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(54) Title: A FILTER WITH PLEATED METAL FIBER MEDIUM

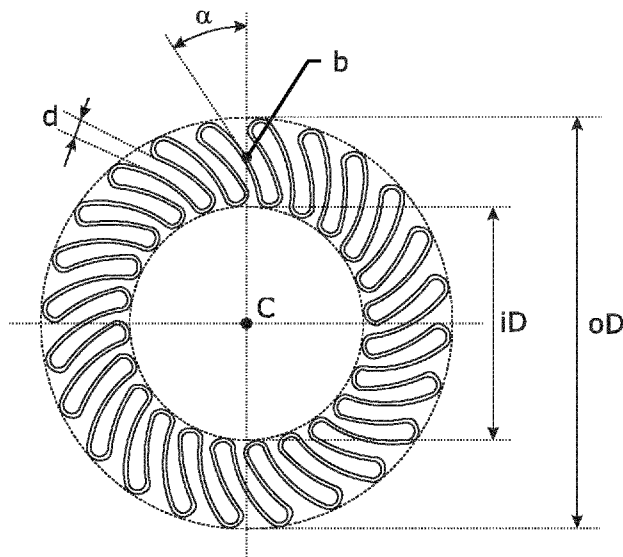


Fig. 2

(57) Abstract: A filter comprises a housing having an inlet and an outlet defining at least one fluid flow path, and a mesh pack being disposed in the housing and in the fluid flow path for filtering a fluid. The mesh pack comprises a metallic filter medium for filtering the fluid, wherein said metallic filter medium is made from a corrugated sheet having a filter medium folded multiple times in a zig-zag manner to form a plurality of pleats. The pleats are homogeneously distributed along the inner surface of the housing and the distance between adjacent pleats is at least 0.5 mm.



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Title: A Filter With Pleated Metal Fiber Medium

Description

Technical Field

[0001] The invention relates to filters for liquid or gas filtration, and in particular to filters with pleated metal fiber medium and the structure of pleated sintered metal fiber medium.

Background Art

[0002] Cylindrical filter elements are among the most common types of filter elements and are used to filter innumerable fluids, i.e., liquids or gases, such as polymer filtration or hot gas filtration. The filtration device for polymer filtration usually comprises filter candle, also named as candle filters or tubular filters.

[0003] For most of the applications for which sintered metal fiber medium is used, it is of importance to provide as much filter medium as possible per volume of filter cartridge in which the medium is used. It is known in the art to pleat sintered metal fiber medium for making pleated medium.

[0004] In a typical cylindrical pleated filter element, a plurality of pleats are arranged around a tubular core to define a cylinder. As viewed in a transverse cross-section, the individual pleats of such a filter element extend radially outward from the core toward the outer periphery of the filter element. It is good design practice to have enough pleats in a cylindrical filter element so that adjoining pleats contact one another along the circumference of the core. As disclosed in US patent no. 5,543,047, a filter element has a plurality of longitudinal pleats, each of the pleats having a pair of legs. Each of the legs has a first surface and a second surface. The pleats are in a laid-over state in which the first surface of each leg is in intimate contact with the first surface of an adjoining leg and the second surface of each leg is in intimate contact with the second surface of an adjoining leg over substantially the entire height of each leg and over a continuous region extending for at least approximately 50% of the axial length of the filter element.

[0005] Each pleat has a height greater than the difference between the outer and inner radius. Because the pleats are in a laid-over state or because the height of each pleat is greater than the difference between the outer and inner radius, the height of the pleats is much larger than that of a conventional filter of the same dimensions. As a result, the surface area of the filter usable for filtration, which is proportional to the pleat height, can be greatly increased. However, this type of filter is not easy to be properly cleaned after each use because the pleats are over-laid.

10 Disclosure of Invention

[0006] It is an object of the present invention to provide a filter which has a filter which has a greater filtering capacity than a conventional filter of the same external dimensions.

[0007] It is a further object of the present invention to provide a filter having pleated filtering elements and a design for better cleaning and prolonged lifetime.

[0008] According to a first aspect of the present invention, it is provided a filter, comprising

- a housing having an inlet and an outlet defining at least one fluid flow path,
- a mesh pack being disposed in the housing and in the fluid flow path for filtering a fluid,

wherein said mesh pack comprises a metallic filter medium for filtering the fluid,

wherein said metallic filter medium is made from a corrugated sheet having a filter medium folded multiple times in a zig-zag manner to form a plurality of pleats, and each pleat has two legs being joined to one another at a crown,

wherein said pleats are homogeneously distributed along the inner surface of the housing and the distance between adjacent pleats is at least 0.5 mm, wherein outer periphery of the mesh pack has a diameter of OD, and inner periphery of the mesh pack has a diameter of ID, the height H of each pleat leg is greater than the distance between the inner and outer peripheries of the mesh pack, i.e., $H > (OD - ID)/2$,

and in a cross-section of said filter

wherein said each pleat leg is in straight form and an angle is formed between a pleat leg and a line through the center of said filter and the midpoint of said pleat leg, said angle being in a range of 45 degree to 80 degree, or

5 wherein said each pleat leg is in convex form and an angle is formed between a tangent to said pleat leg at the midpoint of said pleat leg and a line through the center of said filter and the midpoint of said pleat leg, said angle being in a range of 45 degrees to 80 degrees.

[0009] According to the invention, each pleat has two legs being joined to one
10 another at a crown. The height of pleat refers to the shortest distance between two adjacent crowns which are connected by a same pleat leg. According to the invention, because the height of each pleat is greater than the difference between outer periphery of the mesh pack and inner periphery of the mesh pack, the height of the pleats is much larger than that
15 of a conventional filter of the same dimensions. As a result, the surface area of a filter according to the present invention usable for filtration, which is proportional to the pleat height, can be greatly increased resulting in a longer lifetime.

[0010] The filter has a plurality of longitudinal pleats. Each of the pleats has a pair
20 of legs. The legs may have a straight form or a convex form. According to the invention, the pleats are homogeneously distributed along the inner surface of the housing. Importantly, the pleats have a distance between adjacent ones. Herein, the distance between adjacent pleats is the shortest length between adjacent pleats which are joined by a same pleat leg. The
25 distance is at least 0.5 mm, e.g., from 0.5 to 1 mm. As examples, the distance can be 0.5 mm, 0.7 mm, 0.9 mm, 1.0 mm, 1.2 mm, or 1.5 mm.

[0011] A filter may have a hollow center and a cylindrical outer periphery. It can be used for outside-in flow in which a fluid to be filtered flows from the outer periphery through the filter into the hollow center, or it can be used for insid-
30 out flow in which fluid flows from the hollow center through the filter to the outer periphery.

[0012] The medium or fluid, e.g., liquid or gas, flows through the filter element and the dirt particles are retained and the cleaned medium or fluid reaches the

filter outlet. When the differential pressure reaches a certain value, the differential pressure indicator transmits a signal to the control system, which triggers the cleaning process. During cleaning, e.g., backflushing, the dirt particles are flushed off of the filtration surface by filtered fluid reversal of flow (own medium or through external flush medium, compressed air or service water).

[0013] The present invention has great advantages in view of these cleaning process. Thanks to the “open” pleat construction. The filter medium can be properly cleaned within short time. Moreover, the lifetime of the filter medium is prolonged since it can survive from more cleaning cycles. In the prior art, the pleats of over-pleated filter medium have intimate contact with each other, as disclosed in US patent no. 5,543,047. In comparison, the invention filter mesh pack has an open structure so that the filter can be relatively easily and properly cleaned. Thus, the lifetime of the invention filter is significantly longer than conventional ones. It has been tested and verified that the invention filter can survive for at least 20 times normal cleaning. The invention filter can even survive for a few times of intensive backflush cleaning. Our experiments shows that the invention filter is still in good function after 3 to 5 times backflush in addition to 15 to 20 times normal cleaning. The filter medium of the present invention can have at least 80% cleaned functional area after 20 times cleaning.

[0014] In order to have an optional cleaning, it is important to design the configuration of the pleats. On top of keeping distance between adjacent pleats, a “pleat angle” is also crucial. Depending on the form of the pleat leg, the “pleat angle” is defined. When the pleat leg is in straight form, a pleat angle is formed between a pleat leg and a line through the center of said filter and the midpoint of said pleat leg. When the pleat leg is in convex form, a pleat angle is formed between a tangent to said pleat leg at the midpoint of said pleat leg and a line through the center of said filter and the midpoint of said pleat leg. Either the pleat leg in straight form or in convex form, in order to achieve an optimal cleaning, the pleat angle according to the invention is in a range of 45 degrees to 80 degrees. Preferably, the pleat angle is in a range of 50 to 70 degrees. Although when the pleat angle is

more than 45 degrees, the obstruction during cleaning is high, the media has high area for filtration. However, when the pleat angle is more than 80 degrees, the pleats have the possibility to cover each other and thus hamper backflushing.

5 [0015] In order to keep the form of pleat legs or to have robust pleat legs, the pleats preferably have certain strength and hardness. Thus, the metallic filter medium, which is used to form pleats, preferably have a required thickness. For instance, the metallic filter medium of the invention can have a thickness in the range of 0.5 to 5 mm. For instance, the metallic filter medium has a
10 thickness of 3 mm.

[0016] With respect to the shape of pleats, the two legs of each pleat preferably have equal height prior to being formed in to a laid-over state. The pleats are preferably extended in an arcuate manner from a radial inner periphery towards a radial outer periphery of the filter candle. The two legs are
15 connected by a crown which can have a radius of curvature e.g., in a range of 0.5 to 1 mm.

[0017] The filter medium of the present invention can be a mesh pack. The outer periphery of the mesh pack can have a diameter OD in a range of 40 to 50 mm, and inner periphery of the mesh pack can have a diameter ID in a
20 range of 25 to 35 mm depending on the applications. Thus, the distance between the outer periphery and the inner periphery of the mesh pack, e.g., $(OD-ID)/2$, is in a range of 2.5 mm to 12.5 mm. The distance between the outer periphery and the inner periphery of the mesh pack is smaller than the height of the pleat leg H of over-laid pleats. The height of the leg H of over-laid pleats can be in a range of 3 to 15 mm.
25

[0018] The fiber medium of the present invention is made from metallic material. Compared with polymeric filtration medium, the metallic fiber medium is robust, and the pleat shape and position can be remained even under intensive force impact during backflush cleaning. The selection of metallic
30 material depends on filtration applications. For filtration of most type of polymer materials, the metallic filter medium can be made from stainless steel 316L or Aluminium. The size of fiber and porosity of the metallic fiber medium can be selected in order to meet the required filtration rate. For

instance, the metallic filter medium can be made from fibers having a diameter in a range of 2 to 50 μm . In an application of filtration, a mesh pack is normally made up by sandwiching fiber medium by a wire mesh at each side of the fiber medium. In the present invention, the mesh pack comprises an outside wire mesh having 50 to 70 meshes per inch and an inside wire mesh having 30 to 40 meshes per inch.

[0019] According to a second aspect of the present invention, it is provided a metallic filter medium for filtering fluid,

wherein said metallic filter medium is made from a corrugated sheet having a filter medium folded multiple times in a zig-zag manner to form a plurality of pleats, and each pleat has two legs being joined to one another at a crown,

wherein said pleats are homogeneously distributed along the inner surface of the housing and the distance between each pleat is at least 0.5 mm,

wherein outer periphery of the mesh pack has a diameter of OD, and inner periphery of the mesh pack has a diameter of ID, the height H of each pleat leg is equal to or greater than the distance between the inner and outer peripheries of the mesh pack, i.e., $H \geq (OD-ID)/2$,

and in a cross-section of said filter

wherein said each pleat leg is in straight form and an angle is formed between a pleat leg and a line through the center of said filter and the midpoint of said pleat leg, said angle being in a range of 45 degrees to 80 degrees, or

wherein said each pleat leg is in convex form and an angle is formed between a tangent to said pleat leg at the midpoint of said pleat leg and a line through the center of said filter and the midpoint of said pleat leg, said angle being in a range of 45 degrees to 80 degrees.

[0020] According to a third aspect of the present invention, it is provided a mesh pack comprising a metallic filter medium for filtering fluid and two wire meshes sandwiching said metallic filter medium as described above. The

metallic filter medium has two sides, and each side of said metallic filter medium has contact with one of the two wire meshes.

Brief Description of Figures in the Drawings

- 5 [0021] Figure 1 is a transverse cross-section view of a portion of a filter in the prior art.
- [0022] Figure 2 shows a schematic cross-sectional view of an invention filter having pleat legs in convex form.
- [0023] Figure 3 shows a schematic cross-sectional view of an invention filter having
10 pleat legs in straight form.

Mode(s) for Carrying Out the Invention

- [0024] A transverse cross-section view of a portion of a filter as disclosed in US
15 patent no. 5543047 is illustrated in Fig. 1. The pleats 10 are over-laid and the pleats legs 11 are in intimate contact with the adjacent ones. Fig. 2 shows a schematic cross-sectional view of an invention filter having pleat legs in convex form. Fig. 3 shows a schematic cross-sectional view of an invention filter having pleat legs in straight form. The pleats are formed from
20 filtration mesh pack and extend in an arcuate manner from a radial inner periphery towards a radial outer periphery of a fiber candle. As an example, the mesh pack comprises an inner support wire mesh, an outer support wire mesh and a non-woven fiber medium in-between the two support wire
25 mesh. As an embodiment, the inner support wire mesh has 37 meshes per inch and the wire has a diameter of 0.2 mm, while the outer support wire mesh has 60 meshes per inch and the wire has a diameter of 0.11 mm.
- [0025] It shows in Fig. 2 and Fig. 3, the outer periphery of the mesh pack has a
30 diameter of OD, and inner periphery of the mesh pack has a diameter of ID, the height H of each pleat leg is greater than the distance between the inner and outer peripheries of the mesh pack, i.e., $H > (OD - ID)/2$. As an example, the outer periphery of the mesh pack OD has a diameter of 48 mm, the inner periphery of the mesh pack has a diameter of 33 mm, and thus the distance between the inner and outer peripheries of the mesh pack is 7.5 mm. The pleat legs can be in convex form or straight form, and the height H of each

pleat leg is more than 7.5 mm, e.g., 8, 9, 10, 11 or 12 mm. The non-woven fiber media between two support wire meshes is made from stainless steel fibers having a diameter of 20 μm . The pleats of the invention mesh pack have a distance d between adjacent ones. The distance can be 0.5 mm, 0.7 mm, 0.9 mm, 1.0 mm, 1.2 mm, or 1.5 mm.

[0026] When the pleat leg is in convex form as shown in Fig. 2, an angle α is formed between a tangent to said pleat leg at the midpoint b of said pleat leg and a line through the center C of said filter and the midpoint b of said pleat leg. The pleat angle can be in a range of 45 degrees to 80 degrees, e.g., 45, 50, 60, 70, or 80 degrees.

[0027] When the pleat leg is in straight form as shown in Fig. 3, an angle is formed between a pleat leg and a line through the center of said filter and the midpoint of said pleat leg. The pleat angle can be in a range of 45 degrees to 80 degrees, e.g., 45, 50, 60, 70, or 80 degrees.

[0028] A filter comprising the above mesh pack was in good function after more than twenty times of normal cleanings, e.g., after 23 or 24 times cleaning. In addition, the filter can also survive after a couple of extra intensive rotating backflush cleaning, e.g., backflush cleaning was applied following every five times normal cleaning.

Claims

1. A filter, comprising

-a housing having an inlet and an outlet defining at least one fluid flow path,
-a mesh pack being disposed in the housing and in the fluid flow path for filtering
5 a fluid,

wherein said mesh pack comprises a metallic filter medium for filtering the fluid,
wherein said metallic filter medium is made from a corrugated sheet having a
filter medium folded multiple times in a zig-zag manner to form a plurality of
pleats, and each pleat has two legs being joined to one another at a crown,

10 wherein said pleats are homogeneously distributed along the inner surface of
the housing and the distance between adjacent pleats is at least 0.5 mm, e.g.,
from 0.5 to 1 mm,

wherein outer periphery of the mesh pack has a diameter of OD, and inner
periphery of the mesh pack has a diameter of ID, the height H of each pleat leg
15 is greater than the distance between the inner and outer peripheries of the mesh
pack, i.e., $H > (OD-ID)/2$,

and in a cross-section of said filter

wherein said each pleat leg is in straight form and an angle is formed between a
pleat leg and a line through the center of said filter and the midpoint of said pleat
20 leg, said angle being in a range of 45 degrees to 80 degrees, or

wherein said each pleat leg is in convex form and an angle is formed between a
tangent to said pleat leg at the midpoint of said pleat leg and a line through the
center of said filter and the midpoint of said pleat leg, said angle being in a range
of 45 degrees to 80 degrees.

25 2. A filter according to claim 1, wherein said metallic filter medium has a thickness
in the range of 0.5 to 5 mm.

3. A filter according to claim 1, wherein said metallic filter medium has a thickness
of 3 mm.

4. A filter according to any one of the preceding claims, wherein said filter has at
30 least 80% cleaned functional area after 20 times cleaning.

5. A filter according to any one of the preceding claims, wherein the two legs of
each pleat have equal height prior to being formed in to a laid-over state.

6. A filter according to any one of the preceding claims, wherein the pleats extend in an arcuate manner from a radial inner periphery towards a radial outer periphery of the fiber.
7. A filter according to any one of the preceding claims, wherein the crown has a
5 radius of curvature in a range of 0.5 to 1 mm.
8. A filter according to any one of the preceding claims, wherein OD is in a range of 40 to 50 mm and ID is in a range of 25 to 35 mm.
9. A filter according to any one of the preceding claims, wherein H is in a range of 3 to 15 mm.
10. A filter according to any one of the preceding claims, wherein the metallic filter
10 medium is made from stainless steel 316L or Aluminium.
11. A filter according to any one of the preceding claims, wherein said metallic filter medium is made from fibers having a diameter in a range of 2 to 50 μm .
12. A filter according to any one of the preceding claims, wherein the mesh pack
15 comprises an outside wire mesh have 50 to 70 meshes per inch and an inside wire mesh having 30 to 40 meshes per inch.
13. A metallic filter medium for filtering fluid,
wherein said metallic filter medium is made from a corrugated sheet having a
filter medium folded multiple times in a zig-zag manner to form a plurality of
20 pleats, and each pleat has two legs being joined to one another at a crown,
wherein said pleats are homogeneously distributed along the inner surface of the housing and the distance between each pleat is at least from 0.5 to 1 mm,
wherein outer periphery of the mesh pack has a diameter of OD, and inner periphery of the mesh pack has a diameter of ID, the height H of each pleat leg
25 is equal to or greater than the distance between the inner and outer peripheries of the mesh pack, i.e., $H \geq (OD-ID)/2$,
and in a cross-section of said filter
wherein said each pleat leg is in straight form and an angle is formed between a pleat leg and a line through the center of said filter and the midpoint of said pleat
30 leg, said angle being in a range of 45 degrees to 80 degrees, or
wherein said each pleat leg is in convex form and an angle is formed between a tangent to said pleat leg at the midpoint of said pleat leg and a line through the

center of said filter and the midpoint of said pleat leg, said angle being in a range of 45 degrees to 80 degrees.

14. A mesh pack, comprising

- a metallic filter medium for filtering fluid according to claim 13, said
5 metallic filter medium having two sides, and
- two wire meshes sandwiching said metallic filter medium, each side of said metallic filter medium having contact with one of the two wire meshes.

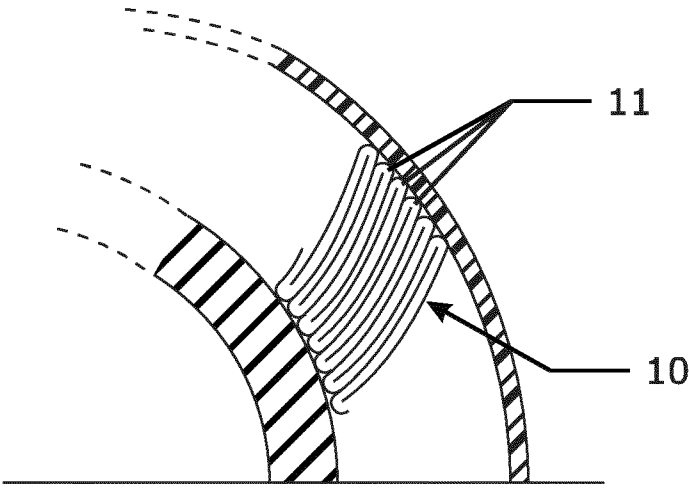


Fig. 1

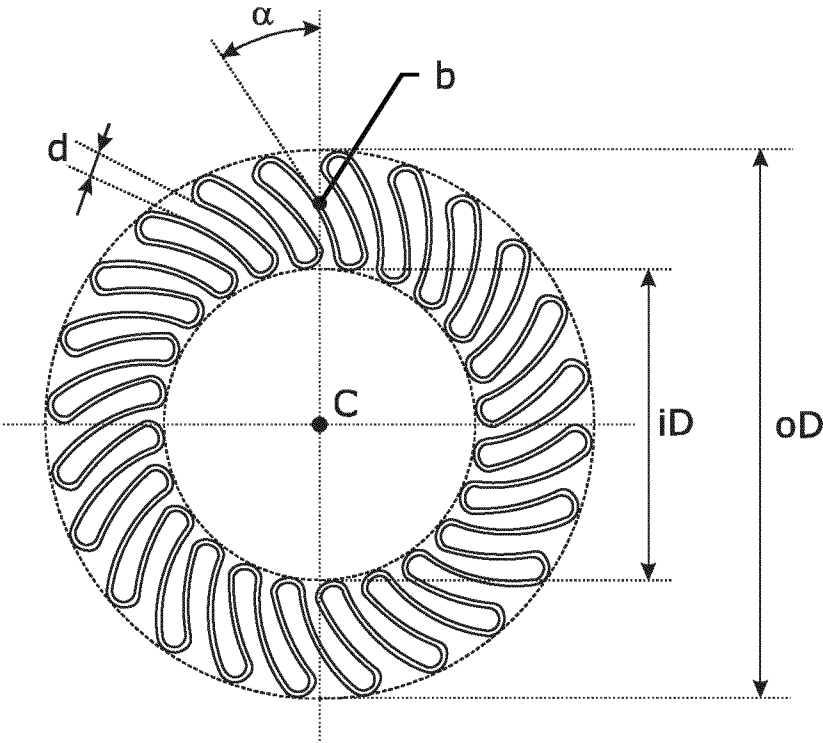


Fig. 2

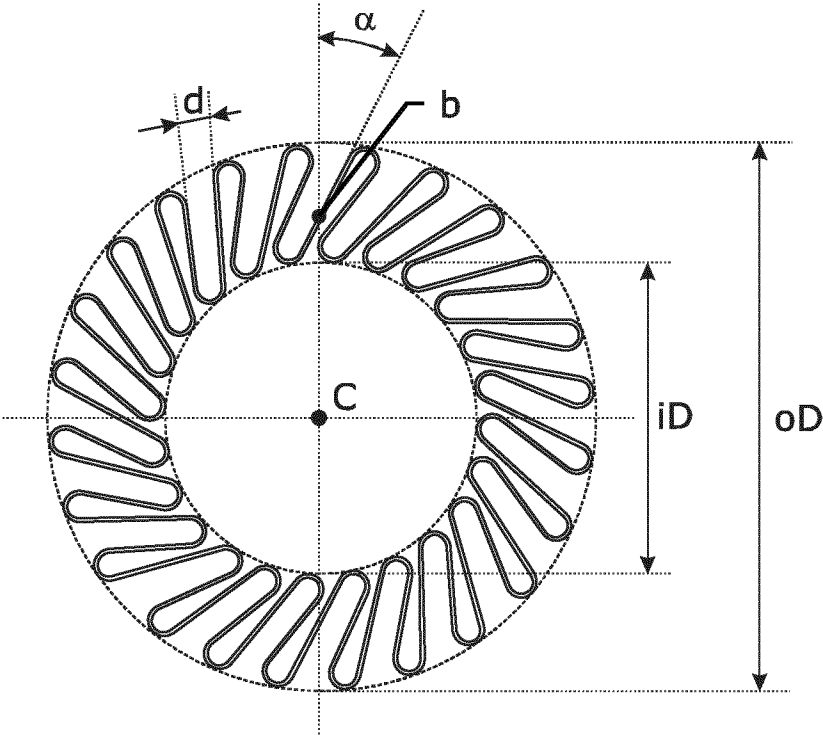


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No

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A. CLASSIFICATION OF SUBJECT MATTER INV. B01D29/11 B01D29/21 B01D29/23 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	WO 2005/094963 A1 (PALL CORP [US]; GUTMAN RICHARD G [GB] ET AL.) 13 October 2005 (2005-10-13) figures 1-14 paragraphs [0028] - [0081] -----	1-14
X	US 2004/238440 A1 (CLEN DENNING MICHAEL ANDREW [US] ET AL) 2 December 2004 (2004-12-02) figures 1-5 paragraphs [0026] - [0056] -----	1-14
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☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
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Date of the actual completion of the international search		Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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