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(71) Applicant: **VALMET AB** [SE/SE]; 851 94 Sundsvall (SE).

(72) Inventors: **ÖDMARK, Leif**; Solvägen 29, 864 33 Matfors (SE). **LÖFGREN, Mikael**; Trafikgatan 3B, 856 44 Sundsvall (SE). **ERIKSSON, Niklas**; Färjevägen 58B, 865 31 Alnö (SE).

(74) Agent: **SVENSSON, Niklas**; Valmet AB, 851 94 Sundsvall (SE).

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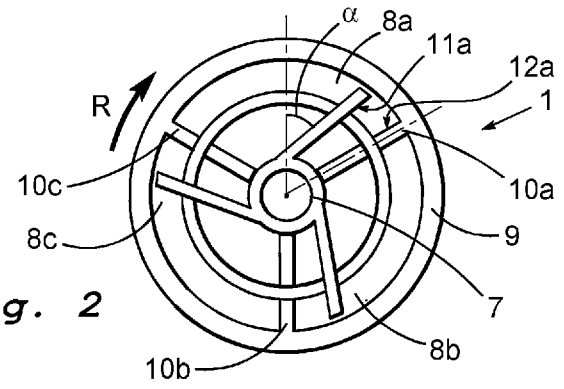

Fig. 2

(57) Abstract: A mixing unit (201) for use in a mixing apparatus for mixing treatment media in liquid or gaseous state with a fiber suspension. The mixing unit is adapted to be arranged in a mixing chamber of the mixing apparatus and comprises at least one rotor (207) and at least one stator (209). Each rotor is adapted to be connected to the drive shaft to rotate with the drive shaft in a direction of rotation (R), and each rotor comprises at least one radially extending rotor arm (208a-f). Each stator is arranged axially adjacent at least one rotor, and each stator comprises at least one radially extending stator arm (210a-g). The at least one stator arm and the at least one rotor arm are mutually configured such that at least a portion of a leading surface of said rotor arm passes a front surface of the stator arm at an angle during rotation of said rotor.

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MIXING UNIT FOR USE IN A MIXING APPARATUS AND A MIXING APPARATUS COMPRISING SUCH A MIXING UNIT

TECHNICAL FIELD

The invention relates to a mixing unit for use in a mixing apparatus for mixing treatment media into a fiber suspension, e.g. a lignocellulosic pulp suspension. The invention further relates to such a mixing apparatus.

BACKGROUND

Throughout the fiberline, i.e. the different process steps involved when converting wood chips or other fibrous raw material into pulp, there are several positions where mixing apparatuses are used to mix different kind of media into the pulp suspension. The treatment media added into the fiber suspension may for example be for heating, delignification or bleaching purposes. The treatment media may be in liquid or gaseous state.

When mixing treatment media into a fiber suspension, the issue of even and homogeneous distribution is of high importance for the mixing result achieved.

WO2013/089615 discloses a mixing unit and a mixing apparatus comprising at least two rotor bodies arranged on a rotor shaft in an axially separated manner with a stator body placed between the rotor bodies. In embodiment as shown in figures 6a-c, the rotor bodies are provided with radially extending rotor bars, and the stator body is provided with radially inwardly extending stator bars.

Although the above described mixer achieves high mixing efficiency due to the interacting rotor and stator bodies, the mixer may suffer from vibration problems. Accordingly, there is a need for an improved mixer with reduced vibrations with maintained or improved mixing performance.

SUMMARY

An object of the invention is to provide an improved unit for mixing for use in a mixing apparatus. A second object is to provide an improved mixing apparatus.

These and other objects are achieved by the present invention by means of a mixing unit and a mixing apparatus according to the independent claims. Preferred embodiments are defined in the dependent claims.

According to a first aspect of the invention, there is provided a mixing unit for use in a mixing apparatus for mixing treatment media in liquid or gaseous state with a fiber suspension, which apparatus comprises a housing defining a mixing chamber, at least one inlet for feeding a fiber suspension and treatment media into the mixing chamber, a drive shaft connectable to a drive device for rotation of the drive shaft in operation, and an outlet for discharging the mixture of fiber suspension and treatment media. The mixing unit is adapted to be arranged in the mixing chamber and comprises at least one rotor and at least one stator. Each rotor is adapted to be connected to the drive shaft to rotate with the drive shaft in a direction of rotation, and each rotor comprises at least one radially extending rotor arm. Each stator is arranged axially adjacent at least one rotor, and each stator comprises at least one radially extending stator arm. The at least one stator arm and the at least one rotor arm are mutually configured such that at least a portion of a leading surface of said rotor arm passes a front surface of the stator arm at an angle during rotation of said rotor.

In other words, each rotor is connectable to the drive shaft by means of for example a rotor shaft forming a part of said rotor, and each rotor comprises one or more rotor arms or bars which extend radially from the rotor shaft. The rotor and stator arms or bars may be described as elongated since they may have a length which is substantially longer than their width. The rotor and stator arms do not necessarily extend only in a radial direction, but may also extend in the tangential direction such that at least a portion thereof is for example angled or curved in the direction of rotation or opposite the direction of rotation. The mutual configuration of the at least one stator and rotor arms may be alternatively be described in the sense that at least one rotor arm rotates past at least one stator arm with at least a portion of a leading surface of said rotor arm at an angle relative a front surface of said stator arm. This may alternatively be described in that at least a portion of the leading surface of the rotor arm is angled in the direction of rotation or opposite the direction of rotation relative a corresponding radial portion of a front surface of a stator arm when the

rotor and stator arms are angularly aligned with each other, i.e. when the rotor arm passes the stator arm. Put differently, at least a portion of the leading surface is angled or curved in the direction of rotation or opposite the direction of rotation relative a portion of the front surface which is at a corresponding radial distance from the axis of rotation. Put differently, adjacent edge portions of the leading and front surfaces (which is at corresponding radial distance from the axis of rotation) form an angle with each other as seen in the axial direction.

The invention is based on the insight that the vibrations which prior art mixers suffer from relate to pulsating loads caused by the long and instantaneous engagement between the straight rotor and stator arms or bars when the leading surfaces of the rotor bars pass the front surfaces of the corresponding stator arms or bars. The invention is further based on the insight that such pulsating loads may be reduced by mutually configuring the rotor and stator arms or bars in such a manner that at least a radial portion of a leading surface of the rotor arms passes the front surface of the stator arm at an angle. Thereby, the whole leading surfaces of the rotor arms or bars do not pass or engage with the corresponding front surfaces of the stator arms or bars at the same time, thus causing longer engagement length there between, consequently reducing pulsating loads and vibrations.

It is understood that the axis of rotation is defined by the rotation of the rotor, which rotation may be caused by a connection to a drive shaft of a mixing apparatus. It is furthermore understood that leading surface and trailing surface refer to the surfaces of the rotor which face the direction of rotation and opposite the direction of rotation, respectively. It is also understood that front surface and rear surface refer to the surfaces or edges of the stator which face opposite the direction of rotation and in the direction of rotation, respectively. In a mixing apparatus of the present type, no axial transport is usually desired. It is therefore understood that the leading and front surfaces are normally not curved or angled along their axial extension, i.e. they are curved or angled only in, or opposite, the direction of rotation, i.e. the surfaces have a normal direction without any axial component. Consequently, it is understood that the above described angle between portions of the leading and front surfaces describes that at least one of the (surface) portions are angled in the direction of rotation or opposite the direction of rotation.

In embodiments, one of the leading or front surfaces is provided with at least one concave portion, while the other of the surfaces may be plane or flat. In embodiments, both the leading surface and the front surface are provided with at least one concave or strictly concave portion, thereby ensuring an even greater engagement length between the rotor and stator arm. The at least one concave portion may be strictly concave. The at least one concave portion may define a curved portion having a radius. The at least one concave portion may be formed by linear segments or a combination of linear and curved segments. The leading and/or front surface may be provided with a single concave or strictly concave portion extending along essentially the entire length of the respective arm. It is understood that many different mutual geometric configurations are foreseeable based on the above embodiments, all having the common advantage that only portions of the leading and front surfaces engage with each other at a given time, and that long engagement lengths are achieved, which may reduce vibrations due to reduced pulsating loads.

In embodiments, the leading surface of the rotor extends radially at a first angle relative a thought radial line extending from the center of rotation (i.e the center of the rotor and stator), and the front surface of the stator extends radially at a second angle relative a thought radial line extending from the center of rotation, where the first angle differs from the second angle. The leading and front surfaces may both be plane, i.e. flat surfaces, which however extend radially at different angles, such that the whole leading surface of the rotor passes the front surface of the stator at an angle. This embodiment has the advantage that it is easy to manufacture.

In embodiments, the at least one rotor arm or the leading surface thereof, either as a whole or portions thereof, is angled or curved in the direction or rotation (as seen from the center of the rotor), preferably in such a manner that a radially outer end of said leading surface, or a portion thereof, is positioned ahead of an inner end of said leading surface in the rotational direction. Put differently, the leading surface, either as a whole or portions thereof, is disposed at positive angle from a thought radial line in the direction of rotation. It is understood that the thought radial line refers to an imaginary line which extends straight in the radial direction from the center of rotation

(i.e. the center of the rotor) to its circumference. Such an embodiment is advantageous not only in that vibrations may be reduced but further in that separation between the fiber suspension and gas/liquid is prevented since the fiber suspension is pressed radially inwardly.

In an even more advantageous embodiment, the at least one stator arm or the front surface thereof is angled or curved against or opposite the direction of rotation (as seen from the center of the stator). The at least one stator arm or the front surface thereof is preferably angled or curved in such a manner that a radially inner end of said front surface is positioned ahead of an outer end of said front surface in the rotational direction. Put differently, the front surface, either as a whole or portions thereof, is disposed at a positive angle from a thought radial line and against the direction of rotation. It is understood that the thought radial line refers to an imaginary line which extends straight in the radial direction from the center of the stator to its circumference. This further enhances radial transport of the fiber suspension. In other embodiments, a rotor with an angled leading surface may be combined with a stator having a front surface extending straight radially, i.e. with a tangential normal direction. In yet other embodiments, a stator with an angled front surface may be combined with a rotor having a leading surface extending straight radially, i.e. with a tangential normal direction.

In embodiments, the at least one rotor arm is provided with a trailing surface facing opposite the direction of rotation and side surfaces connecting the leading and trailing surfaces, wherein at least one of said side surfaces is provided with at least one groove extending between the leading and trailing surfaces. This embodiment is advantageous since the overall shear surface, and thus the size of the mixing zone, is increased without an increase in the projected area in the rotational direction, thus without an increase in inputted energy. The at least one rotor arm may be provided with a plurality of grooves which are distributed along the radial extension of the arm. The at least one groove or the plurality of grooves may be tangential.

In embodiments, the at least one stator arm is provided with a rear surface facing the direction of rotation and side surfaces connecting said front and rear surfaces, wherein at least one of these side surfaces is provided with at least one groove

extending between the front and rear surfaces. This embodiment is advantageous since the overall shear surface, and thus the size of the mixing zone, is increased without an increase in the projected area in the rotational direction, thus without an increase in inputted energy. The at least one stator arm may be provided with a plurality of grooves which are distributed along the radial extension of the arm. The at least one groove or the plurality of grooves may be tangential. In an advantageous embodiment, both the rotor and stator are provided with side surfaces with grooves, resulting in an even greater increased mixing performance.

In embodiments, the rotor arms of the rotor extend radially outwardly from a radially innermost center portion or rotor shaft. The stator arms of the stator may extend radially inwardly from an outer peripheral ring portion, preferably to a radial position in close vicinity of the center portion or rotor shaft. In such an embodiment, the rotor arms preferably extend to a radial position in close vicinity of the outer peripheral ring portion. The stator and rotor arms advantageously extend in this manner to ensure a high mixing efficiency by providing the longest possible radial overlap between the leading and front surfaces. Alternatively, the rotor arms may extend radially inwardly, and the stator arms extend may radially outwardly.

In embodiments, at least one of rotor comprises flow-restraining means in the form of at least one concentric ring portion interconnecting said rotor arms.

In embodiments, the tangential width of the stator and/or rotor arms decreases along their length, i.e. with the distance from the axis of rotation, i.e. the arms have a greater width at a radial inner end than at an outer radial end.

The rotor and stator arms usually extend in respective planes being perpendicular to the axis of rotation, but may in embodiments be angled in the axial direction. In such embodiments, the above described side surfaces are formed at an angle relative these perpendicular planes.

According to a second aspect of the invention there is provided a mixing unit for use in a mixing apparatus for mixing treatment media in liquid or gaseous state with a fiber suspension, which apparatus comprises a housing defining a mixing chamber,

at least one inlet for feeding a fiber suspension and treatment media into the mixing chamber, a drive shaft connectable to a drive device for rotation of the drive shaft in operation, and an outlet for discharging the mixture of fiber suspension and treatment media. The mixing unit is adapted to be arranged in the mixing chamber and comprises at least one rotor. Each rotor is adapted to be connected to the drive shaft to rotate with the drive shaft in a direction of rotation, and each rotor comprises at least one radially extending rotor arm. The rotor arm is provided with a leading surface facing in the direction of rotation and a trailing surface facing opposite the direction of rotation. Side surfaces connect the leading and trailing surfaces, wherein at least one of said side surfaces is provided with at least one groove extending between the leading and trailing surfaces. The rotor arm may be provided with a plurality of grooves which are distributed along the radial extension of the arm. The at least one groove or the plurality of grooves may be tangential.

The grooves provide an increase in the overall shear surface, and thus the size of the mixing zone is increased, thus providing improved mixing performance. This effect is achieved without an increase in the projected area in the rotational direction, thus without an increase in inputted energy.

In embodiments of the mixing unit according to the second aspect of the invention, the mixing unit further comprises at least one stator arranged axially adjacent at least one rotor, wherein each stator comprises at least one radially extending stator arm provided with a rear surface facing in the direction of rotation and a front surface facing opposite the direction of rotation. Side surfaces connect the front and rear surfaces, wherein at least one of said side surfaces is provided with at least one groove extending between the front and rear surfaces. The at least one stator arm may be provided with a plurality of grooves which are distributed along the radial extension of the arm. The at least one groove or the plurality of grooves may be tangential.

In an advantageous embodiment of the mixing unit according to the second aspect of the invention, both the rotor and stator are provided with side surfaces with grooves, resulting in an even greater increased mixing performance.

According to a third aspect of the invention, there is provided a mixing apparatus for mixing treatment media in liquid or gaseous state with or into a fiber suspension. The apparatus comprises a housing defining a mixing chamber, at least one inlet for feeding a fiber suspension and treatment media into the mixing chamber, a drive shaft connectable to a drive device for rotation of the drive shaft in operation, an outlet for discharging the mixture of fiber suspension and treatment media, and a mixing unit according to the first or second aspect of the invention or embodiments thereof.

The features of the embodiments described above are combinable in any practically realizable way to form embodiments having combinations of these features. Further, all features and advantages of embodiments described in connection with the mixing unit according to the first or second aspects of the invention may be applied in corresponding embodiments of the mixing apparatus according to the third aspect of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of the present invention will now be described in more detail with reference to the appended drawings, which show presently preferred embodiments of the invention, wherein:

fig. 1 shows a schematic illustration in an axial view of a prior art mixing unit having straight radially extending rotor and stator arms;

fig. 2 shows a schematic illustration in an axial view of a mixing unit according to an embodiment of the first aspect of the invention, which mixing unit is provided with straight forwardly angled rotor arms;

fig. 3 shows a schematic illustration in an axial view of a mixing unit according to another embodiment of the first or second aspect of the invention, which mixing unit is provided with forwardly curved rotor arms;

fig. 4 shows a schematic illustration in an axial view of a mixing unit according to another embodiment of the first aspect of the invention, which mixing unit is provided with curved rotor and stator arms;

fig. 5 shows a schematic illustration in an axial view of a mixing unit according to another embodiment of the first or second aspects of invention, which

mixing unit is provided with curved rotor and stator arms provided with grooves on their side surfaces;

fig. 6 shows a perspective view of the rotor of the mixing unit shown in fig. 5;

fig. 7 shows a schematic illustration in a cross sectional view of a mixing apparatus according to an embodiment of the third aspect of the invention; and

fig. 8 shows a schematic illustration in an axial view of a mixing unit according to an embodiment of the first aspect of the invention, which mixing unit is provided with straight backwardly angled stator arms.

DETAILED DESCRIPTION

Figure 1 shows a schematic illustration in an axial view of a prior art mixing unit 401. The mixing unit comprises a stator 409 having a peripheral ring portion and straight rotor arms 410a-c extending radially inwardly from the ring portion. The rotor and stator are arranged axially adjacent each other. In the figure, the rotor is shown in front of the stator. The mixing unit further comprises a rotor 407 having a center portion connectable to for example a drive shaft for rotation of the rotor in a direction of rotation R, and straight rotor arms or bars 408a-c extending radially outwardly from the center portion, and two concentric ring connecting the rotor arms. The rotor and stator arms are distributed with even angular spacing there between.

Figure 2 shows a schematic illustration in an axial view of a mixing unit 1 according to an embodiment of the first aspect of the invention. The mixing unit is adapted to be arranged in a mixing chamber of a mixing apparatus such as the mixer shown in figure 7. The mixing unit is similar to that shown in figure 1, with the main difference being that all rotor arms 8a-c are angled forwardly with an angle α relative a thought radial line (line-dotted) in the direction of rotation R such that a radially outer end of each leading surface 11a is positioned ahead of an inner end of said leading surface in the rotational direction, while the stator arms 10a-c are extending radially straight. Consequently, the leading surface extends radially at an angle being different than that of said front surface. The leading and front surfaces are both plane, i.e. flat surfaces. Thus, the whole leading surface of the rotor passes the front surface of the stator at an angle during rotation of the rotor. The rotor/stator arms are both of uniform thickness and may thus also be described as rotor/stator bars. The rotor

arms have a length such that they extend to a radius which corresponds to the inner radius of the peripheral ring portion of the stator. The stator arms extend radially into close vicinity of the center portion of the rotor. In this embodiment, the mixing unit comprises one rotor and one stator, but may in other embodiments comprise further rotors and/or stators arranged in an axially consecutive manner.

Figure 3 shows a schematic illustration in an axial view of a mixing unit according to another embodiment of the first aspect of the invention, which embodiment corresponds to the embodiment in figure 2 except in that the rotor arms 108a-c (and the leading surfaces thereof) are curved forwardly, i.e. in the direction of rotation. The stator 9 is identical to that in figure 2. The leading surfaces (for example 111a) of the rotor arms are provided with a concave portion in the form of a curved portion 113a having a radius. The axis defining the radius is perpendicular to the axis of rotation. The leading surface may also be described as being disposed at positive angle in the direction of rotation relative a thought radial line. In other embodiments, the concave portion may be formed by linear segments or a combination of linear and curved segments. The curved portion extends along the whole length of the rotor arms. In other embodiments, there may be two or more curved portions on the leading edge. The rotor arms 108a-c are provided with a trailing surface facing opposite the direction of rotation and side surfaces (for example 114a) connecting the leading and trailing surfaces. The side surfaces are each provided with three tangential grooves (for example 115a1-a3) extending between the leading and trailing surfaces. In other embodiments, more tangential grooves may be provided.

Figure 4 shows a schematic illustration in an axial view of a mixing unit according to another embodiment of the first aspect of the invention. The mixing unit is provided with a rotor 207 having rotor arms 208a-f which are curved forwardly in the direction of rotation. The leading surfaces (for example 211a) of the rotor arms are provided with a concave portion in the form of a curved portion (for example 213a) having a radius. The axis defining the radius is perpendicular to the axis of rotation.
The curved portion extends along the whole length of the rotor arms. The stator 209 is provided with stator arms 210a-g which are curved backwards, i.e. against or opposite in the direction of rotation (as seen from the center of the stator), i.e. the stator arms extend radially outwards being curved against the direction of rotation.

The front surfaces (for example 212a) of the stator arms are provided with a concave portion in the form of a curved portion (for example 214a) having a radius. The axis defining the radius is perpendicular to the axis of rotation. The front surface may also be described as being disposed at positive angle and against the direction of rotation relative a thought radial line. The curved portion extends along the whole length of the stator arms. As can be understood from the figure, the whole leading surface 211a passes the front surface 212a at angle, where an angle β is indicated in the figure for the specific portions of the surfaces which intersect or pass each other in the relative angular positions shown.

Figure 5 shows a schematic illustration in an axial view of a mixing unit according to another embodiment of the first or second aspects of invention, which mixing unit is provided with curved rotor and stator arms. This embodiment is identical to the embodiment shown in figure 4 except that side surfaces of each rotor and stator arm are provided with tangential grooves. The side surfaces (for example 314a) which connect the leading and trailing edges of the rotor arms (for example 308a) are each provided with three tangential grooves (for example 315a1-a3) extending between the leading and trailing surfaces. Each of the stator arms, such as 310a, are provided with tangential grooves in the same manner.

Figure 6 shows a perspective view of the rotor of the mixing unit shown in fig. 5. In this figure it is shown that the rotor 307 has a certain axial thickness, and that the leading and trailing surfaces (for example 311a) are curved or angled only in the direction of rotation. Thus the normal direction of these surfaces have no axial component. Furthermore, the tangential grooves (for example 315a1-a3) are shown.

Figure 7 shows a schematic illustration in a cross sectional view of a mixing apparatus 2 according to an embodiment of the third aspect of the invention. The apparatus comprises a housing defining a mixing chamber 3. A first inlet 4a for the fiber suspension is provided as well as a second inlet 4b, 4b1, 4b2 for treatment media. A drive shaft 5 is provided for connection to a drive device for rotation of the drive shaft in operation. The mixture of fiber suspension and treatment media is discharged through the outlet 1. A mixing unit 1 is arranged in the mixing chamber 3. The mixing unit comprises two rotors 7 and one stator 9 of the same type shown in

figure 2. In other embodiments, other types of rotors and stators may however be used. The rotors are connected to the drive or rotor shaft 5 and are axially spaced apart from each other with the stator arranged there between. The stator is connected to the housing of the apparatus.

Figure 8 shows a schematic illustration in an axial view of a mixing unit 1 according to an embodiment of the first aspect of the invention. The mixing unit is adapted to be arranged in a mixing chamber of a mixing apparatus such as the mixer shown in figure 7. The mixing unit is similar to that shown in figure 2, with the difference being that all rotor arms 508a-c extend straight radially, and where the stator arms 510a-c are angled backwardly with an angle γ relative a thought radial line (line-dotted) in the direction of rotation R such that a radially inner end of each front surface 512a of the stator arms is positioned ahead of an outer end of said front surface in the rotational direction. Consequently, the leading surface 511a extends radially at an angle being different than that of said front surface 512a.

The description above and the appended drawings are to be considered as non-limiting examples of the invention. The person skilled in the art realizes that several changes and modifications may be made within the scope of the invention. For example, the number of rotors and stators of each mixing unit may be varied. Furthermore, the number of rotor and stator arms on each rotor and stator may be varied. Furthermore, the exact shape and angle or curvature of the rotor and/or stator may be varied. The scope of protection is determined by the appended patent claims.

CLAIMS

1. A mixing unit (1) for use in a mixing apparatus for mixing treatment media in liquid or gaseous state with a fiber suspension, which apparatus comprises a housing defining a mixing chamber (3), at least one inlet (4a,4b) for feeding a fiber suspension and treatment media into the mixing chamber, a drive shaft (5) connectable to a drive device for rotation of the drive shaft in operation, and an outlet (6) for discharging the mixture of fiber suspension and treatment media, said mixing unit being adapted to be arranged in said mixing chamber (3) and comprising:
   - at least one rotor (7; 107; 207; 307), each rotor being adapted to be connected to the drive shaft to rotate with said drive shaft in a direction of rotation (R), each rotor comprising at least one radially extending rotor arm(8a-c; 108a-c; 208a-f; 308a); and
   - at least one stator (9; 209; 309), each stator being arranged axially adjacent at least one rotor, said stator comprising at least one radially extending stator arm (10a-c; 210a-g, 310a),

   wherein at least one stator arm and at least one rotor arm are mutually configured such that at least a portion of a leading surface (11a; 111a) of said at least one rotor arm passes a front surface (12a; 212a) of a stator arm at an angle (β) during rotation of said rotor.

2. Mixing unit according to claim 1, wherein said leading surface (11a; 111a) and/or said front surface (12a; 212a) is provided with at least one concave portion (113a; 213a, 214a).

3. Mixing unit according to claim 1, wherein said leading surface (11a; 111a) is provided with at least one concave portion (113a; 213a).

4. Mixing unit according to claim 3, wherein said leading surface (11a; 111a) is provided with one concave portion (113a; 213a) extending along essentially the entire length of said rotor arm.

5. Mixing unit according to any of claims 1-4, wherein said front surface (212a) is provided with at least one concave portion (214a).

6. Mixing unit according to claim 5, wherein said front surface (212a) is provided with one concave portion (214a) extending along essentially the entire length of said stator arm (210a).

7. Mixing unit according to claim 1, wherein said leading surface (11a) extends radially at an angle (α) relative a thought radial line extending from the center of the rotor, which angle is different than the corresponding angle of said front surface (12a).

8. Mixing unit according to any of the preceding claims, wherein the leading surface of said rotor arm (8a; 108a; 208a) is angled or curved in the direction of rotation such that a radially outer end of said leading surface (11a; 111a; 211a) is positioned ahead of an inner end of said leading surface in the rotational direction.

9. Mixing unit according to any of the preceding claims, wherein the front surface of said at least one stator arm (210a) is angled or curved opposite the direction of rotation such that a radially inner end of said front surface (212a) is positioned ahead of an outer end of said front surface in the rotational direction.

10. Mixing unit according to any of the preceding claims, wherein said at least one rotor arm (108a; 308a) is provided with a trailing surface facing opposite the direction of rotation and side surfaces (114a; 314a) connecting said leading and trailing surfaces, wherein at least one of said side surfaces is provided with at least one groove (115a1-a3; 315a1-a3) extending between the leading and trailing surfaces.

11. Mixing unit according to any of the preceding claims, wherein said at least one stator arm (310a) is provided with a rear surface facing the direction of rotation and side surfaces connecting said front and rear surfaces, wherein at least

one of said side surfaces is provided with at least one groove extending between the front and rear surfaces.

12. Mixing unit according to claim 10 or 11, wherein said at least one side surface (114a; 314a) is provided with a plurality of grooves (115a1-a3; 315a1-a3) distributed along the radial extension of the arm.

13. Mixing unit according to any of claims 10-12, wherein said at least one groove (115a1-a3; 315a1-a3) is tangential.

14. Mixing apparatus for mixing treatment media in liquid or gaseous state with a fiber suspension, which apparatus comprises
    - a housing defining a mixing chamber (3);
    - at least one inlet (4a-b) for feeding a fiber suspension and treatment media into the mixing chamber;
    - a drive shaft (5) connectable to a drive device for rotation of the drive shaft in operation;
    - an outlet (6) for discharging the mixture of fiber suspension and treatment media; and
    - a mixing unit (1) according to any of the preceding claims.

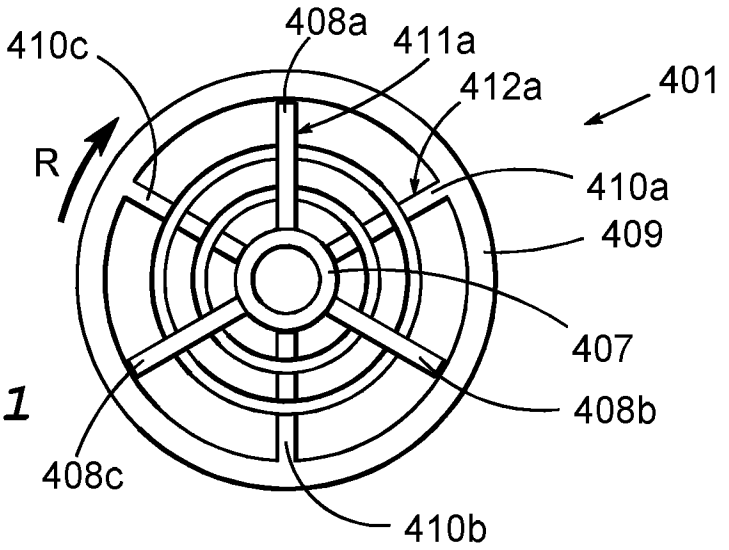


Fig. 1

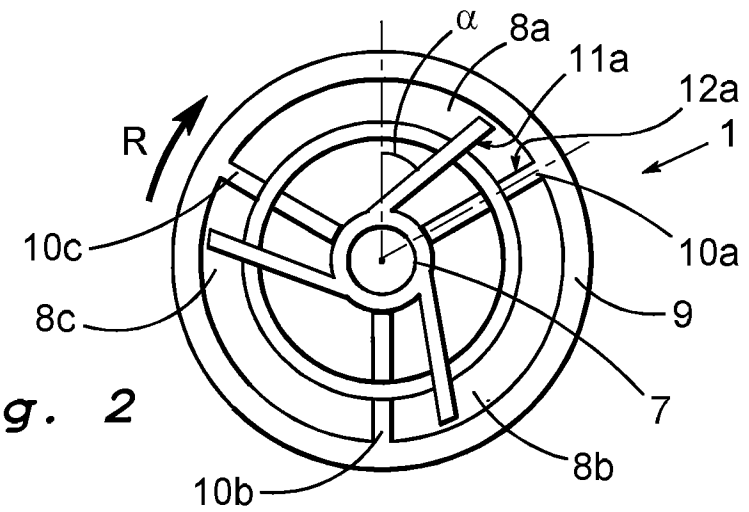


Fig. 2

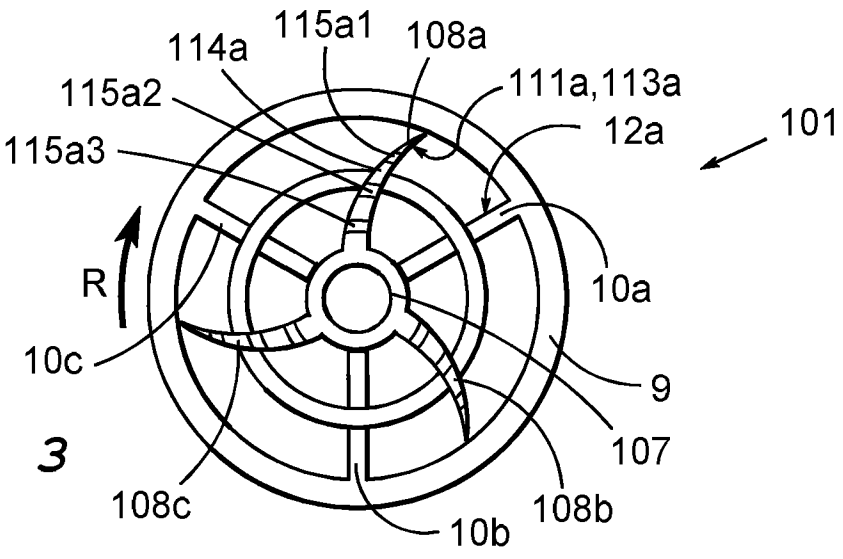
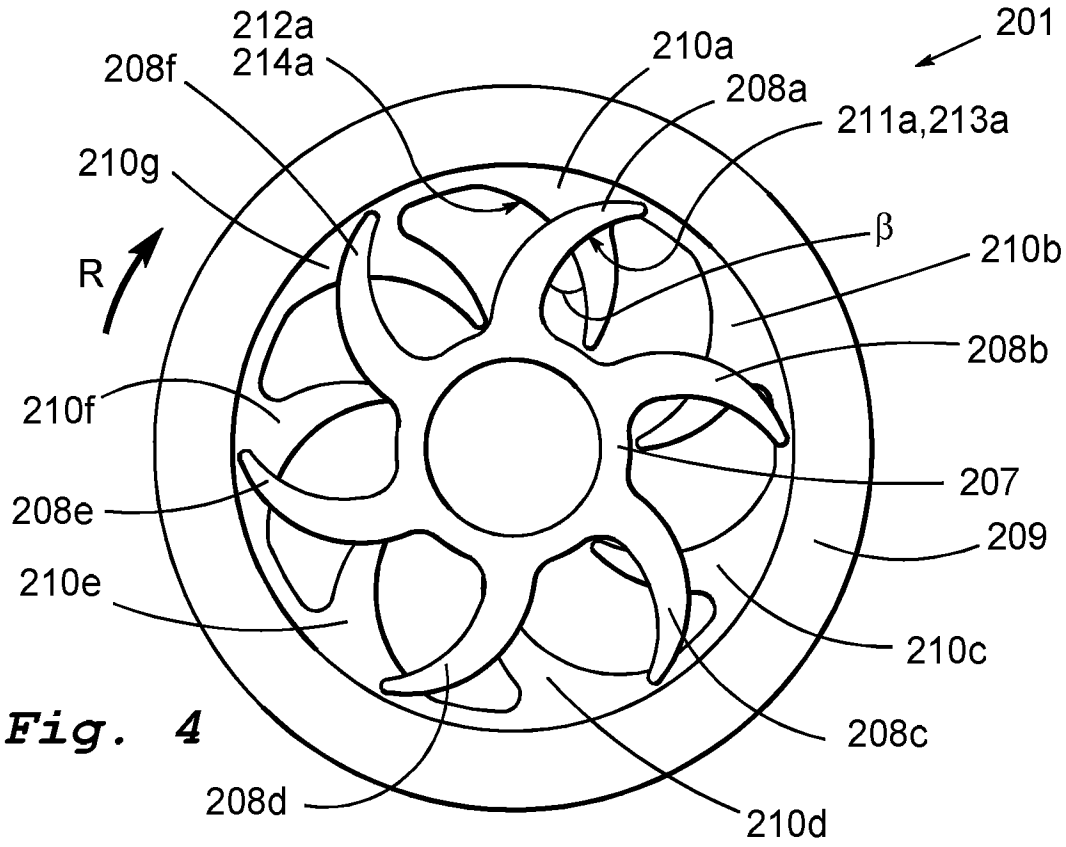


Fig. 3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208d
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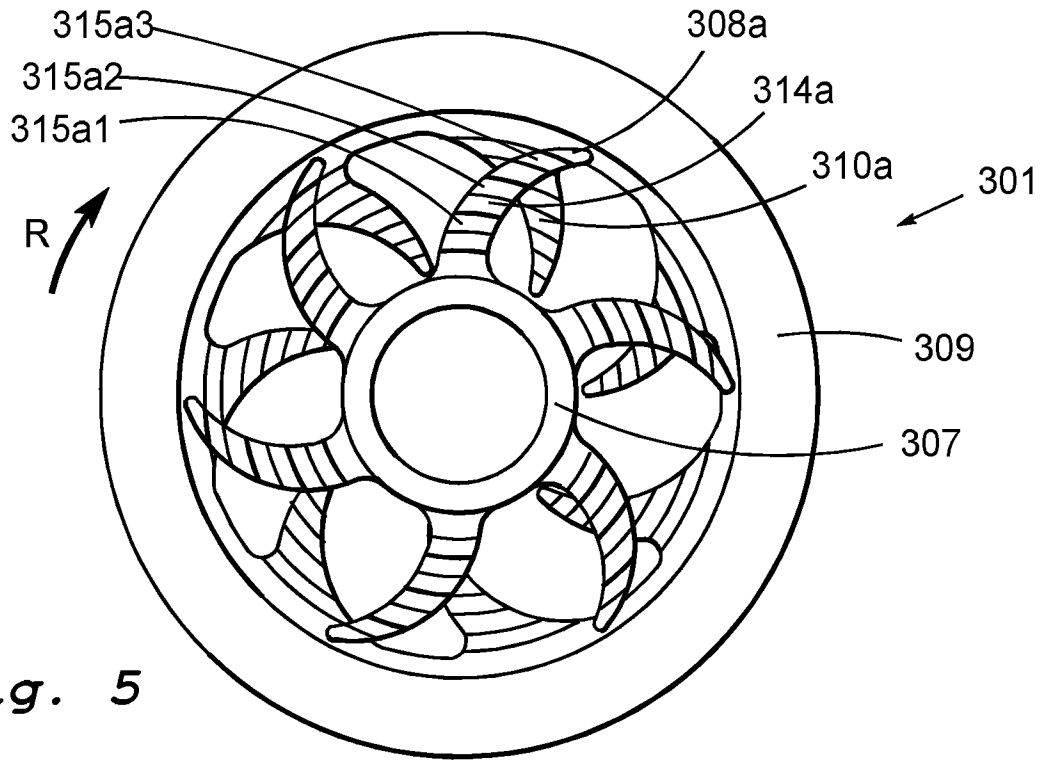
Fig. 4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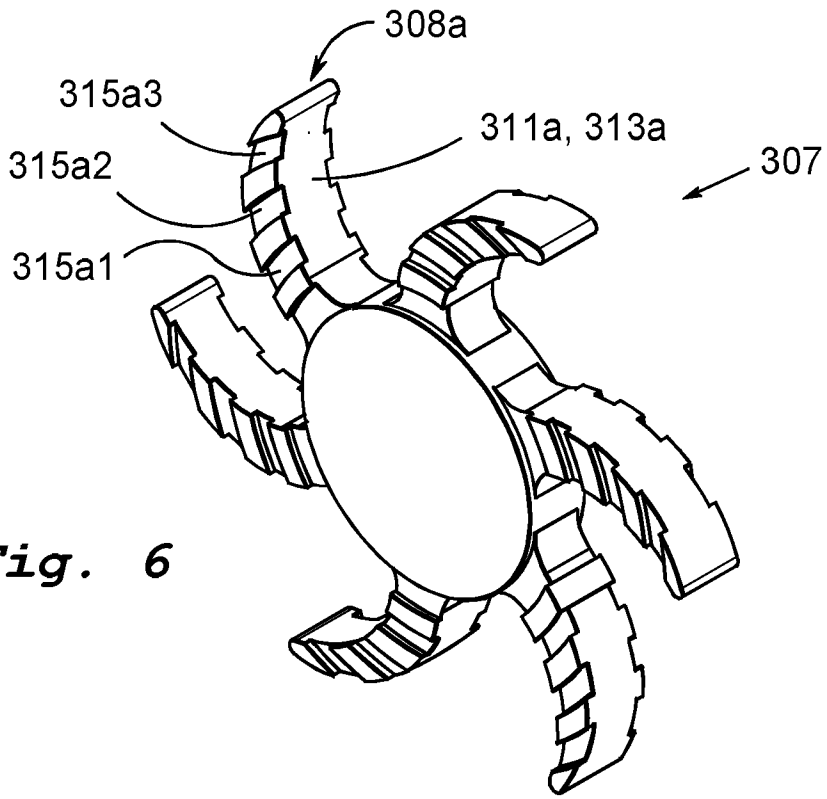
314a
315a1
310a
301
R
309
307

Fig. 5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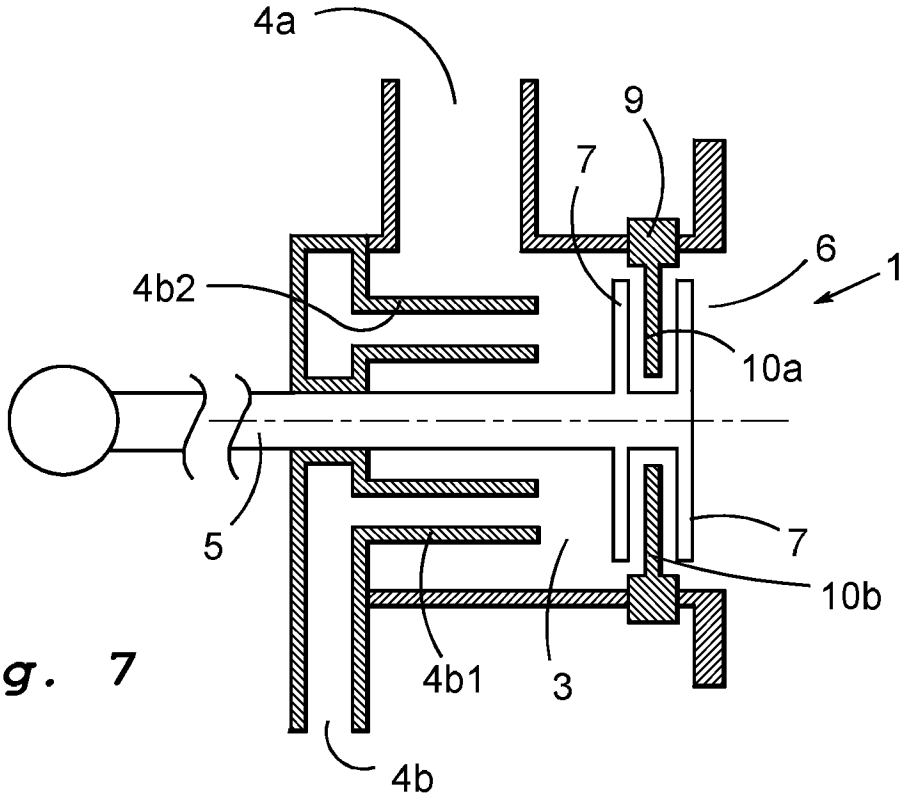
311a, 313a
315a2
307
315a1

Fig. 6


4a
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6
1
4b2
10a
5
7
10b
4b1
3
4b

Fig. 7

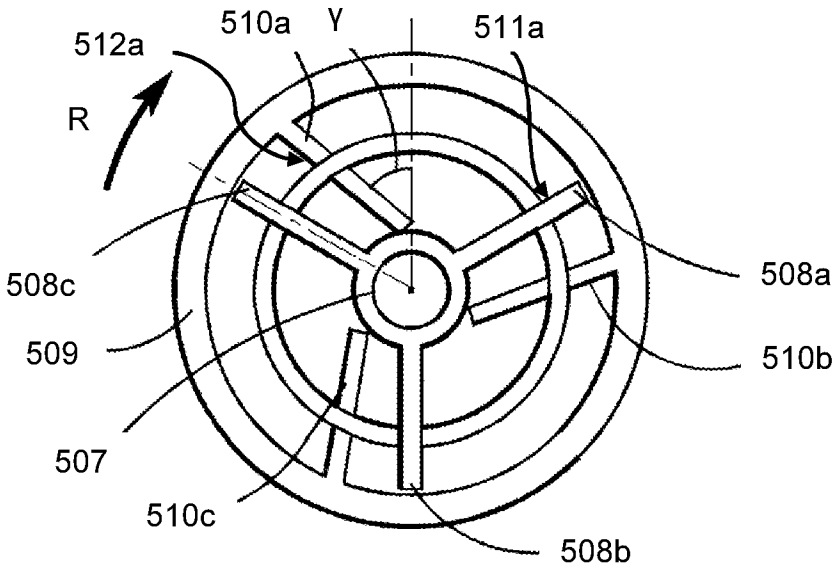

Fig. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2017/050568

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: B01F, D21B, D21C

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, COMPENDEX, IBM-TDB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3218040 A (RICHTER JOHAN C F C), 16 November 1965 (1965-11-16); column 1, line 10 - line 14; column 1, line 20 - line 22; column 1, line 53 - line 67; column 2, line 12 - line 18; column 3, line 6 - line 8; column 3, line 10 - line 16; figures 1-4 --	1, 14
A	WO 2013089615 A1 (METSO PAPER SWEDEN AB), 20 June 2013 (2013-06-20); whole document -- --------	1-14

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

* Special categories of cited documents:

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

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

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"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

"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

"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

"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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12-06-2017	12-06-2017

Name and mailing address of the ISA/SE	Authorized officer
Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Bengt Christensson Telephone No. + 46 8 782 28 00

International application No.
PCT/SE2017/050568

Continuation of: second sheet

International Patent Classification (IPC)

B01F 7/00 (2006.01)
D21B 1/34 (2006.01)
D21C 9/10 (2006.01)

US	3218040	A	16/11/1965	DE	1546228	A1 26/03/1970
				FI	41894	B 01/12/1969
WO	2013089615	A1	20/06/2013	EP	2790823	A1 22/10/2014
				SE	536456	C2 12/11/2013
				SE	1100924	A1 16/06/2013
				US	20140369156	A1 18/12/2014
				US	9468893	B2 18/10/2016