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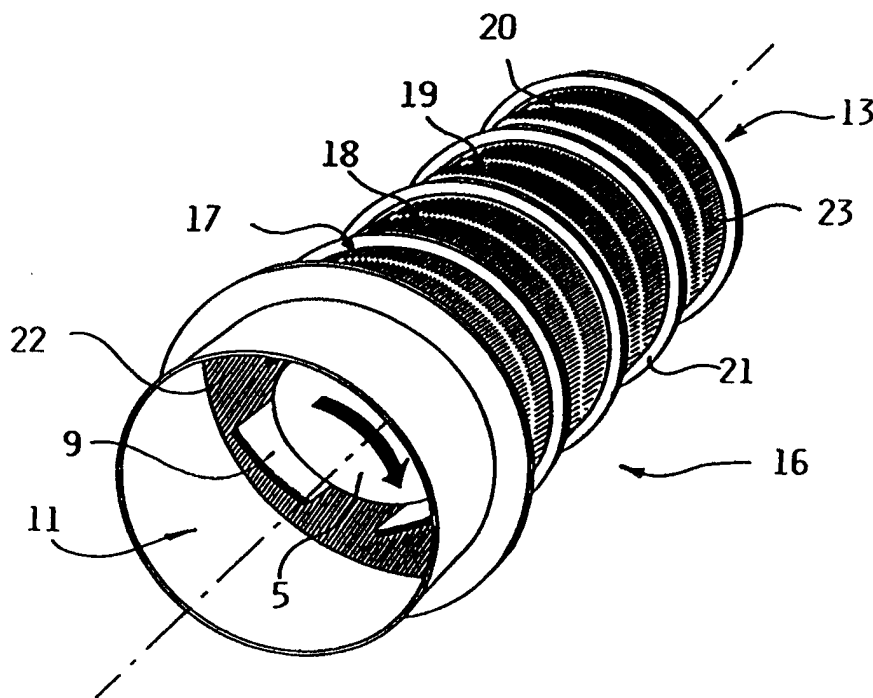
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**(54) Title:** A CYLINDRICAL SCREEN AND A METHOD OF PRODUCING THE SAME

**(57) Abstract**

A cylindrical screen (16) comprises an inlet end (11) for receiving a paper pulp suspension to be separated from undesired particles, and a reject end (13) for removing separated particles. The screen (16) is intended for the kind of pressure screening apparatus having rotor wings (9) adapted to move along a cylindrical path close to the inlet side of the screen. Elongated flow deflecting members (22) are arranged on the inlet side of the screen and are distributed around the circumference of the screen, each elongated flow deflecting member extending obliquely relative to the centre axis of the screen and forwards relative to the direction of rotation of

the rotor wings as seen from the inlet end (11) of the screen. According to the invention the distance between adjacent flow deflecting members (22) as seen in the circumferential direction of the screen is less than 6 mm, whereby a high efficiency is obtained with respect to separation of undesired particles without deteriorating the capacity.



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A cylindrical screen and a method of producing the same

The present invention relates to a cylindrical screen with an inlet side and an outlet side for the kind of pressure screening device which is intended for separating undesired particles from paper pulp suspensions and which has a rotor with a number of rotor wings adapted to move along a cylindrical path, which is coaxial with the cylindrical screen and which extends quite close to the inlet side of the screen. The screen comprises an axial inlet end at the inlet side for receiving the suspension to be separated, an axial reject end at the inlet side for removing separated particles, elongated flow deflecting members, which are arranged at the inlet side of the screen and which are distributed around the circumference of the screen, and screen holes arranged between the flow deflecting members. Each elongated flow deflecting member extends obliquely relative to the centre axis of the cylindrical screen and forwards relative to the direction of rotation of said rotor wings as seen from the inlet end of the screen towards the reject end of the screen, whereby during operation, when the screen is mounted in said pressure screening device, the flow deflecting members affect the suspension flow containing separated particles entrained by said rotor wings along said cylindrical path, so that the suspension flow gets a component of movement towards the reject end of the screen. The invention also relates to a method of producing such a cylindrical screen.

It is important that said oblique flow deflecting members of a conventional screen of this kind efficiently promotes rapid transportation of separated particles towards the reject end of the screen, since each time a

particle is passed by a rotor wing it is subjected to a pulse, which means that the particle runs the risk of being turned so that it may pass through a screen hole. The efficiency of the screen with respect to separation  
5 of undesired particles decreases therefore with increasing number of pulses that each particle is subjected to.

The capacity of the screen depends on the number of screen holes arranged per surface unit, i.e. how large  
10 an open area the screen has. The open area of the screen is, however, limited by reasons of strength (the more screen holes the weaker screen) and by the number of flow deflecting members (more flow deflecting members means room for fewer screen holes). If the open area is  
15 made relatively large at the expense of fewer flow deflecting members the problem arises, however, that the efficiency of the screen with respect to separation of undesired particles is reduced.

20 EP-B-0 046 687 discloses a screen, which comprises a cylindrical plate of uniform thickness and which in one embodiment is provided with oblique flow deflecting members in the form of bars, which are welded on the inlet side of the screen. Between adjacent bars there  
25 are a plurality of screen holes distributed in the circumferencial direction of the screen. It is mentioned that the distance between adjacent bars may be varied from 6.35 to 127 mm, in particular from 12.7 to 127 mm.

30 The object of the present invention is to provide a cylindrical screen for pressure screening apparatuses and having an improved efficiency with respect to separation of undesired particles without the capacity being reduced, as compared with conventional screens.

This object is obtained by a screen of the kind initially stated, which is characterized in that the distance between adjacent operative flow deflecting members as seen in the circumferential direction of the screen is less than six millimeters. Hereby a screen with many flow deflecting members is obtained, which gives a high efficiency with respect to separation of undesired particles. The short distance between adjacent flow deflecting members permits room for only one or possibly two screen holes between said members as seen in the circumferential direction of the cylindrical screen, which gives the advantage that the screen holes are efficiently cleansed from plugging fibres, as the rotor wings pass the screen holes. The efficient cleansing of the screen holes is due to that the pulse from a passing rotor wing creates a strong local turbulence in the narrow area between adjacent flow deflecting members, which uncovers the screen holes from possibly plugging fibres. The theoretical reduced open area of the screen, which is due to the great number of flow deflecting members, is thus surprisingly compensated by said strong local turbulence which arises during operation and which in practice gives at least as large open area of the screen according to the invention as that of conventional screens with fewer flow deflecting members and more screen holes. In addition, the pulse frequency from the rotor wings increases with increasing number of flow deflecting members, which contributes to maintain the screen holes uncovered.

Each elongated flow deflecting member preferably forms an angle to a generatrix to the cylindrical screen which is in the range of 1-40° and which may be constant. Each flow deflecting member may advantageously form an angle to said generatrix relatively close to the reject end of

the screen which is larger than the angle each flow deflecting member forms with said generatrix relatively close to the inlet end of the screen. Hereby, the flow deflecting members will give the suspension flow a larger component of movement towards the reject end of the screen relatively close to the reject end of the screen, where the share of undesired particles in the suspension is relatively large, than relatively close to the inlet end of the screen. Each flow deflecting member may be arranged such that said angle increases stepwise or continuously when the generatrix is moved so that the intersection point between said members and the generatrix is moved in the direction towards the reject end of the screen.

According to a preferred embodiment of the screen according to the invention, the screen is formed by a plane plate of uniform thickness, which is bent to cylindrical shape. A multiplicity of elongated parallel grooves are formed in the plate on the inlet side of the screen by material reducing machining of the plate, the screen holes of the screen opening in said grooves. The grooves are confined by elongated wall surfaces which constitute said flow deflecting members. Said wall surfaces comprise two opposite wall surfaces along each groove, and therefore it is realized that during operation one of said two opposite wall surfaces will be operative as a flow deflecting member of the kind here intended, to affect the suspension flow so that it will get a component of movement towards the reject end of the screen. The screen holes may suitably be oriented in rows, one single row of screen holes extending between adjacent flow deflecting members.

According to another embodiment of the screen according to the invention, the screen is formed by a multiplicity of separate elongated solid wall elements arranged in a circular row. Adjacent wall elements extend in parallel with and at a small distance from each other, so that an elongated gap is formed between them and constitutes one of said screen holes. On the inlet side of the screen adjacent wall elements form grooves which are confined by elongated wall surfaces, which constitute said flow deflecting members.

A further object of the present invention is to provide a simple method of producing a cylindrical screen of the kind here present.

This object is achieved by a method which is characterized by the steps of: a) forming a multiplicity of elongated parallel grooves on one side of a plane plate of uniform thickness by material reducing machining of the plate; b) forming screen holes in the plane plate in the area of each groove by machine cutting of the plate, so that the screen holes extend from the grooves and diverge towards the opposite side of the plate, and c) bending the plate to a cylindrical shape, so that the grooves are on the internal side of the cylindrical plate and extend obliquely relative to the centre axis of the cylindrical plate.

By bending the plate to a cylinder once the screen holes have been cut, the openings of the screen holes on the internal side of the cylindrical screen will be thinner as compared to the corresponding openings on the original plane plate, which gives the advantage that particularly thin inlet openings can be formed even by means of relatively coarse but reliable cutting tools.

The plane plate may be rectangular and the elongated grooves may be formed so that they extend obliquely relative to the side edges of the plate. Then, the plate may be bent to its cylindrical shape so that two of the opposite edges of the plate abut each other, whereby the grooves extend obliquely relative to the centre axis of the cylindrical plate. As an alternative, the plate may initially be provided with the grooves and then be cut to rectangular shape, so that the grooves extend obliquely relative to the side edges of the plate.

Each screen hole may be formed by laser cutting by means of a laser beam which cuts through the plane plate from said opposite side of the plate. The laser beam suitably has an axial cross-section which converge through the plate in the direction from said one side of the plate. As a result, diverging screen holes are obtained with the aid of one single laser beam.

As an alternative, each screen hole may be formed by water cutting.

The invention is explained more closely in the following with reference to the accompanying drawings, in which

figure 1 schematically shows a longitudinal sectional view through a conventional pressure screening apparatus,

figure 2 shows a cylindrical screen according to the invention for use in the pressure screening apparatus according to figure 1,

figures 3-5 schematically show the inlet sides of three cylindrical screens according to the invention having different arrangement of flow deflecting members,

5 figure 6 shows an end view of a screen according to the invention with flow deflecting members arranged on the internal side of the screen,

10 figure 7 shows an end view of a screen according to the invention with flow deflecting members arranged on the external side of the screen,

15 figure 8 shows a part of a cross-section through a preferred embodiment of the screen according to the invention, and

figure 9 shows a part of a cross-section through another embodiment of the screen according to the invention.

20 In the figures, components with the same function are provided with the same reference numerals.

In figure 1 there is shown a conventional pressure screening apparatus comprising a hollow housing 1, a  
25 stationary circular cylindrical screen 2, which extends within the housing 1 and which divides the interior of the housing 1 into a chamber 3 for pulp suspension to be screened by the screen 2 and an annular chamber 4 for receiving screened pulp suspension. A rotor 5 is  
30 journaled in the housing 1 by means of a bearing 6 and extends in the interior of the screen 2, the rotor 5 being rotatable by a drive motor 7 about an axis 8 which is coaxial with the screen 2. The rotor 5 is provided with four rotor wings 9 (more or less than four rotor  
35 wings may however be arranged), which extend axially

along the rotor 5 and at a small distance from the screen 2. The purpose of the rotor wings 9 is to prevent clogging of the screen holes of the screen 2 and to maintain a flow of suspension in the circumferential direction of the screen.

The chamber 3 has an inlet 10 for supplying pulp suspension to be separated to an axial inlet end 11 of the screen 2 and a reject outlet 12 for discharging separated contaminants from an axial outlet end 13 of the screen 2. In the reject outlet 12 there is a valve 14 for adjusting the reject flow. The annular chamber 4 has an accept outlet 15 for separated suspension.

In figure 2 there is shown a cylindrical screen 16 according to a preferred embodiment of the invention intended to be used in the pressure screening apparatus according to figure 1. The screen 16 comprises four separate cylindrical screen elements 17-20, which are releasably coupled to each other by means of annular coupling members 21. As an alternative, the screen 16 may be formed in one single piece. Since the screen 16 is worn faster at the reject end 13 than at the inlet end 11 the screen 16 can be renovated at a low price by exchanging only the screen element 20 which is located closest to the reject end 13 by a new one. In addition to this, the screen 16 may be adapted to different operation conditions by coupling together screen elements 17-20 with different screen hole patterns and/or different arrangements of flow deflecting members. In the screen 16 there is also shown the rotor 5 and the direction of rotation thereof. On the inlet side of the screen 16 each screen element 17-20 has a multiplicity of elongated flow deflecting members 22 distributed around the circumference of the screen 16,

the distance between adjacent operative flow deflecting members 22 as seen in the circumferential direction of the screen 16 being less than 6 mm. Each member 22 extends obliquely relative to the centre axis 23 of the screen and forwards relative to the direction of rotation of the rotor wings 9 as seen from the inlet end 11 of the screen 16 towards the reject end 13 of the screen 16. Between adjacent members 22 there are screen holes in the form of slots 23.

During operation, when the screen 16 is mounted in the pressure screening apparatus according to figure 1, the drive motor 7 drives the rotor 5 so that the rotor wings 9 move along a relatively thin cylindrical path, which is coaxial with the screen 16 and which extends close to the inlet side of the screen 16, here the internal side of the screen 16. The suspension flow containing separated undesired particles that are entrained by the rotor wings 9 along the cylindrical path are affected by the obliquely arranged flow deflecting members 22, so that the suspension flow gets a component of movement towards the reject end 13 of the screen 16.

Each flow deflecting member 22 of the screen according to the invention forms an angle  $\alpha$  to the generatrix G to the cylindrical screen which should be at least  $1^\circ$  and maximally  $40^\circ$ . In the screen 16 according to figure 2 the angle  $\alpha$  is constant regardless of where on the screen 16 said generatrix G intersects a flow deflecting member 22, which is schematically shown in figure 3. As an alternative, each flow deflecting member (24 and 25 in figure 4 and 5, respectively) may form an angle ( $b_1$  and  $c_1$  in figure 4 and 5, respectively) to the generatrix G relatively close to the reject end 13 of the screen which is greater than the angle ( $b_2$  and  $c_2$  in

figure 4 and 5, respectively) which each flow deflecting member forms to the generatrix G relatively close to the inlet end 11 of the screen. As a result, the suspension flow in said cylindrical path is given a greater component of movement towards the reject end of the screen the closer the flow is to the reject end of the screen. This is favourable to the efficiency of the screen with respect to separated contaminants, since the share of fibres in the suspension in the interior of the screen decreases from the inlet end of the screen to the reject end of the screen, and therefore it is more important to promote the axial transportation of the suspension close to the reject end than to separate fibres through the screen. For instance, each flow deflecting member may be arranged so that it forms an angle  $b_1$ ,  $b_2$  which increases continuously (figure 4) or forms an angle  $c_1$ ,  $c_2$  which increases stepwise (figure 5), when the generatrix G is moved so that the intersection point between the flow deflecting member and the generatrix G moves in the direction towards the reject end 13 of the screen.

In figure 6 there is shown an end view of a cylindrical screen 26 according to a preferred embodiment of the present invention with flow deflecting members 27 arranged on the internal side of the screen 26. The screen 26 consists of a plate on which parallel grooves 28 have been milled, so that the inner surface of the screen 26 has a saw-tooth contour with steep flanks 27, which constitute the flow deflecting members, and flattened tooth backs 29. However, it is possible to switch the direction of movement of the rotor wings 9, whereby the flattened tooth backs 29 will be operating as flow deflecting members, though with reduced efficiency as compared to said steep flanks 27. In the area of each

groove 28 one single screen hole 30 is arranged, as seen in the circumferential direction of the screen 26.

In figure 7 there is shown an end view of a cylindrical screen 31, according to another embodiment of the invention, which has the same saw-toothed contour as the screen 26 according to figure 6. However, it differs from the screen 26 in that the saw-tooth contour is arranged on the external side of the screen 31. Thus, the screen 31 is intended for the kind of pressure screening apparatus which separates a suspension flow flowing from outside and into the screen 31. In this case, rotor wings 32 sweeping along the external side of the screen 31 are arranged.

In figure 8 there is shown a part of a cross-section through the screen 26 according to figure 6. The screen 26 may advantageously be produced in the following way. On one side of a plane plate of uniform thickness a multiplicity of elongated parallel grooves 28 are formed by material reducing machining of the plate, preferably milling. Each groove 28 is formed as a V, as seen in a cross-section through the groove 28, with a right angle between the legs of the V, so that the plate has a saw-toothed contour with steep flanks 27 and flattened tooth backs 29. The distance between adjacent flanks is less than 6 mm. Screen holes 30 are formed in the plate in the area of each groove 28 by means of a laser beam which cuts through the plate from the opposite groove-less side of the plate. The laser beam is focused outside the plate adjacent the side of the plate which is provided with the grooves 28, whereby the laser beam converges through the plate and forms screen holes 30 which diverge from the grooves 28 to the groove-less side of the plate. When cutting each screen hole 30, the

plate is moved relative to the laser beam, so that the screen hole 30 takes the form of a slot extending along its groove 28. Finally the plate is bent with grooves 28 and screen holes 30 to a cylindrical shape, so that the grooves 28 are on the internal side of the cylindrical plate and extend obliquely relative to the centre axis of the cylindrical plate. Due to the bending of the plate to the cylindrical shape, the angle between the flank 27 and the tooth back 29 of each groove 28 becomes less than  $90^\circ$ . In addition to this, the inlet opening of each screen hole 30 becomes thinner.

A simple way of forming the obliquely extending grooves 28 is to start from a rectangular plane plate and form the grooves 28 so that they extend obliquely relative to the side edges of the plate, after which the plate is bent to its cylindrical shape so that two of the opposite side edges of the plate abut each other. As an alternative, the plane plate may initially be provided with the grooves 28 and then be cut to rectangular shape, so that the grooves extend obliquely relative to the side edges of the plate.

As an alternative to laser cutting, the screen holes 30 may also be formed by water cutting. In this case, however, each cutting water jet is ejected towards the side of the plane plate which is provided with the grooves 28.

Figure 9 shows a part of an end view of a screen 33 according to another embodiment of the invention. The screen 33 resembles the screen 26 in that it has the same saw-toothed contour on its internal side. However, the screen 33 differs from the screen 26 in that it is formed by a multiplicity of separate elongated wall

elements 34, which are arranged in a circular row.

Adjacent wall elements 34 extend in parallel with and at a small distance from each other, so that an elongated gap 35 is formed between them and constitutes a screen

5 hole. The wall elements 34 have a cross sectional shape which gives a saw-toothed inner contour of the screen 33 which is identical to the inner contour of the screen 26 according to figure 8.

10 In figure 9 there is shown an angle  $\alpha$  between the radius of the screen 33 and a flank 27 of a groove 28, and an angle  $\beta$  between the radius of the screen 33 and the tooth back 29 of said groove 28. As mentioned above, in the embodiments according to figures 8 and 9 the sum of  
15 the angles  $\alpha$  and  $\beta$  is less than  $90^\circ$ . This angle sum may, however, be greater than  $90^\circ$ . For instance, the angle  $\alpha$  may vary between  $5-80^\circ$  and the angle  $\beta$  may vary between  $5-85^\circ$ . The angles  $\alpha$  and  $\beta$  may also be equivalent. However, it is preferred that the angle  $\alpha$  is somewhat  
20 less than  $15^\circ$  and that the angle  $\beta$  is somewhat less than  $75^\circ$ . The angle figures stated are also applicable to the screen 26 according to figure 8.

Claims

1. A cylindrical screen (16,26,31,33) with an inlet side and an outlet side for the kind of pressure screening apparatus, which is intended for separation of undesired particles from paper pulp suspensions and which has a rotor (5) with a number of rotor wings (9) adapted to move along a cylindrical path, which is coaxial with the cylindrical screen and which extends quite close to the inlet side of the screen, which screen comprises an axial inlet end (11) at the inlet side for receiving the suspension to be separated, an axial reject end (13) at the inlet side for removing separated particles, elongated flow deflecting members (22,24,25,27), which are arranged on the inlet side of the screen and which are distributed around the circumference of the screen, and screen holes (23,30,35) arranged between the flow deflecting members, each elongated flow deflecting member extending obliquely relative to the centre axis of the cylindrical screen and forwards relative to the direction of rotation of said rotor wings as seen from the inlet end of the screen towards the reject end of the screen, whereby during operation, when the screen is mounted in said pressure screening apparatus, the flow deflecting members deflect the suspension flow containing separated particles that are entrained by said rotor wings along said cylindrical path, so that the suspension flow gets a component of movement towards the reject end of the screen, c h a r a c t e r i z e d i n that the distance between adjacent operative flow deflecting members (22,24,25,27) as seen in the circumferential direction of the screen is less than 6 mm.
2. A screen according to claim 2, c h a r a c t e -

r i z e d i n that each elongated flow deflecting member (22,24,25,27) forms an angle to the generatrix (G) to the cylindrical screen which is in the range of 1-40°.

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3. A screen according to claim 2, c h a r a c t e - r i z e d i n that each flow deflecting member (22) forms a constant angle (a) to the generatrix (G) to the cylindrical screen.

10

4. A screen according to claim 2, c h a r a c t e - r i z e d i n that each flow deflecting member (24;25) forms an angle (b1;c1) to said generatrix (G) relatively close to the reject end (13) of the screen which is greater than the angle (b2;c2) each flow deflecting member forms to said generatrix relatively close to the inlet end (11) of the screen.

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5. A screen according to claim 4, c h a r a c t e - r i z e d i n that each flow deflecting member (25) forms an angle (c1,c2) to said generatrix (G) which increases continuously when the generatrix is moved so that the intersection point between said member and the generatrix moves in the direction towards the reject end (13) of the screen.

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6. A screen according to claim 4, c h a r a c t e - r i z e d i n that each flow deflecting member (24) forms an angle (b1,b2) to said generatrix (G) which increases stepwise when the generatrix is moved so that the intersection point between said member and the generatrix moves in the direction towards the reject end (13) of the screen.

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35 7. A screen according to any one of claims 1-6,

c h a r a c t e r i z e d in that the screen (26) is formed by a plane plate of uniform thickness, which is bent to a cylindrical shape, that a multiplicity of elongated parallel grooves (28) are formed in the plate on the inlet side of the screen by material reducing machining of the plate, that the screen holes (30) of the screen open in said grooves, and that the grooves are confined by elongated wall surfaces (27,29) constituting said flow deflecting members.

8. A screen according to claim 7, c h a r a c t e r i z e d i n that the screen holes (30) are oriented in rows, one single row of screen holes extending between adjacent flow deflecting members (27,29).

9. A screen according to any one of claims 1-6, c h a r a c t e r i z e d i n that the screen (33) is formed by a multiplicity of separated elongated solid wall elements (34), which are arranged in a circular row, adjacent wall elements extending in parallel with and at a small distance from each other, so that an elongated gap (35) is formed between them and constitutes one of said screen holes, and that on the inlet side of the screen, adjacent wall elements form grooves which are confined by elongated wall surfaces (27,29) constituting said flow deflecting members.

10. A screen according to any one of the preceding claims, c h a r a c t e r i z e d i n that said inlet side is formed by the internal side of the screen.

11. A screen according to any one of claims 1-9, c h a r a c t e r i z e d i n that said inlet side is formed by the external side of the screen.

12. A method of producing a cylindrical screen for use in a pressure screening apparatus intended for separating undesired particles from paper pulp suspensions, comprising the steps of:

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- forming a multiplicity of elongated parallel grooves (28) on one side of a plane plate of uniform thickness by material reducing machining of the plate,

10

- forming screen holes (30) in the plane plate in the area of each groove by cutting the plate, and

- bending the plate to a cylindrical shape, so that the grooves are on the internal side of the cylindrical plate,

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c h a r a c t e r i z e d i n that said screen holes are formed in the plane plate such that they extend from said grooves and diverge towards the opposite side of the plate, and the screen is formed such that said grooves extend obliquely relative to the centre axis of the cylindrical plate when the plate has been bent to cylindrical shape.

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25 13. A method according to claim 12, c h a r a c t e r i z e d i n that said grooves are formed such that ridges are left on both sides of every groove, forming flow deflecting members (22,24,25,27) on the completed screen, the distance between the formed flow deflecting members being less than six millimeters in the circumferential direction of the screen.

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14. A method according to any one of the claims 12-13, c h a r a c t e r i z e d i n that the plane plate is rectangular, that the elongated grooves (28) are formed

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such that they extend obliquely relative to the side edges of the plate, and that the plate is bent to its cylindrical shape so that two of the opposite side edges of the plate abut each other.

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15. A method according to any one of claims 12-13, characterized in that before the plane plate with formed grooves (28) is bent to a cylindrical shape it is cut to rectangular shape, so that the  
10 grooves extend obliquely relative to the side edges of the plate, and that the rectangular plate is bent to a cylindrical shape so that two of the opposite side edges of the plate abut each other.

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16. A method according to any one of claims 12-15, characterized in that each screen hole (30) is formed by laser cutting.

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17. A method according to claim 16, characterized in that each screen hole (30) is formed by means of a laser beam which cuts through the plane plate from said opposite side of the plate, the laser beam having an axial cross-section which converges through the plate in the direction from said opposite side  
25 towards said one side of the plate.

18. A method according to any one of claims 12-15, characterized in that each screen hole (30) is formed by water cutting.

1 / 4

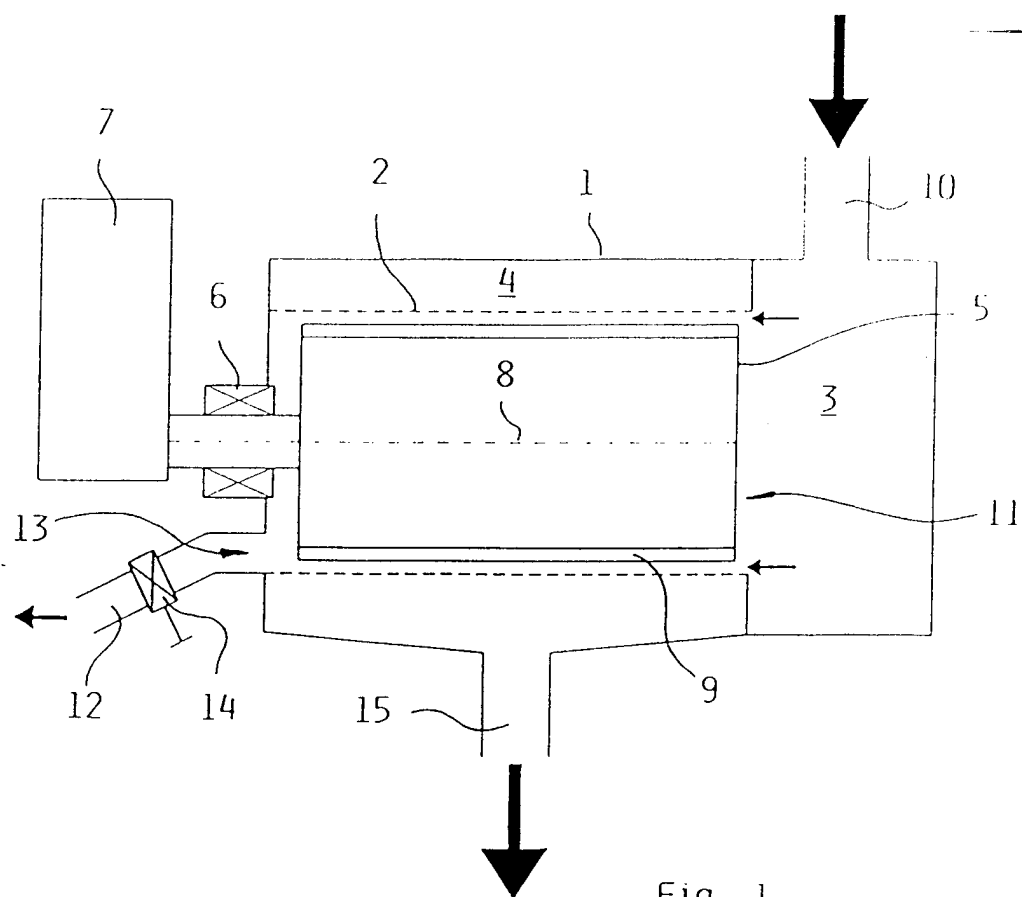


Fig. 1

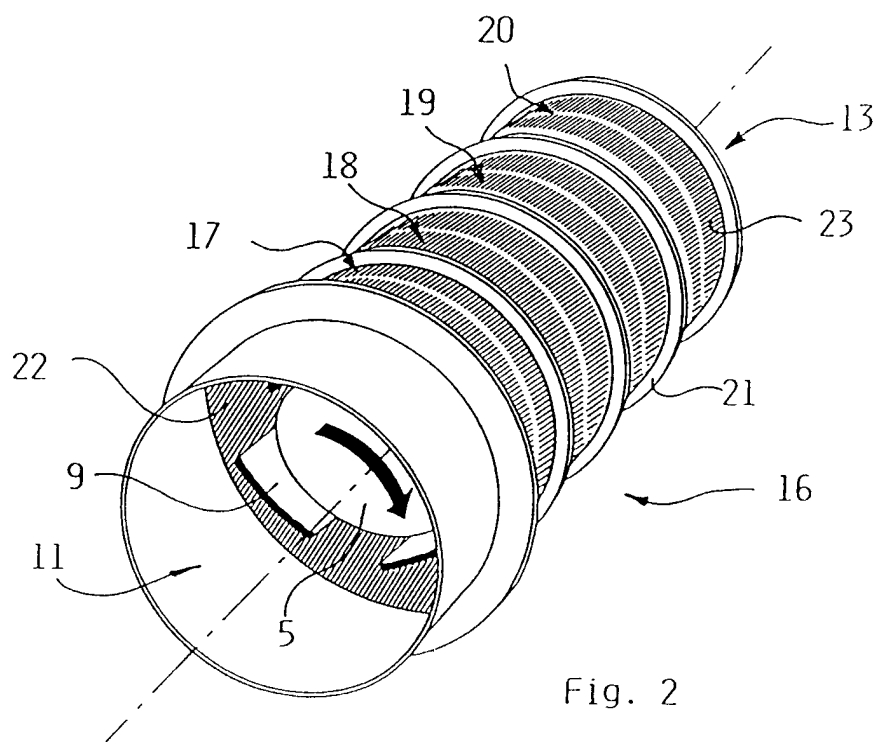


Fig. 2

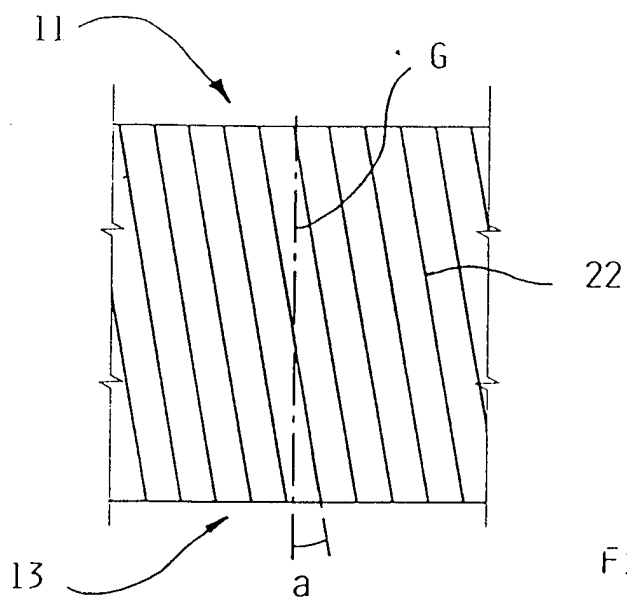


Fig. 3

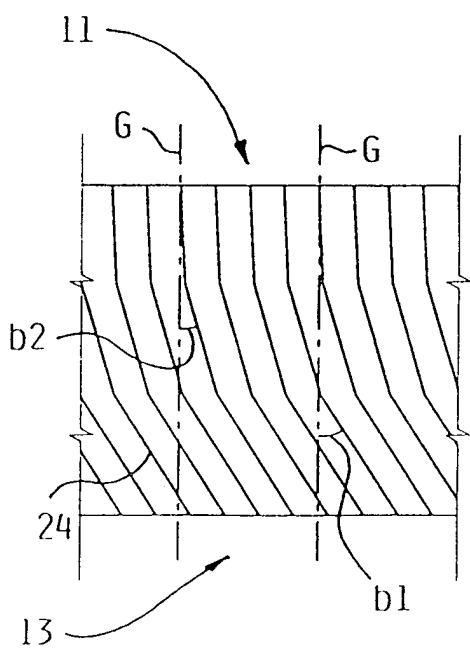


Fig. 4

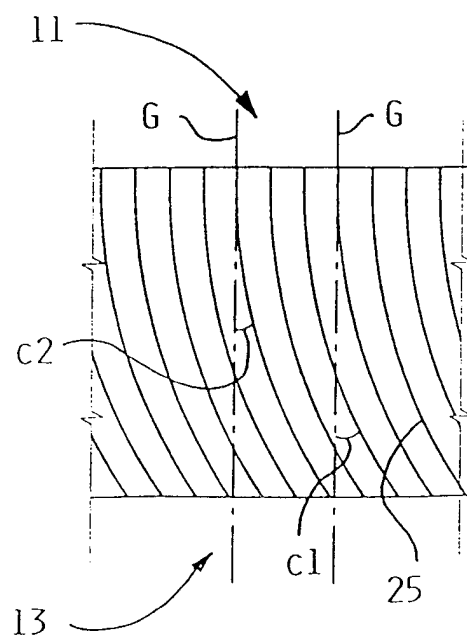


Fig. 5

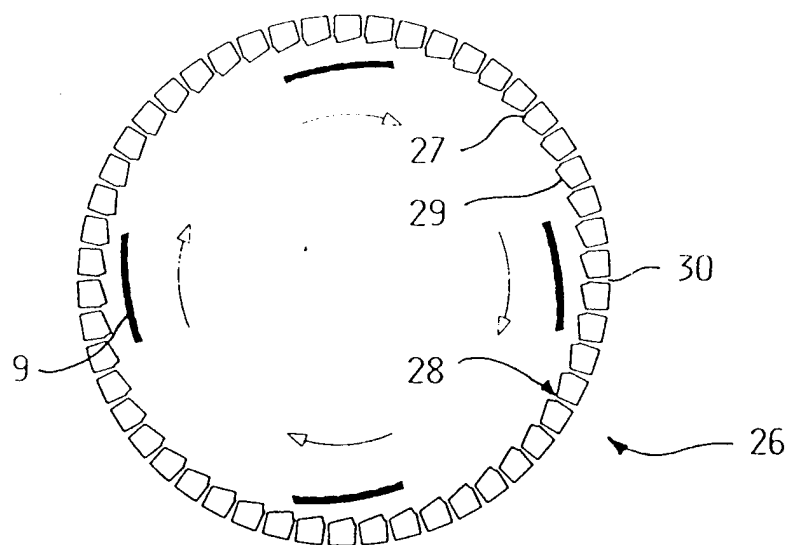


Fig. 6

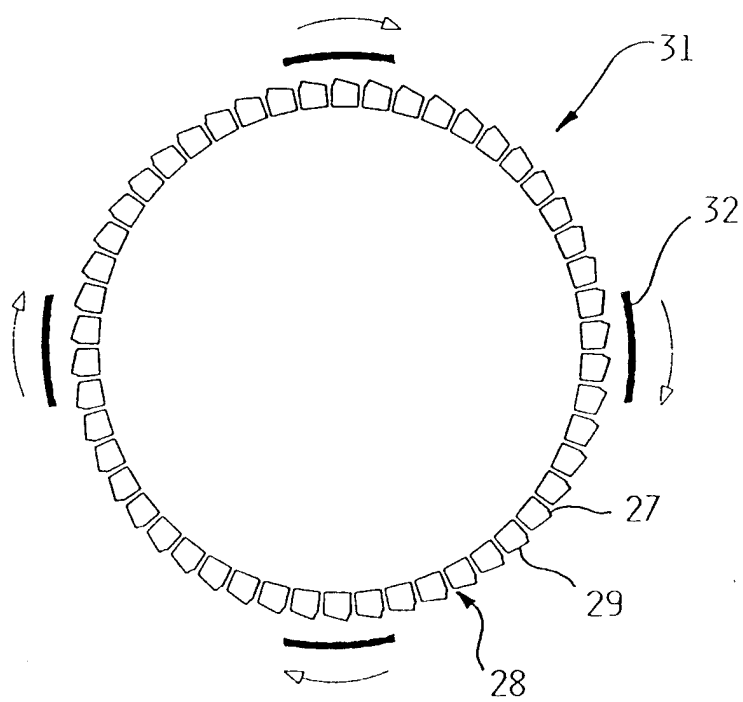


Fig. 7

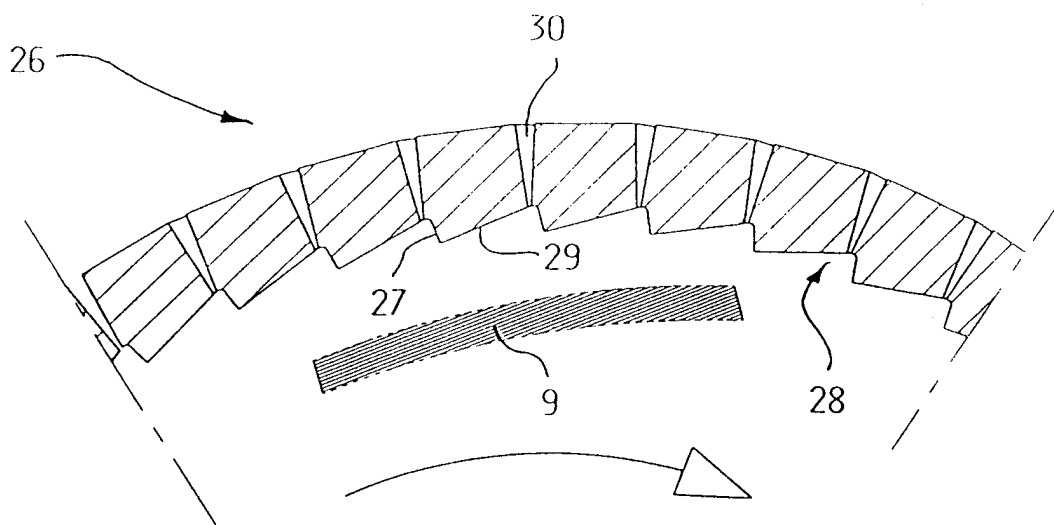


Fig. 8

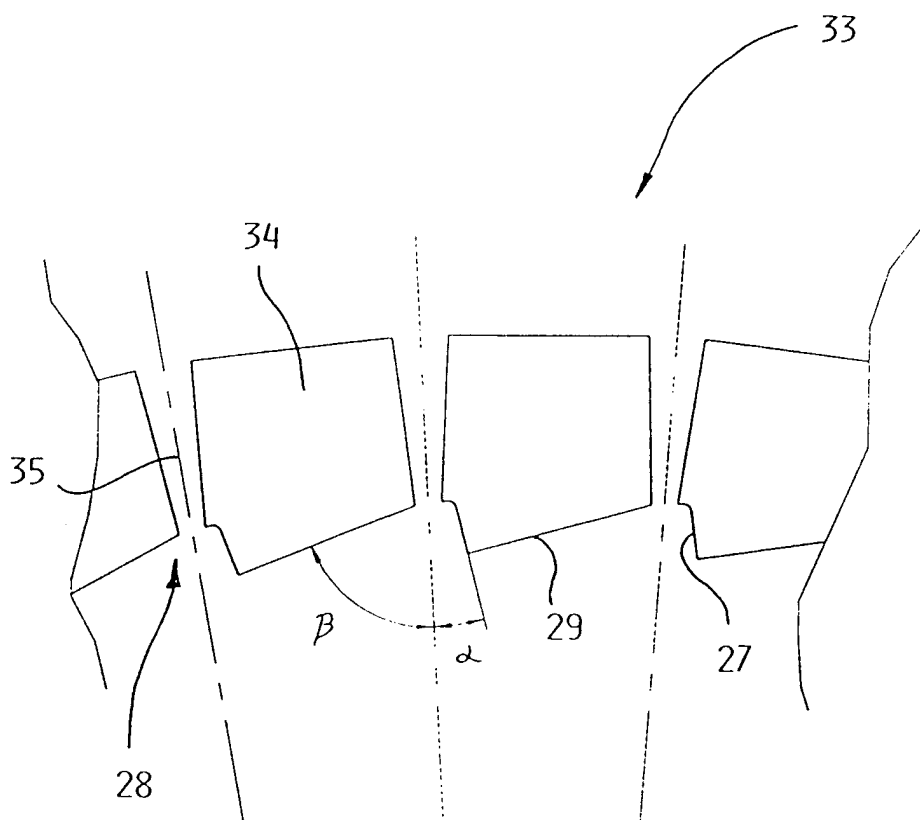


Fig. 9

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 97/02202

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: D21D 5/02, D21D 5/16

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)

IPC6: D21D

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)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                  | Relevant to claim No. |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| A         | EP 0046687 A1 (THE BLACK CLAWSON COMPANY),<br>3 March 1982 (03.03.82), figure 1,<br>abstract<br><br>--                                              | 1-18                  |
| A         | WO 9304797 A1 (SUNDS DEFIBRATOR INDUSTRIES<br>AKTIEBOLAG), 18 March 1993 (18.03.93), page 3,<br>line 4 - line 32<br><br>--                          | 12-18                 |
| A         | US 5587077 A (FRANK AALTONEN ET AL),<br>24 December 1996 (24.12.96), column 2,<br>line 59 - line 62; column 4, line 20 - line 22<br><br>--<br>----- | 16-18                 |

☐ Further documents are listed in the continuation of Box C.
 ☒ See patent family annex.

|                                                                                                                                                                         |                                                                                                                                                                                                                                                  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| * Special categories of cited documents:                                                                                                                                | "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention                                              |
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| "E" earlier document but published on or after the international filing date                                                                                            | "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art |
| "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) | "&" document member of the same patent family                                                                                                                                                                                                    |
| "O" document referring to an oral disclosure, use, exhibition or other means                                                                                            |                                                                                                                                                                                                                                                  |
| "P" document published prior to the international filing date but later than the priority date claimed                                                                  |                                                                                                                                                                                                                                                  |

|                                                                                                                                |                                                                       |
|--------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|
| Date of the actual completion of the international search                                                                      | Date of mailing of the international search report                    |
| 8 April 1998                                                                                                                   | 17 -04- 1998                                                          |
| Name and mailing address of the ISA/<br>Swedish Patent Office<br>Box 5055, S-102 42 STOCKHOLM<br>Facsimile No. +46 8 666 02 86 | Authorized officer<br><br>May Hallne<br>Telephone No. +46 8 782 25 00 |

# INTERNATIONAL SEARCH REPORT

Information on patent family members

02/03/98

International application No.

PCT/SE 97/02202

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s)                                                                                                                      | Publication<br>date                                                                          |
|-------------------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| EP 0046687 A1                             | 03/03/82            | SE 0046687 T3<br>AU 544263 B<br>AU 7461081 A<br>BR 8105386 A<br>CA 1180686 A<br>FI 812609 A<br>JP 57176288 A                                    | 23/05/85<br>04/03/82<br>11/05/82<br>08/01/85<br>26/02/82<br>29/10/82                         |
| WO 9304797 A1                             | 18/03/93            | AU 2563192 A<br>DE 69205837 D,T<br>EP 0602161 A,B<br>SE 0602161 T3<br>FI 941039 A<br>JP 6510572 T<br>SE 9102550 A                               | 05/04/93<br>04/04/96<br>22/06/94<br>04/03/94<br>24/11/94<br>06/03/93                         |
| US 5587077 A                              | 24/12/96            | AT 133729 T<br>CA 2120250 A<br>DE 69208100 D,T<br>EP 0613509 A,B<br>SE 0613509 T3<br>ES 2085038 T<br>FI 89521 B<br>JP 7502308 T<br>WO 9307334 A | 15/02/96<br>05/04/93<br>11/07/96<br>07/09/94<br>16/05/96<br>30/06/93<br>09/03/95<br>15/04/93 |