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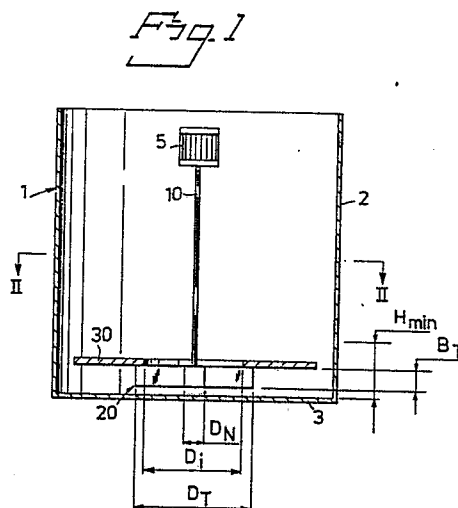
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⑤④ **Stirring device.**

⑤⑦ An apparatus for stirring liquid with both high and low liquid levels in a vessel (1), including a turbine (20) which has a vertical shaft, is situated centrally at the bottom of the vessel (1) and is driven for rotation such as to drive the liquid radially outwards. An annular disc (30) co-axial with the turbine (20) is carried by the upper side of the turbine, with its inner edge portion resting on the radially outer parts of the turbine blades (21).



Description

Stirring apparatus

TECHNICAL FIELD

The invention relates to a stirring apparatus of the kind which will be seen from the preamble of the accompanying claim 1, i.e. a stirring apparatus which give effective stirring of a fluid in a vessel, both when the vessel is full and when the fluid level is very low in the vessel.

BACKGROUND ART

In many chemical processes requiring stirring, there often occur requirements that stirring a liquid volume in a vessel shall be enabled in a suitable manner, both when the vessel is full and when the liquid level in it is very low. The problem resides partly in that a stirring means which is designed for effective stirring at very low liquid levels in a vessel often gives poor or uneconomical stirring in the normal case, when the liquid level is high in the vessel, and partly because requirements for suitable revolutionary speed and power for the stirring means seldom can be combined with corresponding requirements relating to an additional stirring means placed higher up on the same shaft as the one carrying the first-mentioned stirring means. Examples of stirring means which often give both expensive and poor stirring at both high level and low level, are so-called anchor stirrer, gate stirrer, as well as other types of apparatuses which are provided with scrapers. A stirring means which is of the latter type, and which causes problems, is a turbine placed low in the vessel for generating a substantially radial flow. In order to enable such a turbine to give good stirring in the entire tank volume right down to a low liquid level, it is required that the difference between the tank diameter T and the turbine diameter D_T is smaller than $4H_{\min}$, where $H_{\min}$ is the lowest liquid height, and also that the height B_t of the turbine blades and the diameter D of the turbine are in reasonable proportion to the liquid height. The latter requirement can be approximately formulated as $H_{\min} > 2xB_t$, and $H_{\min} > 0.4 D$. These requirements then lead to the situation that the liquid level must be at least about $0.15T$ for the liquid to be well stirred, and furthermore the turbine diameter must be selected to be at least $0.4T$. Since such a turbine requires about 10 times more power than an equally as large propeller mounted on the same shaft, it will be understood that this very often constitutes an impossible combination in practice.

One object of the invention is therefore to propose a stirring apparatus which circumvents the above-mentioned limitations relating to lowest liquid height and selection of smallest turbine diameter. The term "turbine" has been used here, but his expression must be given a wide interpretation, and it should thus be clear that the function of the "turbine" is to drive a fluid flow in a generally radial direction outwards when rotating in a fluid.

CHARACTERIZATION OF THE INVENTION

A stirring apparatus in accordance with the invention includes a container and a rotor in the bottom region of the container, wherein the rotor is rotatable about its at least substantially vertically oriented shaft, is provided with blades which are disposed for driving the fluid generally radially outwards, and is distinguished by the rotor being provided upwardly with an annular disc limiting an upward movement of the generally radial fluid flow caused by the rotor in the immediate vicinity of the latter. Such an annular disc has minor effect on the power consumption and pumping capacity of the rotor or turbine, but separates ingoing and outgoing fluid so that the fluid movement from a relatively small turbine or rotor is also forced out towards the corners of the container. Good fluid stirring within the entire volume is obtained when the container diameter T , the smallest fluid height $H_{\min}$ and the outer and inner diameters D_y and D_i of the disc meet the conditions:

$$T - H_{\min} > D_y > T - 6H_{\min}$$

and

$$2H_{\min} < D_i < 4H_{\min}.$$

The diameter of the stirring means or turbine can be freely selected, e.g. to give suitable stirring and power consumption at a given revolutionary speed. This free selection is expressed by the diameter of the stirring means or turbine not being included in the given conditions. Since D_i can be regarded in practice as being limited downwards by the diameter of the stirring means/turbine, and generally the latter diameter can hardly be selected as being smaller than $0.2T$, the stirring means can be practically utilizable in favourable cases for stirring right down to a fluid level of $0.05T$.

The annular disc prevents the flow departing from the stirring means from being freely deflected upwards, so that the flow is directed towards the corners of the vessel instead, whereby the fluid will be stirred in these regions also, while at the same time the turbine diameter can be kept relatively small.

The invention will now be described in the following in the form of an example, with reference to the accompanying drawings, where an embodiment of an apparatus in accordance with the invention is illustrated.

DRAWINGS

Figure 1 is a schematic axial section through an apparatus in accordance with the invention. Figure 2 is a view taken along the line II-II in Figure 1.

EMBODIMENT

A container 1 is illustrated on the drawings, and includes a circular cylindrical shell 2 with a diameter T and a circular flat bottom 3. A drive shaft 10 is mounted for rotation about its axis which is co-axial with that of the container. The shaft 10 is drivable for rotation by the indicated motor 5. At its lower end

the shaft 10 carries an open turbine 20. The turbine 20 includes a hub 21, with six equally spaced mutually alike turbine blades 22 each extending in an axial plane to the hub 21. An annular disc 30 is rigidly mounted on the upper side of the turbine 20, substantially co-axially with it. The inner diameter D_i of the disc 30 is smaller than the outer diameter D_T of the turbine, so that the disc rests on the turbine blades 22, particularly their outer upper end portions, and is connected to at least some of the blades. The greater part of the radial extension of the turbine is thus left open for receiving a fluid flow into the turbine.

The outer diameter D_y of the disc 30 is substantially larger than the outer diameter D_T of the turbine, so that the substantially radial flow departing from the turbine is guided by the disc 30 towards the corner regions of the container 1 to cause stirring of the fluid also in the corners of the container, even though the outer diameter of the turbine is relatively small. Due to the annular disc 30, which is placed on top of the turbine, an effective stirring of liquid in the container 1 is afforded, both when the liquid level is low and when the fluid level in the container 1 is high, while the turbine diameter can be freely selected, e.g. to give suitable stirring and power consumption for a given rotational speed.

A simple turbine is illustrated in the exemplifying embodiment but it should be clear that the invention is not restricted to the use of the turbine illustrated in Figures 1 and 2, and the turbine can be replaced with some other open stirring means, the blades of which cause a substantially radially outwardly directed fluid flow, the open stirring means being provided with a substantially concentric annular disc on its upper side. The annular disc preferably has concentric circular defining lines.

The apparatus is practically utilizable with a turbine diameter which does not need to be larger than about $0.2T$, right down to a smallest liquid depth $H_{min} = 0.05T$, if

$$T - H_{min} > D_y > T - 6H_{min}$$

$$2H_{min} < D_i < 4H_{min}$$

The inner diameter of the disc 30 must on the one hand be sufficiently large to allow the liquid to pass from above and into the central portions of the turbine, and on the other hand it must be sufficiently small for preventing the radial flow from the turbine to be deflected directly upwardly through the disc 30 to a substantial extent.

In practice it is suitable to allow the inner diameter of the disc 30 to be somewhat smaller than the outer diameter of the turbine, so that the disc 30 can be carried directly by the turbine blades. The disc 30 is preferably a single intrinsic plate between its outer and inner edges, i.e. it is not perforated.

The outer diameter D_T of the turbine is suitably smaller than $0.6T$, preferably smaller than $0.4T$. In addition, the outer diameter D_T of the turbine is suitably larger than $0.1T$, preferably larger than $0.2T$.

Claims

1. Apparatus for stirring a fluid, including a container (1) for the fluid, and a rotor (20) centrally situated in the bottom region of the container, the rotor being provided with blades (22) and rotating about its at least substantially vertically oriented shaft (10) for driving the fluid generally radially outwards, **characterized** in that the rotor (20) is provided at its upper side with an annular disc (30), which is at least substantially co-axial with the rotor, and has an outer diameter (D_y), which is larger than the outer diameter (D_T) of the rotor, the inner diameter (D_i) of the disc being such that fluid flow from the upper side through the central hole in the disc and into the rotor is enabled.

2. Stirring apparatus as claimed in claim 1, **characterized** in that

$$T - H_{min} > D_y > T - 6H_{min}$$

and

$$2H_{min} < D_i < 4H_{min}$$

where T is the diameter of the container,

H_{min} is the smallest fluid height in the container for good fluid stirring in the entire fluid volume in the container,

D_y and D_i are the outer and inner diameters of the annular disc.

3. Apparatus as claimed in claim 1 or 2, **characterized** in that the rotor (20) includes a hub (21) and that the inner diameter (D_i) of the annular disc (30) is larger than the outer diameter (D_N) of the hub.

4. Apparatus as claimed in claim 3, **characterized** in that the inner diameter (D_i) of the annular disc (30) is smaller than the outer diameter (D_T) of the rotor (20).

5. Apparatus as claimed in any one of claims 2-4, **characterized** in that the outer diameter (D_T) of the rotor (20) is smaller than $0.6T$.

6. Apparatus as claimed in claim 5, **characterized** in that the outer diameter (D_T) of the rotor is larger than or equal to $0.1T$.

7. Apparatus as claimed in any one of the preceding claims, **characterized** in that the annular disc (30) rests on, and is attached to the blades (22) of the rotor (20).

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Fig. 1

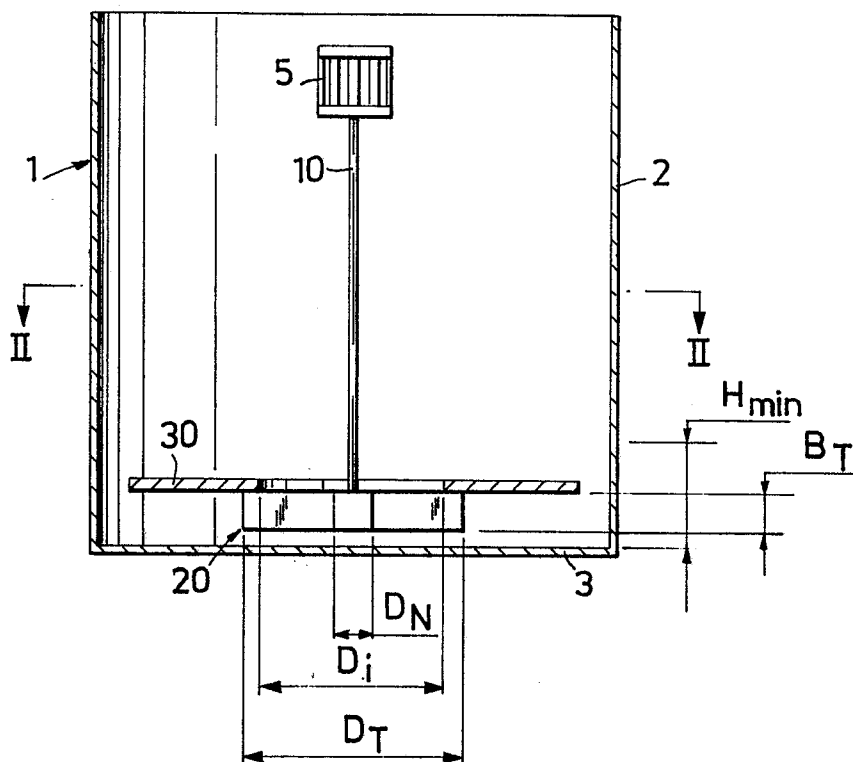
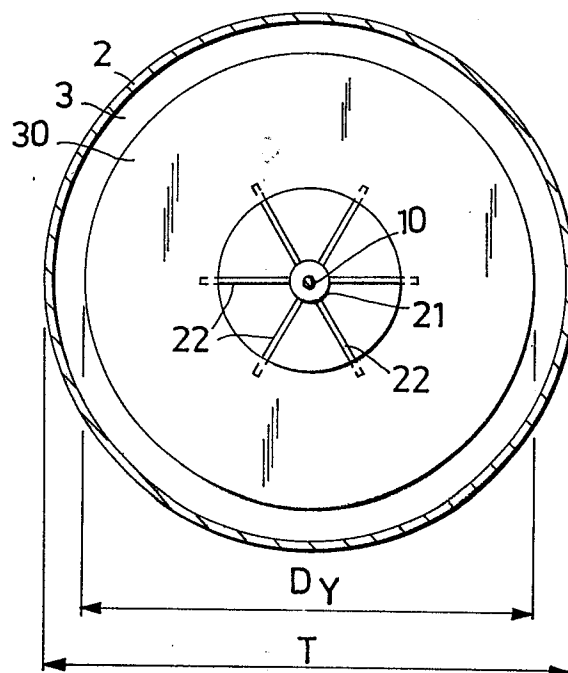


Fig. 2





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 88 85 0120

DOCUMENTS CONSIDERED TO BE RELEVANT					
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)		
A	US-A-3 690 621 (M. TANAKA et al.) * claim 1; figure 1 * ----	1	B 01 F 5/16		
A	GB-A-1 220 250 (AMES CROSTA MILLS) * claim 1, figure 1 * -----	1			
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)		
			B 01 F 5/00 B 01 F 7/00 B 01 F 15/00 F 04 D 29/00		
The present search report has been drawn up for all claims					
Place of search BERLIN		Date of completion of the search 20-06-1988	Examiner KESTEN W.G.		
<table><tr><td>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</td><td>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</td></tr></table>				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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