurate fitting together of panels, thus simplifying and speeding erection of tanks and other structures. Such panels can be readily produced in large numbers all of required standard.

Such accuracy and simplicity also leads to a simple and advantageous sealing technique using the simplest of seal elements a mere adhesive tape compressed between panels or between panel and auxiliary or other member. Such technique is vastly superior to the very difficult situation arising where steel panels are used which requires very skilled assembly and sealing operations for success.

It is to be noted that prior theoretical proposals referred to above using plastic panels for tank construction are wholly silent on the matter of sealing or postulate impractical bonding of panels one to another without the use of a seal element.

The present invention achieves a unique simplicity of construction which is nowhere taught by any prior proposals nor achieved in any practical structure.

Tanks constructed according to the invention have bracing loads applied to the integral flanges 36 of the panels. No holes pass through the panel wall 30 so that no bolt or other securements apply load to the wall and no leakage through such holes can arise. All bracing loads pass through the auxiliary members 50 and relative panel movement transversely to the plane of the wall or floor is prevented by the inter-engagement of auxiliary members and flanges 36 at the extensions 58.

WHAT WE CLAIM IS:

1. A liquid storage tank having walls and a floor comprising panels made from reinforced synthetic plastic material each panel comprising a wall of generally rectangular shape the periphery of which has adjacent sides joined by portions which are generally inclined to those sides and the wall having at the periphery a flange integral therewith extending away therefrom at right angles to the general plane thereof and the wall having at least one stiffening formation integral therewith, the panels being arranged with the flanges of adjacent panels in a wall or in the floor having their flanges adjacent one another and with said portions of the panel peripheries defining spaces in which auxiliary members are located, a seal or seals being arranged between the adjacent flanges and between said portions and adjacent auxiliary members and between flanges at the margins of the walls and floor of the tank and elongate

members, said adjacent flanges and said elongate members and said flanges adjacent thereto being held together by fastening means engaging the respective flanges and the respective flanges and elongate members to compress the respective seal therebetween and also to compress the respective seal between said auxiliary members and adjacent portions of the respective panel peripheries, at least some of the auxiliary members each having a sub-member inside the tank to which a stay or brace is secured, said auxiliary members being shaped so as to interlock with adjacent panels to prevent relative movement of auxiliary members and panels transversely of the panels.

2. A tank according to claim 1, in which said portions of said wall of each panel are at 45° to said adjacent sides.

3. A tank according to claim 1 or claim 2, in which each panel the or each stiffening formation is a dished portion.

4. A tank according to claim 1, 2 or 3, in which each panel the or each stiffening formation protrudes in the same direction as said flange.

5. A tank according to claim 4, in which the or each stiffening formation protrudes no further than said flange.

6. A tank according to claim 1, 2 or 3, in which in each panel the or each stiffening formation protrudes in the opposite direction to said flange.

7. A tank according to any preceding claim, in which in each panel the or each stiffening formation is a dished circular portion.

8. A tank according to any preceding claim, in which each panel is square and in which the stiffening formation is centred on the centre of the panel.

9. A tank according to any preceding claim, in which each panel is moulded from glass reinforced synthetic plastics material.

10. A tank according to claim 10, 11 or 12, in which a single first-type auxiliary member occupies the space defined by four adjacent portions of the peripheries of four adjacent co-planar panels of the tank, in which a single second-type auxiliary member occupies the space defined by two adjacent portions of the peripheries of two adjacent co-planar panels and an adjacent elongate member and in which three third-type auxiliary members occupy the space defined by a portion of a periphery of a panel and two elongate members at a corner of the tanks.

11. A liquid storage tank according to claim 1 substantially as herein described with reference to Figures 2 to 8 of the accompanying drawings.

12. A liquid storage tank according to claim 1 comprising panels substantially as herein described with reference to Figures 13 and 14 of the accompanying drawings.

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13. A liquid storage tank substantially as herein described with reference to Figures 1 to 12 of the accompanying drawings.

14. A liquid storage tank substantially as 5 herein described with reference to Figures 1 and 9 to 12 of the accompanying drawings

but modified as described herein with reference to Figures 13 and 14 of the accompanying drawings.

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