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(54) **Paddle for a stirring device**

(57) There is provided a paddle (100) for a stirring device. In accordance with embodiments, the paddle (100) comprises a rod (102) with a mounting portion (104) being mountable to a rotatable shaft of the stirring device; a head (106), the head (106) and the mounting portion (104) defining an outward direction (110) from the mounting portion (104) to the head (106); and a protrusion (108) extending outwardly from the head (106) in the outward direction (110), the protrusion (108) thereby forming an outer end of the paddel (100). According to a further embodiment, the protrusion (108) may be tapered in circumferential direction.

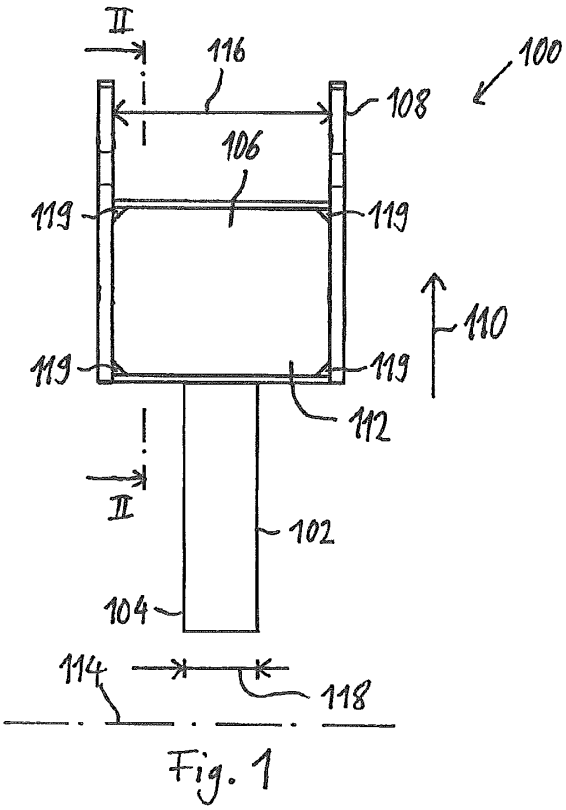

Fig. 1

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to the field of stirring devices for fermenters.

BACKGROUND OF THE INVENTION

[0002] EP 1841853 B1 discloses a horizontal fermenter consisting of a tank and a driven shaft penetrating in the tank in its longitudinal direction. The driven shaft comprises a plurality of agitator arms arranged thereon with paddles. The paddles are formed from two shares arranged in a V-shaped manner which act in one rotational direction as paddles and in the other rotational direction of the agitator as plough shares.

[0003] There may be a need for a paddle of a stirring device with improved characteristics.

SUMMARY OF THE INVENTION

[0004] This need may be met by the subject matter according to the independent claims. Advantageous embodiments are in particular described by the dependent claims.

[0005] According to an embodiment of a first aspect of the herein disclosed subject matter there is provided a paddle for a stirring device of a fermenter, the paddle comprising a rod with a mounting portion being mountable to a rotatable shaft of the stirring apparatus; a head, the head and the mounting portion defining an outward direction from the mounting portion to the head; and a protrusion extending outwardly from the head in the outward direction, the protrusion forming an outer end of the paddle.

[0006] This aspect is based on the idea that by the outwardly extending protrusion a loosening or breaking up of a sediment layer is achieved without requiring an excessive driving torque for driving the rotatable shaft. Depending on its configuration, the head may be adapted for providing an efficient mixing of the fermentation material contained in the fermenter. According to an embodiment, the stirring device is operated intermittently, with alternating stop periods and operation periods. Without the protrusions either the sediment layer formed during a stop period is not broken up or, if the paddle extends into the sediment layer, the startup of the stirring device requires a high driving torque. But also in embodiments where the stirring device is operated continuously, the protrusion combine a loosening of a sediment layer and a reduction of the sediment layer with a relatively low driving torque for driving the stirring device.

[0007] According to an embodiment, the rotatable shaft defines an axial direction parallel to an axis of rotation and radial directions perpendicular to the axial direction. A rotation of the rotatable shaft defines two circumferential directions, clockwise and counterclockwise. Hence, if the paddle is mounted to the rotatable shaft, during a rotation of the shaft the head moves in one of the circumferential directions, i.e. clockwise or counterclockwise. In order to distinguish both opposite circumferential directions without need to specify a particular one, the circumferential directions are also referred to as first circumferential direction and second circumferential direction, wherein the first circumferential direction is one of clockwise and counterclockwise and the second circumferential direction is the other of clockwise and counterclockwise.

[0008] According to an embodiment the head is an individual part mounted to the rod. According to another embodiment, the head is formed by an outer end of the rod wherein the outer end is opposite the mounting portion. With regard to the axial direction, the outer end is a radially outer portion of the rod.

[0009] In accordance with an embodiment, the protrusion extends from the head in a direction opposite to the rod. In other words, the head is located between the rod and the radially outwardly extending protrusion.

[0010] According to an embodiment, the protrusion is adapted to the stirring motion the paddle performs during the stirring operation. For example according to an embodiment, a rotation of the paddle mounted to the shaft and hence rotation of the shaft defines a first circumferential direction. According to an embodiment, the protrusion has a tapered end pointing in the first circumferential direction. According to a further embodiment, the protrusion has a second tapered end, pointing in the second circumferential direction opposite the first circumferential direction. The tapered end(s) of the protrusion can be moved more easily through the sediment in the fermenter compared to a straight end, thereby reducing the driving torque required for driving the shaft to which the paddle is mounted. Having two tapered ends pointing in opposite directions, the reduced driving torque is achieved for both rotational directions, i.e. for the first circumferential direction as well as for the second circumferential direction. According to a further embodiment, the protrusion is symmetrically formed with regard to the rod or, in another embodiment is symmetrically formed with regard to a radial direction perpendicular to the axis of rotation of the rotatable shaft. According to an embodiment, the paddle is configured symmetrically such that for equal rotational velocities the driving torque for driving the rotatable shaft clockwise is identical to the driving torque for driving the rotatable shaft counterclockwise.

[0011] According to an embodiment, at least one of the first tapered end and the second tapered end is tapered in a plane perpendicular to the axis of rotation of the rotatable shaft. According to a further embodiment the protrusion as a first portion which forms the radially outer end of the paddle and a second portion which provides for an attachment to the rod. In an embodiment, the first portion has a first dimension in circumferential direction and the second portion has a second dimension in circumferential direction wherein the first dimension is larg-

er than the second dimension. The protrusion may be attached to the head, to the rod, or to both, the head and the rod. It should be understood that in case the head is formed by the rod, attachment of the protrusion to the rod means attachment to a portion of the rod different from the head portion.

[0012] According to an embodiment, the protrusion is formed by a plate. For example, in an embodiment the plate has two opposing major surfaces running parallel. According to an embodiment, the major surfaces of the plate are oriented perpendicular to the axis of rotation of the shaft. According to other embodiments, the major surfaces of the plate forming the protrusion are oriented at an angle to the axis of rotation. In such an orientation, where the major surfaces of the plate are oriented at an angle different from 90 degrees with regard to the axis of rotation of the shaft of the stirring apparatus, the driving torque required to drive the shaft is higher compared to an orientation where the major surfaces of the plate are oriented at an angle of 90 degrees (i.e. perpendicular) to the axis of rotation of the shaft.

[0013] According to an embodiment, the paddle comprises at least one further protrusion, wherein the protrusions are spaced from each other in the axial direction. According to a further embodiment, at least two protrusions are each formed of a plate with the major surfaces of the plates being parallel.

[0014] According to a further embodiment, the head of the paddle comprises a recess having an opening facing the first circumferential direction. The recess in the head of the paddle promotes transport of fermentation material by the head, wherein the head acts as a shovel.

[0015] According to a further embodiment, the recess is a first recess and the head further comprises a second recess having an opening being oriented opposite the opening of the first recess. By having two oppositely oriented recesses, the transport capabilities for transport of fermentation material are increased for both directions of rotation, i.e. clockwise as well as counterclockwise.

[0016] According to an embodiment, the first recess and the second recess are configured to require an identical driving torque in both rotational directions. According to another embodiment, the first recess and the second recess are configured so as to require different driving torque for a rotation of the shaft in different rotational directions (corresponding to the different circumferential directions).

[0017] According to an embodiment, the first recess and the second recess are formed by an I-shaped beam, having its longitudinal direction oriented crosswise the first circumferential direction. According to an embodiment, the I-shaped beam has its longitudinal direction oriented perpendicular to the circumferential direction, i.e. parallel to the axial direction of the rotatable shaft.

[0018] Generally herein, an I-shaped beam comprises a base and two side portions flanking the base and being oriented transverse to the base. According to respective embodiments, the side portions may be parallel or non-parallel with respect to each other. According to a further embodiment, the side portions may be oriented perpendicular to the base. According to a further embodiment, the base and the side portions each may be formed of a plate having two parallel surfaces.

[0019] According to an embodiment, the head is variable in its size and/or shape, e.g. for varying the stirring resistance exerted by the head. In such embodiments, the protrusion may for the radially outer end in only one state of the variable head or in two or more states of the variable head, or in every state of the variable head.

[0020] According to a further embodiment, the paddle comprises a variable head portion, the variable head portion generating a first stirring resistance in the first position and generating a second stirring resistance in a second position, wherein the first stirring resistance is smaller than the second stirring resistance. The variable head portion therefore allows changing the stirring resistance depending on the position of the variable head portion. For example, in an embodiment the variable head portion is configured for taking up the first position during rotation in a first circumferential direction and for taking up the second position during a rotation in a second circumferential direction opposite the first circumferential direction. For example, according to an embodiment the variable head portion is a flap pivotable between the first position and the second position. According to an embodiment, the axis of rotation of the flap is oriented parallel to the axis of rotation of the rotatable shaft. According to another embodiment, the axis of rotation of the flap is oriented at an angle to the axis of rotation of the rotatable shaft. According to an embodiment, the flap is pivotable with regard to a radial direction, wherein the flap is closer to the radial direction in the second position than it is in the first position. For example, according to an embodiment in the second position the flap is parallel to the radial direction whereas in the first position the flap is perpendicular oriented with regard to the radial direction. According to other embodiments, the variable head portion may include a head element that is translatory moveable. According to another embodiment, the variable head portion is variable by a translatory and a rotational movement of a head element.

[0021] According to an embodiment of a second aspect of the herein disclosed subject matter, a stirring device of a fermenter is provided, the stirring device comprising rotatable shaft; and at least one paddle mounted on the rotatable shaft, there at least one paddle being configured in accordance with one or more aforementioned embodiments of the first aspect.

[0022] According to an embodiment of a third aspect, a fermenter is provided, the fermenter comprising a stirring device according to an embodiment of the second aspect.

[0023] According to a further embodiment, the fermenter comprises a curved bottom, wherein the protrusion has a curved outer edge facing the curved bottom, the curved outer edge comprising a curvature that is

adapted to the curvature of the curved bottom of the fermenter. According to a further embodiment, the curved outer edge of the protrusion has a curvature that is concentric with the curvature of the curved bottom of the fermenter.

[0024] According to an embodiment of a fourth aspect, a method of providing a stirring device is provided, the method comprising providing a rotatable shaft; providing at least one paddle according to an embodiment of the second aspect; and mounting the at least one paddle to the rotatable shaft.

[0025] Mounting of the paddles to the rotatable shaft may be performed in any suitable way, for example by attaching the mounting portion of the rod to the rotatable shaft. Attachment of the rod to the rotatable shaft may be performed by welding, gluing, etc. According to an embodiment, mounting the paddle to the rotatable shaft comprises: providing a recess on the shaft; placing the rod of the paddle into the recess; and grouting the rod in the recess with a grouting material. According to a further embodiment, the method comprises curing the grouting material. A suitable grouting material may be for example a metal or an alloy, having a melting point that is lower than the melting point of the material of the shaft of the stirring device, plastic, resin, etc. Grouting the rod in the recess has the advantage that the shape and the mechanical stresses in the shaft may not (or at least less) be adversely affected by mounting the rod to the rotatable shaft compared to e.g. welding. Further, since the surface area of the rod that transfers forces from the rod to the rotatable shaft is larger in case of a grouted portion of the rod compared to e.g. a weld line, the mechanical stress in the rod as well as in the rotatable shaft is reduced.

[0026] It has to be noted that embodiments of the herein disclosed subject matter have been described with reference to different aspects of the herein disclosed subject matter. In particular, some embodiments have been described with reference to method type embodiments whereas other embodiments have been described with reference to apparatus type embodiments. However, a person skilled in the art will gather from the above and from the following description that, unless otherwise notified, in addition to any combination of features belonging to one aspect also any combination between features relating to different aspects and embodiments, in particular between features relating to method type embodiments and features relating to apparatus type embodiments is considered to be disclosed with this document.

[0027] The aspects and embodiments defined above and further aspects and embodiments of the herein disclosed subject matter are apparent from the examples to be described hereinafter and are explained with reference to the drawings but to which the invention is not limited.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028]

Fig. 1 shows a paddle in accordance with embodiments of the herein disclosed subject matter.

Fig. 2 shows a cross-sectional view of the paddle of Fig. 1 along line II-II in Fig. 1.

Fig. 3 shows a further paddle in accordance with embodiments of the herein disclosed subject matter.

Fig. 4 shows a further paddle in accordance with embodiments of the herein disclosed subject matter.

Fig. 5 shows an side view of the paddle of Fig. 4 when viewed from line V-V in Fig. 4.

Fig. 6 shows a fermenter in accordance with embodiments of the herein disclosed subject matter.

Fig. 7 illustrates an embodiment of a method of providing a stirring device according to embodiments of the herein disclosed subject matter.

DETAILED DESCRIPTION

[0029] The illustration of the drawings is schematical. It is noted that in different figures, similar or identical elements are provided with the same reference signs or with reference signs which are different from the corresponding reference signs only within the first digit or an appended character.

[0030] Fig. 1 shows a paddle in accordance with embodiments of the herein disclosed subject matter.

[0031] In the paddle 100 comprises a rod 102 having a mounting portion 104 which is mountable to a rotatable shaft of a stirring apparatus (not shown in Fig. 1). The paddle 100 further comprises a head 106 which is located opposite the mounting portion 104. In the paddle 100 further comprises a protrusion 108 extending radially outwardly from the head, i.e. in an outward direction 110 from the mounting portion 104 to the head 106. In accordance with an embodiment, the protrusion 108 forms a radially outer end of the paddle 100.

[0032] In accordance with an embodiment, the paddle 100 comprises two of the protrusions 108. In accordance with an embodiment, the protrusions extend over the head 106 in a direction away from the rod 102. In accordance with a further embodiment, the head 106 is configured for transporting and mixing fermentation material contained in a fermenter. According to an embodiment, the head 106 has a shovel face 112 which is oriented transverse to an axis of rotation 114 about which the paddle is rotated during stirring operation. For example, according to an embodiment, the shovel face 112 of the head is oriented at a right angle with regard to the axis

of rotation 114. According to an embodiment, the shovel face 112 has a width 116 that extends over the width of 118 of the rod 102.

[0033] The head 106 may comprise through openings 119 allowing liquid to pass through the head 106. The through openings 119 may avoid or at least reduce the elevation of liquid from during stirring operation, thereby reducing the stirring resistance.

[0034] According to an embodiment, each protrusion 108 is formed by a plate which is attached to a side of the head 106.

[0035] Fig. 2 shows a cross-sectional view of the paddle 100 of Fig. 1 along line II-II in Fig. 1.

[0036] According to an embodiment, the head 106 is formed of an I-shaped beam 123 having a base 132 and side portions 134, 136 flanking the base 132. The side portions 134, 136 are arranged transverse to the base 132, e.g. at an angle of 90 degrees and may be parallel with regard to each other. According to an embodiment, the I-shaped beam has its longitudinal direction oriented crosswise a circumferential direction indicated at 120 in Fig. 2. According to an embodiment, the I-shaped beam 123 has its longitudinal direction oriented at the right angle with respect to the circumferential direction 120. Accordingly, the longitudinal direction of the I-shaped beam 123 extends perpendicular to the drawing plane of Fig. 2.

[0037] In accordance with an embodiment, the protrusion 108 has a first tapered end 122 and a second tapered end 124. The first tapered end is pointing in the same direction as the shovel face 112 of the head. In accordance with a further embodiment, the paddle 100 further comprises an opposite shovel face 126 pointing in an opposite direction opposite to the direction in which the first shovel face 112 is pointing. The second tapered end 124 is pointing in the same direction as the second shovel face 126.

[0038] According to an embodiment, having regard to the rotation of the paddle during the stirring operation of the stirring device, the first tapered end 122 and the second tapered end 124 are tapered in a motion plane in which the paddle moves during the stirring operation. In particular, according to an embodiment the first tapered end 122 points in a first circumferential direction 120 and the second tapered end points in a second circumferential direction, opposite the first circumferential direction 120.

[0039] In accordance with an embodiment, the head further comprises two recesses 128, 130 pointing in opposite directions. According to an embodiment, each recess points in a circumferential direction. In a further embodiment, the shovel face 112, 126 is formed by a base 132 of the I-shaped beam 123. In this case, the side portions 134, 136 flanking the base 132 form the recesses 128, 130 together with the base 132.

[0040] In accordance with an embodiment, the rod 102 is also formed by an I-shaped beam having a base 138 flanked by two side portions 140, 142. According to an embodiment, the I-shaped beam which forms the rod 102 has its flanking side portions 140, 142 oriented in circumferential directions, as shown in Fig. 2.

[0041] Fig. 3 shows a further paddle 200 in accordance with embodiments of the herein disclosed subject matter.

[0042] The paddle 200 shown in Fig. 3 comprises basically the same features as the paddles 200 shown in Fig. 1 except that the protrusions 108 are attached not only to the head 106 but also to the rod 102. According to an embodiment this is accomplished by providing respectively formed plates 150 providing the protrusions 108 and, at an opposite end thereof an attachment portion 152 for attachment of the plate 150 to the rod 102. In accordance with an embodiment, the plates 150 comprise a bend 154 which allows the plates to be attached to the head 106 and makes the attachment portions 152 abutting the rod 102. In case the rod 102 has recesses facing the attachment portion 152 of the plates 150, the attachment portions may be attached to a ground of the recesses formed in the rod 102. In case the rod 102 is formed by an I-shaped beam, the attachment portion 152 may be attached to the base 138 as well as to the side portions 140, 142. The attachment portions 152 being attached in a recess of the rod may further increase the strength of the paddle.

[0043] Fig. 4 shows a further paddle 300 in accordance with embodiments of the herein disclosed subject matter.

[0044] The paddle 300 comprises a head 306 capable of providing a configuration wherein the head has a large shovel area provided by a fixed head portion 306a and a variable head portion 306b. The variable head portion 306b has a first position in which the variable head portion 306b has a first effective height 360. Further, the variable head portion can be brought into a second position shown in solid lines in Fig. 4, in which the variable head portion has a second effective height 362 which is larger than the first effective height 360. Since the width of the variable head portion (perpendicular to the drawing plane of Fig. 4) is the same in both positions, the variable head portion 306b provides, in accordance with a further embodiment, a first stirring area in the first position and a second stirring area in a second position, wherein the first stirring area is smaller than the second stirring area.

[0045] In accordance with an embodiment, the variable head portion 306b is realized by a pivotable flap 364 which can be fixed in the first position 356 and in the second position 358. For fixation of the first and second positions, 356, 358, stop elements may be provided. For example, a first stop element 366 is provided according to an embodiment, the first stop element 366 limiting a movement of in the variable head portion 306b and fixing the variable head portion 360 in the second position if the paddle is moved in a first circumferential direction 120 in which the fermentation material exerts a force towards the first stop element 366 on the variable head portion 306b. According to a further embodiment, the paddle 300 comprises a second stop element 368 against which the variable head portion 306b is urged during movement of the paddle 300 in a second circum-

ferential direction 121, opposite the first circumferential direction 120. During movement in the second circumferential direction 121, the fermentation material (not shown in Fig. 4) exerts a force on the variable head portion, this force urging the variable head portion 306b, i.e. the pivotable flap 364 of the head 306 down until its rotational movement is stopped by the second stop element 368, corresponding to the first position of the variable head portion.

[0046] The variable head portion 306b thus results in a first stirring resistance in the first position and in a second stirring resistance when the variable head portion 306b is in the second position, wherein the first stirring resistance is smaller than the second stirring resistance.

[0047] It should be noted that the pivotable flap is just one embodiment of a variable head portion according to embodiments of the herein disclosed subject matter. It should be understood that the variable head portion can be configured in various different ways. For example while in the exemplary paddle shown in Fig. 4 the rotation axis of the variable head portion 306b is oriented parallel to an axis of rotation of the paddle which is generally perpendicular to the drawing plane of Fig. 4, other orientations of a rotation axis of a pivotable flap, e.g. a radial orientation in a radial direction with regard to the axis of rotation of the paddle is also possible.

[0048] Fig. 5 shows a side view of the paddle 300 of Fig. 4 when viewed from line V-V in Fig. 4.

[0049] In Fig. 5 the cutting plane resulting in the cross sectional view of Fig. 4 is indicated at the line IV-IV. Further shown in Fig. 5 is the axis of rotation 370 about which the variable head portion 306b is pivotable.

[0050] According to an embodiment, the protrusion 108 forms a radially outer end of the paddle in the first position of the variable head portion as well as in the second position of the variable head portion, as shown in Fig. 5. However, according to other embodiments, the protrusion forms a radially outer end of the paddle only in either the first or the second position of the variable head portion (not shown in Fig. 5).

[0051] According to an embodiment, the paddle as a whole or only part thereof may be armoured, e.g. by hardening, hard coating, e.g. with wolfram carbide, etc.

[0052] It should be noted that although many embodiments described herein include protrusions, portions thereof are tapered in circumferential direction, other embodiments with protrusions without tapered portions in circumferential direction are also possible. For example, according to an embodiment, the protrusions may formed by plates that have straight, radially extending edges pointing in circumferential direction. While the configuration and shape of edges pointing in circumferential direction may influence the stirring resistance of caused by the protrusion, the protrusion may still be useful for loosening the sediment in the fermenter.

[0053] Fig. 6 shows a fermenter 690 in accordance with embodiments of the herein disclosed subject matter.

[0054] The fermenter 690 comprises a stirring device 692 comprising a rotatable shaft 694 and a plurality of paddles 600 mounted to the rotatable shaft 694, one of which is shown in Fig. 6. In accordance with an embodiment, the fermenter 690 has a curved bottom 695 wherein the protrusion 108 has a curved outer edge 693 comprising a curvature that is concentric with the curvature of the curved bottom 695 of the fermenter 690.

[0055] In accordance with an embodiment, the fermenter is a horizontal fermenter having a stirring device with a horizontal axis. For example, according to an embodiment the fermenter is a so-called plug flow fermenter wherein fermentation material is introduced at the first end of the fermenter and is discharged at a second end of the fermenter. According to an embodiment, the rotatable shaft of the stirring device runs on bearings at the end portions of the fermenter 690. Additionally, an auxiliary support 691 may be provided for supporting the rotatable shaft 694 between the first end and the second end of the fermenter.

[0056] Fig. 7 illustrates an embodiment of a method of providing a stirring device according to embodiments of the herein disclosed subject matter.

[0057] The method generally comprises providing a rotatable shaft, providing at least one paddle in accordance with embodiments of the herein disclosed subject matter and mounting the at least one paddle to the rotatable shaft.

[0058] In accordance with an embodiment, the method comprises providing a recess 696 on the rotatable shaft 694, placing the rod 102 of the paddle into the recess 696 and grouting the rod 102 in the recess with a grouting material 697.

[0059] According to an embodiment, the recess 696 is provided on an outer surface of the rotatable shaft 694, as shown in Fig. 7. For example, according to an embodiment the recess 696 is provided by attaching a formwork 698 on the rotatable shaft 694. According to other embodiments, the recess will be formed by the rotatable shaft 694 itself, e.g. by deep drawing of a portion of the rotatable shaft 694. It should be noted that in accordance with an embodiment of the inventive subject matter the rotatable shaft 694 is a hollow shaft. The formwork 698 may be removed after curing of the grouting material or may be left in place, even during operation of the stirring device.

[0060] According to other embodiments, the paddles are mounted to the rotatable shaft by any suitable means, e.g. by welding, glueing, threaded bolts, etc.

[0061] The arrangement of the paddles on the rotatable shaft may be of any suitable configuration. According to an embodiment, the smallest angle between two paddles takes a first value, e.g. a value in the range between 20 degrees and 50 degrees, e.g. 36 degrees. According to an embodiment, two paddles forming the smallest angle with respect to each other, i.e. a first paddle and a second paddle, are spaced apart from each other in an axial direction. According to a still further embodiment, between the two paddles forming the closest angle with

respect to each other a third paddle is axially arranged between these two paddles. Hence, in the axial direction the first paddle is spaced from the third paddle by a first distance and the second paddle is spaced from the third paddle by a second distance, wherein the first distance and the second distance are smaller than a third distance between the first paddle and the second paddle. However, in accordance with the embodiment described before, the first paddle and the second paddle form a first angle which is smaller than a second angle between the first paddle and the third paddle and a third angle between the second paddle and the third paddle.

[0062] According to another embodiment, subsequent paddles in axial direction form a first angle which is larger than the smallest angle between two paddles.

[0063] It should be noted that any entity disclosed herein, e.g. components and elements, e.g. of the paddle, of the stirring device, or of the fermenter, are not limited to a dedicated entity as described in some embodiments. Rather, the herein disclosed subject matter may be implemented in various ways and various granularities on device level while still providing the desired functionality. Further, it should be noted that according to embodiments a separate entity may be provided for each of the functions disclosed herein. According to other embodiments, an entity is configured for providing two or more functions as disclosed herein. For example, an I-shaped beam may be formed by a single element or may be formed by two or more elements which are combined or attached to each other in order to provide the desired functionality. Further, also the protrusion or a plate forming the protrusion may be formed of a single piece or may be formed of two or more separate elements which are combined or attached to each other to provide the desired functionality.

[0064] It should be noted that the term "comprising" does not exclude other elements or steps and that "a" or "an" does not exclude a plurality. Also elements described in association with different embodiments may be combined. It should also be noted that reference signs in the claims should not be construed as limiting the scope of the claims.

[0065] In order to recapitulate the above described embodiments of the present invention one can state:

[0066] There is provided a paddle for a stirring device. In accordance with embodiments, the paddle comprises a rod with a mounting portion being mountable to a rotatable shaft of the stirring apparatus; a head, the head and the mounting portion defining an outward direction from the mounting portion to the head; and a protrusion extending outwardly from the head in the outward direction, the protrusion thereby forming an outer end of the paddel. According to a further embodiment, the protrusion may be tapered in circumferential direction.

List of reference signs

[0067]

100	paddle
102	rod
104	mounting portion
106	head
108	protrusion
110	outward direction
112	shovel face
114	axis of rotation
116	width of 112
118	width of 102
119	openings
120	(first) circumferential direction
121	second circumferential direction
122	first tapered end
123	I-shaped beam
124	second tapered end
126	opposite shovel face
128, 130	recess
132	base
134, 136	side portion
138	base of I-shaped beam
140, 142	side portion
150	plate
152	attachment portion
154	bend
200	paddle
300	paddle
306	head
306a	fixed head portion
306b	variable head portion
356	first position
358	second position
360	first effective height
362	second effective height
364	pivotable flap
366	first stop element
368	second stop element
370	axis of rotation of 306b
600	paddle
690	fermenter
691	auxiliary support
692	stirring device
693	outer edge
694	rotatable shaft
695	curved bottom
696	recess
697	grouting material
698	formwork

Claims

1. Paddle (100, 200, 300, 600) for a stirring device (692) of a fermenter (690), the paddle comprising:

   - a rod (102) with a mounting portion (104) being mountable to a rotatable shaft (694) of the stirring device (692);

- a head (106), the head (106) and the mounting portion (104) defining an outward direction (110) from the mounting portion (104) to the head (106); and
- a protrusion (108) extending outwardly from the head (106) in the outward direction (110), the protrusion (108) thereby forming an outer end of the paddel.

2. Paddle according to claim 1,

- wherein a rotation of the paddle mounted to the shaft (694)defines a first circumferential direction (120);
- the protrusion (108) having a first tapered end (122) pointing in the first circumferential direction (120) and a second tapered end (124) pointing in an second circumferential direction (121), opposite the first circumferential direction (120).

3. Paddle according to claim 2, the first tapered end (122) and the second tapered end (124) being tapered in a plane perpendicular to the axis of rotation (114) of the rotatable shaft (694).

4. Paddle according to any one of the preceding claims, the protrusion (108) being formed of a plate.

5. Paddle according to any one of the preceding claims,

- the paddle further comprising at least one further protrusion (108);
- the protrusions (108) being spaced from each other in an axial direction.

6. Paddle according to any one of the preceding claims, the head (106) further comprising

- a recess (128, 130) having an opening facing a cirumferential direction (120, 121).

7. Paddle according to claim 6,

- the recess being a first recess (128);
- the head (106) further comprising a second recess (130) having an opening being oriented opposite the opening of the first recess (128).

8. Paddle according to claim 7, the first recess (128) and the second recess (130) being formed by an I-shaped beam having its longitudinal direction oriented crosswise the first circumferential direction (120).

9. Paddle according to one of the preceding claims, further comprising

- a variable head portion (306b);
- the variable head portion (306b) generating a first stirring resistance in a first position (356) and generating a second stirring resistance in a second position (362), wherein the first stirring resistance is smaller than the second stirring resistance.

10. Paddle according to claim 9, wherein the variable head portion (306b) is configured for taking up the first position (356) during a rotation in circumferential direction (121) and for taking up the second position (358) during a rotation in an opposite circumferential direction (120).

11. Paddle according to claim 10, wherein the variable head portion (306b) is a flap (364) pivotable between the first position (356) and the second position (358).

12. Stirring device (692) of a fermenter, the stirring device comprising:

- a rotatable shaft (694);
- at least one paddle (100, 200, 300, 600) according to one of the preceding claims mounted on the rotatable shaft (694).

13. Fermenter (690) comprising a stirring device (692) according to claim 12.

14. Fermenter according to claim 13, further comprising:

- a curved bottom (695);
- wherein the protrusion (108) has a curved outer edge (693) facing the curved bottom (695);
- the curved outer edge (693) comprising a curvature that is concentric with the curvature of the curved bottom (695) of the fermenter (690).

15. Method of providing a stirring device, the method comprising:

- providing a rotatable shaft (694);
- providing at least one paddle (100, 200, 300, 600) according to one of claims 1 to 11;
- mounting the at least one paddle to the rotatable shaft (694).

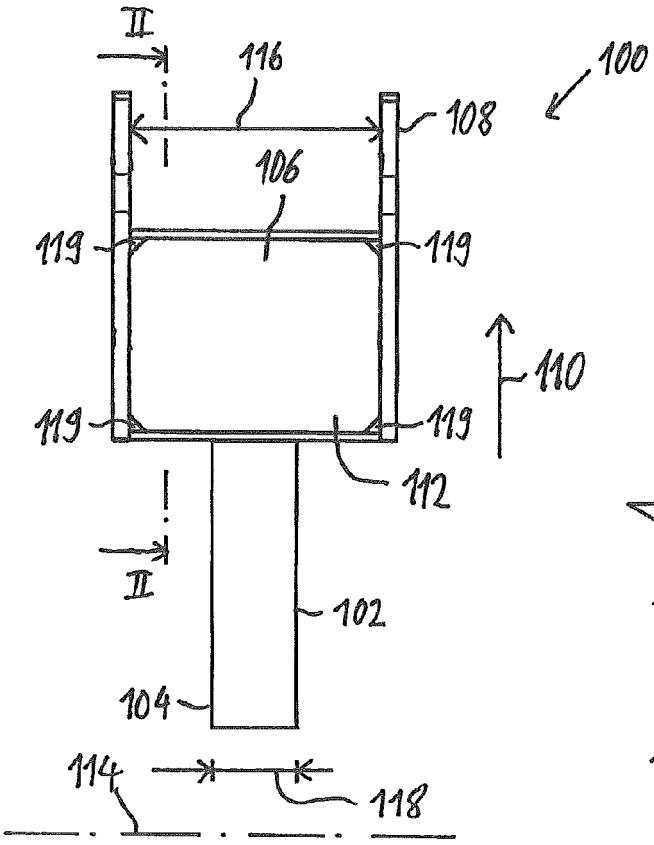

Fig. 1

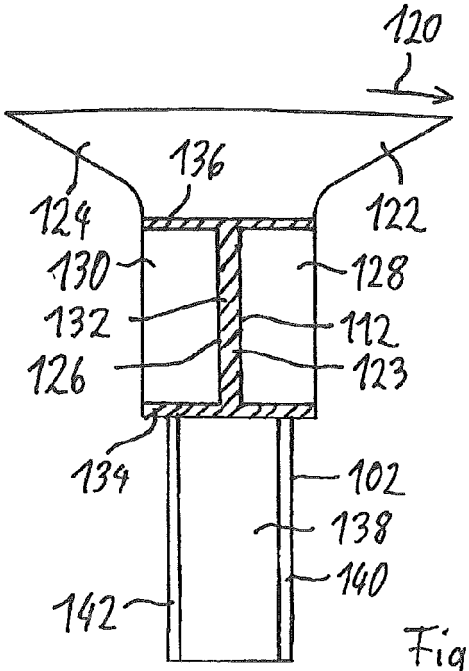

Fig. 2

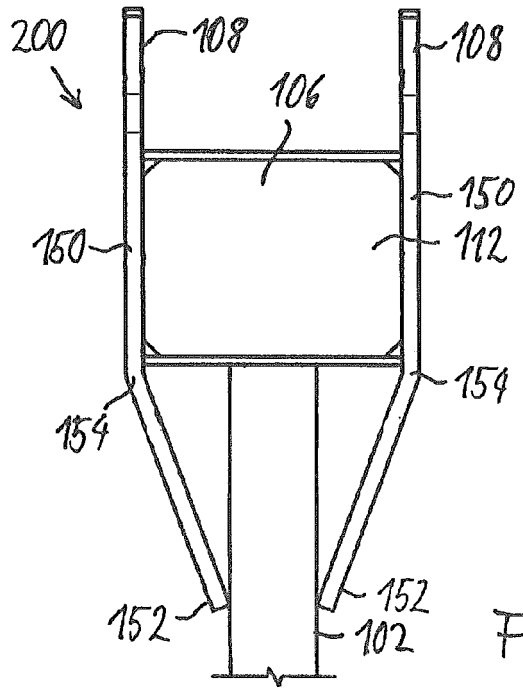

Fig. 3

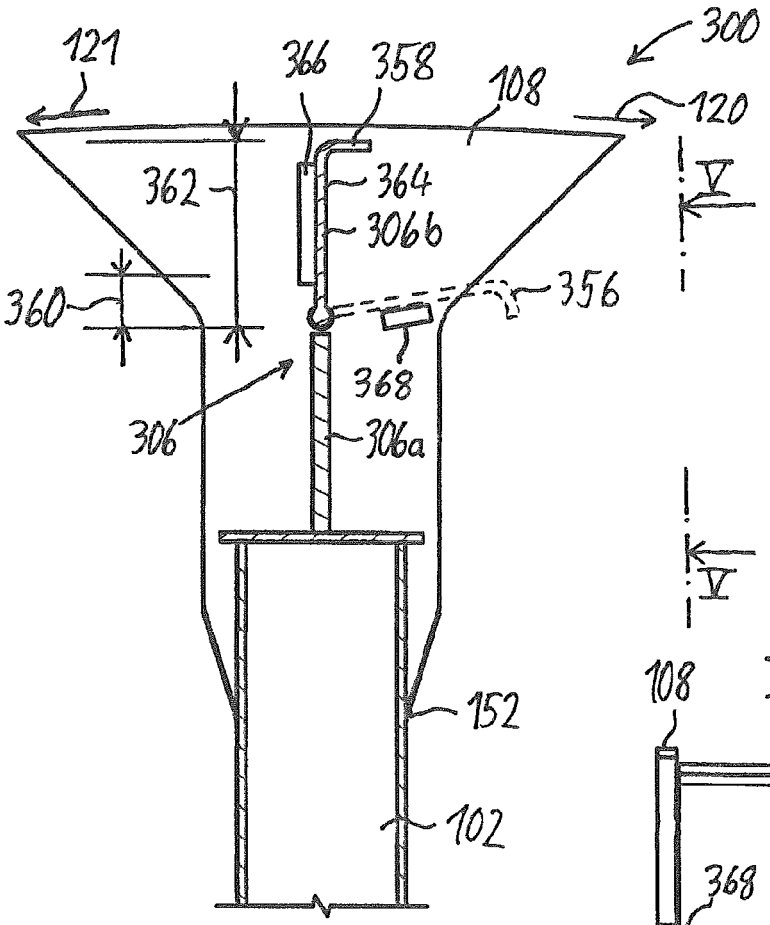
121
366
358
300
108
120
362
364
3066
V
360
356
368
306
306a
152
102

Fig. 4

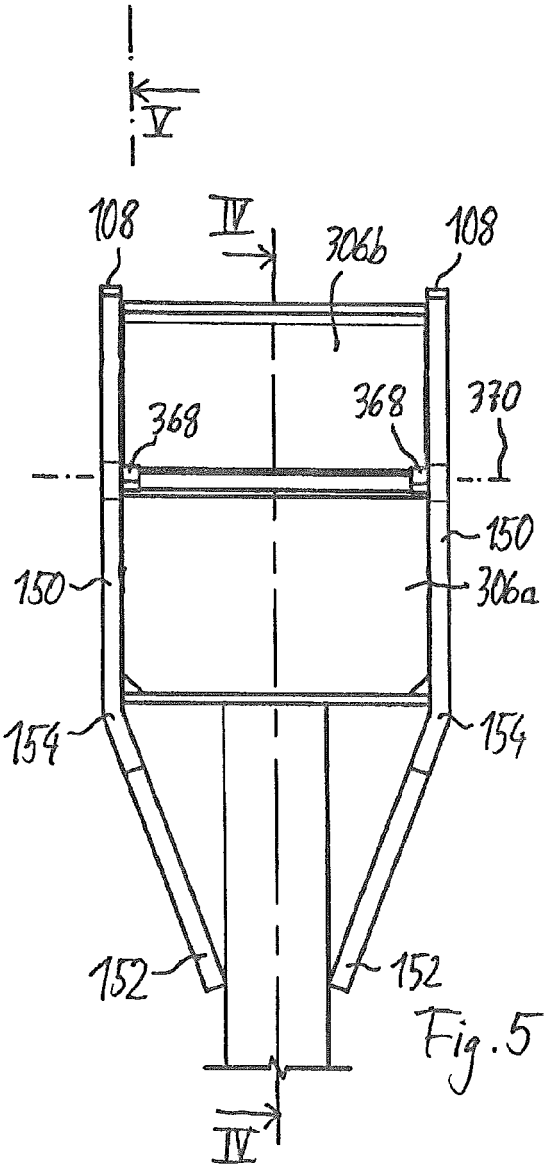
V
108
IV
3066
108
368
368
370
150
150
306a
154
154
152
152
IV

Fig. 5

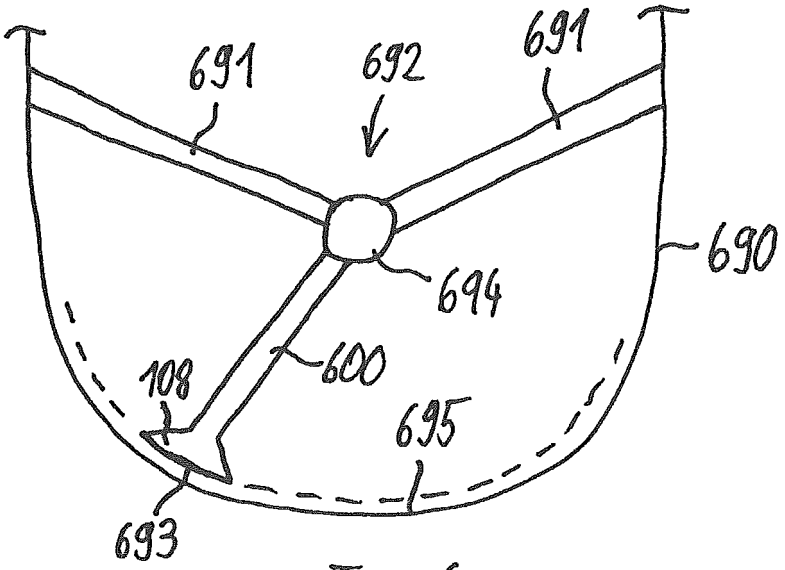

Fig. 6

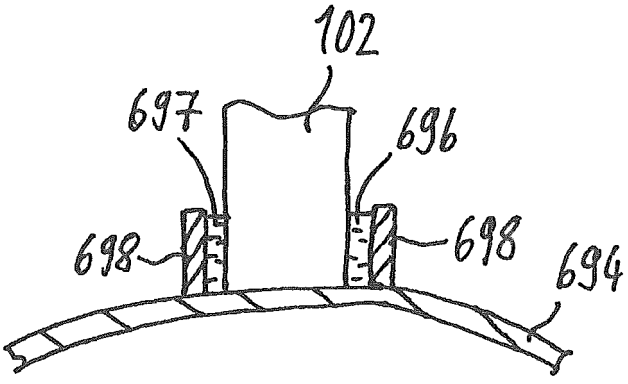

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 12 17 6961

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Place of search	Date of completion of the search	Examiner
Munich	28 November 2012	Muller, Gérard

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1

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