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PATENT SPECIFICATION

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(54) PANEL ASSEMBLED TANK

(71) We, BRIDGESTONE TIRE KABUSHIKI KAISHA, of No. 1-1, 1-Chome, Kyobashi, Chuo-Ku, Tokyo, Japan, a company organized according to the laws of Japan, 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:—

This invention relates to a panel assembled tank, and more particularly to a tank consisting of high water pressure resistant square panels made of reinforced plastics.

There have been used a great number of tanks of various kinds of shapes and constructions sited at high levels as, for example, on roofs of high buildings. In these cases, tanks manufactured by the assembly of a number of prefabricated panels having peripheral surfaces upturned to form securing flanges for connecting together the panels need comprise only the panels themselves to assemble the tanks no matter how large the volume of the tank. Such panels are particularly useful for manufacturing tanks to be sited at high positions because the number of types of panels can be limited to a small number suitable for mass-production.

Reinforced plastics have been preferably used for the material of the panels. With large tanks, however, there are many problems to be solved particularly in respect of pressure resistance and water tightness. For example, the pressure of water within the tank causes the panels and their walls to bulge outwardly. In order to reduce the bulge of the panels, it has been suggested to form each panel with a protrusion in the form of a pyramid or truncated pyramid as explained later in connection with the drawings.

In the event that the thus formed panel having a uniform thickness fixed at its periphery is subjected to internal excess pressure, stresses will concentrate at corners of the panel or at bottoms of the securing flanges to cause partial failure or breakdown thereat.

With a large tank, the bulge of the side walls as a whole caused by the internal excess

pressure could not be avoided and the increased weight of the ceiling wall requires a reinforcement to support the weight, which reinforcement may generally be columns. Furthermore, such columns must be worked at their ends so as to meet the shape of the bottom wall and require mounting members for settling the columns onto the bottom wall of the tank.

It is desired to reinforce the opposite side walls of the tank by means of tie rods connecting the side walls in order to restrain the bulge of the side walls as a whole to a minimum value. In fact, however, it is not easy to assemble the panels to form a tank by rigidly clamping the tie rods to the side wall panels and to provide complete watertightness at the connections of the tie rods to the panels when the tank is filled with water in a manner such that the tie rods are effectively subjected to tensile forces without undue forces acting upon the panels.

The bottom wall panels of the assembled tank are generally intended to resist the internal pressure by supporting tensile stresses. In other words, the panels commonly have protrusion portions extending out of the tank. Consequently, there is a tendency for connections between the panels to open away from each other, resulting in reduced watertightness. With such panels, the cleaning of the inside of the tank is apt to be insufficient because there are recesses holding pools of water in the tank, at the back of the outwardly extending protrusions of the panels.

These tanks require piping for pumping and supplying water. The configuration of the panels having the pyramidal protrusions makes it difficult to provide the piping and requires particular attachments for connecting pipes to the oblique surfaces of the protrusions, which may increase the cost of the tank even if they improve the accuracy of connecting the pipes. A square panel formed with a truncated pyramid having a flat surface can avoid the oblique attachment for the piping. In this case, however, the position of the piping is invariably at the center of the

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panel corresponding to the top of the truncated pyramid, so that the effective water level of the tank is unavoidably limited to a small value.

Moreover, sealing materials are generally embraced between the flanges of the panels for the purpose of preventing leakage at the connections. Dimensional errors of the assembled tank resulting from the sealing material, which is generally deformable, may often result in extra cost for settling the tank.

Furthermore, when the assembled tank is used for water supply, there is a danger of damage to the tank by the dynamic water pressure resulting from the oscillation of water caused by for example an earthquake.

The present invention provides a tank comprising prefabricated panels connected together, each panel being formed with a protrusion portion in the form of a pyramid or truncated pyramid and with securing flanges formed by folding peripheral edges of the panel, each said panel further comprising chamfering faces radially arranged around the apex of the pyramid and connecting adjacent side surfaces of the said pyramid, the said panels consisting of (a) bottom wall panels in which securing flanges are folded in a direction opposite to the projecting direction of the said protrusion portion of the bottom wall panel, and (b) side wall panels in each of which securing flanges are folded in a direction the same as that of the protrusion portion of the side wall panel, the said side wall panels being formed adjacent the flanges with flat portions in the general plane of the panels, the said securing flanges of the said bottom and side wall panels facing outwardly and flanges of the said bottom panels and the said flat portions of the side wall panels being clamped together to form the tank.

Preferably the securing flanges and the flat portions at the bottoms of the side wall portions are thicker than those portions comprising the pyramids of the panels.

The tank may be hermetically sealed by means of unvulcanized rubber sheets interposed between the securing flanges of the panels to improve the sealing therebetween.

The tank may suitably incorporate a square side wall panel for piping and a bottom wall panel for drainage.

The tank may be made highly pressure resistant by providing tie rods and brackets for reinforcing the side walls thereof.

The tank preferably further comprises a base frame and a mounting structure for mounting the tank on the base frame.

The tank may further suitably incorporate partitions depending from the inner face of the roof thereof.

The invention will be further described, by way of example only, with reference to the accompanying drawings, in which:—

Fig. 1 is a perspective view of one embodi-

ment of a highly pressure resistant tank according to the invention, a few panels thereof having been removed;

Fig. 2 is a sectional perspective view of a previously known side wall panel;

Fig. 3 is a sectional perspective view of a side wall panel having a pyramid portion for use in the tank according to the invention;

Fig. 4 is a perspective view of a side wall panel having a truncated pyramid portion for use in the tank according to the invention;

Fig. 5 is a plan view of a bottom wall panel to be used in the tank according to the invention;

Fig. 6 is a sectional view of the bottom wall panel taken along the line VI—VI in Fig. 5;

Fig. 7 is a sectional view of the bottom wall panel taken along the line VII—VII in Fig. 5;

Fig. 8 is a perspective view showing a part of the tank according to the invention, part of the side wall being cut away, and the top and some side wall panels being shown in outline only;

Fig. 9 is a partial sectional view of the tank having unvulcanized rubber sheets embraced between the side wall panels;

Fig. 10 is a plan view of a square panel for securing piping for use in the tank according to the invention;

Fig. 11 is a sectional view of a tank according to the invention using square panels for securing piping;

Fig. 12 is a perspective view showing a part of a tank according to the invention using a bottom wall panel having a scupper, the side walls being shown in outline only;

Fig. 13 is a perspective view of a tank according to the invention, partially cut away, incorporating tie rods;

Fig. 14 is an enlarged sectional view showing the connections of the tie rods to the panels;

Fig. 15 is a partial sectional view showing the connection of a panel to the end of a tie rod before clamping;

Fig. 16 is a perspective view of the connection of a bracket at the corners of the panels; and

Fig. 17 is a sectional elevation of a part of a tank according to the invention incorporating partitions.

The tank shown in Fig. 1 comprises side wall panels 10 and bottom wall panels 20. A side wall panel 10 is shown in detail in Fig. 3, and consists of flanges 1, flat portions 2 and a protrusion portion 5. The flanges 1 and the flat portions 2 are thicker than the protrusion portion 5. The protrusion portion 5 is in the form of a pyramid comprising surfaces 6 radially arranged and connecting the adjacent surfaces of the square based pyramid and which form chamfered edges of the pyramid. These chamfered edges are uni-

form in thickness. A side wall panel 10 shown in Fig. 4 is substantially the same as that shown in Fig. 3 except that the protrusion portion is in the form of a truncated pyramid. Fig. 2 shows a previously known panel in which the flanges 1 and flat portions 2 are uniform in thickness and in which a protrusion in the form of a pyramid has no chamfered edges.

A test was carried out for the purpose of comparison of the panel according to the invention as shown in Fig. 4 with known panels A, B and C as shown in Fig. 2. These panels are square having 100 centimeter sides and made of a plastics material such as orthophthalic resin reinforced by glass mat 450#. The panels B and C have thicker flanges which are shown by increased plies in Table 1 which shows the results of the test.

TABLE 1

	Panels according to the present invention.	Known Panels			
		(A) Uniform thickness	(B)		(C)
Flange and flat portion	Glass matt 450# 10 plies	Glass matt 450# 5 plies	Thickened flanges	Flat portions	Flat portions
			Glass matt 450# 7 plies	Glass matt 450# 4 plies	Glass matt 450# 2 plies
Pyramidal portions	Glass matt 450# 2 plies	Glass matt 450# 5 plies	Glass matt 450# 4 plies	Glass matt 450# 2 plies	Glass matt 450# 2 plies
Weight	10.5 Kg	11 Kg	13 Kg	10.5 Kg	10.5 Kg
Breaking pressure	2.4 Kg/cm ²	0.5 Kg/cm	1.0 Kg/cm ²	1.3 Kg/cm ²	1.3 Kg/cm ²

As can be seen from the data in Table 1, the panel according to the invention is superior in pressure resistance to the prior art panels. In case of the panels (A) and (B) the breaks occur in the proximity of an area shown at 3 in Fig. 2 and in the panel (C) in the proximity of an area shown at 4. In contrast herewith, the panel according to the invention can avoid such local breaks, although whitening occurs (the portion subjected to bending stress becomes white) all over the pyramidal portion when it is subjected to a load much higher than those in the panels (A), (B) and (C), and the break occurs all over the surfaces without local failures at lower loads as in the prior art.

It should be noted from the above that the panel according to the invention ensures the uniform distribution of stresses acting thereupon, to improve the pressure resistance of the tank effectively without increasing the required amount of material.

A bottom wall panel 20 comprises a protrusion portion 5 progressively increasing in height in the form of a pyramid or truncated pyramid, and peripheral edges which are bent in a direction opposite to the protrusion portion 5 to form flanges 1. These flanges 1 of the bottom wall panels 20 are connected to each other to form a bottom wall of an assembled tank.

With the above bottom wall panels forming the bottom wall of the tank, since square wall surfaces 8 extend inwardly like arches in the direction opposite to the extending direction of the flanges 1, there is a tendency for the bottom wall panels to be flattened when they are subjected to the pressure of liquid in the tank, so that the panels are forced toward each other at the contact surfaces of the flanges 1 to increase the contact pressure therebetween, that is to tighten the panels to each other. Accordingly, the internal pressure in the tank tends to bring the panels into close contact with each other at the flanges in an air and water tight manner without adversely affecting the drainage at the bottom of the tank. These effects will be explained in more detail later.

In the bottom wall panel the adjacent surfaces forming the edges of the pyramid or truncated pyramid are connected to each other by the surfaces 6 to form at four corners of the panel flat surfaces 7 surrounded by the bottom sides 6a of the surfaces 6 and peripheral sides 1a of the square wall surface 8. The flat surfaces 7 provide a flat surface 9a for a column 9 having an area sufficient to support it upstanding in the assembled tank at the center of four bottom wall panels when they are connected together (Fig. 8).

The flat surface 9a is surrounded by the surfaces 6 and protrusion portions 5 to provide a snugly supporting surface for the column 9, preventing it from being shifted

without requiring any securing members for settling the column 9 on the flat surface 9a. What is required is to cut the bottom ends of the column 9 at right angles to its axial direction.

It is preferable to form the flat surface 9a for the column 9 having slightly larger sides than the outer diameter of the column. It is also preferable to make the flat surfaces 7 correspond to a right-angled isosceles triangle as shown in Fig. 5, to form the square flat surface 9a when the four bottom wall panels are connected together. The flat surfaces 7 may be of another configuration according to the section of the column 9.

As can be seen from the above description, the bottom wall panel having the protrusion portion 5 and the flanges extending in the opposite direction from the protrusion portion can provide a self hermetic seal between the flanges of the adjacent panels resulting from the internal pressure in the tank to keep the tank highly air or watertight at the bottom thereof without adversely affecting the drainage. Furthermore, the bottom wall panels makes it possible to set a column stably on the bottom of the tank by the use of flat surfaces surrounded by the bottom sides of the surfaces 6 and peripheral sides 1a of the square wall surface 8.

Fig. 9 illustrates a partial section of the assembly of the side wall panels 10 and bottom wall panels 20. The side wall panels 10 have all the securing flanges 1 extending outwardly around pressure supporting square surfaces 8'a for connecting together the adjacent panels to form side wall panels for the tank. The bottom wall panels 20 also have all the securing flanges 1 extending outwardly around pressure supporting square surfaces 8'b for connecting together the adjacent panels to form a bottom wall panel for the tank. The connection of the side and bottom wall panels is effected by securing the flanges 1 of the bottom wall panels 20 to the flat portions 2a at the bottoms of the flange of the side wall panels as shown in Fig. 9.

In order to further improve the hermetic seal of the assembled tank, unvulcanized rubber sheets 12 are arranged between the securing flanges 1a of the side wall panels 10, between the securing flanges 1b of the bottom wall panels 20, and between the securing flanges 1c of the bottom wall panels 20 and the flat portions 2a at the bottoms of the securing flanges of the side wall panels 10, and then these flanges and flat portions are tightened by means of bolts 11.

The unvulcanized rubber sheets used generally exhibit visco-elasticity to accommodate variation in distance between the securing flanges 1a, 1'a and 1b, 1'b and the securing flanges 1c and the flat surfaces 2a. Particularly, when a cross-shaped connection is formed by the four connected panels, the

unvulcanized rubber sheet flows into the central portion of the cross-shaped connection to completely seal the connection in an air and watertight manner.

The unvulcanized rubber is generally adhesive at its surfaces, which serves to prevent the rubber sheets 12 from being shifted or falling off, to facilitate the assembling of the panels. Moreover, the unvulcanized rubber sheet can easily be drilled for the clamping bolts.

The unvulcanized rubber sheet is preferably weather resistant and waterproof and is for example butyl rubber.

When pumping pipes, water supply pipes, over-flow pipes, etc. are arranged on the tank, it is convenient to combine them with the panels. As shown in Fig. 10, the square panel 10a or 10b for mounting pipes is formed with wall surfaces in the form of a truncated pyramid 8a extending in the same direction as the flanges 1. The truncated pyramid 8a comprises four oblique surfaces 5a—5d and a piping securing surface 15 in parallel with the flat surface 2 and jointed at the top of the pyramid to the oblique surfaces 5a—5d.

The lengths of the sides of the oblique surface 5a and the chamfered surfaces 6a, 6d connected to each other are longer than those of the sides of the oblique surface 5c and the surfaces 6c, 6d to make the piping securing surface 15 eccentric to the center of the square panel 10a or 10b as shown in Fig. 10.

In assembling the square panels 10 having the pyramids or truncated pyramids and the panels 10a and 10b having the eccentric truncated pyramids, the square panel 10a is arranged at the upper portion of the side surface of the tank in the position where the shorter oblique surface 5c is located above the longer oblique surface 5a and the square panel 10b is arranged at the lower portion of the side surface of the assembled tank in the position where the shorter oblique surface 5c is located below the longer oblique surface 5a as shown in Fig. 11 and these square panels 10a and 10b are connected at the flanges 1 to each other. Then an over-flow pipe 16 and a water supply pipe 17 are connected to the piping securing surfaces 15 of the upper and lower square panels 10a and 10b, respectively. In this case, as shown in Fig. 11, the over-flow pipe 16 is arranged as high as possible relative to the associated piping securing surface 15 and the supply pipe 17 is arranged as low as possible relative to the associated piping securing surface 15 to provide the largest possible effective water level (as shown by H in Fig. 11) when used as a water tank.

As can be seen from the above description, the highly pressure resistant tank using the square panels having the piping securing surfaces of the truncated pyramids eccentric to the center thereof does not require any par-

ticular attachment for connecting the pumping pipes and water supply and over-flow pipes, and can obtain a high effective water level of the tank.

As shown in Fig. 12, at least one panel 20' is formed at the center of the pressure receiving square surface 8'a with a recess 24 which is preferably in the form of a truncated pyramid and is further provided at its bottom with a scupper 25 to which is fitted a drain plug (not shown).

The panels 20 other than the panel having the drainage means have protrusion portions 5 progressively increasing in height toward the centers of the respective panels to form drain paths 26 between the unit panels. As shown in Fig. 12, these drain paths communicated with each other in the form of a lattice in a substantially horizontal plane and with the recess 24 of the panel 20', so that when the scupper 25 is opened, the water in the tank is completely drained.

In the tank illustrated in Fig. 13 the side wall panels 10 are reinforced by tie rods 18 connecting them to withstand the increased pressure within the large tank. Each tie rod 18 is formed at ends with threaded portions 18a and with larger diameter portions 18b as stops spaced from the threaded portions 18a as shown in Figs. 14 and 15. The threaded portion 18a of the tie rod 18 passes from the inside of the tank through a connecting hole 2a formed in the flat surface 2 of the panel 10 and a flanged cylindrical rubber bush 19 longer than the thickness of the panel 10 is fitted in the hole 2a and onto the rod 18. A spacer 21 is provided about a part of the threaded portion on the rubber bush 19 and a bracket 22 is further arranged on the bush and clamped thereon by a nut 23 threadedly engaged with the threaded portion 18a of the tie rod 18.

Fig. 15 illustrates the condition of the tie rod before tightening the nut 23, wherein the larger diameter portion 18b must be inside the inner surface of the flat surface 2 of the panel and the length of the flanged rubber bush 19, except that the flange must be longer than the thickness of the flat surface 2 of the panel. If the larger diameter portion 18b of the tie rod 18 is considerably spaced from the inner surface of the tank, the watertightness at the hole 2a of the panel after clamping will decrease even if the length of the flanged rubber bush 19 is sufficiently longer than the thickness of the panel. Accordingly, the tie rod 18 should be so designed that the larger diameter portions are as near as possible to the inner surfaces of the tank. The outer diameter of the flange 19b of the rubber bush 19 should be larger than the inner diameter of the hole 2a of the flat surface of the square panel.

The tie rod is preferably made of a rigid material such as steel. The tie rod preferably

consists of two or three component rods which are axially connected to form a tie rod having at its ends the threaded portions 18a and the larger diameter portions 18b. Such a prefabricated tie rod makes it very easy to effect the assembly of the tank and makes it possible to adjust the overall length of the tie rod to position the larger diameter portions 18b of the rod at the optimum positions to improve the watertightness as described later.

Starting from the position of the tie rod 18 as shown in Fig. 15, when the nut 23 is threadedly tightened up progressively on the threaded portion 18a of the rod 18, the inner end 19a of the rubber bush 19 expands at the larger diameter portion 18b of the rod 18 and the flange 19b of the bush 19 is brought into contact with the outer surface of the flat surface 2 of the square panel. Accordingly, the panel 10 is not inwardly attracted to an undue extent so that the panels 10 can be fixedly clamped without being subjected to undue stresses. When the tank is filled with water, the water pressure acts on the panels 10 so as to force them outwardly. In this case, however, the flange 19b of the rubber bush 19 maintains the watertightness at the outer surface of the flat surface 2 of the panel and the tie rods 18 prevent the side walls from bulging.

Fig. 16 is a perspective view on an exaggerated scale of the ends of the tie rods wherein a T-shaped bracket 22 is fixed to the securing flanges 1' forming a cross connection at the corners of four panels. The tie rods 18 pass through the bracket 22 so that the load from the water pressure in the tank is distributed to the three pairs of securing flanges 1 forming a T-shaped connection and is supported by the bracket 22 to be transmitted to the tie rods 18 without unduly loading the panels. The bracket may be in the form of a cross embracing all four pairs of the securing flanges 1. In this case, the load from the water pressure in the tank acting upon the four pairs of the securing flanges is supported by the tie rods.

As can be seen from the above detailed explanation, the tank reinforced by the tie rods does not bulge as a result of the water pressure even if the tank is full of water. Accordingly, this construction is particularly preferable in the case of a large tank. The water pressure in the tank acting upon the side walls is distributed through the tie rods to the respective side wall panels, so that the pressure resistance of the tank as a whole is substantially equal to the respective pressure resistance of the panels. Moreover, the flanged rubber bushes are interposed between the tie rods and the panels and the inner ends of the bushes are expanded by the larger diameter portions of the tie rods, so that the watertightness at the connection of the tie

rods to the panels can be remarkably improved.

The thus assembled tanks have the unvulcanized rubber sheets 12 interposed between the securing flanges 1a and 1'a and 1b and 1'b and securing flanges 1c and the flat surfaces 2a. Accordingly, dimensional errors in manufacturing the tanks are unavoidable. To avoid difficulties resulting from such dimensional errors, apertures 13 for bolts formed in the securing flanges 1'c of the side wall panels and base frame 14 for securing to each other are made as elongate apertures of which the longer axes are perpendicular to each other when the tank is arranged on a base frame 14 sited on the roof of a building as shown in Fig. 1. In this manner, the tank can easily be fixed onto the base frame by means of bolts and nuts irrespective of dimensional errors in manufacturing the tank and frame. It should be noted that the fixing method described herein is not limited to a tank using unvulcanized rubber sheets interposed between the panels.

When the large assembled tank is to be filled with water, long period oscillations such as 2—10 seconds are included in vibrations from an earthquake and these may coincide with the primary period of natural vibration of water in the tank, causing resonance of the vibrations resulting in damage to the tank.

In general, the primary period (T seconds) of natural vibration of water in the tank is obtained by the following empirical formula where D centimeters is the length of the tank in the vibrational direction.

$$T=0.11\sqrt{D}$$

When D is 400 centimeters, T is 2 seconds. Accordingly, there is a high possibility that a tank having a length of more than 4 meters will resonate with vibration components having long periods from an earthquake.

Fig. 17 illustrates an embodiment of a tank particularly designed in order to solve the problem of resonance, wherein flexible partitions 28 are arranged within the tank at suitable intervals such as 2—4 meters and depend from the upper portion 20u of the tank to somewhat above the bottom plates. Each partition is preferably made of a flexible material such as rubber or plastics or a composite material consisting of a flexible portion to be fixed to the tank and a remaining portion made of a rigid material. The height H of the depending partitions should be more than one half of the distance Hs between the upper and bottom portions of the tank because if the water in the tank occupies not more than one half of the volume of the tank, the load caused by the movement of the water will become smaller and there is no trouble resulting from the resonance of vibrations. The partition does not have to be

7 watertight and may be provided at the lower
portion thereof with through apertures 29.
The partitions are preferably fixed to the
upper closure as in the embodiment shown
5 in Fig. 17. However, they may be fixed to
the side or bottom walls. The partitions are
not necessarily arranged at equal intervals
apart and may be arranged at suitable inter-
vals such as 2—4 meters at will. With such
10 an arrangement, the partitions, that is wave
damping plates, can bring about an effect
as if the length D of the tank were 2—4
meters, which is an important factor relating
to the natural period of water. Accordingly,
15 however large the tank may be, the natural
period of the tank can be restrained to less
than two seconds, which is different from the
long periods of 2—10 seconds of an earth-
quake vibration and is sufficient to avoid the
20 resonance and prevents the side wall of the
tank from being damaged.

The through apertures 29 formed in the
lower portions of the partitions serve to damp
the oscillation of water quickly because the
25 resistance of the water at the apertures occurs
when flowing through them. Furthermore, the
flexibility of the partitions makes it easy to
fix them to the wall of the tank and reduces
the moment at the connections between the
30 partition and the panels in order to avoid
torsional forces acting upon the tank. In a
more preferable embodiment, the partitions
are arranged at random so that the natural
periods of water in sections defined by the
35 partitions are different from each other, with
the result that the loads acting upon the
partitions are cancelled by the damping effect
resulting from the interference of the shifted
phases of the waves. The arrangement of the
40 partitions makes it possible to change the
directions of the waves to further improve the
effectiveness of the partitions arranged in the
tank. In consideration of horizontal vibrations
in all directions, the partitions are required
45 to have at least two directions.

WHAT WE CLAIM IS:—

1. A tank comprising prefabricated panels
connected together, each panel being formed
with a protrusion portion in the form of a
50 pyramid or truncated pyramid and with secur-
ing flanges formed by folding peripheral edges
of the panel, each said panel further com-
prising chamfering faces radially arranged
around the apex of the pyramid and connect-
ing adjacent side surfaces of the said
55 pyramid, the said panels consisting of (a)
bottom wall panels in which securing flanges
are folded in a direction opposite to the pro-
jecting direction of the said protrusion por-
tion of the bottom wall panel, and (b) side
60 wall panels in each of which securing flanges
are folded in a direction the same as that of
the protrusion portion of the side wall panel,
the said side wall panels being formed adjacent

the flanges with flat portions in the general
plane of the panels, the said securing flanges
of the said bottom and side wall panels facing
outwardly and flanges of the said bottom
panels and the said flat portions of the side
70 wall panels being clamped together to form
the tank.

2. A tank as claimed in claim 1, wherein
the said securing flanges and flat portions of
the said side wall panels are thicker than
those portions constituting the said pyramids
75 of the panels.

3. A tank as claimed in claim 1 or 2,
wherein the said side wall panels are con-
nected together with their securing flanges
to form a side wall panel assembly and the
80 said bottom wall panels are connected to-
gether with their securing flanges to form a
bottom wall panel assembly, and the said
flat portions of the said thus assembled side
wall panel assemblies and the said securing
85 flanges at the periphery of the said thus
assembled bottom wall panel assembly are
connected together to form the tank.

4. A tank as claimed in any of claims 1
to 3, wherein unvulcanized rubber sheets are
90 interposed between the said securing flanges
of the tank and are bolted together to connect
the panels to form the tank.

5. A tank as claimed in any of claims 1
to 4, wherein at least one of the said side
95 wall panels has its protrusion portion in the
form of a truncated pyramid, of which the
top truncated surface in parallel with the
said flat portions of the panel is eccentric
to the center of the panel to form a pipe
100 securing surface.

6. A tank as claimed in any of claims 1
to 5, wherein at least one of the said bottom
wall panels has its protrusion portion in the
form of a truncated pyramid of which the
105 truncated surface is provided with a scupper,
and the said securing flanges are folded in
a direction the same as that of the protrusion
portion of the bottom wall panel.

7. A tank as claimed in any of claims 1 to
6, which further comprises tie rods formed
at their ends with threaded portions and larger
diameter portions spaced from the ends, por-
tions between the threaded portions and the
115 larger diameter portions of the tie rods pass-
ing through connecting holes formed in the
opposite side wall panels, and flanged cylin-
drical rubber bushes longer than the thick-
ness of the panels being fitted about the tie
rods and the said connecting holes of the side
120 walls, and the tie rods being tightened by
means of nuts to reinforce the side wall of
the tank.

8. A tank as claimed in claim 7, wherein
the tank further comprises brackets fixed to
125 the said securing flanges at respective corners
of four side wall panels of opposite side walls
of the tank and covering at least three pairs
of securing flanges, and the tie rods having



(13)

7 watertight and may be provided at the lower
portion thereof with through apertures 29.
The partitions are preferably fixed to the
upper closure as in the embodiment shown
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apart and may be arranged at suitable inter-
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damping plates, can bring about an effect
as if the length D of the tank were 2—4
meters, which is an important factor relating
to the natural period of water. Accordingly,
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torsional forces acting upon the tank. In a
more preferable embodiment, the partitions
are arranged at random so that the natural
periods of water in sections defined by the
35 partitions are different from each other, with
the result that the loads acting upon the
partitions are cancelled by the damping effect
resulting from the interference of the shifted
phases of the waves. The arrangement of the
40 partitions makes it possible to change the
directions of the waves to further improve the
effectiveness of the partitions arranged in the
tank. In consideration of horizontal vibrations
in all directions, the partitions are required
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60 tion of the bottom wall panel, and (b) side
wall panels in each of which securing flanges
are folded in a direction the same as that of
the protrusion portion of the side wall panel,
the said side wall panels being formed adjacent

the flanges with flat portions in the general 65
plane of the panels, the said securing flanges
of the said bottom and side wall panels facing
outwardly and flanges of the said bottom
panels and the said flat portions of the side
70 wall panels being clamped together to form
the tank.

2. A tank as claimed in claim 1, wherein
the said securing flanges and flat portions of
the said side wall panels are thicker than
those portions constituting the said pyramids 75
of the panels.

3. A tank as claimed in claim 1 or 2,
wherein the said side wall panels are con-
nected together with their securing flanges
to form a side wall panel assembly and the
80 said bottom wall panels are connected to-
gether with their securing flanges to form a
bottom wall panel assembly, and the said
flat portions of the said thus assembled side
wall panel assemblies and the said securing
85 flanges at the periphery of the said thus
assembled bottom wall panel assembly are
connected together to form the tank.

4. A tank as claimed in any of claims 1
to 3, wherein unvulcanized rubber sheets are 90
interposed between the said securing flanges
of the tank and are bolted together to connect
the panels to form the tank.

5. A tank as claimed in any of claims 1
to 4, wherein at least one of the said side 95
wall panels has its protrusion portion in the
form of a truncated pyramid, of which the
top truncated surface in parallel with the
said flat portions of the panel is eccentric
to the center of the panel to form a pipe 100
securing surface.

6. A tank as claimed in any of claims 1
to 5, wherein at least one of the said bottom 105
wall panels has its protrusion portion in the
form of a truncated pyramid of which the
truncated surface is provided with a scupper,
and the said securing flanges are folded in
a direction the same as that of the protrusion
portion of the bottom wall panel.

7. A tank as claimed in any of claims 1 to 110
6, which further comprises tie rods formed
at their ends with threaded portions and larger
diameter portions spaced from the ends, por-
tions between the threaded portions and the
115 larger diameter portions of the tie rods pass-
ing through connecting holes formed in the
opposite side wall panels, and flanged cylin-
drical rubber bushes longer than the thick-
ness of the panels being fitted about the tie
120 rods and the said connecting holes of the side
walls, and the tie rods being tightened by
means of nuts to reinforce the side wall of
the tank.

8. A tank as claimed in claim 7, wherein 125
the tank further comprises brackets fixed to
the said securing flanges at respective corners
of four side wall panels of opposite side walls
of the tank and covering at least three pairs
of securing flanges, and the tie rods having



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at their ends threaded portions extending between the said opposite side wall panels and threadedly clamped through spacers between the said opposite brackets.

- 5 9. A tank as claimed in any of claims 1 to 8, provided with a base frame suitable for mounting the tank thereon by means of the securing flanges extending from the peripheries of the said bottom side wall panels,
- 10 portions of the base frame confronting the said securing flanges being formed with elongate apertures of which the longer axes are perpendicular to each other to facilitate mounting the tank on the base frame.

10. A tank as claimed in any of claims 1 to 9, wherein flexible partitions are arranged within the tank at intervals and depending from the upper end of the tank to above the bottom wall of the tank.

11. A tank according to claim 1, substantially as herein described with reference to, and as shown in, the accompanying drawings.

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MARKS & CLERK,
Chartered Patent Agents,
57-60 Lincoln's Inn Fields,
London, WC2A 3LS.
Agents for the Applicants.

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