(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
17 November 2016 (17.11.2016)

WIPO | PCT

(10) International Publication Number
WO 2016/181025 A1

(51) International Patent Classification:
B03D 1/02 (2006.01) *B03D 1/20* (2006.01)
B03D 1/14 (2006.01) *E04H 5/00* (2006.01)

(21) International Application Number:
PCT/FI2015/050328

(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).

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(54) Title: A FLOTATION PLANT AND ITS USES AND METHODS OF MAINTENANCE OF A FLOTATION PLANT

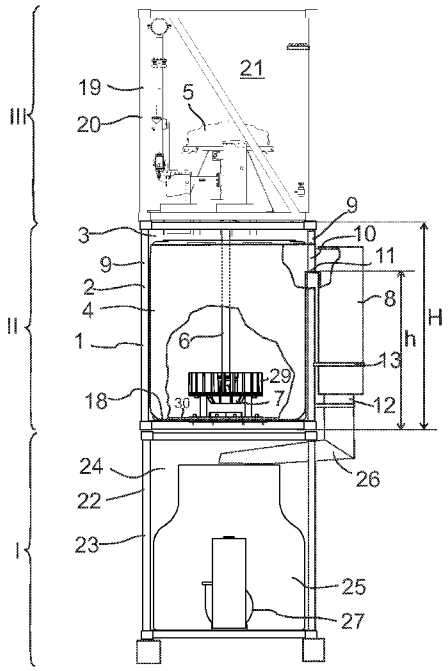

Fig. 2

(57) Abstract: A flotation plant comprises a tank module (1). The tank module includes a self-supporting framework (2) having an inner space (3). The tank module includes at least one flotation tank (4). The flotation tank is disposed in the inner space (3) of the self-supporting framework (2). The tank module (1) is a self- supporting unit capable of being transferable and hoistable as an integral entity. Drive units (5) for the rotation of drive shafts (6) are connected to a rotor (7) for mixing and forming bubbles in the flotation tanks (4). The flotation plant comprises an oveflow receptacle (8). The overflow receptacle (8) is disposed outside the tank module (1) at the level of the upper part of the tank module for receiving the overflow overflowing from the flotation tanks (4).

WO 2016/181025 A1

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))*

A FLOTATION PLANT AND ITS USES AND METHODS OF MAINTENANCE OF A FLOTATION PLANT

FIELD OF THE INVENTION

The present invention relates to a froth flotation plant. Further, the invention relates to uses of the froth flotation plant. Further, the invention relates to methods of maintenance of the flotation plant.

SUMMARY OF THE INVENTION

According to a first aspect, the present invention provides a flotation plant. The flotation plant comprises a tank module. The tank module includes a self-supporting framework having an inner space. The tank module includes at least one flotation tank. The flotation tank is disposed in the inner space of the self-supporting framework. The tank module is a self-supporting unit capable of being transferable and hoistable as an integral entity. Further, the flotation plant comprises drive units for the rotation of drive shafts, the drive shaft being connected to a rotor for mixing and forming bubbles in the flotation tank. Further, the flotation plant comprises an overflow receptacle. The overflow receptacle is disposed outside the tank module at the level of the upper part of the tank module for receiving the overflow from the flotation tank.

The technical effect of the invention is that the overflow receptacle being located outside the tank module enables a maximal flotation capacity in a modular flotation plant.

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 an 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 tank. In none 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.

In one embodiment of the flotation plant, the overflow receptacle is located on one side of the tank module. The technical effect of the overflow receptacle being located only on one side of the tank module is that installing can be made quickly at the site of use.

In one embodiment of the flotation plant, the self-supporting framework of the tank module has a shape of a parallelepiped and comprises framework sidewalls, one of the sidewalls having an opening, and the flotation tank is in fluid communication with the overflow receptacle via the opening.

In one embodiment of the flotation plant, the flotation tank comprises an overflow lip located at the upper part of the flotation tank, over which overflow lip the overflow flows from the flotation tank to the overflow receptacle.

In one embodiment of the flotation plant, the overflow lip is located at a height within a range of 85% to 100% of the height of the tank module, wherein the total height of the tank module represents 100%. The technical effect is that flotation capacity is maximized as most of the tank height is utilized as a liquid volume, but in froth flotation there still is a sufficient space for the froth.

In one embodiment of the flotation plant, the tank module comprises 1 to 6, preferably 1 to 4, flotation tanks arranged in a row and in fluid communication with each other inside the self-supporting framework of the tank module.

In one embodiment of the flotation plant, the overflow receptacle has a general shape of a funnel and has an outlet at the lowest part of the overflow receptacle.

In one embodiment of the flotation plant, the outlet is located in the middle area of the longitudinal direction of the tank module within a range of 30-70% of the total length of the tank module. The technical effect is that a suitable degree of sloping can be achieved so that the overflow can flow at a suitable speed downwards by gravity and clogging of the outlet by the overflow can be eliminated.

In one embodiment of the flotation plant, the overflow receptacle is supported by brackets to the self-supporting framework of the tank module.

In one embodiment of the flotation plant, the flotation plant comprises an accessory module. The accessory module is disposed on the side and next to the tank module. The accessory module includes a self-supporting framework having an inner space. The overflow receptacle is disposed in the inner space of the self-supporting framework and supported by brackets to the self-supporting framework of the accessory module. The accessory module is a self-supporting unit capable of being transferable and hoistable as an integral entity. The technical effect is easy maintenance as the tank module can be transferred and hoisted separately from the overflow receptacle.

In one embodiment of the flotation plant, the self-supporting framework of the tank module comprises a framework bottom which together with the framework sidewalls defines the inner space.

In one embodiment of the flotation plant, the flotation tank is a self-supporting structure, and the flotation tank is placed in the inner space of the self-supporting framework without being attached to the framework bottom and the framework sidewalls.

In one embodiment of the flotation plant, the flotation plant comprises a drive module, and the drive units are placed inside the drive module, the drive module being a self-supporting structure being transferable and hoistable as an integral entity, and the drive module is removably placed on top of the tank module.

In one embodiment of the flotation plant, the drive module comprises a self-supporting framework having a shape of a rectangular parallelepiped, the self-supporting framework defining an inner space within the self-supporting framework. The drive units are supported to the self-supporting framework in the inner space of the self-supporting framework. The drive units are releasably connectable to the drive shafts.

In one embodiment of the flotation plant, the drive module comprises two to six, preferably two to four drive units.

In one embodiment of the flotation plant, the flotation plant comprises a pump sump module. The pump sump module is a rigid and self-supporting unit capable of being transferable and hoistable as an integral entity. The pump sump module comprises a self-supporting framework. The self-supporting framework has an inner space. The pump sump module also comprises a sump tank The sump tank is arranged in the inner space of the self-supporting framework. Further, the pump sump mod-

ule comprises a pump. The pump is connected in fluid communication with the sump tank.

In one embodiment of the flotation plant, the accessory module is disposed on top of the pump sump module.

In one embodiment of the flotation plant, flotation is froth flotation.

In one embodiment of the flotation plant, the flotation plant comprises gas adding equipment for adding gas to the feedstock subject of flotation.

In one embodiment of the flotation plant, the flotation plant comprises gas adding equipment to the stream of the feedstock subject of flotation before entering the flotation tank.

In one embodiment of the flotation plant, the flotation plant comprises gas adding equipment for adding gas to the feedstock subject of flotation in the flotation tank

In one embodiment of the flotation plant, the gas adding equipment includes a rotor inside the flotation tank.

In one embodiment of the flotation plant, the gas adding equipment includes a hollow rotatable drive shaft and the rotor is connected to the drive shaft.

In one embodiment of the flotation plant, the feedstock subject of flotation is slurry or pulp.

In one embodiment of the flotation plant, the flotation plant comprises mixing equipment.

In one embodiment of the flotation plant, the mixing equipment includes a rotor inside the flotation tank.

In one embodiment of the flotation plant, the mixing equipment includes a stator inside the flotation tank.

In one embodiment of the flotation plant, the flotation tank having a bottom is disposed inside a framework, and the stator is connected to the framework through the bottom.

According to a second aspect of the invention, the invention provides use of the froth flotation plant according to the first aspect 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.

According to a third aspect of the invention, the invention provides use of the froth flotation plant according to the first aspect 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.

According to a fourth aspect of the invention, the invention provides use of the froth flotation plant according to the first aspect for concentrating ore by froth flotation. An ore is a type of rock that con-

tains sufficient minerals with important elements 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 natural hydrophilic/hydrophobic difference or based on hydrophilic/hydrophobic differences made by addition of a surfactant or collector chemical or other chemical.

According to a fifth aspect of the invention, the invention provides use of the froth flotation plant according to the first aspect for flotation of substances containing abrasive material. The abrasive mineral may be, for example, pyrite, silica, chromite. 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 abrasive material. Use of the flotation plant which is easy to maintenance is effective when flotation is made to abrasive material.

According to a sixth aspect of the invention, the invention provides use of the froth flotation plant according to the first aspect for froth flotation of ore containing pyrite, silica, chromite. Use of the flotation plant 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 pyrite, silica, chromite.

According to a seventh aspect of the invention, the invention provides a method of maintenance of a flotation plant of the first aspect of the invention. In the method an uppermost module in the stack of modules

is subject of maintenance, and the uppermost module is hoisted up and transferred aside from the top of the lower module and the uppermost module is replaced by a another uppermost module which is placed on top of the lower module.

According to an eighth aspect of the invention, the invention provides a method of maintenance of a flotation plant of the first aspect of the invention. In the method a lower module underneath the uppermost module is subject of maintenance, and the uppermost module is hoisted up from the top of the lower module and transferred aside for gaining access to the lower module.

In one embodiment of the method, while the uppermost module is away from the top of the lower module, maintenance operations are performed for the lower module.

In one embodiment of the method, while the uppermost module is away from the top of the lower module, the lower module is replaced by another lower module.

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 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 de-

scription help to explain the principles of the invention. In the drawings:

Figure 1 is a side view of the flotation plant according to one embodiment of the invention,

Figure 2 is a cross-section II-II of Figure 1, and

Figure 3 is a cross-section of an alternative embodiment to the embodiment shown in Figure 2.

DETAILED DESCRIPTION OF THE INVENTION

Although flotation is disclosed in the following examples by reference to froth flotation, it should be noted that the principles of a storeyed modular structure of the flotation unit and plant 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 froth flotation, dissolved air flotation or induced gas flotation.

Figures 1 and 2 show an embodiment of a simple froth flotation plant. The modules from which the froth flotation plant has been built are removably stacked on top of each other to form a modular three-storeyed structure having a first storey I at the bottom, a second storey II in the middle and a top storey III. A tank module 1 is located in the second storey II.

Referring to Figure 2, the tank module 1 is a self-supporting unit which can be transferred and hoisted as an integral entity. The tank module 1 includes a self-supporting framework 2 having an inner space 3. The self-supporting framework 2 of the tank module 1 comprises a framework bottom 18 and framework sidewalls 9 which together define the inner space 3. The

tank module 1 includes four froth flotation tanks 4 arranged in a row inside the inner space 3 of the self-supporting framework 2. The neighboring flotation tanks 4 are in fluid communication with each other so that a continuous flow of underflow can flow through the successive flotation tanks 4. The froth flotation tanks 4 are each self-supporting structures. The froth flotation tanks 4 are placed in the inner space 3 of the self-supporting framework 2 without being attached to the framework bottom 18 and the framework sidewalls 9.

A preferable embodiment of the tank module 1 and its framework 2 is that they are compatible to intermodal freight container standards whereby they have dimensions and corner fittings which enable intermodal transportability.

The froth flotation plant comprises four drive units 5 arranged for each of the froth flotation tanks 4, for the rotation of a drive shaft 6 and a rotor 7 connected to the drive shaft. The rotor 7 via which frothing gas is fed into the slurry is for mixing the slurry and for forming bubbles therein in the froth flotation tank 4.

The four drive units 5 are located in and connected to a drive module 19 which is removably placed on top of the tank module 1. The drive module 19 is a self-supporting structure which is transferable and hoistable as an integral entity. The drive module 19 comprises a self-supporting framework 20 having a shape of a rectangular parallelepiped. The self-supporting framework 20 defines an inner space 21 within the self-supporting framework 20. The drive units 5 are supported to the self-supporting framework 20 in the inner space 21 of the self-supporting framework. The

drive units 5 are releasably connectable to the drive shafts 6.

A preferable embodiment of the drive module 19 and its framework 20 is that they are compatible to intermodal freight container standards whereby they have dimensions and corner fittings which enable intermodal transportability.

With reference to Figures 1 and 2, the froth flotation plant comprises an overflow receptacle 8. The overflow receptacle 8 is for receiving the overflow overflowing from the froth flotation tank 4. The overflow receptacle 8 is disposed on one side of the tank module 1 outside the tank module 1 at the level of the upper part of the tank module 1. One of the sidewalls 9 of the tank module 1 has an opening 10. Each froth flotation tank 4 is in fluid communication with the overflow receptacle 8 via the opening 10.

The froth flotation tank 4 comprises an overflow lip 11 located at the upper part of the froth flotation tank, over which overflow lip 11 the overflow flows from the froth flotation tank to the overflow receptacle 8. The overflow lip 11 is located at a height h within a range of 85% to 100% of the height H of the tank module 1, wherein the total height H of the tank module represents 100%.

As shown in Figure 1, the overflow receptacle 8 has a general shape of a funnel. The overflow receptacle has an outlet 12 at the lowest part of the overflow receptacle 8. The outlet 12 is located in the middle area of the longitudinal direction of the tank module 1 within a range of 30-70% of the total length of the tank module 1. The overflow receptacle 8 is supported

by brackets 13 to the side of the self-supporting framework 2 of the tank module 1.

Figure 3 shows a froth flotation plant having a tank module 1, a drive module 19 and an overflow receptacle 8 as those disclosed in connection with the embodiment of Figure 2. The difference in the embodiment of Figure 3 is that the overflow receptacle 8 is located inside and connected to an accessory module 14. The accessory module 14 is located on one side and next to the tank module 1. The accessory module 14 comprises a self-supporting framework 15 having an inner space 16. The overflow receptacle 8 is disposed in the inner space 16 and supported by brackets 17 to the self-supporting framework 15 of the accessory module 14. The accessory module 14 is a self-supporting unit which can be transferred and hoisted as an integral entity just like the other modules. A preferable embodiment of the accessory module 14 and its framework 15 is that they are compatible to intermodal freight container standards whereby they have dimensions and corner fittings which enable intermodal transportability.

Figures 2 and 3 show that the froth flotation plant comprises a pump sump module 22 which is located in the first storey I.

In the embodiment of Figure 2 the pump sump module 22 is located right below the tank module 1 so that the tank module 1 and the drive module 19 are removably stacked on top of the pump sump module 22. Thereby the pump sump module 22 acts as a supporting foundation for the tank module 1 and the drive module 19.

In the embodiment of Figure 3 the pump sump module 22 is located right below the accessory module 14 so that

the accessory module 14 is removably stacked on top of pump sump module 22. Thereby the pump sump module 22 acts as a supporting foundation for the accessory module 14. In Figure 3, the tank module 1 and the drive module 19 are supported by a foundation module 28 on top of which they are stacked.

The pump sump module 22 is a rigid and self-supporting unit which can be transferred and hoisted as an integral entity. The pump sump module 22 comprises a self-supporting framework 23, the self-supporting framework having an inner space 24. A sump tank 25 is arranged in the inner space 24 of the self-supporting framework 23. A first end on an overflow channel 26 opens to the outlet 12 of the overflow receptacle 8 and the other end of the overflow channel 26 opens to the mouth of the sump tank 25. The overflow channel 26 conducts the overflow from the outlet 12 of the overflow receptacle 8 to the sump tank 25. The pump sump module 22 further comprises a pump 27. The pump 27 is connected in fluid communication with the sump tank 25. The pump 27 is arranged to discharge the overflow collected into the sump tank 25 out from the sump tank 25 for further processing.

A preferable embodiment of the pump sump module 22 and its framework 23 is that they are compatible to intermodal freight container standards whereby they have dimensions and corner fittings which enable intermodal transportability.

A preferable embodiment of the foundation module 28 is that it is compatible to intermodal freight container standards whereby it has dimensions and corner fittings which enable intermodal transportability.

Maintenance of the flotation unit or plant is easy and can be performed quickly. If an uppermost module in the stack of modules is subject of maintenance, the uppermost module is simply hoisted up and transferred aside and is replaced by another uppermost module. If a lower module located underneath the uppermost module is subject of maintenance, then the uppermost module is hoisted up from the top of the lower module and transferred aside for gaining access to the lower module. While the uppermost module is away from the top of the lower module, maintenance operations are performed for the lower module. Alternatively, the lower module can simply be replaced by another lower module.

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 plant, the flotation plant comprising

- a tank module, the tank module including a self-supporting framework having an inner space, and the tank module includes at least one flotation tank, the flotation tank being disposed in the inner space of the self-supporting framework, the tank module being a self-supporting unit capable of being transferable and hoistable as an integral entity,
- drive units for the rotation of drive shafts, the drive shaft being connected to a rotor for mixing and forming bubbles in the flotation tank, and
- an overflow receptacle, the overflow receptacle being disposed outside the tank module at the level of the upper part of the tank module for receiving the overflow from the flotation tank.

2. The flotation plant according to claim 1, wherein the overflow receptacle is located on one side of the tank module.

3. The flotation plant according to claim 1 or 2, wherein the self-supporting framework of the tank module has a shape of a parallelepiped and comprises framework sidewalls, one of the sidewalls having an opening, and the flotation tank is in fluid communication with the overflow receptacle via the opening.

4. The flotation plant according to any one of the claims 1 to 3, wherein the flotation tank comprises an overflow lip located at the upper part of the flotation tank, over which overflow lip the overflow flows from the flotation tank to the overflow receptacle.

5. The flotation plant according to claim 4, wherein the overflow lip is located at a height within a range of 85% to 100% of the height of the tank module, wherein the total height of the tank module represents 100%.

6. The flotation plant according to any one of the claims 1 to 5, wherein the tank module comprises two to six, preferably two to four, flotation tanks arranged in a row and in fluid communication with each other inside the self-supporting framework of the tank module.

7. The flotation plant according to any one of the claims 1 to 6, wherein the overflow receptacle has a general shape of a funnel and has an outlet at the lowest part of the overflow receptacle.

8. The flotation plant according to claim 7, wherein the outlet is located in the middle area of the longitudinal direction of the tank module within a range of 30-70% of the total length of the tank module.

9. The flotation plant according to any one of the claims 1 to 8, wherein the overflow receptacle is supported by brackets to the self-supporting framework of the tank module.

10. The flotation plant according to any one of the claims 1 to 9, wherein the flotation plant comprises an accessory module, the accessory module being located on the side and next to the tank module, the accessory module including a self-supporting framework having an inner space, the overflow receptacle being disposed in the inner space and supported by brackets to the self-supporting framework of the accessory module, the accessory module being a self-supporting unit ca-

pable of being transferable and hoistable as an integral entity.

11. The flotation plant according to any one of the claims 1 to 10, wherein the self-supporting framework of the tank module comprises a framework bottom, which together with the framework sidewalls define the inner space.

12. The flotation plant according to claim 11, wherein the flotation tank is a self-supporting structure, and the flotation tank is placed in the inner space of the self-supporting framework without being attached to the framework bottom and the framework sidewalls.

13. The flotation plant according to any one of the claims 1 to 12, wherein the flotation plant comprises a drive module, and the drive units are placed inside the drive module, the drive module being a self-supporting structure being transferable and hoistable as an integral entity, and the drive module is removably placed on top of the tank module.

14. The flotation plant according to claim 13, wherein, the drive module comprises a self-supporting framework having a shape of a rectangular parallelepiped, the self-supporting framework defining an inner space within the self-supporting framework, and the drive units are supported to the self-supporting framework in the inner space of the self-supporting framework, and the drive units are releasably connectable to the drive shafts.

15. The flotation plant according to claim 14, wherein the drive module comprises two to six, preferably two to four, drive units.

16. The flotation plant according to any one of the claims 1 to 15, wherein the flotation plant comprises a pump sump module, the pump sump module being a rigid and self-supporting unit capable of being transferable and hoistable as an integral entity, the pump sump module comprising

- a self-supporting framework, the self-supporting framework having an inner space,
- a sump tank, the tank being arranged in the inner space of the self-supporting framework, and
- a pump, the pump being connected in fluid communication with the sump tank.

17. The flotation plant according to claim 16, wherein the accessory module is disposed on top of the pump sump module.

18. The flotation plant according to any one of the claims 1 to 17, wherein flotation is froth flotation.

19. The flotation plant according to claim 18, wherein the flotation plant comprises gas adding equipment for adding gas to the feedstock subject of flotation.

20. The flotation plant according to claim 19, wherein the flotation plant comprises gas adding equipment to the stream of the feedstock subject of flotation before entering the flotation tank.

21. The flotation plant according to claim 19, wherein the flotation plant comprises gas adding equipment for adding gas to the feedstock subject of flotation in the flotation tank

22. The flotation plant according to claim 21, wherein the gas adding equipment includes a rotor inside the flotation tank.

23. The flotation plant according to claim 22, wherein the gas adding equipment includes a hollow rotatable drive shaft and the rotor is connected to the drive shaft.

24. The flotation plant according to any one of the claims 1 to 23 wherein the feedstock subject of flotation is slurry or pulp.

25. The flotation plant according to any one of the claims 1 to 24, wherein the flotation plant comprises mixing equipment.

26. The flotation plant according to claim 25, wherein the mixing equipment includes a rotor inside the flotation tank.

27. The flotation plant according to claim 26, wherein the mixing equipment includes a stator inside the flotation tank.

28. The flotation plant according to claim 27, wherein the flotation tank having a bottom is disposed inside a framework, and the stator is connected to the framework through the bottom.

29. Use of the flotation plant according to any one of the claims 1 to 28 for separating material by flotation based on differences of buoyancy properties of substances.

30. Use of the flotation plant according to any one of the claims 1 to 28 for separating solid material by froth flotation based on differences of hydrophilic properties of substances.

31. Use of the flotation plant according to any one of the claims 1 to 28 for concentrating ore by froth flotation.

32. Use of the flotation plant according to any one of the claims 1 to 28 for flotation of substances containing abrasive material.

33. Use of the flotation plant according to any one of the claims 1 to 28 for froth flotation of ore containing pyrite, silica, chromite.

34. A method of maintenance of a flotation plant according to any one of the claims 1 to 28, in which method an uppermost module is subject of maintenance, and the uppermost module is hoisted up and transferred aside from the top of the lower module and the uppermost module is replaced by a another uppermost module which is placed on top of the lower module.

35. A method of maintenance of a flotation plant according to any one of the claims 1 to 28, in which method a lower module, which is underneath an uppermost module, is subject of maintenance, and the uppermost module is hoisted up from the top of the lower module and transferred aside for gaining access to the lower module.

36. The method of maintenance according to claim 35, wherein while the uppermost module is away from the top of the lower module, maintenance operations are performed for the lower module.

37. The method of maintenance according to claim 35, wherein while the uppermost module is away from the top of the lower module, the lower module is replaced by another lower module.

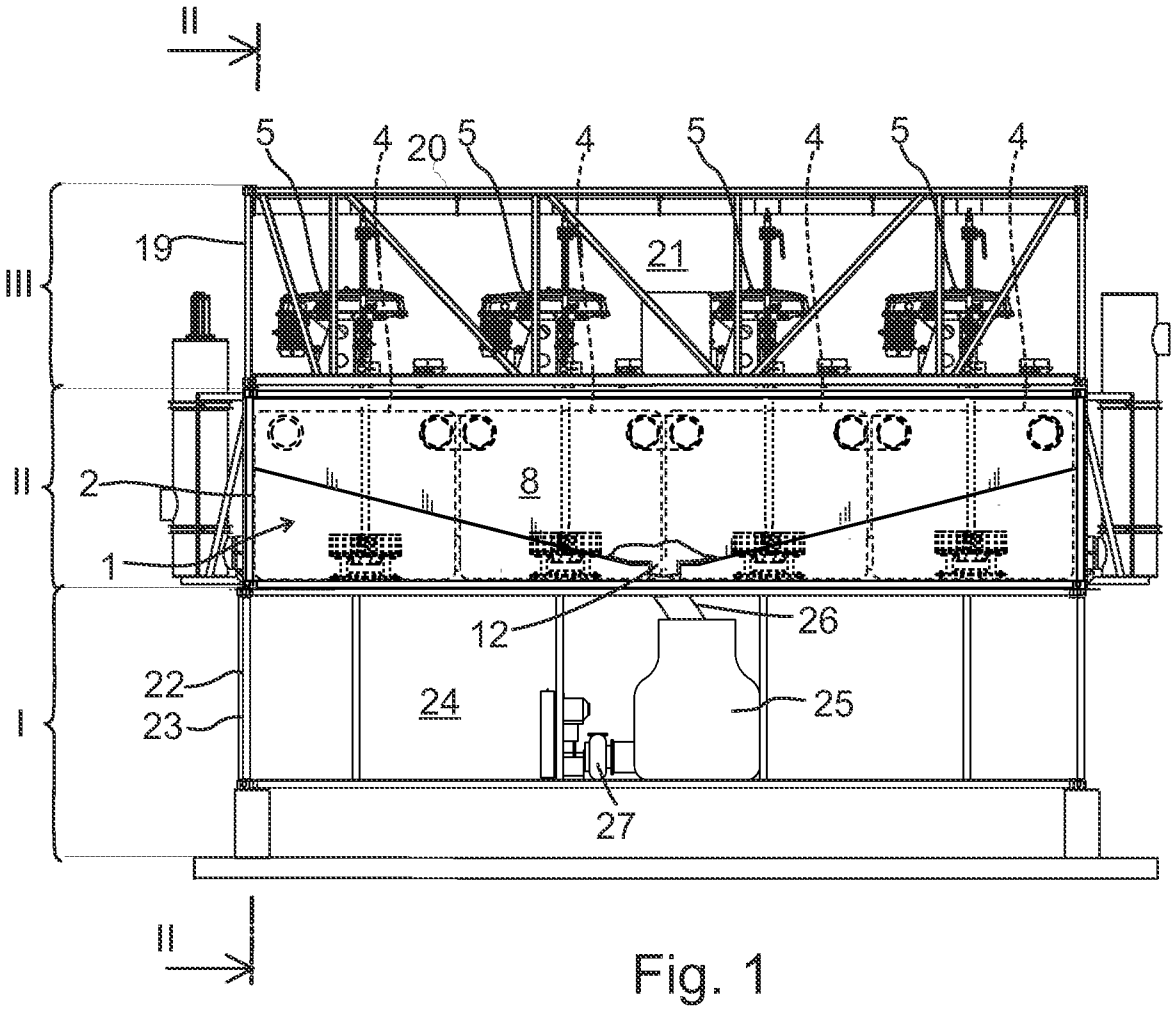

Fig. 1

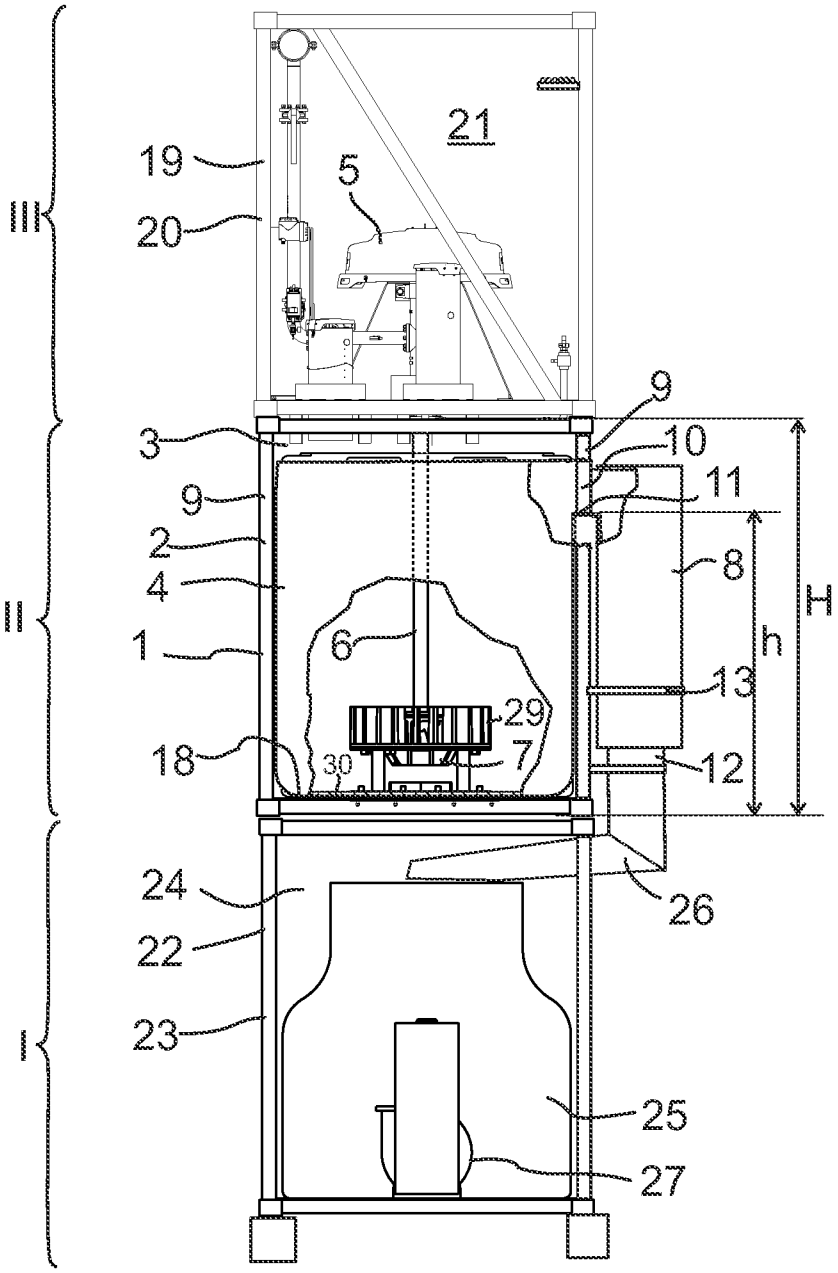
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Fig. 2

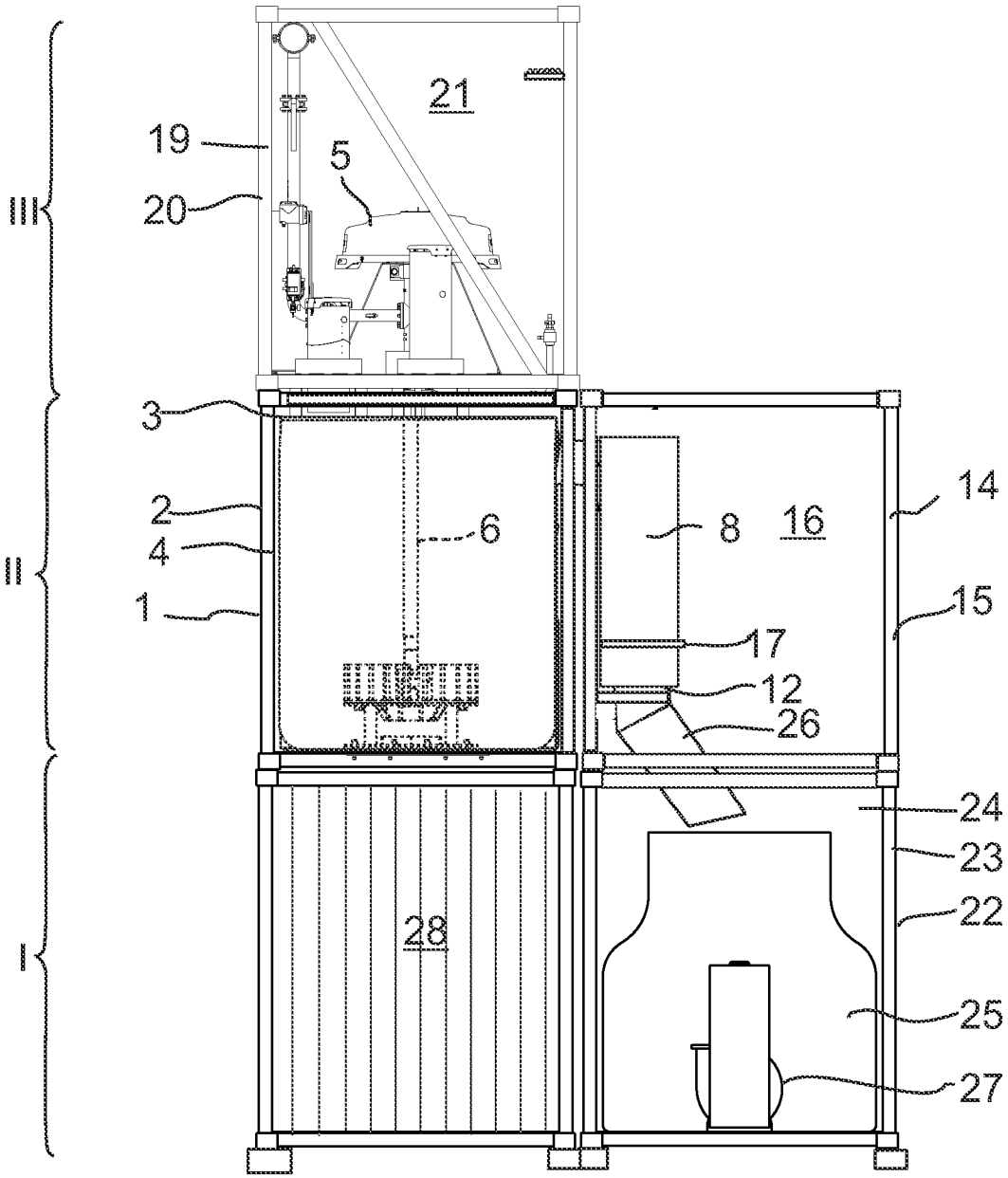

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/FI2015/050328

A. CLASSIFICATION OF SUBJECT MATTER
INV. B03D1/02 B03D1/14 B03D1/20 E04H5/00
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 E04H

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 2 413 015 A (WIGTON PAUL L) 24 December 1946 (1946-12-24)	1-9,13, 18,19, 21-33
Y	column 3, line 33 - line 38 column 4, line 1 - line 6; figures 1-3; examples 1-17	10-12, 14-17, 20,34-37

Y	EP 0 156 699 A1 (MINEMET RECH SA [FR]) 2 October 1985 (1985-10-02)	10-12, 14-17, 20,34-37
	page 1, line 3 - line 8 page 4, line 4 - line 20 page 17, line 25 - line 31; figures 1-7	

A	US 2004/168964 A1 (LAMBERT DAVID P [US] ET AL) 2 September 2004 (2004-09-02) figure 2	7-9

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"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	Date of mailing of the international search report
13 November 2015	25/11/2015

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	García Alonso, Nuria

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/FI2015/050328

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		AU 3915085 A	31-10-1985
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		EP 0156699 A1	02-10-1985
		ES 8700088 A1	01-01-1987
		FR 2560532 A1	06-09-1985
US 2004168964 A1	02-09-2004	NONE	