June 4, 1957 L. D. FESSENDEN 2,794,628

PROPELLER AGITATORS AND THE DISPERSING OF MATERIALS THEREWITH

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Fig. 1

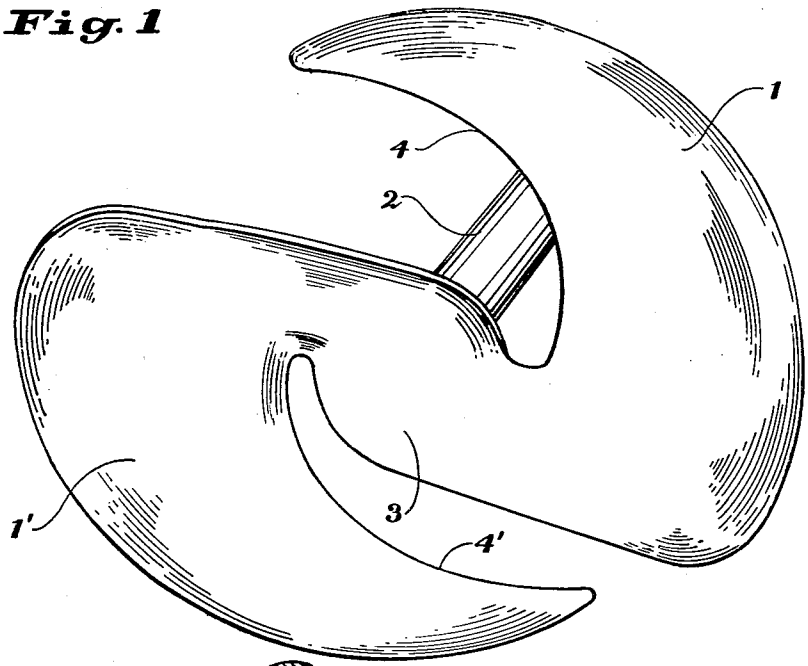
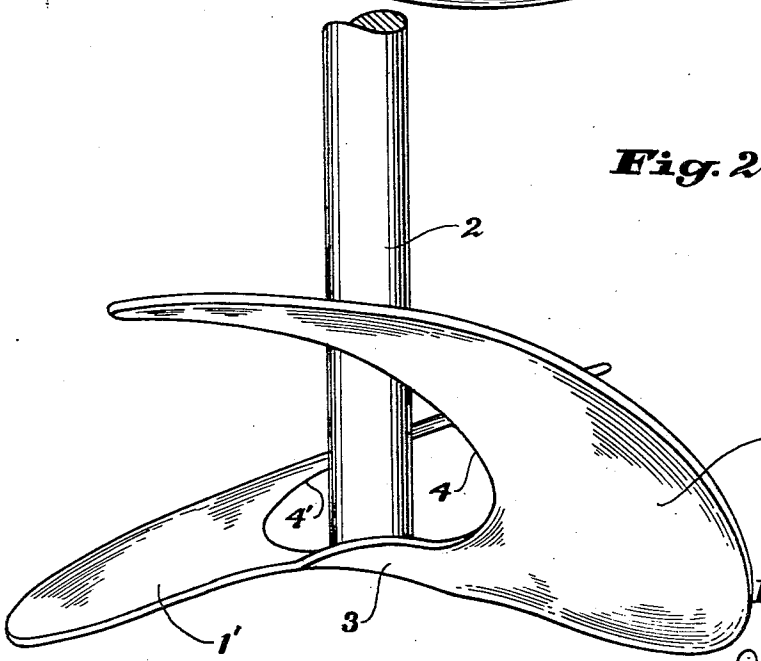


Fig. 2



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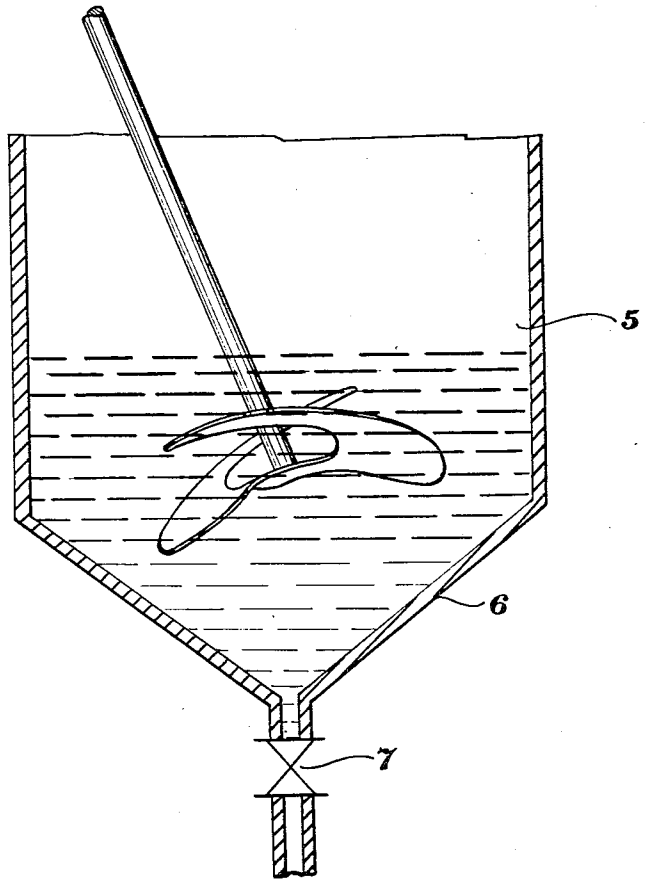
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Fig. 3



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PROPELLER AGITATORS AND THE DISPERSING OF MATERIALS THEREWITH

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Application September 29, 1954, Serial No. 459,004

5 Claims. (Cl. 259—133)

This invention relates to a propeller agitator which effectuates both cutting or slicing and agitating of the material being mixed.

In the mixing of material which requires subdivision as well as movement of the material in the vessel in which it is contained, various difficulties have arisen in the use of mechanical stirrers; hence in many such cases the mixing operations have been conducted manually such as with paddles whereby subdividing and mixing both occur in the same operation.

One situation in which both subdividing and mixing of the material is desirable in converting it to liquid form is in the converting of gelatin from the gel to the liquid state. Conventional mechanical stirrers have been found to be ineffective or poorly effective in this connection. Often due to the resistance offered by the gelatin material the stirrer blade will not move or if movement is possible a small area of loosened gelatin is obtained without any effect upon the mass as a whole. In the liquefying of a gelled gelatin mass ordinarily the walls of the containing vessel are heated. Therefore, agitation which will (1) break the gelatin up into subdivided pieces and (2) assure passage of the gelatin mass along the heated walls so as to obtain uniformity of the liquefying operation is desirable. Due to the shortcomings of mechanical stirring up to the time the propeller agitator described herein was developed, gelatin in gel form has been liquefied or dissolved in water in heated vessels using manual stirring. The results obtained have lacked uniformity and various other difficulties have also arisen in those operations.

One object of my invention is to provide an agitator which is useful for mixing viscous materials. Another object of my invention is to provide an agitator of the type which cuts or slices as well as circulates the material in which the agitating member is operated. Another object of my invention is to provide an agitator which will subdivide the material which is being agitated so as to contribute to its movability while at the same time moving the material upon rotation of the agitator. Other objects of my invention will appear herein.

I have found that an agitating blade having certain desirable characteristics will accomplish the objects which have been listed above. The agitator blade as described continually cuts or slices the material as it rotates therein and in addition moves the material along so that the entire mass is circulated in the vessel in which it is contained. In the case of gelatin, in gel form, for instance, the mass is subdivided until reduced approximately to golf ball size which makes for easy remelting of the gelatinous mass without any overheating because of localized effects therein.

The nature of the agitator in accordance with my invention may be better ascertained by reference to the accompanying drawings. Figure 1 is a plan view of the agitator from beneath while Figure 2 is a side view of the agitator connected to a shaft for rotating the same.

It is ordinarily desirable that the shaft be centered on the agitator. Figure 3 is a view in section of the propeller agitator in use.

The propeller agitator, as illustrated in Figures 1 and 2, of stainless steel sheet is composed of two like blades with a hub 3 to which a shaft 2 is welded or otherwise joined in such manner that the agitator is rotated by rotation of the shaft. The blades 1 and 1' are pitched so as to propel the material in which the agitator rotates. As illustrated this material is moved in a downward direction (away from the shaft) although by reversing the pitch, movement in a direction upwards of the shaft can be obtained. The elements 1 and 1' are so shaped that the open area of the agitator is 25–75%. The blades as shown are adapted to be rotated in a clockwise direction looking down to the agitator along the shaft. The blades of the agitator are supplied with leading edges 4 and 4' having curvatures corresponding to the formula; $r=\frac{1}{2}D\times 2.72^{[(.4 \text{ to } .7)\theta]}$. The leading edge portions of the blade may be recessed to accommodate a hard cutting edge material. The leading edges may be sharpened or not as desired. For instance, as a material offers greater resistance to cutting it is desirable that increased sharpness be used in the leading edges of the agitator.

The agitator of my invention may be operated in a vessel 5 shown in Fig. 3 provided with cylindrical side walls and a conical bottom 6 which may be jacketed if it is desired to raise or lower the temperature of the agitated mass. The vessel 5 as shown is provided with a valved outlet 7 at the apex of the conical bottom to remove the contents of the vessel as desired. In agitating the contents of the vessel 5, circulation occurs with the material contacting the sides of the vessel in a considerable portion of its course.

The shaft is operated in a clockwise direction, the leading edge being adapted for cutting or slicing. As a rule the more solid or viscous the material to be cut the finer the edge used. For instance, with gelatin of 18% concentration a fine edge is desired while with gelatin having a concentration of, for instance, 3% or with aqueous gelatin of a degraded or of a low viscosity type the edge may be less sharp. The blade should be of sufficient area and pitch to produce propulsion. For instance, the open area of the agitator should be no more than 25–75% and its pitch preferably within the range of ½ to 1½ diameters. The variation of pitch is governed somewhat by the amount of propulsion required and the speed of operation. The curve of the leading edges of the blades should be in accordance with the formula: $r=\frac{1}{2}D\times 2.72^{[(.4 \text{ to } .7)\theta]}$ wherein D is the diameter of the hub of the propeller and r and θ are the regular polar coordinates with θ expressed in radians. The leading edge may, where desired, be provided with a hard cutting edge material such as high carbon steel, or tungsten or molybdenum steel.

A blade in accordance with my invention if 8 inches in diameter may be conveniently operated at 300–700 R. P. M. With a smaller diameter blade a higher R. P. M. may possibly be desired depending on the circumstances such as the size of the vessel, the viscosity of the mass being mixed and the like. Instead of gelatin the blade as described herein is useful for mixing other materials in which both subdividing and mixing are desired, for instance, in the blending or mixing of plastics, natural and synthetic rubbers, chemical gelatinous materials such as silica gel or foods such as cheese or other food products having a high liquid or liquefiable content. Ordinarily the agitator as described herein would be operated at at least 1–3 horsepower although of course this may vary depending upon the load which is presented initially to the agitating blade.

The following example illustrates the use of my invention for converting a gel mass of gelatin to the liquid form.

Example 1

The propeller agitator used was two-bladed, 8 inches in diameter, the curve of the leading edges of which accords with the formula $r=1/2D\times2.72^{.5774\theta}$. The leading edges were sharpened and the angle of approach to the material to be agitated was 30° at any point on the leading edge. Each blade had an area of 14½ square inches and the hub was approximately 3.14 square inches. The open area of the propeller was 38.5%. The appended shaft of ⅞ inch diameter was driven by a 1½ horsepower motor at a speed of approximately 431 R. P. M. The agitator was of stainless steel sheet of ⅛" thickness, had an 8" diameter and was pitched 8 inches. The attached shaft was centered thereon.

70 gal. of gelatin in the form of a solid aqueous gel was added to a conical bottomed jacketed vessel of 100 gallon capacity. The propeller was positioned within the vessel slightly to the right of center and about 2 inches above the bottom. 10 gal. of water was also added to the vessel. Steam was run into the jacket of the vessel and the propeller was operated. The gelatin material began to move after 20 seconds and a good flow pattern was obtained in 2 to 2½ minutes. Upon reaching 103–110° F. the solid material had liquefied. Initially the agitator broke up the gelatin into pices of about golf ball size prior to liquefying the material.

Although my invention in its preferred form is a two-bladed agitator of the type described, agitators with more than two blades are within the scope of my invention. However, in the case of agitators with, for instance, 3 or 4 blades, the propeller must be designed to accommodate the presence of the increased number of blades on the shaft.

I claim:

1. A spiral type propeller agitator composed of at least 2 blades, each blade having a leading edge in accordance with the formula:

$$r=1/2D\times2.72^{[(.4\text{ to }.7)\theta]}$$

D being the diameter of the hub of the propeller and r and θ being regular polar coordinates, θ expressed in radians, the propeller having a pitch of ½ to 1½ diameters and an open area of 25–75%.

2. A spiral type propeller agitator composed of at least two blades, each blade having a leading edge in accordance with the formula:

$$r=1/2D\times2.72^{.5774\theta}$$

D being the diameter of the hub of the propeller and r and θ being regular polar coordinates, θ expressed in radians, the propeller having a pitch of ½ to 1½ diameters and an open area of 25–75%.

3. A propeller blade spiral in the direction of rotation with a pitch of ½ to 1½ diameters and having a leading edge the curve of which is in accordance with the formula:

$$r=1/2D\times2.72^{[(.4\text{ to }.7)\theta]}$$

wherein D is the diameter of the hub to which the blade is attached and r and θ are regular polar coordinates, θ being in radians.

4. A two-bladed propeller agitator spiral in the direction of rotation having a pitch of ½ to 1½ diameters and an open area of 25–75%, the curve of the leading edges of the blades being in accordance with the formula:

$$r=1/2D\times2.72^{[(.4\text{ to }.7)\theta]}$$

wherin D is the diameter of the hub of the propeller and r and θ are regular polar coordinates, θ being in radians.

5. A two-bladed propeller agitator spiral in the direction of rotation having a pitch of ½ to 1½ diameters and an open area of approximately 38.5%, the curve of the leading edges of the blades being in accordance with the formula:

$$r=1.57\times2.72^{.5774\theta}$$

wherein r and θ are regular polar coordinates, θ being in radians.

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