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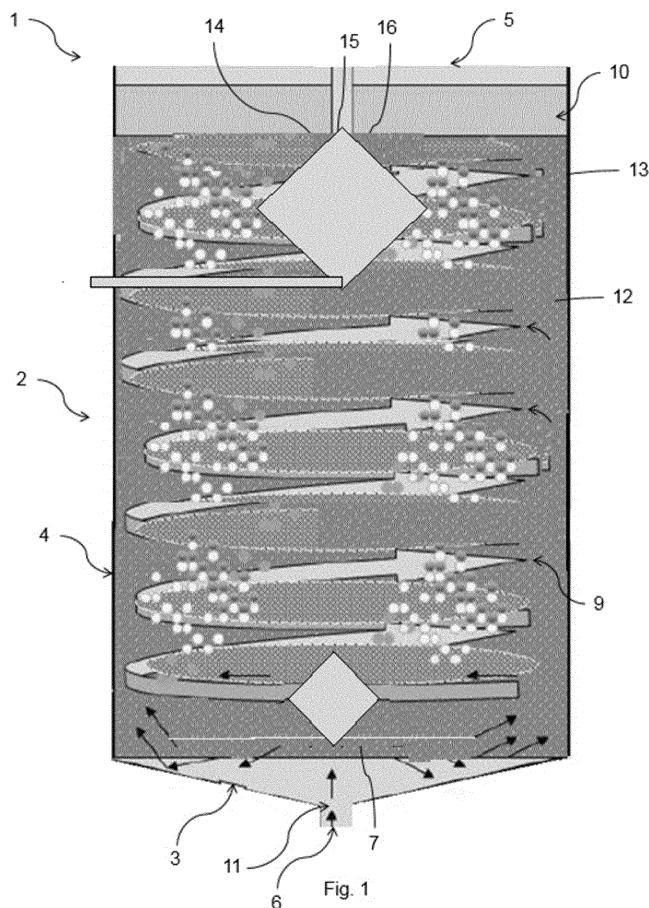
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(54) **FLOTATION SYSTEM FOR SEPARATING PARTICLES FROM A LIQUID**

(57) The present invention relates to the field of treatment of liquid. In particularly, the present invention relates to a flotation system for separating particles from a liquid, more specifically to an air flotation system.



Description

Field of invention

[0001] The present invention relates to the field of treatment of liquid. In particular, the present invention relates to a flotation system for separating particles from a liquid, more specifically to an air flotation system.

Background of invention

[0002] The principle of in an air flotation system is that particles, such as impurities in liquid, for example water, are separated from the water using air. Typically, a flotation tank being filled with contaminated water is installed with a single diffuser. The diffuser is mounted inside the tank such that small air bubbles, i.e. microbubbles, adhere to the impurities in the water, such as particles, and reduce their specific weight. The particles float to the surface of the water, hence the flotation, wherefrom they are removed by a scraper.

[0003] In known air flotation systems, the spreading of air bubbles is typically very inefficient in that only a specific volume of water within the flotation tank is exposed to air bubbles.

Summary of invention

[0004] The present disclosure relates to an air flotation system, overcoming the inefficient spreading of air bubbles in known air flotation systems. The present invention provides in general a flotation system for separating particles from liquid, comprising a flotation tank comprising at least a bottom surface, a sidewall and a top; an inlet in said flotation tank, configured for letting liquid and/or particles into said flotation tank; a deflector inside said flotation tank in fluid communication with said inlet, configured for redirecting said liquid and/or particles from said inlet towards said sidewall; a plurality of diffusers in said flotation tank configured for providing air bubbles into said liquid in said flotation tank.

[0005] An effect of having a plurality of diffusers is that air bubbles are provided to the liquid such that the air bubbles cover an area of liquid within the sidewalls, preferably the entire area of liquid. In this way, the area of liquid, preferably the entire area of liquid may be able to float to the top of the flotation tank, i.e. to the surface of the liquid.

[0006] In this way, so-called dead zones, i.e. zones where the liquid with the particles is not exposed to air bubbles, can be avoided. In other words, the present invention provides an efficient air flotation system, where all the particles can be exposed to air bubbles and thus float to the top surface of the liquid. Hence, an objective of the present invention is to reduce the amount of dead zones, preferably eliminate any dead zones, in the liquid in the flotation tank, such that the rate of flotation is maximized.

[0007] An effect of the deflector is that the liquid and/or particles is/are redirected from said inlet into a plurality of directions of said sidewall, in particular such that liquid and/or particles is/are spread over the entire flotation tank, thereby providing an efficient mixing of the liquid and/particles with the air bubbles from the plurality of diffusers.

Description of drawings

[0008] Fig. 1 shows an embodiment of the flow through the system according to the present invention.

Detailed description of the invention

Scraper:

[0009] In one embodiment of the present invention, the flotation system is further comprising a scraper. The scraper may be placed at the top of the flotation tank, where the particles are floating, and may be led out of the flotation tank by the scraper.

Flotation tank:

[0010] In a preferred embodiment of the present invention, the flotation tank is cylindrical. In this way, there may be provided boundary conditions for specific flows within the flotation tank, the flow may for example be initiated by the diffusers.

[0011] In one embodiment of the present invention, the flotation tank comprises a conical bottom surface, for example a circular conical surface, in particular if the flotation tank is cylindrical. The conical bottom surface may comprise an apex to be located as the lowest point of said flotation tank. In this way, there may also be provided boundary conditions for specific flows within the flotation tank, the flow may for example be initiated by the diffusers.

[0012] In another embodiment of the present invention, the flotation system, in particular the flotation tank, comprises a deflector inside said flotation tank in located above said inlet and configured for redirecting said liquid and/or particles from said inlet towards said sidewall.

Liquid collecting container

[0013] In a preferred embodiment of the present invention, the flotation tank comprises a liquid collecting container inside said flotation tank, the liquid collecting container configured with an opening for receiving said liquid. The liquid collecting container may be placed in the centre of said flotation tank. The liquid collecting container may be placed close to said top. In this way, liquid, meaning liquid without particles, may be collected in the liquid collecting container. As described above, there may be a certain flow within the flotation tank, especially a flow that provides particles to be flowing near the sidewall,

and liquid to be flowing near the centre of the flotation tank. Thus, by having the liquid collecting container placed as described, only liquid, may be located in the centre of the flotation tank, such that only liquid may be collected in the liquid collecting container.

[0014] In a preferred embodiment of the present invention, the opening is in a horizontal plane such that liquid, for example near the centre of the flotation tank, is able to enter the liquid collecting container from all radial directions, and/or in principle from above.

Blocking surface

[0015] However, in a more preferred embodiment of the present invention, the liquid collecting container is configured with a blocking surface located above said opening, such that liquid is unable to enter said liquid collecting container from above said blocking surface. Thus, liquid may be able to enter the liquid collecting container from only radial directions.

[0016] In a most preferred embodiment of the present invention, the blocking surface is a conical surface having an apex and a base, preferably, where the base is placed closer to said opening than said apex. Also preferably, the base has an area identical to or larger than said opening. By having a conical surface, and in particular as further described, it may be possible to collect liquid more efficiently.

[0017] In another preferred embodiment of the present invention, the blocking surface is configured such that it is able to move perpendicular to said opening, for example in order to adjust the flowrate of liquid entering the liquid collecting container.

Inlet

[0018] In one embodiment of the present invention, the inlet is located in the centre of said bottom surface. An effect of locating the inlet in the bottom of the surface is that liquid and/or particles are spread at the bottom, from where it is going to float to the surface, thereby providing the liquid and/or particles furthest away from the surface, so that the particles can experience the longest way of travel to the surface of the liquid. In this way, an efficient separation may be achieved.

Sidewall

[0019] In one embodiment of the present invention, the sidewall comprises a plurality of holes configured for being attached with the diffusers. The diffusers may be attached to the outside of the sidewall, such that air bubbles are generated outside the flotation tank, and are led into the flotation tank by the holes.

[0020] In a preferred embodiment of the present invention, the holes are substantially elliptical. More preferably, the holes each defines a major axis and a minor axis, the minor axis being located off centre in relation to said ma-

ior axis, thereby forming a drop shape. By having elliptical holes as described, the air bobbles may be diffused inside the flotation tank such that the area and/or volume within the flotation tank of micro bubbles is/are optimized. It may be due to the pressure, along an elliptical hole, when attached to a diffuser, that there is obtained an optimized diffusion area of air bubbles.

[0021] In a more preferred embodiment of the present invention, the holes are radially displaced along said sidewall with an interval of between 10-180 degrees, such as between 20-160 degrees, such as between 30-140 degrees, such as between 40-120 degrees, such as between 50-100 degrees, such as between 60-80 degrees, and/or such as between 65-75 degrees. By such a displacement, the entire area within the side wall is able to be exposed to air bubbles. The combination of specific holes as previously described and the displacement may be of particular relevance for obtaining a very efficient flotation system.

[0022] In a most preferred embodiment of the present invention, the holes are placed near said bottom surface. This allows for the liquid and/or particles to be exposed to air bubbles as soon as possible and in particular such that the particles will undergo the longest way of travel to the surface of the liquid. More importantly, the particles that may be at the bottom, may be exposed to air bubbles, and thereby be lifted to the surface. In this way an efficient flotation system may also be provided.

Diffusers

[0023] The diffusers for the flotation system as herein disclosed may comprise an elongated tubed housing accommodating: an inlet configured for being attached to a nozzle; and an outlet, the periphery of said outlet forming a curved opening in the housing.

[0024] In a preferred embodiment, the diffusers are configured to generate a flow of liquid and/or particles within said flotation tank, such that said particles are exposed to a centrifugal force. Thereby, the particles may be located near the sidewall, whereas the liquid may be located near the centre of the flotation tank. A scraper may therefore be configured to scrape off the particles near the sidewalls, at the surface of the liquid. Hence the flow allows for further optimization of the scraper in that its scraping area can be reduced.

[0025] In a more preferred embodiment of the present invention, the flow is a helical flow. As previously described, the flow may be initiated by the diffusers, and at the bottom, such that the flow may be from bottom to top. The helical flow may thus provide an even longer way of travel for the particles in comparison to a system where no flow is provided. A very long way of travel for the particles is thus obtained in the flotation tank, in particular a way of travel which is longer than the distance from the bottom to the top. In this way, more of the particles may experience floatation since the particles on the longer way is able to be exposed to more air bubbles. The helical

flow provides in particular the centrifugal force to the particles, such that the particles are spread towards the sidewall of the flotation tank.

[0026] In one embodiment of the present invention, the curved opening is formed as curved cut-out of the elongated tubed housing extending longitudinally along said housing.

[0027] In another embodiment of the present invention, the curved opening is specified by a radius of curvature.

[0028] In a preferred embodiment of the present invention, the radius of curvature is selected to fit tightly to a circular surface having said radius of curvature. The circular surface may be a surface of the flotation tank, preferably the sidewall of the flotation tank, in particular the outside of the sidewall, such that the diffusers are mounted on onto the holes of the side sidewall.

[0029] In another preferred embodiment of the present invention, the radius of curvature is between 500 mm and 2000 mm, such as between 700 mm and 1800 mm, such as between 900 mm and 1600 mm.

[0030] In a first preferred embodiment of the present invention, the radius of curvature is 1500 mm.

[0031] In a second preferred embodiment of the present invention, the radius of curvature is 872 mm.

[0032] In one embodiment of the present invention, the curved opening is substantially elliptical. In the context of being substantially elliptical, it must be understood that the elliptical opening is not defined in a flat plane, but rather on a plane defined by a curved surface.

[0033] In another embodiment of the present invention, the curved opening defines a major axis and a minor axis, the minor axis being located off centre in relation to said major axis. This may be an alternative way of defining that the curved opening may be substantially elliptical.

[0034] In a third embodiment of the present invention, the curved opening is substantially drop shaped.

[0035] In a preferred embodiment of the present invention, the periphery is forming a closed rim.

[0036] In another preferred embodiment of the present invention, the periphery is forming an opened rim.

[0037] The shape of the periphery or rather the rim, may be responsible for a specific and desired flow within the flotation tank.

[0038] According to the present invention, the flotation system may comprise one or more of the diffuser(s) as here described.

[0039] In some embodiments, the diffuser(s) comprises one or more of the features as here described.

Deflector

[0040] The deflector for the flotation system as herein disclosed may comprise a conical surface having an apex and a base, configured to be mounted inside a flotation tank of a flotation system.

[0041] In one embodiment of the present invention, the base is configured to be placed in said flotation tank such that said apex is pointing upwards. In this way, the liquid

and/or particles coming from below may be deflected optimally towards the sidewalls of the flotation tank. In particular the shape and orientation of the deflector may be such that the liquid and/or particles coming from below may be deflected optimally towards the sidewalls and/or the bottom surface of the flotation tank. Preferably, the liquid and/or particles are directed directly towards the diffusers.

[0042] In another embodiment of the present invention, the deflector is configured for redirecting liquid and/or particles substantially radially away from the apex.

[0043] In a preferred embodiment of the present invention, the said base has an area that allows for liquid and/or particles to be guided away from said apex and pass said surface. In this way, the liquid and/or particles may be able to float to the surface of the liquid, such that a separation can take place.

[0044] In a preferred embodiment of the present invention, the conical surface is formed by a circular disc having a sector removed from said disc. The sector, being a circular sector, may have a central angle of between 5 degrees and 25 degrees.

[0045] Preferably, the sector has a central angle of between 5 degrees and 25 degrees.

[0046] More preferably, the sector may have a central angle of between 10 degrees and 15 degrees.

[0047] Most preferably, the sector may have a central angle of 12.3 degrees. This may allow for a very specific angle of the cone to be formed, thus an optimal angle at which the liquid is distributed in the flotation tank.

[0048] In a preferred embodiment of the present invention, the circular disc has a radius of between 200 mm and 400 mm.

[0049] In a most preferred embodiment of the present invention, the circular disc has a radius of 388 mm.

[0050] According to the present invention, the flotation system may comprise a deflector, comprising one or more of the features of the deflector as here described.

Nozzles

[0051] In one embodiment of the present invention, the nozzle is configured for providing at least air bubbles. Thus, the diffuser may be configured for providing air bubbles in that the diffuser may be connected to a nozzle.

[0052] In one embodiment of the present invention, the nozzle is attached to said inlet such that said nozzle is covered by said tubed housing.

[0053] In another embodiment of the present invention, the nozzle is attached to said inlet such that said nozzle partly covered by said tubed housing.

[0054] The placement of the nozzle inside the housing may provide a specific and desired flow of liquid and/or particles within the flotation tank.

[0055] Preferably, the nozzle may be part of the diffuser.

Nozzle inlet

[0056] In a preferred embodiment of the present invention, the nozzle inlet is provided in a cylindrical section of the tubed housing.

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Example 1: A flotation system showing flow within the flotation tank

[0057] Fig. 1 shows an embodiment of the flotation system according to the present invention, the flotation system **1** comprises a flotation tank **2** comprising at least a bottom surface **3**, a sidewall **4** and a top **5**; an inlet **6** in said flotation tank **2**, configured for letting liquid and/or particles into said flotation tank **2**; a deflector **7** inside the flotation tank located above said inlet **6** and configured for redirecting said liquid and/or particles from the inlet **6** towards the sidewall **4**; a plurality of diffusers **8** (not to be seen in this figure) configured for providing air bubbles into the liquid in said flotation tank **2**. However, as indicated in the figure, the flow **9** of liquid and/or particles, here shown as a helical flow, is generated by the plurality of diffusers. A scraper **10** is located in the top of the flotation tank **2**. The bottom surface **3** is in this example a conical bottom surface. The conical bottom surface comprises an apex, at least an apex point **11**, which is the lowest point of said flotation tank. The inlet **6** is located in the centre of said bottom surface, thus at the apex **11** of the bottom surface. The flotation tank comprises further in this example a liquid collecting container **12** inside the flotation tank **2**, the liquid collecting container **12** configured with an opening **13** for receiving the liquid, the opening **13** is here in a horizontal plane. The liquid collecting container **12** is placed in the centre of said flotation tank **2** and close to the top **5**. Further, the liquid collecting container **12** is configured with a blocking surface **14** located above said opening **13**, such that liquid is unable to enter said liquid collecting container **12** from above said blocking surface **14**. In this example, the blocking surface **14** is a conical surface having an apex **15** and a base **16**. The base **16** is placed closer to said opening **13** than said apex **15**. The base **16** has an area identical to the opening **13**.

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[0058] The invention is described in further detail by the following items:

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Items

[0059]

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1. A flotation system for separating particles from liquid, comprising

- a flotation tank comprising at least a bottom surface, a sidewall and a top;
- an inlet in said flotation tank, configured for letting liquid and/or particles into said flotation tank;
- a deflector inside said flotation tank located

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above said inlet and configured for redirecting said liquid and/or particles from said inlet towards said sidewall;

- a plurality of diffusers configured for providing air bubbles into said liquid in said flotation tank.

2. The flotation system according to item 1 further comprising a scraper.

3. The flotation system according to any of the preceding items, wherein said flotation tank is cylindrical.

4. The flotation system according to any of the preceding items, wherein said flotation tank comprises a conical bottom surface.

5. The flotation system according to item 4, wherein said conical bottom surface comprises an apex to be located as the lowest point of said flotation tank.

6. The flotation system according to any of the preceding items, wherein said flotation tank comprises a liquid collecting container inside said flotation tank, the liquid collecting container configured with an opening for receiving said liquid.

7. The flotation system according to item 6, wherein said liquid collecting container is placed in the centre of said flotation tank.

8. The flotation system according to items 6-7, wherein said liquid collecting container is placed close to said top.

9. The flotation system according to items 6-8, wherein said opening is in a horizontal plane.

10. The flotation system according to items 6-9, wherein said liquid collecting container is configured with a blocking surface located above said opening, such that liquid is unable to enter said liquid collecting container from above said blocking surface.

11. The flotation system according to item 9, wherein said blocking surface is a conical surface having an apex and a base.

12. The flotation system according to item 11, wherein said base is placed closer to said opening than said apex.

13. The flotation system according to items 6-12, wherein said base has an area identical to or larger than said opening.

14. The flotation system according to items 6-13, wherein said blocking surface is configured such that

it is able to move perpendicular to said opening.

15. The flotation system according to any of the items, wherein said inlet is located in the centre of said bottom surface.

16. The flotation system according to any of the items, wherein said sidewall comprises a plurality of holes configured for being attached with said plurality of diffusers.

17. The flotation system according to item 16, wherein said holes are substantially elliptical.

18. The flotation system according to item 17, wherein said holes, each defines a major axis and a minor axis, the minor axis being located off centre in relation to said major axis.

19. The flotation system according to items 16-18, wherein said holes are radially displaced along said sidewall with an interval of between 10-180 degrees, such as between 20-160 degrees, such as between 30-140 degrees, such as between 40-120 degrees, such as between 50-100 degrees, such as between 60-80 degrees, and/or such as between 65-75 degrees.

20. The flotation system according to items 16-19, wherein said holes are placed near said bottom surface.

21. The flotation system according to any of the preceding items, wherein said diffusers are configured to generate a flow of liquid and/or particles within said flotation tank, such that said particles are exposed to a centrifugal force.

22. The flotation system according to item 21, wherein said flow is a helical flow.

Claims

1. A flotation system for separating particles from liquid, comprising

- a flotation tank comprising at least a bottom surface, a sidewall and a top;
- an inlet in said flotation tank, configured for letting liquid and/or particles into said flotation tank;
- a deflector inside said flotation tank located above said inlet and configured for redirecting said liquid and/or particles from said inlet towards said sidewall;
- a plurality of diffusers configured for providing air bubbles into said liquid in said flotation tank.

2. The flotation system according to any of the preceding claims, wherein said flotation tank is cylindrical.

3. The flotation system according to any of the preceding claims, wherein said flotation tank comprises a conical bottom surface.

4. The flotation system according to any of the preceding claims, wherein said flotation tank comprises a liquid collecting container inside said flotation tank, the liquid collecting container configured with an opening for receiving said liquid.

5. The flotation system according to claim 4, wherein said liquid collecting container is placed in the centre of said flotation tank.

6. The flotation system according to claims 4-5, wherein said liquid collecting container is configured with a blocking surface located above said opening, such that liquid is unable to enter said liquid collecting container from above said blocking surface.

7. The flotation system according to claim 6, wherein said blocking surface is configured such that it is able to move perpendicular to said opening.

8. The flotation system according to any of the claims, wherein said inlet is located in the centre of said bottom surface.

9. The flotation system according to any of the claims, wherein said sidewall comprises a plurality of holes configured for being attached with said plurality of diffusers.

10. The flotation system according to claim 9, wherein said holes are substantially elliptical.

11. The flotation system according to claim 10, wherein said holes, each defines a major axis and a minor axis, the minor axis being located off centre in relation to said major axis.

12. The flotation system according to claims 9-11, wherein said holes are radially displaced along said sidewall with an interval of between 10-180 degrees, such as between 20-160 degrees, such as between 30-140 degrees, such as between 40-120 degrees, such as between 50-100 degrees, such as between 60-80 degrees, and/or such as between 65-75 degrees.

13. The flotation system according to claims 9-12, wherein said holes are placed near said bottom surface.

14. The flotation system according to any of the preceding

ing claims, wherein said diffusers are configured to generate a flow of liquid and/or particles within said flotation tank, such that said particles are exposed to a centrifugal force.

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15. The flotation system according to claim 14, wherein said flow is a helical flow.

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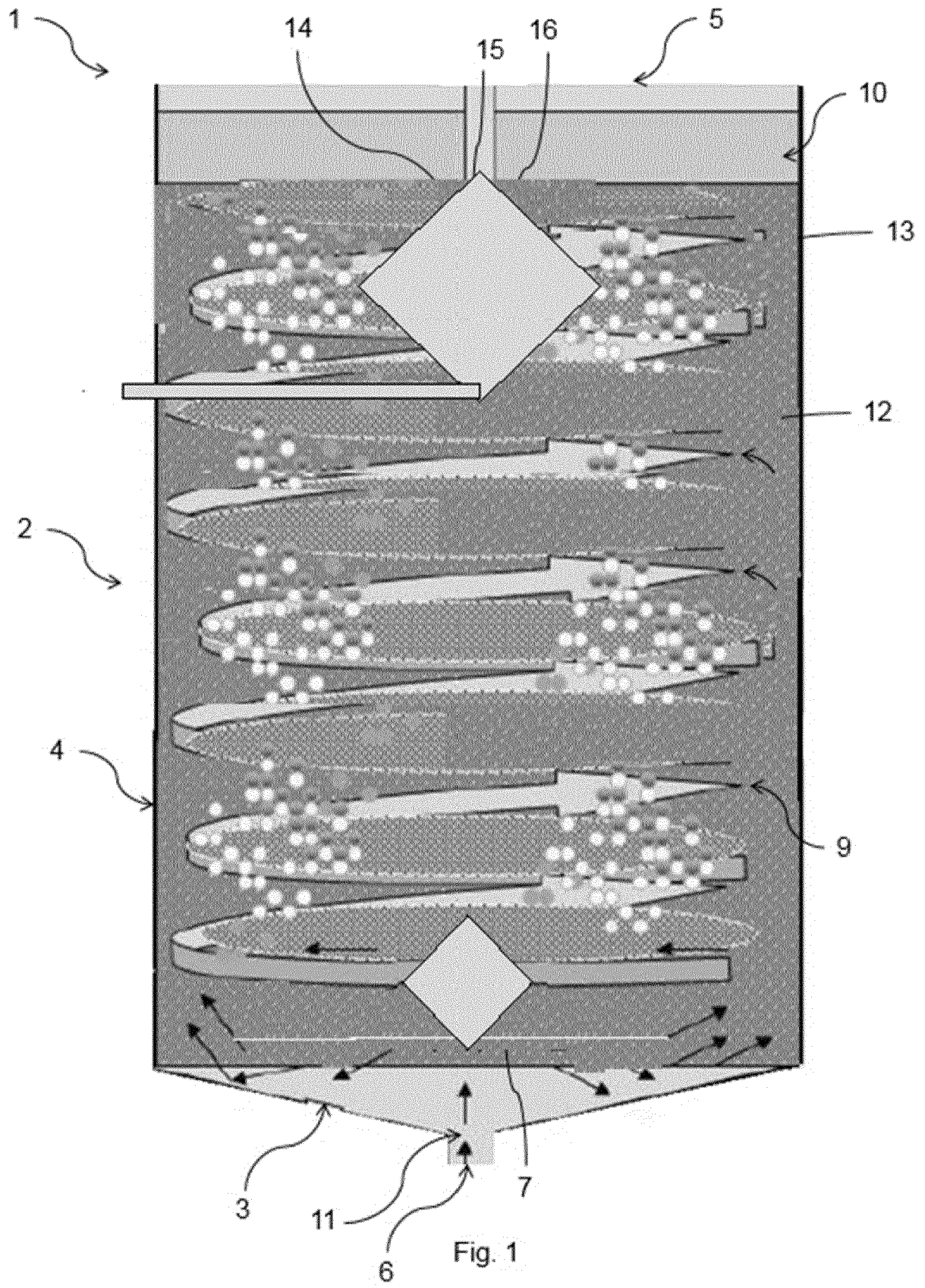
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EUROPEAN SEARCH REPORT

 Application Number
 EP 16 18 4086

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 20 February 2017	Examiner Varga, Viktoria
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