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(54) **AGITATOR ARRANGEMENT**

(57) The present disclosure relates to an agitator arrangement (2) for mixing a liquid in a mixing tank (1) and for cleaning the mixing tank (1). The agitator arrangement (2) comprises a rotatable hollow shaft (4) extending in an axial direction (5), a first impeller (7) secured to the shaft (4) at a first axial position, and a second impeller (8) secured to the shaft (4) at a second axial position. Moreover, the second impeller (8) comprises a plurality of openings (9) configured for spraying a cleaning liquid on the first impeller (7) for cleaning the first impeller (7). The present disclosure also relates to a mixing tank (1) including an agitator arrangement (2), wherein the first impeller (7) is located above the second impeller (8).

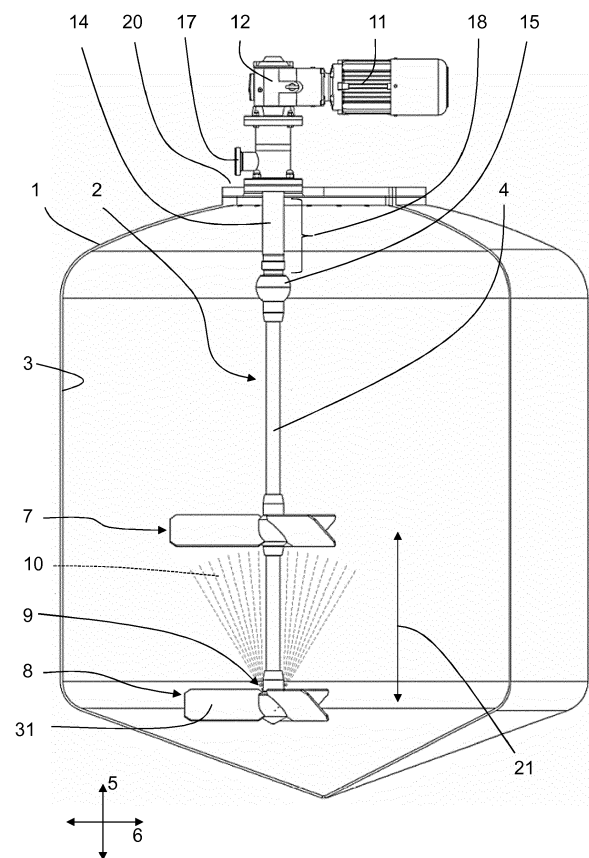


FIG.1

Description

TECHNICAL FIELD

[0001] The disclosure relates to an agitator arrangement for mixing a liquid in a mixing tank and for cleaning the mixing tank. The disclosure also relates to a mixing tank comprising such an agitator arrangement.

[0002] The disclosure can be arranged for example in the liquid food industry of dairy, beverage, brewing, processed foods, pharmaceutical and cosmetics, or the like.

BACKGROUND ART

[0003] In the food and beverage industry mixing tanks and agitators should preferably be designed for providing highly efficient mixing, improved cost-efficiency, zero in-tank maintenance and eliminating contamination risks.

[0004] Consequently, there is a continuous demand for improved agitation of the liquid within the tank and to use larger tanks with maintained agitation capacity, while also enabling efficient deaeration of the liquid within the tank and adequate cleaning of the agitator arrangement and tank interior.

[0005] However, despite the activities in the field, currently known solutions are not entirely satisfactory. There is therefore still a demand for an improved agitator arrangement, which is capable of meeting the above-mentioned requirements.

SUMMARY OF THE DISCLOSURE

[0006] This section provides a general summary of the disclosure, and is not a comprehensive disclosure of its full scope or all of its features.

[0007] An object of the present disclosure is to provide an agitator arrangement and mixing tank including such an agitator arrangement, where the previously mentioned problems are avoided. This object is at least partly achieved by the features of the independent claims. The dependent claims contain further developments of the agitator arrangement.

[0008] According to a first aspect of the present disclosure, there is provided an agitator arrangement for mixing a liquid in a mixing tank and for cleaning the mixing tank. The agitator arrangement comprises a rotatable hollow shaft extending in an axial direction, a first impeller secured to the shaft at a first axial position and a second impeller secured to the shaft at a second axial position. The second impeller comprises a plurality of openings configured for spraying a cleaning liquid on the first impeller for cleaning the first impeller.

[0009] Having two impellers located different axial positions along the shaft enables significantly improved agitation of the liquid within the tank compared with a single impeller. Moreover, the two axially displaced impellers alternatively enables use of a larger mixing tank with maintained agitation capacity.

[0010] Finally, for ensuring efficient and satisfactory cleaning of the agitator arrangement having at least two impellers, the second impeller comprises a plurality of openings configured for spraying a cleaning liquid on the first impeller for cleaning the first impeller.

[0011] Further advantages are achieved by implementing one or several of the features of the dependent claims.

[0012] In one example embodiment, the second impeller includes an impeller hub and impeller blades secured to the impeller hub, and wherein the plurality of openings are located in the impeller hub. Having the plurality of openings located in the impeller hub enables simplified manufacturing and more cost-effective design of the agitator arrangement because thereby no additional cleaning units have to be manufactured and installed along the rotatable hollow shaft. Instead, the impeller hub has dual functionality in terms of securing the impeller blades and acting as spray unit for the cleaning liquid.

[0013] According to a further example embodiment, the second impeller comprises at least 4, specifically at least 6, more specifically at least 8 and even more specifically at least 16 openings configured for spraying a cleaning liquid on the first impeller. For ensuring adequate cleaning of the first impeller at least 4 openings configured for spraying the cleaning liquid on the first impeller are required. The openings are preferably more or less equally distributed around the circumference of the hub of the second impeller.

[0014] According to still a further example embodiment, the agitator arrangement comprises a flow path from a first end region of the rotatable hollow shaft to the plurality of openings, such that pressurized cleaning liquid supplied at the first end region of the rotatable hollow shaft may be sprayed out at the plurality of openings. The rotatable shaft thus has dual functionality in terms of transmitting rotational motion to the impellers and conveying pressurized cleaning liquid from a source outside of the mixing tank to the openings of the second impeller, thereby providing a cost-effective design of the agitator arrangement.

[0015] According to a further example embodiment, the plurality of openings have a substantially cylindrical shape with a diameter of 1 - 4 mm, and specifically of 1.5 - 3 mm. The substantially cylindrical shape enables the openings to be cost-efficiently drilled. Moreover, the specific diameter of the openings has during experimental testing shown to provide a strong cleaning spray with adequate flow and coverage for enabling efficient cleaning of the first impeller.

[0016] According to a further example embodiment, an axial orientation of the plurality of openings, respectively, define an inclination angle of 1-45 degrees, specifically 1-10 degrees, and more specifically 2-5 degrees, with respect to the axial direction of the rotatable hollow shaft. A suitable inclination angle of the axial orientation of the plurality of openings depends on parameters such as the distance between the first and second impeller and the

diameter of the first impeller. The defined ranges generally provide a satisfactory cleaning result of the first impeller.

[0017] According to a further example embodiment, a centre of an outlet of the plurality of openings, respectively, is located 10 - 50 mm from an exterior surface of the rotatable hollow shaft, as seen in a direction perpendicular to the axial direction of the rotatable hollow shaft. This range of distance the centre of an outlet of the plurality of openings, respectively and an exterior surface of the rotatable hollow shaft enables location of the openings in the hub of the second impeller or another relatively small unit attached to the rotatable shaft for simplified and cost-effective design. The flow path from the hollow rotatable shaft to the openings, in a direction perpendicular to the axial direction, may also be held short, thereby also resulting in simplified and cost-effective design.

[0018] According to a further example embodiment, an axial orientation of the plurality of openings, respectively, define an angle of about 90 degrees with respect to a plane of an interior surface of the impeller hub at a location of each corresponding opening. This enables simplified manufacturing of the impeller hub because the openings may be more easily formed, for example by drilling, when the openings extend perpendicular to the surface of the impeller hub at a location of each corresponding opening. Forming an opening, for example by drilling, at an angle α , wherein $0 < \alpha < 90$ degrees, is increasingly difficult upon departing from the perpendicular (90 degrees) orientation to a surface.

[0019] According to a further example embodiment, the impeller hub comprises a first part and a second part, wherein the first and second parts are attached to each other, and wherein the plurality of opening are located in the first part and the impeller blades are attached to the second part. Having the impeller hub formed of at least two parts enables simplified and more cost-effective manufacturing of the hub, because the first part may be specifically designed for enabling appropriate location, orientation and manufacturing of the openings, while the second part may be specifically designed for enabling appropriate location, fixation and manufacturing of the impeller blades. The first and second part may thereafter be joined, for example by welding, threading connection, etc.

[0020] According to a further example embodiment, a distance between the first axial position and the second axial position is 400 - 4000 mm, specifically 500 - 3000 mm, in the axial direction of the rotatable hollow shaft. These ranges enable improved agitation of the liquid within the tank, as well as use of larger tanks with maintained agitation capacity.

[0021] According to a further example embodiment, the rotatable hollow shaft comprises one or more first shaft sections extending from the first end region of the rotatable shaft to a first axial end of the first impeller, and a second shaft section extending from a second axial end of the first impeller to a first axial end of the second

impeller. Having the rotatable designed in a modular form with at least a first and a second shaft section enables simplified installation, manufacturing and servicing of the agitator arrangement.

[0022] According to a further example embodiment, the first impeller is free from openings configured for spraying a cleaning liquid. It is known that deaeration of a liquid food product within the tank results in reduced oxygen content in liquid food products leads to extended shelf life and improved taste stability. Stripping gas for deaeration of the liquid food product is preferably introduced, for example via openings in the agitator arrangement, at a low position within the tank for enabling a maximal reaction time with the liquid food product before the stripping gas bubbles reach the surface of the liquid food product and are vented. Consequently, for providing efficient deaeration of the liquid within the tank, it is preferred avoiding introduction of a stripping gas in the region of the uppermost-located impeller of the first and second impellers, because this would enable a large part of the stripping gas to enter the liquid food product in the region of the uppermost-located impeller. However, since the openings in the agitator arrangement for ejecting stripping gas into the liquid food product often also are used for injecting cleaning liquid into the mixing tank for cleaning the interior of the tank and the agitator arrangement in-between batches of liquid food product, it is preferred avoiding having openings in the first impeller configured for spraying a cleaning liquid.

[0023] This design further underlines the need for providing the second impeller with a plurality of openings configured for spraying a cleaning liquid on the first impeller for cleaning the first impeller, because the lack of openings in the first impeller configured for spraying a cleaning liquid makes cleaning of the first impeller more difficult.

[0024] According to a further example embodiment, the second impeller further comprises at least one additional opening for each blade of the second impeller and configured for spraying a cleaning liquid on the blades of the second impeller. Thereby, cleaning liquid may be sprayed onto the blades of the second impeller for providing adequate cleaning of the second impeller.

[0025] According to a further example embodiment, the agitator arrangement may further comprise a third impeller secured to the shaft at a third axial position. The third impeller may for example include a plurality of openings configured for spraying a cleaning liquid on the first and/or second impeller for cleaning the first and/or second impeller. A third impeller may further enable improved agitation of the liquid within the tank, as well as use of larger tanks with maintained agitation capacity.

[0026] Alternatively, the third impeller may be free from openings configured for spraying a cleaning liquid. For example, if the third impeller is located above the first and second impeller, the third impeller may be free from openings configured for spraying a cleaning liquid for enabling improved deaeration of the liquid food product, as

discussed above.

[0027] According to a further example embodiment, a first end region of the rotatable shaft is configured to be attached to an upper side of the mixing tank, and the first impeller is located between the first end region and the second impeller.

[0028] According to a further example embodiment, the disclosure relates to a mixing tank including an agitator arrangement as described above. The first impeller may be located above the second impeller in the mixing tank.

[0029] According to a further example embodiment, a first end region of the rotatable shaft is attached to an upper side of the mixing tank, and a second end region of the rotatable shaft is free from attachment to the mixing tank. This simplifies the installation of the agitator arrangement within the mixing tank and eliminates the need to clean a bottom bearing attachment of the agitator arrangement to the mixing tank.

[0030] According to a further example embodiment, a first end region of the rotatable shaft is attached to an upper side of the mixing tank and a second end region of the rotatable shaft is attached to a lower side of the mixing tank, wherein the agitator arrangement comprises openings in lower cleaning hub for spraying cleaning liquid on a bottom bearing support of the agitator arrangement and/or bottom of the mixing tank.

[0031] Further features of, and advantages with, the present disclosure will become apparent when studying the appended claims and the following description. The skilled person realize that different features of the present disclosure may be combined to create embodiments other than those described in the following, without departing from the scope of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] The various example embodiments of the disclosure, including its particular features and example advantages, will be readily understood from the following illustrative and non-limiting detailed description and the accompanying drawings, in which:

- Fig. 1 is a sectional view through a mixing tank and further including an agitator arrangement;
- Fig. 2 is a cross-sectional view of the agitator arrangement 2 of figure 1;
- Fig. 3 is a cross-sectional view of the second impeller;
- Fig. 4 is a top-view of the second impeller;
- Fig. 5 shows a two-part hub of the second impeller;
- Fig. 6 shows a side view of the second impeller including three additional openings for spraying cleaning liquid on the blades of the second impeller; and
- Figure 7 shows a cross-sectional view of the second impeller further illustrating the additional openings.

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS OF THE DISCLOSURE

[0033] The present disclosure will now be described more fully hereinafter with reference to the accompanying drawings, in which exemplary embodiments of the disclosure are shown. The disclosure may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided for thoroughness and completeness. Like reference characters refer to like elements throughout the description. The drawings are not necessarily to scale and certain features may be exaggerated in order to better illustrate and explain the exemplary embodiments of the present disclosure.

[0034] Referring now to figure 1, there is depicted a partly sectional view of a mixing tank 1 and an outside view of an agitator arrangement 2 located within the mixing tank 1. Figure 2 shows a cross-sectional view of the same agitator arrangement 2 according to the disclosure.

[0035] The mixing tank 1 and agitator arrangement 2 are configured for being employed in the food and beverage industry, but also pharmaceutical and cosmetics industry, and should thus preferably be designed for providing highly efficient mixing, improved cost-efficiency, zero in-tank maintenance and very low contamination risk.

[0036] Low contamination risk is partly realised by manufacturing the mixing tank 1 and the agitator arrangement 2 primarily from stainless steel, and to provide a Clean-in-place (CIP) technology for enabling automatic cleaning the interior surface 3 of the mixing tank 1 and internal and external surfaces of the agitator arrangement 2 without disassembly and without need for manual cleaning.

[0037] CIP cleaning may for example include providing high-energy spray of a cleaning solution to the interior of the mixing tank 1 and the agitator arrangement 2. This is typically performed by supplying high pressure cleaning solution to an interior pipe of the agitator arrangement 2 and further to spray openings at one or more locations along the length of the agitator arrangement 2. CIP cleaning further often involves providing highly turbulent flow of the cleaning solution within the mixing tank 1 by means of the agitator arrangement 2. The cleaning process is generally performed using high temperature cleaning solution with added chemical detergents for improved cleaning effectiveness.

[0038] The agitator arrangement 2 is suitable for mixing a liquid in the mixing tank 2 and for cleaning the mixing tank 2. The agitator arrangement thus at least has a dual functionality.

[0039] In the example embodiment of figure 1 and 2 the agitator arrangement 2 is configured for being attached to a top portion 20 of the mixing tank and to protrude into the mixing tank from said top portion 20. The attachment of the agitator arrangement to the tank may for example be realised by means a flange of the agitator

arrangement and threaded fasteners.

[0040] The agitator arrangement 2 comprises a rotatable hollow shaft 4 extending in an axial direction 5, which is perpendicular to a transverse direction 6. The axial direction 5 may for example be parallel with a vertical direction, and the transverse direction 6 may for example be parallel with a horizontal direction.

[0041] A first impeller 7 is secured to the shaft 4 at a first axial position, and a second impeller 8 is secured to the shaft 4 at a second axial position. Furthermore, the second impeller 8 comprises a plurality of openings 9 configured for spraying a cleaning liquid 10 on the first impeller 7 for cleaning the first impeller 7.

[0042] The first end region 14 of the rotatable shaft 4 is configured to be attached to the upper side of the mixing tank 1, and the first impeller 7 is located between the first end region 14 and the second impeller 8. Moreover, the first impeller is located above the second impeller in the mixing tank 1 shown in figure 1.

[0043] In a mixing mode of the agitator arrangement a power source 11, such as an electrical motor, drivingly connected to the hollow shaft, for example via a transmission unit 12, causes the hollow shaft and associated first and second impellers 7, 8 to rotate and to generate a strong whirl flow and mixing effect of a liquid located within the tank 2.

[0044] In a cleaning mode, pressurized cleaning liquid from an external source is supplied to a first external inlet 13 (shown in figure 2) of the agitator arrangement 2, which first external inlet 13 is located outside of the mixing tank 1. Moreover, the first external inlet 13 is in fluid communication with an internal flow path 19 of the rotatable hollow shaft 4, which flow path extends from the first end region 14 of the rotatable hollow shaft 4 to the plurality of openings 9. Thereby, pressurized cleaning liquid supplied at the first external inlet 13 of the agitator arrangement 2 may flow through the rotatable hollow shaft, from the first end region 14 to the plurality of openings 9.

[0045] Pressurized cleaning liquid supplied at the first external inlet 13 and further conveyed through the rotatable hollow shaft 4 may be sprayed out also at other openings (not shown) of the agitator arrangement 2 for cleaning the agitator arrangement and/or the interior surface 3 of the mixing tank 1, such as for example openings at the first impeller 7 and/or at the rotatable hollow shaft 4 configured for spraying a cleaning liquid on the interior surface of the tank or parts of the agitator arrangement, such as the second impeller 8.

[0046] Moreover, the second impeller 8 may comprise further openings configured for spraying the interior surface of the mixing tank and/or a bearing support of the agitator arrangement at a lower part of the agitator arrangement, if such a bearing support is provided.

[0047] According to the example embodiment of the agitator arrangement 2 shown in figure 1 and 2, pressurized cleaning liquid may also be supplied at a second external inlet 17 in the cleaning mode, and further conveyed through an outer flow path of a double walled sec-

tion 18 of the shaft 4 to openings located in a spray ball 15 included in the agitator arrangement 2. However, the basic concept of the disclosure is equally applicable to an agitator arrangement 2 without a double walled section of the shaft 4 and without a spray ball 15.

[0048] Cleaning liquid may be drained from the mixing tank via an outlet (not shown) of the mixing tank 1 and re-circulated to the external inlet 13 of the agitator arrangement 2.

[0049] The two axially spaced apart first and second impellers 7, 8 generally provide improved agitation of the liquid within the tank compared with a single impeller agitator arrangement. The first and second impeller design also enables use of larger mixing tanks with maintained agitation capacity. Hence, the first and second impeller design enables improved manufacturing cost-efficiency.

[0050] A distance 21 between the first axial position and the second axial position may for example be about 400 - 4000 mm, specifically about 500 - 3000 mm, in the axial direction 5 of the rotatable hollow shaft 4.

[0051] In addition, having the second impeller 8 designed to spray cleaning liquid on the first impeller 7 during cleaning of the agitator arrangement improved cleaning and reduced risk of contamination is accomplished. Cleaning of the impellers may generally be complicated due to their often complex shapes, and even if the impellers may have openings configured for spraying a cleaning liquid on the same impeller this may sometimes be insufficient.

[0052] Moreover, the design wherein the second impeller 8 comprises openings configured for spraying a cleaning liquid on the first impeller 7 during cleaning of the agitator arrangement may be particularly relevant in situations wherein the first impeller 7 for any reason is free from openings configured for spraying a cleaning liquid.

[0053] In other words, when the first impeller 7 for any reason does not have any openings configured for spraying a cleaning liquid on the first impeller 7, cleaning of the first impeller may be problematic. In such situations, it may be advantageous that the second impeller 8 comprises opening configured for spraying a cleaning liquid on the first impeller 7 during cleaning of the agitator arrangement.

[0054] One situation in which the first impeller 7 may be designed to be free from openings configured for spraying a cleaning liquid is when the agitator arrangement 2 further is configured for performing a deaeration process of the liquid within the tank, wherein the openings 9 for spraying a cleaning liquid in a cleaning mode of the agitator arrangement 2 also are used for injecting a deaeration gas into the liquid of the tank 1 in a deaeration mode of the agitator arrangement 2.

[0055] In a deaeration process a deaeration gas, e.g. N₂ or CO₂, is supplied to the liquid within the tank via the agitator arrangement 2.

[0056] In detail, a deaeration gas, also referred to as stripping gas, is supplied from an external source to the

agitator arrangement, which subsequently guides the stripping gas to the plurality of openings 9 of the second impeller 8, such that small bubbles of stripping gas are created and allowed to whirl upwards towards the surface of the liquid, thereby stripping oxygen out of the liquid. Minimizing the oxygen content in liquid food products like soft drinks, beer and edible oil leads to extended shelf life and improved taste stability.

[0057] However, considering that the stripping is lighter than the liquid and the stripping gas bubbles therefore rise towards the surface, and that it is desirable to have a long reaction time of the gas bubbles with the liquid before the gas bubbles reach the surface of the liquid within the tank 1, it is often advantageous to supply the stripping gas at a low position in the mixing tank. Consequently, when the first impeller 7 is located above the second impeller 8, as seen in a vertical direction of an assembled agitator arrangement within the mixing tank 1, it may be advantageous to have the first impeller 7 free from openings configured for spraying a cleaning liquid, because otherwise a significant portion of the stripping gas would be entering the liquid via openings in the first impeller 7.

[0058] To conclude, having the second impeller 8 comprising openings configured for spraying a cleaning liquid on the first impeller 7 during cleaning of the agitator arrangement enables implementation of an efficient deaeration process of the liquid within the tank while maintaining an adequate cleaning of the agitator arrangement and tank interior.

[0059] As best shown in figure 2, the rotatable hollow shaft 4 comprises a plurality of first shaft sections 22, 23 that are mutually connected and extending from the first end region of the rotatable shaft to a first axial end 25 of the first impeller 7, and a second shaft section 24 extending from a second axial end 26 of the first impeller 7 to a first axial end 27 of the second impeller 8. Thereby, a more modular design of the rotatable hollow shaft 4 is accomplished for simplified manufacturing, installation and servicing.

[0060] The first and second shaft sections 22, 23, 24 may be threadingly attached to first and/or second impeller 7, 8. In particular, the second shaft section 24 may be threadingly attached to the first axial end 27 of the second impeller 8.

[0061] Figure 3 shows a cross-sectional view of an example embodiment of a second impeller 8 in a close-up view. In particular, figure 3 shows two of the plurality of openings 9 located in the second impeller 8 and configured for spraying a cleaning liquid on the first impeller for cleaning the first impeller 7.

[0062] The openings 9 provide a fluid passage between the internal flow path 19 of the rotatable hollow shaft 4 and the exterior of the agitator arrangement 2.

[0063] Design aspects of the plurality of openings that have an effect of the spraying of a cleaning liquid on the first impeller for cleaning the first impeller, such as for example number of openings, position of openings, size

of the openings, orientation of the openings and the like are selected according to the specific circumstances of each implementation, taking into account factors like type of liquid food product to be cleaned away, the pressure, temperature and detergent of the cleaning liquid, the axial distance between the first and second impellers 7, 8, the radial length of the impeller blades 31, or the like.

[0064] For example, the plurality of openings 9 may have a substantially cylindrical shape. This enables the openings to be cost-efficiently manufactured by drilling.

[0065] Furthermore, the plurality of openings 9 may have a diameter of 1 - 4 mm and specifically of 1.5 - 3 mm. This diameter generally results in improved cleaning effect of the first impeller 7.

[0066] In addition, a centre of an outlet of the plurality of openings 9, respectively, is located a distance 33 of about 10 - 50 mm from an exterior surface 32 of the rotatable hollow shaft, as seen in a transverse direction 6, which is perpendicular to the axial direction 5 of the rotatable hollow shaft 4.

[0067] Moreover, the second impeller may for example comprise at least 4, specifically at least 6, more specifically at least 8 and even more specifically at least 16 openings 9 configured for spraying a cleaning liquid on the first impeller 7. In the example embodiment of figure 4, which corresponds to a sectional view of the second impeller 8 along cut A-A in figure 3, the second impeller comprises 16 openings 9.

[0068] The second impeller 8 of the example embodiment of figure 4 further comprises a total of three impeller blades 31, equally distributed around the circumference of the second impeller 8. However, the number of impeller blades can be varied.

[0069] As shown in figure 3, the second impeller 8 further includes an impeller hub 34 having the impeller blades 31 secured thereto. The impeller hub 34 enables a more modular design of the agitator arrangement by assembling the rotatable shaft 4 out of a suitable combination of first and second shaft sections 22-24 and impeller hubs 34. The first and second shaft sections 22-24 may for example be threadingly attached to the impeller hubs 34, either directly or by means of an individual attachment collar 35 as shown in the example embodiment of figure 3.

[0070] The plurality of openings 9 configured for spraying cleaning liquid on the first impeller 7 may for example be located in the impeller hub. Thereby the impeller blades 31 and the shaft sections 22-24 of the tubular shaft 4 may have a less complicated design and thus being more cost-efficient.

[0071] Figure 5 shows a cross-sectional view along an axial plane of the impeller hub 34. Figure 5 clearly shows that the impeller hub may comprise a first part 40 and a second part 41, wherein the first and second parts 40, 41 are attached to each other. In the example embodiment of figure 5 the first part 40 is configured for being attached to the tubular shaft 4, and the second part 41 is configured to be free from connections to the mixing

tank 1 for enabling simplified cleaning of the mixing tank 1 and agitator arrangement 2.

[0072] However, in alternative embodiments (not shown) of the agitator arrangement 2, the second part 41 of the impeller hub 34, or any other part of the agitator arrangement 2, may have connection arrangement for rotatable connecting the rotatable hollow shaft 4 of the agitator arrangement 2 to a bearing support for rotatably attaching the second part 41 to the mixing tank 1. Such additional fastening of the agitator arrangement 2 may be necessary for avoiding too large bending motion of the rotatable hollow shaft 4 during rotation of the first and second impellers 7, 8.

[0073] If a first end region 14 of the rotatable shaft 4 is attached to an upper side of the mixing tank 1 and a second end region of the rotatable shaft 4 is attached to a lower side of the mixing tank 1, the agitator arrangement may comprise at least one opening 50 in a second part 41 of the hub 34 for spraying cleaning liquid on a bottom bearing support of the agitator arrangement 2 and/or bottom of the mixing tank 1.

[0074] In the example embodiment of figure 5 the first and second parts 40, 41 are welded together along a circumferentially extending weld seam 42. Manufacturing of the second impeller in two parts 40, 41 has several advantages, such as simplified manufacturing of the openings 9.

[0075] Moreover, the second impeller 34 further has a more modular design wherein a single type of first part 40 may be connected with various different types of second parts 41, for example for enabling attachment to various types and sizes of impeller blades to the impeller hub 34.

[0076] In the example embodiment of figure 5, the plurality of openings 9 are located in the first part 40 and the impeller blades are configured to be attached in slits 56 made in the sidewall of the second part 41.

[0077] In detail, the first part 40 of the impeller hub 34 may for example, on a first axial side, have a sleeve section 57 facing the second section 24 of the tubular shaft 4, and being configured to be attached to said second section 24. The first part 40 of the impeller hub 43 may further, on a second axial side located opposite to the first axial side, have a flange section 58 that extends radially outwards from the sleeve section 57.

[0078] The openings 9 for spraying cleaning liquid on the first impeller 8 may be located in the flange section 58 of the first part 40 of the second impeller 7.

[0079] In addition, an axial orientation 60 of the plurality of openings, respectively, defines an inclination angle 43 of 1-45 degrees, specifically 1-10 degrees, and more specifically 2-5 degrees, with respect to the axial direction 5 of the rotatable hollow shaft 4. These ranges of the inclination angle 43 has shown to provide good results in terms of cleaning effect of the first impeller.

[0080] For enabling simplified manufacturing of the openings 9, an axial orientation 60 of the plurality of openings 9, respectively, define an angle 44 of about 90 de-

grees with respect to a plane of an interior surface 45 of the impeller hub 34 at a location of each corresponding opening 9. In other words, upon forming the openings 9, for example by drilling the openings from the inner side of the hub 34, it is advantageous if the surface 45 at the area of the opening 9 is substantially perpendicular to the axial orientation of each opening 9, because thereby the risk that the top edge of the drill drifts away from a desired drilling location. Drilling an opening at an inclined angle with respect to a surface is significantly more difficult than drilling an opening at a straight angle to the surface.

[0081] Moreover, the modular design of the hub 34 enables drilling from the inside of the hub 34 before the first and second parts 40, 41 of the hub have been secured to each other.

[0082] The second part 41 of the impeller hub 43 may have a substantially cylindrical shape, and one axial side of the second part 41 may be fastened to the radially outer edge of the flange section 58 of the first part 40 of the hub 34.

[0083] Figure 6 shows a side view of the second impeller 8. As briefly mentioned above, the second impeller 8 may comprise additional openings 70 for each impeller blade 31 of the second impeller 8 and configured for spraying a cleaning liquid on the impeller blades 31 of the second impeller 8.

[0084] The flow passages 71 of three additional openings 70 are clearly shown in figure 7, which shows a sectional view along section N-N of figure 7.

[0085] Although the agitator arrangement 2 according to the disclosure has been mainly described with reference to a first and a second impeller 7, 8, the agitator arrangement 2 may equally be equipped with a third impeller secured to the rotatable hollow shaft 4 at a third axial position. The third impeller may for example comprise a plurality of openings configured for spraying a cleaning liquid on the first and/or second impeller for cleaning the first and/or second impeller. Alternatively, the third impeller may be free from openings configured for spraying a cleaning liquid. Also yet further impellers are possible.

[0086] Although the disclosure has been described in relation to specific combinations of components, it should be readily appreciated that the components may be combined in other configurations as well which is clear for the skilled person when studying the present application. Thus, the above description of the example embodiments of the present disclosure and the accompanying drawings are to be regarded as a non-limiting example of the disclosure and the scope of protection is defined by the appended claims. Any reference sign in the claims should not be construed as limiting the scope.

[0087] The use of the word "a" or "an" in the specification may mean "one," but it is also consistent with the meaning of "one or more" or "at least one." The term "about" means, in general, the stated value plus or minus 10%, or more specifically plus or minus 5%. The use of

the term "or" in the claims is used to mean "and/or" unless explicitly indicated to refer to alternatives only.

[0088] The terms "comprise", "comprises" "comprising", "have", "has", "having", "include", "includes", "including" are open-ended linking verbs. As a result, a method or device that "comprises", "has" or "includes" for example one or more steps or elements, possesses those one or more steps or elements, but is not limited to possessing only those one or more elements.

Claims

1. Agitator arrangement (2) for mixing a liquid in a mixing tank (1) and for cleaning the mixing tank (1), the agitator arrangement (2) comprising:

a rotatable hollow shaft (4) extending in an axial direction (5),
 a first impeller (7) secured to the shaft (4) at a first axial position,
 a second impeller (8) secured to the shaft (4) at a second axial position,
 wherein the second impeller (8) comprises a plurality of openings (9) configured for spraying a cleaning liquid on the first impeller (7) for cleaning the first impeller (7).

2. Agitator arrangement according to claim 1, wherein the second impeller (8) includes an impeller hub (34) and impeller blades (31) secured to the impeller hub (34), and wherein the plurality of openings (9) are located in the impeller hub (34).

3. Agitator arrangement according to any one of the preceding claims, wherein the second impeller (8) comprises at least 4, specifically at least 6, more specifically at least 8 and even more specifically at least 16 openings (9) configured for spraying a cleaning liquid on the first impeller (7).

4. Agitator arrangement according to any one of the preceding claims, wherein the agitator arrangement (2) comprises a flow path (19) from a first end region (14) of the rotatable hollow shaft (4) to the plurality of openings (9), such that pressurized cleaning liquid supplied at the first end region (14) of the rotatable hollow shaft (4) may be sprayed out at the plurality of openings (9).

5. Agitator arrangement according to any one of the preceding claims, wherein the plurality of openings (9) have a substantially cylindrical shape with a diameter of 1 - 4 mm, and specifically of 1.5 - 3 mm.

6. Agitator arrangement according to any one of the preceding claims, wherein an axial orientation (60) of the plurality of openings (9), respectively, define

an inclination angle (43) of 1-45 degrees, specifically 1-10 degrees, and more specifically 2-5 degrees, with respect to the axial direction (5) of the rotatable hollow shaft (4).

7. Agitator arrangement according to any one of the preceding claims, wherein a centre of an outlet of the plurality of openings (9), respectively, is located a distance (33) of 10 - 50 mm from an exterior surface (32) of the rotatable hollow shaft (4), as seen in a direction (6) perpendicular to the axial direction (5) of the rotatable hollow shaft (4).

8. Agitator arrangement according to any one of the preceding claims 2 - 7, wherein an axial orientation (60) of the plurality of openings (9), respectively, define an angle (44) of about 90 degrees with respect to a plane of an interior surface (45) of the impeller hub (34) at a location of each corresponding opening (9).

9. Agitator arrangement according to any one of the preceding claims 2 - 8, wherein the impeller hub (34) comprises a first part (40) and a second part (41), wherein the first and second parts (40, 41) are attached to each other, and wherein the plurality of openings (9) are located in the first part (40) and the impeller blades (31) are attached to the second part (41).

10. Agitator arrangement according to any one of the preceding claims, wherein a distance (21) between the first axial position and the second axial position is 400 - 4000 mm, specifically 500 - 3000 mm, in the axial direction (5) of the rotatable hollow shaft (4).

11. Agitator arrangement according to any one of the preceding claims, wherein the rotatable hollow shaft (4) comprises one or more first shaft sections (22, 23) extending from the first end region (14) of the rotatable shaft (4) to a first axial end (25) of the first impeller (7), and a second shaft section (24) extending from a second axial end (26) of the first impeller (7) to a first axial end (27) of the second impeller (8).

12. Agitator arrangement according to any one of the preceding claims, wherein the first impeller (7) is free from openings configured for spraying a cleaning liquid.

13. Agitator arrangement according to any one of the preceding claims, wherein the second impeller (8) further comprises at least one additional opening (70) for each blade (31) of the second impeller (8) and configured for spraying a cleaning liquid on the blades (31) of the second impeller (8).

14. Agitator arrangement according to any one of the

preceding claims, further comprising a third impeller secured to the shaft (4) at a third axial position, wherein

- the third impeller comprises a plurality of openings configured for spraying a cleaning liquid on the first and/or second impeller (7, 8) for cleaning the first and/or second impeller (7, 8), or
- the third impeller is free from openings configured for spraying a cleaning liquid.

- 15.** Mixing tank including an agitator arrangement according to any one of the preceding claims, wherein the first impeller (7) is located above the second impeller (8).

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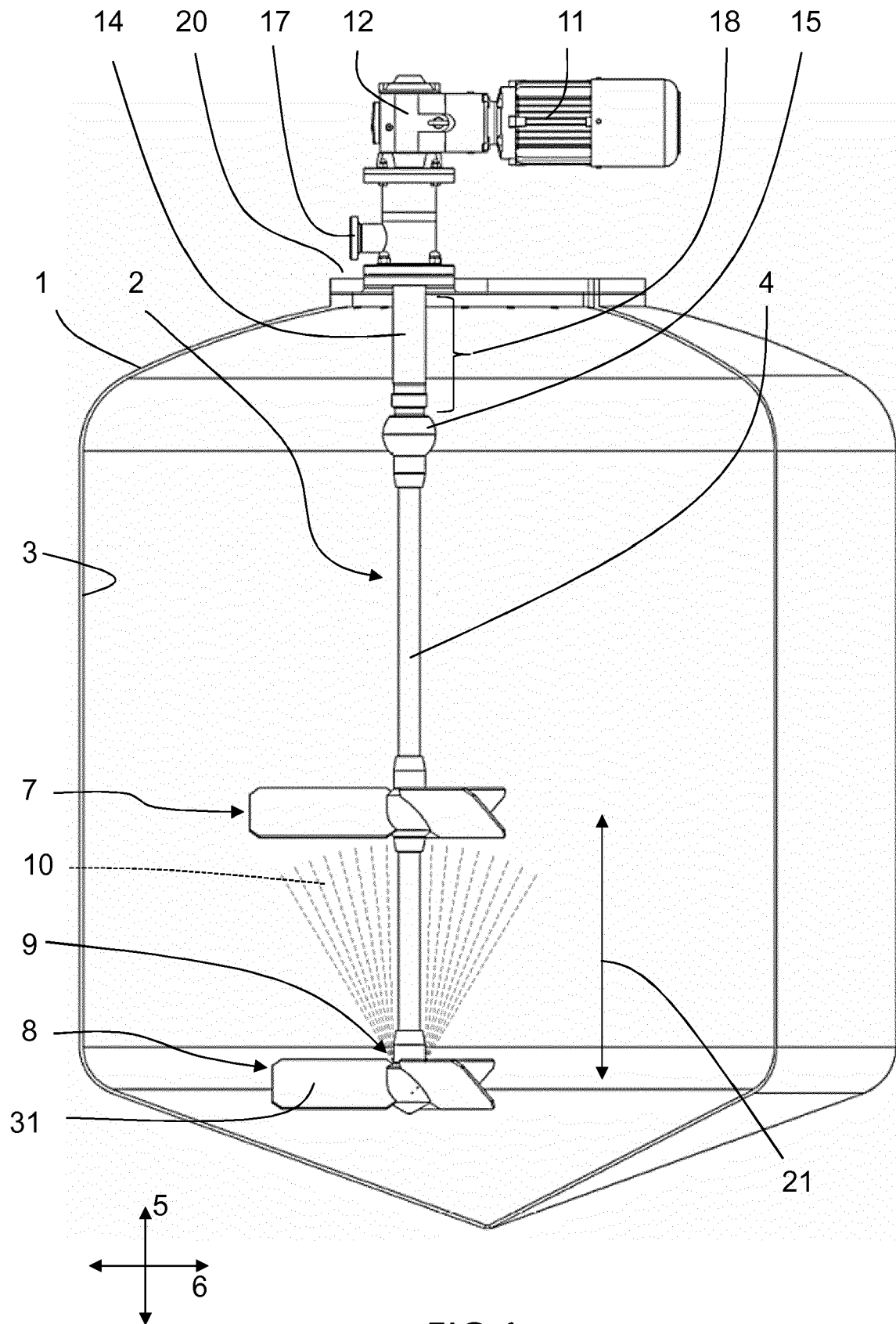


FIG.1

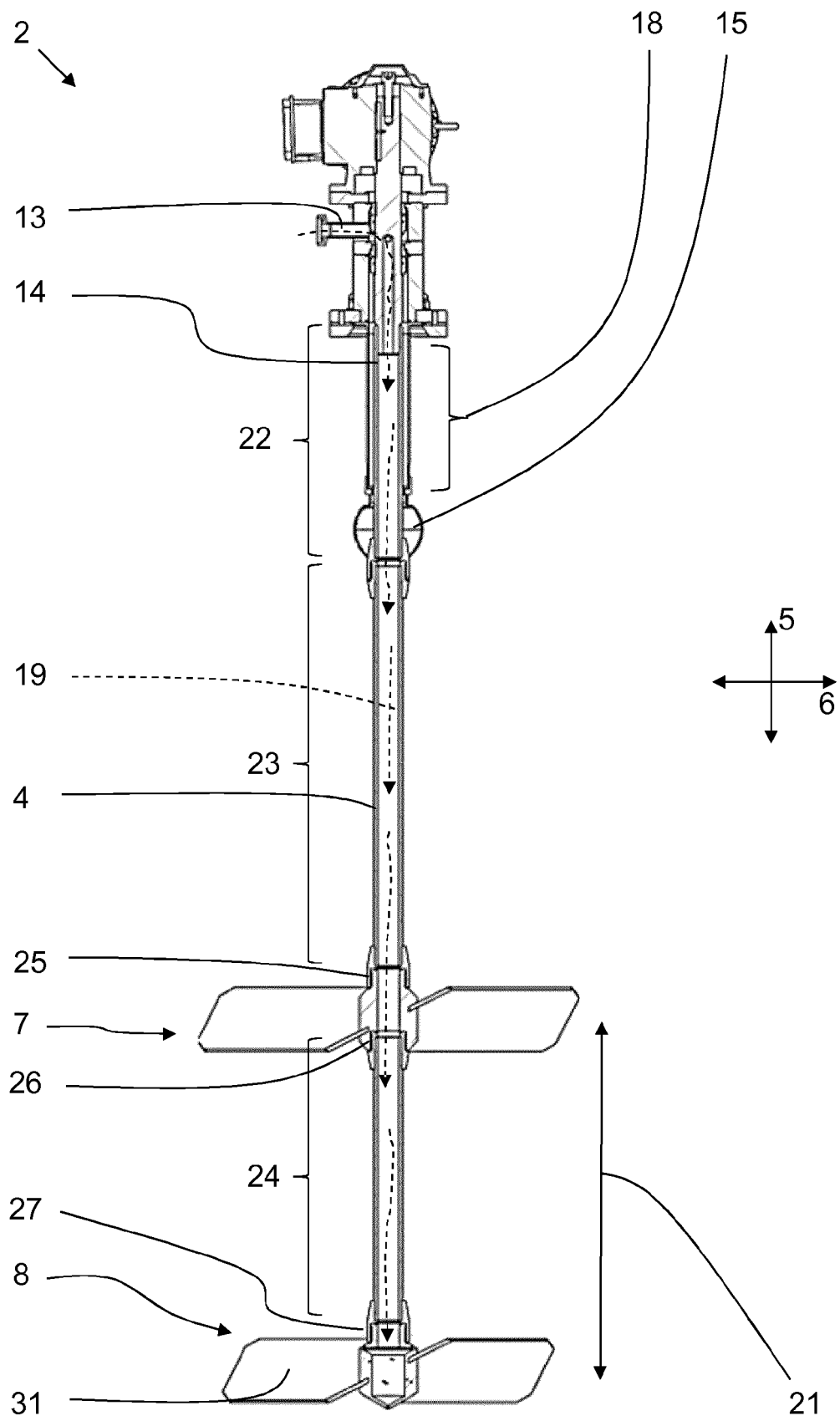
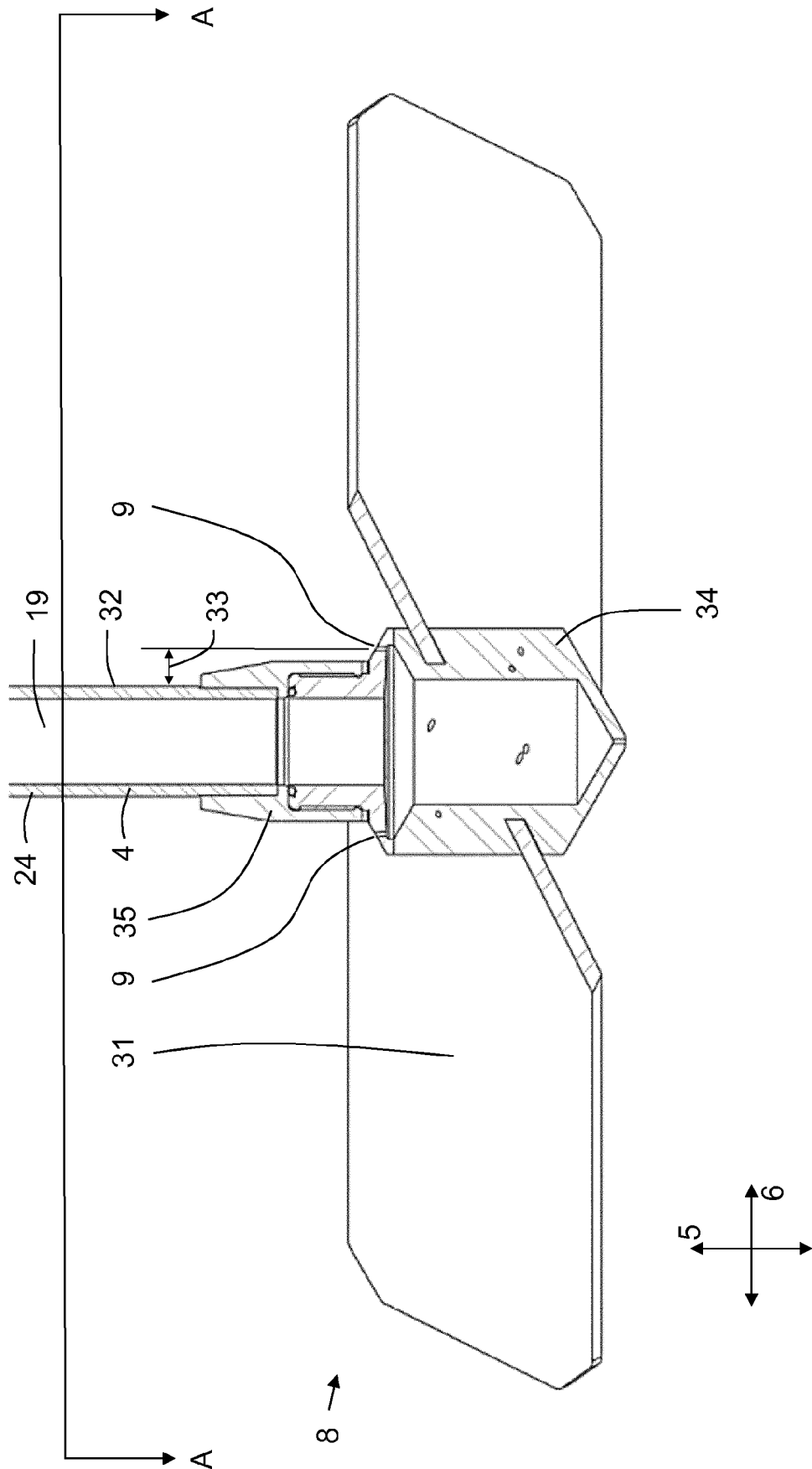


FIG.2



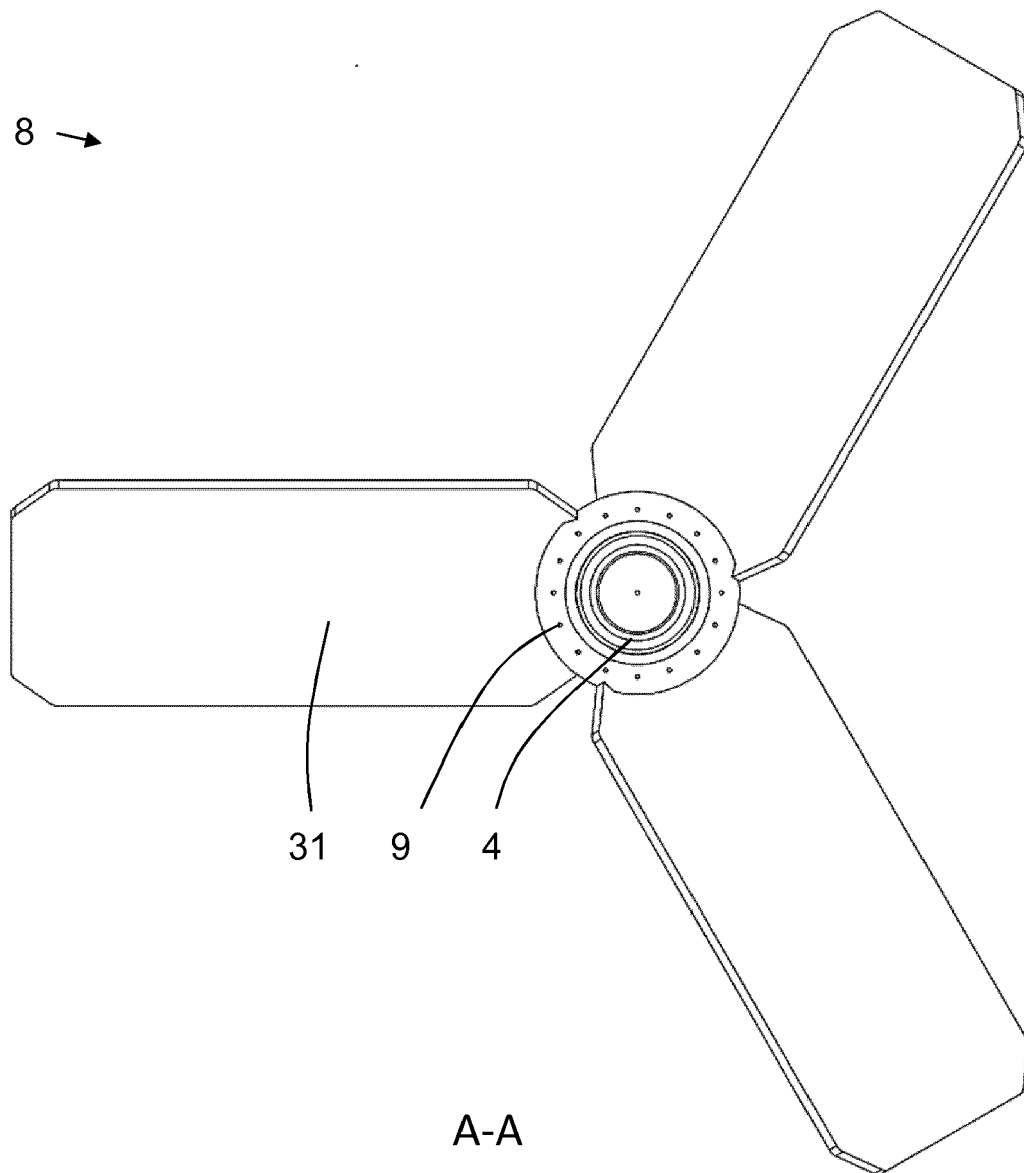


FIG.4

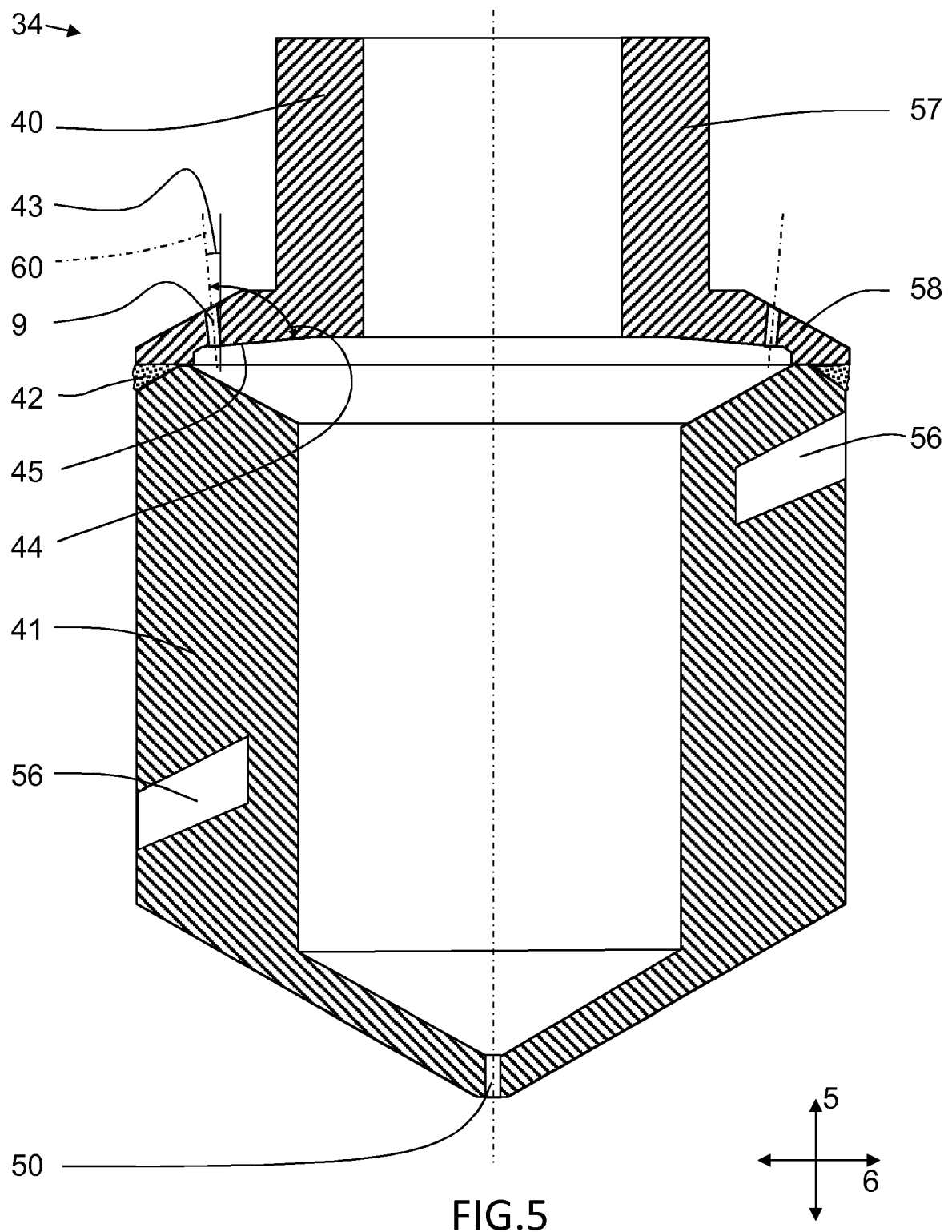


FIG.5

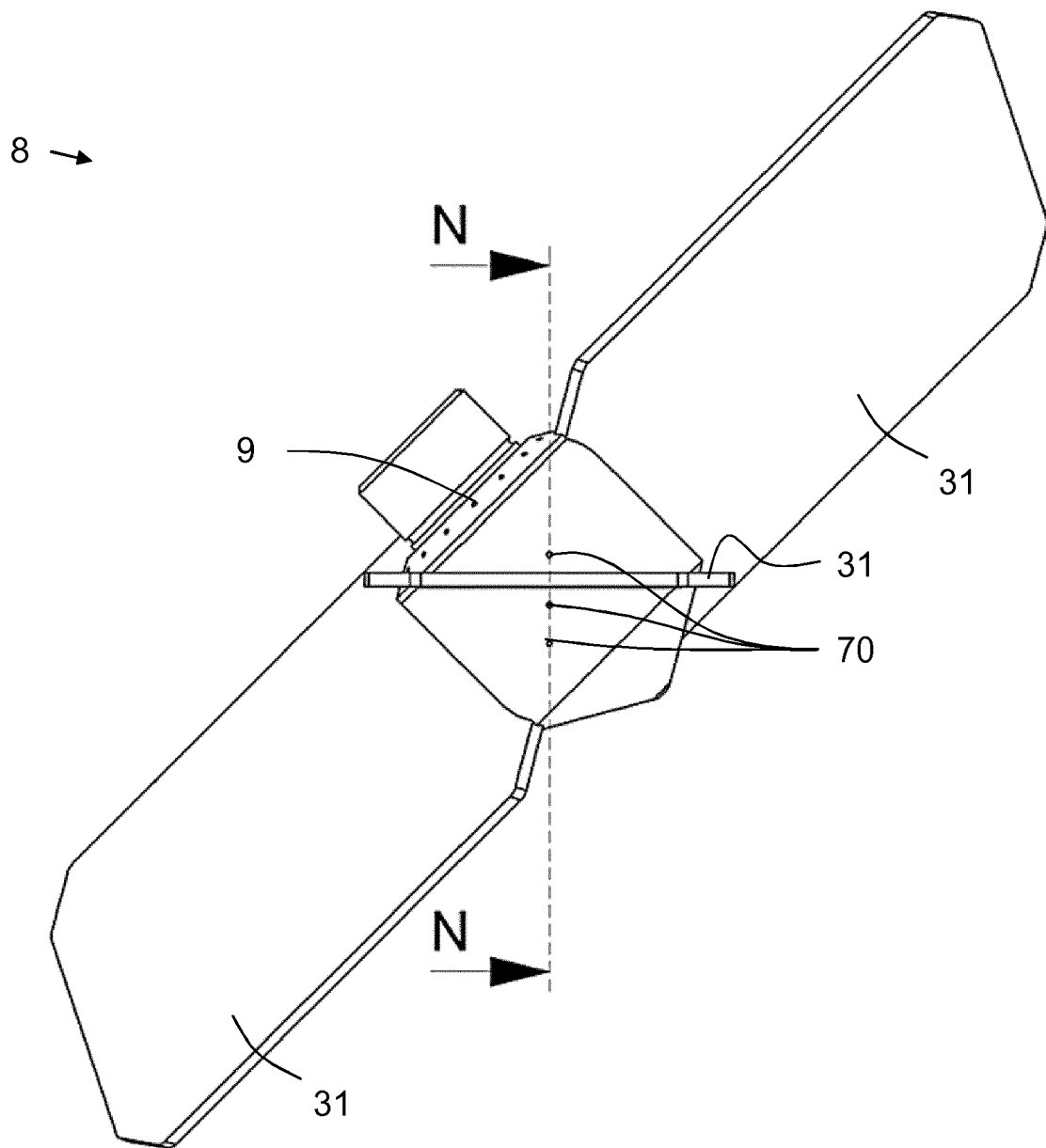


FIG.6

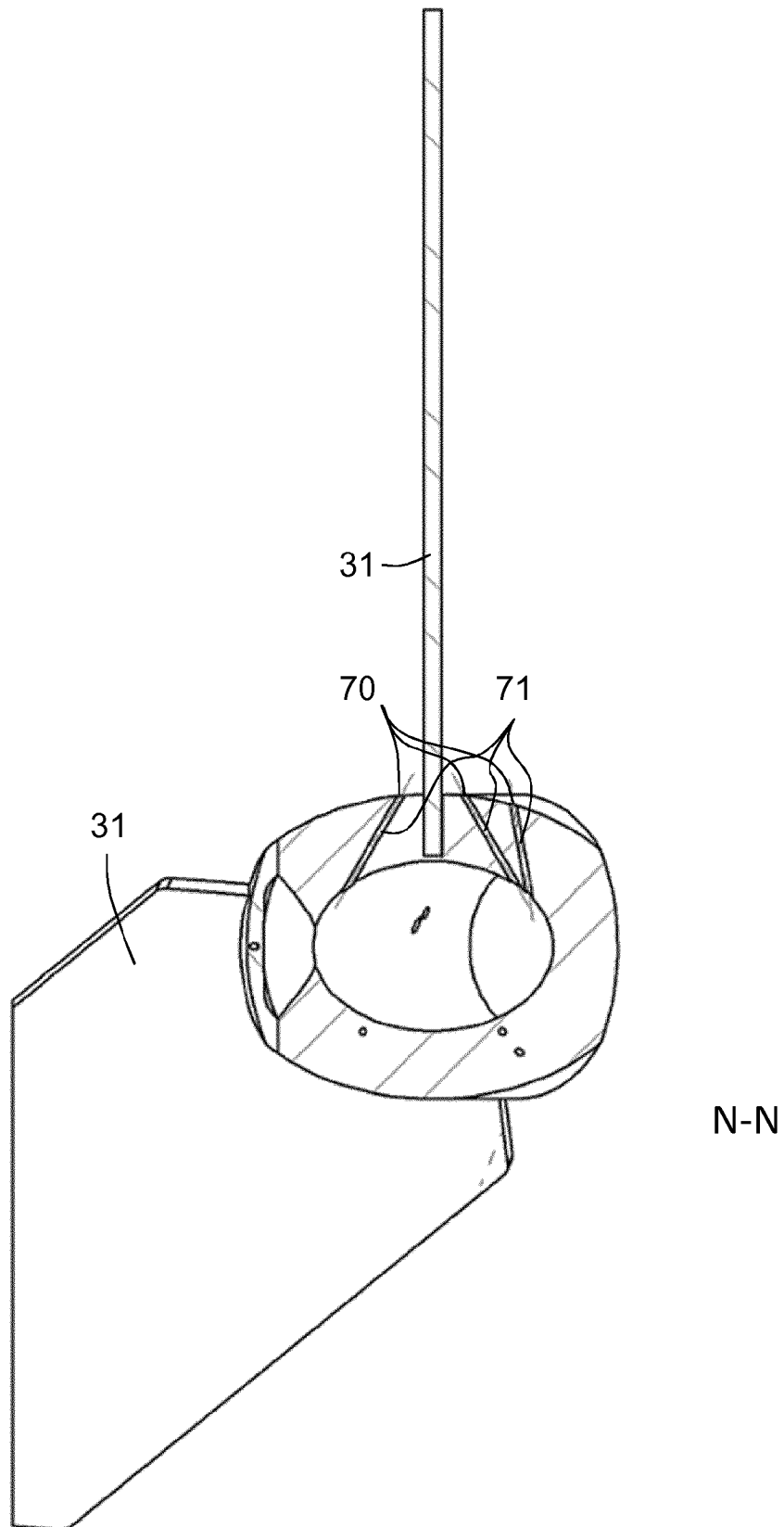


FIG.7



EUROPEAN SEARCH REPORT

 Application Number
 EP 18 17 7890

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	CN 206 980 591 U (ZHEJIANG YANGTSE RIVER MIXERS CO LTD) 9 February 2018 (2018-02-09) * paragraph [0002] * * paragraph [0013] - paragraph [0017] * * paragraph [0026] * * paragraph [0032] - paragraph [0035] * * figures *	1-15	TECHNICAL FIELDS SEARCHED (IPC) B01F B08B
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 17 December 2018	Examiner Real Cabrera, Rafael
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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The members are as contained in the European Patent Office EDP file on
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82