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(71) Applicant: **OUTOTEC (FINLAND) OY** [FI/FI]; Rauhalanpuisto 9, 02230 Espoo (FI).

(72) Inventors: **VÄNTTINEN, Kari**; Vehaksenkuja 6, 02330 Espoo (FI). **ILLI, Mika**; Marmoritie 4 B 1, 01700 Vantaa (FI). **HINDSTRÖM, Rolf**; Alokkaantie 9, 20810 Turku (FI).

(74) Agent: **KOLSTER OY AB**; (Iso Roobertinkatu 23), P.O.Box 148, 00121 Helsinki (FI).

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Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

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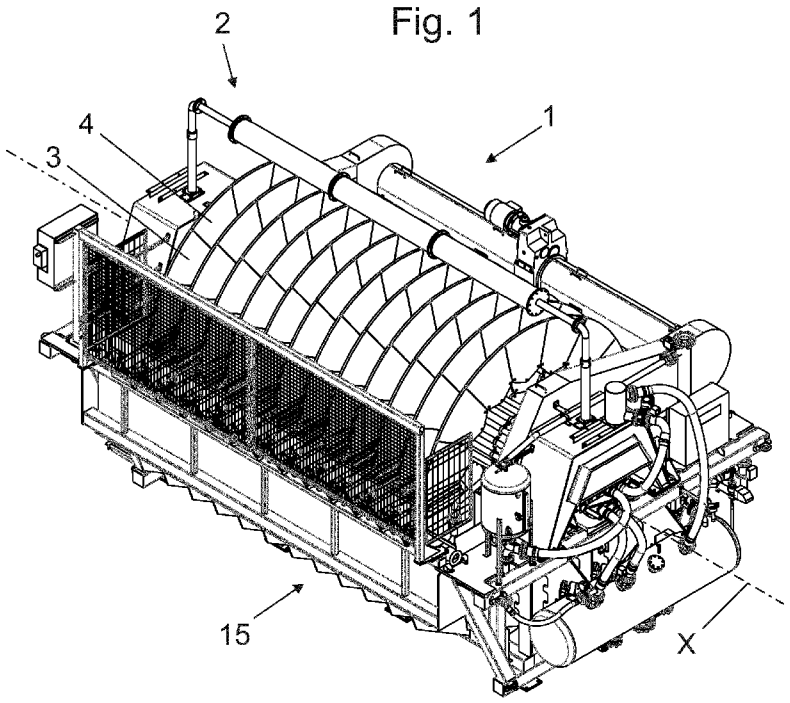
(54) Title: FILTER ELEMENT WITH CONDUCTIVE BREAKING INDICATOR

Fig. 1



(57) Abstract: A filter element of a disc filter apparatus, a disc filter apparatus, and a method. The filter element comprises filter members on both sides of the element, and the filter member comprises a microporous permeable membrane layer. The filter member is formed to cause a capillary phenomenon in a filtering process. The filter element has outer edge surface comprising said microporous material, and a porous substrate arranged between the filter members. The filter element further comprises an elastic layer arranged on a peripheral outer edge surface of the filter element and covering the microporous material on said peripheral outer edge surface.

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Published:

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FILTER ELEMENT WITH CONDUCTIVE BREAKING INDICATOR

Background

The invention relates to a filter element of a disc filter apparatus, the filter element comprising filter members on both sides of the element, the filter member comprising a microporous permeable membrane layer, the filter member formed to cause a capillary phenomenon in a filtering process, the filter element having outer edge surface comprising said microporous material, and a porous substrate arranged between the filter members.

The invention further relates to a disc filter apparatus comprising one or more consecutive co-axial filter disc(s) with sectors formed by a plurality of the filter elements.

The invention still further relates to a method for regeneration of a disc filter apparatus.

Filtration is a widely used process whereby a slurry or solid liquid mixture is forced through a filter member, with the solids retained on the filter member, as a cake, and the liquid phase passing through. This process is generally well understood in the industry. Examples of filtration types include depth filtration, pressure and vacuum filtration, and gravity and centrifugal filtration.

The cake formation in vacuum filtration is based on generating suction within the filtrate channels. The most commonly used filter members for vacuum filters are filter cloths and coated media, e.g. the ceramic filter members. These filter members are commonly used in filter apparatuses having filter comprising multiple filter elements, e.g. in rotary vacuum disc filter apparatuses.

Rotary vacuum disc filters are used for the filtration of relatively free filtering suspensions on a large scale, such as the dewatering of mineral concentrates. The dewatering of mineral concentrates requires large capacity in addition to producing a cake with low moisture content. Such large processes are commonly energy intensive and means to lower the specific energy consumption are needed. The vacuum disc filter may comprise a plurality of filter discs arranged in line co-axially and around a central pipe or shaft. Each filter disc may be formed of a number of individual filter elements or sectors, called filter plates, that are mounted circumferentially in a radial plane around the central pipe or shaft to form the filter disc, and as the shaft is fitted so as to

revolve, each filter plate or sector is, in its turn, displaced into a slurry basin and further, as the shaft of rotation revolves, rises out of the basin. When the filter member is submerged in the slurry basin where, under the influence of the vacuum, the cake forms onto the medium. Once the filter sector or plate comes out of the basin, the pores are emptied as the cake is deliquored for a predetermined time which is essentially limited by the rotation speed of the disc. The cake can be discharged by a back-pulse of air or by scraping, after which the cycle begins again. Whereas the use of a cloth filter medium requires heavy duty vacuum pumps, due to vacuum losses through the cloth during cake deliquoring, the ceramic filter member, when wetted, does not allow air to pass through, which further decreases the necessary vacuum level, enables the use of smaller vacuum pumps and, consequently, yields significant energy savings.

The filter element is affected by slurry particles and extraneous compounds, especially in the field of dewatering of mineral concentrates. Therefore, the filter elements have to be regenerated. The filter element is periodically regenerated with the use of one or more of three different methods, for example: (1) backwashing, (2) ultrasonic cleaning, and (3) acid washing. Whereas the regenerative effect of backwashing and ultrasound are more or less mechanical, regeneration with acids is based on chemistry.

The regeneration with acids is performed by applying acid, i.e. typically acid-water –compound, by elevated pressure or positive pressure created in a backwashing equipment inside the filter element. However, the pressure used in the regeneration may create cracks or crazes or expand already existing cracks or crazes in the microporous material. The acid may spurt or spray through the cracks out from the filter element and, in some circumstances, may create a risk for operators of the apparatus to be exposed to the acid.

This risk is highest regarding cracks in the area of a peripheral outer edge surface of the filter element are, because acid spray is directed there outwards from the filter element, i.e. in direction where the operators typically are working. It is to be noted, however, that the probability to the acid spurts or sprays is practically very low, but there is still a need for further increase already high user safety by protecting the operators from potential acid leakages.

Brief description

Viewed from a first aspect, there can be provided a filter element of a disc filter apparatus, the filter element comprising filter members on both sides of the element, the filter member comprising a microporous permeable membrane layer, the filter member formed to cause a capillary phenomenon in a filtering process, the filter element having outer edge surface comprising said microporous material, and a porous substrate arranged between the filter members, the filter element further comprising an elastic layer arranged on a peripheral outer edge surface of the filter element and covering the microporous material on said peripheral outer edge surface.

Thereby a filter element the use of which is safe may be achieved.

Viewed from a further aspect, there can be provided a disc filter apparatus, comprising one or more consecutive co-axial filter disc(s) with sectors formed by a plurality of filter elements, the filter arranged around a central shaft and being rotatable around longitudinal axis of the central shaft, the filter apparatus, the disc filter apparatus further comprising a filter element of a disc filter apparatus, the filter element comprising filter members on both sides of the element, the filter member comprising a microporous permeable membrane layer, the filter member formed to cause a capillary phenomenon in a filtering process, the filter element having outer edge surface comprising said microporous material, and a porous substrate arranged between the filter members, the filter element further comprising an elastic layer arranged on a peripheral outer edge surface of the filter element and covering the microporous material on said peripheral outer edge surface.

Thereby a disc filter apparatus the use of which is safe may be achieved.

Viewed from a still further aspect, there can be provided a method for regeneration of a disc filter apparatus, the disc filter apparatus comprising the filter element according to any one of claims 1 – 13, the method comprising creating an elevated pressure in the interior space of the filter element by feeding a washing agent into said interior space with a backwashing equipment.

Thereby a method that has a high user safety level may be achieved.

Some other embodiments are characterised by what is stated in the claims. Inventive embodiments are also disclosed in the specification and drawings of this patent application. The inventive content of the patent applica-

tion may also be defined in other ways than defined in the following claims. The inventive content may also be formed of several separate inventions, especially if the invention is examined in the light of expressed or implicit subtasks or in view of obtained benefits or benefit groups. Some of the definitions contained in the following claims may then be unnecessary in view of the separate inventive ideas. Features of the different embodiments of the invention may, within the scope of the basic inventive idea, be applied to other embodiments.

Brief description of figures

Some embodiments illustrating the present disclosure are described in more detail in the attached drawings, in which

Figure 1 is a perspective top view of an exemplary disc filter apparatus,

Figure 2 illustrates an embodiment of a disc filter element, and

Figure 3 is another view of the filter element shown in Figure 2.

In the figures, some embodiments are shown simplified for the sake of clarity. Similar parts are marked with the same reference numbers in the figures.

Detailed description

Principles of the embodiments can be applied for drying or dewatering fluid materials in any industrial processes, particularly in mineral and mining industries. In embodiments described herein, a material to be filtered is referred to as a slurry, but embodiments are not intended to be restricted to this type of fluid material. The slurry may have high solids concentration, e.g. base metal concentrates, iron ore, chromite, ferrochrome, copper, gold, cobalt, nickel, zinc, lead and pyrite.

Figure 1 is a perspective top view of an exemplary disc filter apparatus 1. In the disc filter apparatus 1, the actual filter 2 comprises at least one filter disc 3, each of which comprises number of sector-shaped filter elements 4 that are mounted circumferentially in a radial planar plane around the central axis of the disc filter apparatus 1. The number of the filter elements 3 included in a filter disc may be 12 or 15, for example. The number of the filter discs 3 may range from 2 to 20, for example. The diameter of each disc 3 may be ranging from 1.5 m to 4 m, for example. Examples of commercially available disc filters include Ceramec CC filters, models CC-6, CC-15, CC-30,

CC-45, CC-60, CC-96 and CC-144 manufactured by Outotec Inc.

The structure of the filter elements 4 is decribed more detailed later in this description.

As the filter disc 3 rotate, each filter element 4 is, in its turn, displaced into a slurry basin and further, as the rotation continues, rises out of the basin.

Figure 2 is a perspective exploited view of an exemplary disc filter element, and Figure 3 is a view of the filter element shown in Figure 2 assembled.

The filter element 4 comprises filter members 11 on both sides of the element 4. The filter member 11 comprises a microporous permeable membrane layer 7 which is formed to cause a capillary phenomenon in the filtering process. There is a porous substrate 8 arranged between the filter members 11, the material of which may be ceramics. An advantage of the ceramics is good filtering properties and ability to create said capillary phenomenon.

However, due to its nature, the microporous material has susceptibility to brittle fracture.

The filter element 4 is a truncated-sector-shaped filter element 4. Thus it is suitable for use in common disc filter apparatuses.

The filter element 4 has an outer edge surface 12 that circulates around the element 4. This outer edge surface 12 also comprises the microporous material. The part of the outer edge surface 12 lying in the wider end of the truncated-sector-shaped filter element 4 is the peripheral outer edge surface 9 of the filter element 4.

The filter element 4 further comprises an elastic layer 13 arranged on the peripheral outer edge surface 9. The elastic layer 13 may be attached to the peripheral outer edge surface 9 by e.g. gluing, vulcanizing, welding etc.

The elastic layer 13 covers at least part of the microporous material on said peripheral outer edge surface 9. The elastic layer has a solid structure, i.e. there are no holes extending through the elastic layer 13.

In an embodiment the elastic layer 13 may comprise thermoplastic material. An advantage is that thermoplastic materials are usually easy to convert into shape of product, i.e. the manufacturing process of the elastic layer 13 is easy.

In another embodiment, the elastic layer 13 may comprise thermo-

set material. An advantage is that thermoset materials have usually good chemical and mechanical properties.

In an embodiment, the elastic layer 13 is made of rubber. An advantage is that rubber has good elastic properties.

The elastic layer 13 may be an independent and stand-alone layer or element, or alternatively, it may be combined with another layer or element that may have a non-elastic nature. Furthermore, the elastic layer 13 may comprise one or multiple layers of elastic material(s).

In an embodiment, the length of the elastic layer 13 is 90 % - 100 % of the length of the peripheral outer edge surface 9. The elastic layer 13 being less than 100 % of said dimension may be arranged symmetrically or asymmetrically with respect to the width of the peripheral outer edge surface 9.

In another embodiment, the width of the elastic layer 13 is 90 % - 100 % of the width of the peripheral outer edge surface. The elastic layer 13 being less than 100 % of said dimension may be arranged symmetrically or asymmetrically with respect to the width of the peripheral outer edge surface 9.

An advantage is that the protection against leakages through cracks in peripheral outer edge surface 9 is good enough when 90 % of the length or the width is covered, and very good when 100 % of the peripheral outer edge surface 9 is covered. Thus the user safety may be increased.

In an embodiment, the thickness of the elastic layer 13 is 2 mm – 9 mm, preferably 3 mm – 5 mm. The elastic layer of this thickness may assure that at least typical jet/flush of washing agent does not penetrate through elastic layer 13.

In an embodiment, the filter element 4 comprises an indicator 5 arranged to generate a break indication upon breakage of the filter element 4. At least a portion of the indicator 5 may be arranged on the microporous material on the peripheral outer edge surface 9 and under the elastic layer 13. Other portions, if any, of the indicator 5 may extend along the filter element 4 to form a continuous circuit and arranged to break upon breakage of the filter element 4.

The indicator 5 may increase user safety by creating the break indication, such as visual and/or audible alarm, in case the filter element 4 is breaking or crazing. This way operators of the apparatus are able to be vigilant and avoid thus potential safety risks caused e.g. by spurting or spraying acid. In other words, the user safety is assured two ways: firstly by the elastic layer

13 that increases the passive safety of the filter process, and secondly by actively functioning indicator 5 that gives the alarm. In an embodiment, as a consequence of the break indication, the control system of the filter apparatus is arranged to stop automatically the filter apparatus.

In an embodiment, the indicator 5 comprises an electrically conductive layer, e.g. a printed electric wire, a casted electric wire, a microstrip line, separate electric wire, a metal tape or a painted electric circuit, for example.

The indicator 5 may be attached to the microporous material by a brittle adhesive. An advantage is that the development of a break or craze comes across to the indicator 5 without substantive dampening.

There is an interior space defined between the opposed filter members 11, i.e. in the substrate 8

The interior space provides a flow canal or canals where a negative pressure is maintained, i.e. a pressure difference is maintained over the filter members 11, during the filtration process. Under the influence of the negative pressure, the cake forms onto the filter members 11.

In a regeneration stage performed by washing agent, e.g. acid or acid-water composition is fed into the interior space with a certain backwashing pressure. The regeneration stage is performed by backwashing equipment 15 comprising e.g. necessary pumps, washing agent containers, and feeding channels.

In this stage there are used regeneration means of the filter apparatus 1. The objective of the acid washing is to remove impurities etc. attached to the filter members 11 and micropores therein back and out from the filter members.

The backwashing pressure creates an elevated or positive pressure in the interior space. The positive pressure may create such cracks and crazes in the brittle microporous material that the acid leaks out form the filter element 4. Especially problematic, or even dangerous, to users of the filter apparatus are spray- or spurt-like leaks in the peripheral outer edge surface 9. Now, the elastic layer 13 arranged on the peripheral outer edge surface 9 prevents or at least restrains these leaks so that the safety of the personnel can be improved.

In an embodiment, the filter element comprises an RFID tag 14 that includes the identification data of the filter element 4. The RFID tag 14 can be arranged under the elastic layer 13, thus the RFID tag is protected against mechanical wear and chemical stresses. The peripheral outer edge surface 9 is

usually an advantageous place for the RFID tag because it can be read there easily by RFID reader arranged in a frame of the filter apparatus.

The invention is not limited solely to the embodiments described above, but instead many variations are possible within the scope of the inventive concept defined by the claims below. Within the scope of the inventive concept the attributes of different embodiments and applications can be used in conjunction with or replace the attributes of another embodiment or application.

The drawings and the related description are only intended to illustrate the idea of the invention. The invention may vary in detail within the scope of the inventive idea defined in the following claims.

Reference symbols

1	filter apparatus
2	filter
3	filter disc
4	filter element
5	indicator
7	membrane layer
8	substrate
9	peripheral outer edge surface
11	filter member
12	outer edge surface
13	elastic layer
14	RFID tag

CLAIMS

1. A filter element of a disc filter apparatus, the filter element comprising filter members on both sides of the element,

the filter member comprising a microporous permeable membrane layer, the filter member formed to cause a capillary phenomenon in a filtering process,

the filter element having outer edge surface comprising said microporous material, and

a porous substrate arranged between the filter members, the filter element further comprising

an elastic layer arranged on a peripheral outer edge surface of the filter element and covering the microporous material on said peripheral outer edge surface,

the filter element comprises an indicator arranged to generate a break indication upon breakage of said filter element, and at least a portion of the indicator is arranged on the microporous material on the peripheral outer edge surface and under the elastic layer, and that

the portion of the indicator is attached to the microporous material by a brittle adhesive.

2. The filter element according to claim 1, being a truncated-sector-shaped filter element, and the peripheral outer edge surface being situated in the wider end of the truncated-sector-shaped filter element.

3. The filter element according to claim 1 or 2, wherein the microporous material has susceptibility to brittle fracture.

4. The filter element according to any one of the preceding claims, wherein the microporous material is ceramic.

5. The filter element according to any one of the preceding claims, wherein the length of the elastic layer is 90 % – 100 % of the length of the peripheral outer edge surface.

6. The filter element according to any one of the preceding claims, wherein the width of the elastic layer is 90 % – 100 % of the width of the peripheral outer edge surface.

7. The filter element according to any one of the preceding claims, wherein the thickness of the elastic layer is 2 mm – 9 mm, preferably 3 mm – 5 mm.

8. The filter element according to any one of the preceding claims, wherein the elastic layer comprises thermoplastic material.

9. The filter element according to any one of claims 1 – 7, wherein the elastic layer comprises thermoset material.

10. The filter element according to claim 9, wherein the elastic layer is made of rubber.

11. The filter element according to any one of the preceding claims, comprising further an RFID tag that includes the identification data of the filter element, wherein

the RFID tag is arranged under the elastic layer.

12. A disc filter apparatus, comprising one or more consecutive coaxial filter disc(s) with sectors formed by a plurality of filter elements,

the filter arranged around a central shaft and being rotatable around longitudinal axis of the central shaft,

the disc filter apparatus further comprises the filter element according to any one of the preceding claims.

13. The disc filter apparatus according to claim 12, comprising a backwashing equipment for performing backwashing of the filter elements.

14. A method for regeneration of a disc filter apparatus, the disc filter apparatus comprising the filter element according to any one of claims 1 – 11, the method comprising

creating an elevated pressure in the interior space of the filter ele-

ment by feeding a washing agent into said interior space with a backwashing equipment.

15. A filter element of a disc filter apparatus, the filter element comprising filter members on both sides of the element,

the filter member comprising a microporous permeable membrane layer, the filter member formed to cause a capillary phenomenon in a filtering process,

the filter element having outer edge surface comprising said microporous material, and

a porous substrate arranged between the filter members, the filter element further comprising

an elastic layer arranged on a peripheral outer edge surface of the filter element and covering the microporous material on said peripheral outer edge surface.

16. The filter element according to claim 15, being a truncated-sector-shaped filter element, and the peripheral outer edge surface being situated in the wider end of the truncated-sector-shaped filter element.

17. The filter element according to claim 15 or 16, wherein the microporous material has susceptibility to brittle fracture.

18. The filter element according to any one of claims 15 - 17, wherein the microporous material is ceramic.

19. The filter element according to any one of claims 15 - 18, wherein the length of the elastic layer is 90 % – 100 % of the length of the peripheral outer edge surface.

20. The filter element according to any one of claims 15 - 19, wherein the width of the elastic layer is 90 % – 100 % of the width of the peripheral outer edge surface.

21. The filter element according to any one of claims 15 - 20, wherein the thickness of the elastic layer is 2 mm – 9 mm, preferably 3 mm – 5 mm.

22. The filter element according to any one of claims 15 - 21, wherein the elastic layer comprises thermoplastic material.

23. The filter element according to any one of claims 15 – 21, wherein the elastic layer comprises thermoset material.

24. The filter element according to any one of claims 22 – 23, wherein the elastic layer is made of rubber.

25. The filter element according to any one of claims 15 – 24, comprising an indicator arranged to generate a break indication upon breakage of said filter element, and at least a portion of the indicator is arranged on the microporous material on the peripheral outer edge surface and under the elastic layer.

26. The filter element according to any of claims 15 - 25, wherein the portion of the indicator is attached to the microporous material by a brittle adhesive.

27. The filter element according to any one of claims 15 - 26, comprising further an RFID tag that includes the identification data of the filter element, wherein

the RFID tag is arranged under the elastic layer.

28. A disc filter apparatus, comprising one or more consecutive coaxial filter disc(s) with sectors formed by a plurality of filter elements,

the filter arranged around a central shaft and being rotatable around longitudinal axis of the central shaft, the filter apparatus,

the disc filter apparatus further comprising the filter element according to any one of the preceding claims.

29. The disc filter apparatus according to claim 28, comprising a backwashing equipment for performing backwashing of the filter elements.

30. A method for regeneration of a disc filter apparatus, the disc fil-

ter apparatus comprising the filter element according to any one of claims 1 – 13 or 15 - 29, the method comprising

creating an elevated pressure in the interior space of the filter element by feeding a washing agent into said interior space with a backwashing equipment.

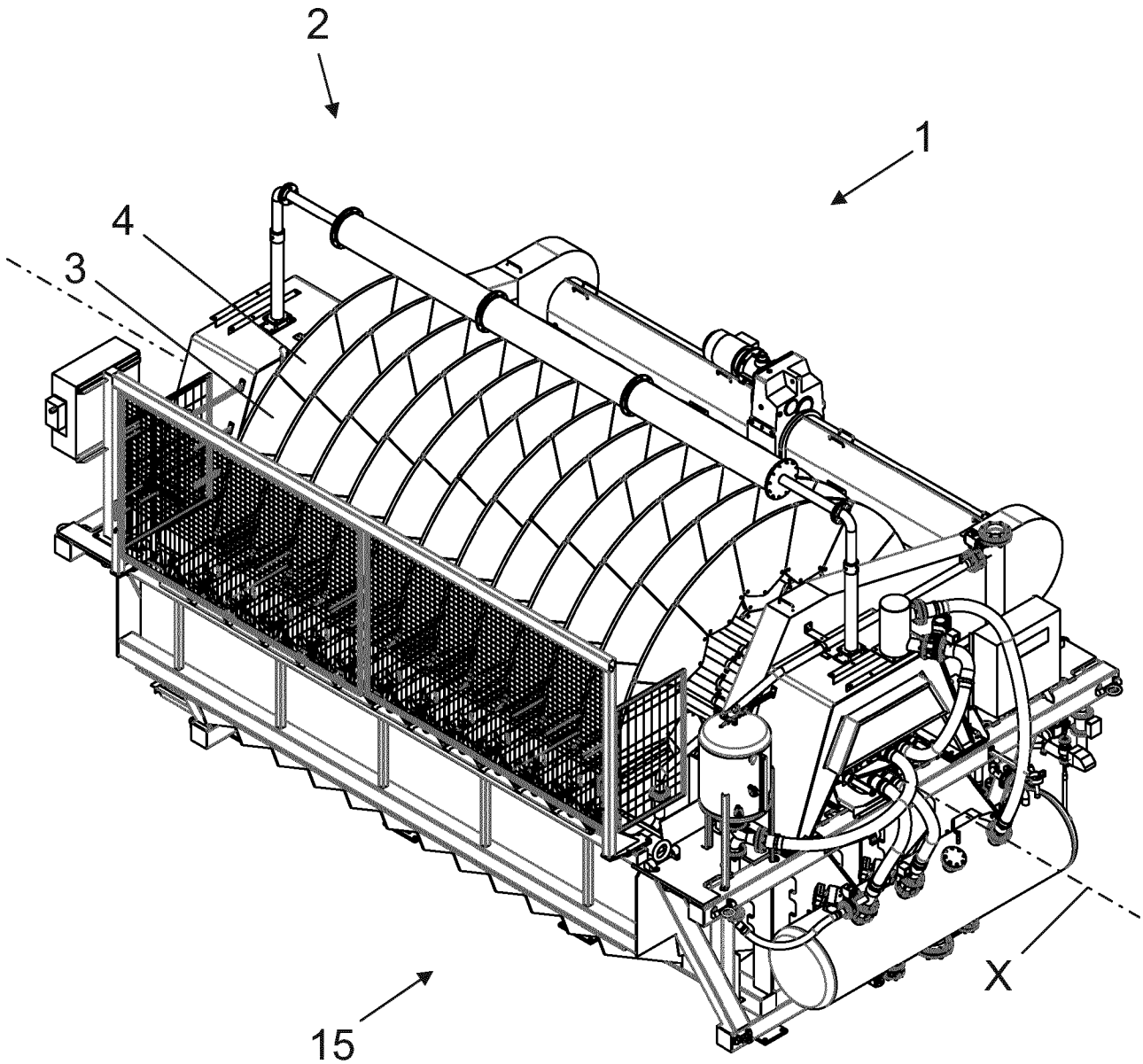

Fig. 1

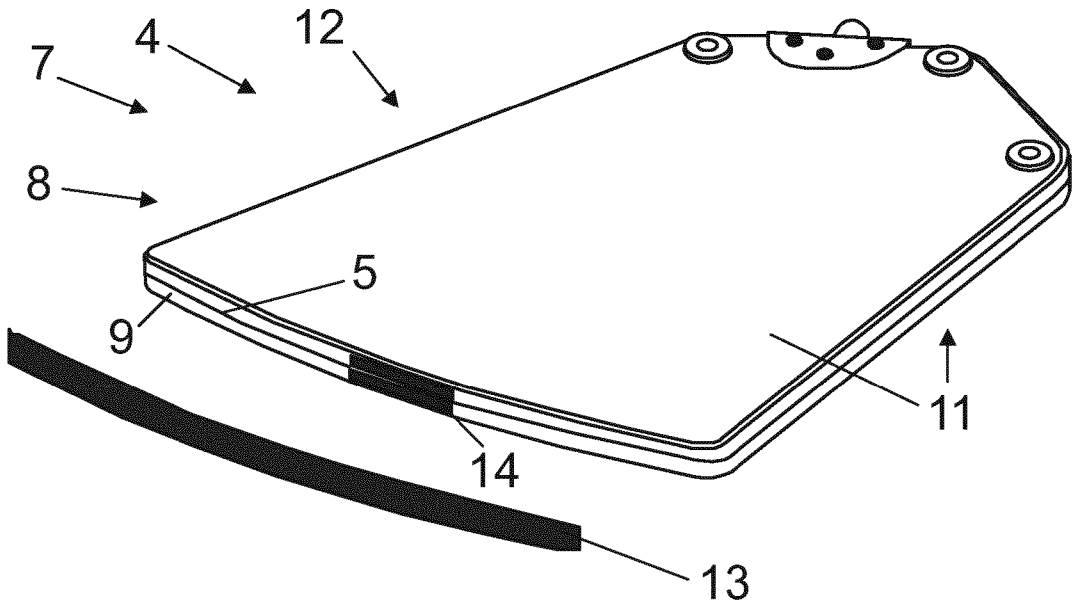

Fig. 2

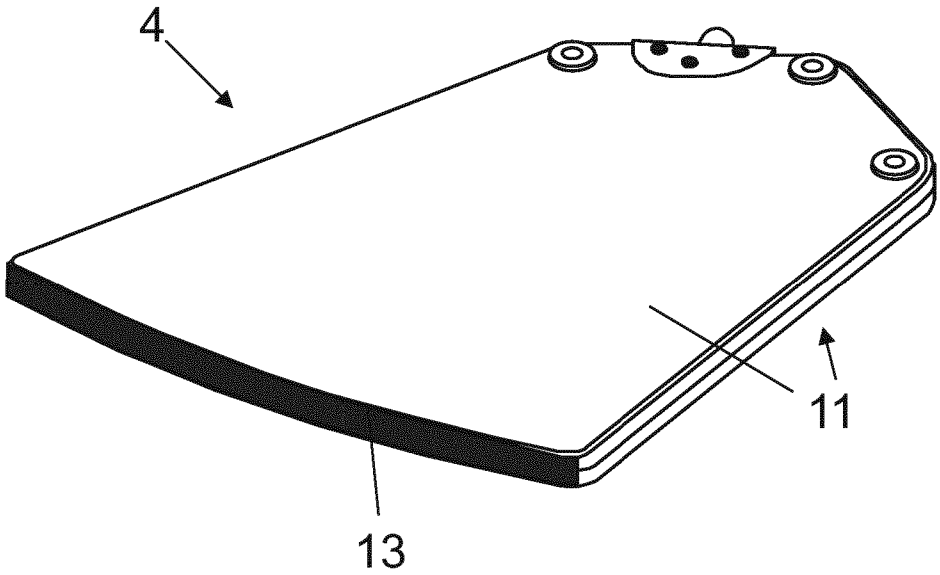

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/FI2016/050478

A. CLASSIFICATION OF SUBJECT MATTER
INV. B01D33/15 B01D33/21 B01D33/23 B01D35/143
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B01D

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	WO 2014/170532 A1 (OUTOTEC FINLAND OY [FI]) 23 October 2014 (2014-10-23) figures 6A, 8B	1-7, 11-21, 25-30 8-10, 22-24

Y A	GB 945 065 A (SIMONACCO LTD) 18 December 1963 (1963-12-18) figure 1	8-10, 22-24 1-7, 11-21, 25-30

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 September 2016	16/09/2016

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

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Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/FI2016/050478

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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1

INTERNATIONAL SEARCH REPORT

Information on patent family members

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