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(54) Stirring device for a fermentation device

(57) It is described a stirring device (100) for stirring a liquid fermentation material. The stirring device (100) comprises a shaft (102) rotatable about an axis of rotation (104) and at least two stirring paddles (106) including a first stirring paddle (106) and a second stirring paddle (106) being spaced from the first stirring paddle (106) in an axial direction (124). A connector (118) extends between the first stirring paddle (106) and the second stirring paddle (106), wherein the connector (118) is radially spaced from an outer end (114) of the first stirring paddle (106).

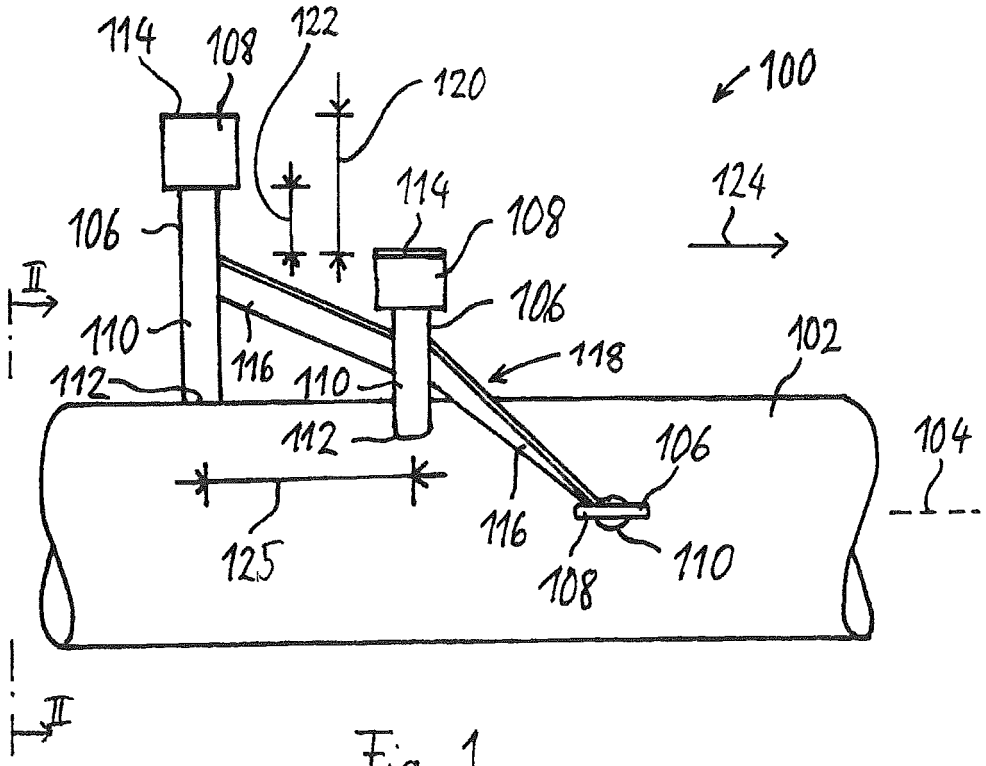

Fig. 1

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to the field of fermentation devices and in particular to a stirring device for a fermentation device.

BACKGROUND OF THE INVENTION

[0002] EP 1 332 805 A1 relates to a waste disposal equipment having an agitation device inside a processing tank, wherein the agitation device is fixed inside the processing tank end extends in a longitudinal direction thereof. Many agitating blades are fixed on the shaft at approximately equal intervals in axial direction and with approximately equal angular spacing relative to each other around the shaft so that ends of the blades lie on a spiral.

[0003] In view of the above described known agitation device there exists a need for an improved technique that allows for a good mixing of the fermentation material in a fermentation device.

SUMMARY OF THE INVENTION

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

[0005] According to an embodiment of a first aspect of the herein disclosed subject matter, there is provided a stirring device for a fermentation device, the stirring device being configured for stirring a fermentation material, the stirring device comprising: a shaft rotatable about an axis of rotation; at least two stirring paddles including a first stirring paddle and a second stirring paddle being spaced from the first stirring paddle in an axial direction; the first stirring paddle and the second stirring paddle each having an inner end mounted to the shaft and an outer end opposite the inner end, the stirring paddles thereby moving in a circumferential direction upon rotation of said shaft; a connector extending between the first stirring paddle and the second stirring paddle; the connector being radially spaced from said outer end of the first stirring paddle.

[0006] This embodiment of the first aspect of the herein disclosed subject matter is based on the idea that by providing the connector which extends between the first stirring paddle and the second stirring paddle, wherein the connector is radially spaced from the outer end of the first stirring paddle, an advantageous stirring of the fermentation material is provided by the movement of the stirring paddles through the fermentation material while in addition hereto a stirring motion and a transport of fermentation material in the axial direction of the shaft is provided by the connector, leading to improved mixing of the content of the fermenter.

[0007] According to an embodiment, the stirring device is adapted for liquid fermentation material. It should be understood that liquid fermentation material usually includes a certain amount of solid material while the overall behavior of the fermentation material is the behavior of a liquid.

[0008] According to an embodiment, there is provided a driving unit for driving the shaft into the rotation about its axis of rotation.

[0009] According to an embodiment, the stirring device is installed in a fermenter of the fermentation device. According to a further embodiment, the shaft of the stirring device is located horizontally. According to a further embodiment, the shaft of the stirring device is located vertically. However, it should be understood that in accordance with embodiments the shaft of the stirring device may be located at any suitable angle with regard to ground.

[0010] According to an embodiment, the first stirring paddle and the second stirring paddle are spaced from each other in circumferential direction. In other words, the first stirring paddle and the second stirring paddle form an angle therebetween with regard to the axial direction. This causes the connector to be located transverse to the axial direction. The connector extending transverse to the axial direction may generate a flow of fermentation material into the axial direction upon rotation of the shaft. The flow of fermentation material in axial direction may increase mixing of the fermentation material and may reduce the formation of a floating layer.

[0011] According to a further embodiment, the stirring device comprises at least one further stirring paddle. According to a further embodiment, the connector connects the first stirring paddle, the second stirring paddle and the at least one further stirring paddle. According to a further embodiment, the connector connects the first stirring paddle, the second stirring paddle and the at least one further stirring paddle along a helical path. A helical path along which the connector extends may generate a flow of fermentation material in the axial direction. According to an embodiment, the connector is made of a single element. According to a further embodiment, the connector comprises at least two individual connector elements, wherein each connector element extends between two of the first stirring paddle, the second stirring paddle and the at least one further stirring paddle. The individual connector elements which together form the connector as described with regard to two embodiments of the herein disclosed subject matter, facilitates in the mounting of the connector to the stirring paddles. In particular, the individual connector elements extending between two stirring paddles have smaller dimensions and therefore facilitate the handling.

[0012] According to an embodiment, a plurality of stirring paddles is mounted to the shaft. The actual number of stirring paddles may be chosen depending on design parameters of the stirring device, e.g. on the length of the shaft, on the axial distance between the stirring pad-

dles, the angle formed between two neighboring stirring paddles, etc.

[0013] According to an embodiment, the connector described herein is configured for generating a flow of the fermentation material in the axial direction upon rotation of the shaft about the axis of rotation. Generation of a flow in axial direction improves the stirring and mixing of the fermentation material and further may provide for fewer stirring devices being necessary for stirring the content of a given fermentation device.

[0014] According to an embodiment, the connector or a connector element thereof extends between two axially neighboring paddles. According to other embodiments, the connector or a connector element connects two stirring paddles which are not neighboring in axial direction. In other words, according to an embodiment a further stirring paddle may be located axially between the two paddles which are connected by the connector or the connector element.

[0015] According to a further embodiment, the connector is made of a plate-shaped element. For example, according to an embodiment the connector or connector element is formed of an elongated metal plate. According to further embodiments, other configurations of the connector or the connector elements also contemplated.

[0016] According to a further embodiment, at least one of the first stirring paddle and the second stirring paddle has a head. According to a further embodiment, each paddle mounted to the shaft comprises a head. A head may improve the stirring of the fermentation material.

[0017] According to an embodiment, three or more stirring devices are provided in a single fermenter. For example, in an embodiment, the fermenter is a circular fermenter with three stirring devices which are supported by a single middle support in the middle of the fermenter. Such a middle support may be e.g. a concrete post. In an embodiment, the connector has an end which extends over a paddle and which is connected to the shaft. An end of the connector connected to the shaft allows a stirring operation in a region of the stirring device where no paddle is provided. Such an embodiment may be suitable in a fermenter which has two stirring devices that form an angle smaller than 180 therebetween. An example may be e.g. a fermenter which has three stirring devices forming an angle of 120 degrees between two adjacent stirring devices. In such a fermenter two stirring devices have their inner paddles (near the middle support) omitted in order to avoid the paddles of adjacent stirring device contacting each other.

[0018] According to a further embodiment, the head comprises a cutting edge pointing in circumferential direction. A cutting edge may reduce the torque necessary to rotate the shaft. Further, the cutting edge may improve the breaking of a floating layer forming on top of the fermentation material. Further, a cutting edge may assist in breaking up solid portions or at least portions with a high viscosity in the fermentation material.

[0019] According to a further embodiment, the head further comprises a recess opposite the cutting edge. The recess opposite the cutting edge provides for increased stirring of the fermentation material if the shaft is rotated in a direction such that the recess forms the leading edge of the head. Moreover, providing a cutting edge pointing in circumferential direction and a recess opposite the cutting edge provides for a torque which depends on the rotational direction. Hence, on the one hand the stirring of the fermentation material depends on the rotational direction, requiring a first torque if the cutting edge forms the leading edge of the head and requiring a second torque, which is higher than the first torque, if the recess forms the leading edge of the head. Hence, upon start-up of the stirring motion, the shaft may first be rotated in a rotational direction such that the cutting edge forms the leading edge of the head while after a certain time, for example after a predetermined time, the rotational direction is reversed thereby providing for increased stirring of the fermentation material due to the recess.

[0020] According to a further embodiment, the head has a toothed edge. A toothed edge may assist in the mixing of a floating layer of fermentation material with the remaining fermentation material in the fermentation device. Further, the toothed edge may assist in breaking up of solids or highly viscous portions of the fermentation material. For example, if the toothed edge forms the leading edge, fermentation material may be taken along the path of motion of the head. During movement along this circular path of motion, some of the material is lost by the head and is therefore deposited in lower regions of the fermenter or, if material from lower regions is taken along by the head, this material may be deposited in an upper region of the fermentation material.

[0021] According to a further embodiment, at least one of the first stirring paddle and the second stirring paddle further comprises a rod connecting the head to the shaft, wherein the rod comprises an edge pointing in circumferential direction. According to an embodiment, the rod comprises a single edge pointing in circumferential direction. In such a case, only for one rotational direction an edge of the rod forms a leading edge. According to other embodiments, an edge pointing in circumferential direction is provided on opposite sides of the rod, meaning the irrespective sense of rotation of the shaft, an edge of the rod points in the direction of motion and forms a leading edge.

[0022] According to a further embodiment of the first aspect, a stirring device for a fermentation device comprises a shaft rotatable about an axis of rotation, a first support surface and a second support surface, wherein the shaft extends between the first support surface and the second support surface. According to an embodiment, the stirring device further comprises a clamping device for pressing the first support surface and the second support surface towards each other with a mounting force. According to an embodiment, the first support surface and the second support surface are clamped to the

shaft by the clamping device. According to a further embodiment, the stirring device comprises a support element extending between the first support surface and the second support surface for absorbing part of the mounting force. By absorbing part of the mounting force exerted by the clamping device, the first support surface and the second support surface may be clamped against each other with a high mounting force while only part of the mounting force is exerted on the shaft. This may be in particular advantageous if the shaft is a hollow shaft which is capable of bearing only a limited load. Further, the support element may limit the force which is exerted onto the shaft when pressing the first support surface and the second support surface together by means of the clamping device.

[0023] According to a further embodiment, the support element sealingly covers the clamping device or at least the portion thereof which extends between the first support surface and the second support surface. According to an embodiment, the support element is sealingly attached to the shaft. These embodiments prevent fermentation material from entering a space between the first support surface and the second support surface and, according to an embodiment, also a space between the clamping device and the shaft. By preventing fermentation material from entering open spaces in the vicinity of the clamping device may prevent corrosion of parts provided in the vicinity of the clamping device.

[0024] According to a further embodiment, at least one of the first support surface and the second support surface is formed by the inner end of the first paddle. For example, according to an embodiment the paddle comprises a plate or other mounting element at its inner end, wherein the plate or other mounting element provides the first support surface. This allows for a mounting of the stirring paddle to the shaft with very few parts.

[0025] According to a further embodiment, the shaft has a mounting structure thereon which provides a third support surface, wherein the inner end of the first paddle comprises a mounting surface facing the third support surface. According to an embodiment, the mounting structure on the shaft includes a support element as described herein. According to a further embodiment, the clamping device is adapted for pressing the mounting surface onto the third support surface. Hence, according to an embodiment, the clamping device attaches the mounting surface on the third support surface and hence the first stirring paddle to the shaft.

[0026] According to a further embodiment, a mounting structure attached to the shaft is provided. According to an embodiment, the mounting structure is attached to the shaft at the first surface portion of the shaft and a second surface portion of the shaft, wherein the first surface portion and the second surface portion are located diametrically opposite to each other. Attaching the surface structure at diametrically opposite surface portions of the shaft has the advantage that the mechanical load on the shaft exerted by the mounting structure is symmetrical.

[0027] According to an embodiment, the mounting structure is attached to the shaft by welding. According to other embodiments, attachments of the mounting structure to the shaft may be performed by any other suitable means.

[0028] According to an embodiment, the first surface portion and the second surface portion, i.e. the surface portion in which the mounting structure contacts the shaft, each extend over less than 35% of a complete circumference of the shaft. It should be understood that if the first surface portion and the second surface portion each extend over 50 % of a complete circumference (i.e. together they extend over 100 % of the whole circumference), the attachment structure extends over the whole circumference (and attaches to the whole circumference) of the shaft. Making the contact surface between the shaft and the mounting structure, i.e. the first surface portion and the second surface portion, extending over only part of the circumference of the shaft reduces the influence of the attachment procedure on the shaft. For example, with the first and second surface portion extending over only part of a complete circumference, the distortion of the shaft due to the welding of the mounting structure to the shaft is reduced. According to an embodiment, the first surface portion and the second surface portion each extends over less than 25% of a complete circumference of the shaft. According to a further embodiment, the first surface portion and the second surface portion each extend over less than 15 percent of a complete circumference of the shaft. According to a further embodiment, the first surface portion and the second surface portion each extend over less than 10 percent of a complete circumference of the shaft. According to a further embodiment, the first surface portion and the second surface portion each extend over less than 5 percent of a complete circumference of the shaft.

[0029] According to a still further embodiment, the mounting structure comprises a first part attached to the first surface portion and a second part attached to the second surface portion. As the first surface portion and the second surface portion are located diametrically opposite to each other, the first part and the second part form a pair of parts of the mounting structure attached to the diametrically opposed first and second surface portion. According to a further embodiment, the mounting structure comprises at least one further pair of a first part and a second part.

[0030] According to an embodiment, the first stirring paddle is arranged symmetrically with regard to the first surface portion and the second surface portion.

[0031] According to an embodiment, the mounting structure defines a mounting plane in which the inner end of the first stirring paddle is mounted to the mounting structure. The mounting plane allows the inner end of the first stirring paddle to have a planar surface which is positioned in the mounting plane, thereby allowing for an easy and cost-efficient manufacture of the stirring pad-

dles. Moreover, one type of stirring paddle may be mounted on different shafts and types of shafts, e.g. on shafts having different diameters, shapes, etc., as long as the mounting structure provides for attachability of the first stirring paddle to it.

[0032] According to an embodiment, the mounting plane is spaced from the shaft. Hence, in this embodiment, the inner end of the first stirring paddle is mounted spaced from the shaft. This allows for a particular force distribution in the shaft. For example, by maintaining the inner end of the first stirring paddle spaced from the shaft and by having the first surface portion and the second surface portion extending over only part of a half circumference of the shaft an advantageous forced distribution in the shaft can be obtained. For example, in an embodiment only little stiffness is added to the shaft by the mounting structure, thereby reducing the forces acting in the first and second surface portion upon bending of the shaft, e.g. due to gravitational forces. According to a further embodiment, the inner end of the first stirring paddle is mounted to the first part and to the second part, wherein the inner end of the first stirring paddle is spaced from the shaft.

[0033] According to an embodiment, the mounting structure comprises a bridging plate from which the first part and the second part extend, wherein optionally the bridging plate is spaced from the shaft and the inner end of the first stirring paddle is mounted to the bridging plate.

[0034] According to an embodiment, the first part, the second part and the bridging plate are formed from a single plate of material. According to other embodiments, the first part, the second part and the bridging plate are formed as individual elements, wherein the first part and the second part are attached to the bridging plate.

[0035] According to an embodiment, the mounting structure comprises a further first part and a further second part attached to the shaft in diametrically opposed surface portions, the first stirring paddle being attached to the first part, the second part, the further first part and to the further second part, the first part being axially spaced from the further first part and the second part being axially spaced from the further second part.

[0036] Hence, according to an embodiment, the mounting structure comprises at least two pairs of a first part and a second part, the at least two pairs of a first part and a second part being spaced from each other in axial direction and the inner end of the first stirring paddle is mounted to the at least two pairs of a first part and a second part. In an alternative embodiment, a bridging plate is mounted to the at least two pairs of a first part and a second part and the inner end of the first stirring paddle is mounted to the bridging plate.

[0037] According to an embodiment, instead of a bridging plate a bridging element is provided, the bridging element having a mounting surface which is located adjacent a corresponding mounting surface on the first stirring paddle. The bridging element may have any suitable shape as long as the mounting surfaces of the bridging element and the first stirring paddle are compatible with each other allowing attachment of the first stirring paddle on the mounting structure.

[0038] According to a further embodiment of the first aspect, a stirring device for a fermentation device is provided, the stirring device being configured for stirring a fermentation material, the stirring device comprising a shaft rotatable about an axis of rotation; and a bearing for supporting the shaft and allowing the shaft to rotate about the axis of rotation.

[0039] According to an embodiment, the bearing is configured for allowing the shaft to move in the axial direction. For example, this can be achieved by providing a respectively configured bearing, allowing the shaft to move axially with regard to the bearing. According to another embodiment, the bearing is movably mounted in the fermentation device so as to be movable in the axial direction.

[0040] According to a further embodiment, the bearing is pivotable about a pivot axis located transverse to the axial direction of the shaft. This allows for a bending of the shaft due to gravitational forces, in particular if the fermentation device is empty. Thus, the movability of the bearing in axial direction and the pivotability of the shaft transverse to the axial direction supports the bending of the shaft under gravitational forces without exerting excessive forces to the bearing or to the support of the bearing. Further, the pivotability of the shaft transverse to the axial direction may level out different settlements of a middle support of the shaft in the middle of the fermenter and a fermenter wall. Further, the pivotability of the shaft transverse to the axial direction may level out manufacturing tolerances, e.g. of the middle support and/or of the fermenter wall.

[0041] According to an embodiment, the bearing comprises a lubricant inlet for receiving a lubricant. This allows for providing a lubricant to the bearing, e.g. during a production stage of the stirring device. According to a further embodiment, a lubricant supply line is provided by which the lubricant can be provided to the lubricant inlet and hence to the bearing during operation of the fermentation device. For example, according to an embodiment the lubricant supply line runs through the shaft. According to a further embodiment, the lubricant supply line is located in a bottom and/or a wall of a housing of the fermentation device. According to another embodiment, the lubricant supply line runs through a support of the bearing.

[0042] Lubricant can be provided to the lubricant supply line manually. According to a further embodiment, the stirring device comprises a lubricant pump for transporting the lubricant to the bearing via the lubricant supply line. The lubricant pump allows to supply lubricant continuously or intermittently to the bearing without manual interaction. According to an embodiment, a control unit is provided, the control unit controlling the lubricant pump so as to supply the lubricant to the bearing according to a predetermined lubrication schedule.

[0043] According to an embodiment, the lubrication schedule is configured for operating the lubricant pump such that lubricant is provided to the bearing in an amount such that at least part of the lubricant exits the bearing into the fermentation material. This may provide the advantage that the exiting/emission of the lubricant into the fermentation material prevents fermentation material from an entrance into the bearing. Hence, the lifetime of the bearing can be increased.

[0044] According to a further embodiment of the first aspect, a stirring device for a fermentation device is provided, the stirring device being configured for stirring a fermentation material and comprising a shaft rotatable about an axis of rotation and at least two stirring paddles mounted on the shaft, wherein the shaft comprises a corrosion protection.

[0045] According to an embodiment, the corrosion protection comprises a coating, for example two-component coating. The coating may be applied to the shaft by any suitable means, e.g. by spray-painting, by rolling, etc. According to an embodiment, the mounting structure also comprises a corrosion protection. According to a further embodiment, the mounting structure is configured for being easily coated with a coating.

[0046] In practice it was found that a two-component coating is well suited for a corrosion protection of the shaft. According to a further embodiment, the corrosion protection includes an anti-corrosive material. For example, an anticorrosive material may be a material which is not corroded by the fermentation material and the chemical compounds existing in the fermentation material. According to a further embodiment, the corrosion protection includes a sacrificial material. For example, according to an embodiment, the corrosion protection includes zinc which, when in conductive connection with iron prevents corrosion of the iron by corroding the zinc (or, generally, the sacrificial material). According to a further embodiment, the corrosion protection comprises a power supply for cathodic protection of the shaft.

[0047] According to an embodiment of a second aspect of the herein disclosed subject matter, a method of stirring a fermentation material in a fermentation device is provided, the method comprising rotating at least two stirring paddles including a first stirring paddle and a second stirring paddle about an axis of rotation, the first stirring paddle and the second stirring paddle being spaced from each other in an axial direction; and moving a connector along a circumferential path about said axis of rotation, the connector extending between said first stirring paddle and said second stirring paddle and being radially spaced from an outer end of the first stirring paddle.

[0048] According to a an embodiment of the second aspect, a method of building a stirring device is provided, the method comprising: providing a shaft; and attaching a mounting structure to the shaft. According to an embodiment, the method comprises attaching the mounting structure to the shaft in a first surface portion and a second surface portion being located diametrically opposite to the first surface portion.

[0049] According to a further embodiment, the method comprises providing a corrosion protection to the shaft and the mounting structure after attaching the mounting structure to the shaft and before mounting the stirring paddles to the mounting structures. In this way, good corrosion protection is achieved since the mounting of the stirring paddles does not harm the corrosion protection, in particular at contact portions where the mounting structure contacts the shaft. Moreover, in accordance with embodiments disclosed herein, providing the corrosion protection to the shaft and the mounting structure, without having the paddles mounted on the mounting structure, may be done at a production site, where the stirring device is fabricated.

[0050] According to an embodiment, the method comprises mounting the shaft into a fermenter of the fermentation device and thereafter mounting the stirring paddles to the mounting structure on the shaft.

[0051] According to a further embodiment of the first aspect, a method of operating a stirring device of a fermentation device is provided, the method comprising providing lubricant to a bearing of the stirring device during operation of the stirring device. According to a further embodiment, the method comprises supplying a lubricant to the bearing in an amount such that at least part of the lubricant exits the bearing into the fermentation material. According to an embodiment, lubricant is continuously supplied to the bearing.

[0052] According to an embodiment of a third aspect of the herein disclosed subject matter, a control unit is provided. The control unit is configured for operating a lubricant pump in accordance with embodiments of the herein disclosed subject matter. For example, according to an embodiment, the control unit is configured for operating a lubricant pump so that the lubricant pump supplies a lubricant to the bearing in an amount such that at least part of the lubricant exits the bearing into the fermentation material.

[0053] According to an embodiment, the control unit comprises a processor device capable of executing a computer program. According to an embodiment, a computer program is provided which is configured for, when executed by a processor device, performing a method as disclosed herein.

[0054] The computer program may be implemented as computer readable instruction code by use of any suitable programming language, such as, for example, JAVA, C++, and may be stored on a computer-readable medium (removable disk, volatile or non-volatile memory, embedded memory/processor, etc.). The instruction code is operable to program a computer or any other programmable device to carry out the intended functions. The computer program may be available from a network, such as the World Wide Web, from which it may be downloaded.

[0055] Aspects and embodiments of the invention may be realized by means of a computer program respectively software. However, the invention may also be realized

by means of one or more specific electronic circuits respectively hardware. Furthermore, the invention may also be realized in a hybrid form, i.e. in a combination of software modules and hardware modules.

[0056] In the above there has been described and in the following there will be described exemplary embodiments of the subject matter disclosed herein with reference to a stirring device, to a fermentation device comprising such a stirring device and to respective methods. It has to be pointed out that of course any combination of features relating to different aspects or embodiments of the herein disclosed subject matter is also possible. In particular, some embodiments have been or will be described with reference to method type claims whereas other embodiments have been or will be described with reference to apparatus type claims. However, a person skilled in the art will gather from the above and 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 or embodiments, for example even between features of the apparatus type embodiments and features of the method type embodiments is considered to be disclosed with this application.

[0057] According to embodiments of the herein disclosed subject matter, apparatus type features are adapted for providing the functionality of one or more of the embodiments of the method type features and/or for providing the functionality as required by one or more of the method type features.

[0058] According to further embodiments of the herein disclosed subject matter, method type features are adapted for providing the functionality of one or more of the embodiments of the apparatus type features and/or for providing the functionality as required by one or more of the apparatus type features.

[0059] 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

[0060]

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

Fig. 2 shows a side view of the stirring device in Fig. 1 when viewed along line II-II in Fig. 1

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

Fig. 4 shows the head of the stirring paddle of Fig. 3 when viewed from above along line IV-IV.

Fig. 5 shows a cross-section of the rod of the stirring paddle of Fig. 3 when viewed along line V-V in Fig. 3.

Fig. 6 shows a cross-sectional view of a part of a stirring device in accordance with embodiments of the herein disclosed subject matter.

Fig. 7 shows a cross-sectional view of the stirring device of Fig. 6 when viewed along line VII-VII.

Fig. 8 shows a cross-sectional view of a part of a stirring device according to embodiments of the herein disclosed subject matter.

Fig. 9 shows a cross-sectional view of a stirring device according to embodiments of the herein disclosed subject matter.

Fig. 10 shows the stirring device of Fig. 9 when viewed along line X-X in Fig. 9.

Fig. 11 shows a side view of a stirring device in accordance with embodiments of the herein disclosed subject matter.

Fig. 12 shows a stirring device according to embodiments of the herein disclosed subject matter.

Fig. 13 shows a fermentation device in accordance with embodiments of the herein disclosed subject matter.

DETAILED DESCRIPTION

[0061] The illustration in the drawings is schematic. 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.

[0062] Fig. 1 shows a stirring device 100 in accordance with embodiments of the herein disclosed subject matter.

[0063] The stirring device 100 comprises a shaft 102 rotatable about an axis of rotation 104. The stirring device 100 further includes a plurality of stirring paddles 106, three of which are shown in Fig. 1. The stirring paddle 106 comprises a head 108 and a rod 110 connecting the head 108 to the shaft 102. Each stirring paddle has an inner end 112 mounted to the shaft. According to an embodiment, the inner end 112 of the paddle 106 is formed by the rod 110, as shown in Fig. 1.

[0064] In accordance with a further embodiment, each stirring paddle comprises an outer end 114 opposite the inner end 112. In accordance with an embodiment, the outer end 114 of the paddle 106 is formed by the head 108 of the paddle.

[0065] In accordance with an embodiment, the stirring device 100 comprises a connector element 116 between

two axially adjacent paddles 106. In an embodiment, multiple connector elements 116 are provided. In accordance with an embodiment, the connector elements 116 can be regarded as forming a connector 118 which may connect all stirring paddles of the stirring device. In a further embodiment, the connector connects only a subset of all the stirring paddles of the stirring device, i.e. the connector 118 connects only part of the stirring paddles of the stirring device 100. In accordance with another embodiment, the connector 118 may include a common connector element (not shown in Fig. 1) connecting more than two stirring paddles. For example, according to an embodiment the common connector element may connect three stirring paddles.

[0066] In accordance with an embodiment, each connector element 116 is radially spaced from the outer end 114 of the stirring paddle by a distance 120. In accordance with an embodiment, the connector 118 (or the connector element 116) is spaced from the head 108 of the stirring paddle 106 by a distance 122.

[0067] In accordance with an embodiment, the stirring paddles 106 are spaced from each other in an axial direction 124 by a distance indicated at 125 in Fig. 1. The axial direction 124 is parallel to the axis of rotation 104 by definition.

[0068] In accordance with an further embodiment, the connector 118 connects the stirring paddles 106 along a helical path, a part of which can be seen in Fig. 1. The helical path follows the connector elements 116 in Fig. 1. By providing the connector 118 along a helical path, the connector is configured for generating a flow of fermentation material (not shown in Fig. 1) in the axial direction 124 upon rotation of the shaft 102 about the axis of rotation 104. It should be understood that the flow of fermentation material is either to the left or to the right in Fig. 1, depending on the rotational direction in which the shaft 102 rotates. According to an embodiment, the helical connector 118 is a left-handed helical connector. According to another embodiment, the helical connector 118 is a right-handed helical connector.

[0069] Fig. 2 shows a side view of the stirring device in Fig. 1 when viewed along line II-II in Fig. 1

[0070] It should be understood that the stirring paddles of the stirring device 100 are distributed around the whole circumference 126 of the shaft 102 while only two paddles 106 are shown in Fig. 2. In accordance with an embodiment, axially subsequent stirring paddles are spaced from each other in circumferential direction by a distance 128, as shown in Fig. 2. Hence, if the axially subsequent stirring paddles 106 are connected by a connector element 116, the two paddles which are directly connected by the connector 118 are spaced from each other in the circumferential direction by the distance 128. Since according to an embodiment the stirring paddles 106 are mounted perpendicular to the shaft 102, the distance 128 between the stirring paddles 106 in circumferential direction corresponds to an angle of twist 130 between the two paddles that are directly connected by the connector 118.

[0071] Fig. 3 shows a stirring paddle in accordance with embodiments of the herein disclosed subject matter.

[0072] The head 108 is supported by a rod 110. In accordance with an embodiment, the head 108 comprises a cutting edge 132 pointing in circumferential direction 129. In accordance with an embodiment, the cutting edge 132 is formed by a blade attached to a body of the head 108.

[0073] In accordance with a further embodiment, the head further comprises a recess 134 opposite the cutting edge 132. In accordance with an embodiment, the head further comprises a toothed edge 136. For example, in an embodiment, the toothed edge 136 is provided adjacent the recess 134. For example, walls 138 which form the recess 134 comprise a toothed edge portion as shown in Fig. 3. According to an embodiment, part of the edge around the opening of the recess 134 is toothed. However also the whole edge around the opening of the recess 134 may be toothed.

[0074] Fig. 4 shows the head 108 of the stirring paddle of Fig. 3 when viewed from above along line IV-IV.

[0075] In accordance with an embodiment, the head 108 is generally V-shaped. When viewed from above, wherein the tip of the V comprises the cutting edge 132. According to an embodiment, the head 108 comprises two walls 138 which extend away from each other and having a top plate 140 thereon which defines the recess 134 from above. In accordance with an embodiment, the top plate 140 has a toothed edge 136.

[0076] Fig. 5 shows a cross-section of the rod 110 of the stirring paddle of Fig. 3 when viewed along line V-V in Fig. 3.

[0077] In accordance with an embodiment, the rod 110 comprises an edge 142 pointing in circumferential direction 129. According to an embodiment, the rod 110 is a hollow rod. According to a further embodiment, the rod 110 has a rectangular cross-section. However, other configurations and cross sectional shaped of the rod are also possible.

[0078] Fig. 6 shows a cross-sectional view of a part of a stirring device 200 in accordance with embodiments of the herein disclosed subject matter.

[0079] The stirring device 200 comprises a rectangular shaft 202 and a first support surface 244 and a second support surface 246. The shaft 202 extends between the first support surface 244 and the second support surface 246. Further, a clamping device 248 of the stirring device presses the first support surface and the second support surface towards each other with a mounting force. In accordance with an embodiment, the clamping device comprises a bolt, e.g a threaded bolt 249. In accordance with an embodiment, the first support surface 244 is provided by a first plate 250 and the second support surface is provided by a second plate 252. According to an embodiment, the clamping device 248 extends through the first plate 250 and the second plate 252. For example, according to an embodiment, the clamping device compris-

es upper and lower forcing elements 253 which force the first plate 250 and the second plate 252 against each other. In an embodiment the forcing elements are nuts cooperating with the threaded bolt 249.

[0080] In accordance with an embodiment, the stirring device comprises a support element 254 extending between the first support surface 244 and the second support surface 246 for absorbing part of the mounting force. The support element 254 may be a loose element clamped between the first support surface 244 and the second support surface 246. According to other embodiments, the support element 254 is attached to shaft 202.

[0081] According to an embodiment, the first plate 250 is part of the inner end of the stirring paddle 106, as shown in Fig. 6.

[0082] Fig. 7 shows a cross-sectional view of the stirring device 200 of Fig. 6 when viewed along line VII-VII.

[0083] According to an embodiment, only a single clamping device 248 is provided for each paddle. According to another embodiment, two or more clamping devices 248, e.g. four clamping devices, are provided for mounting a single paddle 106 (not shown in Fig. 7) to the shaft 202.

[0084] In accordance with an embodiment, the support elements 254 sealingly enclose its corresponding clamping devices 248. For example, according to an embodiment, a sealing weld line 256 is provided in the contact region of the support element 254 and the first and second support surfaces 244, 246. Further, a sealing weld line 258 may be provided in the contact region between the support element 254 and the shaft 202. Instead of weld lines any other suitable sealing can be provided.

[0085] Fig. 8 shows a cross-sectional view of a part of a stirring device according to embodiments of the herein disclosed subject matter.

[0086] The stirring device 300 in Fig. 8 is similar to the stirring device 200 in Fig. 6 except that the stirring paddle 106 does not form the first support surface 244. Rather, the first support surface 244 is provided by a first plate 360 which together with the second plate 252 and the support elements 254 forms a mounting structure 362 to which the stirring paddle 106 can be attached. Providing a mounting structure 362 may have the advantage that the mounting structure 362 can be premanufactured at the production site such that at an installation site only the paddle 106 has to be mounted to the mounting structure 362, thereby requiring less work at the installation site. For example all the sealing weld lines described with regard to Fig. 7 can be provided already at the production site.

[0087] In accordance with an embodiment, the stirring paddle 106 is attached to the mounting structure 362 by the clamping device 248 which presses the first support surface 244 and the second support surface 246 towards each other. Further, the clamping device 248 presses a mounting surface 261 of the paddle 106 to a third support surface 263 of the mounting structure 362. In accordance with an embodiment, the third support surface 263 and the first support surface 244 of the mounting structure 362 are formed by a single element, e.g. the first plate 360, as shown in Fig. 8.

[0088] According to another embodiment not shown in Fig. 8, the clamping device 248 which presses the first support surface 244 to the second support surface 246 may be installed separately from the mounting of the paddle 106 to the mounting structure 362. Such an embodiment has the advantage that even the clamping device 248 may be installed already at the production site of the stirring device, while on the other hand such an embodiment requires an additional attachment element (not shown in Fig. 8) for attaching the stirring paddle 106 to the mounting structure 362.

[0089] According to an embodiment, the mounting structure is manufactured at a production site, remote from the final installation site where the stirring device is installed in a fermenter of the fermentation device. Depending on the particular embodiments realized in the stirring device, the clamping device may be part of the mounting structure (if the clamping device is installed at the production site) or may not be part of the mounting structure (if the clamping device is not installed at the production site but e.g. at the installation site).

[0090] Fig. 9 shows a cross-sectional view of a stirring device 400 according to embodiments of the herein disclosed subject matter.

[0091] The stirring device 400 comprises a shaft 402 and further having a mounting structure 462 attached to the shaft 402 at a first surface portion 464 and a second surface portion 466 of the shaft 402. In accordance with an embodiment, the first surface portion 464 and the second surface portion 466 are located diametrically opposite to each other as shown in Fig. 9.

[0092] In accordance with an embodiment, the mounting structure 462 comprises a first part 463a and a second part 463b. In accordance with an embodiment, the first part 463a and the second part 463b are individual elements attached to the shaft 402. In accordance with an embodiment, the first part 463a and the second part 463b define a mounting surface 468 to which the inner end 112 of the stirring paddle 106 is mountable. The mounting surface 468 may comprise a single continuous surface or may comprise two or more individual surface portions that are separated from each other, as shown in Fig. 9.

[0093] The mounting surface 468 defines a mounting plane 470 which in accordance with an embodiment is spaced from the shaft 402. Attachment of the stirring paddle 106 to the mounting structure 462 can be performed by any suitable means, e.g. by threaded bolts 472, as shown in Fig. 9, or e.g. by welding (not shown in Fig. 9).

[0094] In accordance with an embodiment, each of the first part 463a and the second part 463b comprises an elongated portion 474 and an attachment portion 476 extending from the elongated portion 474. In accordance with an embodiment, the first surface portion 464 and the second surface portion 466 are formed by the attachment portion 476 of the respective part 463a, 463b. According

to an embodiment, the attachment portion 476 is a protrusion extending from the elongated portion 474 towards the shaft 402.

[0095] According to an embodiment, the elongated portion 474 and the attachment portion 476 are formed by a single piece of material, e.g. by a single plate. According to a further embodiment, the elongated portion 474 and the attachment portion 476 are formed by two pieces which are attached to each other (not shown in Fig. 9).

[0096] Fig. 10 shows the stirring device 400 when viewed along line X-X in Fig. 9.

[0097] The same elements are denoted by the same reference numbers in the description of which is not repeated here.

[0098] In accordance with an embodiment, the mounting structure 462 comprises two pairs of a first part 463a and a second part 463b. Fig. 9 shows one such pair consisting of the first part 463a and the second part 463b. In Fig. 10 only the first parts 463a of the two pairs are visible. According to an embodiment, more than two pairs, e.g. three or four pairs of a first part 463a and a second part 463b are provided. In accordance with an embodiment, the pairs of a first part and a second part (and hence the first parts 463 of the pairs) are spaced in axial direction 124, e.g. by a distance 465 as shown in Fig. 10. Hence, the mounting structure 462 of the stirring device 400 comprises four parts which define the mounting surface 468 to which the inner end 112 of the stirring paddle 106 is mounted. Due to the elongated portions 474 and due to the fact that the first and second surface portions 464, 466 only extend over a part of a half circumference of the shaft, bending flexibility of the shaft 402 transverse to the axial direction 124 is maintained thereby reducing the mechanical stress load on the mounting structure and the inner end 112 of the paddle 106 due to bending of the shaft 402, e.g. during installation of the stirring device in the fermenter (not shown in Fig. 10). Further, the relatively small first surface portion 464 and second surface portion 466 and the fact that these surface portions are located diametrically opposite to each other, the distortion of the shaft 402 due to welding the first part 463a and the second part 463b to the shaft 402 is relatively low, at least compared to larger first and second surface portions.

[0099] Providing individual first and second parts, e.g. two first parts and two second parts of the mounting structure may have the advantage that the surfaces of the mounting structure and the shaft may be advantageously reachable with a coating beam for coating the mounting structure with a corrosion protection, such as a two-component lacquer. Hence corrosion protection may be applied in a continuous layer at the production site. In such cases, coating of the shaft and/or mounting structure at the installation site may be unnecessary.

[0100] Fig. 11 shows a side view of a stirring device 500 in accordance with embodiments of the herein disclosed subject matter.

[0101] The stirring device 500 comprises a mounting structure 562 which comprises two pairs of a first part and a second part, of which the first part 463a is visible in Fig. 11. The first part 463a comprises a first surface portion 464 and the second part comprises a second surface portion (not shown in Fig. 11). In accordance with an embodiment, the mounting structure 562 comprises a bridging element 577, e.g. in the form of a plate, from which the first part 463a and the second part extend. In accordance with an embodiment, the bridging element 577 bridges not only the first part and the second part of one pair but also two different pairs each of which contains the first part 463a and the second part 463b, as shown in Fig. 11. In accordance with an embodiment, the bridging element 577 forms a bridging plate which defines the mounting surface 468 to which the inner end 112 of the paddle 106 is attached by suitable attachment elements (not shown in Fig. 11). In accordance with an embodiment, the first part 463a, the second part 463b (not shown in Fig. 11) and the bridging element 577 are formed from a single piece of material, e.g. from a single plate which comprises cut-outs and bends to form the first parts, the second parts, the first surface portions and the second surface portions.

[0102] Fig. 12 shows a stirring device 600 according to embodiments of the herein disclosed subject matter.

[0103] The stirring device comprises a shaft 602 and a bearing 678 for supporting the shaft 602. In accordance with an embodiment, the bearing is configured to allow the shaft 602 to move in axial direction 124. Hence, in accordance with an embodiment the bearing 678 forms a so-called movable bearing. Movable bearings are known in the art. Further, in order to allow movability in axial direction, the bearing may be movably mounted on a support (not shown in Fig. 12).

[0104] In accordance with an embodiment, the bearing 678 is pivotable about an axis 680 located transverse to the axial direction 124. This can be achieved for example by pivotably supporting the bearing 678.

[0105] In accordance with an embodiment, the bearing 678 comprises a lubricant inlet 682 for receiving a lubricant, indicated at 684 in Fig. 12. Further, the stirring device 600 may comprise a lubricant supply line 686 coupled to the lubricant inlet 682. According to an embodiment, the stirring device 600 comprises a lubricant pump 688 for transporting the lubricant 684 to the bearing 678 via the lubricant supply line 686. According to an embodiment, the lubricant supply line 686 runs outside the shaft 602. According to another embodiment, the lubricant supply line 686 runs inside the shaft 602.

[0106] Further, the stirring device 600 comprises a controller 690 for controlling the lubricant pump 688. According to an embodiment, the lubricant pump 688 and the controller 690 form a lubricant pump unit. In accordance with an embodiment, the controller 690 is configured for providing control signals 691 to the lubricant pump 688 so as to supply lubricant 684 such that at least part of the lubricant exits the bearing 678 into the fermen-

tation material (not shown in Fig. 12) . The emission of the lubricant from the bearing 678 is indicated at 692 in Fig. 12. According to an embodiment, the control signals 691 are configured so as to effect a supply of lubricant to the bearing 678 at a rate (amount of lubricant per time unit) that the lubricant exits the bearing. In such a way, ingression of fermentation material into the bearing 678 may be prevented. For example according to an embodiment, the control signals are configured so as to supply between 1 kg and 17 kg lubricant 684 per week to the bearing 678.

[0107] For providing the lubricant 684 to the lubricant pump 688, a lubricant reservoir 693 and a lubricant transport line 694, which fluidably connects the lubricant reservoir 693 with the lubricant pump 688, is provided.

[0108] Fig. 13 shows a fermentation device 795 in accordance with embodiments of the herein disclosed subject matter.

[0109] The fermentation device 795 comprises a fermenter 796 for receiving fermentation material. In the fermenter 796 there is provided a support 797 and three stirring devices 800, of which a shaft 802 is shown in Fig. 13. According to an embodiment, the support 797 is located in the middle of the fermenter 796 (as shown in Fig. 13) and hence in such embodiments the support may be referred to as middle support. The shafts 802 are supported by bearings 678 which are in turn supported by the support 797. The opposite end of the shaft 802 is supported in a bearing located in a fermenter wall of the fermenter 796. In a further embodiment, more than three stirring devices 800 are mounted in the fermenter 796. In a still further embodiment, less than three stirring devices 800 (e.g. one or two stirring devices) are mounted in the fermenter 796.

[0110] Having regard to the subject matter disclosed herein, it should be mentioned that embodiments of the herein disclosed subject matter, e.g. also embodiments shown in and described with regard to different figures may be combined if possible.

[0111] It should be noted that any entity disclosed herein (e.g. components, units, elements, portions, parts and devices) 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 with various granularity 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. According to an embodiment, the controller comprises a processor device including at least one processor for carrying out at least one computer program or at least one software module in order to provide the desired functionality.

[0112] It should be noted that the term "comprising" does not exclude other elements or steps and the "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.

[0113] In order to recapitulate the above described embodiments of the present invention one can state:

It is described a stirring device (100) for stirring a liquid fermentation material. The stirring device (100) comprises a shaft (102) rotatable about an axis of rotation (104) and at least two stirring paddles (106) including a first stirring paddle (106) and a second stirring paddle (106) being spaced from the first stirring paddle (106) in an axial direction (124). A connector (118) extends between the first stirring paddle (106) and the second stirring paddle (106), wherein the connector (118) is radially spaced from an outer end (114) of the first stirring paddle (106).

List of reference signs

[0114]

100	stirring device
102	shaft
104	axis of rotation
106	paddle
108	head
110	rod
112	inner end of 106
114	outer end of 106
116	connector element
118	connector
120	distance between 114 and 116
122	distance between 108 and 116
124	axial direction
125	distance in axial direction between adjacent paddles
126	circumference of 102
128	distance between paddles in circumferential direction
129	circumferential direction
130	angle of twist between two paddles connected by 118
132	cutting edge
134	recess
136	tooted edge
138	wall
140	top plate
142	edge pointing in circumferential direction
200	stirring device
202	shaft
244	first support surface
246	second support surface
248	clamping device
249	threaded bolt
250	first plate
252	second plate
253	forcing elements

254	support element
256	sealing weld line
258	sealing weld line
261	mounting surface of paddle
263	third support surface
300	stirring device
360	first plate
362	mounting structure
400	stirring device
402	shaft
462	mounting structure
463a	first part of 462
463b	second part of 462
464	first surface portion
465	distance between pairs of 463a, 463b in axial direction
466	second surface portion
468	mounting surface
470	mounting plane
472	threaded bolts
474	elongated portion of 463a, 463b
476	attachment portion of 463a, 463b
500	stirring device
562	mounting structure
577	bridging element
600	stirring device
602	shaft
678	bearing
680	axis of rotation
682	lubricant inlet
684	lubricant
686	supply line
688	lubricant pump
690	controller
691	control signal
692	emission of lubriant
693	lubricant reservoir
694	lubricant transport line
795	fermentation device
796	fermenter
797	support
800	stirring device
802	shaft

Claims

1. Stirring device (100, 200, 300, 400, 500, 600, 800) for a fermentation device (795), the stirring device being configured for stirring a fermentation material, comprising:

a shaft (102, 202, 402, 602, 802) rotatable about an axis of rotation (104);
at least two stirring paddles (106) including a first stirring paddle (106) and a second stirring paddle (106) being spaced from the first stirring paddle (106) in an axial direction (124);
the first stirring paddle (106) and the second stirring paddle (106) each having an inner end (112) mounted to the shaft (102, 202, 402, 602, 802) and an outer end (114) opposite the inner end (112), the stirring paddles (106) thereby moving in a circumferential direction (129) upon rotation of said shaft (102, 202, 402, 602, 802);
a connector (118) extending between the first stirring paddle (106) and the second stirring paddle (106);
the connector (118) being radially spaced from said outer end (114) of the first stirring paddle (106).

2. Stirring device according to the preceding claim, further comprising at least one of the following features:

said first stirring paddle (106) and said second stirring paddle (106) being spaced from each other in said circumferential direction (129);
said stirring device (100, 200, 300, 400, 500, 600, 800) being configured for stirring liquid fermentation material.

3. Stirring device according to any one of the preceding claims, further comprising:

at least one further stirring paddle (106);
the connector (118) connecting the first stirring paddle (106), the second stirring paddle (106) and the at least one further stirring paddle (106) along a helical path.

4. Stirring device according to claim 3, further comprising at least one of the following features:

the connector (118) comprising at least two individual connector elements (116), wherein each connector element (116) extends between two of said first stirring paddle (106), said second stirring paddle (106) and said at least one further stirring paddle (106);
the connector (118) being configured for generating a flow of said fermentation material in said axial direction (124) upon rotation of said shaft (102, 202, 402, 602, 802) about said axis of rotation (104).

5. Stirring device according to any one of the preceding claims,
at least one of said first stirring paddle (106) and said second stirring paddle (106) having a head (108).

6. Stirring device according to the preceding claim, further comprising at least one of the following features:

the head (108) comprising a cutting edge (132) pointing in said circumferential direction (129);

the head (108) further comprising a recess (132) opposite said cutting edge (132);
the head (108) having at least one toothed edge (136);
at least one of said first stirring paddle (106) and said second stirring paddle (106) further comprising a rod (110) connecting said head (108) to said shaft (102, 202, 402, 602, 802), the rod (110) comprising an edge (142) pointing in said circumferential direction (129).

7. Stirring device according to any one of the preceding claims, further comprising:

a first support surface (244) and a second support surface (246), the shaft (102, 202, 402, 602, 802) extending between the first support surface (244) and the second support surface (246);
a clamping device (248) for pressing the first support surface (244) and the second support surface (246) towards each other with a mounting force;
a support element (254) extending between the first support surface (244) and the second support surface (246) for absorbing part of the mounting force.

8. Stirring device according to the preceding claim, further comprising at least one of the following features:

at least one of the first support surface (244) and the second support surface (246) being formed by the inner end (112) of the first paddle (106);
the shaft (202) having a mounting structure (362, 462, 562) thereon, the mounting structure (362, 462, 562) including the support element (253) and providing a third support surface (263), the inner end (112) of the first paddle (106) comprising a mounting surface (261) facing the third support surface (263), the clamping device (248) being adapted for pressing the mounting surface (261) onto the third support surface (263).

9. Stirring device according to any one of claims 1 to 6, further comprising:

a mounting structure (362, 462, 562) attached to said shaft (102, 202, 402, 602, 802) at a first surface portion (464) and a second surface portion (466) of said shaft (102, 202, 402, 602, 802), the first surface portion (464) and the second surface portion (466) being located diametrically opposite to each other.

10. Stirring device according to the preceding claim, further comprising at least one of the following features:

the first surface portion (464) and the second surface portion (466) being spaced from each other in circumferential direction (129);
the mounting structure (362, 462, 562) being attached to said shaft (102, 202, 402, 602, 802) by welding;
the first surface portion (464) and the second surface portion (466) each extend over less than 35 percent of a complete circumference of the shaft (102, 202, 402, 602, 802);
the first surface portion (464) and the second surface portion (466) each extend over less than 25 percent of a complete circumference of the shaft (102, 202, 402, 602, 802);
the first surface portion (464) and the second surface portion (466) each extend over less than 15 percent of a complete circumference of the shaft (102, 202, 402, 602, 802);
the first surface portion (464) and the second surface portion (466) each extend over less than 10 percent of a complete circumference of the shaft (102, 202, 402, 602, 802);
the first surface portion (464) and the second surface portion (466) each extend over less than 5 percent of a complete circumference of the shaft (102, 202, 402, 602, 802).

11. Stirring device according to any one of claims 9 or 10, the mounting structure (362, 462, 562) comprising a first part (463a) attached to the first surface portion (464), a second part (463b) attached to the second surface portion (466), the mounting structure (362, 462, 562) optionally further comprising at least one of the following features:

the mounting structure (362, 462, 562) defining a mounting plane (470) in which said inner end (112) of the first stirring paddle (106) is mounted to said mounting structure (362, 462, 562), the mounting plane (470) optionally being spaced from said shaft (102, 202, 402, 602, 802);
the mounting structure (362, 462, 562) comprising a bridging element (577) from which the first part (463a) and the second part (463b) extend, the bridging element (577) being spaced from said shaft (102, 202, 402, 602, 802) and the inner end (112) of the first stirring paddle (106) being mounted to the bridging element (577), wherein optionally the first part (463a), the second part (463b) and the bridging plate (577) are formed from a single plate of material;
the inner end (112) of the first stirring paddle (106) being mounted to the first part (463a) and the second part (463a), the inner end (112) of the first stirring paddle (106) optionally being spaced from said shaft (102, 202, 402, 602, 802);
the mounting structure (362, 462, 562) compris-

es a further first part (463a) and a further second part (463b) attached to the shaft (102, 202, 402, 602, 802) in diametrically opposed surface portions (464, 466), the first stirring paddle (106) being attached to the first part (464), the second part (466), the further first part (463a) and to the further second part (463b), the first part (463a) being axially spaced from the further first part (463a) and the second part (463b) being axially spaced from the further second part (463b).

12. Stirring device according to any one of the preceding claims, further comprising
a bearing (678) for supporting the shaft (102, 202, 402, 602, 802), the bearing (678) optionally comprising at least one of the following features:

said bearing (678) allowing said shaft (102, 202, 402, 602, 802) to move in said axial direction (124);
said bearing (678) being pivotable about an axis (680) located transverse to said axial direction (124);
said bearing (678) comprising a lubricant inlet (682) for receiving a lubricant (684); wherein the stirring device (100, 200, 300, 400, 500, 600, 800) optionally further comprises
a lubricant supply line (686) coupled to said lubricant inlet (682); and
a lubricant pump (688) for transporting said lubricant (684) to said bearing (678) via said lubricant supply line (686), said lubricant pump (688) optionally being configured for supplying said lubricant (684) to said bearing (678) such that at least part of said lubricant (684) exits said bearing (678) into the fermentation material.

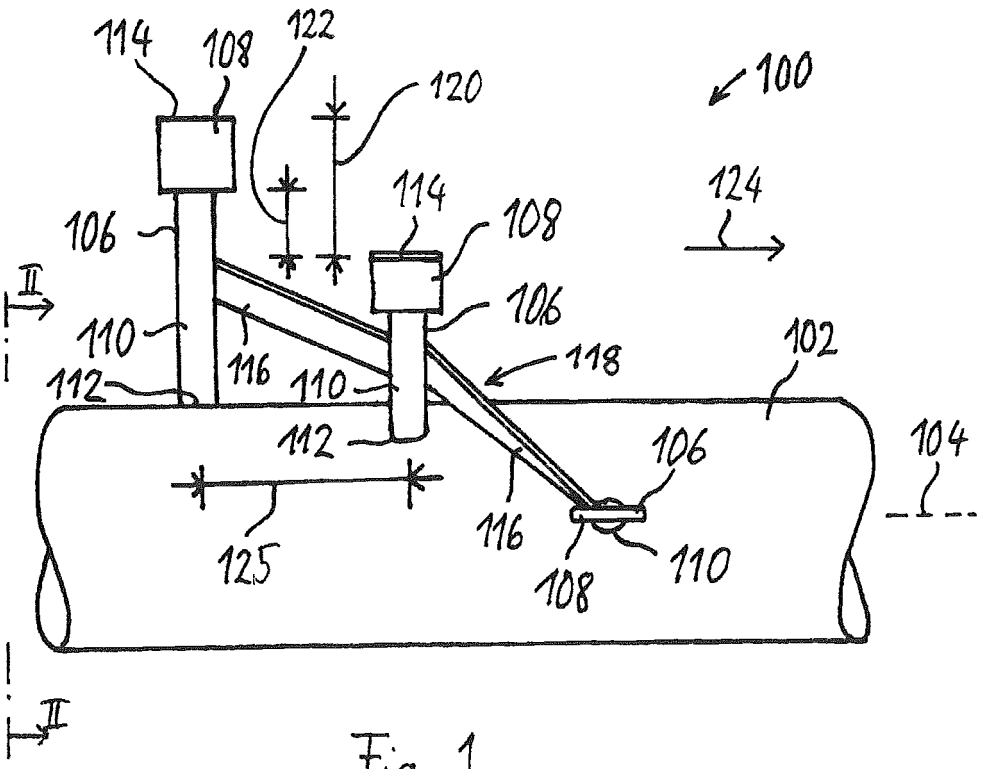
13. Stirring device according to any one of the preceding claims, the shaft (102, 202, 402, 602, 802) comprising a corrosion protection, wherein optionally the corrosion protection comprises at least one of the following features:

a coating, in particular a two-component coating;
a anticorrosive material;
sacrificial material;
a power supply for cathodic protection of the shaft.

14. Method of stirring a fermentation material in a fermentation device (795), the method comprising:

rotating at least two stirring paddles (106) including a first stirring paddle (106) and a second stirring paddle (106) about an axis of rotation (104), the first stirring paddle (106) and the second stirring paddle (106) being spaced from each other in an axial direction (124); and
moving a connector (118) along a circumferential path about said axis of rotation (104), the connector (118) extending between said first stirring paddle (106) and said second stirring paddle (106) and being radially spaced from an outer end (114) of the first stirring paddle (106).

15. Fermentation device (795) for fermenting a fermentation material, the fermentation device (795) comprising a stirring device (100, 200, 300, 400, 500, 600, 800) according to any one of claims 1 to 13.


114
108
122
120
100
124
106
114
108
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106
116
110
118
102
112
112
106
104
125
116
110
108
II

Fig. 1

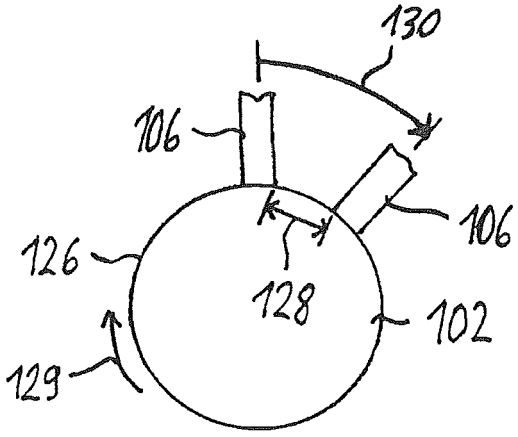

130
106
106
126
128
102
129

Fig. 2

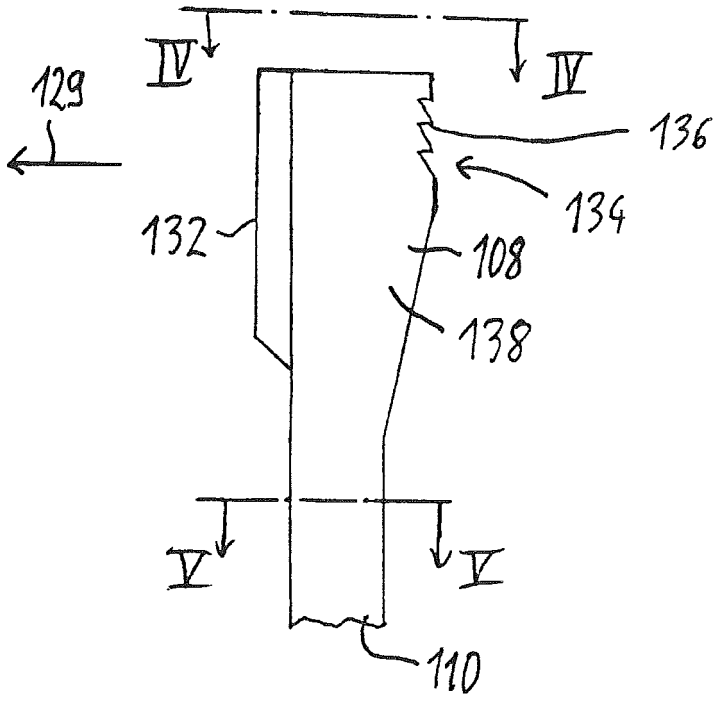


Fig. 3

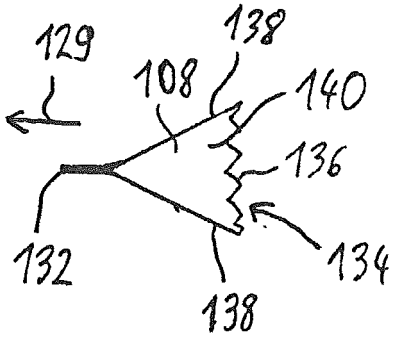


Fig. 4

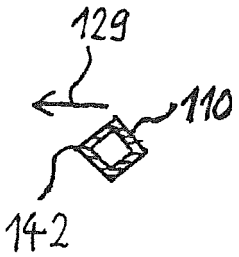


Fig. 5

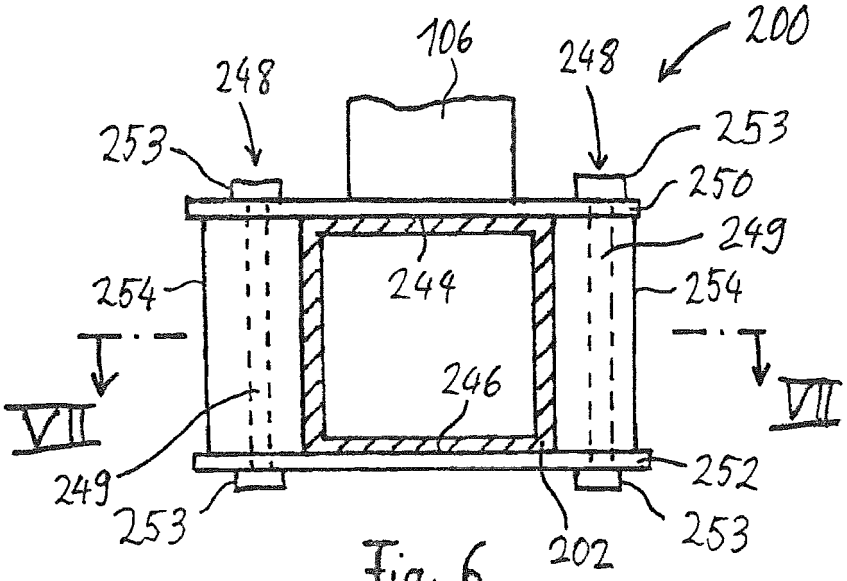
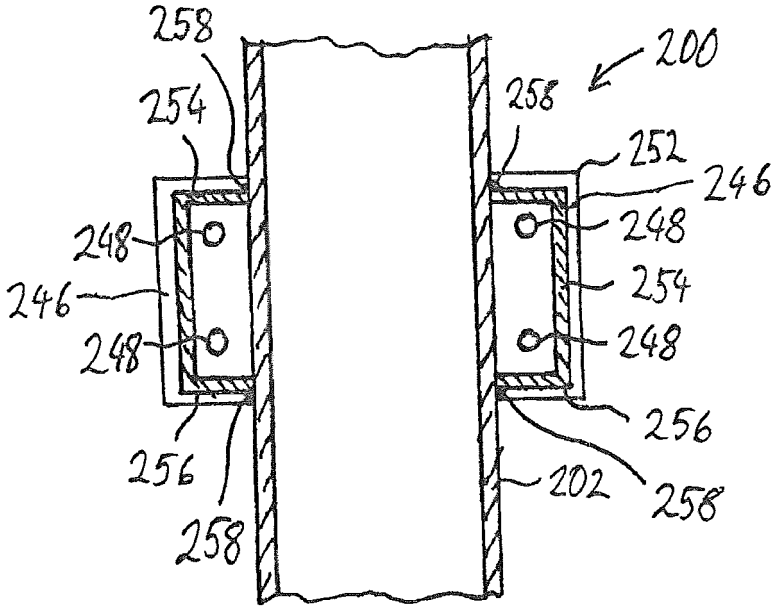

200
106
248
248
253
253
250
249
244
254
254
246
VII
VII
249
253
252
253
202

Fig. 6


200
258
258
254
252
246
248
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254
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248
256
256
202
258
258

Fig. 7

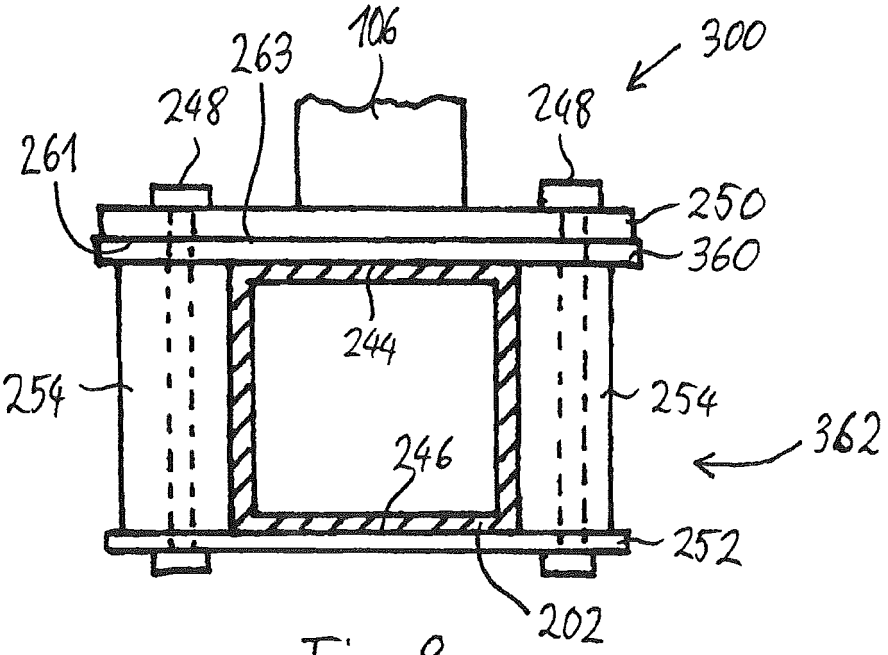
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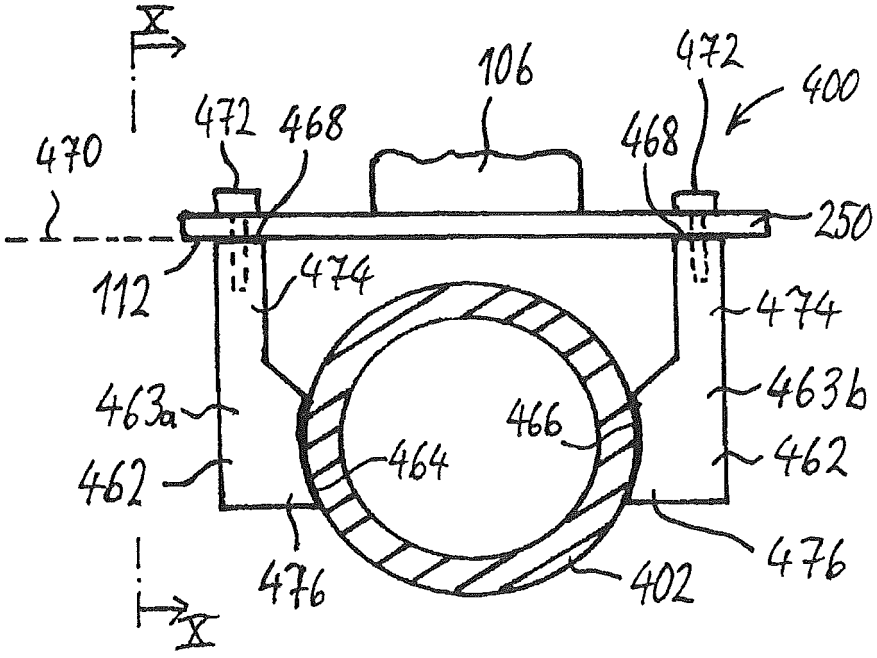
Fig. 8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X

Fig. 9

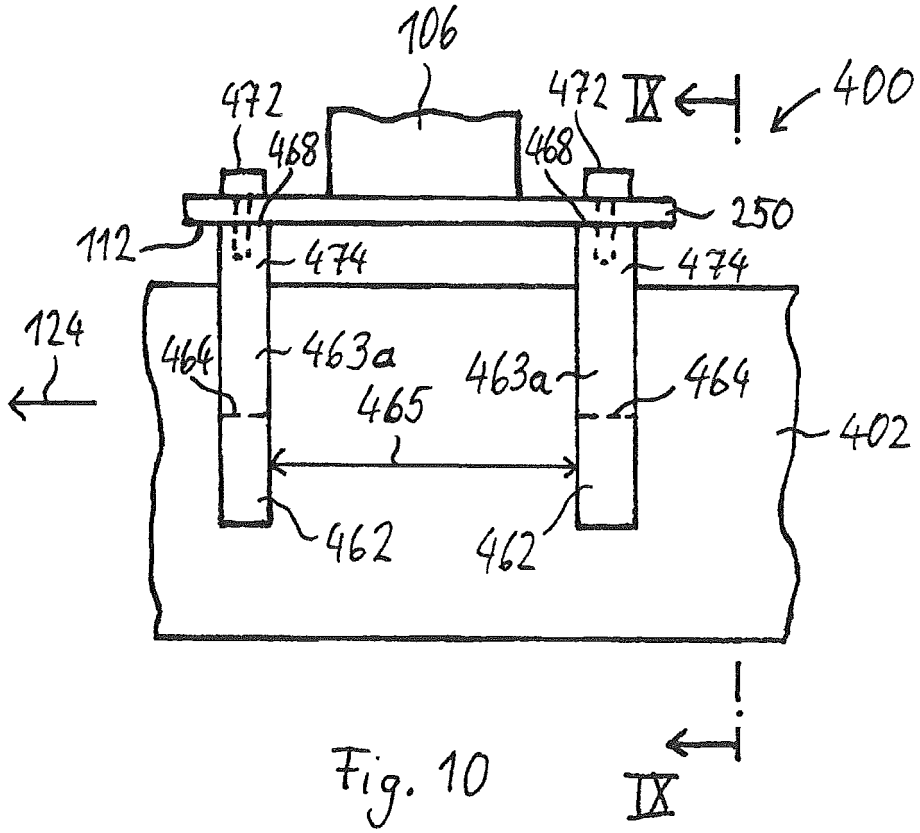
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Fig. 10

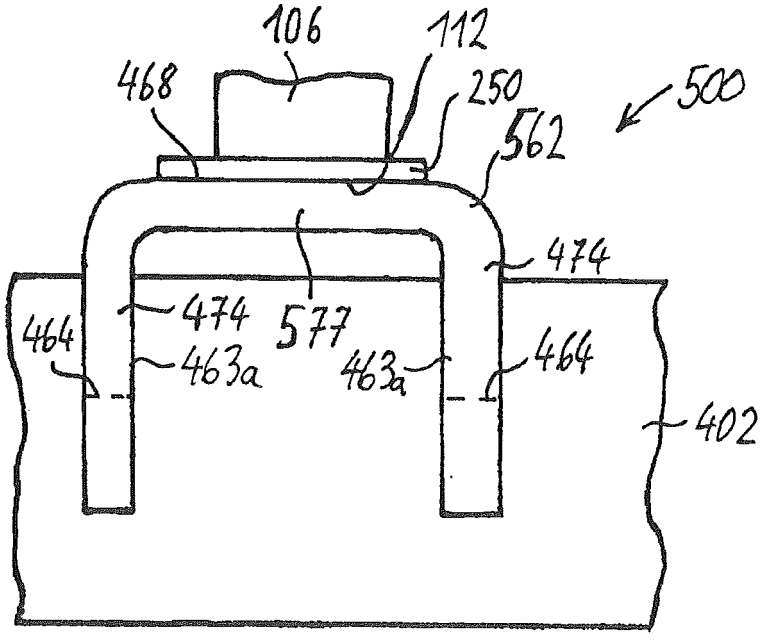
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Fig. 11

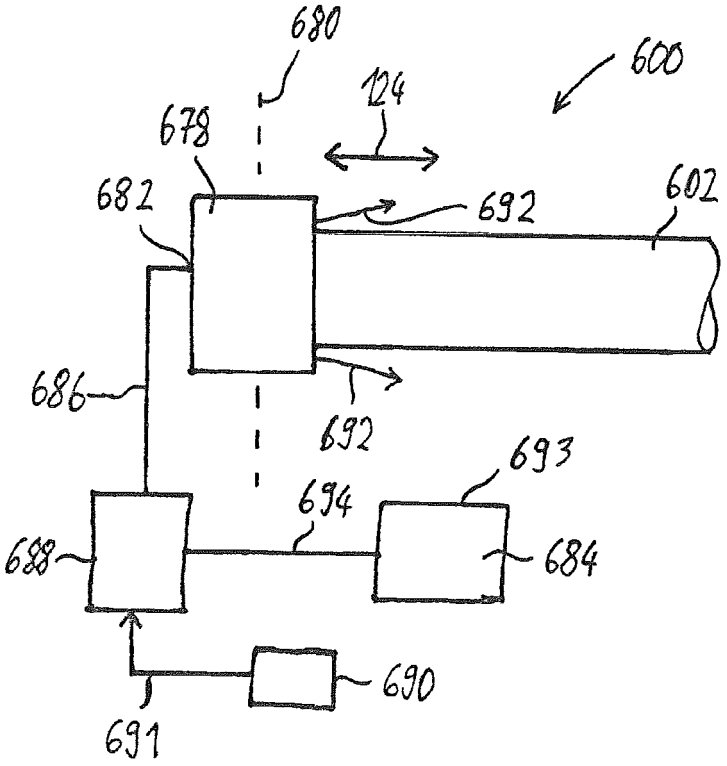
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Fig. 12

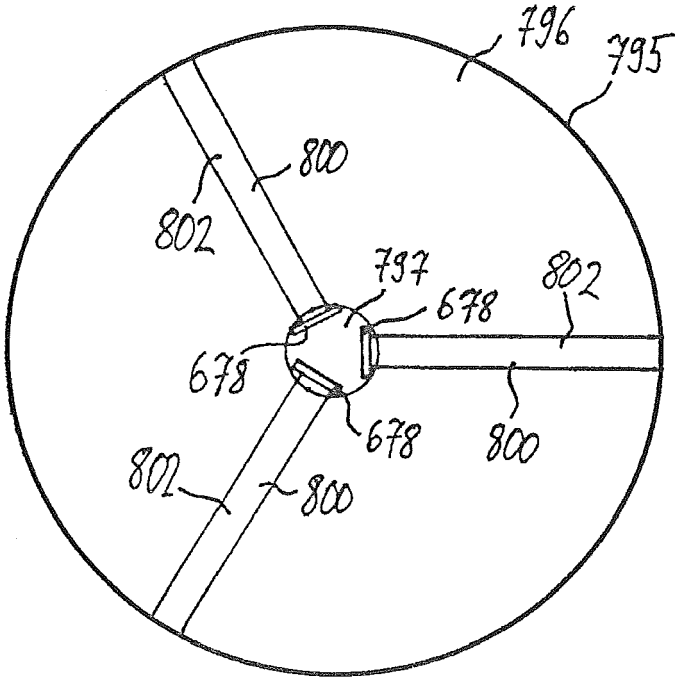
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Fig. 13

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EUROPEAN SEARCH REPORT

Application Number
EP 12 16 5574

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
The Hague	29 January 2013	Krasenbrink, B

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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EUROPEAN SEARCH REPORT

Application Number
EP 12 16 5574

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
The Hague	29 January 2013	Krasenbrink, B

CATEGORY OF CITED DOCUMENTS

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& : member of the same patent family, corresponding document

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CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☒ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

1-6, 12, 14, 15

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

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LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 12 16 5574

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1, 2, 14, 15(completely); 12(partially)

   Stirring device comprising the first and second stirring paddles being spaced from each other in the circumferential direction

   ---

2. claims: 3, 4

   Stirring device comprising at least one further stirring paddle and the connector connecting the stirring paddels along a helical path

   ---

3. claims: 5, 6

   Stirring device comprising the stirring paddle having a head

   ---

4. claims: 7, 8

   Stirring device comprising a first support surface and a second support surface, the shaft extending between the first support surface and the second support surface, a clamping device for pressing the first support surface and the second support surface towards each other with a mounting force, and a support element extending between the first support surface and the second support surface

   ---

5. claims: 9-11

   Stirring device comprising a mounting structure attached to said shaft at a first surface portion and a second surface portion of said shaft, the first surface portion and the second surface portion being located diametrically opposite to each other

   ---

6. claim: 12(partially)

   Stirring device comprising a bearing allowing the shaft to move axially

   ---

7. claim: 12(partially)

   Stirring device comprising a bearing being pivotable

   ---

8. claim: 12(partially)

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LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 12 16 5574

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

Stirring device comprising a bearing with a lubricant inlet
---

9. claim: 13

Stirring device comprising a shaft having a corrosion protection
---

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 12 16 5574

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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29-01-2013

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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- EP 1332805 A1 **[0002]**