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Apparatus for mixing and dispersing materials.

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Mixing and dispersing apparatus shown in Figure 1 has a series of rotors (22, 30) of different diameter carried by and driven by a main rotor shaft (10) and located in a vessel having at least a portion shape (10) generally complimentary to that of the set of rotors. Material in the vessel which is circulating in the vessel or flowing through the vessel is subject to a series of accelerations and shearing forces in flow between each rotor tip and the vessel wall.

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APPARATUS FOR MIXING AND DISPERSING MATERIALS

This invention relates to apparatus for mixing and dispensing particulate materials in solvent liquids, especially but not exclusively in the manufacture of paints by incorporating opacifiers and pigments in the solvents

A successful prior art apparatus comprises a cylindrical vessel having a slow speed rotor with a blade generally of the shape and size of the vessel so as to closely conform to the vessel side wall and which is for maintaining a general mixing or circulating flow in the vessel contents, together with one or more high speed rotor discs for dispersion, which is effected by the shearing forces provided by the acceleration of the material due to the high speed rotor.

The economic considerations of the mixing and dispersing apparatus include energy input and time taken (which are in general related) but limiting factors include heat evolution which may be deleterious to some materials which are to be mixed as well as representing energy loss.

The object of the invention is to provide improved apparatus.

According to a first broader aspect of the invention, we provide mixing and dispersing apparatus having a main rotor shaft provided with a series of axially spaced rotors of progressively greater effective diameter along the length of the shaft.

The rotors may be driven at constant speed, or e.g. at variable speeds according to the stage in the mixing and dispersion cycle.

By these means, in general, it is possible to bring about circulation in the vessel or flow through the vessel without using a slow speed rotor. However a slow speed rotor may also be used in the arrangements of the invention. The series of axially spaced rotors, acting on the vessel contents in its flow within the vessel subjects the material to a series of accelerations and shearing forces, and where the flow is from the smaller diameter rotor to the larger diameter rotor, these shearing forces will be of progressively greater effect. It is believed that this will enable high energy inputs but avoiding problems therefrom.

The stacked rotor assembly of the present invention may be used in a container or vessel arranged for a natural circulation or flow within the vessel or it may be arranged for flow through the vessel, that is to say from an inlet past the rotors to an outlet with continuous flow therethrough, possibly with recirculation via an external passage.

The vessel may be of generally the same cross sectional shape as the stacked rotor assembly giving the possibility of shearing forces being created by flow between the rotor discs and the

vessel wall.

Alternatively and according to a feature of the invention, the stacked rotor assembly is associated with a cage which is generally complementary in shape to the stacked rotors, so that acceleration and shear forces are created between the cage and the rotor tips. In this case the cage may be complementary to the vessel shape or not. This also creates the possibility of using a vessel of more complex shape and of arranging for the rotor assembly with or without cage to be movable relative to the vessel so as to operate in different portions of the vessel to different effects at different times. According to an important preferred feature, the cage is water-cooled.

The invention is further described with reference to the accompanying drawings in which each of the five figures is a diagrammatic elevation of a different embodiment.

Referring first to Figure 1, the arrangement there comprises a vessel 10 which is generally conical and has a bottom inlet 12 and a top outlet 14. Overhung shaft 16 extends generally axially of the vessel from a motor 18 at the top through a seal 20, and carries a series of (in this instance) five rotor discs 22 - 30 which are of progressively larger diameter from the free end towards the motor so that there is a generally similar clearance between the tip of each rotor and the vessel wall.

The solvents and pigment may be fed through common or separate supply means via inlet 12, and circulated via a passage connecting outlet 14 with inlet 12 or for example solvent can be pumped continuously through the inlet 12 and out of the outlet 40 and from time to time pigments, and opacifiers and the like charged into the vessel at any suitable point. In short the arrangement of Figure 1 can run continuously whilst circulating a single batch, or continuously producing completely mixed and dispersed product.

In flow from the inlet 12 to the outlet 14, the materials are subject to increasing acceleration due to the series of discs of progressively larger diameter, and all of which are inherently driven at the same rotary speed and hence higher tip speed, so that the material is subject to a series of increasing shearing forces at the tips.

In Figure 2, the arrangement is more primarily concerned for batch production and the vessel 101 has a frusto-conical lower portion 30 and a generally cylindrical upper portion 32. The stacked rotor assembly carried by shaft 161 is designed to be raised and lowered, i.e. moved in the direction of the arrows AA relative to the vessel. The shaft 16 is again overhung, and the vessel is provided

with ports 121 and 141 at the bottom and top respectively. The vessel may be charged with solvent for example through the port 141 and particulate material may be vacuum induced in the vessel through the port 121. Alternatively and for example, the particulate material may be charged through the port 141.

The arrangement shown in Figure 3 is a further version primarily arranged for batch production like Figure 2 but in this case the stacked rotor set driven by the overdrive shaft 162 is associated with a cage 36 carried by a stationary guide member 38, and the shearing forces applied to the material are due to the flow of the material between the rotor disc peripheries and the cage portions 40. The whole assembly of cage and rotors is vertically movable relative to the vessel.

Figure 3 also shows the use of a slow speed stirring rotor 42 which in this instance is underdriven from shaft 44 via gearbox 46. The shaft 44 may be a hollow one providing for vacuum induction of particulate material via the valve 48.

Preferably the cage is cooled, for example water-cooled and coolant may be delivered to the cage via pipes 41,43 extending through a non-rotating sleeve 45 journalling the drive shaft 162. The arrangement shown in Figure 4 differs from that in Figure 3 in that the slow speed rotor 421 is overdrive instead of being underdriven.

At least in the case of Figures 2-3 the whole rotor assembly may be raised and lowered. The effect on the product will be varied by so doing. In the case of Figure 2 the effect (of raising) will be to reduce the shear forces effect from the lower rotors because of the increased space from the vessel wall, and hence produce a more general stirring effect.

The arrangement in Figure 5 is generally similar to that in Figure 1 but in this case the arrangement includes a series of fixed baffles 50 interposed between the successive rotors and extending from the container walls towards the shaft. The effect of these is to cause an extended flow path for the whole of the material in flow from the inlet to the outlet so that it reverses direction radially and is subject to shearing forces in flow not only between the rotor tip and the container wall but also between the rotor and each of the baffles.

Claims

1. Mixing and dispersing apparatus comprising a vessel and a main rotor shaft provided with a series of axially spaced rotors of progressively greater effective diameter along the length of the shaft.

2. Apparatus as claimed in Claim 1 wherein the

vessel comprises a conical portion concentric to the axis of the main rotor shaft.

3. Apparatus as claimed in Claim 2 wherein the vessel has an inlet at the small end of the cone adjacent to the smallest of the series of rotors and an outlet at the large end of the cone adjacent the largest of the series of rotors.

4. Apparatus as claimed in Claim 1 wherein the vessel comprises a cylindrical portion and a conical portion, the said rotor shaft extends axially of the two portions and is displaceable axially to take the set of rotors into and out of the conical portion of the vessel.

5. Apparatus as claimed in Claim 1 wherein a cage surrounds the said series of rotors and the rotors are rotatable relative to said cage.

6. Apparatus as claimed in any proceeding Claim wherein a slow speed rotor comprising one or more blades closely conforming to the wall of the vessel is located between the same and the said series of spaced rotors.

7. Apparatus as claimed in Claim 1 comprising a series of fixed baffles each interposed between two adjacent rotors and mounted on the wall of the vessel and extending towards said shaft.

8. Apparatus as claimed in Claim 5 wherein said cage is water-cooled.

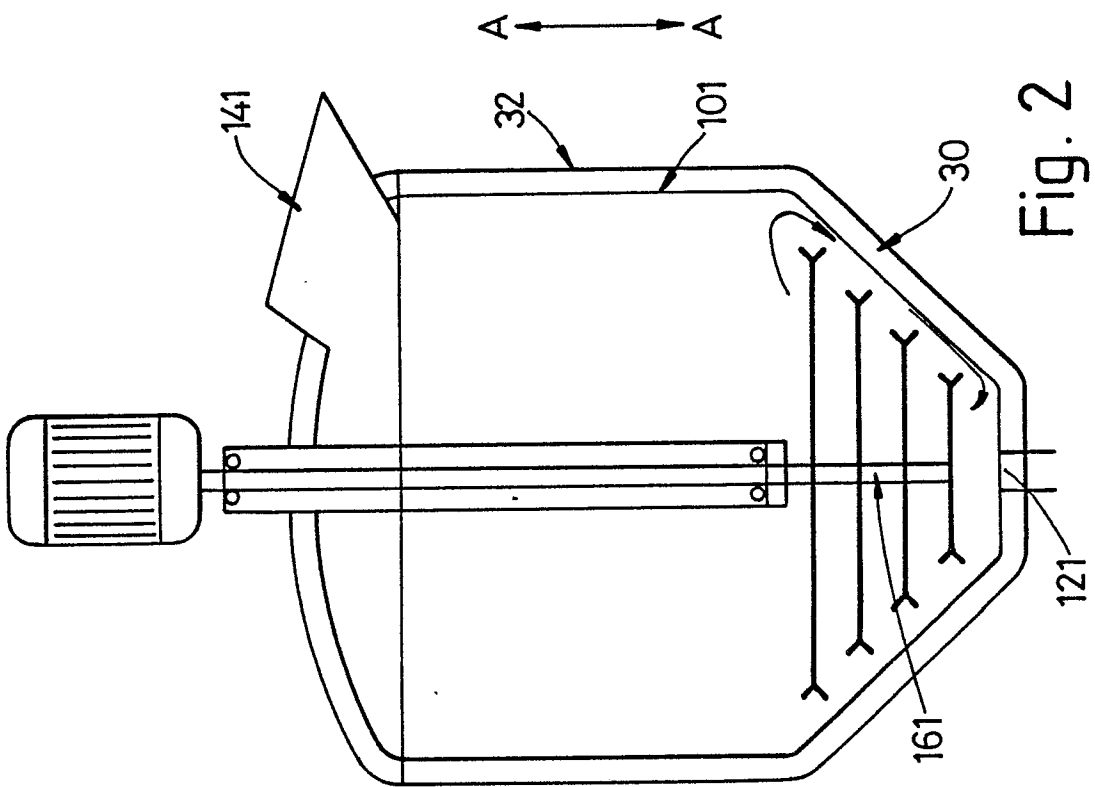


Fig. 1

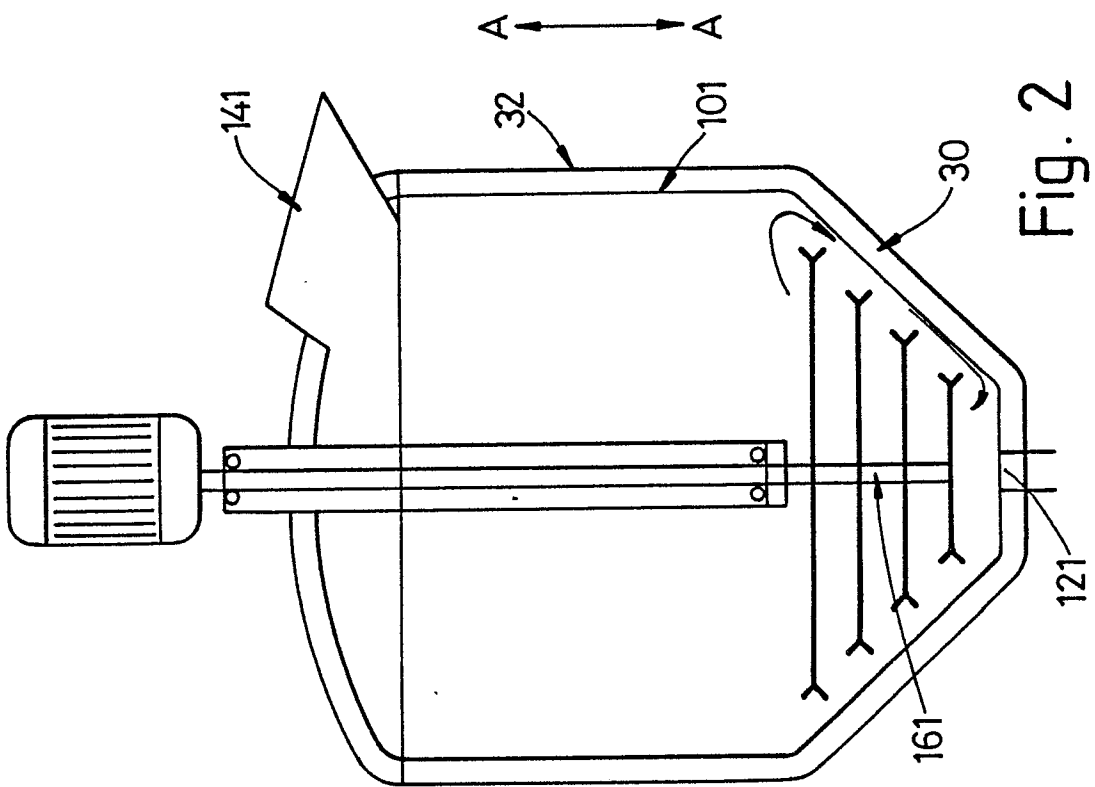


Fig. 2

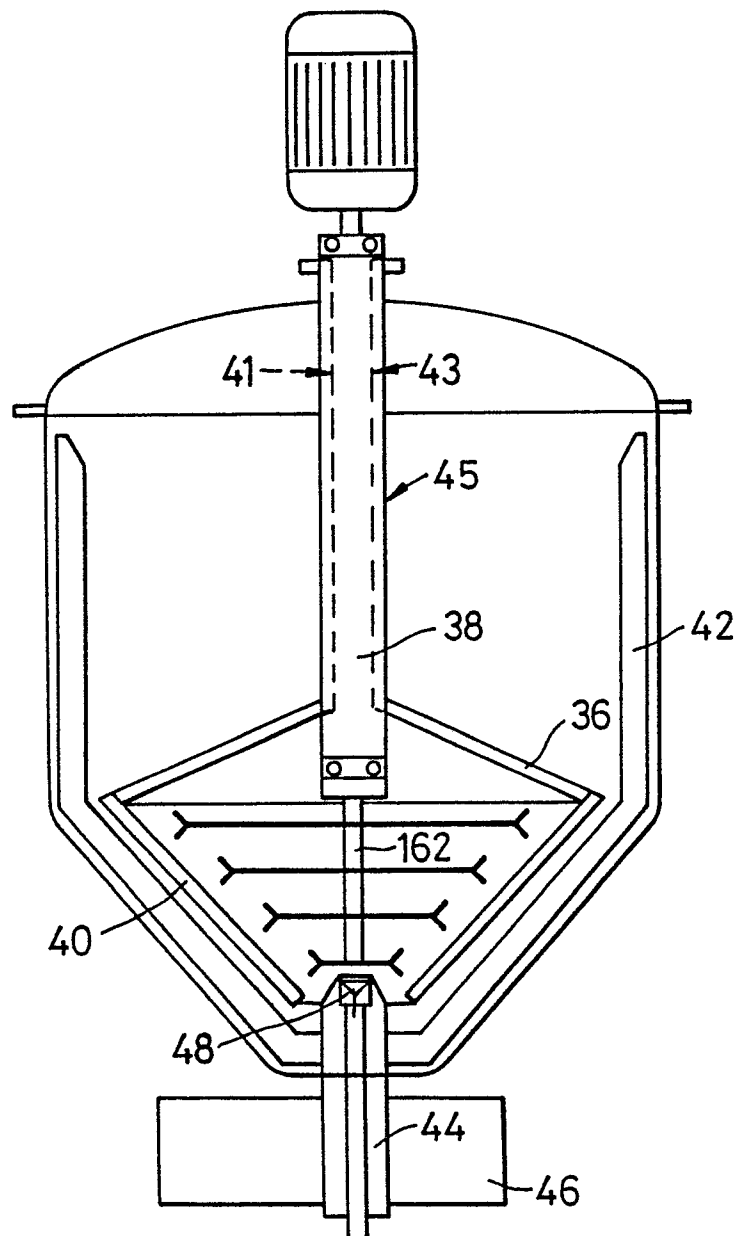


Fig. 3

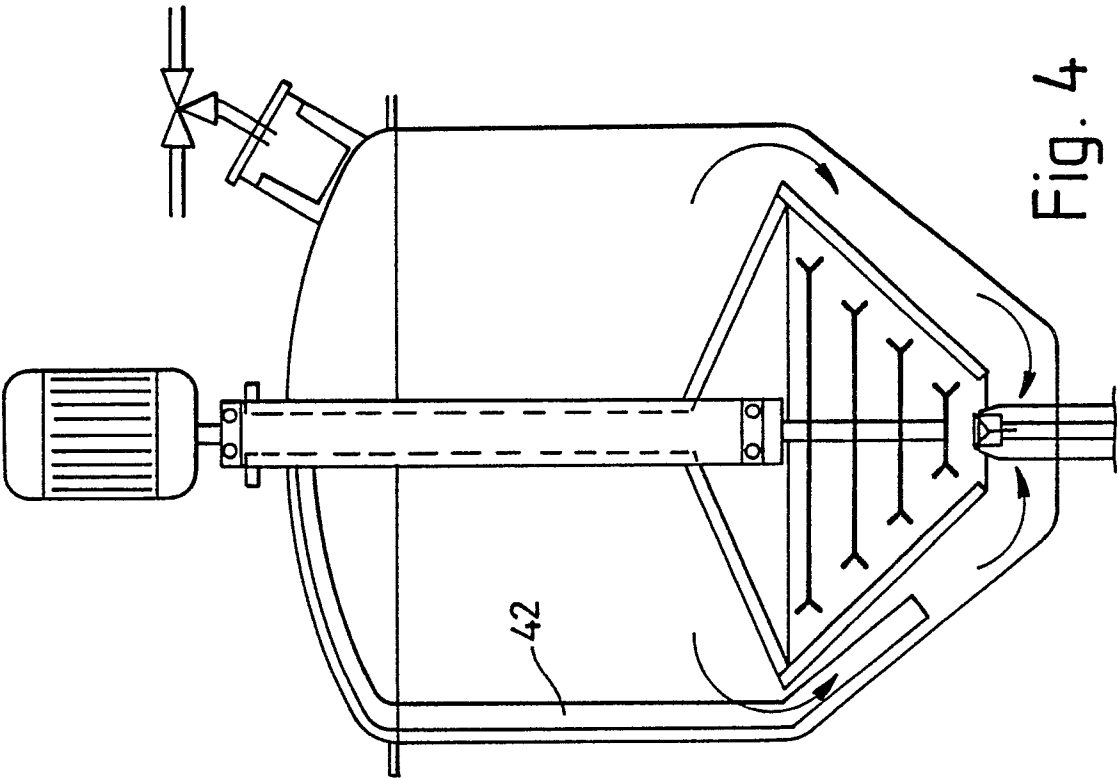


Fig. 4

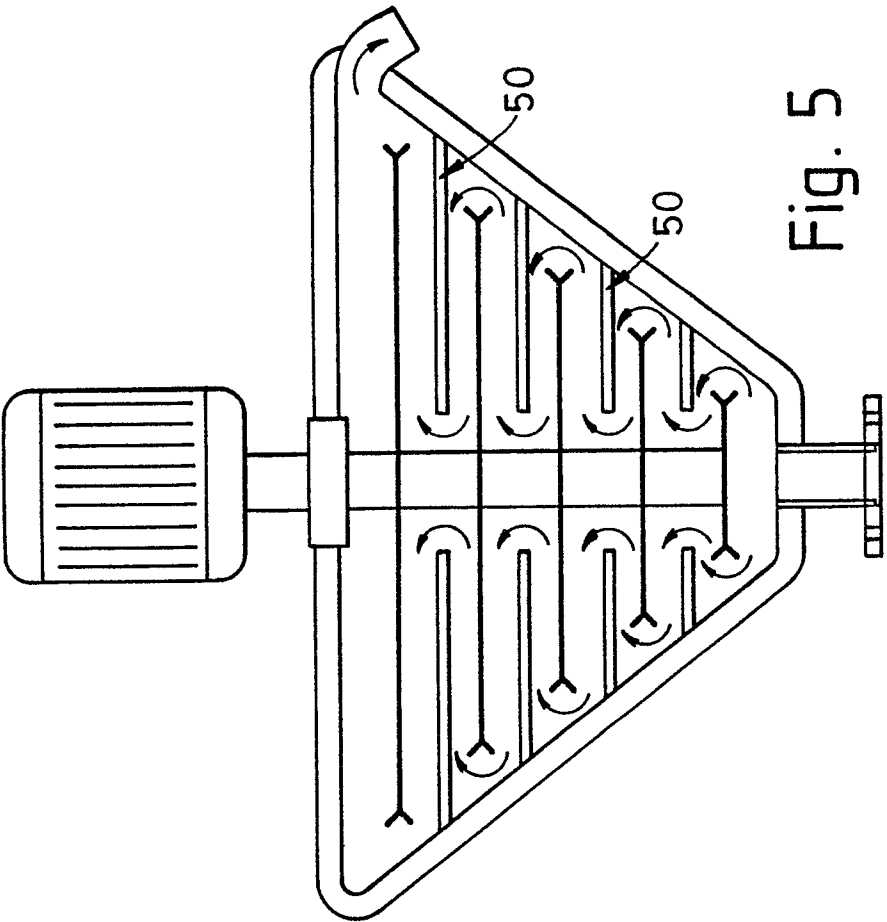


Fig. 5



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.5)
X	GB-A- 378 841 (HENKEL) * Page 1, line 68 - page 2, line 4; figure *	1,2,5,6	B 01 F 7/26 B 01 F 7/16
X	DE-A-2 446 975 (HOECHST) * Figure 1 *	1,2,4,8	
A	US-A-3 010 803 (WISTRICH) * Figure 1 *	7	
A	FR-A-1 525 094 (KALICH) * Figures 6-10 *	1	
A	US-A-3 172 609 (OLSEN) * Figure 1 *	3	
A	US-A-2 315 251 (EPPENBACH)		
A	US-A-2 163 150 (MEISSNER)		
A	US-A-3 158 358 (FISCHER)		
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			B 01 F
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 04-09-1989	Examiner PEETERS S.
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			