United States Patent

Kaelin

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[54] **SPINNING TOP FOR THE VENTILATION OF LIQUIDS**

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[51] **Int. Cl.** **B01f 3/04**

[58] **Field of Search**.....................................261/91; 210/219

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[57] **ABSTRACT**

An aerating impeller apparatus for liquids, particularly for purifying sewage, is formed of a rotor member or blade ring dependently secured from a rotatable vertically extending shaft. The rotor member extends upwardly from an inlet to an outlet and has an inner wall shaped arcuately in the radial direction joined along its upper and lower edges to an outer frustoconically shaped wall so that an annular hollow space is formed between the two walls. A floatable material can be placed in the hollow space. A plurality of angularly spaced blade members are secured to and extend inwardly from the inner surface of the inner wall-forming conveyor ducts for directing liquids from the inlet to the outlet of the rotor member. The blade members have a T-shaped cross section of generally increasing size from the inlet to the outlet. The edges of the crossrail or head of the T-shaped cross section are spaced apart approximately distance constant discance from the inlet to the outlet.

8 Claims, 3 Drawing Figures

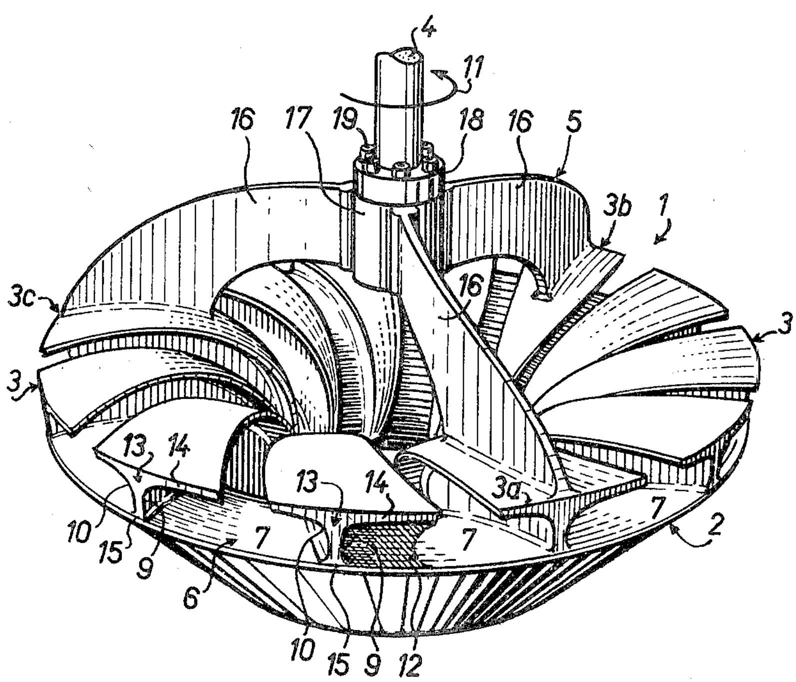

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Fig. 1

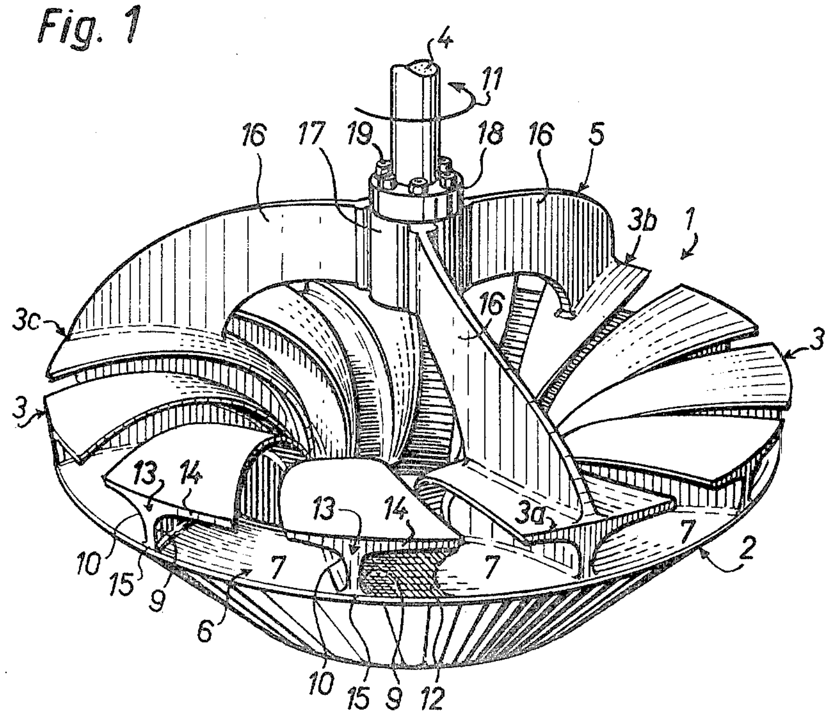

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Fig. 2

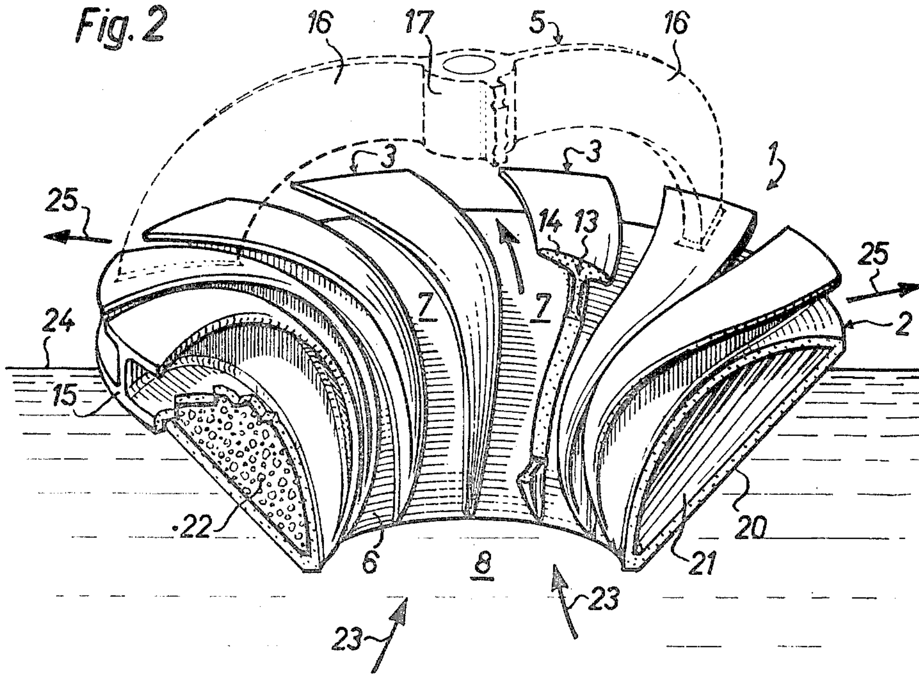
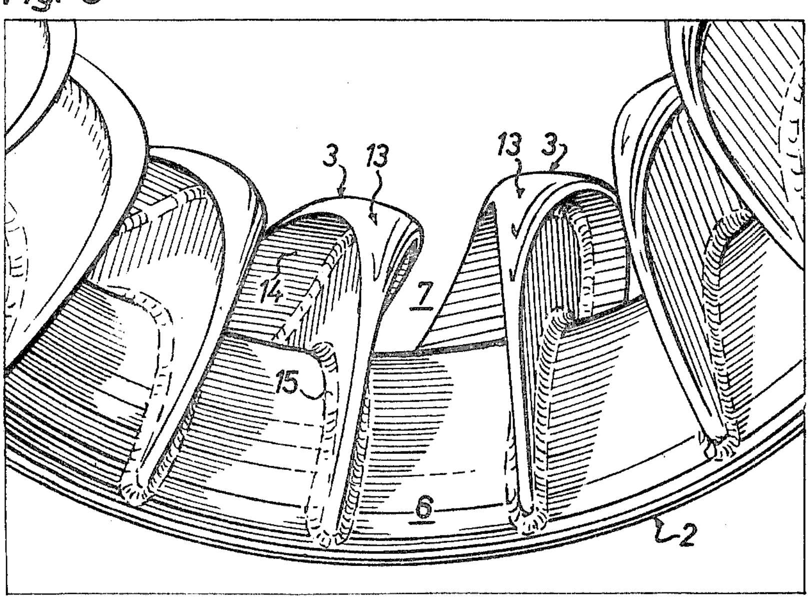


Fig. 3



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SPINNING TOP FOR THE VENTILATION OF LIQUIDS

SUMMARY OF THE INVENTION

It has therefore been suggested, in the case of ventilation tops of the above type, to close the conveyor ducts along their length by covering the lateral edges of the blades facing the axle of the spinning top by means of an internal guide wall and thus to raise the specific input performance. This resulted in a spinning top which can be compared, for instance, to an axially sucking radial pump impeller. This raised the performance of the spinning top considerably, and thus also the input of air per unit of time, resulting in the fact that, even though the necessary drive energy increased, the ratio of air injected per unit of drive energy consumed improved.

However, this form of construction of the ventilation spinning top which, can be compared to a pump impeller, resulted in a drawback, which, particularly when ventilating sewage to be purified which contains quantities of fibrous solid substances, such as hair, threads, etc., more than offset the improved input performance of the spinning top. This drawback consists of the fact that the closed conveyor ducts of the spinning top tend to be obstructed by the particles contained in the liquid to be ventilated. These particles accumulate at the inlet openings of the conveyor ducts and increase the flow resistance inside the ducts. At the same time, they form a barrier where additional particles accumulate, so that the conveyor ducts of the spinning top are partially obstructed within a short period and are thus unable to convey the liquid.

The tendency to obstruct is considerably reduced in the above-mentioned spinning tops equipped with blades on the inside or outside, because the possibility of fibrous particles covering one of the ducts practically does not exist, as the conveyor ducts are limited in a U-shape, i.e., are open on the inside or outside along their length. The remaining risk of obstruction in the case of "Simplex" spinning tops does not affect so much their performance as the amount of energy required to drive them, because the fibrous particles tend to tangle at the supporting structure and thus form a dead weight which has to revolve together with the spinning top and is liable to offer a higher flow resistance to the liquid.

The slight risk of obstruction can be somewhat reduced in "Simplex" spinning tops by driving the top in one direction and then in the other, which is done in any case in order to prevent the whole of the liquid from revolving after a certain time.

The object of the invention is to provide a spinning top of the internally bladed type which, with regard to performance and input, is generally or nearly equivalent to spinning tops with closed conveyor ducts and, as regards tendency to obstruct, is generally equivalent to, or an improvement on, existing spinning tops equipped with blades on the inside or outside.

Accordingly, the invention provides a vertical axis-spinning top, for the ventilation of liquids, comprising a rotor diverging from the bottom to the top and equipped with a blade ring on the inside, and a supporting structure for linking the spinning top of a drive shaft, the blade ring dividing the inside of the rotor into a number of conveyor ducts leading from an inlet at the bottom to the top and open on the inside, for the liquid to be ventilated, wherein at least some of the blades are fitted with conveyor surfaces projecting over the bases of the blades at least within the peripheral end zone of the conveyor ducts.

In other words, this means that at least some of the conveyor ducts are considered to be closed as it were, at least within their end zone, with the exception of an open slot facing the inside of the spinning top, thus ensuring a better performance, on the one hand, and reducing the risk of obstruction to a minimum, on the other.

In view of the fact that, as already mentioned, it is normal to drive the spinning top in alternate directions, the blades preferably have a T-shaped section, particularly as both sides of the blades thus serve as conveyor surfaces.

The risk of obstruction is particularly slight in a preferred form of construction of the spinning top, in which the height of the blades gradually increase, starting at the beginning of the conveyor ducts, from zero to a maximum value, whereby the maximum height of the blades lies between the beginning and the end zone of the conveyor ducts.

The T-shaped section of the blades is preferably such that the width of the crossrail of the T-shaped section gradually increases from the beginning to the end zone of the conveyor ducts, while the supporting structure is preferably at the same time secured to the free-standing top of the crossrail of the blades of a T-shaped section.

An embodiment of the invention will now be described in detail, by way of example, with reference to the accompanying drawings, wherein:

FIG. 1 shows a perspective view of a ventilation spinning top with its supporting structure secured to a drive shaft;

FIG. 2 shows an open view of part of the ventilation spinning top as per FIG. 1; and

FIG. 3 shows a partial view, on a larger scale, diagonally from the bottom to the top through the lower suction opening of the ventilation spinning top as per FIGS. 1 and 2.

The spinning top 1 is equipped with a rotor 2 which diverges to the top from a suction opening or inlet 8 (FIG. 2) at the bottom. An internal wall 6 of the rotor 2 is equipped with a number of blades 3 which limit a number of conveyor ducts 7 extending from the bottom to the top for carrying the liquid to be purified. As shown by FIGS. 1 to 3, the conveyor ducts 7 are open on the inside. The tops of the blades 3*a*, 3*b* and 3*c* are fitted with a supporting structure 5 which provides a link to a drive shaft 4.

The ventilation-spinning top illustrated is intended to be driven in alternate directions. This is the reason why both lateral surfaces of the blades 3 are designed in the form of conveyor surfaces 9 and 10 (FIG. 1) whereby, if driven in the sense of arrow 11, each conveyor surface 9 becomes effective, as shown in FIG. 1 by shaded section 12. On the other hand, if the spinning top revolves in the opposite direction the conveyor surfaces 10 become effective. Particularly in the peripheral or outer end zone of the conveyor ducts 7, the blades 3 are given a pronounced T-shaped section 13 by means of crossrails 14 whose free extremities form the longitudinal edges of the conveyor surfaces 9 and 10 respectively.

This results in the fact that the conveyor surfaces 9, respectively 10, of the blades 3 clearly project over bases 15 of the blades.

The shape of the blades 3 is clearly illustrated by FIGS. 2 and 3. On the one hand, the height of the section of the blades 3, located at about right angles on the internal wall 6 of rotor 2 increases, starting at the suction opening 8, from zero to a maximum value and decreases again somewhat towards the end of the conveyor ducts 7, i.e., towards the periphery of the spinning top. On the other hand, the width of the crossrail 14 of the T-shaped section 13 increases, starting at the suction opening, from zero to its maximum at the end of the conveyor ducts 7. The width of the crossrails 14 is such that the distance between the free extremities of adjacent crossrails facing each other remains practically constant from the inlet opening 8 to the end of the conveyor ducts 7.

The junction between the surface of internal wall 6 and the adjacent section of the blade surface at base 15 of the blade is rounded off (see FIG. 3), as are the junctions at the bridge of the upright of the T-shaped section with the crossrail 14.

This rounded-off shape can be still more pronounced than illustrated by the drawing, until the bridge and the crossrail of the T-shaped section gradually pass into the surface of the internal wall 6 in the shape of an arc.

As can be seen in FIGS. 1 and 2, the supporting structure 5 comprises a three-pronged star whose arms 16 have a flat vertical section and extend in an arc shape from a central hub 17 to the top of the crossrails of the blades 3*a*, 3*b* and 3*c*. The outer extremities of the arms 16 are welded to the crossrails of these blades 3*a*, 3*b* and 3*c*, whereby all the junctions are clearly rounded off.

The same rounding off is applied to the junctions of the inner extremities of the arms **16** where they are secured to the hub **17**.

As shown by FIG. **1**, the drive shaft **4** is secured to the hub **17** with the aid of a flange **18** and a bolt **19**.

FIG. **2** shows that the shape of the internal wall **6** of the rotor **2** is convex on the inside. On the other hand the external wall **20** assumes the shape of a truncated cone diverging conically from the bottom to the top, whereby the base lines coincide with the edges of the internal wall. The rotor thus assumes a shape which is comparable to a torus with a circular segment as generatrix. The rotor **2** thus comprises a ring-shaped hollow **21** which can either be empty (right-hand side of FIG. **2**) or filled with a floating material **22**, such as a foamed plastics material.

The reason for this design is explained below with the aid of FIG. **2**. The aim in actual practice is to achieve a high degree of efficiency as hereinbefore discussed. The drive of this spinning top has to provide sufficient energy not merely for the purpose of sucking up the liquid to be ventilated in the direction of arrows **23**, to lift if above level **24**, but also to compensate for a not inconsiderable loss in transmission and bearings. As the spinning top illustrated is freely suspended, the bearing of the shaft **4** has to absorb the weight of the spinning top and of the shaft, which acts in the axial direction and to which, when in actual operation, has to be added the force of reaction acting in the same direction which is generated by the lifting of the liquid above level **24**. The axial bearing thus has to absorb substantial axial forces which increase with the amount of liquid lifted by the spinning top. Due to the hollow **21**, which may be filled with the floating material **22**, bouyancy forces are generated which act in the opposite direction to that of these axial forces and which reduce the bearing load considerably, and thus also the bearing losses.

The spinning top illustrated can be made, in addition to stainless metal alloys, particularly light metal alloys, of plastic materials, such as glass fiber reinforced polyester resins, which enable perfectly smooth surfaces to be obtained, without any special further processing.

What I claim is:

1. An aerating impeller apparatus for liquids comprising a rotatable vertical shaft, a rotor member secured to said shaft for rotation therewith, said rotor member comprising an outwardly and upwardly flaring annular wall member coaxially positioned relative to said shaft, said wall member defining an inlet at its lower end and an outlet at its upper end and presenting an arcuate profile extending substantially vertically in the range of said inlet and substantially horizontally in the

range of said outlet, a plurality of blade members secured to said wall member and extending thereon between the inlet and the outlet, said blade members arranged in angularly spaced relationship to one another, each of said blade members comprising a leg portion extending radially inwardly and upwardly from said wall member and a yoke portion extending substantially at right angles to said leg portion and in spaced relationship from said wall member, said yoke portion defining at least one lateral free edge extending along the length of said yoke portion between the inlet and the outlet, and the free edge of said yoke portion blending in the range of said inlet with the surface of said leg portion and the height of said leg portion decreasing in the range of said inlet to a minimum value.

2. An aerating impeller apparatus, as set forth in claim **1**, wherein said yoke portion has a leading lateral edge and a lagging lateral edge in the direction of rotation of said rotor member, both said lateral edges blending tangentially with the surface of said leg portion in the range of said inlet, and the leg portion and yoke portion constituting a T-profile in the range of said outlet.

3. An aerating impeller apparatus, as set forth in claim **2**, wherein the distance between the leading lateral edge of the yoke portion of one said blade member and the lagging lateral edge of said yoke portion of the adjacent said blade member is approximately constant along the lengths of said blade members.

4. An aerating impeller apparatus, as set forth in claim **1**, wherein the width of said yoke portion gradually increases from said inlet to said outlet.

5. An aerating impeller apparatus, as set forth in claim **1**, characterized in that a supporting structure is secured to said yoke portions of a number of said blade members and to the lower end of said shaft.

6. An aerating impeller apparatus, as set forth in claim **1**, wherein the height of said leg portion gradually and uniformly increases from zero at said inlet to a maximum height intermediate said inlet and said outlet.

7. An aerating impeller apparatus, as set forth in claim **1**, wherein said rotor member comprises a frustoconically-shaped outside wall member, said outside wall member sealingly adjoining said outwardly and upwardly flaring annular wall member at its lower edge and its upper edge.

8. An aerating impeller apparatus, as set forth in claim **7**, characterized in that an annular hollow space is formed between the outer surface of said outwardly and upwardly flaring annular wall member and the inner surface of said outside wall member, and a foamed floating filler being disposed in said hollow space.

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