Aug. 12, 1969 G. HÜGLI 3,460,811

MIXING DEVICE

Filed Nov. 30, 1967 2 Sheets-Sheet 1

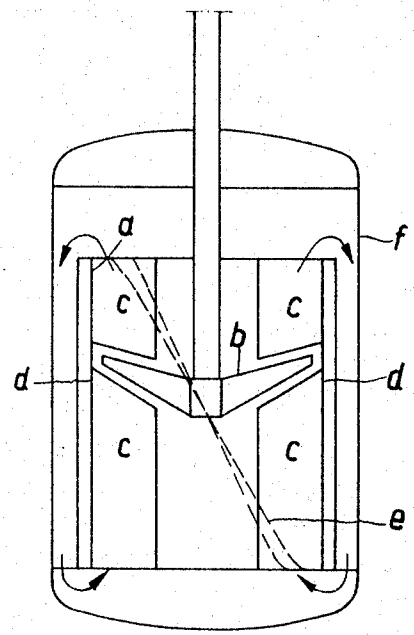

Fig. 1

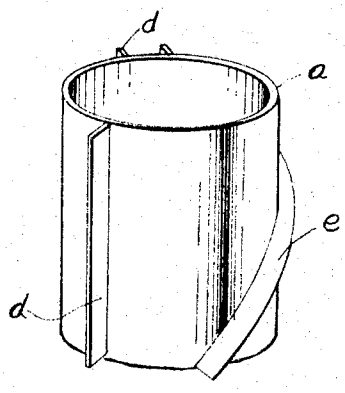

Fig. 3

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MIXING DEVICE

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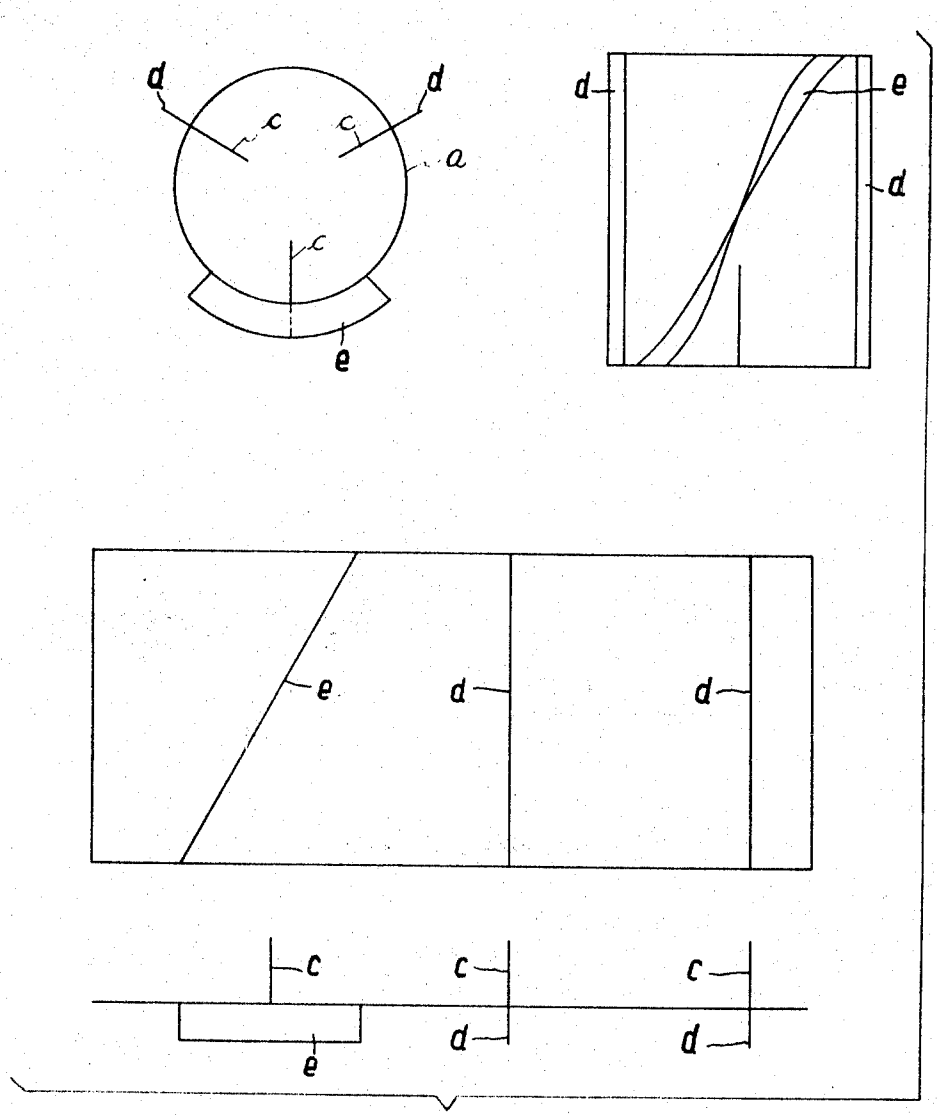

Fig. 2

United States Patent Office 3,460,811
Patented Aug. 12, 1969

3,460,811

MIXING DEVICE

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Filed Nov. 30, 1967, Ser. No. 686,867
Claims priority, application Switzerland, Dec. 1, 1966, 17,200/66
Int. Cl. B01f 7/22, 5/10
U.S. Cl. 259—97 6 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for mixing materials including a cylindrical housing with a coaxial cylindrical jacket disposed therein to form an inner chamber and an outer chamber, an impeller disposed in the inner chamber, and a plurality of baffles disposed in the outer chamber to define a plurality of flow paths having varying cross sectional areas throughout the outer chamber.

This invention relates to an improved mixing apparatus particularly suitable for the mixing of viscous liquids.

Conventional mixers using agitators and stirrers are frequently not able to produce a satisfactory mixing action in highly viscous liquids.

It is known to use built-in annular arrangements such as encased propellers to improve the performance of such stirrers. Even then, the mixing effect remains unsatisfactory because either the flow speed is too low or there is to little forced rotary motion of the contents.

It is, therefore, a principal object of the invention to provide a mixing device which improves the mixing effect, particularly in viscous liquids.

Other objects and advantages will be apparent from a consideration of the specification and claims.

The mixer according to the invention contains a cylindrical jacket which divides the inner space into two communicating compartments whereby said jacket is on its inner face provided with longitudinal baffles and surrounds an impeller producing vertical flow. In the space between said jacket and the outer wall of the tank, there are provided either at least one vertical baffle and at least one inclined baffle, or at least two inclined baffles in order to produce a large speed gradient and high speeds.

The portions of the fluid flowing around the edge of the propeller jacket where said portions are not subjected to the action of the dividing baffles and flow at high but widely differing speeds, are subjected to high shearing stresses and pressure drops which produce a very intensive blending of said portions.

Due to the built-in guiding means, the forced flow, which provides for a mixing effect independent of the impeller, can be maintained in all sections of the device even for liquids of very high viscosity; this is not possible in conventional mixing devices.

The cross-sectional ratio of propeller compartment to jacket compartment is preferably in the range of 1.5:1 to 5:1.

The number of deflecting baffles disposed in the interspace between the outer wall and the jacket is chosen with advantage so as to provide at least one inclined baffle in addition to two vertical baffles or only at least two inclined baffles. Preferably, two to nine baffles will be provided. An excessive number of baffles increases the frictional losses.

The slope of the inclined baffles is preferably in the range of 15° to 45° to the vertical.

Normally, the axis of the cylindrical inner jacket or

sleeve will coincide with the axis of the device. However, it is also possible to arrange said axis at an angle and/or to shift it with respect to the impeller axis.

For certain applications, the two communicating compartments of the device can be arranged side by side or one behind the other.

The device of the invention is particularly suitable for viscous liquids such as solutions of high molecular polymers, fertilizers, and the like.

An illustrative embodiment of the device of the invention is shown, by way of example, in the accompanying drawings, wherein:

FIG. 1 is a sectional view of a mixing device according to the invention showing the arrangement of the impeller, inner jacket, and baffles;

FIG. 2 shows the arrangement of the various baffles with respect to the inner jacket in top view, side view, and as development of the jacket; and

FIG. 3 is a perspective view of the mixer.

Referring to the drawings, an inner cylindrical sleeve *a* divides the cross-sectional area of the mixer in the proportion of 3 (inside):1 (outside). An impeller *b* produces between vertical deflecting baffles *c* a strong current of preferably 0.5–5 m./sec. in vertical direction inside said sleeve. The outer ring space is divided by three deflecting baffles into three zones or flow paths through which the materials to be mixed moves in parallelly divided flows; two of the baffles *d* are vertical while one baffle *c* is inclined to the vertical by an angle of 15 to 45°. In this way, the liquid is divided into flow paths of three different speeds.

The different speeds or flow rates in the flow paths cause intensive mixing at the top and bottom of the jacket where the flow paths communicate due to high speed gradients and shearing stresses, and intensive mixing occurs in the outer ring space or chamber due to the varying cross sectional areas of the flow paths defined by one longitudinal baffle *d* and inclined baffle *e* which are skewed with respect to each other.

EXAMPLE

A mixing tank of 450 liter capacity and an outer diameter of 940 mm. contained an inner cylinder of 700 mm. diameter which was provided with two outwardly projecting vertical baffles of about 120 mm. width and a third outwardly projecting baffle which is inclined at an angle of 30° to the vertical. Said baffles extended over the entire length of the jacket. The three-bladed propeller had a diameter of 550 mm.

The mixer was used for the decomposition of a raw phosphate with nitric acid at a temperature of 50–56° C. 1500 kg./hour of raw phosphate and 4100 kg. of 58% nitric acid were continuously passed through the mixer whereby the products were introduced near the bottom of the mixer by means of a dip tube and the acidulated mixture was drawn off through a lateral outlet provided below the upper edge of the stirrer. The speed of the propeller was 220 r.p.m. The viscosity of the produced mesh was 10–60 poise (non-Newtonian liquid). The mixer was operated for more than 3 months without interruptions.

To obtain the same effect with a conventional mixer, such mixer must have a capacity of about 5000 liter, and material strongly adheres to the walls, requiring frequent stoppages for cleaning.

I claim:

1. Apparatus for mixing materials comprising

a cylindrical housing, a cylindrical jacket having an inner surface and an outer surface and disposed within said housing to form an inner chamber defined by the inner surface of said jacket, and an outer chamber communicating with said inner

chamber and defined by said housing and the outer surface of said jacket;

an impeller disposed in said inner chamber for causing materials to be mixed to flow through said inner chamber and said outer chamber; and

a plurality of baffles disposed in said outer chamber to define a plurality of flow paths through said outer chamber, said plurality of baffles including a pair of adjacent baffles skewed with respect to each other such that the cross sectional area of a first flow path defined between said adjacent baffles varies throughout said outer chamber whereby intensive mixing of materials occurs in said outer chamber.

2. The invention as recited in claim **1** wherein said pair of adjacent baffles includes a first baffle disposed in longitudinal alignment with said jacket and a second baffle disposed at an incline to said first baffle.

3. The invention as recited in claim **2** wherein said plurality of baffles includes a third baffle arranged in parallel with said first baffle to define a second flow path through said outer chamber between said first baffle and said third baffle and a third flow path through said outer chamber between said second baffle and said third baffle, said third flow path having a cross sectional area varying throughout said outer chamber, whereby intensive mixing of materials occurs where said first flow path, said second flow path and said third flow path communicate due to different flow rates in the flow paths.

4. The invention as recited in claim **3** wherein said jacket and said housing are coaxial.

5. The invention as recited in claim **3** wherein said second baffle has an incline of from 15° to 45° with respect to said first baffle.

6. The invention as recited in claim **3** wherein the ratio between the cross sectional area of said inner chamber and the cross sectional area of said outer chamber is in the range of 1.5:1 to 5:1.

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