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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
3 October 2013 (03.10.2013)

WIPO | PCT

(10) International Publication Number
WO 2013/147671 A1

(51) International Patent Classification:
C02F 3/12 (2006.01)

(21) International Application Number:
PCT/SE2013/050123

(22) International Filing Date:
13 February 2013 (13.02.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
1250307-4 28 March 2012 (28.03.2012) SE

(71) Applicant: **XYLEM WATER SOLUTIONS AB** [SE/SE]; S-361 80 Emmaboda (SE).

(72) Inventor: **UBY, Lars**; Torulfsvägen 5, S-163 51 Spånga (SE).

(74) Agent: **BRANN AB**; P.O. Box 12246, S-102 26 Stockholm (SE).

(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, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, 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, 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, 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, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

(54) Title: TREATMENT PLANT FOR SEWAGE TREATMENT

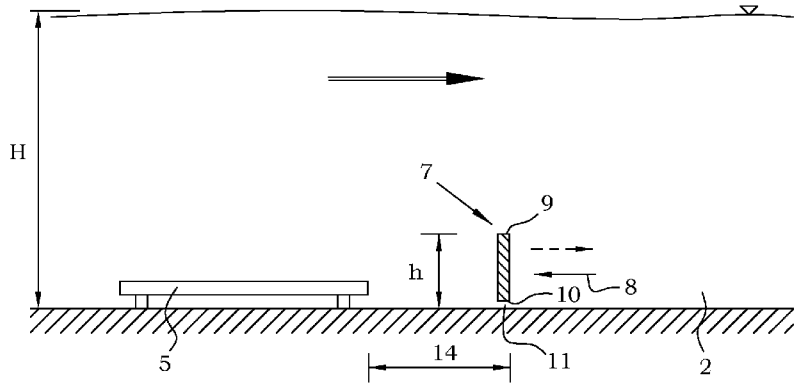

Fig. 2

(57) Abstract: The invention relates to a treatment plant for waste water treatment, comprising a circulation tank (2), which is arranged to accommodate waste water up to a predetermined filling height (H), and at least one aerator section (5) arranged at the bottom of the circulation tank (2), which aerator section (5) is arranged to supply gas bubbles to the waste water, the circulation tank (2) having a predetermined direction of flow along which the waste water is arranged to flow. The treatment plant is characterized in that the same comprises a partition wall (7) arranged transversely to the circulation tank (2) downstream the aerator section (5), which partition wall (7) has an upper end (9) that in the vertical direction is situated at a height (h) that is lower than 25% of the above-mentioned filling height (H).

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TREATMENT PLANT FOR SEWAGE TREATMENT

Technical Field of the Invention

The present invention relates generally to a treatment plant for waste water treatment. In particular, the present invention relates to a treatment plant for biological waste water treatment, the treatment plant comprising a circulation tank, which is arranged to accommodate waste water up to a predetermined filling height, and at least one aerator section arranged at the bottom of the circulation tank. The circulation tank has a predetermined direction of flow along which the waste water is arranged to flow, and the aerator section is arranged to supply gas bubbles to the waste water when the same passes the aerator section.

Background of the Invention and Prior Art

A circulation tank, or oxidation ditch, is an open, endless tank that is used in biological purification, or oxidation, of waste water, in which the waste water is brought to flow along the circulation tank and thereby brought to pass different zones in the circulation tank. In such a biological purification, usually the waste water is cleaned from nitrogen and biological material by micro-organisms decomposing the biological material into carbon dioxide and water, and bacteria converting the waterborne nitrogen into aerial nitrogen. In case the waterborne nitrogen is not eliminated, this entails the risk of over-fertilization of watercourses and the biological material is strongly oxygen depleting, which gives watercourses deficient in oxygen, if untreated water is discharged. The decomposition of the biological material is stimulated by the supply of large amounts of oxygen to the waste water, and the elimination of the waterborne nitrogen occurs in areas in the circulation tank without supplied oxygen. Along the circulation tank, there are found at least one so-called aerated zone and at least one so-called non-aerated zone.

Accordingly, the above-mentioned aerator section is arranged in the aerated zone.

In one, or a few, aerated zones along the circulation tank, oxygen is added to the waste water by gas bubbles being discharged into the waste water by means of aerator sections arranged at the bottom of the circulation tank. Microorganisms in the so-called activated sludge use the supplied oxygen to decompose the biological material found in the waste water.

Per definition, the waste water should circulate along the circulation tank, and a known attempt to provide a main liquid flow along the circulation tank and to simultaneously obtain uniform aeration of the waste water is disclosed in the withdrawn US patent application 09/801,667. This patent application shows a plant that utilizes the lift of the air in order to create a main liquid flow. The waste water is entered into the aerator section in the vicinity of the bottom of the circulation tank and is discharged on the opposite side of the aerator section in the vicinity of the liquid surface; in this way, the liquid flow and the air flow have more or less the same direction above the aerator section. Accordingly, the main liquid flow is provided by the fact that a first transverse partition wall, arranged upstream the aerator section, extends down into the waste water from above the liquid surface and that a second transverse partition wall, arranged downstream the aerator section, extends up from the bottom of the circulation tank. It is important that the lower end of the first, upper partition wall is on a level that is situated below half the height of the circulation tank, and that the upper end of the second, lower partition wall is on a level that is situated above half the height of the circulation tank. In this way, a liquid flow past the aerator section is created, at the same time as the rise velocity of the air in the waste water is increased. A large disadvantage of the disclosed plant is thus that the supplied air will rise

quickly to the surface and leave the waste water. A further disadvantage is that only the upper liquid volume downstream the aerator section will be provided with a flow rate along the circulation tank at the same time as the lower liquid volume will stand still, or recirculate slowly, downstream the aerator section, whereupon the biological material in the waste water risks being accumulated at the bottom of the circulation tank.

In a traditional circulation tank without such partition walls, there is found a strongly rearwardly directed return liquid flow closest to the bottom of the circulation tank, which rearwardly directed return flow is sucked into the aerator section and thereby creates an increased rise velocity of the supplied air. Accordingly, when considering the cross-section of the circulation tank, there are obtained differently directed liquid flows in a cross-section downstream the aerator section, more precisely a high flow rate along the circulation tank in the area of the liquid surface and a rearwardly directed flow at the bottom of the circulation tank.

Brief Description of the Objects of the Invention

The present invention aims at obviating the above-mentioned disadvantages and failings of previously known treatment plants and at providing an improved treatment plant. A primary object of the invention is to provide an improved treatment plant of the initially defined type, which provides a more uniform main liquid flow along the circulation tank when considering a cross-section of the circulation tank downstream the aerator section.

Brief Description of the Features of the Invention

According to the invention, at least the primary object is achieved by the initially defined treatment plant having the features defined in the independent claims. Preferred

embodiments of the present invention are furthermore defined in the depending claims.

According to the present invention, a treatment plant of the type initially defined is provided, which is characterized in that the same comprises a partition wall arranged transversely to the circulation tank downstream the aerator section, which partition wall has an upper end that in the vertical direction is situated at a height that is lower than 25 % of the predetermined filling height of the circulation tank.

Accordingly, the present invention is based on the understanding that a low partition wall arranged downstream the aerator section stops the rearwardly directed return liquid flow found closest to the bottom of the circulation tank in the area downstream the aerator section, with the purpose of lowering the rise velocity of the air and with the purpose of recovering the linear momentum of the rearwardly directed return flow by means of the reaction force of the partition wall on the waste water, which strengthens the main liquid flow, at the same time as the main liquid flow that passes the aerator section along the circulation tank is affected to an as small as possible extent.

According to a preferred embodiment of the present invention, the upper end of the partition wall in the vertical direction is situated at a height that is less than 20 % of the filling height, preferably less than 15 %.

According to a preferred embodiment, the partition wall has a lower end that in the vertical direction is situated at a distance from the bottom of the circulation tank. Preferably, the distance between the lower end of the partition wall and the bottom of the circulation tank is more than 5 cm and less than 15 cm. This entails that solid material found in the waste water does not risk being accumulated at the partition wall but can pass freely under the same.

Preferably, the partition wall has a first surface turned downstream, which first surface is plane. In a further preferred embodiment, the first surface of the partition wall is essentially vertical. A plane and vertical surface of the partition wall turned downstream gives maximum effective target area in relation to the rearwardly directed return liquid flow with a minimal size of the partition wall. Further, the partition wall has a second surface turned upstream, which second surface is curved in the upstream direction, with the purpose of minimizing the effect on the main liquid flow that passes the aerator section along the circulation tank.

In a further preferred embodiment, the treatment plant comprises at least one flow generating machine arranged upstream said at least one aerator section, which flow generating machine is arranged to generate the main liquid flow along said circulation tank.

Additional advantages and features of the invention are seen in the other dependent claims as well as in the following, detailed description of preferred embodiments.

Brief Description of the Drawings

A more complete understanding of the above-mentioned and other features and advantages of the present invention will be clear from the following, detailed description of preferred embodiments, reference being made to the accompanying drawings, wherein:

Fig. 1 is a schematic elevated view from above of a treatment plant according to the invention,

Fig. 2 is a schematic side view of the aerator section and partition wall of the treatment plant,

Fig. 3 is a schematic cross-sectional view of the partition wall of the treatment plant according to a first embodiment,

Fig. 4 is a schematic cross-sectional view of the partition wall of the treatment plant according to a second embodiment, and

Fig. 5 is a schematic cross-sectional view of the partition wall of the treatment plant according to a third embodiment.

Detailed Description of Preferred Embodiments

Reference is initially made to Figures 1 and 2. The present invention relates to a treatment plant, generally designated 1, for waste water treatment comprising biological material. The treatment plant comprises an endless circulation tank 2, or oxidation ditch, which in the embodiment shown consists of an elongate tank having rounded ends and comprising a centrally placed longitudinal partition 3, whereupon the circulation tank 2 obtains two parallel and straight channel segments that are connected to each other by two redirecting/semicircular channel segments. It should be pointed out that circulation tanks may have other feasible shapes, for instance an annular shape or a serpentine shape; accordingly, the circulation tank may comprise more straight and redirecting channel segments, respectively, or have an entirely circular/elliptical path shape. The circulation tank 2 is arranged to accommodate waste water up to a predetermined filling height H, even if the actual liquid level in operation may be below as well as exceed said filling height H without the present invention being affected. The waste water is cleaned batch-wise, or continuously, in a treatment plant 1 according to the invention, and with a waste water volume that reaches up to said filling height H, an optimal utilization of the treatment plant 1 is obtained. A typical filling height H is in the order of 3-4 m, but can be as high as 7-8. The circulation tank 2 is arranged with a predetermined direction of flow, schematically illustrated by means of the arrow 4,

along which the waste water is intended to flow, while forming a main liquid flow. According to the invention it is of secondary importance how the main liquid flow is obtained, as long as there is a predetermined direction of flow in the circulation tank 2.

Further, the treatment plant 1 according to the invention comprises at least one aerator section 5 that is arranged in an aerated zone of the circulation tank 2. Upstream the aerator section 5, there is found a non-aerated zone of the circulation tank 2. In the embodiment shown, the aerator section 5 is arranged in the beginning of a straight channel segment, even if other positions are feasible. Said at least one aerator section 5 is arranged at the bottom of the circulation tank 2 and is arranged to supply oxygen-containing gas bubbles, such as air or pure oxygen, to the waste water, with the purpose of supplying oxygen to the waste water. The aerator section 5 consists, for instance, of a vast number of diffusers or aerator elements, which jointly cover the entire or the main part of the width of the circulation tank 2, a typical width of the circulation tank 2 is in the order of 10-15 m. The length of the aerator section 5 along the circulation tank 2 is in the order of 5-25 % of the entire length of the circulation tank 2. Preferably, the treatment plant 1 comprises two or more aerator sections 5, which preferably are equidistantly arranged along the circulation tank 2.

In a preferred embodiment, the treatment plant 1 comprises at least one flow generating machine 6 arranged upstream said at least one aerator section 5. The flow generating machine 6 is arranged to generate a flow of waste water along said circulation tank 2, and may consist of one or more so-called slow-moving agitators. Preferably, the treatment plant 1 comprises flow generating machines 6 in two or more positions, which preferably are equidistantly arranged along the circulation tank 2.

The treatment plant according to the invention comprises also at least one partition wall 7 arranged transversely to the circulation tank 2 downstream said at least one aerator section 5. In the description as well as in the appended claims, by the expression "transversely to the circulation tank", reference is made to the fact that the partition wall 7 extends transversely to the direction of flow 4 of the circulation tank 2. Preferably, the partition wall 7 is arranged perpendicular to the direction of flow 4 of the circulation tank 2. The purpose of the partition wall 7 is to prevent a rearwardly directed return flow, schematically illustrated by means of the arrow 8, at the bottom of the circulation tank 2. When the rearwardly directed return flow 8 meets the partition wall 7, the same is redirected without having influenced the operation of the aerator section 5. In other words, a reaction force is exerted from the partition wall 7 on the waste water, which strengthens the main liquid flow.

The partition wall 7 has an upper end 9 that in the vertical direction is situated at a height h that is situated lower than 25 % of the predetermined filling height H of the circulation tank. Preferably, the upper end 9 of the partition wall 7 in the vertical direction is situated at a height h that is lower than 20 % of the filling height H, more preferably lower than 15 %. A typical height H is in the order of 0,5 m.

Further, the partition wall 7 has a lower end 10 that in the vertical direction preferably is situated at a distance 11 from the bottom of the circulation tank 2. It is further preferred that the distance 11 between the lower end 10 of the partition wall 7 and the bottom of the circulation tank 2 is more than 5 cm and less than 15 cm. The purpose of arranging the partition wall 7 with a distance between the lower end 10 of the partition wall 7 and the bottom of the circulation tank 2 is to prevent solid material from being accumulated at the partition wall 7.

Now, reference is made primarily to Figures 3-5, which show different embodiments of the partition wall 7 according to the invention. The partition wall 7 has a first surface 12 turned downstream and a second surface 13 opposite the first surface and turned upstream.

According to a preferred embodiment, said first surface 12 is plane; in addition, it is preferred that the first surface 12 is inclined less than 45° in relation to a vertical line. Most preferably, the first surface 12 of the partition wall 7 should be essentially vertical, with the purpose of having as large effective surface as possible in relation to the rearwardly directed return flow 8. It should be appreciated that the partition wall 7 may be divided into several partition wall segments (not shown) arranged beside each other, which may have different mutual angular orientation in relation to a vertical line, with the purpose of optimizing the partition wall 7 in relation to non-uniform rearwardly directed return flow as viewed transversely to the bottom of the circulation tank 2.

The second surface 13 of the partition wall 7 may also be plane, like the first surface 12, and is in this case preferably parallel to said first surface 12, according to Figure 3. Alternatively, the second surface 13 may incline in the direction downstream (not shown), i.e., in the direction away from the aerator section 5, preferably less than 45° in relation to a vertical line. However, it is preferred that the second surface 13 is curved, or non plane, and has some kind of bulging in the upstream direction. In Figure 4, there is shown a curved second surface 13 of the partition wall 7 in the form of a curvature having an arched, or semicircular, cross-section, and in Figure 5, there is shown a curved second surface 13 of the partition wall 7 in the form of a curvature having a triangular, or acute, cross-section. It should be pointed out that the cross-section of the second surface 13 alternatively may have other shapes than those shown, for

instance a polygonal cross-section. The curved shape of the second surface 13 of the partition wall 7 entails that the effect of the partition wall 7 on the main liquid flow 4 can be minimized.

Now, reference is made again to Figure 2. The partition wall 7 should be situated at a distance from the aerator section 5. According to the preferred embodiment, the first surface 12 of the partition wall 7 in the area of the lower end 10 of the partition wall 7 should be situated at a distance 14 from the aerator section 5 that is less than two times the filling height H. Preferably, said distance should be less than the filling height H, more preferably less than 25 % of the filling height H. A rearwardly directed return flow between the partition wall 7 and the aerator section 5 is thereby prevented from being generated.

Feasible Modifications of the Invention

The invention is not limited only to the embodiments described above and shown in the drawings, which only have the purpose of illustrating and exemplifying. This patent application is intended to cover all adaptations and variants of the preferred embodiments described herein, and consequently the present invention is defined by the wording of the accompanying claims and accordingly, the equipment may be modified in all feasible ways within the scope of the accompanying claims.

It should also be pointed out that all information about/regarding terms such as above, below, upper, under, etc., should be interpreted/read with the equipment orientated in accordance with the figures, with the drawings orientated in such a way that the reference designations can be read in a proper way. Accordingly, such terms only indicate mutual relationships in the shown embodiments, which relationships may be changed if the equipment

according to the invention is provided with another construction/design.

It should be pointed out that even if it is not explicitly mentioned that features from one specific embodiment can be combined with the features of another embodiment, this should be regarded as evident when possible.

Claims

1. Treatment plant for waste water treatment, comprising a circulation tank (2), which is arranged to accommodate waste water up to a predetermined filling height (H), and at least one aerator section (5) arranged at the bottom of the circulation tank (2), which aerator section (5) is arranged to supply gas bubbles to the waste water, the circulation tank (2) having a predetermined direction of flow along which the waste water is arranged to flow, **characterized** in that the treatment plant further comprises a partition wall (7) arranged transversely to the circulation tank (2) downstream the aerator section (5), which partition wall (7) has an upper end (9) that in the vertical direction is situated at a height (h) that is lower than 25 % of the above-mentioned filling height (H).

2. Treatment plant according to claim 1, wherein the upper end (9) of the partition wall (7) in the vertical direction is situated at a height (h) that is lower than 20 % of the filling height (H), preferably lower than 15 %.

3. Treatment plant according to claim 1 or 2, wherein the partition wall (7) has a lower end (10) that in the vertical direction is situated at a distance from the bottom of the circulation tank(2).

4. Treatment plant according to claim 3, wherein the distance between the lower end (10) of the partition wall (7) and the bottom of the circulation tank (2) is more than 5 cm and less than 15 cm.

5. Treatment plant according to any one of the preceding claims, wherein the partition wall (7) has a first surface (12) turned downstream, which first surface (12) is plane.

6. Treatment plant according to claim 5, wherein the first surface (12) of the partition wall (7) is inclined less than 45° in relation to a vertical line.

7. Treatment plant according to claim 5 or 6, wherein the first surface (12) of the partition wall (7) is essentially vertical.

8. Treatment plant according to any one of the preceding claims, wherein the partition wall (7) has a second surface (13) turned upstream, which second surface (13) is curved in the upstream direction.

9. Treatment plant according to any one of the preceding claims, wherein the first surface (12) of the partition wall (7) in the area of the lower end (10) of the partition wall (7) is situated at a distance from the aerator section (5), which distance is less than two times the filling height (H).

10. Treatment plant according to claim 9, wherein the distance between the aerator section (5) and the first surface (12) of the partition wall (7) in the area of the lower end (10) of the partition wall (7) is less than the filling height (H), preferably less than 25 % of the filling height (H).

11. Treatment plant according to any one of the preceding claims, wherein the same comprises at least one flow generating machine (6) arranged upstream said at least one aerator section (5), which flow generating machine (6) is arranged to generate a flow of waste water along said circulation tank (2).

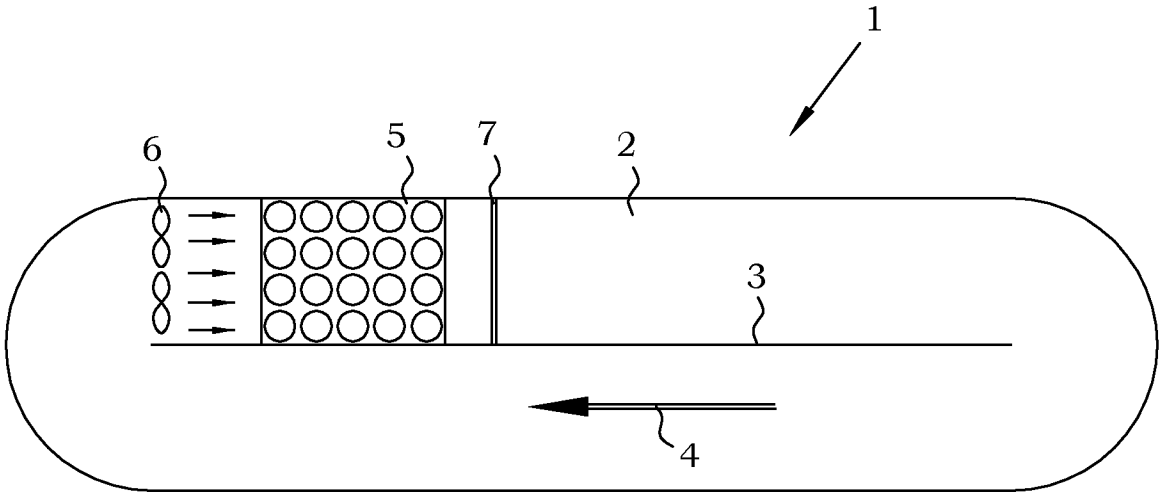

Fig. 1

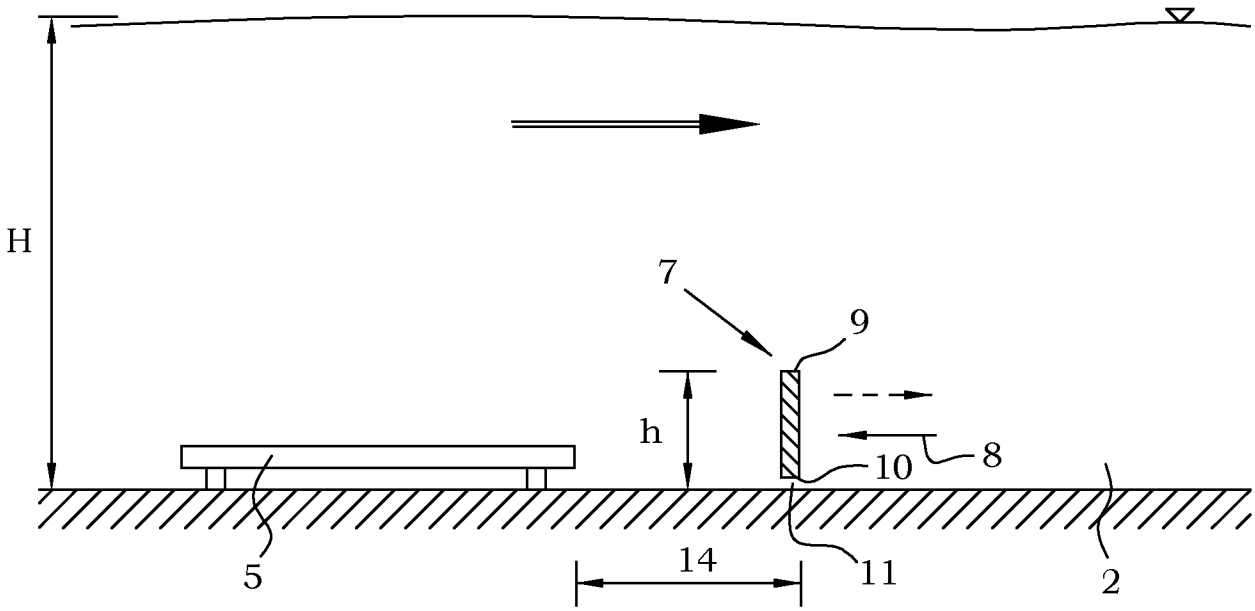

Fig. 2

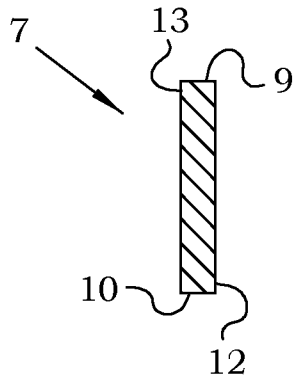

Fig. 3

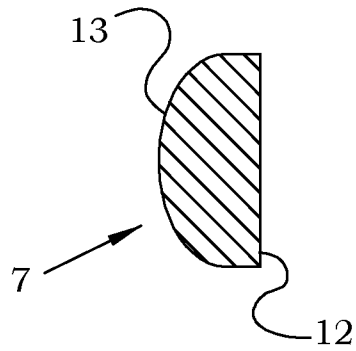

Fig. 4

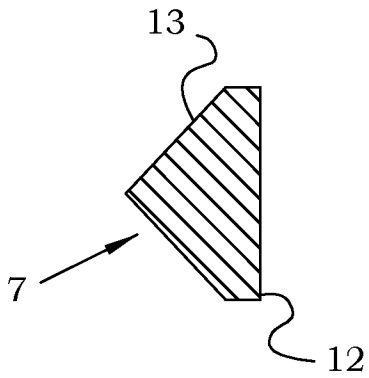

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2013/050123

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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)

IPC: C02F

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

SE, DK, FI, NO classes as above

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

EPO-Internal, PAJ, WPI data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 20020070164 A1 (HENRICH HERIBERT JOSEF), 13 June 2002 (2002-06-13); paragraphs [0004], [0008], [0025]; figures 1-2	1-11
A	US 3884812 A (LINDQUIST HANS), 20 May 1975 (1975-05-20); abstract; column 3, line 11 - line 20; figures 1-3	1-11
A	SE 516258 C2 (ITT MFG ENTERPRISES INC), 10 December 2001 (2001-12-10); abstract; figures	1-11
A	GB 191400729 A (JONES & ATTWOOD LTD ET AL), 7 January 1915 (1915-01-07); page 3, line 27 - line 36; figure 3	1-11

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

☒ See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search	Date of mailing of the international search report
21-05-2013	21-05-2013

Name and mailing address of the ISA/SE
Patent- och registreringsverket
Box 5055
S-102 42 STOCKHOLM
Facsimile No. + 46 8 666 02 86

Authorized officer
Jens Waltin
Telephone No. + 46 8 782 25 00

International application No.
PCT/SE2013/050123

Continuation of: second sheet
International Patent Classification (IPC)
C02F 3/12 (2006.01)

US	20020070164	A1	13/06/2002	NONE			
US	3884812	A	20/05/1975	NONE			
SE	516258	C2	10/12/2001	SE	0001393	L	15/10/2001
GB	191400729	A	07/01/1915	NONE			