



(51) International Patent Classification:

B03D 1/02 (2006.01) *B03D 1/20* (2006.01)
B03D 1/14 (2006.01) *E04G 5/00* (2006.01)

(21) International Application Number:

PCT/FI2015/050331

(22) International Filing Date:

13 May 2015 (13.05.2015)

(25) Filing Language:

English

(26) Publication Language:

English

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,

HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- of inventorship (Rule 4.17(iv))

Published:

- with international search report (Art. 21(3))

(54) Title: A FLOTATION TANK MODULE AND ITS USES, A FLOTATION PLANT, A METHOD OF CHANGING OF A FLOTATION TANK MODULE, A METHOD OF REPLACING THE SELF-SUPPORTING TANK IN THE FLOTATION TANK MODULE AND A SELF-SUPPORTING TANK

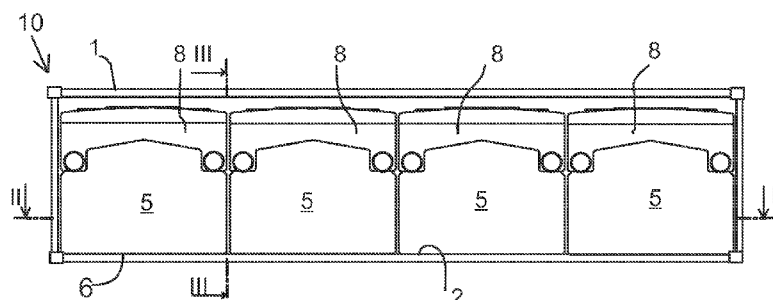


Fig. 1

(57) Abstract: The invention relates to a flotation tank module and its uses, a flotation plant, a method of changing of the flotation tank module, a method of replacing the self-supporting tank in the flotation tank module and a self-supporting tank. The flotation tank comprises a framework. The framework has a shape of a rectangular parallelepiped and comprises a framework bottom and framework sidewalls (3, 4). A self-supporting tank for receiving the liquid is placed inside the framework without being attached to the framework bottom and the framework sidewalls (3, 4).

**A FLOTATION TANK MODULE AND ITS USES, A FLOTATION
PLANT, A METHOD OF CHANGING OF A FLOTATION TANK MOD-
ULE, A METHOD OF REPLACING THE SELF-SUPPORTING TANK IN
THE FLOTATION TANK MODULE AND A SELF-SUPPORTING TANK**

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FIELD OF THE INVENTION

The present invention relates to a flotation tank mod-
ule. Further, the invention relates to uses of the
flotation tank module. Further, the invention relates
10 to a flotation plant. Further, the invention relates
to a method of changing a flotation tank module. Fur-
ther, the invention relates to a method of replacing
the self-supporting tank in the flotation tank module
Finally, the invention relates to a self-supporting
15 tank.

SUMMARY OF THE INVENTION

According to a first aspect, the present invention
provides a flotation tank module comprising
20 - a self-supporting framework, the framework hav-
ing a shape of a rectangular parallelepiped, the
framework comprising a framework bottom and framework
sidewalls, and
- a self-supporting tank for receiving the liq-
25 uid, the self-supporting tank being placed inside the
framework without being attached to the framework bot-
tom and the framework sidewalls.

The self-supporting tank is a part that wears in use
30 due to severe conditions inside the tank during flota-
tion process. The self-supporting tank has an integral
monocoque structure that is able to hold its form
while it is used, transferred and hoisted. The tech-
nical effect of the invention is that the self-
35 supporting tank can easily be installed into the
framework and also can easily be removed therefrom for

maintenance or replacement since it is not attached to the framework.

In this application the following definitions apply regarding flotation. Flotation involves phenomena related to the relative buoyancy of objects. The term flotation includes all flotation techniques. Flotation can be for example froth flotation, dissolved air flotation (DAF) or induced gas flotation. Froth flotation is a process for separating hydrophobic materials from hydrophilic materials by adding gas, for example air, to process. Froth flotation could be made based on natural hydrophilic/hydrophobic difference or based on hydrophilic/hydrophobic differences made by addition of a surfactant or collector chemical. Gas can be added to the feedstock subject of flotation (slurry or pulp) by a number of different ways. In one embodiment gas can be added to the stream of feedstock subject to flotation before it is fed to the flotation tank. In one embodiment gas can be added to feedstock subject to flotation in the flotation tank. In one embodiment gas adding equipment can include gas dispersing equipment at the bottom of the tank. In one embodiment gas adding equipment can include a feedstock (slurry or pulp) jet for jetting the feedstock to air. In one embodiment gas adding equipment includes a rotor inside the tank. In one embodiment gas can be added under the rotor. In one embodiment gas is added by a pipe ending under rotor. The pipe can be inside the flotation tank. The pipe can go through the bottom of the flotation tank. In one embodiment the rotor takes gas from the surface of sludge by vortex. In one embodiment gas is added by axis of the rotor. In one embodiment mixing equipment is arranged for mixing the slurry/pulp. Mixing equipment could be for example a pump or a rotor. When the mixing is made by pump, the feedstock subject of flotation could be taken from one part of

flotation tank and put back to another part of flotation tank. When mixing is made by the rotor, the rotor is inside the flotation tank. In one embodiment mixing equipment can include a rotor inside the flotation
5 tank. In one embodiment mixing equipment can include a stator inside the flotation tank. The stator is for boosting mixing and to diffuse air to the feedstock (slurry or pulp) subject to flotation.

10 In one embodiment of the flotation tank module, the self-supporting tank has a rectangular cross-sectional shape.

In one embodiment of the flotation tank module, the
15 self-supporting tank comprises a tank bottom and four tank sidewalls, and at least two of the tank sidewalls of the self-supporting tank lean against the framework sidewalls. In this embodiment the cross-sectional shape of the self-supporting tank is rectangular or
20 quadrangular. The self-supporting tank can be designed to be a light-weight structure since the framework may support the tank from outside. The framework can be designed to receive the majority of the forces exerted by the hydrostatic pressure which is caused by the
25 liquid filled inside the tank.

In one embodiment of the flotation tank module, the tank sidewalls comprise a planar wall part, the planar wall part having a width which is at least 70% of the
30 total width of the tank sidewall, and at least two of the planar parts of the tank sidewalls lean against the framework sidewalls.

In one embodiment of the flotation tank module, self-
35 supporting tank has a circular cross-sectional shape.

In one embodiment of the flotation tank module, the framework is made of metal.

5 In one embodiment of the flotation tank module, the self-supporting tank is made of plastics.

In one embodiment of the flotation tank module, the wall thickness of the self-supporting tank is 5 - 30 mm. The technical effect of the wall thickness within
10 this range is that the tank will not be too heavy so that it can be changed easily but yet it is stiff enough so that it can be easily installed. The tapering of the tank at its upper part makes it stiff so that the tank is stiff despite the relatively thin
15 wall.

In one embodiment of the flotation tank module, the self-supporting tank is made of a thermoplastic polymer.
20

In one embodiment of the flotation tank module, the thermoplastic polymer is polyethylene PE or polypropylene PP. The technical effect of these materials is that they are very resistant to abrasive wear. Especially, when the tank is in use it may accommodate a
25 rotating rotor for gas adding and/or mixing, the mixing of the feedstock subject of flotation by a rotor causes the feedstock (which can be very abrasive) to flow against inner surface of the tank wall and thereby causes severely abrasive wear conditions.
30

In one embodiment of the flotation tank module, the thermoplastic polymer is polyethylene.

35 In one embodiment of the flotation tank module, the thermoplastic polymer is polypropylene.

In one embodiment of the flotation tank module, the flotation tank module comprises the flotation tank module comprises one to six, preferably one to four, self-supporting tanks.

5

In one embodiment of the flotation tank module, the self-supporting tanks are arranged in a row and in fluid communication with each other inside the framework

10

In one embodiment of the flotation tank module, the volume of the self-supporting tank is $0.5 - 20 \text{ m}^3$, preferably $1 - 15 \text{ m}^3$, most preferably $1 - 8 \text{ m}^3$. The technical effect is that the tanks can be changed easily as they are not too big and heavy. The tanks are still big enough so that a significant volume of capacity can be subjected to maintenance by changing a few tanks. The maintenance operations can be easily made for tanks which are not too big and heavy.

20

In one embodiment of the flotation tank module, the flotation tank module comprises an overflow receptacle for receiving the overflow from the self-supporting tank, when in use during flotation.

25

In one embodiment of the flotation tank module, the self-supporting tank has a lower tank part and a tapered upper tank part which is narrower than the lower tank part

30

In one embodiment of the flotation tank module, the overflow receptacle is disposed in the area of the tapered upper tank part of the self-supporting tank.

35

In one embodiment of the flotation tank module, the overflow receptacle and the self-supporting tank are connected to each other by welding. The technical ef-

fect is that the flotation tank has a good structural stiffness.

5 In one embodiment of the flotation tank module, the self-supporting tank has a mouth at the upper end of the upper tank part.

10 In one embodiment of the flotation tank module, the overflow receptacle surrounds circumferentially the mouth of the self-supporting tank. The technical effect is that the tank has a good structural stiffness.

15 In one embodiment of the flotation tank module, an overflow lip is at the periphery of the mouth.

In one embodiment of the flotation tank module, the overflow lip comprises a separate lip member, and the lip member is connectable to the upper part of the self-supporting tank at a desired height position to
20 obtain a suitable overflow height for the overflow. The technical effect is that the overflow heights of identical tanks can be made different with an adjustable lip member.

25 In one embodiment of the flotation tank module, the overflow receptacle comprises a chute for collecting the overflow, when in use, and at least one outlet at the lower part of the overflow receptacle, and the chute is inclined towards the outlet. The technical
30 effect is that the flow of overflow by gravity is ensured by the inclination.

In one embodiment of the flotation tank module, an angle of inclination of the chute is 5° - 30° , more
35 preferably 8° - 20° , most preferably 10° - 15° . $^{\circ}$. The technical effect of the angle of inclination especially for the angles 8° - 20° , most preferably 10° - 15° ,

is that the chute does not become blocked and does not wear excessively.

In one embodiment of the flotation tank module, the cross-sectional shape of the lower tank part is rectangular when the volume of the self-supporting tank is greater than 8 m³. The technical effect is that such great tanks can be supported by sidewalls of the self-supporting framework in the inner space of which the tanks are installed in a tank module. The wall of the tank can be supported against the sidewall of the framework so that the framework bears loads exerted by the hydrostatic pressure of the liquid filled inside the tank.

In one embodiment of the flotation tank module, the cross-sectional shape of the lower tank part is circular when the volume of the self-supporting tank is at most 8 m³. The technical effect is that the round form gives the required stiffness for the tank up to this size class.

In one embodiment of the flotation tank module, the cross-sectional shape of the lower tank part being rectangular the mouth is rectangular or circular. The technical effect of the circular mouth is that it stiffens the structure of the tank.

In one embodiment of the flotation tank module, the cross-sectional shape of the lower tank part being circular the mouth is circular. The technical effect of the circular mouth is that the entity formed by the tank and the overflow receptacle together is stiff to enable easy handling, lifting and maintenance.

In one embodiment of the flotation tank module, the overflow receptacle is arranged inside the framework.

In one embodiment of the flotation tank module, the overflow receptacle is outside the framework.

- 5 In one embodiment of the flotation tank module, the flotation is froth flotation.

According to a second aspect, the present invention provides a flotation plant comprising a flotation tank
10 module according to the first aspect of the invention.

In one embodiment of the flotation plant, the flotation plant is a modular structure comprising

- a tank module, the tank module being a self-supporting structure capable of being transferable and
15 hoistable as an integral unit, the tank module comprising

- a first self-supporting framework having a shape of a rectangular parallelepiped, the framework
20 comprising a framework bottom and framework sidewalls (3, 4), and

- a self-supporting tank for receiving the liquid, the self-supporting tank being placed inside the first self-supporting framework without being attached
25 to the framework bottom and the framework sidewalls (3, 4).

In one embodiment of the flotation plant, the flotation plant comprises

- a bubble forming and mixing equipment within
30 the self-supporting tank, the equipment comprising a rotatable drive shaft, and

- a drive module, the drive module being a self-supporting structure so as to be transferable and
35 hoistable as an integral entity, the drive module being removably disposed on top of the tank module, the drive module comprising

-- a second self-supporting framework having a shape of a rectangular parallelepiped, the second self-supporting framework defining an inner space within the second self-supporting framework, and

5 -- a drive unit, the drive unit being supported to the second self-supporting framework in the inner space of the self-supporting framework, and the drive unit is connectable to the rotatable drive shaft for the rotation of the rotatable shaft.

10

According to a third aspect, the present invention provides use of the flotation tank module according to the first aspect of the invention for separating material by flotation based on differences of buoyancy properties of substances. For example there is buoyancy difference when organic material is separated from aqueous material.

15

According to a fourth aspect, the present invention provides use of the flotation tank module according to the first aspect of the invention for separating solid material by froth flotation based on differences of hydrophilic properties of substances. Solid materials separated by froth flotation could be oil sands, carbon, coal, talk, industrial minerals and mineral particles. The minerals may include industrial minerals and ore. Froth flotation to solid material could be made based on natural hydrophilic/hydrophobic difference or based on hydrophilic/hydrophobic differences made by addition of a surfactant or collector chemical or other chemical.

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According to a fifth aspect, the present invention provides use of the flotation tank module according to the first aspect of the invention for concentrating ore by froth flotation. An ore is a type of rock that contains sufficient minerals with important elements

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including metals that can be economically extracted from the rock. Metal ores are generally oxides, sulfides, silicates, or metals such as native copper or gold. Froth flotation of ore could be made based on
5 natural hydrophilic/hydrophobic difference or based on hydrophilic/hydrophobic differences made by addition of a surfactant or collector chemical or other chemical.

10 According to a sixth aspect, the present invention provides use of the flotation tank module according to the first aspect of the invention for flotation of substances containing abrasive material. The abrasive mineral may be, for example, pyrite, silica, chromite.
15 The drive module being hoistable and transferable as one unit to gain access to the tanks enables that the tanks can easily be maintained or replaced when they are outworn and are at the end of their life. This is important especially with the use in connection with
20 abrasive material. Use of the flotation plant which is easy to maintenance is effective when flotation is made to abrasive material.

According to a seventh aspect, the present invention
25 provides use of the flotation tank module according to the first aspect of the invention for froth flotation of ore containing pyrite, silica, chromite. Use of the tank module which is easy to maintenance and has preferably tanks made from PE or PP is effective when flotation is made to ore containing pyrite, silica, chromite. PE and PP are durable against the ore containing
30 pyrite, silica, chromite.

According to an eighth aspect, the present invention
35 provides a method of changing of the flotation tank module according to the first aspect of the invention, in which method the flotation tank module subject of

maintenance is replaced by another flotation tank module.

According to a ninth aspect, the invention provides a
5 method of replacing the above described self-supporting tank, the method comprising steps of
- removing the self-supporting tank out from inside the framework, and
- installing another self-supporting tank into the
10 framework.

In one embodiment of the method, the steps of removing and installing the self-supporting tank are implemented by lifting the self-supporting tank.

15 According to a tenth aspect, the invention provides a self-supporting tank made of plastics, preferably thermopolymer, the self-supporting tank having a lower part and a tapered upper part which is narrower than
20 the lower part.

In one embodiment of the self-supporting tank, the self-supporting tank comprises an overflow receptacle made of plastics, preferably thermopolymer, the overflow receptacle being disposed in the area of the tapered upper part of the self-supporting tank, and the overflow receptacle is connected to the self-supporting tank to form an integral part with the self-supporting tank.

30 The embodiments of the invention described hereinbefore may be used in any combination with each other. Several of the embodiments may be combined together to form a further embodiment of the invention. An apparatus, a method, a composition or a use, to which the
35 invention is related, may comprise at least one of the embodiments of the invention described hereinbefore.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and constitute a part of this specification, illustrate embodiments of the invention and together with the description help to explain the principles of the invention. In the drawings:

10 Figure 1 is cross-section I-I from Figure 3, and shows an elevation view of a flotation tank according to one embodiment of the invention, the froth flotation tank being a tank module including four self-supporting tanks inside a framework,

15

Figure 2 is a cross-section II-II from Figure 1,

Figure 3 is a cross-section III-III from Figure 1,

20 Figure 4 shows an axonometric view of an assembly formed of a self-supporting tank and an overflow receptacle attached thereto,

Figure 5 shows an axonometric view of the self-supporting tank of Figure 4,

25

Figure 6 shows a cross-section VI-VI from Figure 4,

Figures 7 to 9 shows further examples of an assembly formed of a self-supporting tank and an overflow receptacle attached thereto in different forms.

30

Figures 10 to 12 shows examples of the flotation tank modules having tanks with a circular cross-sectional shape,

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Figure 13 shows an elevation view of a froth flotation plant according to one embodiment of the invention, and

5 Figure 14 shows a cross section XIV-XIV from Figure 13.

DETAILED DESCRIPTION OF THE INVENTION

Although flotation is disclosed in the following exam-
10 ples by reference to froth flotation, it should be noted that the principles according to the invention can be implemented regardless of the specific type of the flotation, i.e. the flotation technique can be any of the known *per se* flotation techniques, such as
15 froth flotation, dissolved air flotation or induced gas flotation.

Figures 1 - 3 show a froth flotation tank arranged as a tank module 10. The tank module 10 is a self-
20 supporting structure which can be transferred and hoisted as an integral unit.

The tank module 10 includes a framework 1. The framework 1 has a shape of a rectangular parallelepiped.
25 A preferable embodiment of the tank module 10 and its framework 1 is that they are compatible to intermodal freight container standards whereby they have dimensions and corner fittings which enable intermodal transportability.

30

The framework 1 comprises a horizontal framework bottom 2 and framework sidewalls 3, 4. For illustrative purposes, in order to show the self-supporting tanks 5 inside the framework 1, Figure 1 is a section I-I from
35 Figure and does not show the frontal (in Figure) framework sidewall 3.

In the example shown in Figures 1 and 2, four self-supporting tanks 5 for receiving the liquid are arranged inside the framework 1. The tanks 5 are arranged in a row and in fluid communication with each other so that an underflow can flow through the tanks.

In the shown example, in Figures 1 to 3, the self-supporting tanks 5 have a rectangular cross-sectional shape. The self-supporting tanks 5 lean loosely against the framework bottom 2 and the framework sidewalls 3, 4 without being attached to the framework bottom 2 and the framework sidewalls 3, 4.

Each self-supporting tank 5 comprises a tank bottom 6 and four tank sidewalls 7. As can be seen in Figure 2, at least two of the tank sidewalls 7 of each self-supporting tank 5 lean against the framework sidewall 3, 4. At the ends of the tank module 10 the three tank sidewalls 7 of the tank 5 lean against the framework sidewalls 3, 4, and the fourth tank sidewall 7 leans against the tank sidewall 7 of the neighboring self-supporting tank 5. The two self-supporting tanks 5 residing in the middle of the row each have two tank sidewalls 7 leaning against the opposite framework sidewalls 3 while two of the tank sidewalls 7 lean against tank sidewalls of the neighboring self-supporting tanks 5.

As can be seen in Figures 2, 4 and 5 the self-supporting tank 5 has a generally rectangular cross-sectional shape having four tank sidewalls 7. Each of the tank sidewalls comprises a planar wall part 17. The planar wall part 17 has a width w (see Figure 2) which is at least 70% of the total width W of the tank sidewall 7. The planar parts 17 lean against the framework sidewalls 3, 4.

Preferably, the framework 1 is made of metal and the self-supporting tank 5 is made of plastics. The wall thickness of the self-supporting tank 5 is preferably 5 - 30 mm. The self-supporting tank 5 is preferably made of a thermoplastic polymer, such as polyethylene PE or polypropylene PP.

Although in the embodiment shown in Figures 1 and 2 there are four self-supporting tanks 5 inside the framework 1, in other (not shown) embodiments the number of the self-supporting tanks 5 inside the framework 1 can be less than four, i.e. one, two or three. Preferably the number of the self-supporting tanks 5 is two to four. The volume of the self-supporting tank 5 is 0.5 - 20 m³, preferably 1 - 15 m³, most preferably 1 - 8 m³.

With reference to Figures 3 - 6, the froth flotation tank comprises an overflow receptacle 8. The overflow receptacle 8 is for receiving the overflow which overflows from the self-supporting tank 5, when in use during froth flotation process.

The self-supporting tank 5 has a lower part 18 and a tapered upper part 9 which is narrower than the lower part 18. The overflow receptacle 8 is disposed in the area of the tapered upper part 9 of the self-supporting tank 5. As can be seen in Figure 3, the overflow receptacle 8 is also inside the framework 1. In a not-shown embodiment the overflow receptacle 8 may also be outside the framework 1.

With reference to Figures 4-6, a self-supporting tank 5 is made of plastics, preferably of thermopolymer. The self-supporting tank 5 has a lower part 18 and a tapered upper part 9 which is narrower than the lower part 18. The overflow receptacle 8 which also made of

plastics, preferably of thermopolymer, is in the area of the tapered upper part 9 of the self-supporting tank 5. The overflow receptacle 8 is welded to the self-supporting tank 5 to form an integral part with the self-supporting tank.

The self-supporting tank 5 is upwards open and has a mouth 21. The upper end forms an overflow lip 20. The overflow receptacle 8 is in a form of a peripheral chute 23 which surrounds the overflow lip 20 so that the overflow (froth) which overflows from the tank 5 over the overflow lip 20 is received by the overflow receptacle 8. The overflow lip 20 comprises a separate lip member 22. The lip member 22 is connected to the upper part of the self-supporting tank 5 at a desired height position to obtain a suitable overflow height for the overflow.

In Figures 4 and 6 can be seen that outlets 24 are disposed at the lower part of the overflow receptacle 8. The chute 23 is inclined towards the outlet. The bottom the chute 23 is straight. An angle α of inclination of the chute 23 is $5^{\circ} - 30^{\circ}$, more preferably $8^{\circ} - 20^{\circ}$, most preferably $10^{\circ} - 15^{\circ}$.

The framework 1 is preferably an upwards open structure so that the self-supporting tanks 5 can be installed into the framework 1 and/or can be removed therefrom by hoisting in a vertical direction.

In a method of replacing the self-supporting tank 5 the self-supporting tank 5 is removed out from inside the framework 1. Another self-supporting tank 5 is installed into the framework 1 to replace the one that has been removed. Preferably removing and installing the self-supporting tank 5 are implemented by lifting the self-supporting tank 5.

Figures 7 to 9 show three examples of possible shapes of the tank 5 and the overflow receptacle. In Figures 7 and 8 the lower tank part 18 of the tank 5 has a rectangular cross-sectional shape which is suitable for tanks 5 having a volume greater than 8 m³. In Figure 7 the mouth 21 is circular and in Figure 8 the mouth 21 is rectangular.

Figure 9 shows an example wherein the lower tank part 18 of tank 5 is circular in cross-section, i.e. cylindrical, and also the mouth 21 and the overflow receptacle 8 are circular.

Figures 10 to 12 show further examples of the flotation tank modules 10 having assemblies of tanks 5 and overflow receptacles 8 as shown in Figure 9.

In Figures 13 and 14 there is shown an embodiment of a simple froth flotation plant which is implemented as a modular structure. The froth flotation plant comprises a tank module 10. The tank module 10 can be as has been described above with reference to Figures 1-3. The tank module 10 is a self-supporting structure capable of being transferable and hoistable as an integral unit. The tank module 10 comprises a first self-supporting framework 1 having a shape of a rectangular parallelepiped. The first self-supporting framework 1 comprises a framework bottom 2 and framework sidewalls 3, 4. A self-supporting tank 5 for receiving the liquid is arranged inside the first self-supporting framework 1 to lean loosely against the framework bottom 2 and the framework sidewalls 3, 4 without being attached thereto.

With reference to Figure 8, the froth flotation plant comprises a bubble forming and mixing equipment 11

within the self-supporting tank 5, the equipment comprising a rotatable drive shaft 12. Further, the plant comprises a drive module 13. The drive module 13 is a self-supporting structure so as to be transferable and hoistable as an integral entity. The drive module 13 is removably disposed on top of the tank module 10 so that an access to the tank module 10 can be made simply by lifting the drive module 10.

10 The drive module 13 comprises a second self-supporting framework 14 having a shape of a rectangular parallel-piped, the second self-supporting framework defining an inner space 15 inside the second self-supporting framework 14. The drive module 13 further comprises a drive unit 16. The drive unit 16 is supported to the second self-supporting framework 14 in the inner space 15 of the self-supporting framework. The drive unit 16 is connectable to the rotatable drive shaft 12 for the rotation of the rotatable shaft 12.

20 A preferable embodiment of the drive module 13 and its framework 14 is that they are compatible to intermodal freight container standards whereby they have dimensions and corner fittings which enable intermodal transportability.

It is obvious to a person skilled in the art that with the advancement of technology, the basic idea of the invention may be implemented in various ways. The invention and its embodiments are thus not limited to the examples described above, instead they may vary within the scope of the claims.

CLAIMS

1. A flotation tank module comprising
 - a framework, the framework having a shape of a rectangular parallelepiped, the framework comprising a framework bottom and framework sidewalls, and
 - a self-supporting tank for receiving the liquid, the self-supporting tank being disposed inside the framework without being attached to the framework bottom and the framework sidewalls.
2. The flotation tank module according to claim 1, wherein the self-supporting tank has a rectangular cross-sectional shape.
3. The flotation tank module according to claim 2, wherein the self-supporting tank comprises a tank bottom and four tank sidewalls, and at least two of the tank sidewalls of the self-supporting tank lean loosely against the framework sidewalls.
4. The flotation tank module according to claim 3, wherein the tank sidewalls comprise a planar wall part, the planar wall part having a width which is at least 70% of the total width of the tank sidewall, and at least two of the planar parts of the tank sidewalls lean against the framework sidewalls.
5. The flotation tank module according to claim 1, wherein the self-supporting tank has a circular cross-sectional shape.
6. The flotation tank module according to any one of the claims 1 to 5, wherein the framework is made of metal.

7. The flotation tank module according to any one of the claims 1 to 6, wherein the self-supporting tank is made of plastics.

5 8. The flotation tank module according to claim 7, wherein the wall thickness of the self-supporting tank is 5 - 30 mm.

9. The flotation tank module according to claim 7 or
10 8, wherein the self-supporting tank is made of a thermoplastic polymer.

10. The flotation tank module according to claim 9,
15 wherein the thermoplastic polymer is polyethylene (PE) or polypropylene (PP).

11. The flotation tank module according to claim 9
wherein the thermoplastic polymer is polyethylene
(PE).

20

12. The flotation tank module according to claim 9,
wherein the thermoplastic polymer is polypropylene
(PP).

25 13. The flotation tank module according to any one of the claims 1 to 12, wherein the flotation tank module comprises one to six, preferably one to four, self-supporting tanks.

30 14. The flotation tank module according to claim 13, wherein the self-supporting tanks are arranged in a row and in fluid communication with each other inside the framework.

35 15. The flotation tank module according to any one of the claims 1 to 14, wherein the volume of the self-

supporting tank is $0.5 - 20 \text{ m}^3$, preferably $1 - 15 \text{ m}^3$, most preferably $1 - 8 \text{ m}^3$.

16. The flotation tank module according to any one of
5 the claims 1 to 15, wherein the flotation tank module comprises an overflow receptacle for receiving the overflow overflowing from the self-supporting tank, when in use during flotation.
- 10 17. The flotation tank module according to any one of the claims 1 to 16, wherein the self-supporting tank has a lower tank part and a tapered upper tank part which is narrower than the lower part.
- 15 18. The flotation tank module according to any one of the claims 1 to 16, wherein the overflow receptacle is disposed in the area of the tapered upper tank part of the self-supporting tank.
- 20 19. The flotation tank module according to claim 18, wherein the overflow receptacle and the self-supporting tank are connected to each other by welding.
- 25 20. The flotation tank module according to any one of the claims 17 to 19, wherein the self-supporting tank has a mouth at the upper end of the upper tank part.
- 30 21. The flotation tank module according to claim 20, wherein the overflow receptacle surrounds circumferentially the mouth of the self-supporting tank.
- 35 22. The flotation tank module according to claim 21, wherein an overflow lip is at the periphery of the mouth.

23. The flotation tank module according to claim 22, wherein the overflow lip comprises a separate lip member, and the lip member is connectable to the upper part of the self-supporting tank at a desired height position to obtain a suitable overflow height for the overflow.

24. The flotation tank module according to any one of the claims 16 to 23, wherein the overflow receptacle comprises a chute for collecting the overflow, when in use, and at least one outlet at the lower part of the overflow receptacle, and the chute is inclined towards the outlet.

25. The flotation tank module according to claim 24, wherein an angle (α) of inclination of the chute is 5° - 30° , more preferably 8° - 20° , most preferably 10° - 15° .

26. The flotation tank module according to any one of the claims 17 to 25, wherein the cross-sectional shape of the lower tank part is rectangular when the volume of the self-supporting tank is greater than 8 m^3 .

27. The flotation tank module according to any one of the claims 17 to 25, wherein the cross-sectional shape of the lower tank part is circular when the volume of the self-supporting tank is at most 8 m^3 .

28. The flotation tank module according to any one of the claims 17 to 27, wherein the cross-sectional shape of the lower tank part being rectangular the mouth is rectangular or circular.

29. The flotation tank module according to any one of the claims 17 to 27, wherein the cross-sectional shape

of the lower tank part being circular the mouth is rectangular or circular.

30. The flotation tank module according to any one of
5 the claims 16 to 29, wherein the overflow receptacle is arranged inside the framework.

31. The flotation tank module according to claim 16,
10 wherein the overflow receptacle is outside the framework.

32. The flotation tank module according to any one of
15 the claims 1 to 31, wherein the flotation is froth flotation.

33. A flotation plant comprising a flotation tank module according to any one of the claims 1 to 32.

34. The flotation plant according to claim 33, the
20 flotation plant being a modular structure comprising
- a tank module, the tank module being a self-supporting structure capable of being transferable and hoistable as an integral unit, the tank module comprising

25 -- a first self-supporting framework having a shape of a rectangular parallelepiped, the framework comprising a framework bottom and framework sidewalls, and

30 -- a self-supporting tank for receiving the liquid, the self-supporting tank being placed inside the first self-supporting framework without being attached to the framework bottom and the framework sidewalls.

35. The flotation plant according to claim 32, wherein
35 the flotation plant comprises

- a bubble forming and mixing equipment within the self-supporting tank, the equipment comprising a rotatable drive shaft, and

5 - a drive module, the drive module being a self-supporting structure so as to be transferable and hoistable as an integral entity, the drive module being removably disposed on top of the tank module, the drive module comprising

10 -- a second self-supporting framework having a shape of a rectangular parallelepiped, the second self-supporting framework defining an inner space within the second self-supporting framework, and

15 -- a drive unit, the drive unit being supported to the second self-supporting framework in the inner space of the self-supporting framework, and the drive unit is connectable to the rotatable drive shaft for the rotation of the rotatable shaft.

36. Use of the flotation tank module according to any
20 one of the claims 1 to 32 for separating material by flotation based on differences of buoyancy properties of substances.

37. Use of the flotation tank module according to any
25 one of the claims 1 to 32 for separating solid material by froth flotation based on differences of hydrophilic properties of substances.

38. Use of the flotation tank module according to any
30 one of the claims 1 to 32 for concentrating ore by froth flotation.

39. Use of the flotation tank module according to any
35 one of the claims 1 to 32 for flotation of substances containing abrasive material.

40. Use of the flotation tank module according to any one of the claims 1 to 32 for froth flotation of ore containing pyrite, silica, chromite.

5 41. A method of changing of the flotation tank module according to any one of the claims 1 to 32, in which method the flotation tank module subject of maintenance is replaced by another flotation tank module.

10 42. A method of replacing the self-supporting tank in the flotation tank module according to any one of the claims 1 to 32, the method comprising steps of

- removing the self-supporting tank out from inside the framework, and
- 15 - installing another self-supporting tank into the framework.

43. The method according to claim 42, wherein the steps of removing and installing the self-supporting tank are implemented by lifting the self-supporting tank.

20

44. A self-supporting tank made of plastics, preferably thermopolymer, the self-supporting tank having a lower part and a tapered upper part which is narrower than the lower part.

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45. The self-supporting tank according to claim 44, wherein the self-supporting tank comprises an overflow receptacle made of plastics, preferably thermopolymer, the overflow receptacle being disposed in the area of the tapered upper part of the self-supporting tank, and the overflow receptacle is connected to the self-supporting tank to form an integral part with the self-supporting tank.

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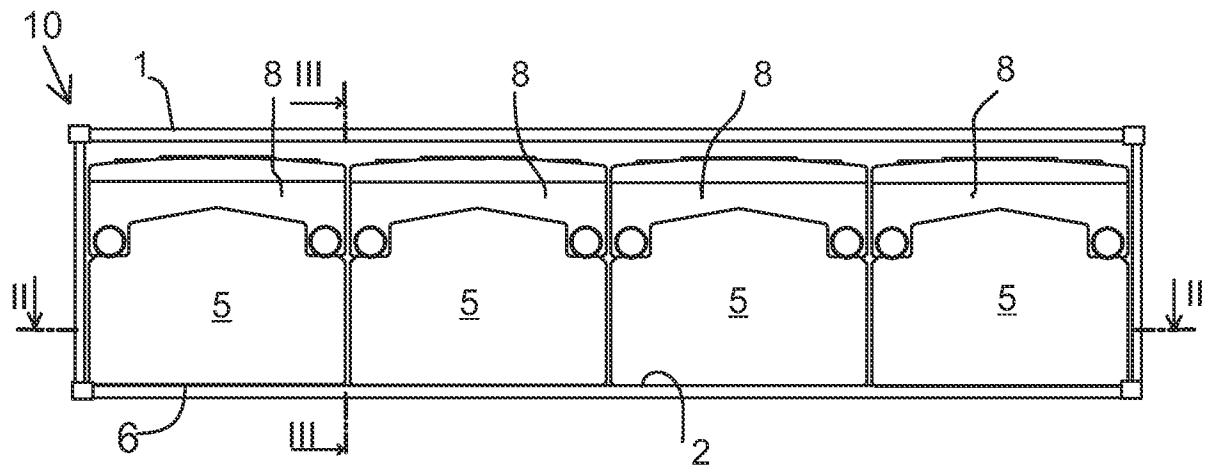


Fig. 1

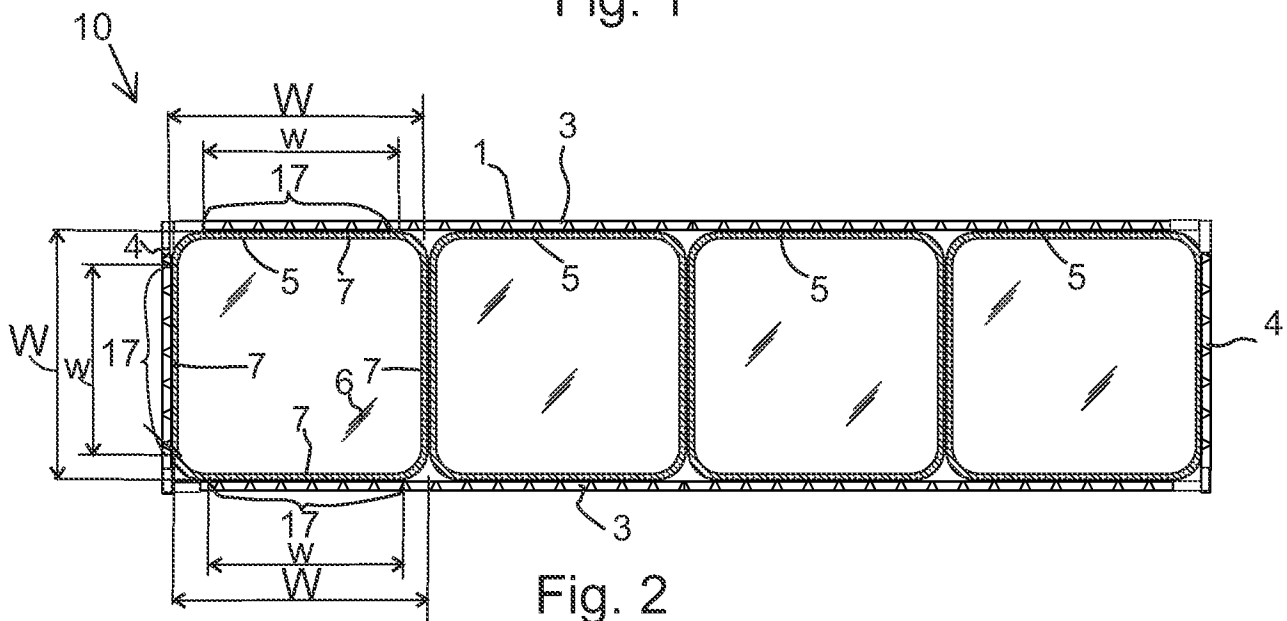


Fig. 2

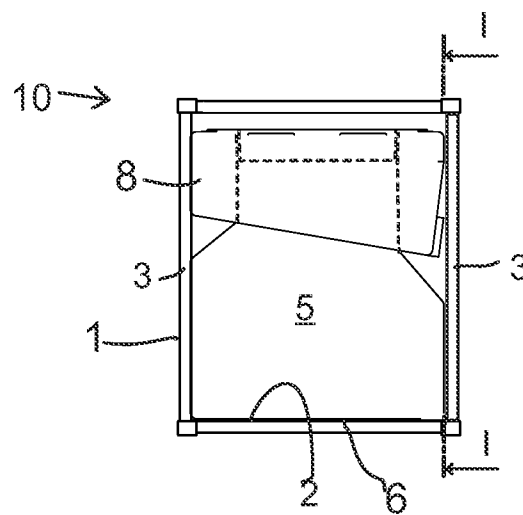


Fig. 3

2/6

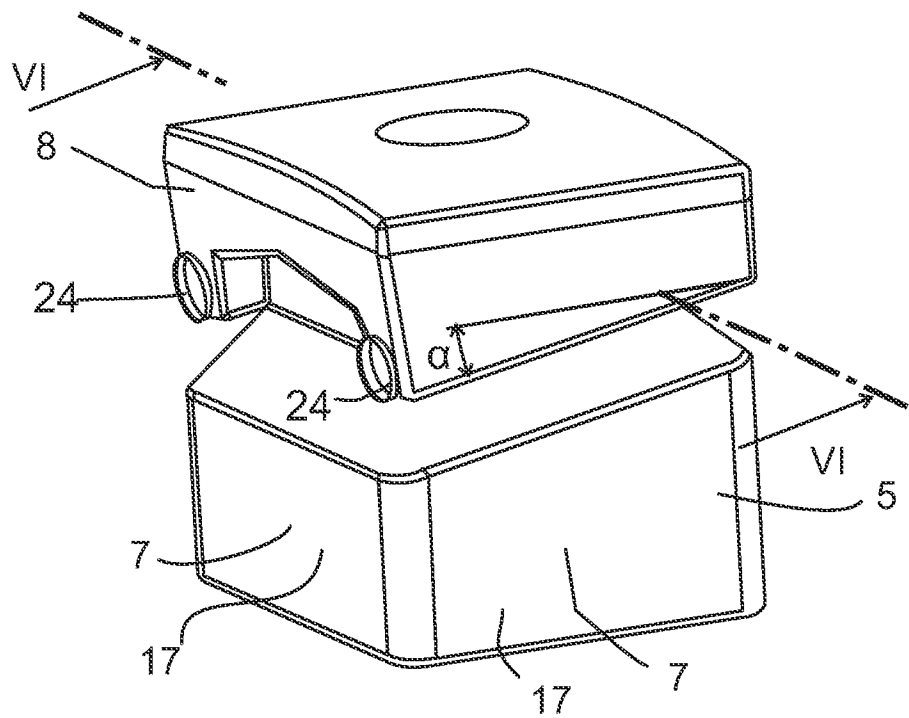


Fig. 4

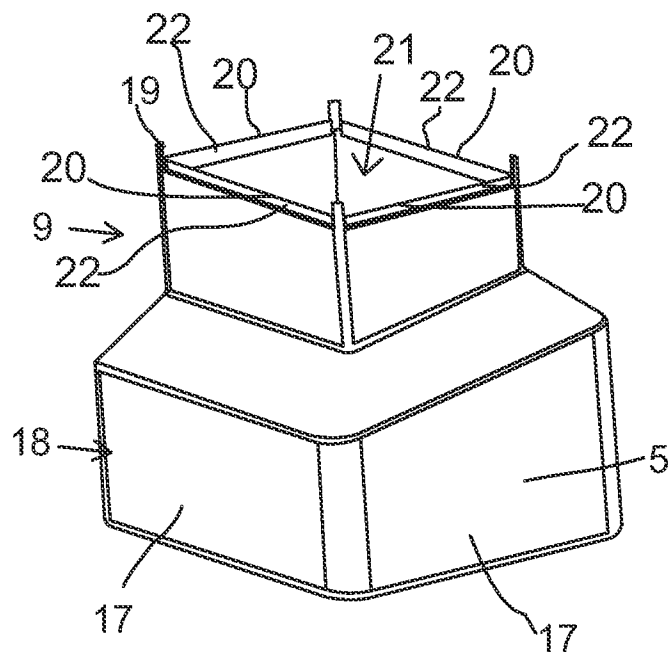


Fig. 5

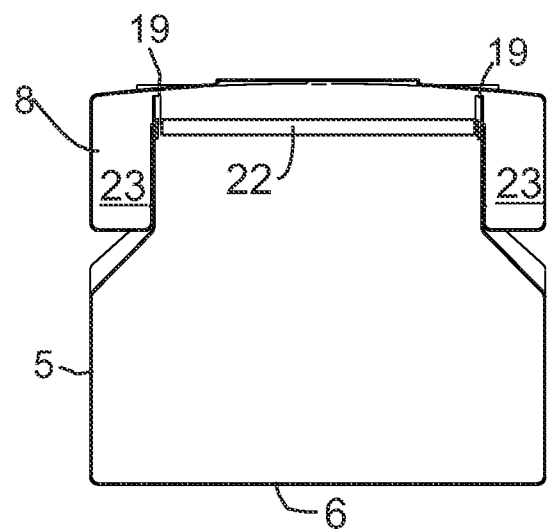


Fig. 6

3/6

Fig. 7

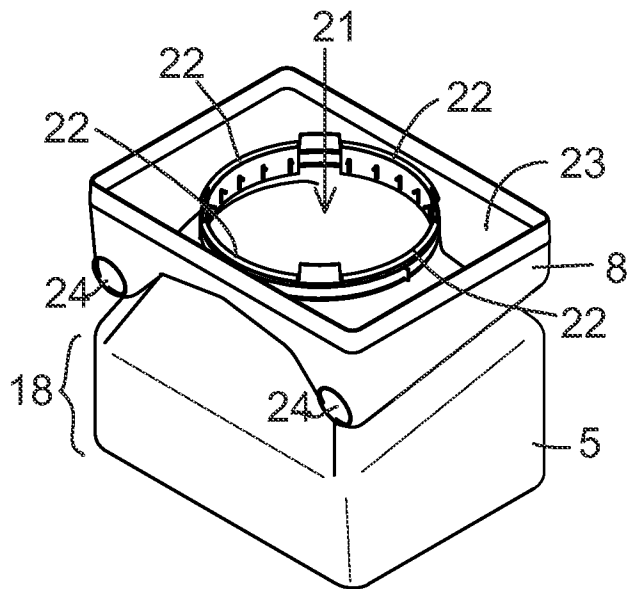


Fig. 8

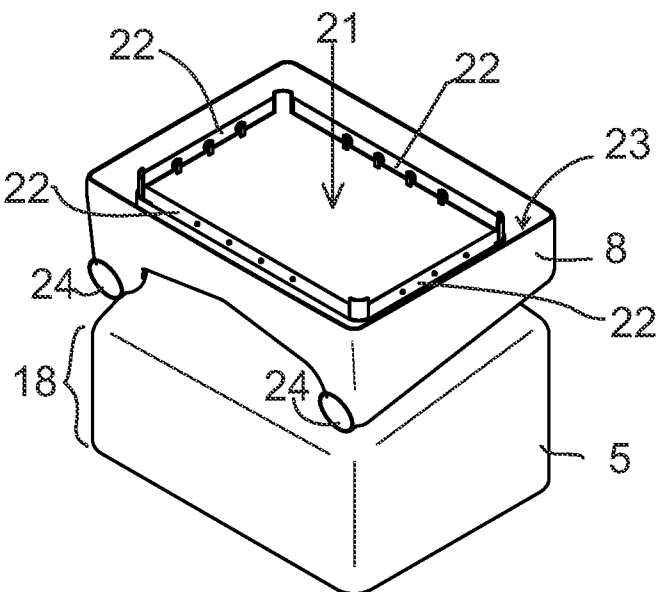
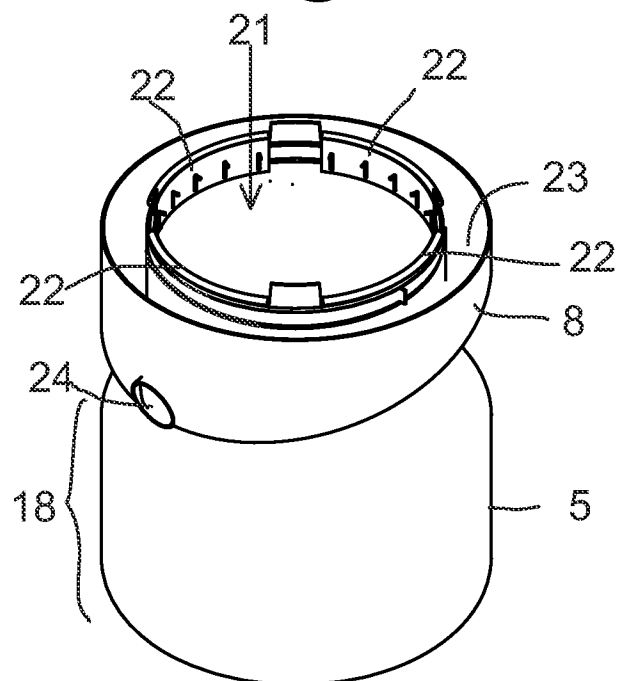


Fig. 9



4/6

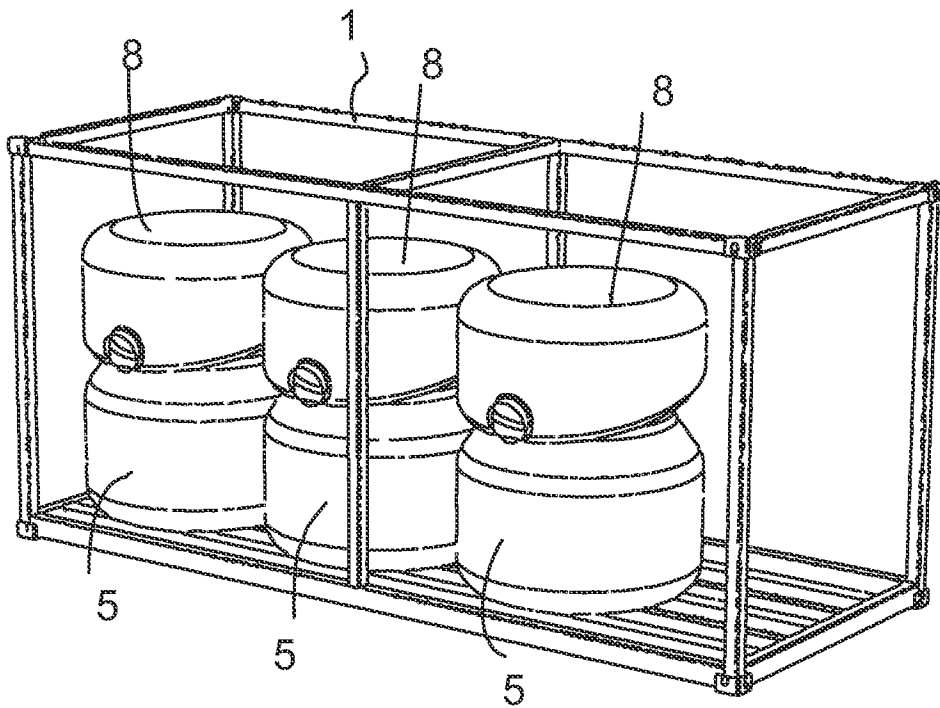


Fig. 10

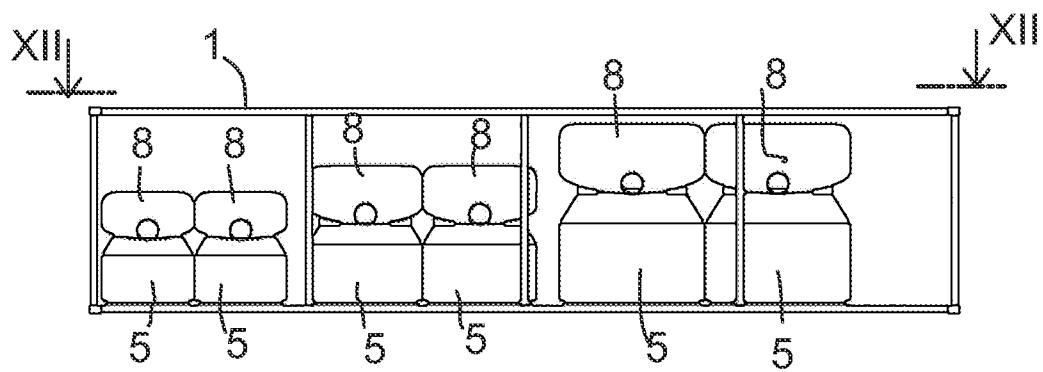


Fig. 11

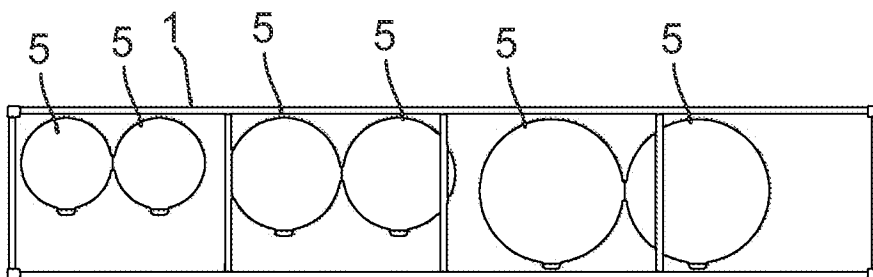


Fig. 12

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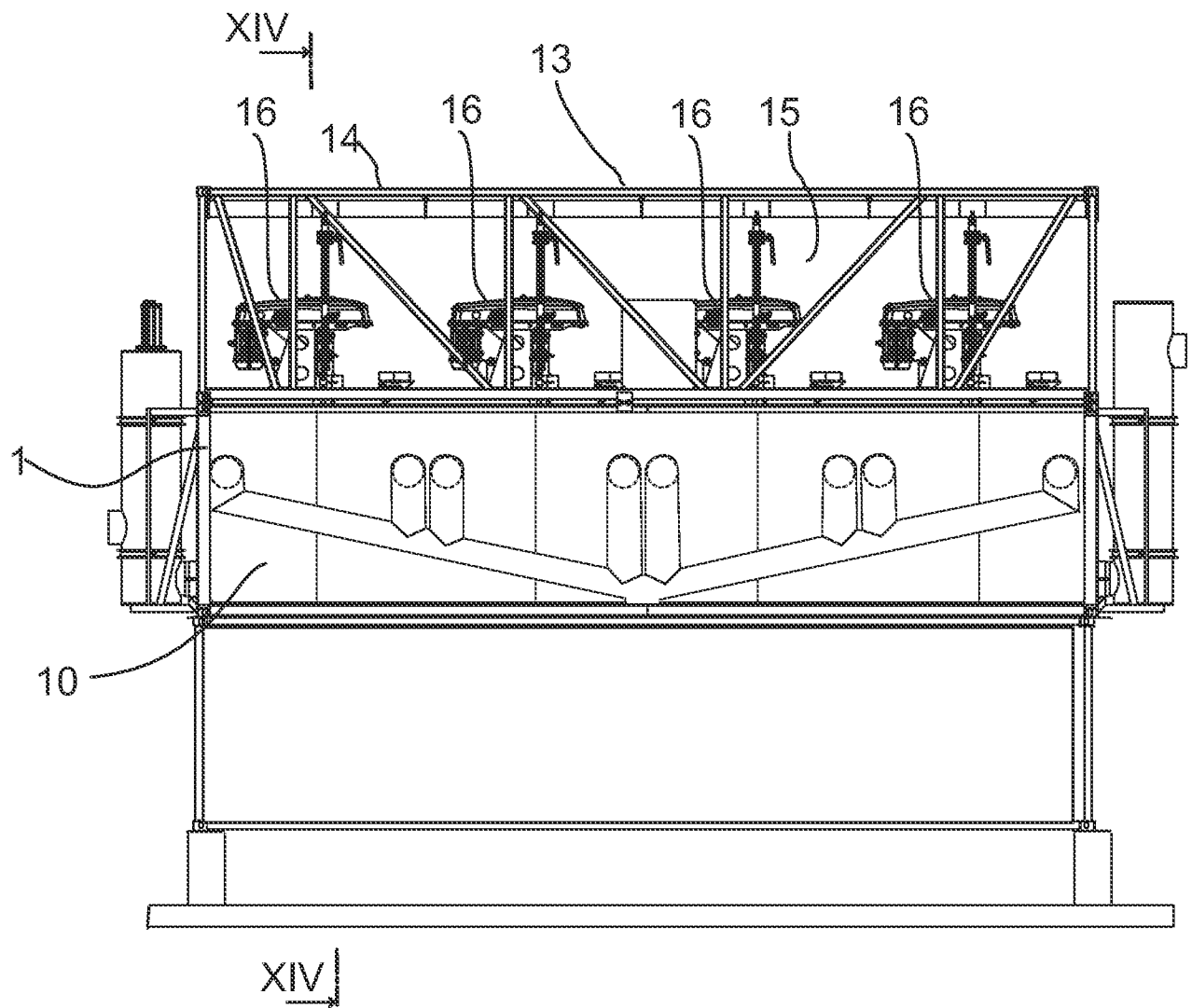


Fig. 13

6/6

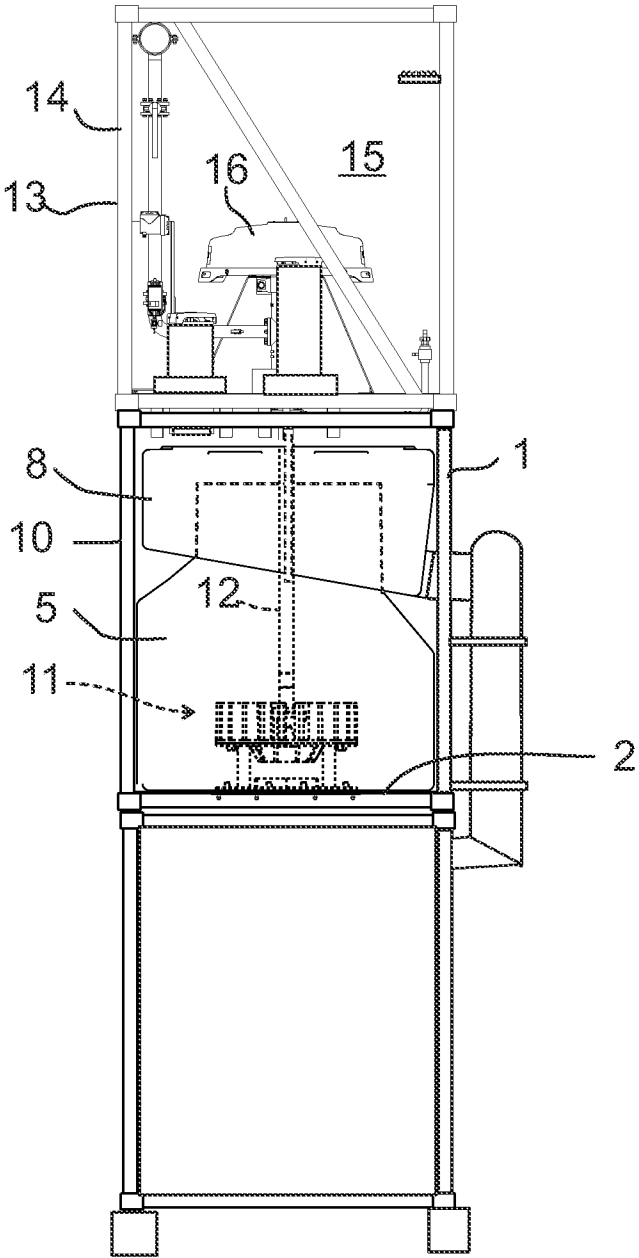


Fig. 14

INTERNATIONAL SEARCH REPORT

International application No
PCT/FI2015/050331

A. CLASSIFICATION OF SUBJECT MATTER

INV. B03D1/02 B03D1/14 B03D1/20 E04G5/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B03D E04G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2004/168964 A1 (LAMBERT DAVID P [US] ET AL) 2 September 2004 (2004-09-02)	1-4,6, 15,16, 32-43
Y	paragraph [0011] - paragraph [0017]; figure 1	7-12, 17-31
X	EP 0 156 699 A1 (MINEMET RECH SA [FR]) 2 October 1985 (1985-10-02)	1,2,5,6, 13,14, 32-43
Y	page 1, line 3 - line 8; figures 1-7 page 4, line 17 - line 35	7-12, 17-31
Y	DE 20 2008 018158 U1 (KURTZE INGOLF [DE]) 22 December 2011 (2011-12-22) claim 2	7-12
	----- -/-	



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

20 January 2016

Date of mailing of the international search report

28/04/2016

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
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Authorized officer

García Alonso, Nuria

INTERNATIONAL SEARCH REPORT

International application No
PCT/FI2015/050331

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2010/135760 A1 (NEWCASTLE INNOVATION LTD [AU]; JAMESON GRAEME JOHN [AU]) 2 December 2010 (2010-12-02) figure 3 -----	17-31

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2015/050331

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-43

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-43

Flotation system

2. claims: 44, 45

Self-supporting tank

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/FI2015/050331

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2004168964	A1	02-09-2004	NONE

EP 0156699	A1	02-10-1985	AU 3382189 A 05-10-1989
		AU 3915085 A 31-10-1985	
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		FR 2560532 A1 06-09-1985	

DE 202008018158	U1	22-12-2011	NONE

WO 2010135760	A1	02-12-2010	AU 2009346778 A1 12-01-2012
		CA 2762841 A1 02-12-2010	
		SE 1100941 A1 27-02-2012	
		US 2012061298 A1 15-03-2012	
		WO 2010135760 A1 02-12-2010	
