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Title: FILTER DEVICE COMPRISING ROTATABLE FILTER LAMELLAE.

Abstract: The invention relates to a filter device comprising a frame (2), rotatable lamella axes (4) positioned at the frame (2) at a distance from one another, filter lamellae (6) positioned on the lamella axes (4) next to one another at a distance and arranged in such a manner that the filter lamellae (6) on the adjacent lamella axes (4) are arranged to overlap at least partly, whereby a liquid or material to be filtered is arranged to pass between the filter lamellae (6). Intermediate lamellae (5) are mounted in the gaps between the adjacent filter lamellae (6) to provide a distance between the adjacent filter lamellae (6) and to clean the gap between the adjacent filter lamellae (6).
Filter device comprising rotatable filter lamellae

BACKGROUND OF THE INVENTION

[0001] The invention relates to a filter device and particularly to a filter device as claimed in the preamble of claim 1, comprising a frame, rotatable lamella axes positioned at the frame at a distance from one another, filter lamellae positioned on the lamella axes next to one another at a distance and arranged in such a manner that the filter lamellae on the adjacent lamella axes are arranged to overlap at least partly, whereby a liquid or material to be filtered is arranged to pass between the filter lamellae.

[0002] A liquid or other material may be filtered by a filter, which comprises rotatable lamella axes at a distance from one another and plate-like filter lamellae mounted on these lamella axes. Successive lamella axes are preferably positioned in a line extending stepwise obliquely upwards to provide a step filter. According to the operating principle of this filter, the lamella axes and the filter lamellae are placed in succession so that the filter lamellae of the successive lamella axes overlap at least partly, whereupon a liquid or material to be filtered flows from the gaps between the filter lamellae, but impurities or solid matter in the liquid or other material to be filtered cannot pass through the gaps between the plates. The filter plates rotating with the lamella axes rotate between one another, transferring away impurities and solid matter that have remained in the gaps between them from the gaps forward to the filter lamellae of the next axis. The filtered material then travels, carried by the filter lamellae rotating in the filter, to discharge means and away from the filtered, clean liquid or other material. The filter lamellae, which rotate between one another at least partly in an overlapping manner, also partly clean themselves, as the overlapping filter lamellae remove impurities and solid matter accumulated between the adjacent filter lamellae.

[0003] A problem with the arrangement described above is that, since the step filter uses rectangular or oval filter lamellae or filter lamellae having some other shape than round, the filter lamellae of the successive lamella axes overlap, due to their rotational motion, only partly for the most part of their revolution, whereby a gap remains between the lamella axis and the filter lamella overlapping between the filter lamellae adjacent to the lamella axis, which gap can be cleaned by the filter lamellae rotating between one another on only a part of the revolution of the filter lamellae. This means that the
filter gap between the adjacent filter lamellae is blocked on at least part of the revolution of the filter lamellae when solid matter is packed in this gap. This may wedge the filter lamellae apart, whereupon they may bend and lead to malfunctions of the filter.

**BRIEF DESCRIPTION OF THE INVENTION**

[0004] It is thus an object of the invention to provide a filter according to the characterizing part of claim 1 so that the above-mentioned problems can be solved. The object of the invention is achieved by a filter, which is characterized in that intermediate lamellae are mounted in the gaps between the adjacent filter lamellae to provide a distance between the adjacent filter lamellae and to clean the gap between the adjacent filter lamellae.

[0005] Preferred embodiments of the invention are disclosed in the dependent claims.

[0006] The invention is based on mounting intermediate lamellae between the adjacent cleaning lamellae, separating the adjacent filter lamellae to a distance from one another. By changing the thickness of the intermediate lamellae, a desired distance between the adjacent filter lamellae can thus be achieved. In a preferred embodiment, the thickness of these intermediate lamellae is such that the distance between the adjacent filter lamellae substantially corresponds to the thickness of the filter lamella. The intermediate lamellae are mounted in such a manner that the intermediate lamella between the filter lamellae adjacent to the lamella axis is arranged to extend between the lamella axis and the filter lamella overlapping between said adjacent filter lamellae. The intermediate lamellae may also be shaped in such a manner that they compensate for the partial overlapping of the filter lamellae in the course of their revolution. In this case, the intermediate lamella between the adjacent filter lamellae may be shaped in such a manner that the gap between the outermost edge of the intermediate lamella and the outermost edge of the filter lamella overlapping between said adjacent filter lamellae can be substantially minimized in the course of the revolution of the filter lamellae. The intermediate lamellae may also be shaped in such a manner that its shape substantially corresponds to the orbit of the outermost edge of the adjacent filter lamella overlapping between the adjacent filter lamellae between the adjacent filter lamellae on at least part of the revolution of the filter lamellae.
[0007] The method and system of the invention provide the advantage that cleaning of the gap between the adjacent filter lamellae by means of intermediate lamellae may be made more effective, which improves the filtering result considerably, since all impurities and solid matter tend to accumulate on the filter lamellae of the last lamella axis or pass through them. Due to the design of the intermediate lamella, the gap between the adjacent filter lamellae may be blocked in a controlled manner, whereupon the filter gap between the adjacent filter lamellae can be reduced and the filter is capable of achieving a better filtering result. In addition, the intermediate lamellae according to the invention stiffen the filter lamella pack consisting of adjacent filter lamellae.

BRIEF DESCRIPTION OF THE FIGURES

[0008] The invention will now be described in greater detail in connection with preferred embodiments with reference to the attached drawings, in which

Figures 1A to 1D show an embodiment of a filter according to the present invention; and

Figures 2 to 8 show an embodiment of filter lamellae and intermediate lamellae of the filter of an embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0009] With reference to Figure 1A, a principle view of an embodiment of a filter according to the present invention is shown. The filter comprises a frame 2, which is provided with an inlet conduit 22, through which a liquid or material to be filtered is supplied into the filter. The filter also comprises an outlet conduit 24 for filtered liquid and an outlet conduit 26 for filtered solid matter. Accordingly, the outlet conduits 24 and 26 may comprise a discharge container or a basin and/or outlet pipes as well as feasible pumps for forwarding the filtered material.

[0010] The outlet conduits 24 and 26 for liquid and solid matter are positioned successively according to Figure 1A. The filter frame 2 is further provided with a holder 28, on which lamella axes 4 are mounted successively at regular intervals from one another. The holder 28 extends obliquely upwards in the direction of motion of the material to be filtered, in which case the lamella axes are also mounted obliquely upwards on the holder 28 in succession. The lamella axes 4 are rotated by a motor or some other power source 30. In the figures the direction of rotation of the lamella axes 4 is clockwise. The lamella
axes 4 are connected to the power source 30 by power transmission means, which preferably rotate all lamella axes 4 at the same speed. In Figures 1A to 1D, the lamella axes 4 are rotated clockwise in the figures. Filter lamellae 6 are mounted at a distance from one another on the lamella axes, overlapping in the gaps between the corresponding filter lamellae 6 of the adjacent lamella axis 4, whereby the gaps between the adjacent filter lamellae on the same lamella axis 4 become smaller. Lamella axes 4 are mounted on the holder 28 in succession such that they extend over the outlet conduit 24 for liquid, whereby the liquid is able to pass and drop from the gaps between the filter lamellae 6 to the outlet conduit 24 for liquid, while the filtered solid matter is transferred forwards by the rotational motion of the filter lamellae 6. The holder 28 and lamella axes 4 extend as far as to the outlet conduit 26 for solid matter, whereby solid matter carried on top of the filter lamellae passes over the outlet conduit 24 for liquid to the outlet conduit 26 for solid matter, where it drops or is transferred from the last filter lamellae 6.

[0011] Close to the last lamella axis 4, preferably below it, there is provided a rotatable auxiliary axis 10, which in the solution of Figure 1C is connected to the holder 28. In Figures 1A and 1C, the auxiliary axis is positioned obliquely in front of and below the last lamella axis 4. Cleaning lamellae 8 are mounted on the auxiliary axis 10, which are arranged to extend to the gaps between the filter lamellae 6 of the highest lamella axis 4, which is the last lamella axis in the direction of motion of the material to be filtered. The auxiliary axis 10 is rotated in the same direction as the lamella axes 4, i.e. clockwise in Figure 1C. The cleaning lamellae 8 push away the solid matter or impurities accumulated in the gaps between the filter lamellae of the last lamella axis 4 and transfer them to the outlet conduit 26 for solid matter.

[0012] The auxiliary axis 10 may be fixed to the holder 28 in the same way as the lamella axes 4 or by separate fixing means 12, as shown in Figure 1A. The auxiliary axis 10 may be functionally connected to at least one lamella axis 4 or, alternatively, to the power transmission means connected to the lamella axes 4, in which case the auxiliary axis 10 receives its rotational power from the same power source as the lamella axes 4. Consequently, the auxiliary axis 10 may be rotated at the same speed as the lamella axes 4. Alternatively, between the auxiliary axis 10 and the lamella axes 4 or between the auxiliary axis 10 and the power transmission means connecting the lamella axes 4 there are connected transmission means, by which the rotational speed
of the auxiliary axis 10 may be changed with respect to the rotational speed of the lamella axes 4. Thus, the auxiliary axis 10 and the cleaning lamellae 8 thereon may be rotated faster than the lamella axes 4, which improves the cleaning of the gaps between the filter lamellae 6 of the last lamella axis 4 and transfer of solid matter separated by the filter lamellae to the outlet conduit 26 for solid matter. In Figures 1A and 1C, the transmission means comprise a transmission axis 14, which is functionally connected to the power source 30 or to the power transmission means connecting the power source 30 and the lamella axes 4 or directly to one or more lamella axes 4. A first pulley 15 is mounted on the transmission axis 14 and a second pulley 17 is mounted on the auxiliary axis 10. The pulleys are connected to one another by a belt 16. The diameters of these pulleys are selected so that the auxiliary axis 10 rotates faster than the lamella axes 4. However, it is also possible to select the diameters of the pulleys 15, 17 in some alternative manner. Alternatively, the power transmission means may be provided by cogwheel means or some other similar transmission means. Instead of the belt 16 and the pulleys 15, 17, a chain and chain pulleys may be used.

[0013] Alternatively, the auxiliary axis 10 or the transmission means may be connected to a separate auxiliary power source, which is separate from the power source 30. In this case, rotation of the auxiliary axis 10 may be controlled by this auxiliary power source or its control means. The auxiliary power source may then be arranged to rotate the auxiliary axis 10 faster or slower than the lamella axes 4 or at the same speed as them. The auxiliary power source also rotates the auxiliary axis 10 independently of the lamella axes 4.

[0014] According to Figures 1A and 1C, the cleaning lamellae 8 are round plate-like elements, but they may also have a substantially oval, rectangular, polygonal or some other shape. Although the auxiliary axis is positioned below the last lamella axis in the embodiment of Figures 1A to 1D, it may also be put, if desired, in the same line with the lamella axes 4 or above the last lamella axis 4.

[0015] Using the auxiliary axis and the cleaning lamellae eliminates the problem relating to cleaning of the filter lamellae on the last lamella axis, which results from the fact that the cleaning of the filter lamellae on the last lamella axis is only carried out by means of the filter lamellae on the second last lamella axis. In other words, in the gaps between the filter lamellae of the
last lamella axis, filter lamellae of the adjacent lamella axis only overlap from one side of the last lamella axis, whereas in the gaps between the filter lamellae of the preceding lamella axes, filter lamellae of the adjacent lamella axes overlap from both sides. A poor self-cleaning of the last axis impairs the filtering result of the filtering equipment. Problems are caused by solid matter in particular, which tends to adhere to the filter lamellae.

[0016] This problem is, however, eliminated by cleaning lamellae, whereby impurities and solid matter may also be removed efficiently from the filter lamellae of the last lamella axis and transferred to a solid matter outlet or discharge means. The auxiliary axis is preferably rotated faster than the lamella axes.

[0017] According to Figures 1B and 1D, in front of the filter lamellae and the first lamella axis 4 in the flow direction of a liquid or material to be filtered there are fixed lamellae 32 mounted at a distance from one another and leading the material to be filtered to the filter lamellae 6 rotating on the lamella axes 4. The fixed lamellae 32 are mounted preferably detachably on the holder 28 and/or the filter frame 2, in which case they may be detached from the filter for cleaning.

[0018] The filter is also provided with flow guides, the purpose of which is to equalize and diminish the flow pressure of the filtering material to be supplied through the inlet conduit 22 to the filter, directed to the filter lamellae. The flow guides are provided close to the inlet conduit 22 in such a manner that flow of the filtering material or liquid to be supplied to the filter can be guided immediately when it enters into the filter. In Figure 1A, the flow guides comprise a first flow guide 18, which turns the flow entering into the filter from the inlet conduit 22 to the opposite direction and away from the filter lamellae, and a second flow guide 20, which, for its part, turns the flow back towards the filter lamellae. Thus, the flow direction is turned twice, whereby its flow intensity decreases considerably and, simultaneously, the flow pressure directed by the flow to the filter lamellae is also reduced. Thereby less solid matter penetrates into and through the gaps between the filter lamellae 6.

[0019] The filter may also be connected with ultrasonic washing means in such a manner that ultrasound may be utilized while the filtering equipment is washed. The ultrasonic washing means may also constitute a part of the rest of the washing system. Ultrasonic washing and other washing may be arranged to be automatic and occur at predefined intervals or it may be
performed whenever necessary. In ultrasonic washing, an oscillator converts electric energy into sound waves of 30 kHz/1 kW, for example. Such ultrasonic washing may last for 20 minutes, for instance, and it may be performed after preliminary washing by using water or some other liquid, such as a lye-bearing washing agent, as a medium.

[0020] Figures 2 to 8 show the principle of the filter lamella operation 6 when the filter is in use. The figures illustrate the positions of the filter lamellae 6 in stages as they rotate clockwise during the filter use. In accordance with Figures 2 to 8, an intermediate lamella 5 is mounted between the adjacent cleaning lamellae 6 on the same lamella axis 4. The size of the intermediate lamella 5 is smaller than that of the filter lamella and its thickness substantially corresponds to the thickness of the filter lamella 6 in a preferred embodiment, whereby the distance between the adjacent filter lamellae 6 is a bit longer than the thickness of the filter lamella 6. Alternatively, the thickness of the intermediate lamella 5 may be greater than the thickness of the filter lamella when it is desired that the size of the filter gap defined by the distance between the adjacent filter lamellae 6 would be bigger. If desired, the thickness of the intermediate lamella 5 may also be smaller than the thickness of the filter lamella, because a rotational clearance of 0.1 to 0.15 mm is typically used between the filter lamellae 6 and/or the intermediate lamellae 5. As stated above, it is possible to provide a desired distance between the adjacent filter lamellae by using an intermediate lamella. The intermediate lamellae 5 are arranged to be rotated together with the filter lamellae 6 on the lamella axis 4.

[0021] The intermediate lamellae 5 are positioned in the filter in such a manner that the intermediate lamella 5 between the adjacent filter lamellae 6 of the lamella axis 4 is arranged to extend between the lamella axis 4 and the filter lamella 6 overlapping between said adjacent filter lamellae 6. In other words, the intermediate lamella 5 extends between the adjacent filter lamellae, where also the filter lamella 6 of the adjacent lamella axis 4 overlaps. In this case, the intermediate lamella 5 and the overlapping filter lamella 6 fill the filter gap between the adjacent filter lamellae. The better or the more complete this filter gap is filled while the filter lamellae 6 overlap the filter rotate, the denser the filtering surface of the filter becomes, and it is capable of achieving an even better filtering result. Also, the intermediate lamellae 5 prevent the gap between the adjacent filter lamellae 6, i.e. the filter gap, from growing and stiffen the structure of the filter lamellae or the filter lamella zone.
[0022] When round filter lamellae 6 and intermediate lamellae 5 are used, the filter gap may in practice be blocked entirely, since the outer edges of the round filter lamellae 6 and intermediate lamellae 5 may almost be in contact with one another for the entire revolution because of the rotationally symmetrical shape. In this case, the real filter gap is formed by the rotational clearance between the filter lamellae 6 and/or the intermediate lamellae 5, which is smaller than the above-mentioned filter gap. The aforementioned preferred solution is, however, not implemented when the filter lamellae are oval, rectangular or have a shape other than round.

[0023] In the case according to Figures 2 to 8, it is shown by way of example that the filter lamellae 6 have a substantially rectangular shape. As can be seen from these figures, the distance of the outer edge, or tip, of the filter lamellae from the adjacent lamella axis 4 changes while the filter lamella 6 rotates. When the intermediate lamella 5 between the adjacent filter lamellae 6 of the lamella axis 4 is arranged to extend between the lamella axis 4 and the filter lamella 6 overlapping between said adjacent filter lamella 6, a gap 7 is formed between the filter lamellae 6 and the intermediate lamella 5 in specific rotation positions, as shown in Figures 2, 3, 4 and 8. The gap 7 is different in different rotation positions. To minimize the gap 7, the intermediate lamella 5 between the adjacent filter lamellae 6 is shaped such that the gap 7 between the outermost edge of the intermediate lamella 5 and the outermost edge of the filter lamella 6 overlapping between said adjacent filter lamellae 6 can be substantially minimized in the course of the revolution of the filter lamellae 6. The gap 7 is preferably not minimized in a specific position but the purpose is to minimize the cumulative gap 7 in the course of the entire revolution. In this case, the intermediate lamella 5 may be formed such that between the adjacent filter lamellae 6 its shape substantially corresponds to the orbit of the outermost edge of the adjacent filter lamella 6 overlapping between the adjacent filter lamellae 6 at least on a part of the revolution of the filter lamellae 6. This can be seen in Figures 5, 6 and 7, where the outermost edge of the filter lamella 6 travels along the outermost edge of the intermediate lamella 5.

[0024] In the embodiment of Figures 2 to 8, the filter lamellae 6 have a substantially rectangular shape and the intermediate lamellae 5 have a substantially oval or elliptical shape. The intermediate lamellae 5 are also mounted on the lamella axis 4 in such a manner that their longitudinal axis is substantially parallel to the longitudinal direction of the filter lamellae 6. The
gap 7 may thus be efficiently minimized in the course of the revolution of the filter lamellae 6 and the intermediate lamella 5. The filter gap between the adjacent filter lamellae 6 may thus be minimized, in other words filled, as efficiently as possible in the course of the revolution, which means that the rotational clearance to an increasing degree covers the filter gap between the lamellae, stopping the solid matter particles. With this change in the filter gap, a bed of solid matter can be formed faster from finer solid matter particles on top of the filter lamellae, whereby solid material of a specific size passes through, the bigger material does not. The passing material can thus be separated from the material that remains on the filter element and has to be transferred away. In particular, this provides the advantage that the filter may be used for separating materials or products having a smaller size than before. In addition, the oval shape of the intermediate lamellae, in accordance with the invention, provides the filter lamellae with a longitudinal support.

[0025] It is obvious to a person skilled in the art that the desired end product of the material to be filtered may be either a filtered liquid or solid matter, depending on the material to be filtered.

[0026] It is obvious to a person skilled in the art that, as technology advances, the basic idea of the invention may be implemented in various ways. The invention and the embodiments thereof are thus not restricted to the above examples but may vary within the scope of the claims.
CLAIMS

1. A filter device comprising a frame (2), rotatable lamella axes (4) positioned at the frame (2) at a distance from one another, filter lamellae (6) positioned on the lamella axes (4) next to one another at a distance and arranged in such a manner that the filter lamellae (6) on the adjacent lamella axes (4) are arranged to overlap at least partly, whereby a liquid or material to be filtered is arranged to pass between the filter lamellae (6), characterized in that intermediate lamellae (5) are mounted in the gaps between the adjacent filter lamellae (6) to provide a distance between the adjacent filter lamellae (6) and to clean the gap between the adjacent filter lamellae (6).

2. A filter device as claimed in claim 1, characterized in that the thickness of the intermediate lamellae (5) is arranged such that the distance between the adjacent filter lamellae (6) substantially corresponds to the thickness of the filter lamella (6).

3. A filter device as claimed in claim 1 or 2, characterized in that the thickness of the intermediate lamella (5) substantially corresponds to the thickness of the filter lamella (6), whereby the distance between the adjacent filter lamellae (6) is a bit longer than the thickness of the filter lamella (6).

4. A filter device as claimed in any one of the preceding claims 1 to 3, characterized in that the intermediate lamellae (5) are arranged to be rotated together with the filter lamellae (6) on the lamella axis (4).

5. A filter device as claimed in any one of the preceding claims 1 to 4, characterized in that the size of the intermediate lamellae (5) is smaller than that of the filter lamellae (6).

6. A filter device as claimed in any one of the preceding claims 1 to 5, characterized in that the intermediate lamella (5) between the filter lamellae (6) adjacent to the lamella axis (4) is arranged to extend between the lamella axis (4) and the filter lamella (6) overlapping between said adjacent filter lamellae (6).

7. A filter device as claimed in any one of the preceding claims 1 to 6, characterized in that the intermediate lamella (5) between the adjacent filter lamellae (6) is shaped in such a manner that a gap (7) between the outermost edge of the intermediate lamella (5) and the outermost edge of the filter lamella (6) overlapping between said adjacent filter lamellae (6) can be substantially minimized in the course of the revolution of the filter lamellae (6).
8. A filter device as claimed in any one of the preceding claims 1 to 7, characterized in that the intermediate lamella (5) is shaped in such a manner that between the adjacent filter lamellae (6) its shape substantially corresponds to the orbit of the outermost edge of the adjacent filter lamella (6) overlapping between the adjacent filter lamellae (6) on at least part of the revolution of the filter lamellae (6).

9. A filter device as claimed in any one of the preceding claims 1 to 8, characterized in that the filter lamellae (6) have a substantially rectangular shape.

10. A filter device as claimed in claim 9, characterized in that the intermediate lamellae (5) have a substantially oval shape.

11. A filter device as claimed in claim 10, characterized in that the intermediate lamellae (5) are mounted on the lamella axis (4) in such a manner that their longitudinal axis is substantially parallel to the longitudinal direction of the filter lamellae (6).

12. A filter device as claimed in any one of the preceding claims 1 to 11, characterized in that the intermediate lamellae (5) are arranged to prevent the gap between the adjacent filter lamellae (6) from growing and to stiffen the structure of the filter lamellae.
INTERNATIONAL SEARCH REPORT

International application No. PCT/FI2008/050216

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: BOID

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 database consulted during the international search (name of database and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>MO 9833574 A1 (MEIKO OY), 6 August 1998 (06.08.1998)</td>
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D. Further documents are listed in the continuation of Box C. [x] See patent family annex.

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