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(54) Title: REFINER DISC INLET WITH GUIDE BARS

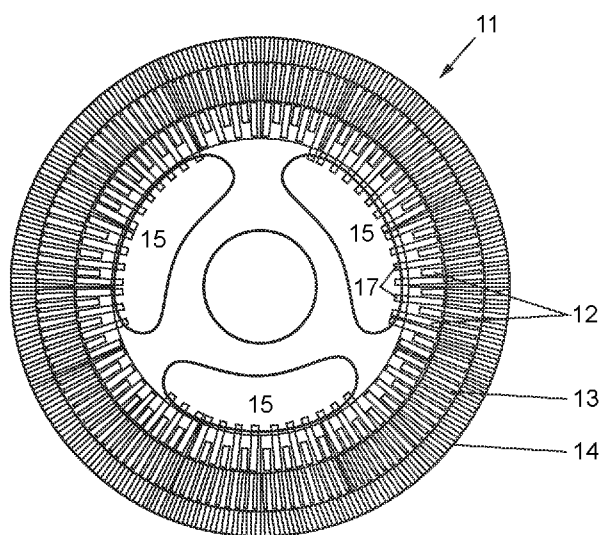


Fig.2

(57) Abstract: A feed-end refiner disc(11; 21; 31; 41) for a double-disc refiner, comprising at least one inlet opening (15; 25; 35; 45) for feed material, which inlet opening (15; 25; 35; 45) comprises a through hole having an inner wall (26; 36; 46), wherein at least a portion of the inner wall (26; 36; 46) comprises guide bars (17; 27; 37; 47) and wherein the feed-end refiner disc (11; 21; 31; 41) further comprises inner bars (12; 22; 32; 42), which are arranged at an inner portion on the surface of the feed-end refiner disc (11; 21; 31; 41), and wherein at least one guide bar (17; 27; 37; 47) continuously transforms into one inner bar.



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REFINER DISC INLET WITH GUIDE BARS

TECHNICAL FIELD

The present invention relates generally to a double-disc refiner for refining lignocellulosic material, and particularly to a refiner disc to be used in such a double-disc refiner, and even more particularly to a feed-end refiner disc having an inlet opening comprising a through hole extending through the refiner disc, wherein an inner wall of the through hole comprises guide bars, which are arranged to radially accelerate and guide the incoming lignocellulosic material.

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BACKGROUND

Lignocellulosic material, e.g., wood chips, saw dust and other fibrous material from wood or plant, is refined by mechanical refiners that separate fibers from the fiber network that forms the lignocellulosic material. One type mechanical refiner for processing fibrous lignocellulosic material is a double-disc refiner, wherein a feed-end disc and a control-end disc are positioned opposite to each other in a counter-rotating relation, to define a refining zone therebetween; and the lignocellulosic material to be refined enters the refining zone via through holes arranged in the feed-end disc. As the feed-end disc and the control-end disc counter-rotate, centrifugal forces created by the relative rotation between the two refiner discs move the lignocellulosic material outwards and towards the periphery of the refiner discs. Both the feed-end disc and the control-end disc comprise further refiner disc segments, which have surfaces that include bars and grooves; and the lignocellulosic material is – in the refining zone provided between crossing bars of the opposing refiner disc segments – separated into fibers by forces created by the crossing bars as the refiner discs counter-rotate in relation to each other.

An exemplifying double-disc refiner of this type is disclosed in the U.S. Patent No. 5,167,373 to Bohn et al., wherein a double-disc refiner comprises a control-end disc and a feed-end disc, which counter-rotate in relation to each other. The control-end disc and the feed-end disc are opposing each other and define a refining zone therebetween; and feed

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material enters the refining zone through off-centered inlet openings arranged in the feed-end disc. In this patent, it is theorized that the feed material has a tendency to follow the feed-end disc, because feed-end spokes, which extend radially between the inlet openings in the feed-end disc, accelerate the feed material into the feed-end disc. Thus, it is the feed-
5 end disc that mainly determines the residence time for the feed material in the refining zone, and by increasing the rotational speed of the feed-end disc, the residence time in the refining zone for the feed material is decreased, which, in turn, reduces the overall energy consumption of the double-disc refiner in accordance with the main objective of this invention. However, increasing the rotational speed of a feed-end disc can increase the
10 wear of the refiner discs, and can also be detrimental to some pulp quality characteristics.

An object of the present invention is therefore to provide an improved design for a feed-end refiner disc for a double-disc refiner, which reduces the wear of the refiner discs and thereby provides a longer useful life-time. To reduce the energy consumption in a refiner is
15 a continuously ongoing goal in the field of mechanical pulping, and a further object of the invention is to reduce the specific energy needed to produce a certain amount of refined lignocellulosic material (i.e. mechanical pulp). A still further object is to provide an improved feed-end refiner disc for a double-disc refiner, which provides a more even material flow distribution and thereby improved fiber quality characteristics.

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SUMMARY OF THE INVENTION

The above-mentioned objects are achieved with a feed-end refiner disc for a double-disc refiner according to the independent claim. Preferred embodiments are set forth in the dependent claims.

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In all embodiments of the present invention disclosed herein, it is presumed that a refiner disc is a feed-end refiner disc, which typically is positioned opposite to a control-end disc in (typically) a counter-rotating relationship, to define a refining zone therebetween. It is, however possible, and within the scope of the invention, to arrange two feed-end discs,
30 which are positioned opposite to each, i.e. feed material enters the refining zone from two sides. Further, according to the embodiments of the present invention, a feed-end disc for a double-disc refiner comprises at least one inlet opening for feed material, i.e. the

lignocellulosic material to be refined, wherein said at least one inlet opening comprises a through hole extending through the feed-end disc, which through hole has an inner wall which is provided with at least one guide bar – and is preferably provided with several guide bars. In operation, the feed-end disc rotates, and, as the feed material advances
5 through the through hole(s) and into the refining zone, the guide bars will impose a controlled radial acceleration on the feed material, such that the feed material has a radial acceleration as it reaches the refining zone provided between the feed-end disc and an opposing and, typically, counter-rotating control-end disc.

10 It should thereby be appreciated that the guide bars protrude into the incoming flow of feed material and give a relatively large amount of the incoming a radial acceleration already before the feed material has entered the refining zone. This is in contrast with the prior art, wherein only the outmost feed material is affected by the inner walls of the inlet openings as the feed material is about to enter a refining zone. Further, without being bound by
15 theory, it is believed that the present arrangement with guide bars in a through hole promotes and enhances a laminar flow of the incoming feed material in relation to a more turbulent flow.

Thus, according to the invention, a feed-end refiner disc for a double-disc refiner
20 comprises at least one inlet opening for feed material, which inlet opening comprises a through hole having an inner wall, wherein at least a portion of the inner wall comprises guide bars and wherein the feed-end refiner disc further comprises inner bars, which are arranged at an inner portion on the surface of the feed-end refiner disc, and wherein at least one guide bar continuously transforms into one inner bar.

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In one embodiment of the invention, guide bars extend out from the through hole in a ninety degree turn and form surface guide bars on the surface of the feed-end disc. These surface guide bars on the surface of the feed-end disc are herein referred to as inner bars, since they are located at an innermost area of the feed-end refiner disc. With this
30 arrangement, the acceleration that already has commenced inside a through hole continues in a controlled fashion also on the surface of the feed-end disc. To further enhance a smooth transition for the feed material into a refining zone, the edge of the inlet opening

can comprise a transition zone, which is rounded or chamfered, a feature that is incorporated in another embodiment of the invention. A trough hole extends apparently through the thickness of a feed-end disc, and according to one embodiment of the invention, a guide bar extends at least 1.0 cm into the trough hole, and more preferably
5 3.0 cm or even 5.0 cm into the through hole, as measured perpendicular from the surface of the feed-end disc.

The invention relates also to a double-disc refiner equipped with a feed-end refiner disc according to the invention.

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BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be further explained hereinafter by means of non-limiting examples and with reference to the appended drawings, wherein:

Fig. 1 is a schematic illustration of a refiner disc comprising refiner segments and inlet
15 openings according to the prior art;

Fig. 2 is a schematic illustration of a feed-end refiner disc comprising refiner segments and inlet openings according to the present invention;

Fig. 3 illustrates schematically an inlet opening having an inner wall provided with guide bars according to one embodiment of the present invention;

20 Fig. 4 illustrates schematically an inlet opening having an inner wall provided with guide bars according to another embodiment of the present invention; and

Fig. 5 is an enlarged portion of a smoothly rounded inlet opening provided with guide bars according to yet another embodiment of the present invention.

25 DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The general shape and design of a feed-end refiner disc 1 for a double-disc refiner according to the prior art is schematically illustrated in Fig. 1. The refiner disc 1 comprises three (3) circumferential and concentrically arranged rows or portions of bars, i.e. inner bars 2, intermediate bars 3, and outer bars 4. As is typical for a refiner disc for a double-
30 disc refiner, the inner bars 2 are rather coarse and their main purpose is to radially accelerate incoming feed material towards the more peripheral intermediate bars 3 and

outer bars 4, where the main part of the refining of the feed material takes place. The feed material enters a refining zone, which is created between the feed-end refiner disc 1 and an opposing control-end refiner disc (which is not shown in Fig. 1), via three (3) inlet openings 5, which are arranged in the form of through holes extending through the refiner disc 1. In this conventional design, the inner walls of the through holes comprise no structures or protruding parts, and it can be appreciated that only a small portion of the incoming feed material flow is in direct contact with the inner walls of the through holes 5 as the feed-end disc 1 rotates, and that the material feeding into the refining zone takes place in a rather uncontrolled and unguided way, which, in turn, creates a highly turbulent feed material flow. As a general comment, it can be said that inlet openings provided in a feed-end disc for a double-disc refiner are typically arranged in off-center positions, since there is typically a central axle arranged, which creates the rotational movement of the feed-end refiner disc. This arrangement is in contrast with a typical single-disc refiner comprising a stationary disc and an opposing rotating disc, and wherein the material to be refined typically is introduced into a refining zone via a central inlet opening provided in the stationary disc by means of a ribbon feeder.

Fig. 2 illustrates schematically a feed-end refiner disc 11 for a double-disc refiner according to the present invention. The feed-end refiner disc 11 comprises three (3) circumferential and concentrically arranged rows of bars, i.e. inner bars 12, intermediate bars 13, and outer bars 14. The feed material enters a refining zone, which is created between the feed-end refiner disc 11 and an opposing control-end refiner disc (which is not shown in Fig. 2), via three (3) inlet openings 15, which are arranged in the form of through holes extending through the feed-end disc 11. Upon entering this refining zone, the feed material first encounters and is engaged by the inner bars 12. The inner bars 12 are coarser and also fewer in number than the intermediate bars 13 and, in particular, the outer bars 14; and the main purpose of the inner bars 12 is to impose a radial acceleration of the incoming feed material, such that the feed material moves outwardly and into contact with first the intermediate bars 13 and thereafter the outer bars 14, where the refining mostly takes place, as is known in the art. In Fig. 2, three (3) inlet openings 15 are arranged, but it is within the scope of the invention to arrange more or fewer inlet openings, as long as at least one inlet opening 15 is provided. Also, inlet openings can have any useful shape, in

particular including an oval shape or circular shape, or a more bent shape as is illustrated in Fig. 2. Further, more or fewer circumferential rows of bars can be arranged, and the bars can be arranged in more or less regular patterns or irregular patterns, for example such that no distinct rows are discernable. A feed-end refiner disc according to the invention
5 comprises, however, always an inner portion, which adjoins to at least one inlet opening and comprises preferably a number of inner bars, whose main purpose is to guide and radially accelerate the incoming feed material.

From Fig. 2 it can further be appreciated that some of the inner bars 12 adjoining one of
10 the inlet openings 15 comprise extension portions 17, which extend into the inlet opening 15, i.e. extends a distance into the through hole of which the inlet opening 15 constitutes the opening. In other words, the extension portions 17 are arranged in at least a portion of an inner wall of a through hole, which is part of the inlet opening 15. Thus, the extension portions 17 are arranged as protrusions from at least a circumferential portion of the inner
15 wall of a through hole which is part of an inlet opening 15, and herein these protruding extension portions 17 will also be referred to as guide bars 17. In accordance with the invention, the purpose of the extension portions or guide bars 17 is to impose a radial acceleration of the incoming feed material already before the feed material has entered the refining zone. From Fig. 2 it can also be appreciated that the guide bars 17 protrude into
20 the incoming flow of feed material; and inlet openings 15 comprising through holes having an inner wall comprising guide bars 17 will therefore engage a larger portion of the incoming feed material flow than inlet openings which, in accordance with prior art, lack such guide bars. Since the feed material – due to the guide bars 17 – already has a radial acceleration as it enters a refining zone, the “ordinary” inner bars 12, which are arranged
25 on the surface of the feed-end disc 11, will merely continue and enhance the radial acceleration already imposed by the guide bars 17. The material flow in the refining zone will therefore be less turbulent, i.e. more laminar, by the provision of the guide bars 17, which, in turn, leads to a more even material flow distribution and, ultimately, to a more efficient refining process with a higher yield and lower specific energy consumption.

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An enlarged section of a feed-end refiner disc 21 for a double-disc refiner is schematically illustrated in Fig. 3, wherein the feed-end disc 21 comprises an inner circumferential

portion with inner bars 22, an intermediate circumferential portion with intermediate bars 23, and an outer circumferential portion with outer bars 24. The feed-end disc 21 comprises further an inlet opening 25 in the form of a through hole, which extends through the feed-end disc 21 and comprises an inner wall 26. The inner wall 26 is, in accordance with the invention, provided with a number of protrusions in the form of guide bars 27, whose function is to radially accelerate the incoming feed material, as was explained above. From Fig. 3 it can further be seen that some of the guide bars 27 continues and transforms into inner bars 22, i.e. an inner bar 22 can in this case be regarded as an extension of a guide bar 27, i.e. a continuous extension of a guide bar 27. To arrange a guide bar 27, which starts as a protrusion from the inner wall 26 and continues and transforms into an inner bar 22 arranged in inner circumferential portion on the surface of the feed-end refiner disc 21, creates a smooth transition for the incoming feed material from the inlet opening 25 into a refining zone created between the feed-end refiner disc 21 and an opposing control-end refiner disc (which is not shown in Fig. 3). Such a smooth transition promotes a laminar material flow and leads to a more even material flow distribution, and ultimately to a lower specific energy consumption.

In the embodiment described above in conjunction with Fig. 3, there were more inner bars 22 than guide bars 27 in a refiner disc sector enclosing the inlet opening 25, i.e. some inner bars 22 were not a continuation or extension of a guide bar 27. The opposite situation is also possible, and Fig. 4 illustrates an embodiment of a feed-end refiner disc 31 having a surface comprising an inner circumferential portion with inner bars 32, an circumferential intermediate portion with intermediate bars 33, and a circumferential outer portion with outer bars 34. Incoming feed material enters a refining zone created between the feed-end disc 31 and an oppositely arranged control-end disc (which is not shown in Fig. 4) via an inlet opening 35, which comprises a through hole having an inner wall 36, from which a number of guide bars 37 protrude. In this embodiment, there more guide bars 37 than inner bars 32, in the refiner disc sector enclosing the inlet opening 35, i.e. some of the guide bars 37 do not continue and transform into an inner bar 32. From Fig. 3 and Fig. 4 it can be seen that guide bars, which are arranged on an inner wall of a through hole being part of an inlet opening, can be provided and arranged independently of inner bars, which are arranged on the surface of a feed-end refiner disc. Although optionally, it is, however,

preferred that at least some guide bars continue and continuously transform into inner bars, as this promotes a smooth transition for the incoming feed material and contributes to a laminar feed material flow and an even feed material distribution.

- 5 In the embodiment discussed above, inlet openings are essentially arranged perpendicular to a surface of a refiner disc, i.e. the through holes, which are part of the inlet openings, extend perpendicular to a refiner disc surface, which means that feed material that advances through the through holes has to make a sharp ninety degree turn into a refining zone as the feed material leaves the inlet opening. In Fig 5, a feed-end refiner disc 41 is
- 10 schematically illustrated, wherein the feed-end disc 41 comprises an inner portion with inner bars 42. (The feed-end disc 41 comprises also more peripheral bars, which, however, are not seen in Fig. 5.) Feed material enters a refining zone, which is created between the feed-end disc 41 and an opposing control-end disc (which is not seen in Fig. 5) via an inlet opening 45 comprising a through hole having an inner wall 46, which is provided with a
- 15 number of guide bars 47. In this embodiment, the inlet opening 45 comprises further a transition portion 48, which is rounded or chamfered, such that that incoming feed material experiences a smooth and gradual transfer from a through hole and into the refining zone. In other words, instead of the sharp ninety degree turn which accompanied the embodiments shown in Fig. 2, Fig. 3 and Fig. 4, respectively, the incoming feed material
- 20 can follow a gradually and smoothly changing path from a through hole and into a refining zone, which promotes a laminar material flow and leads to a more even material flow distribution, and ultimately to a lower specific energy consumption. A rounded or chamfered inlet opening, such as inlet opening 45, i.e. an inlet opening which comprises a rounded or chamfered transition portion, such as transition portion 48, can be provided for
- 25 and combined with all embodiments and examples disclosed herein. It can further be noted that in this embodiment, the number of guide bars 47 is equal to the number of inner bars 42 in a refiner disc sector enclosing the inlet opening 45, i.e. all guide bars 47 continuously transforms into one respective inner bar 42.
- 30 Sizes and dimensions for bars, i.e. in particular inner bars and guide bars, depend on the sizes and dimensions of the refiner disc of the which bars are components. The maximal length of a guide bar according to the invention, i.e. the distance that the guide bar extends

into a through hole depends apparently on the thickness of the refiner disc, but otherwise suitable sizes and dimension of guide bars (and inner bars) are in the centimeter scale, or fractions of centimeters. A guide bar according to the invention can, for example, have a width of about 1.0 cm, a height (as measured from an inner wall) of about 1.0 cm to 3.0 cm
5 or be even higher such as 5.0 cm, and a length of about 1.0 cm to 5.0 cm or be even longer longer such 10 cm. Further, for all embodiment disclosed herein, an inlet opening can have any position on a refiner disc surface, but has preferably an off-center position. It should further be noted that, for all embodiments and examples presented herein, guide bars are provided only on a portion of an inner wall of a through hole, but it is possible and within
10 the scope of the invention to arrange guide bars on the whole circumference of a through hole. It is, however, preferred to only provide guide bars on a circumferential outer portion of an inner wall, to thereby provide the most laminar material flow. Further, as is evident from the figures, all guide bars disclosed and described herein extend generally in the same direction as the direction of the through hole, on whose inner wall the guide bars are
15 arranged. However, guide bars can according to the invention deviate from the general direction of a through hole, to thereby enhance the radial acceleration that the guide bars impose on incoming feed material.

Although the present invention has been described with reference to specific embodiments,
20 also shown in the appended drawings, it will be apparent to those skilled in the art that many variations and modifications can be done within the scope of the invention as described in the specification and defined with reference to the claims below.

CLAIMS

1. A feed-end refiner disc (11; 21; 31; 41) for a double-disc refiner, comprising at least one inlet opening (15; 25; 35; 45) for feed material, which inlet opening (15; 25; 35; 45) comprises a through hole having an inner wall (26; 36; 46), **characterized in** that at least a
5 portion of the inner wall (26; 36; 46) comprises guide bars (17; 27; 37; 47) and that the feed-end refiner disc (11; 21; 31; 41) further comprises inner bars (12; 22; 32; 42), which are arranged at an inner portion on the surface of the feed-end refiner disc (11; 21; 31; 41), and that at least one guide bar (17; 27; 37; 47) continuously transforms into one inner bar.
- 10 2. The feed-end refiner disc (11; 21; 31; 41) according to claim 1, **characterized in** that the guide bars (17; 27; 37; 47) are arranged on a circumferential outer portion of the inner wall (26; 36; 46).
3. The feed-end refiner disc (11; 21) according to claim 1 or claim 2, **characterized in**
15 that there are more inner bars (12; 22) than guide bars (17; 27) arranged in a refiner disc sector enclosing the inlet opening (15; 25).
4. The feed-end refiner disc (31) according to claim 3, **characterized in** that there are more guide bars (37) than inner bars (32) arranged in a refiner disc sector enclosing the
20 inlet opening (35).
5. The feed-end refiner disc (41) according to any preceding claim, **characterized in** that the inlet opening (45) further comprises a rounded or chamfered transition portion (48), which provides a smooth transition from the through hole, which is part of the inlet
25 opening (45), to the surface of the feed-end refiner disc (41).
6. A double-disc refiner comprising the feed-end refiner disc (11; 21; 31; 41) according to any preceding claim.

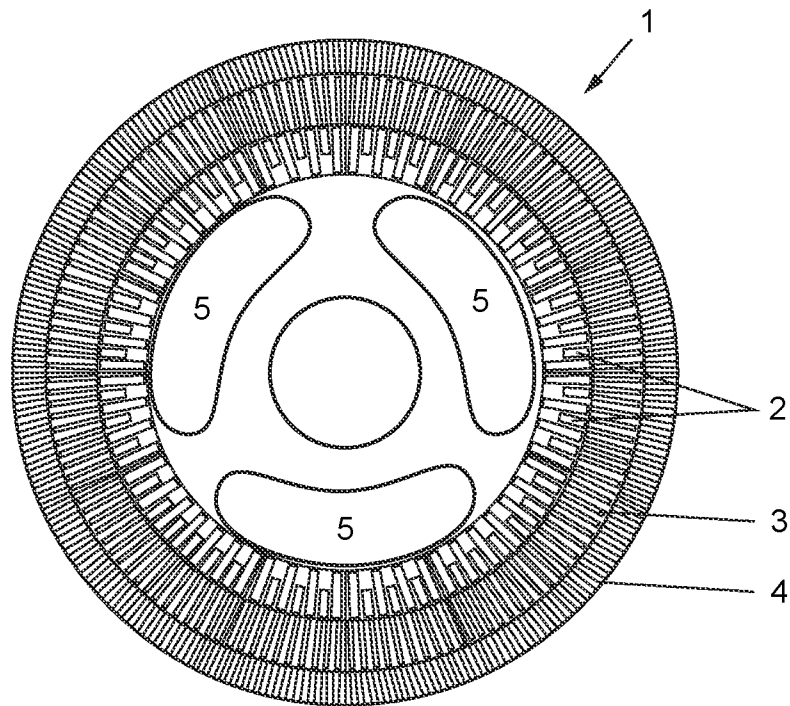


Fig.1
(Prior Art)

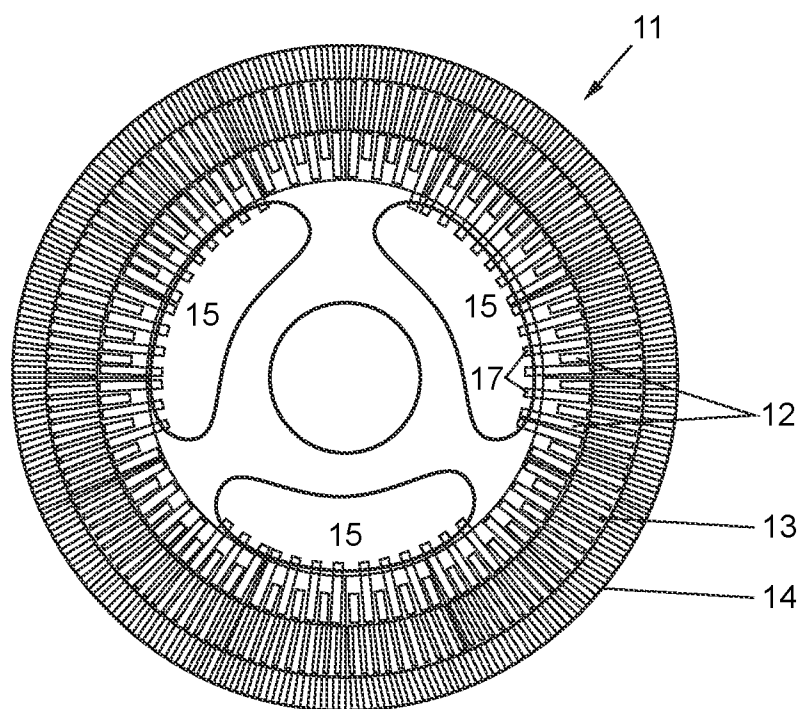


Fig.2

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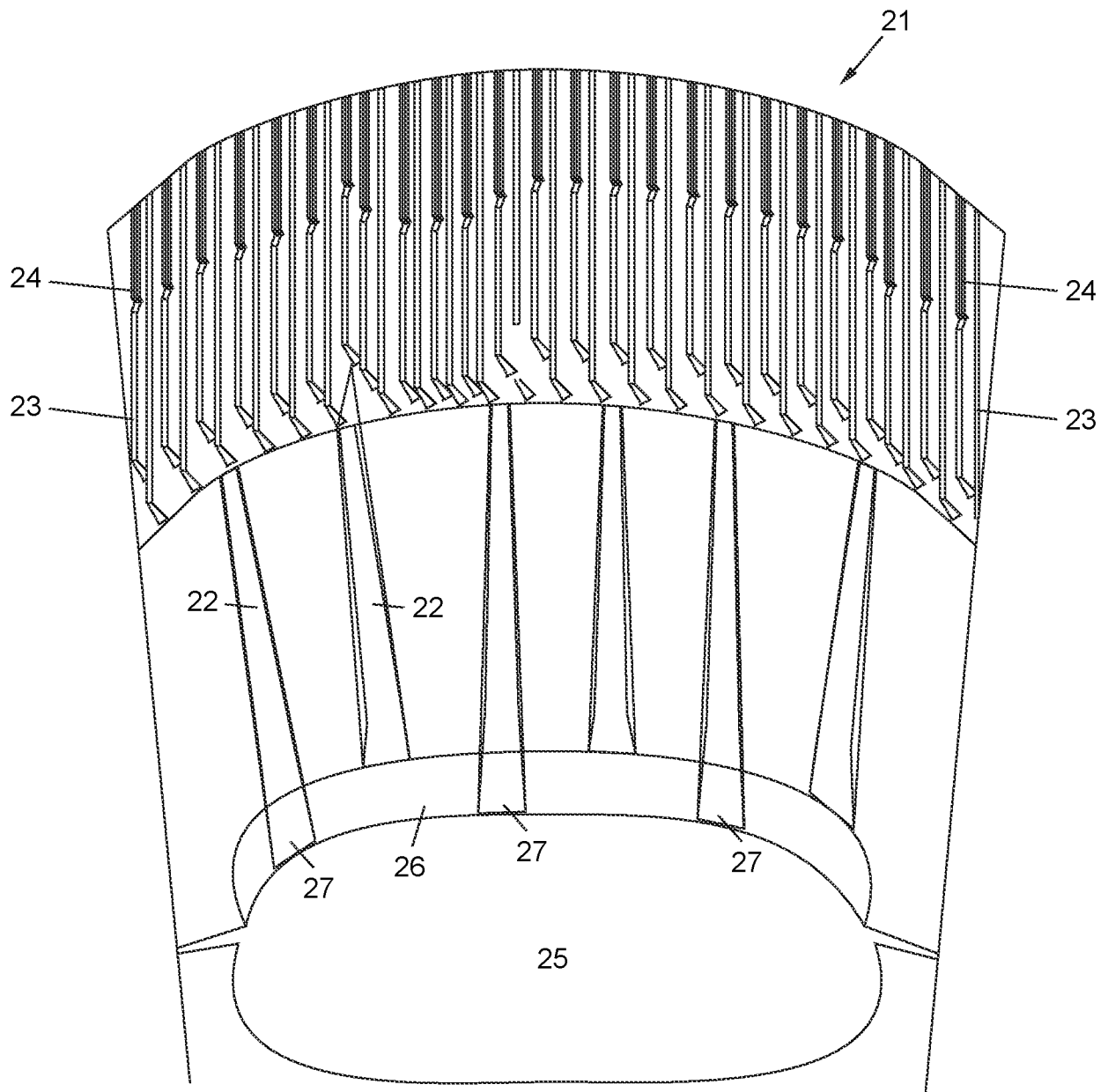


Fig.3

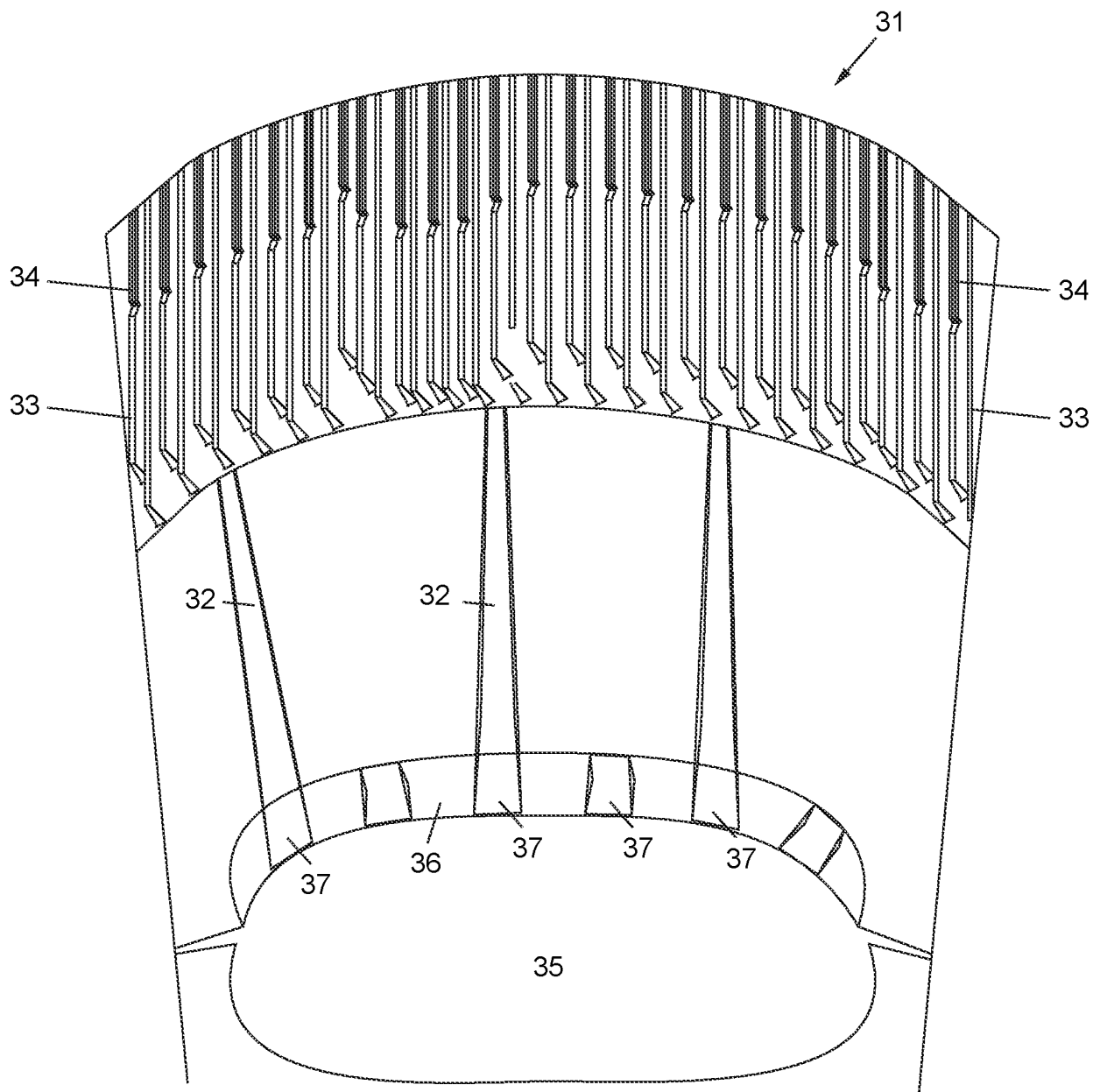


Fig.4

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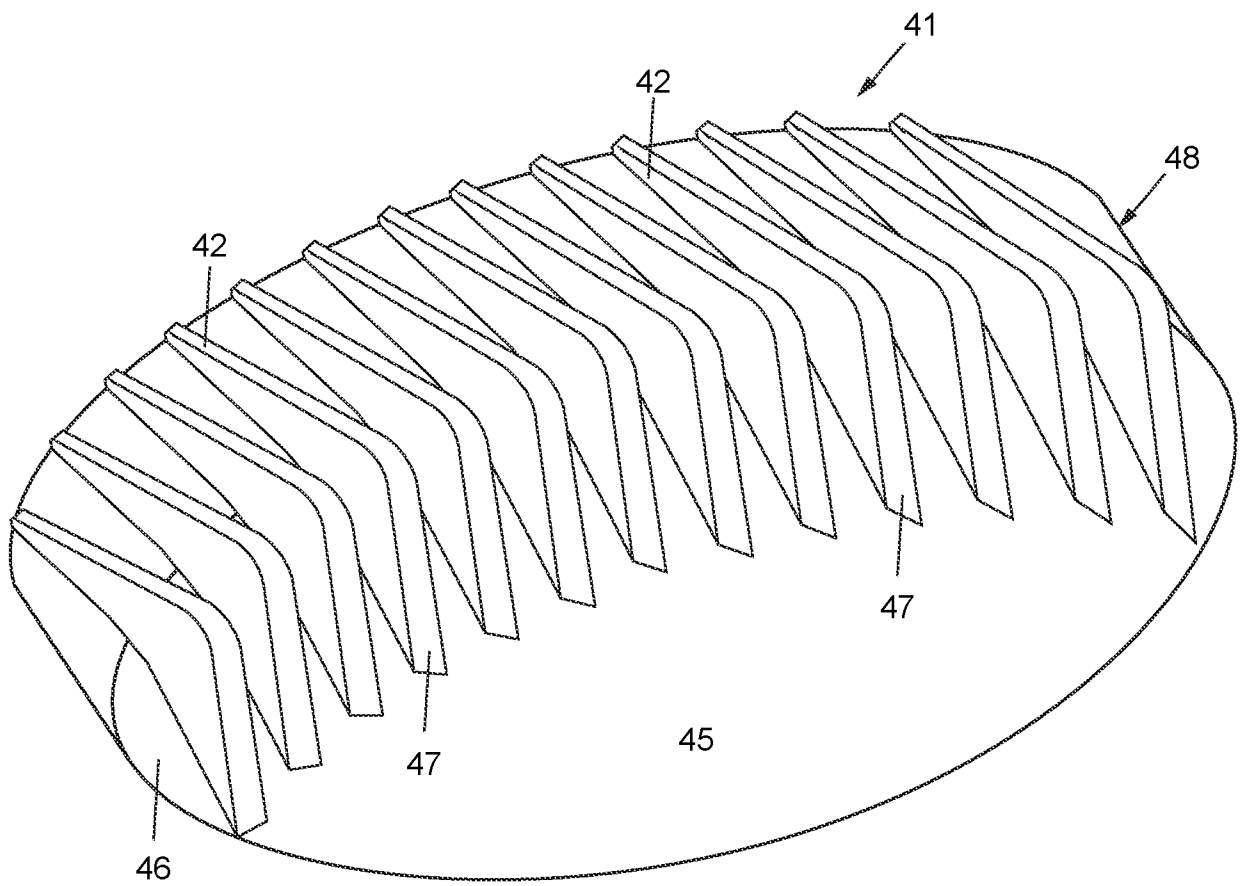


Fig.5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2018/050806

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: B02C, D21B, 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)

EPO-Internal, PAJ, WPI data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 499714 A (CORNING ARTHUR M), 20 June 1893 (1893-06-20); whole document; figures 1-2 --	1-6
A	US 1187360 A (MARTIN MYRON R), 13 June 1916 (1916-06-13); whole document --	1-6
A	CN 107022919 A (ANDRITZ (CHINA) CO LTD), 8 August 2017 (2017-08-08); paragraphs [0024], [0029]; figures 1,2; WPI-abstract --	1-6
A	US 5167373 A1 (BOHN WILLIAM L ET AL), 1 December 1992 (1992-12-01); whole document --	1-6



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
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent 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
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"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

10-10-2018

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2018/050806

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 20080041997 A1 (GINGRAS LUC), 21 February 2008 (2008-02-21); paragraphs [0014], [0015], [0032], [0034]; figures 1,2B,3A,3B,4 --	1-6
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D21D 1/30 (2006.01)

B02C 7/12 (2006.01)

B02C 11/04 (2006.01)

D21B 1/26 (2006.01)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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