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(54) **STIRRING APPARATUS AND METHOD FOR STIRRING A LIQUID TONER**

(57) A stirring apparatus for stirring a mixture, in particular a liquid containing insoluble particles, said apparatus comprising: a container (30) for containing the mixture; a rotor (10) comprising a shaft (17) and a rotor blade (12); driving means for rotating said shaft; and at least one flow disturbing object (40) between said shaft (17) and a circumferential inner wall of the container (30), said flow disturbing object (40) being either fixedly mounted such that said flow disturbing object (40) is stationary in said container (30), or being mounted rotatably around said shaft (17) and being connected to said driving means such that said flow disturbing object (40) is rotated with a rotational speed which is different from the rotational speed of the shaft and/or with a rotational direction which is different from the rotational direction of the shaft.

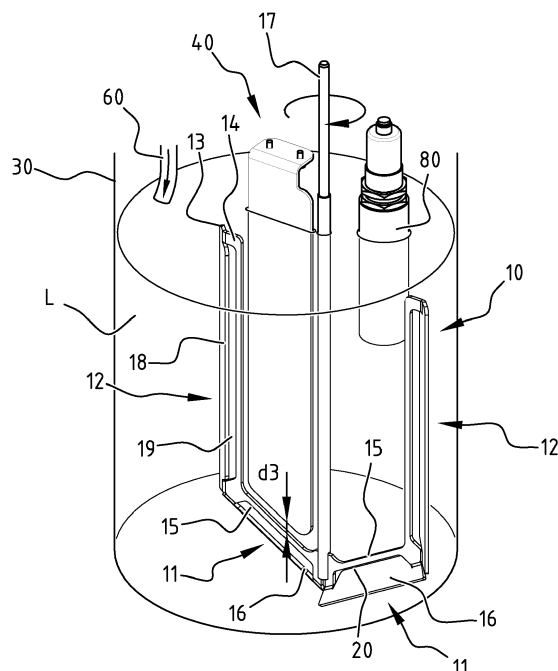


FIG. 1A

Description

Field of Invention

[0001] The field of the invention relates to a stirring apparatus for stirring a substance, typically a liquid, in particular a liquid containing insoluble particles, to a printing system comprising such a stirring apparatus, and to a method for stirring a substance, typically a liquid, in particular a liquid containing insoluble particles, and more in particular a toner liquid.

Background

[0002] Typical prior art mixers use one or more rotors and/or one or more anchor stirrers to stir liquids containing insoluble particles. Such mixers have the disadvantage of requiring high rotational speeds and many components to obtain good mixing results. Liquids containing insoluble particles, and in particular toner liquids are typically thixotropic implying that they are very thick and viscous under static conditions, whilst they will flow and become thin, and less viscous when shaken, agitated, stirred or otherwise stressed. Such non-Newtonian pseudoplastic fluids typically show a time-dependent change in viscosity: the viscosity is lowered as the liquid undergoes shear stress. It is desirable to provide a simple and robust stirring apparatus which is suitable for stirring thixotropic liquids.

Summary

[0003] The object of embodiments of the invention is to provide a stirring apparatus allowing a good mixing at a relatively low rotational speed with few components. More in particular, an object of embodiments of the invention is to obtain a very good mixing whilst adding little energy to the mixture.

[0004] According to a first aspect of the invention there is provided a stirring apparatus for stirring a mixture, in particular a liquid, and more in particular a liquid containing insoluble particles. The apparatus comprises: a container for containing the mixture; a rotor comprising a shaft and a rotor blade; driving means for rotating said shaft; and at least one flow disturbing object between said shaft and a circumferential inner wall of the container, said flow disturbing object being either fixedly mounted such that said flow disturbing object is stationary in said container, or being mounted rotatably around said shaft and being connected to said driving means such that said flow disturbing object is rotated with a rotational speed which is different from the rotational speed of the shaft, and/or with a rotational direction which is different from the rotational direction of the shaft. In other words at least one flow disturbing object may rotate with a different speed, or with the same speed but with an opposite rotation direction.

[0005] Embodiments are based *inter alia* on the inven-

tive insight that by using a flow disturbing object, high shear forces may be obtained within the mixture at relatively low rotational speeds of the rotor. Or, stated differently, the use of a flow disturbing object generates significant shear forces and turbulences in a simple and more effective manner than in prior art solutions where multiple fast rotating rotors and/or anchor stirrers are combined, whilst adding less energy to the mixture. Especially for toner mixtures this will avoid that the mixture "fuses" due to a too high temperature or friction in the mixture. In summary, embodiments of the invention perform significantly better than prior art stirring apparatus.

[0006] Although the stirring apparatus of the invention is particularly useful for stirring toner liquid, it may also be used for many other types of liquids or fluidic materials, such gels, colloids, powder mixtures, etc.

[0007] According to a preferred embodiment the at least one flow disturbing object is located between said shaft and a trajectory followed by the rotor blade of the rotor, when in operation. In that way the rotor blade can cause a rotational flow of the entire volume which is disturbed at the surface of the at least one flow disturbing object, resulting in high shear forces and turbulences. It is noted that in such an embodiment the rotor blade is typically connected to the shaft with a rotor arm which may rotate above or below a flow disturbing object. As set out below, in exemplary embodiments of the invention, there may be provided multiple rotor blades, in which case each rotor blade may be connected to the shaft through a rotor arm.

[0008] According to a preferred embodiment the at least one flow disturbing object is shaped and positioned for disturbing the rotational flow caused by the rotor, when in use. A flow disturbing object is preferably an object that does not have a cylindrical symmetry with respect to the shaft of the rotor.

[0009] Preferably, the rotor blade is shaped for moving the mixture in the direction of the at least one flow disturbing object, and the at least one flow disturbing object is shaped for disturbing the flow caused by the rotor blade, when in use.

[0010] According to a preferred embodiment the container is associated with a maximum filling level, and the rotor blade extends over a height which is at least 50 percent of the maximum filling level, preferably at least 70 percent, and more preferably at least 80 percent. Alternatively there may be provided a plurality of rotor blades which cover together at least 50 percent of the maximum filling level, preferably at least 70 percent, and more preferably at least 80 percent.

[0011] Preferably the at least one flow disturbing object extends in a radial direction from the shaft to the circumferential inner wall of the container, over a distance which is at least 15 percent of the maximum distance between the shaft and the inner wall of the container, more preferably at least 25 percent, and most preferably at least 50 percent of the maximum distance between the shaft and the inner wall of the container. When multiple flow

disturbing objects are used, it is the sum of the radial dimensions of the different objects which fulfills in a preferred embodiment the requirement above. This guarantees a good stirring of the entire volume between the shaft and inner wall of the container.

[0012] In a preferred embodiment the flow disturbing object is a stator object which is mounted in a fixed position in the container. Such an embodiment has the benefit of having a simple construction whilst yielding excellent stirring results for a relatively low energy input.

[0013] In an exemplary embodiment the at least one flow disturbing object comprises a flow disturbing plate. In another exemplary embodiment the at least one flow disturbing object comprises a pillar shaped object, e.g. a hollow pillar. In another embodiment the at least one flow disturbing object comprises a hollow body containing at least one measurement device, such as a level gauge, a pressure sensor, a temperature sensor, a sensor for measuring a characteristic of the mixture, such as a conductivity sensor for measuring the electric conductivity of the mixture, a viscosity sensor for measuring the viscosity of the mixture, a density sensor for measuring the density of the mixture, etc. This hollow body may be fixed to or through a top cover and may be open at a bottom end. The top end may be open or closed. Alternatively this hollow body may be fixed to the bottom of the container and may have an open top end. The hollow body may be provided with a plurality of holes for promoting the flow of fresh mixture through the hollow body.

[0014] In a further developed embodiment the distance between the at least one flow disturbing object and the shaft of the rotor is smaller than 5 cm, preferably smaller than 3 cm. Preferably, this applies for a substantial part of the height of the flow disturbing object, and more preferably in the entire zone where the at least one flow disturbing object and the shaft are meant to be in the mixture. In that way "uninterrupted" or "undisturbed" flows between the shaft and the flow disturbing object(s) can be significantly reduced or avoided. The optimal distance will typically depend on the viscosity of the mixture, and the values provided give good results for, amongst others, liquid toner mixtures.

[0015] In a preferred embodiment the distance between the at least one flow disturbing object and a trajectory followed by the rotor blade of the rotor when in operation, is smaller than 5 cm, preferably smaller than 3 cm. Preferably, this applies for a substantial part of the height of the flow disturbing object, and more preferably in the entire zone where the at least one flow disturbing object and the rotor blade are meant to be in the mixture. In that way "uninterrupted" flows between the rotor blade and the flow disturbing object can be significantly reduced or avoided.

[0016] The rotor blade may be provided with at least one opening arranged for allowing mixture to pass through said at least one opening.

[0017] Preferably, the rotor blade is an elongate upright rotor blade extending substantially parallel to an upright

side of the at least one flow disturbing object. In such an embodiment the opening may be a slit extending in the elongate rotor blade. More preferably, the rotor blade comprises a first upright elongate portion connected to an adjacent second upright elongate portion, said first portion making an angle with said second portion, so that the mixture is moved inwardly during rotation of the rotor, in the direction of the flow disturbing object. More generally, the rotor blade(s) are preferably shaped to direct the mixture to the flow disturbing object(s), which may be inwardly if the flow disturbing object(s) are located between the shaft and the rotor blade(s) or outwardly if the flow disturbing object is located between the inner wall and the rotor blade(s).

[0018] In an exemplary embodiment the elongate upright rotor blade may extend substantially vertically and in particular parallel to the shaft.

[0019] In other exemplary embodiments the elongate upright rotor blade may extend under an angle which is bigger than 90° with respect to a horizontal line tangent to the trajectory of the rotor such that the rotor blade is inclined backwardly when looking into the direction of rotation of the rotor. Such an angle will improve the stirring in a vertical direction by moving the mixture upwardly. In another embodiment the elongate rotor blade may have a curved shape, e.g. a helical shape. When the rotor blade is slanted backwardly when looking into the direction of rotation of the rotor, or when the rotor blade is helically shaped such that it is curved backwardly when looking into the direction of rotation of the rotor, the rotor blade will push the mixture in the container upwardly. The upward motion of the mixture may at least partially compensate for the downward motion behind the flow disturbing object, and further improve the mixing, in particular when mixing at relatively low rotational speeds. The angle of the rotor blade may be optimized to generate a closed curve motion, e.g. a circular or elliptical motion of the mixture in a plane perpendicular on the rotation direction of the rotor.

[0020] In yet another exemplary embodiment the elongate upright rotor blade may extend under an angle which is smaller than 90° with respect to a horizontal line tangent to the trajectory of the rotor such that the rotor blade is inclined forwardly when looking into the direction of rotation of the rotor. Such an angle will improve the stirring in a vertical direction by moving the mixture downwardly. In another embodiment the elongate rotor blade may have a curved shape which is extending forwardly when looking into the direction of rotation of the rotor. When the rotor blade is slanted forwardly when looking into the direction of rotation of the rotor, or when the rotor blade is helically shaped such that it is curved forwardly when looking into the direction of rotation of the rotor, the rotor blade will push the mixture in the container downwardly. Also here, the angle of the rotor blade may be optimized to generate a closed curve motion, e.g. a circular or elliptical motion of the mixture in a plane perpendicular on the rotation direction of the rotor.

[0021] Preferably an outer edge of the elongate rotor blade extends parallel or substantially parallel to an inner wall of the container, but this outer edge may be extending e.g. vertically or helically in a plane parallel to the inner wall of the container.

[0022] According to further exemplary embodiments of the invention, the stirring apparatus is defined according to any one of the clauses below:

1. A stirring apparatus for stirring a mixture, in particular a liquid containing insoluble particles, said apparatus comprising: a container for containing the mixture; a rotor comprising a shaft and a rotor blade; driving means for rotating said shaft; and at least one flow disturbing object between said shaft and a circumferential inner wall of the container, said flow disturbing object being either fixedly mounted such that said flow disturbing object is stationary in said container, or being mounted rotatably around said shaft and being connected to said driving means such that said flow disturbing object is rotated with a rotational speed which is different from the rotational speed of the shaft and/or with a rotational direction which is different from the rotational direction of the shaft; wherein said at least one flow disturbing object is located between said shaft and a trajectory followed by the rotor blade of the rotor when in operation; wherein the rotor blade is shaped to direct the mixture upwardly and/or downwardly.

2. The stirring apparatus of clause 1, wherein the rotor blade is shaped to direct the mixture inwardly to the at least one flow disturbing object.

3. The stirring apparatus of clause 1 or 2, wherein the rotor blade is an elongate rotor blade extending under an angle which is bigger than 90° or smaller than 90° with respect to a horizontal line tangent to the trajectory of the rotor when looking into the direction of rotation of the rotor, such that the rotor blade is inclined at least partly backwardly and/or at least partly forwardly, when looking into the direction of rotation of the rotor.

4. The stirring apparatus of any one of the previous clauses, wherein the rotor blade has a substantial helical shape arranged around the shaft of the rotor.

5. The stirring apparatus of any one of the previous clauses, wherein the rotor blade comprises a first elongate portion and a second elongate portion, said first portion making an angle with said second portion, so that the mixture is moved towards the at least one flow disturbing object during rotation of the rotor.

6. The stirring apparatus of any one of the previous clauses, wherein the rotor is an elongate rotor blade having a length direction, wherein the rotor blade is provided with an opening arranged for allowing mixture to pass through said at least one opening, wherein the opening is a slit extending in the length direction.

7. The stirring apparatus of any one of the previous

clauses, wherein said at least one flow disturbing object comprises a flow disturbing plate.

8. The stirring apparatus of any one of the previous clauses, wherein the at least one flow disturbing object is a stator object which is mounted in a fixed position in the container.

9. The stirring apparatus of any one of the previous clauses, wherein the at least one flow disturbing object comprises a hollow body containing at least one measurement device.

10. The stirring apparatus of any one of the previous clauses, wherein the rotor blade is fixed to the shaft by means of an arm extending from the shaft in the direction of the circumferential inner wall of the container; wherein preferably the arm is provided with an elongate slit extending in a radial direction between the rotor blade and the shaft.

11. The stirring apparatus of any one of the previous clauses, wherein the container is a cylindrical container having an inner wall extending at a distance of the trajectory followed by the rotor blade, said distance being preferably smaller than 5 cm, more preferably smaller than 3 cm.

12. A printing system comprising: a printing apparatus with a toner feed unit and a toner discharge line, and a stirring apparatus according to any one of the previous clauses; wherein a toner liquid is stored in the container of the stirring apparatus; said container having an outlet for discharging stirred liquid toner, and an inlet; said outlet being connected to the toner feed unit of the printing apparatus, and said inlet being connected to the toner discharge line.

[0023] In a preferred embodiment the rotor blade is fixed to the shaft by means of an arm extending from the shaft in the direction of the circumferential inner wall of the container. Preferably, the distance between the at least one flow disturbing object and a zone in which the arm of the rotor rotates, when in operation, is smaller than 5 cm, more preferably smaller than 3 cm. Preferably, this applies in the entire zone where mixture is meant to be present. The optimal distance will typically depend on the viscosity of the mixture, and the values provided give good results for, amongst others, liquid toner mixtures.

[0024] In a preferred embodiment each arm of the at least one arm is provided with an elongate slit extending in a radial direction between the rotor blade and the shaft. Further, each arm of the at least one arm may comprise a first elongate portion and a second elongate portion, said first and second portion being adjacent portions extending in radial direction between the shaft and an inner wall of the container, said first portion making an angle with said second portion, so that the mixture is moved upward and/or downward during rotation of the rotor. More generally, the arm(s) are preferably shaped to direct the mixture to the flow disturbing object(s), which may be upwardly if a flow disturbing object is located above the rotor blade(s) or downwardly if a flow disturbing

object is located below the rotor arm(s).

[0025] In a preferred embodiment the container is a cylindrical container. Preferably, the inner wall of the container extends at a distance of the trajectory followed by the rotor blade, said distance being smaller than 5 cm, preferably smaller than 3 cm. Preferably at least an outer portion of the rotor blade makes an angle with the radial direction such that mixture is removed from the inner wall of the container. The optimal distance will typically depend on the viscosity of the mixture, and the values provided give good results for, amongst others, liquid toner mixtures.

[0026] In a preferred embodiment the rotor comprises one or more further rotor blades. Such a further rotor blade may have any one or more of the features of the first rotor blade that have been described above. Preferably, the different rotor blades of the rotor are arranged in a symmetrical manner around the shaft.

[0027] Preferably the container has a more or less conical bottom wall with an outlet located near the bottom of the conical bottom wall, such that stirred liquid can be easily discharged.

[0028] In a further developed embodiment the stirring apparatus further comprises an inlet tube having an end part where the mixture leaves the inlet tube. Preferably, the end part is located between the shaft and the rotor blade. In that way, the mixture may be brought into the container at a suitable location in the container where the shear forces are very high. The inlet tube may be arranged in a top cover of the container.

[0029] In a preferred embodiment the driving means are configured for rotating the rotor at a rotational speed that is lower than 120 revolutions per minute, preferably at a rotational speed between 50 and 100 revolutions per minute, more preferably between 50 and 80 revolutions per minute. According to a possible embodiment the flow disturbing object is mounted rotatably around said shaft and is connected to the driving means such that said flow disturbing object is rotated with a rotational speed which is lower than the rotational speed of the shaft and/or which has a different rotation direction. In that way the flow disturbing object still functions in a similar manner as the stator object described above, and a good stirring can be obtained in a simple manner requiring only one motor as a driving means for driving both the rotor and the flow disturbing object at a relatively low rotational speed.

[0030] In an exemplary embodiment the stirring apparatus further comprises a wave guidance portion above the trajectory followed by the rotor blades, said wave guidance portion being configured for guiding any upwardly extending wave(s) downwardly into the container. Typically, the rotation of the mixture by the rotor will cause the shape of the surface of rotating mixture to become concave as a consequence of the centrifugal force. Further the passing of a rotor blade will cause a wave which may extend over the top of the container in the event of high mixture levels in the container. By adding a wave

guidance portion the wave(s) can be intercepted and guided downwardly and/or inwardly in the container. In that way it is avoided that the height of the container needs to be much bigger than the maximum mixture level, resulting in a more compact apparatus.

[0031] According to a second aspect of the invention there is provided a printing system comprising: a printing apparatus with a toner feed unit and a toner discharge line, and at least one stirring apparatus according to any one of the above described embodiments. A toner liquid is stored in the container of the stirring apparatus, and said container has an outlet for discharging stirred liquid toner, and an inlet. The outlet is connected to the toner feed unit of the printing apparatus, and the inlet is connected to the toner discharge line. The toner feed unit may comprise e.g. a main reservoir and a feed roller which is fed by toner liquid in the main reservoir. The outlet of the container of the stirring apparatus may then be connected to an inlet of the main reservoir of the toner feed unit. The toner discharge line may collect any toner liquid from the printing apparatus that needs to be stirred, e.g. toner liquid from the main reservoir as well as any excess toner from the printing apparatus, e.g. excess toner that is removed from the feed roller or from the developer roller during printing.

[0032] In a preferred embodiment the printing system further comprises one or more of the following: a reservoir for storing dispersion agent, said dispersion agent reservoir being connected via a dispersion agent dosing unit to the inlet of the container; a reservoir for storing carrier liquid, said carrier liquid reservoir being connected via a carrier liquid dosing unit to the inlet of the container; a further stirring apparatus according to any one of the embodiments disclosed above, wherein the container of said further stirring apparatus stores a concentrated solution of toner liquid; said container of said further stirring apparatus having an outlet which is connected via a concentrated solution dosing unit to the inlet of the container which stores the toner liquid. This allows the composition of the toner liquid in the container of the stirring apparatus to be adjusted as needed.

[0033] In a further developed embodiment the printing system further comprises one or more measurement devices for measuring one or more properties of the liquid toner, and a control unit configured for controlling at least one of said dispersion agent dosing unit, said carrier liquid dosing unit, and said concentrated solution dosing unit in function of said at least one measured property.

[0034] In an exemplary embodiment the printing system further comprises a feed reservoir and a return line for returning excess liquid toner to the feed reservoir, wherein the stirring apparatus is included in the return line.

[0035] According to another aspect of the invention, there is provided a method for mixing a mixture using a stirring apparatus according to any one of the embodiments above. Preferably the rotor is rotated at a rotational speed that is lower than 120 revolutions per minute, pref-

erably at a rotational speed between 50 and 100 revolutions per minute. The mixture may be a toner liquid comprising carrier liquid, marking particles and a dispersion agent.

[0036] In an exemplary embodiment the mixture has in the mixed state a dynamic viscosity in a range between 3 and 500 mPa.s. This viscosity of the mixture may be measured e.g. with a Haake Rheostress RS6000 operated in shear rate sweep from 0.1 to 30001/s at 25°C and expressed in mPa.s. The viscosity measurement instrument may be equipped with a cone/plate geometry type C60/1° and the gap may be set e.g. to 0.052mm. In a preferred embodiment the mixture is an ink mixture, e.g. a toner liquid for electrophotography printing or an ink mixture for inkjet printing. The stirring apparatus of embodiments of the invention will be particularly advantageous for mixing suspensions where the Brownian motion is not capable of avoiding sedimentation.

Brief description of the figures

[0037] The accompanying drawings are used to illustrate presently preferred non-limiting exemplary embodiments of devices of the present invention. The above and other advantages of the features and objects of the invention will become more apparent and the invention will be better understood from the following detailed description when read in conjunction with the accompanying drawings, in which:

Figures 1A-1C illustrate schematically a perspective view of a first embodiment of a stirring apparatus of the invention;

Figure 2 illustrates schematically a cross section through a plane perpendicular on the shaft of the first embodiment;

Figure 3 illustrates schematically a cross section of a second embodiment;

Figure 4 illustrates schematically a cross section of a third embodiment;

Figure 5 illustrates schematically a cross section of a fourth embodiment;

Figure 6 illustrates schematically a first embodiment of a printing system of the invention;

Figure 7 illustrates schematically a second embodiment of a printing system;

Figure 8 illustrates schematically a third embodiment of a printing system;

Figures 9 and 10 illustrate schematically two further variants of a stirring apparatus of the invention;

Figures 11A and 11B illustrate schematically a perspective view and a top view of a fourth embodiment of a stirring apparatus of the invention;

Figures 12A, 12B, 12C and 12D illustrate schematically a first and second perspective view, a top view and a longitudinal section of a fifth embodiment of a stirring apparatus of the invention;

Figures 13A and 13B illustrate schematically a first

and second perspective view of an embodiment with a backwardly curved helical rotor blade;

Figures 14A and 14B illustrate schematically a first and second perspective view of another embodiment with a backwardly curved helical rotor blade;

Figures 15A and 15B illustrate schematically a first and second perspective view of an embodiment with a backwardly curved slotted helical rotor blade; and

Figures 16A and 16B illustrate schematically a first and second perspective view of an embodiment with a forwardly curved slotted helical rotor blade.

Description of embodiments

[0038] Figures 1A-1C and 2 illustrate schematically a first embodiment of a stirring apparatus for stirring a liquid L, in particular a liquid containing insoluble particles, and more in particular a toner liquid comprising carrier liquid, marking particles and dispersion agent.

[0039] In xerography processes operating with liquid toner, the imaging particles or marking particles are supplied as solid particles suspended in a carrier liquid. The imaging particles consist of pigment grains, typically embedded in a small bead of resin. A dispersing agent or dispersant is added to the mix to avoid clustering of the marking particles. Dispersants deflocculate the imaging particles and reduce the viscosity of the liquid toner dispersion. The carrier liquid may comprise any suitable liquids as is known in the art, and may include silicone fluids, mineral oils, low viscosity or high viscosity liquid paraffin, isoparaffinic hydrocarbons, fatty acid glycerides, fatty acid esters, vegetable oils, chemically modified vegetable oils, or any combinations thereof. The carrier liquid may further contain variable amounts of charge control agent (CCA), wax, plasticizers, and other additives, although they also can be incorporated into the toner particle itself. The carrier liquid may be volatile or non-volatile. An exemplary digital printing system using liquid toner is described in more detail in US patent application with publication no. 2009/0052948, the content of which is hereby incorporated in its entirety by reference. Typically, the toner liquid may have a solid concentration between 5% and 60 wt%. The high-shear viscosity, as measured at a shear rate of 3000 s⁻¹ at 25°C with a cone plate geometry of C60/1° and a gap of 52 μm, is preferably in the range of 5-500 mPa.s.

[0040] The stirring apparatus according to the first embodiment comprises a container 30 for containing the liquid L, a rotor 10 and a flow disturbing object in the form of a stator object 40. The container 30 has a bottom, preferably with a conical inner surface, a top cover 90, and a cylindrical body between the bottom and the top cover 90. The rotor 10 has a shaft 17 with two arms 11 which are each provided with a rotor blade 12. The stator object 40 is formed as a stator plate and is fixedly mounted between the shaft 17 and a cylindrical inner wall of the container 30.

[0041] Although the illustrated embodiment comprises

a rotor 10 with two arms 11 and two rotor blades 12, the skilled person understands that also one arm or more than two arms may be provided. Further, there may be provided more than one stator object 40. Also, instead of a cylindrical shape the container 30 may have a box shape, and the stator object 40 may be provided with through-holes allowing liquid to pass through the stator object.

[0042] In the first embodiment the stator object 40 is located between the shaft 17 and a trajectory T (see figure 2) followed by the rotor blades 12 of the rotor 10, when in operation. The stator object 40 is shaped and positioned for interrupting the rotating flow caused by the rotor 10, when in use. In other words the stator object 40 should not be rotation-symmetrical around the shaft 17. The stator object 40 extends in a radial direction from the shaft 17 to the inner wall of the container 30, over a distance DS which is at least 25 percent of the maximum distance D between the shaft 17 and the inner wall of the container 30, and preferably at least 50 percent of the maximum distance D between the shaft 17 and the inner wall of the container 30, see figure 2. In that way the rotating flow caused by the rotor is disturbed, causing high shear forces and resulting in a good mixing and stirring of the liquid. Typically, the surface of the liquid will remain more or less flat during stirring, especially in the quadrant behind the flow disturbing object 40, and will not have a conical shape as in prior art mixers. This more or less flat surface also creates more possibilities for the location of a level sensor for measuring the liquid level in the container. In the illustrated embodiment, there is provided a hollow body 80 which is attached to the top cover 90, and which forms a housing for a level sensor. The use of a hollow body 80 as a housing for the level sensor further improves the accurateness of the measurements.

[0043] The distance d1 between the stator object 40 and the shaft 17 of the rotor 10 is smaller than 5 cm, preferably smaller than 4 cm, over a substantial part of the height of the stator object 40, preferably over at least 70 percent of the height of the stator object 40. Similarly, the distance d2 between the stator object 40 and the trajectory T followed by the rotor blades 12 of the rotor 10, when in operation, is smaller than 5 cm, preferably smaller than 3 cm, over a substantial part of the height of the stator object 40, preferably over at least 70 percent of the height of the stator object 40. The distance d2 may be e.g. between 2,5 and 4,0 cm. Also the distance d3 between the stator object 40 and an arm 11 of the rotor 10 when the arm 11 is located underneath the stator object 40, is smaller than 5 cm, preferably smaller than 3 cm, over a substantial part of the length of the arm 11, preferably over at least 70 percent of the length of the arm 11.

[0044] The rotor blade 12 is an elongate upright rotor blade extending substantially parallel to an upright side of the stator object 40. The rotor blade 12 is provided with an opening in the form of an elongate slit 19 extend-

ing in a length direction of the rotor blade 12 and arranged for allowing liquid to pass through said slit 19. The rotor blade 12 comprises a first upright elongate portion 13 adjacent the inner wall of the container 30. The first elongate portion 13 is connected to a second upright elongate portion 14 adjacent an edge of the stator object 40. The first portion 13 makes an angle with said second portion 14, seen in a cross section perpendicular on the shaft 17 (see figure 2), so that the liquid is moved inward during rotation of the rotor 10. As illustrated in figure 1, bending and cutting an elongate plate element may form the rotor blade 12. The rotor blade 12 is preferably positioned so that, at least an outer portion of each rotor blade 12 also makes an angle with the radial direction such that liquid is removed from the inner wall of the container 30.

[0045] In a similar manner, each arm 11 may be provided with an elongate slit 20 extending in a radial direction between the rotor blade 12 and the shaft 17, said slit being arranged for allowing liquid to pass through. Also each arm 11 may comprise a first elongate portion 15 and a second elongate portion 16, said first and second portions 15, 16 being adjacent portions which extend in radial direction between the shaft 17 and an inner wall of the container 30. The first portion 15 making an angle with the second portion 16, seen in a cross section perpendicular on the arm 11. The angle is such that the liquid is moved upward during rotation of the rotor 10. Also the arm 11 may be formed in an easy manner by bending and cutting an elongate plate element.

[0046] Preferably, the distance d4 between the inner wall and the trajectory T followed by the at least one rotor blade 12, is smaller than 5 cm, more preferably smaller than 3 cm. The distance d4 may be e.g. between 0,1 cm and 3,0 cm. By decreasing the distances d2 and d4, the required rotational speed needed for obtaining sufficient shear, whilst avoiding that air is mixed in the mixture, can be decreased. The lower limit of the distances will typically depend on the tolerances of the components used, and/or on the type of material that is being stirred.

[0047] To avoid or reduce caking of the liquid toner on the rotor 10, on the stator object 40 or on the inner wall of the container 30, these components may be provided with a suitable coating or may be polished.

[0048] The stirring apparatus of the first embodiment further comprises an inlet tube 60 having an end part where the liquid leaves the inlet tube 60, said end part being located between the shaft 17 and the at least one rotor blade 12, seen in a top view of the stirring apparatus. In that way the liquid will enter the container 30 at a location where a good stirring is achieved.

[0049] The stirring apparatus further comprises driving means, typically a motor (not shown) configured for rotating the rotor 10 around the shaft 17 at a rotational speed which is preferably lower than 120 revolutions per minute, more preferably at a rotational speed between 90 and 100 revolutions per minute. The motor may be mounted on the cover 90 of the container 30.

[0050] Figure 3 illustrates a variant of the first embod-

iment. In the embodiment of figure 3 the stator object 40 is a hollow cylindrical body that may contain measurement devices, such as a sensor 50. In this embodiment only one arm 11 (not visible in the cross section of figure 3) with rotor blade 12 is provided. Possible measurement devices that may be included in the hollow body 40 are: a level gauge, a pressure sensor, a temperature sensor, a sensor for measuring a characteristic of the mixture, such as a conductivity sensor for measuring the electric conductivity of the mixture, a viscosity sensor for measuring the viscosity of the mixture, a density sensor for measuring the density of the mixture, etc. This hollow body 40 may be fixed to a top cover (not shown) and may be open at a bottom end. Alternatively this hollow body 40 may be fixed to the bottom of the container 30 and may have an open top end. The hollow body 40 may be provided with a plurality of holes for promoting the flow of fresh mixture through the hollow body 40. Further there may be provided an inlet 60 in the hollow body 40. Alternatively the inlet 60 may end in the container, outside of the hollow body. According to yet another variant there may be provided two hollow bodies 40, a first hollow body with measurement devices and a second hollow body in which or above which the inlet ends.

[0051] Figure 4 illustrates a third embodiment of stirring apparatus of the invention. The apparatus is similar to the second embodiment of figure 3, with this difference that the stator object 40 is a hollow pillar with a rectangular cross section. Although not shown, measurement devices may be provided in the hollow body 40, as in the embodiment of figure 3.

[0052] Figure 5 illustrates in cross section a fourth embodiment of stirring apparatus with a first and second stator object 40a, 40b provided with a first and second through-hole 41a, 41b, respectively. In this embodiment the stator objects 40a, 40b are located near or against the inner wall of the container 30, between the inner wall and a trajectory performed by the rotor blades 12, when in use. Rotor arms 11 connect the rotor blades 12 to the shaft 17. The rotor arms 11 are relatively short compared to the previous embodiments, and the rotor blades 12 are shaped to push the liquid outwardly in the direction of the stator objects 40a, 40b. As in the embodiment of figures 3 and 4, the stator elements 40a, 40b could also be hollow elements provided with measurement devices. The variant of figure 5 may be useful for less viscous liquids and the rotational speed may be higher than in the embodiment of figure 1.

[0053] Figure 6 illustrates a first embodiment of a printing system of the invention. The printing system comprises a digital printer apparatus 200 using liquid toner, a stirring apparatus 100, and a plurality of reservoirs 300, 400, 500. The digital printing apparatus 200 comprises a toner feed unit (not shown) and a toner discharge line. The stirring apparatus 100 may be embodied according to any one of the exemplary embodiments that have been disclosed in figures 1-5, wherein a toner liquid is stored in the container of the stirring apparatus. The container

has an outlet for discharging stirred liquid toner, and an inlet. The outlet is connected to the toner feed unit of the printing apparatus 200, and the inlet is connected to the toner discharge line. The plurality of reservoirs comprises a reservoir 300 for storing dispersion agent (DA), said dispersion agent reservoir 300 being connected via a dispersion agent dosing unit 301 to the inlet of the container of the stirring apparatus 100; a reservoir 400 for storing carrier liquid (CL), said carrier liquid reservoir 400 being connected via a carrier liquid dosing unit 401 to the inlet of the container of the stirring apparatus 100; a reservoir 500 for storing a concentrated liquid toner solution, said concentrated solution reservoir 500 being connected via a concentrated solution dosing unit 501 to the inlet of the container of the stirring apparatus 100. The concentrated solution reservoir 500 may be part of a further stirring apparatus, see also figure 8 which is discussed below.

[0054] In the embodiment of figure 6 there is provided at least one measurement device 150, in the stirring apparatus 100. The measurement devices 150 may be any one or more of the following: a level gauge, a pressure sensor, a temperature sensor, a sensor for measuring a characteristic of the mixture, such as a conductivity sensor for measuring the electric conductivity of the mixture, a viscosity sensor for measuring the viscosity of the mixture, a density sensor for measuring the density of the mixture. The measurements may be collected by a control unit (not shown, but included in the dashed line between device 150 and dosing units 301, 401, 501) which is configured for controlling at least one of said dispersion agent dosing unit 301, said carrier liquid dosing unit 401, and said concentrated solution dosing unit 501 in function of said measurements.

[0055] Figure 7 illustrates a variant of the embodiment of figure 6 for which one or more measurement devices 250 may be included in a separate line connecting the outlet of the container of the stirring apparatus 100 with the inlet thereof. In a similar manner as in the embodiment of figure 6, the measurements may be collected by a control unit (not shown, but included in the dashed line between device 250 and dosing units 301, 401, 501) which is configured for controlling at least one of said dispersion agent dosing unit 301, said carrier liquid dosing unit 401, and said concentrated solution dosing unit 501 in function of said measurements.

[0056] Figure 8 illustrates a further variant of the printing system which combines the features of the embodiments of figures 6 and 7. In this embodiment certain measurements may be performed by one or more measurement devices 150 in the container of the stirring apparatus 100 and other measurements may be performed by one or more measurement devices 250 in the return line. Figure 8 further shows the printing apparatus 200 in more detail. The printing apparatus 200 comprises a feed unit including a feed roller 220 and a feed reservoir 211 (in a main reservoir 210) in which the feed roller 220 rotates. The liquid toner on the feed roller 220 is transferred to a developing roller 230. Excess liquid toner from

the feed roller 220 or from the developer roller 230 or from any further roller (not shown) between the developer roller 230 and the substrate is fed into the main reservoir 210. In order to maintain a good quality liquid toner in the feed reservoir 211 a portion of the liquid toner is returned to the stirring apparatus 100 for stirring, and freshly stirred liquid toner is fed from the stirring apparatus 100 to a feed reservoir 211 in the main reservoir 210. The concentrated solution of liquid toner is stored in a container of a further stirring apparatus 500, said container of said further stirring apparatus having an outlet which is connected via concentrated solution dosing unit 501 to the inlet of the container of the stirring apparatus 100. The measurements may be collected by a control unit (not shown, but included in the dashed lines between devices 150, 250 and dosing units 301, 401, 501) which is configured for controlling at least one of said dispersion agent dosing unit 301, said carrier liquid dosing unit 401, and said concentrated solution dosing unit 501 in function of said measurements.

[0057] Figures 9 and 10 illustrate two further embodiments with a rotatably mounted flow disturbing object 40. The embodiment of figure 9 is similar to the embodiment of figure 1 with this difference that the flow disturbing object 40 is mounted rotatably around the shaft 17 and is connected, using e.g. a reduction mechanism in a hollow axis, to the shaft 17, such that said flow disturbing object 40 is rotated with a rotational speed ω_2 , ω_2' which is different from the rotational speed ω_1 or rotation direction of the shaft 17 and hence of the rotor. When the rotation direction of the rotor 10 is opposite to the rotation direction of the flow disturbing object 40, the value of the rotational speed ω_1 may be the same as the value of the rotational speed ω_2' or may be different. Preferably the rotational speed ω_2 , ω_2' of the flow disturbing object 40 is lower than the rotational speed ω_1 of the rotor.

[0058] Figure 10 illustrates an embodiment with two pairs of rotor blades 12, 12' which rotate at a rotational speed ω_1 , ω_2 , wherein ω_2 and ω_1 may be the same or different. The rotational speed ω_1 of the first pair 12 and ω_2 of the second pair 12' is preferably the same. The flow disturbing object 40 may rotate in the same direction as the rotor blades 12, 12' in which case the rotational speed ω_3 is preferably lower than ω_1 . Alternatively the rotation direction of the rotor blades 12, 12' may be opposite to the rotation direction of the flow disturbing object 40, in which case the value of the rotational speed ω_3 may be the same as the value of the rotational speed ω_1 or may be different.

[0059] Although the embodiments of figures 9 and 10 are slightly more complex than embodiments with a fixed stator object, they may also give good stirring results with a lower rotational speed compared to prior art solutions.

[0060] Figures 11A and 11B illustrate a fourth embodiment which is similar to the first embodiment. The stirring apparatus comprises a container with a cylindrical inner wall (not shown) for containing the mixture, a rotor 10 and a flow disturbing object in the form of a stator object

40. The rotor 10 has two arms 11 and two upwardly extending elongate rotor blades 12. The stator object 40 is formed as a stator plate and is fixedly mounted between the shaft 17 and the cylindrical inner wall of the container. In this embodiment the stator object 40 is provided with an outwardly protruding upper portion 45 extending above the trajectory followed by the rotor blades 12. Also the stator object 40 is provided with a fixation lip 42 for fixing the stator object to a cover (not shown). The upper portion 45 will avoid that mixture is directed upwardly against the cover. This can be understood as follows. The rotation of the mixture by the rotor 10 will cause the shape of the surface of rotating mixture to become concave as a consequence of the centrifugal force. Further the passing of a rotor blade 12 will cause a wave which may extend over the top of the container in the event of high mixture levels in the container. By adding upper portion 45 the wave can be intercepted and guided downwardly and/or inwardly in the container. In that way it is avoided that the height of the container needs to be much bigger than the maximum mixture level, resulting in a more compact apparatus.

[0061] It is noted that upper portion 45 may also be a separate portion instead of being formed integrally with the stator object. More generally there may be provided a wave guidance portion above the trajectory followed by the rotor blades 12 configured for guiding any upwardly extending wave(s) downwardly into the container.

[0062] The other components, dimensions and details that have been described above for the first embodiment may be applied equally in the fourth embodiment, and a description thereof has been omitted.

[0063] Figures 12A, 12B, 12C and 12D illustrate a fifth embodiment which is similar to the fourth embodiment, with this difference that the rotor blades 12 are not extending vertically, but under an angle α which is bigger than 90° with respect to a horizontal line tangent to the trajectory of the rotor 10, when looking in a rotation direction R, see figure 12B and 12C. Such an angle α will improve the stirring in an upward direction, as the rotor blades 12 will push the liquid not only along a circular trajectory but also upwardly. In other words, rotor blade 12 is inclined backwardly when looking in the rotation direction R. In that manner the rotor blade 12 will push the mixture in the container inwardly and upwardly. The upward motion of the mixture may at least partially compensate for the downward motion behind the flow disturbing object 40. The angle α may be optimized to generate a closed curve motion, e.g. circular or elliptical motion of the mixture in a plane perpendicular on the rotation direction of the rotor 10.

[0064] In another non-illustrated embodiment the rotor blades 12 are extending under an angle α which is smaller than 90° with respect to a horizontal line tangent to the trajectory of the rotor 10, when looking in a rotation direction R. Such an angle α will improve the stirring in a downward direction, as the rotor blades 12 will push the liquid not only along a circular trajectory but also

downwardly. In yet another non-illustrated embodiment the rotor blades 12 may extend partly backwardly and partly forwardly when looking into the rotation direction R.

[0065] In other words, an outer edge 112 of rotor blade 12 may be extending either vertically (figures 11A and 11B) or slantwise (under an angle α) as in the embodiment of figures 12A-D.

[0066] Figures 13A and 13B illustrate a sixth embodiment which is similar to the fifth embodiment, with the upwardly extending rotor blades 12 extending under an angle α which is bigger than 90° with respect to a horizontal line tangent to the trajectory of the rotor 10, see figure 13A and 13B. In this embodiment the rotor blade is a curved blade extending as a helix around the shaft 17. Preferably an outer edge 112 of the elongate upright rotor blade 12 extends parallel to an inner wall of the container, i.e. the outer edge 112 extends in a cylindrical surface with an axis corresponding to the axis of the shaft 17. In the embodiment of figure 13A, the rotor 10 is provided with one arm 11 and one rotor blade 12 and the flow disturbing object has been omitted for clarity reasons. In the embodiment of figure 13B the rotor 10 is provided with two arms 11 and two rotor blades 12, and figure 13B further shows the flow disturbing object 40. The rotor 10 is rotated in the direction of arrow R such that the rotor blade 12 is curved backwardly when looking in the rotation direction R. In that manner the rotor blade 12 will push the mixture in the container inwardly and upwardly. The upward motion of the mixture may at least partially compensate for the downward motion behind the flow disturbing object 40. The curve may be optimized to generate a closed curve motion, e.g. circular or elliptical motion of the mixture in a plane perpendicular on the rotation direction of the rotor 10.

[0067] Figures 14A and 14B illustrate an embodiment which is similar to the embodiment of figure 13A and 13B, with this difference that the blade 12 is shaped to move the mixture mainly upwardly and in the direction of rotation, but not or not significantly inwardly. In a cross section perpendicular on shaft 17, the blade 12 is radially oriented, whilst in the embodiment of figures 13A and 13B the rotor blade is oriented under an angle with respect to the radial direction, seen in a cross section perpendicular on shaft 17. In the embodiment of figure 14A, the rotor 10 is provided with one arm 11 and one rotor blade 12 and the flow disturbing object has been omitted for clarity reasons. In the embodiment of figure 14B the rotor 10 is provided with two arms 11 and two rotor blades 12, and figure 14B further shows the flow disturbing object 40. The upward motion of the mixture may cause a "breaking" of the mixture at the surface of the mixture in the container, and may at least partially compensate for the downward motion behind the flow disturbing object 40.

[0068] Figures 15A and 15B illustrate a seventh embodiment which is similar to the sixth embodiment, with this difference that the rotor blade 12 comprises a first helical elongate portion 13 adjacent the inner wall of the container (not shown), and a second helical elongate por-

tion 14 adjacent an edge of the stator object 40 (not shown in figure 15A, but visible in figure 15B). The first portion 13 makes an angle with said second portion 14, seen in a cross section perpendicular on the shaft 17.

5 The curvature and orientation of the first portion 13 and the second portion 14 are such that the fluid is moved inwardly and upwardly by the first portion 13, and outwardly and upwardly by the second portion 14, during rotation of the rotor 10. The first portion 13 is preferably positioned so that it makes an angle with the radial direction such that liquid is removed from the inner wall of the container 30. The rotor blade 12 is provided with an opening in the form of an elongate slit 19 extending between the first helical elongate portion 13 and the second helical elongate portion 14, for allowing liquid to pass through said slit 19. This will increase the turbulence and enhance the mixing. In the embodiment of figure 15B the rotor 10 is provided with two arms 11 and two rotor blades 12, and figure 15B further shows the flow disturbing object 40.

[0069] Figures 16A and 16B illustrate an embodiment which is similar to the embodiment of figures 15A and 15B, with this difference that the curvature and orientation of the first portion 13 and the second portion 14 are such that the fluid is moved inwardly and downwardly by the first portion 13, and outwardly and downwardly by the second portion 14, during rotation of the rotor 10. This will enhance the mixing in a similar manner as described above for the embodiment of figure 15A and 15B. In the embodiment of figure 16B the rotor 10 is provided with two arms 11 and two rotor blades 12, and figure 16B further shows the flow disturbing object 40.

[0070] The stirring apparatus of figures 11A-B, 12A-D, 13A-B, 14A-B, 15A-B, 16A-B further comprise driving means, typically a motor (not shown) configured for rotating the rotor 10 around the shaft 17 at a rotational speed which is preferably lower than 120 revolutions per minute, more preferably lower than 80 revolutions per minute, and may be as low as 30 revolutions per minute whilst still ensuring good mixing properties. Also, the skilled person understands that more than two rotor blades 12, e.g. three or four rotor blades 12 is also an option. The optimal rotational speed will further depend on the number and dimensions of rotor blades 12 and on the number and dimensions of the flow disturbing object 40.

[0071] The embodiments described above are designed for a container with a cylindrical inner wall. The skilled person understands that the design may be easily adapted for container with e.g. a conical inner wall. Further, the embodiments described above have a rotor with at least one arm near the bottom end of the container, below a flow disturbing object which is attached to a cover. The skilled person understands that the arm may also be arranged above a flow disturbing object, in which case the flow disturbing object may be attached to the bottom of the container.

[0072] Further embodiments of the invention relate to

a method for mixing a liquid, in particular a toner liquid, using a stirring apparatus according to any one of the previous embodiments. Preferably the rotor is rotated at a relatively low rotational speed, more preferably at a rotational speed that is lower than 120 revolutions per minute, and most preferably at a rotational speed between 20 and 100 revolutions per minute.

[0073] Whilst the principles of the invention have been set out above in connection with specific embodiments, it is to be understood that this description is merely made by way of example and not as a limitation of the scope of protection, which is determined by the appended claims.

Claims

1. A stirring apparatus for stirring a mixture, in particular a liquid containing insoluble particles, said apparatus comprising:

a container for containing the mixture;
 a rotor comprising a shaft and a rotor blade;
 driving means for rotating said shaft; and
 at least one flow disturbing object between said shaft and a circumferential inner wall of the container, said flow disturbing object being either fixedly mounted such that said flow disturbing object is stationary in said container, or being mounted rotatably around said shaft and being connected to said driving means such that said flow disturbing object is rotated with a rotational speed which is different from the rotational speed of the shaft and/or with a rotational direction which is different from the rotational direction of the shaft;
 wherein said at least one flow disturbing object is located between said shaft and a trajectory followed by the rotor blade of the rotor when in operation;
 wherein the rotor blade is shaped to direct the mixture inwardly to the at least one flow disturbing object.

2. The stirring apparatus of claim 1, wherein the rotor blade comprises a first upright elongate portion and a second upright elongate portion, said first portion making an angle with said second portion, so that the mixture is moved towards the at least one flow disturbing object during rotation of the rotor.
3. The stirring apparatus of claim 1 or 2, wherein the rotor is an elongate rotor blade having a length direction, wherein the rotor blade is provided with an opening arranged for allowing mixture to pass through said at least one opening, wherein the opening is a slit extending in the length direction.

4. The stirring apparatus of any one of the previous claims, wherein said at least one flow disturbing object comprises a flow disturbing plate.

5. The stirring apparatus of any one of the previous claims, wherein the at least one flow disturbing object is a stator object which is mounted in a fixed position in the container.

6. The stirring apparatus of any one of the previous claims, wherein the distance between the at least one flow disturbing object and the shaft of the rotor is smaller than 5 cm, preferably smaller than 3 cm; and/or
 wherein the distance between the at least one flow disturbing object and a trajectory followed by the rotor blade of the rotor, when in operation, is smaller than 5 cm, preferably smaller than 3 cm.

7. The stirring apparatus of any one of the previous claims, wherein the at least one flow disturbing object comprises a hollow body containing at least one measurement device.

8. The stirring apparatus of any one of the previous claims, wherein the rotor blade is fixed to the shaft by means of an arm extending from the shaft in the direction of the circumferential inner wall of the container;
 wherein preferably the distance between the at least one flow disturbing object and a zone in which the arm of the rotor rotates, when in operation, is smaller than 5 cm, more preferably smaller than 3 cm;
 wherein preferably the arm is provided with an elongate slit extending in a radial direction between the rotor blade and the shaft.

9. The stirring apparatus of claim 8, wherein the arm comprises a first elongate portion and a second elongate portion, said first and second portion being adjacent portions extending from the shaft in the direction of the circumferential inner wall of the container, said first portion making an angle with said second portion, so that the mixture is moved towards the at least one flow disturbing object during rotation of the rotor.

10. The stirring apparatus of any one of the previous claims, wherein the rotor blade is shaped to direct the mixture upwardly and/or downwardly.

11. The stirring apparatus of claim 10, wherein the rotor blade is an elongate rotor blade extending under an angle which is bigger than 90° or smaller than 90° with respect to a horizontal line tangent to the trajectory of the rotor when looking into the direction of rotation of the rotor, such that the rotor blade is inclined at least partly backwardly and/or at least partly

forwardly, when looking into the direction of rotation of the rotor.

12. The stirring apparatus of any one of the previous claims, wherein the container is a cylindrical container having an inner wall extending at a distance of the trajectory followed by the rotor blade, said distance being smaller than 5 cm, preferably smaller than 3 cm. 5
13. A printing system comprising: 10
- a printing apparatus with a toner feed unit and a toner discharge line, and
 - a stirring apparatus according to any one of the previous claims, 15
- wherein a toner liquid is stored in the container of the stirring apparatus; said container having an outlet for discharging stirred liquid toner, and an inlet;
- said outlet being connected to the toner feed unit of the printing apparatus, and said inlet being connected to the toner discharge line. 20
14. The printing system of claim 13, further comprising at least one of the following: 25
- a reservoir for storing dispersion agent, said dispersion agent reservoir being connected via a dispersion agent dosing unit to the inlet of the container; 30
 - a reservoir for storing carrier liquid, said carrier liquid reservoir being connected via a carrier liquid dosing unit to the inlet of the container;
 - a further stirring apparatus according to any one of the claims 1-22, wherein the container of said further stirring apparatus stores a concentrated solution of toner liquid; said container of said further stirring apparatus having an outlet which is connected via a concentrated solution dosing unit to the inlet of the container which stores the toner liquid. 35 40
15. The printing system of claim 13 or 14, further comprising a feed reservoir and a return line for returning excess liquid toner to the feed reservoir, wherein the stirring apparatus is included in the return line. 45

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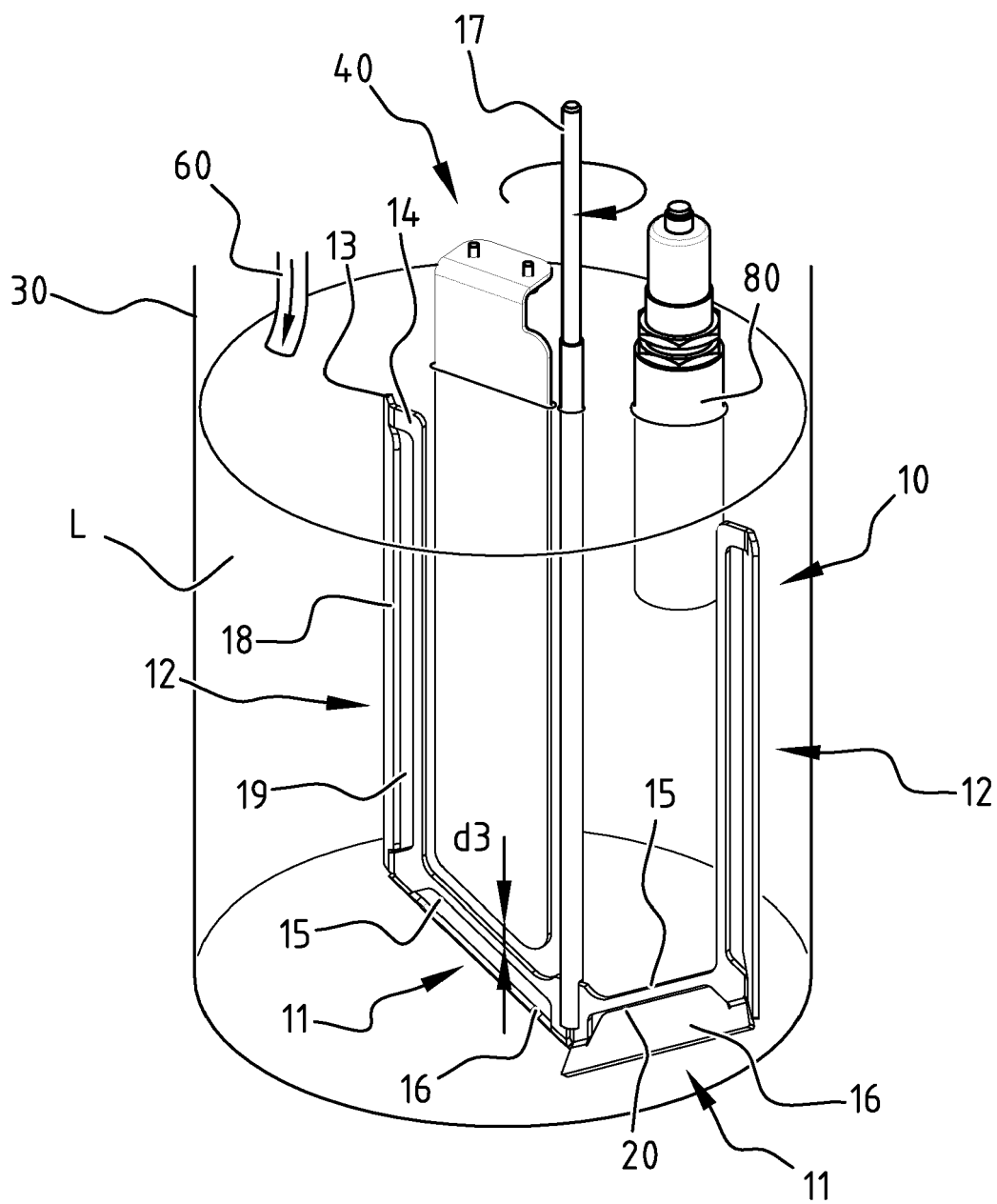


FIG. 1A

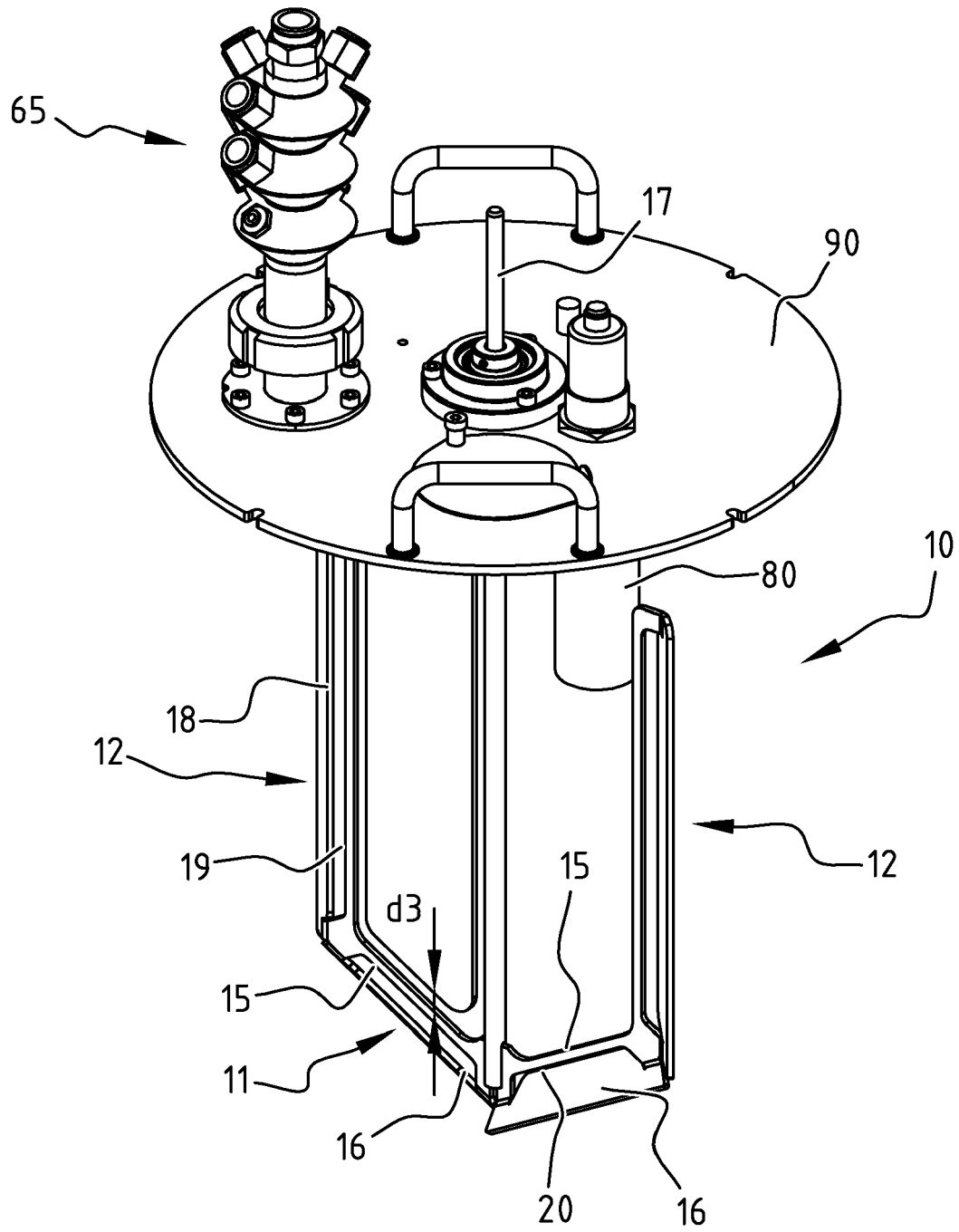


FIG. 1B

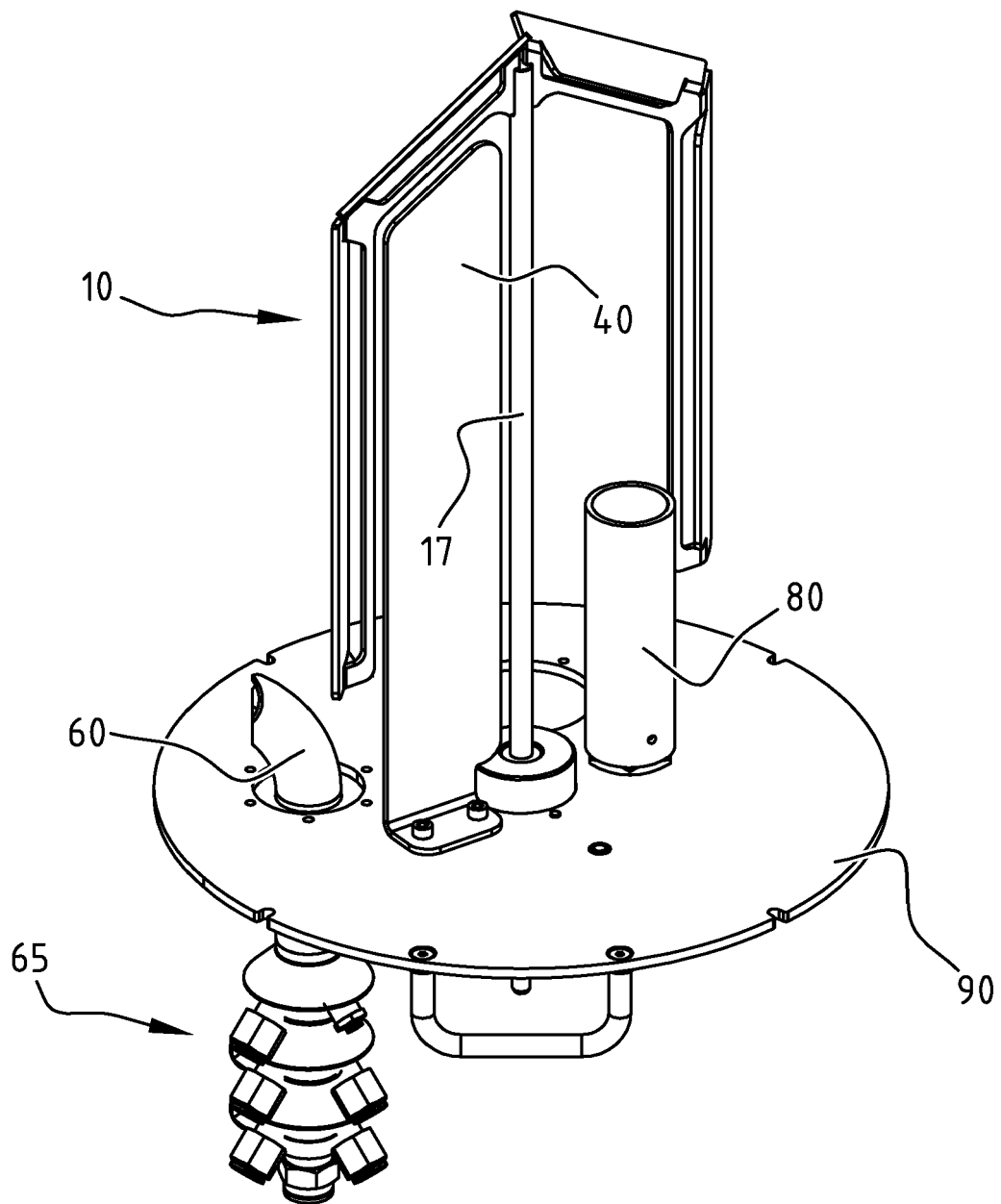
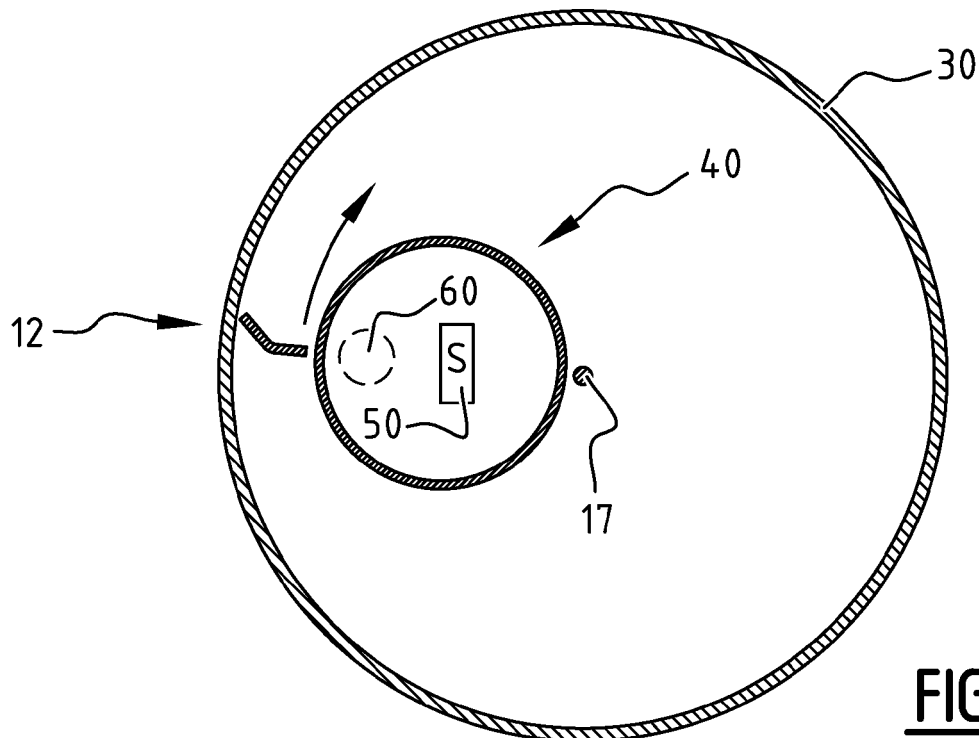
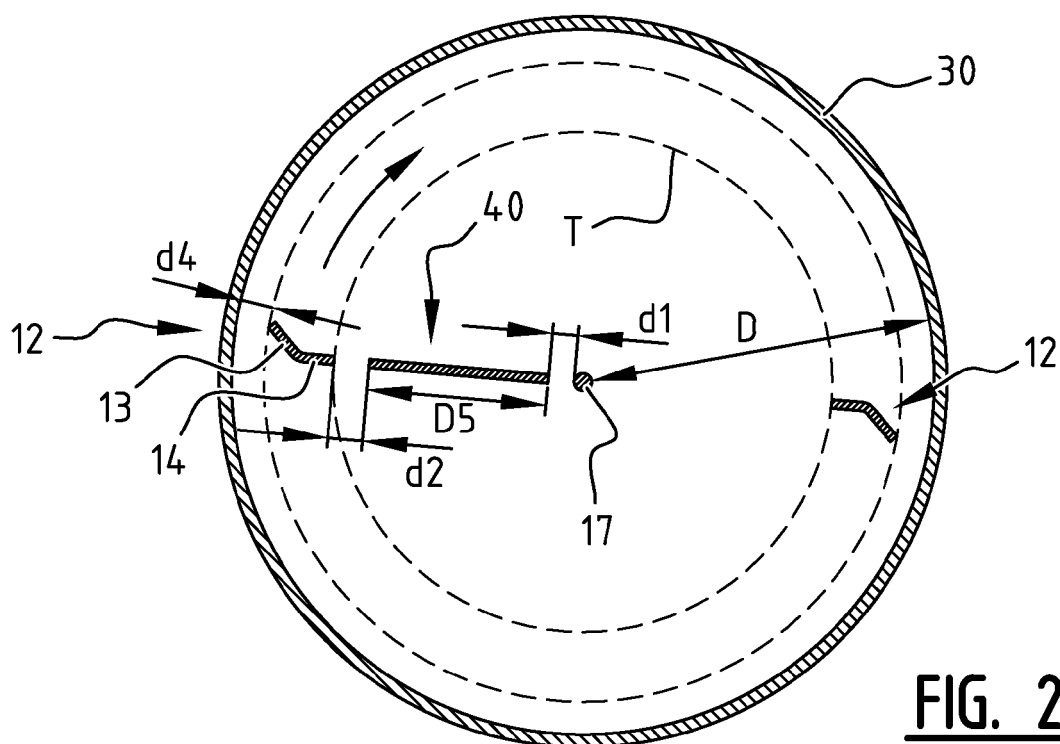
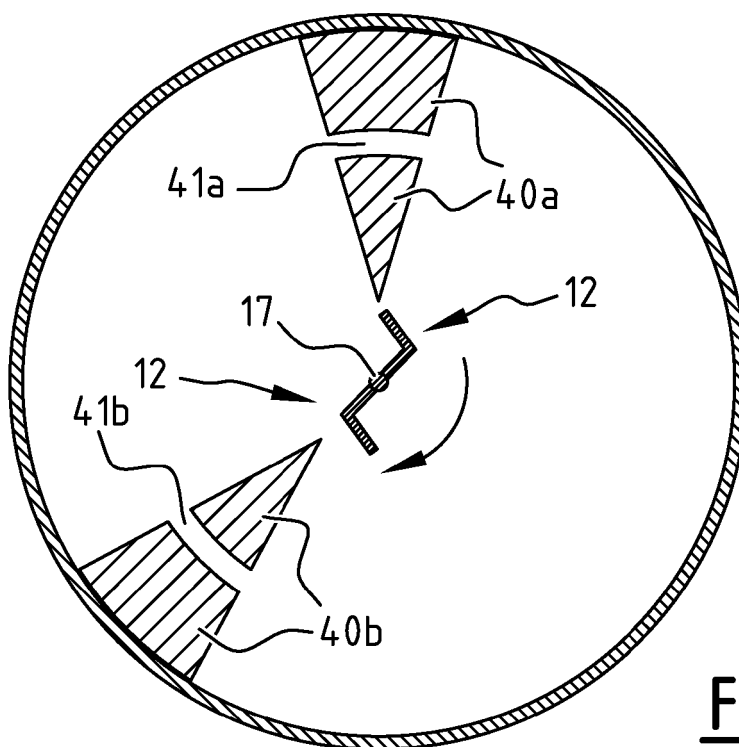
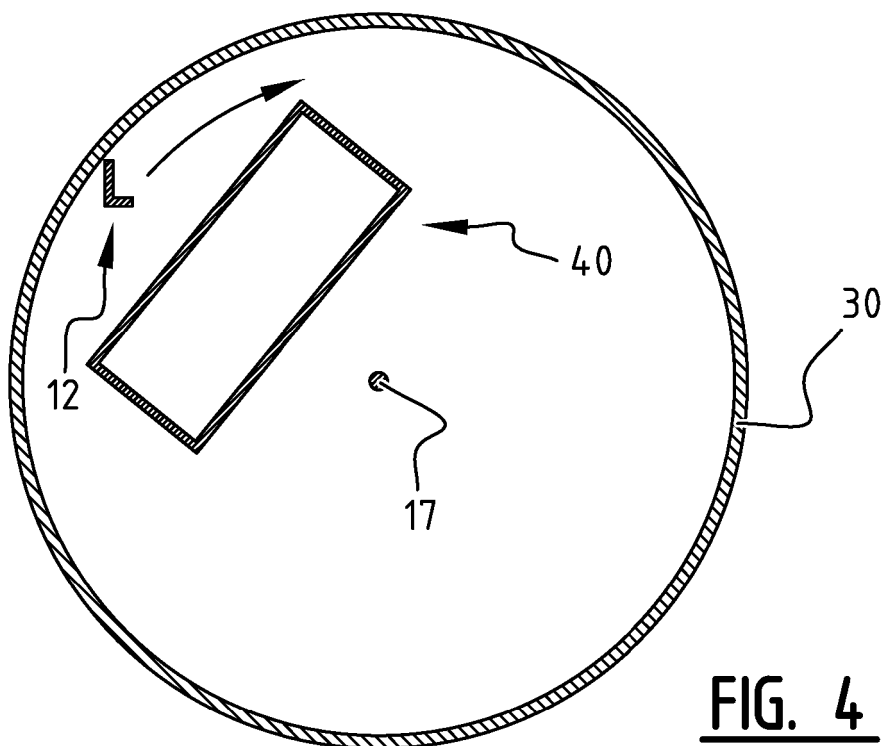


FIG. 1C





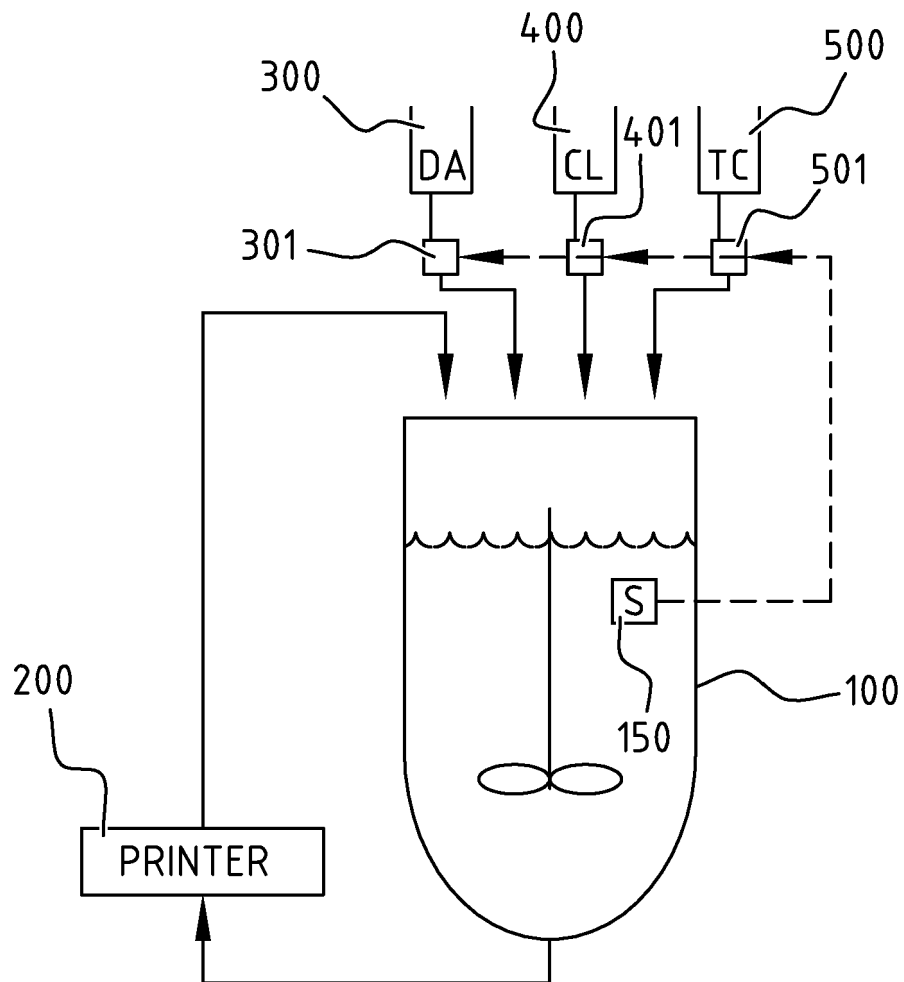


FIG. 6

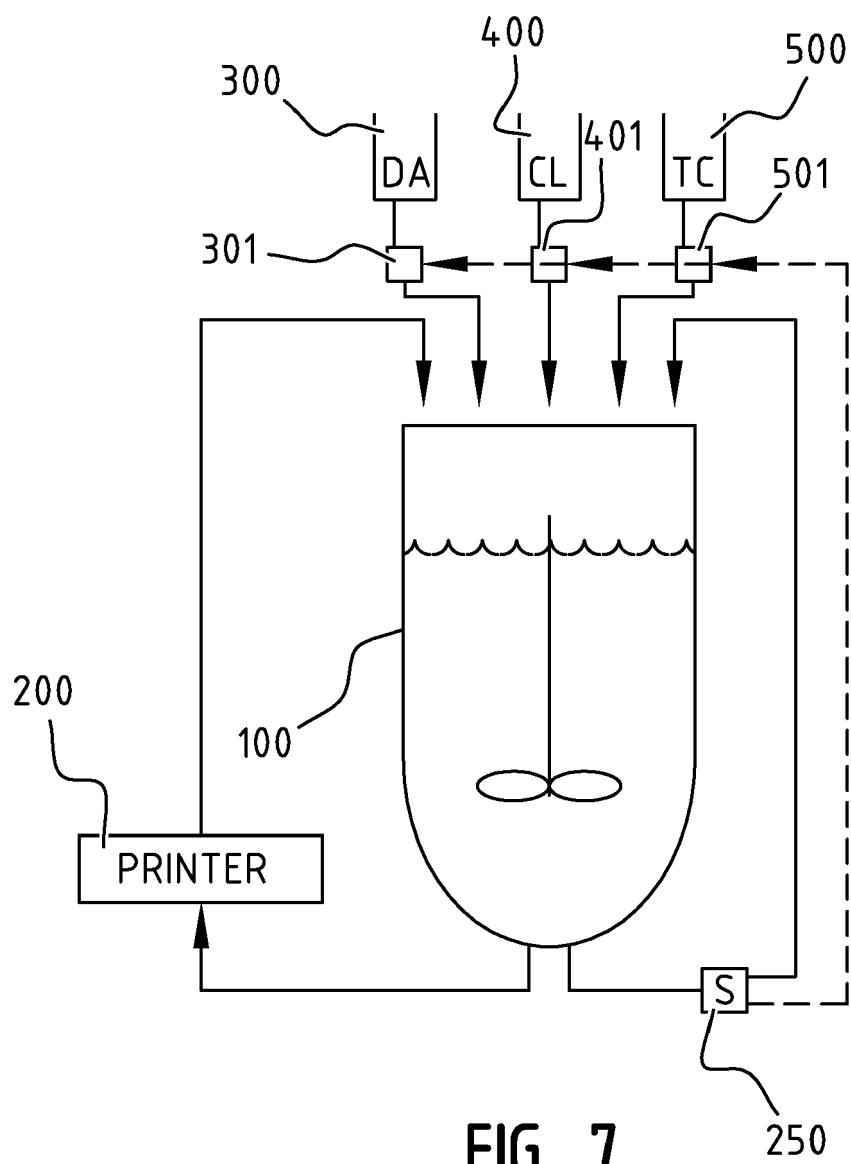


FIG. 7

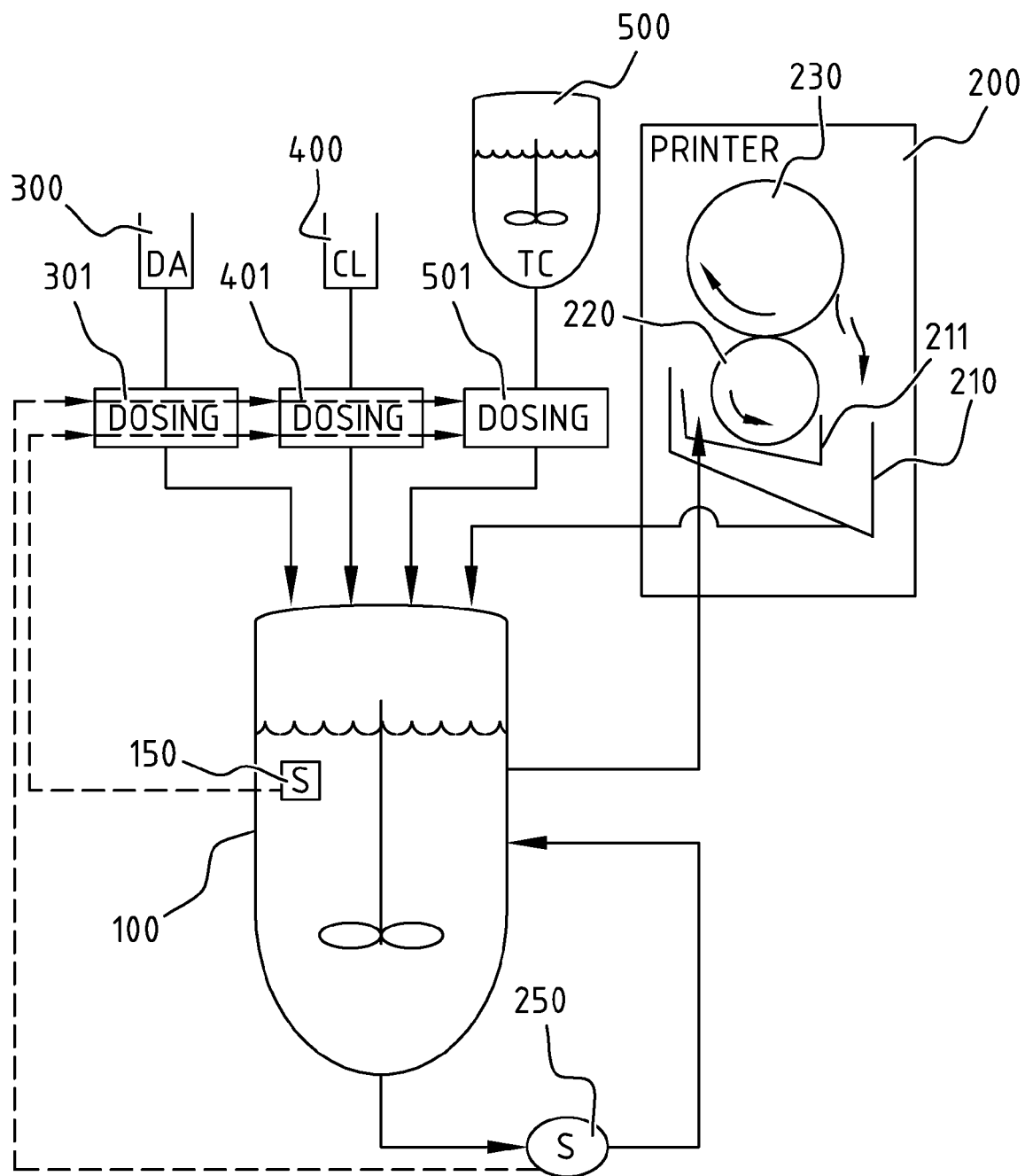


FIG. 8

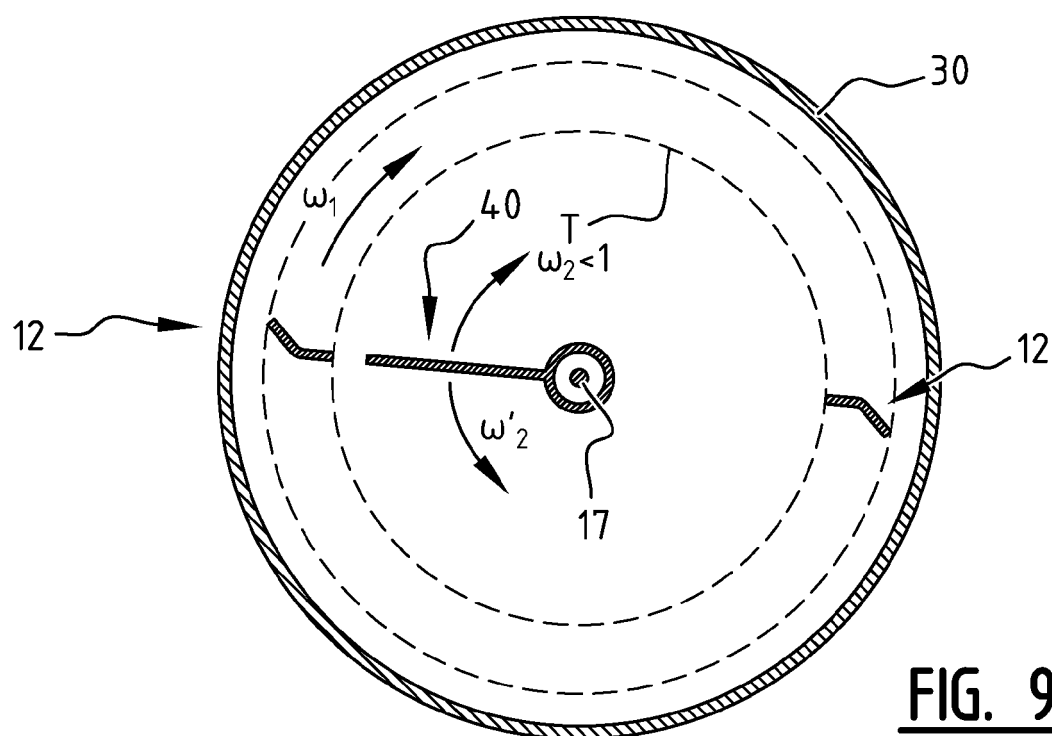


FIG. 9

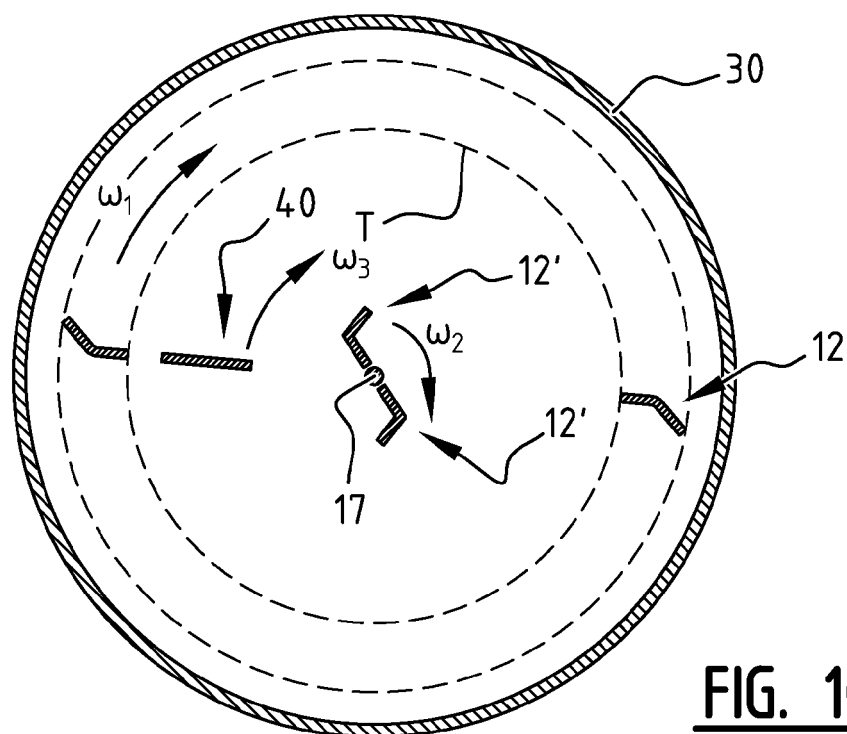


FIG. 10

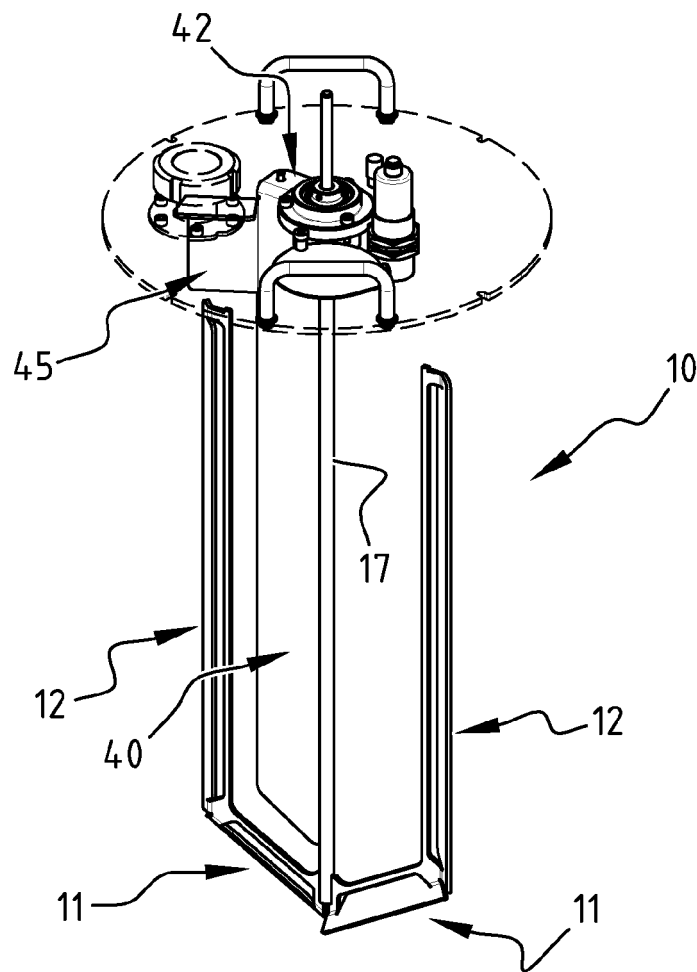


FIG. 11A

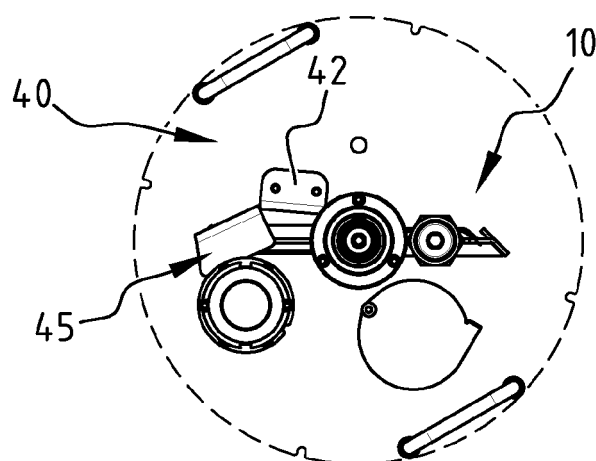


FIG. 11B

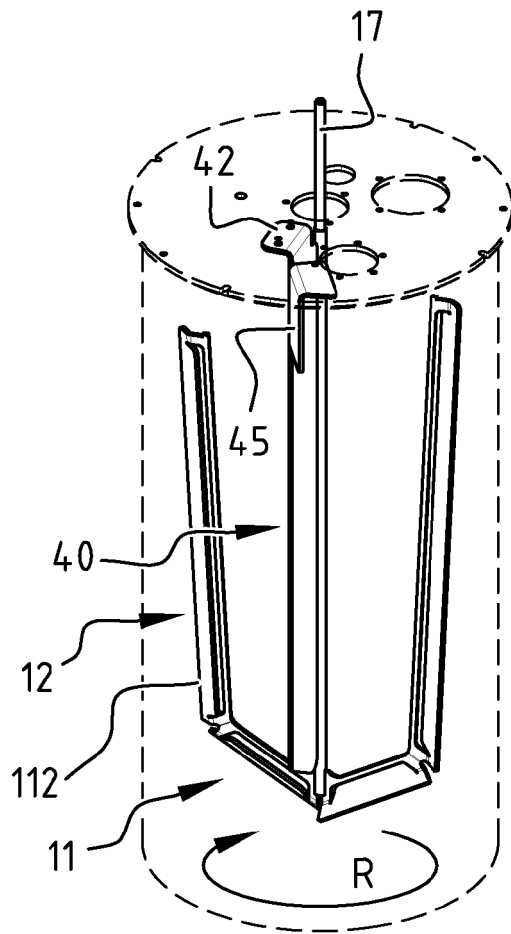


FIG. 12A

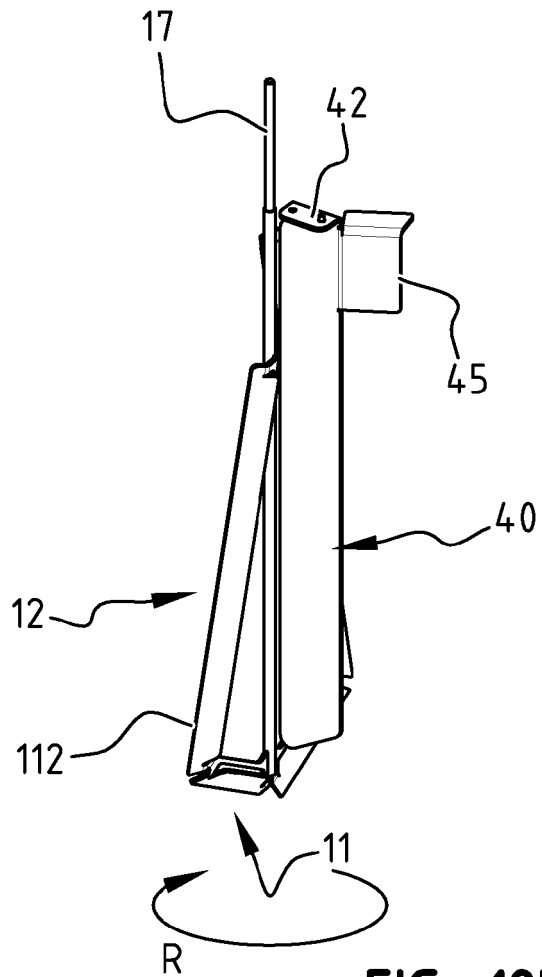


FIG. 12B

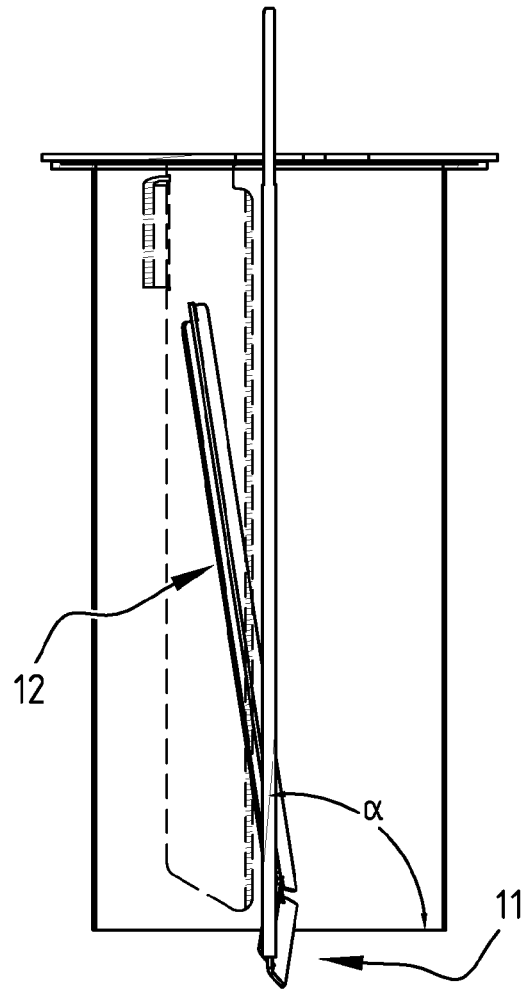


FIG. 12C

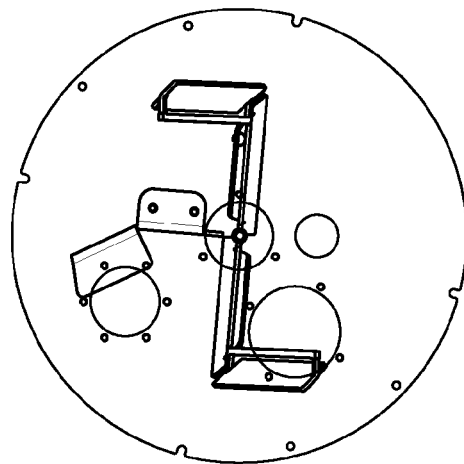


FIG. 12D

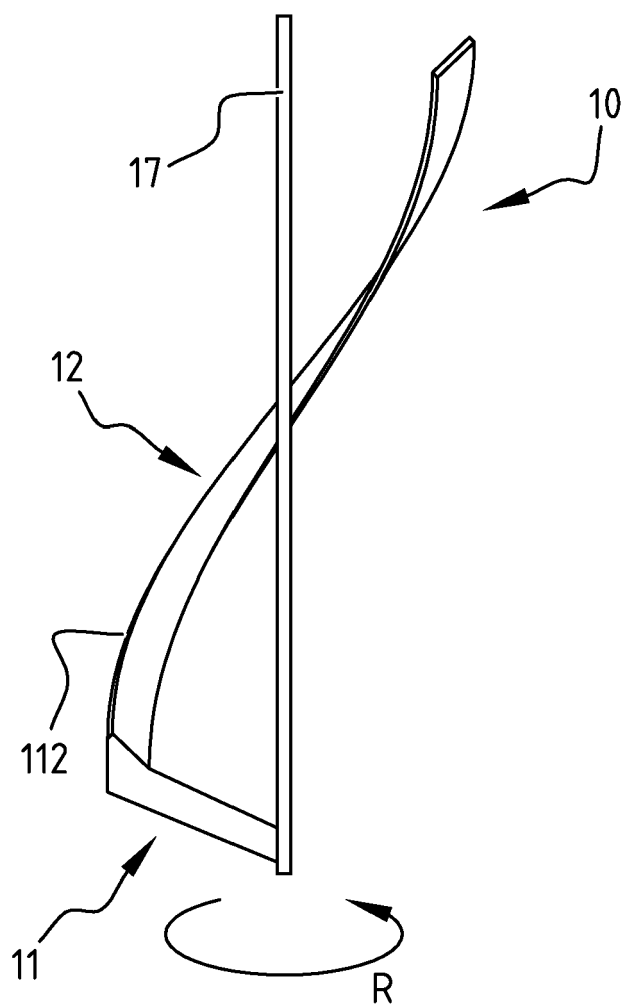


FIG. 13A

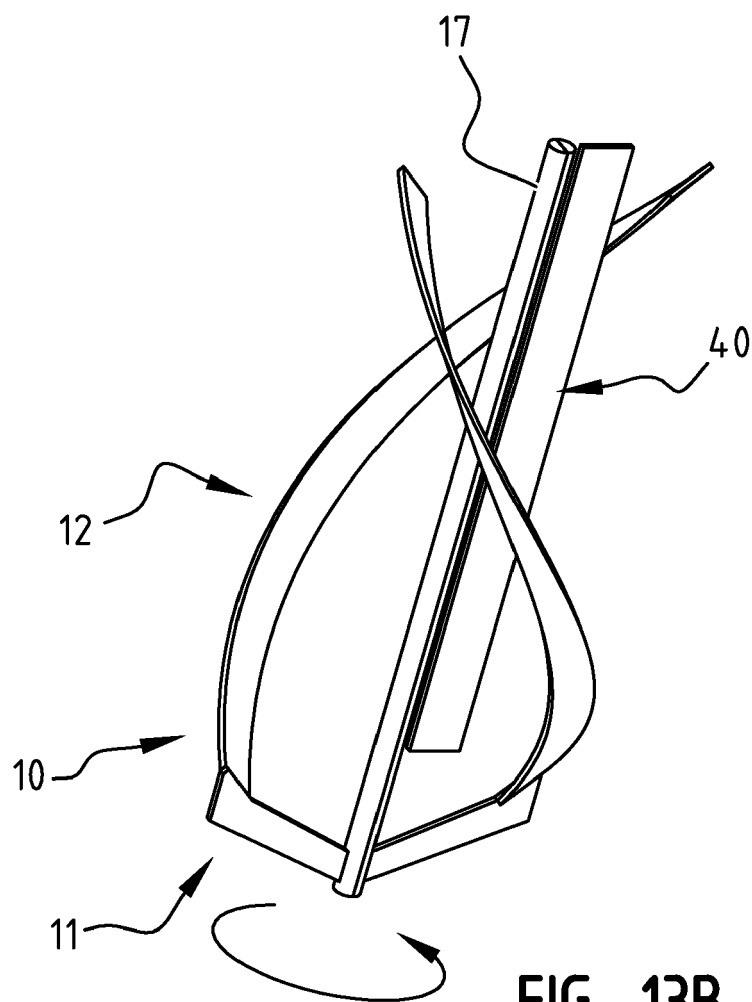


FIG. 13B

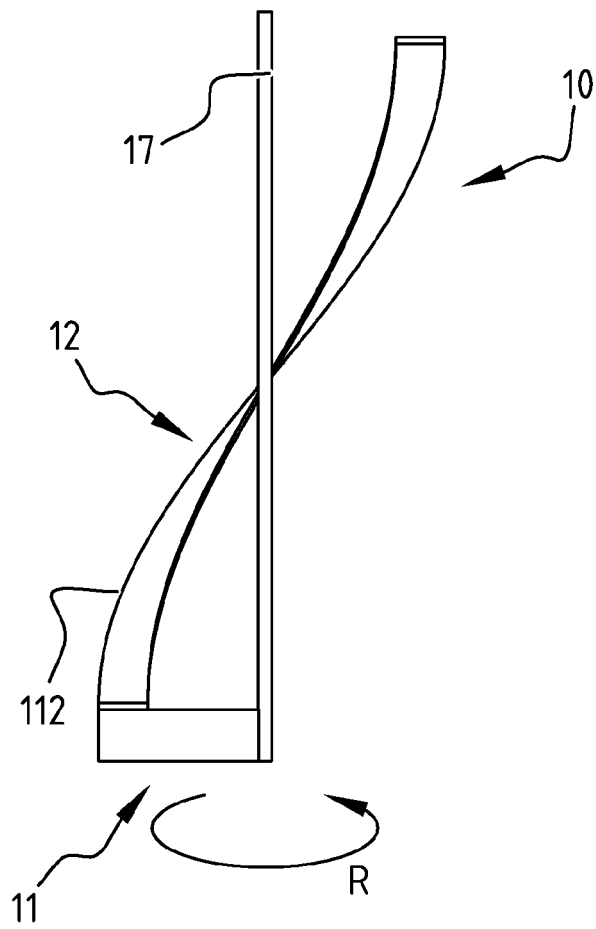


FIG. 14A

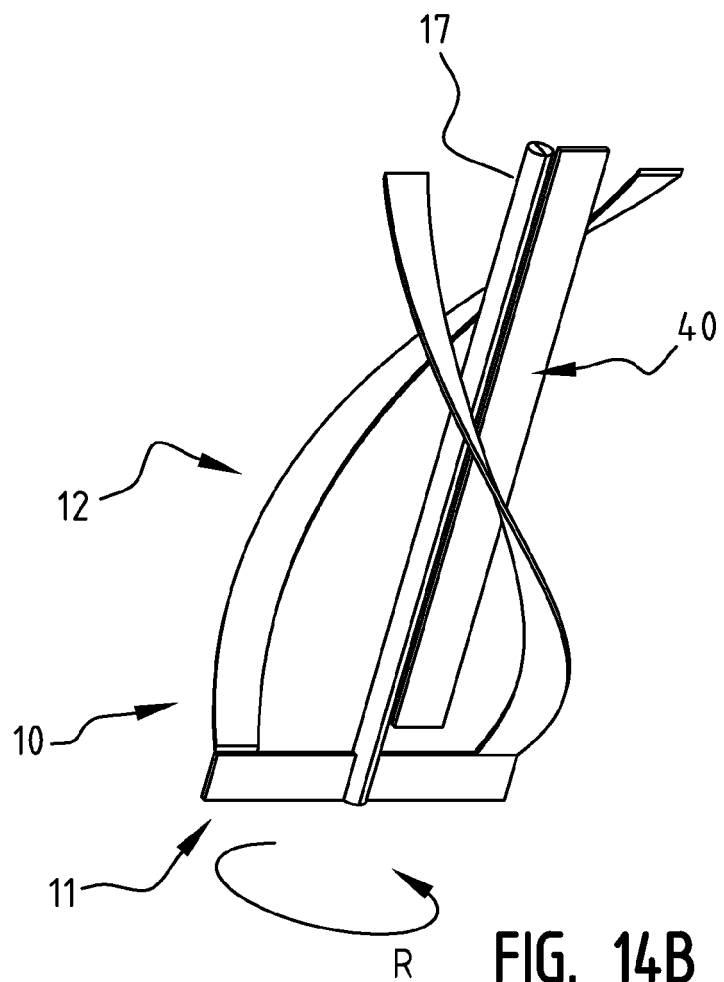
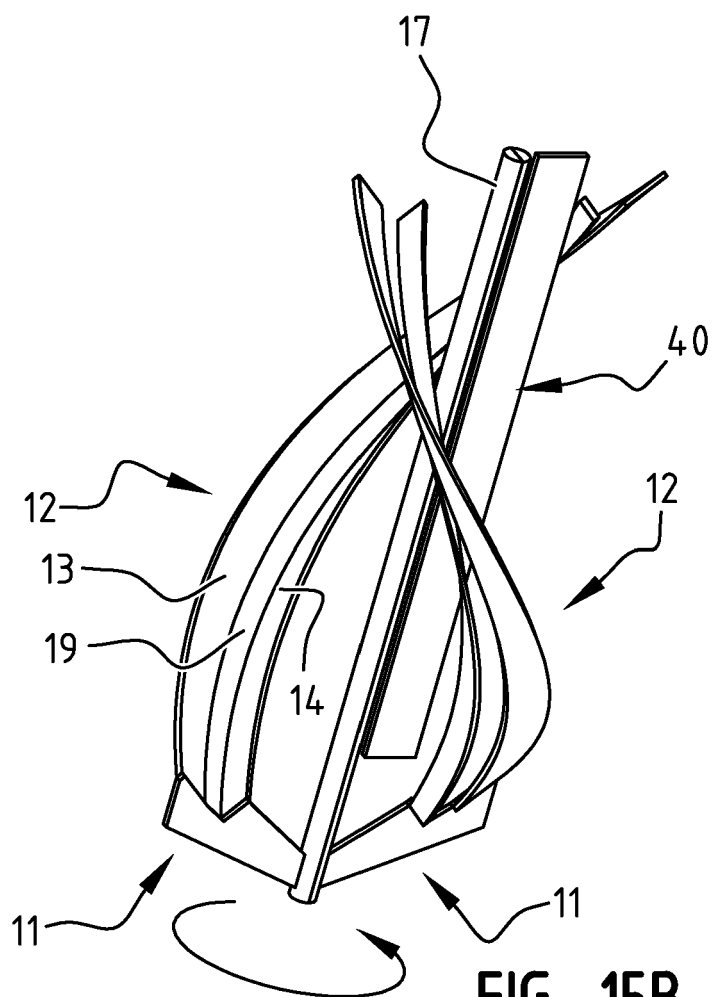
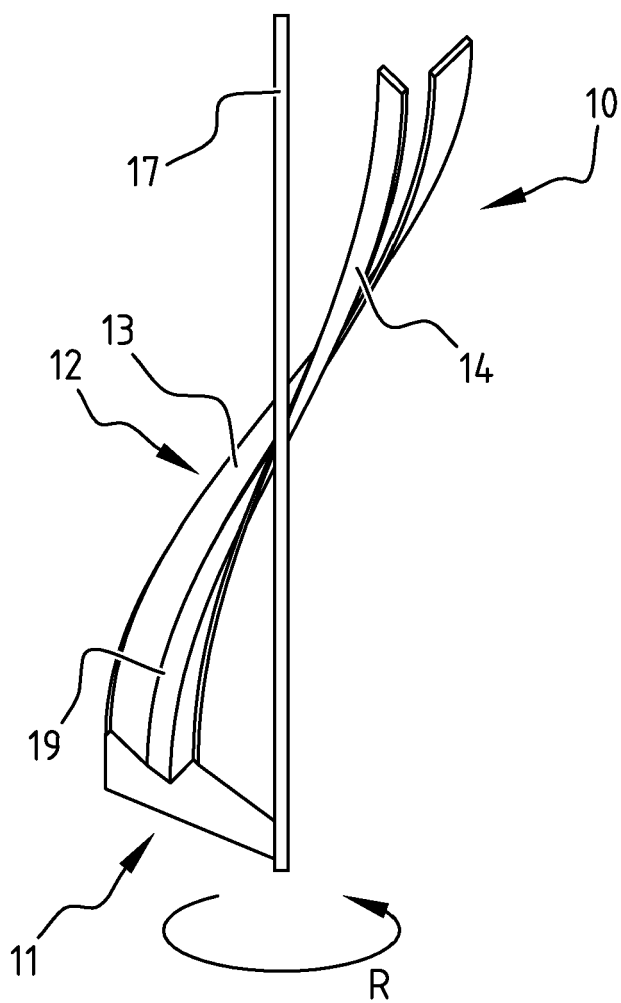
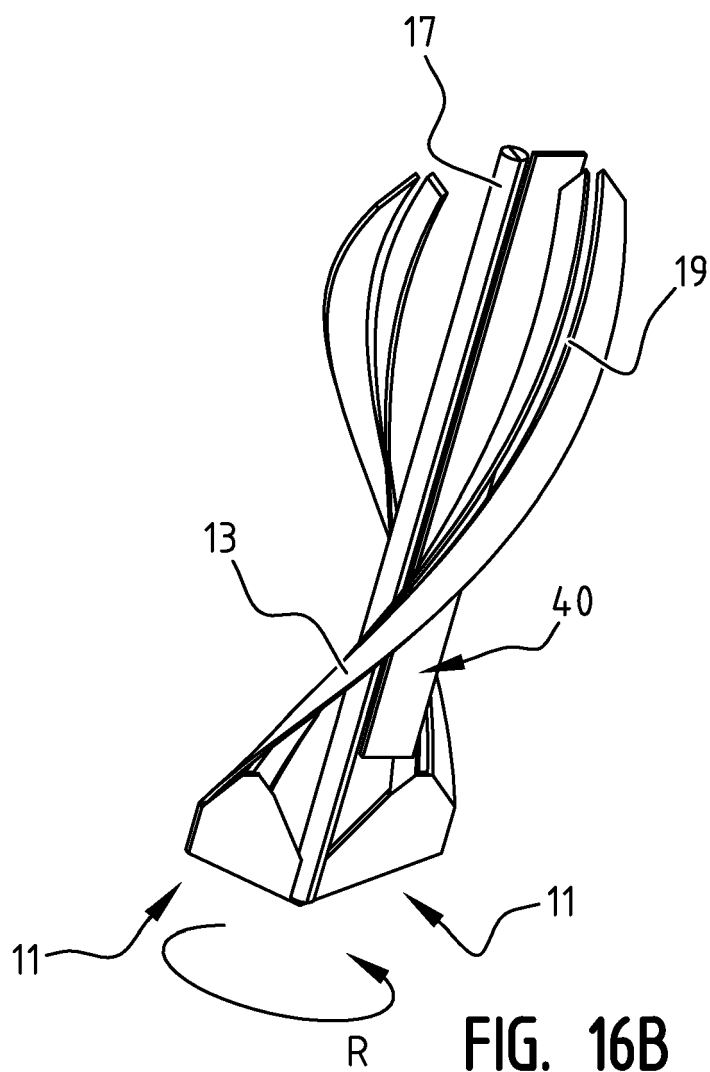
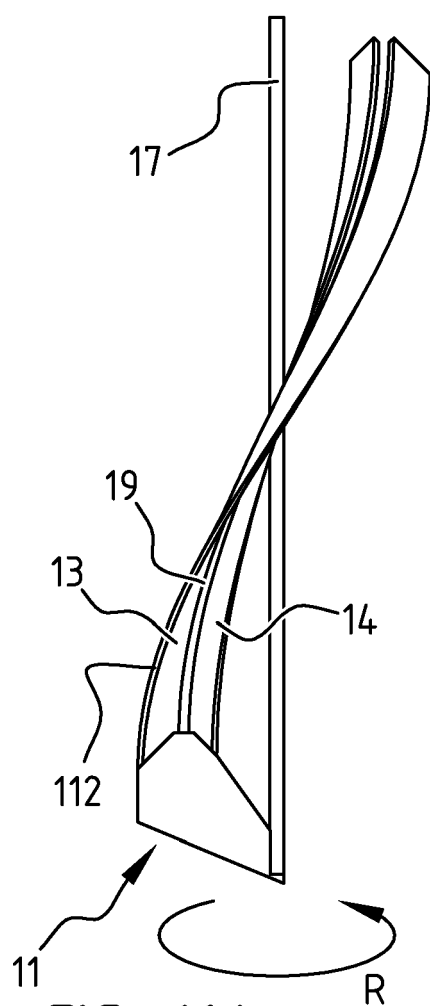


FIG. 14B





REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 20090052948 A [0039]