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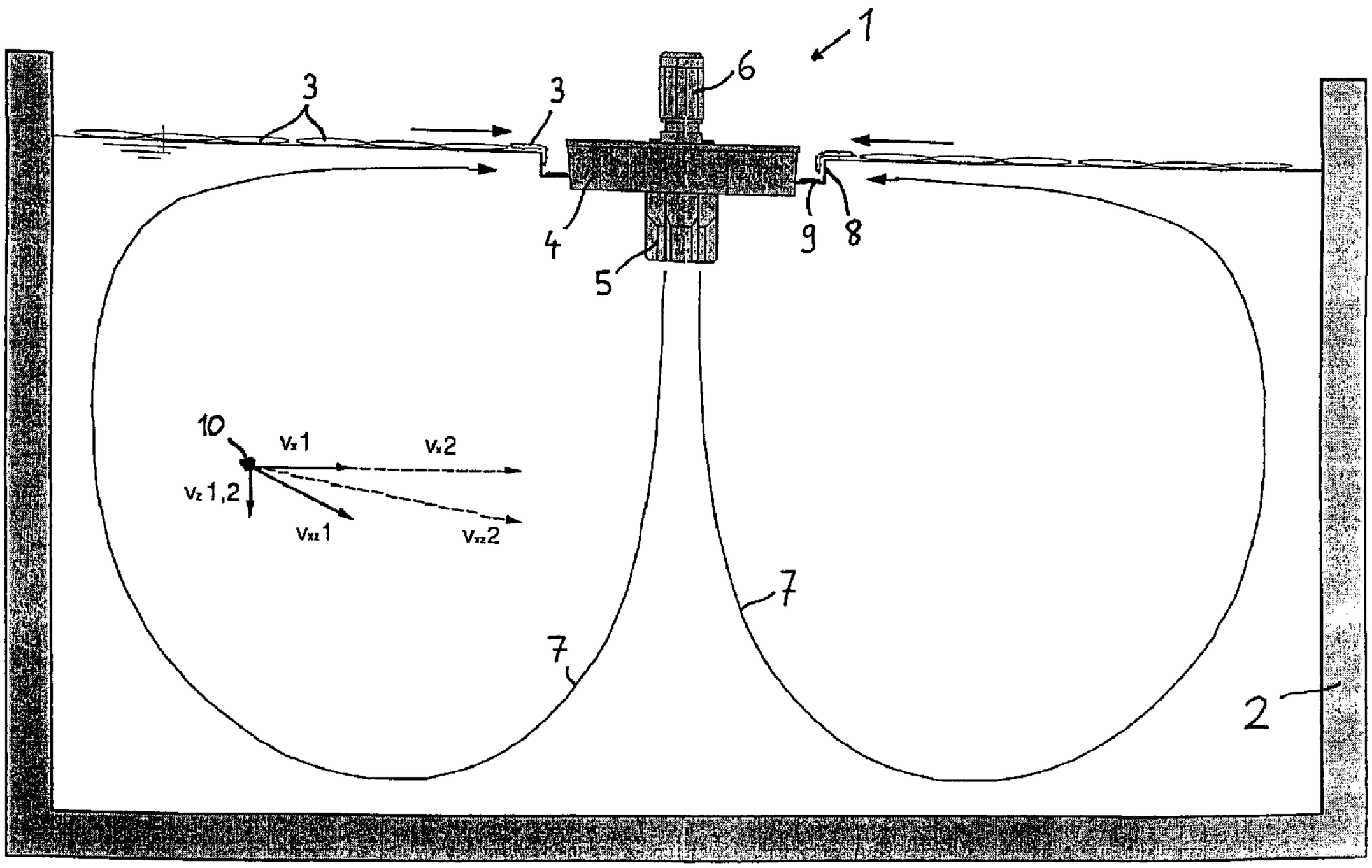

(57) Abrégé/Abstract:
A sludge extraction apparatus including a sedimentation tank; a float; a catch tank with an overflow rim, which runs partially or completely around the float; a mixing unit to generate a fluid flow pattern within the sedimentation tank which provides a fluid flow at the surface of the water towards the catch tank; and a conveyor, which conveys the sludge, overflowing into the catch tank, through an outlet line. The flow generated by the mixing unit moves the scum on the surface of the water to the catch tank, where

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(57) Abrégé(suite)/Abstract(continued):
the scum can be collected. By controlling the mixing unit, the fluid flow can be selected to convey only the light weight particles in the sludge, so that the scum and the light-weight sludge partitions can be extracted selectively and from over a large area. The sludge extraction apparatus is conveniently located in the sedimentation tank by a parallelogram linkage.

1090-79

Abstract

A sludge extraction apparatus including a sedimentation tank; a float; a catch tank with an overflow rim, which runs partially or completely around the float; a mixing unit to generate a fluid flow pattern within the sedimentation tank which provides a fluid flow at the surface of the water towards the catch tank; and a conveyor, which conveys the sludge, overflowing into the catch tank, through an outlet line. The flow generated by the mixing unit moves the scum on the surface of the water to the catch tank, where the scum can be collected. By controlling the mixing unit, the fluid flow can be selected to convey only the light weight particles in the sludge, so that the scum and the light-weight sludge partitions can be extracted selectively and from over a large area. The sludge extraction apparatus is conveniently located in the sedimentation tank by a parallelogram linkage.

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PROCESS AND APPARATUS FOR SLUDGE AND SCUM EXTRACTION

This invention relates to a process and an apparatus for sludge and scum extraction, in particular for the extraction of sludge and scum in a sedimentation tank. Furthermore, the invention relates to a process for selecting the sludge particles in accordance with the sedimentation properties of the sludge in a sedimentation tank. In the context of this invention, the term "scum" refers to materials which are essentially lighter than water, and thus float on the surface; the term "sludge" refers to solid materials which are essentially heavier that water whose particle size largely determines their sedimentation properties.

Mixtures of water and light materials, such as oil or fat, often have a layer of scum on the surface of the water. During the biological treatment of sewage, significant layers of scum can form at the surface in the presence of certain bacteria. Due to scum formation, the air bubbles, fed in for sewage aeration, bind with the biological sludge and result in a viscous layer of scum that floats on the surface of the water. In many sewage treatment units these layers of scum cause problems, because they coat the tank walls, cause odors and a layer of solids to form, and, in extreme cases, the scum can spill over the tank crest. In addition, the removal of these light materials, such as oil or fat, is often desirable, since it facilitates the subsequent treatment of the water. The scum should be separated in such a manner that large quantities of water are not simultaneously removed.

A number of different systems are known for removing layers of scum. In removing the scum, the problem is not so much the

extraction of the layer of scum itself as rather the problem of conveying the light materials to be extracted with the scum to the site of extraction. The extraction systems are frequently installed in the water treatment unit to be substantially stationary; they remove the scum in the immediate vicinity of the extraction point, as desired, but the scum that is somewhat further away remains unaffected.

In the secondary sedimentation tank of sewage treatment plants, floating scum extraction systems are combined with the scrapers in the secondary sedimentation tank. Consequently, the floating scum extraction system reaches the entire tank surface in each scraping step. Since, however, the scraping motion has to be very slow, the relative motion between the scum and the scraper is often inadequate to move the scum into the extraction system. In addition, mechanical devices must then convey the scum into channels and funnels.

This invention seeks to provide a sludge extraction apparatus, and a sludge extraction process for selecting sludge particles, that allow relatively light-weight sludge particles to be extracted selectively and over a large area.

The sludge extraction apparatus of this invention in a first broad embodiment comprises in combination:

a sedimentation tank;

a float;

a catch tank, attached to the float, having an overflow rim which runs at least partially around the float, and an outlet line;

a mixing unit adapted to generate a surface fluid flow within the sedimentation tank towards the catch tank; and

a conveyor, which conveys the sludge, flowing into the catch tank, through the outlet line.

According to an aspect of the present invention there is provided a scum and sludge extraction apparatus for a sedimentation tank filled with water and sewage sludge, the apparatus comprising:

a float incorporating a mixing unit and constructed and arranged to be positioned in the sedimentation tank on the surface of the water and sewage sludge;

a catch tank attached to the float and having a height adjustable overflow rim which extends at least partially around the float and an outlet line, the mixing unit being constructed and arranged to generate a fluid flow within the sedimentation tank towards the catch tank;

an extractor funnel operatively connected to the catch tank and constructed and arranged to receive scum and sludge from the fluid flow;

a conveyor unit operatively connected to the extractor funnel and to the outlet line and constructed and arranged to pump the scum and sludge through the extractor funnel and the outlet line; and

a holding member comprising a parallelogram linkage including the outlet line and constructed and arranged to locate the float and the catch tank so that the float tracks any change of a water level in the sedimentation tank.

According to a further aspect of the present invention there is provided a scum and sludge extraction system for

extracting scum and sludge from a sedimentation basin having an outer wall and a bottom filled with water, scum and sludge, the extraction system comprising:

a variable speed mixing unit for agitating the water, scum and sludge at different speeds and generating a circular fluid flow of the water, scum and sludge away from the mixing unit towards the bottom;

a float having an outer edge for surrounding and positioning said mixing unit to extend into the sedimentation basin, the float maintaining floatation on the water, scum and sludge;

a catch tank attached to the outer edge of the float, and including a height adjustable overflow rim, the overflow rim extending at least partially around the outer edge of the float for catching the water, scum and sludge when the circular fluid flow moves the water, scum and sludge away from the bottom of the sedimentation basin towards the catch tank;

an extraction conduit attached to the outer edge of the float for extracting the scum and sludge from the water collected in the catch tank;

a holding member operatively connected to the float and the catch tank and having an outlet line for transporting the extracted scum and sludge over the outer wall, the holding member locating the float and the catch tank in the sedimentation basin to track any change of a water level in the sedimentation basin; and

a conveying unit for conveying the scum and sludge through the extraction conduit and the outlet line of the holding member.

Preferably, the overflow rim extends partially around the float. Alternatively, the overflow rim extends completely around the float.

In this apparatus, the float causes the catch tank float at the surface of the water, thus permitting extraction of the floating scum and sludge from near the surface. The mixing unit generates a fluid flow within the sedimentation tank downwardly away from the catch tank. This causes the formation of a flow pattern in the sedimentation tank which, on the surface of the water, results in a flow from all sides of the sedimentation tank towards the catch tank. This flow pattern causes all of the scum and light-weight sludge components in the surface layer to move to the catch tank, so that they can be collected there by overflowing the overflow rim into the catch tank. In contrast to the prior art sludge extraction systems, with the apparatus of this invention it is thus possible to remove the scum and at least light-weight sludge components not only locally but over a large area.

To collect the scum and light-weight sludge, the apparatus includes a catch tank having an overflow rim that runs partially or completely around the catch tank. The scum to be removed flows in free overfall over the overflow rim into the catch tank. From the catch tank it is drained through an outlet line by means of a conveyor. The overflow rim prevents the quantity of water, extracted together with the scum and light-weight sludge components, from getting too large. It is possible with the compact sludge extraction apparatus of this invention to remove

the layers of scum and other light-weight sludge materials selectively and over large areas.

According to an advantageous embodiment of the invention, the catch tank is designed as a catch channel that runs completely or partially around the float.

Owing to the flow pattern generated in the water, the scum and light weight sludge moves from all sides of the sedimentation tank in the direction of the catch tank. Therefore, it is advantageous to be able to collect the scum and sludge from as large an angular area as possible around the catch tank. With the aid of a channel shaped catch tank, which runs completely or partially around the float, the bulk of the scum and sludge is collected. At the same time it enables a compact design of the sludge extraction apparatus.

It is advantageous for the height of the overflow rim to be adjustable relative to the water level. The deeper the overflow rim is positioned, the higher is the percentage of water that is extracted together with the scum and sludge. At the same time, however, it can be guaranteed that the complete layer of scum is extracted. The pump capacity demanded of the conveying unit must be taken into consideration, because the available hydraulic capacity of the conveying unit must always be greater than the quantity of incoming scum and sludge. It is possible to selectively remove the scum and sludge over a suitable adjustable of the overflow rim, for example, by the use of spindle screws to adjust the overflow height relative to the water level.

Furthermore, it is advantageous for the catch tank to include a surface inclined toward the conveying unit, so that the

sludge flowing into the catch tank moves along the incline toward the conveying unit. The sludge and scum, which falls into the catch tank, can be conveyed to an extraction funnel. In this manner all of the scum and sludge that overflows into the catch tank can be pumped off by means of the conveying unit.

According to another advantageous embodiment of the invention, the conveying unit is a submersible pump, which can be mounted below the catch tank. This option of being able to mount the pump beneath the water level enables a compact design of the apparatus.

According to another advantageous embodiment of the invention, the mixing unit includes a stirrer, which generates the fluid flow required within the sedimentation tank. Such a stirrer usually includes a propeller, driven conveniently by an electric motor. Whereas the design of the propeller determines the flow profile generated, the rate of flow can be set by means of the speed of the drive motor. Such a stirrer constitutes the simplest and least expensive way to generate the desired fluid flow pattern within the sedimentation tank.

Another advantageous embodiment of the invention includes a controller, with which the speed of the propeller can be varied. The higher the chosen speed of the propeller, the stronger is the flow pattern generated in the sedimentation tank. With a weak convection current only the layer of scum and light-weight sludge particles in the vicinity of the water surface can be extracted. A stronger convection current can cause heavier sludge particles to be swirled up so as to form layers near the surface. Therefore, as the speed of the stirrer increases, higher densities of sludge particles can also be removed. In this

manner it is possible to control the composition of the sludge extracted by the rotational speed of the propeller. This is especially significant if the invention is used in biological sewage clarification, and in particular in activation tanks. In an activation tank, high molecular weight sewage particles are decomposed with the aid of bacteria. These bacteria need oxygen; and, therefore, the activation tank must be sufficiently aerated. The biomass in the activation tank is called "activated sludge". Since the bacteria are constantly multiplying, the mass of activated sludge also increases. Therefore, not only the scum but also a part of the activated sludge is also being continuously extracted from the activation tank. When the sludge extraction apparatus of this invention is used in an activation tank, one can determine through the choice of the speed of the stirrer to what extent not only the scum but also the lighter weight components of the activated sludge are also being extracted.

A preferred embodiment of the present invention provides means for fixing the float in a horizontal position. The components of the mixing unit and in particular the submersible pump ensure uniform loading of the float. The result of this state is that the catch tank often lies obliquely in the water. However, it is necessary for the catch tank to function that the height of the overflow rim be constant over the periphery catch tank with respect to the water surface. Hence it is advantageous to provide a means that locates the catch tank overflow rim in a substantially horizontal plane. A suitable means includes two parallel guide elements, which are pivot mounted on the catch tank and on a suitable support means, such as the wall of the sedimentation tank. The distance between the swivel axes on the catch tank and on the support means is identical, and whereby the

connecting lines of the swivel axes run parallel on both the catch tank and on the support means. The guide elements are configured in the sense of a parallelogram, thus guaranteeing that the horizontal alignment of the catch tank and the float is maintained independently of the height of the water level. It is especially advantageous for at least one of the guide elements to be fabricated to include the outlet line from the catch tank. In this manner an especially simple and inexpensive design is obtained.

Another embodiment of the invention provides that at least one of the guide elements is hinged at two points respectively on the catch tank and on the sedimentation tank wall. The wall sided positioning at two points and the corresponding counter positioning at the float prevent the catch tank from moving sideways should a capsizing instance occur. It is thus guaranteed that the position of the catch tank in the water is substantially stable.

The apparatus of this invention can be used, on the one hand, to simultaneously extract scum and, on the other hand, sludge particles, which can be selected according to their sedimentation properties. The stronger the generated flow pattern current within the sedimentation tank, the higher is the percentage of removed heavy sludge particles. Conversely, if the flow pattern current is weak, only the lightest sludge particles will be removed.

The process of the invention for selecting sludge particles in accordance with their sedimentation properties in a sedimentation tank comprises the following steps. A suitable fluid flow pattern is generated in the sedimentation tank. By

means of a catch tank, which includes an overflow rim just below the water level, sludge particles having predetermined sedimentation properties are collected and then carried away.

In contrast to the extraction devices described in the prior art, it is possible to extract the scum and the lighter weight sludge particles over a large area with the aid of the fluid flow pattern generated in the sedimentation tank. In so doing, only sludge particles having specific sedimentation properties are collected and carried away. The partition of the sludge can be affected by varying the generated fluid flow pattern, especially by varying the rate of this flow.

Other details and advantages of the present invention are explained in detail with reference to several embodiments depicted in the drawings, in which:

Figure 1 shows an overview of the operating mode of the sludge extraction apparatus of the invention;

Figure 2 shows a side view of the sludge extraction apparatus, showing how the sludge extraction can be stabilized in the water;

Figure 3 shows an embodiment of the invention, wherein a catch channel runs only partially around the float; and

Figure 4 shows an embodiment of the sludge extraction apparatus, wherein a catch channel runs completely around the float.

Figure 1 gives an overview of the operating mode of the sludge extraction apparatus according to the invention. The sludge extraction apparatus 1 is located in a sedimentation tank 2, which is filled with water and sewage sludge, and which is typically an activation tank. At the surface of the water there

is a layer of scum 3 including usually at least some sludge particles. The sludge extraction apparatus includes a float 4 and a mixing unit 5. The mixing unit 5 includes a stirrer, in which the propeller of the agitator is driven by means of a drive shaft using a motor 6. It is advantageous to use an electric motor. Stirring devices of this type are well known. The rotating propeller of the mixing unit 5 generates a fluid flow 7, directed downwardly away from the float 4. Fluid flows from the layers near the surface in the direction of the flow 7 generated by the propeller, thus generating a circulating current flow pattern, which results in the scum 3 moving from all sides of the sedimentation tank toward the float 4. The flow pattern will also carry with it at least some of the sludge, the amount depending on the flow current level chosen.

A catch tank, in the shape of the channel 9, which is provided with a height adjustable overflow rim 8 on the outside, runs completely or at least partially around the float 4, to which it is attached. The scum and sludge flow in free overflow over this overflow rim into the channel 9. The height of the overflow rim 8 can be adjusted relative to the water level with spindle screws. In this manner it can be determined how much water is collected together with the scum and sludge in the catch channel 9.

Figure 1 also depicts the speed components of a flake of sludge 10 in the x(horizontal) and z(vertical) direction. The flake of sludge has a higher density than the water and would, therefore, under quiescent conditions sink to the bottom of the sedimentation tank 2. Owing to the fluid flow 7 generated by the mixing unit 5, the flake of sludge is moved in the direction of the water surface. At a low speed the flake of sludge moves only

at the low speed v_x1 in the direction of the catch channel 9. At the same time, however, it decreases at the speed v_z1. The resulting speed $v_{xz}1$ drops, therefore, relatively sharply to the low end. Thus at a low rate of flow the flake of sludge 10 does not flow into the catch channel 9. The situation is different, however, at higher rates of flow. An example is the horizontal speed v_x2, at which the resulting speed $v_{xz}2$ is produced. By suitably adjusting the overflow edge 8, the flake of sludge can flow in this case into the catch channel 9. Thus, at a low rate of flow only the scum and the lightest sludge particles can be extracted, whereas an increase in the rate of flow makes it possible to extract also heavier sludge particles having a higher sedimentation rate.

Figure 2 shows how the scum and sludge collected in the catch channel 9 can be pumped away. For this purpose there is an inclined slope 11 on the bottom of the catch channel 9, so that the scum and sludge slides in the direction of the extraction funnel 12. The hydraulic capacity of the channel is always chosen to be greater than the quantity of inflowing scum and sludge. In the extraction funnel 12 the scum and sludge is extracted from the system with a conveying unit 13, which is preferably a submersible pump, through an outlet line 14. It is convenient to fabricate the outlet line 14 a pipe or hose line.

If the conveying unit 13 and the channel 9 are not centered within the sedimentation tank, there is the problem that the float will no longer be in a position of equilibrium. Then it would not be possible to accurately adjust the position of the overflow 8. Figure 2 shows how the float and catch tank unit can be located in such a manner by a holding device so that the float 4 can easily track any change of the water level in the

sedimentation tank. Two guide elements 15 and 16 are hinged at their outer ends to a frame 17, located on the float 4, and at their inner ends to a frame 20 located on the tank rim. Parallel swivel axes 18 and 21 enable the float 4 together with the catch tank 9 to be moved vertically. To ensure that the float 4 together with the catch tank 9 remains substantially horizontal, the distance between the swivel axes 18 and 21 are the same vertical distance apart, so that the arms 15 and 16 connecting the swivel axes 18 and 21 run parallel. In addition, the two axes 21 in the frame 20, together with the two axes 18 in the frame 17 prevent lateral instability, should an instance of capsizing occur.

One guide element, for example 15, can be designed as the outlet line 14, through which the scum is drained. Another guide element, for example 16, can be used to carry the power cables for the motor 6 and the submersible pump in the conveying unit 13.

Figures 3 and 4 are a top views of the sludge extraction apparatus 1 of this invention. In Figure 3, the catch channel 9 runs only partially around the float 4. Scum and sludge, flowing over the overflow rim 8 into the channel 9, slides in the direction of the extraction funnel 12 and is collected there and pumped away by the submersible pump in the conveying unit 13. In Figure 4, the catch channel 9 runs completely around the float 4. Thus, scum and sludge can fall from all directions over the overflow edge 8 into the catch channel 9 and be pumped away by the submersible pump in the conveying unit 13.

According to the invention, not only the scum but also at least some of the sludge can be extracted from the sedimentation

tank. The sludge, which is usually removed from a secondary sedimentation tank, constitutes the end product of the biological sewage purification. The result of removing at least some of the sludge together with the scum on the surface of the basis of the thoroughly mixed sedimentation tank is a selection of the extracted sludge, during which process the light-weight sludge is preferably extracted.

In an activation tank there are always sludge particles, which are significantly lighter than the others. If there are a lot of light-weight particles in the sedimentation tank, then it is frequently not possible to separate the sludge completely from the sewage in the secondary sedimentation step. This sludge gets into the runoff; it is called the bulking sludge.

If the sludge in a thoroughly mixed activation tank is removed from the surface of the water in the tank with the device of this invention, lighter sludge is preferably extracted as a consequence of the flow and sedimentation characteristics. In this manner the heavier sludge can accumulate, as desired, in the bottom of the tank. The degree of selection can be controlled by the flow rate generated within the tank. The lower the rate of flow, the more lighter particles can be extracted. The flow rate is adjusted by selection of the stirrer speed.

What is claimed is:

1. A scum and sludge extraction apparatus for a sedimentation tank filled with water and sewage sludge, the apparatus comprising:

a float incorporating a mixing unit and constructed and arranged to be positioned in the sedimentation tank on the surface of the water and sewage sludge;

a catch tank attached to the float and having a height adjustable overflow rim which extends at least partially around the float and an outlet line, the mixing unit being constructed and arranged to generate a fluid flow within the sedimentation tank towards the catch tank;

an extractor funnel operatively connected to the catch tank and constructed and arranged to receive scum and sludge from the fluid flow;

a conveyor unit operatively connected to the extractor funnel and to the outlet line and constructed and arranged to pump the scum and sludge through the extractor funnel and the outlet line; and

a holding member comprising a parallelogram linkage including the outlet line and constructed and arranged to locate the float and the catch tank so that the float tracks any change of a water level in the sedimentation tank.

2. A scum and sludge extraction apparatus according to Claim 1 wherein
the float comprises a float frame and the holding member comprises a first and second guide element each having an inner end and an outer end, the outer ends being securable to the float frame at respective first and second swivel axes;
the first guide element comprises the outlet line;
the first and second guide elements are constructed and arranged to be secured at their inner ends at respective third and fourth swivel axes to a tank frame located on a tank rim provided to the sedimentation tank, a vertical distance between the first and second swivel axes being the same as a vertical distance between the third and fourth swivel axes, to maintain the guide elements mutually parallel while enabling said float and said catch tank to move vertically.

3. A scum and sludge extraction apparatus according to Claim 1 or Claim 2, wherein the overflow rim extends partially around the float.

4. A scum and sludge extraction apparatus according to Claim 1 or Claim 2, wherein the overflow rim extends completely around the float.

5. A scum and sludge extraction apparatus according to any one of Claims 1 to 4, wherein the catch tank comprises a catch channel having a bottom with a slope inclined in a direction towards the extractor funnel for conveying scum and sludge to the extractor funnel.

6. A scum and sludge extraction apparatus according to any one of Claims 1 to 5, wherein the conveyor unit includes a submersible pump.

7. A scum and sludge extraction system for extracting scum and sludge from a sedimentation basin having an outer wall and a bottom filled with water, scum and sludge, the extraction system comprising:

a variable speed mixing unit for agitating the water, scum and sludge at different speeds and generating a circular fluid flow of the water, scum and sludge away from the mixing unit towards the bottom;

a float having an outer edge for surrounding and positioning said mixing unit to extend into the sedimentation basin, the float maintaining floatation on the water, scum and sludge;

a catch tank attached to the outer edge of the float, and including a height adjustable overflow rim, the overflow rim extending at least partially around the outer edge of the float for catching the water, scum and sludge when the circular fluid flow moves the water, scum and sludge away from the bottom of the sedimentation basin towards the catch tank;

an extraction conduit attached to the outer edge of the float for extracting the scum and sludge from the water collected in the catch tank;

a holding member operatively connected to the float and the catch tank and having an outlet line for transporting the extracted scum and sludge over the outer wall, the holding member locating the float and the catch tank in the

sedimentation basin to track any change of a water level in the sedimentation basin; and

a conveying unit for conveying the scum and sludge through the extraction conduit and the outlet line of the holding member.

8. A scum and sludge extraction system according to Claim 7, wherein the holding member comprises two guide elements each having an inner end and an outer end, the inner ends being hinged to the outer edge of said float, and the outer edge defining a frame.

9. A scum and sludge extraction system according to Claim 8, wherein a first of the guide elements forms the outlet line and the outer ends are attached to a frame located on the outer wall of the sedimentation basin.

10. A scum and sludge extraction system according to Claim 8 or Claim 9, wherein the inner ends are hinged at first and second swivel axes, the outer ends are securable to the frame at third and fourth swivel axes, a vertical distance between the hinged inner ends being the same as a vertical distance between the swivel axes, for maintaining the guide elements mutually parallel while enabling the float and the catch tank to move vertically.

11. A scum and sludge extraction system according to any one of Claims 7 to 10, wherein the catch tank comprises a catch channel having a bottom with a slope inclined in a direction towards the extractor funnel for conveying scum and sludge to the extractor funnel.

12. A scum and sludge extraction system according to any one of Claims 7 to 11, wherein the conveyor unit includes a submersible pump.

13. A scum and sludge extraction system according to any one of Claims 7 to 12, wherein the extraction conduit is funnel shaped.

14. A scum and sludge extraction system according to any one of Claims 7 to 13, wherein the holding member forms a parallelogram linkage from the edge of the float to the outer wall of the sedimentation basin.

15. A scum and sludge extraction system according to any one of Claims 7 to 14, wherein said variable speed mixing unit is constructed and arranged to agitate the water, scum and sludge at different speeds to generate different circular fluid flows of the water, scum and sludge, and the height adjustable overflow rim catches different amounts of the water, scum and sludge based on the different speeds.

16. A scum and sludge extraction system according to any one of Claims 7 to 15, wherein the overflow rim extends completely around the float.

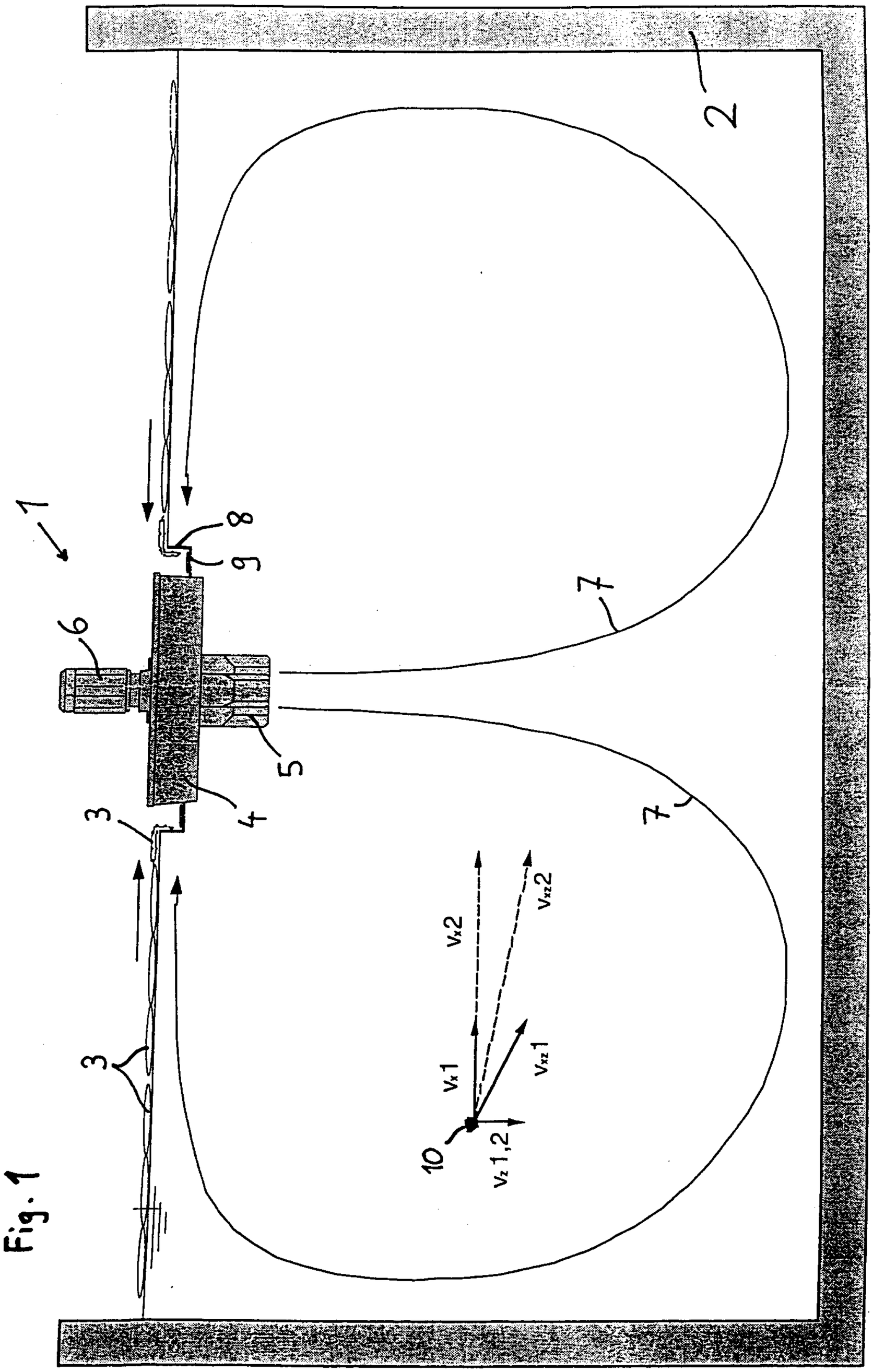


Fig. 1

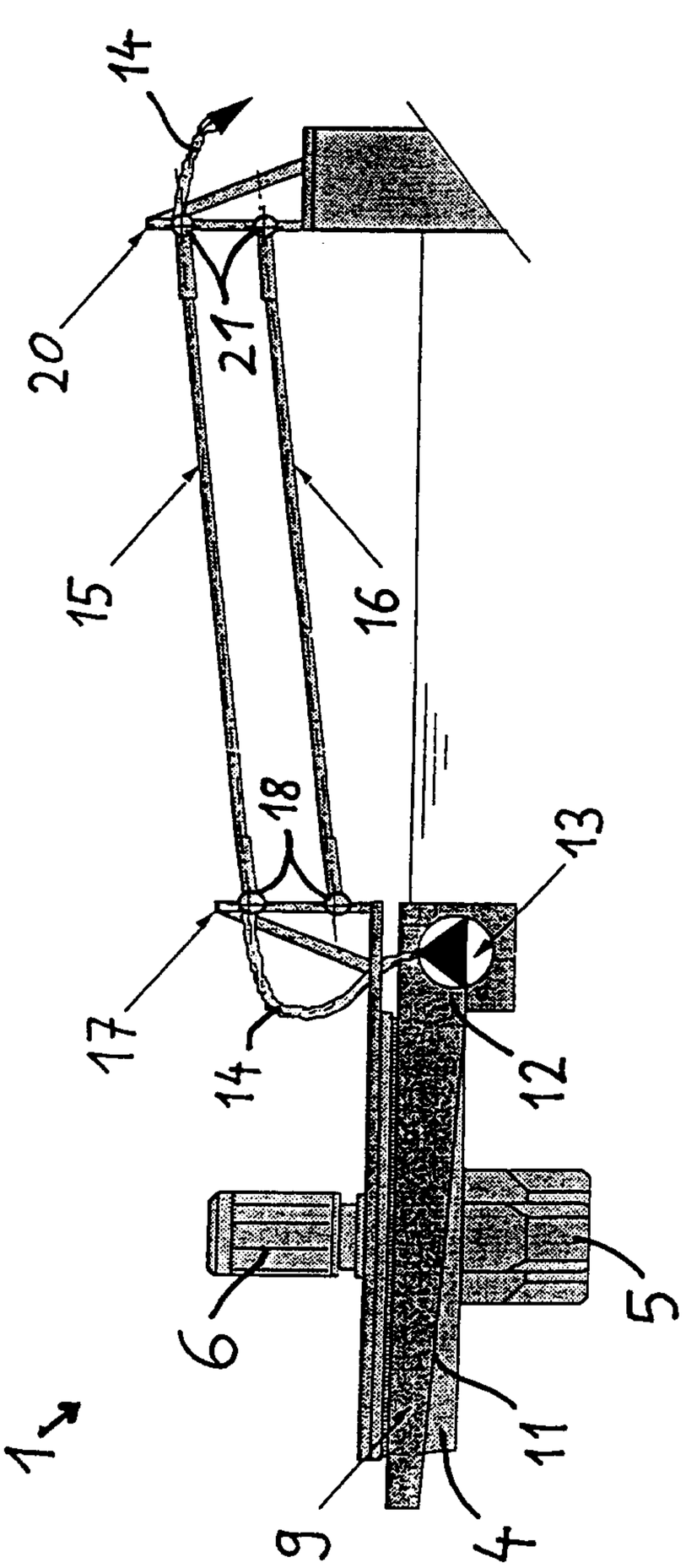


Fig. 2

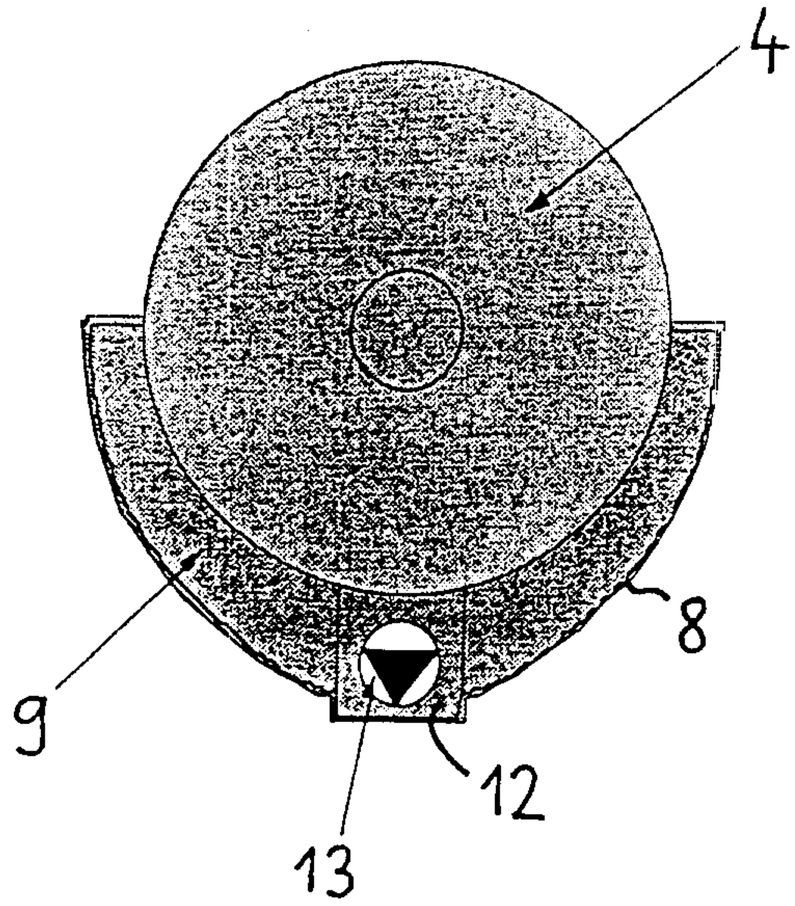


Fig. 3

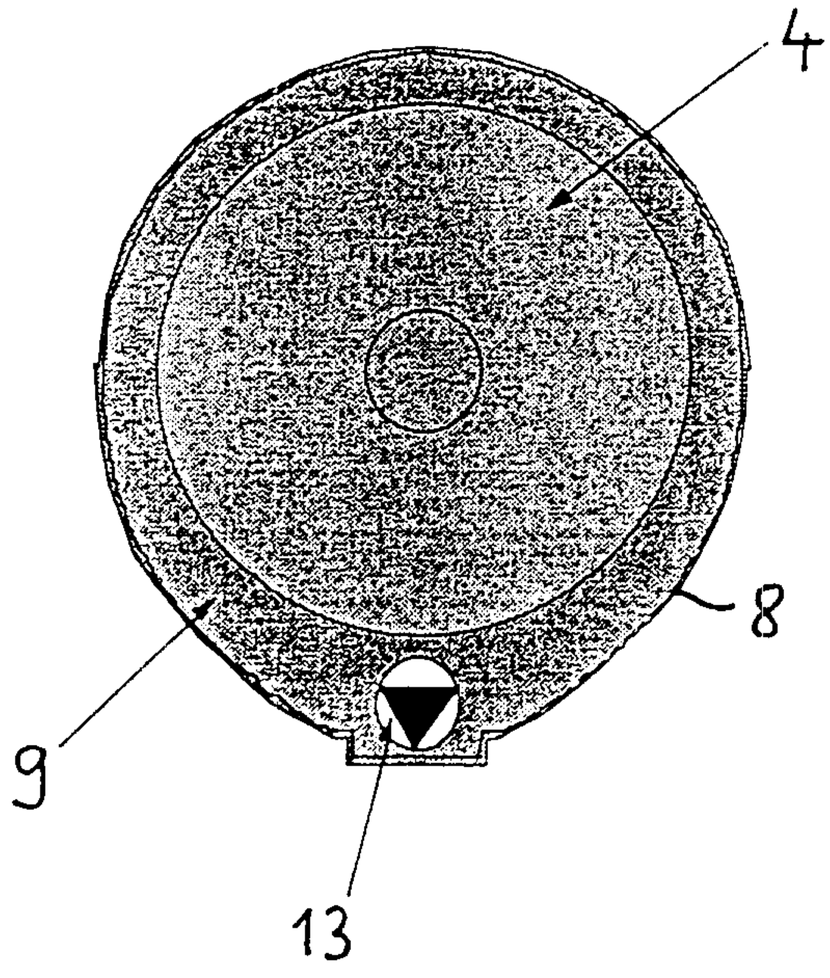
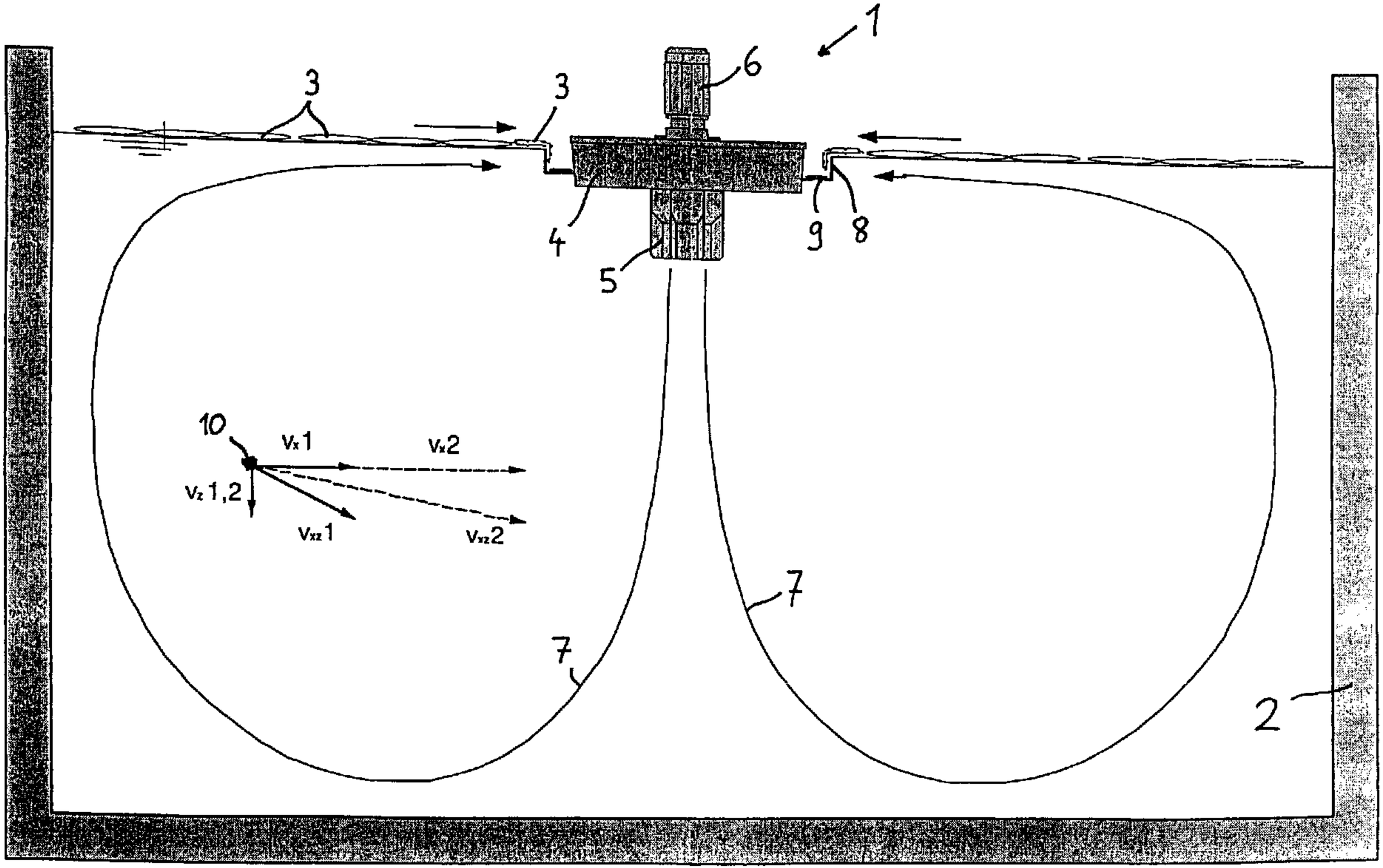


Fig. 4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