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Maynard

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[54] **AGITATOR AND TANK APPARATUS**

[76] Inventor: **Frank L. Maynard,** 2604 Weatherby, Springfield, Mo. 65807

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[52] **U.S. Cl.** **259/109;** 259/95

[51] **Int. Cl.** **B01f 7/06**

[58] **Field of Search** 259/9, 10, 109, 110, 95, 259/97, 25, 26, 45, 46; 68/148, 131

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Primary Examiner—Robert W. Jenkins

Attorney, Agent, or Firm—Rogers, Ezell & Eilers

[57] **ABSTRACT**

This invention relates to a tank and agitator apparatus comprising a vertical tank having an annular side wall, and an agitator mounted in the side wall of the tank. The agitator includes a shaft rotatably mounted in the side wall of the tank, and an impeller mounted on the end of the shaft within the tank. A deflection means is located between the impeller and the mounting means for directing impelled liquid outwardly around the annular wall of the tank. Also included are means for rotating the shaft and impeller means in a direction to draw the liquid from the location of the tank opposite the mounting means and move it in a direction toward the deflection means whereupon it is directed in opposite directions around the annular wall of the tank to meet at the location of the tank opposite the mounting means.

7 Claims, 6 Drawing Figures

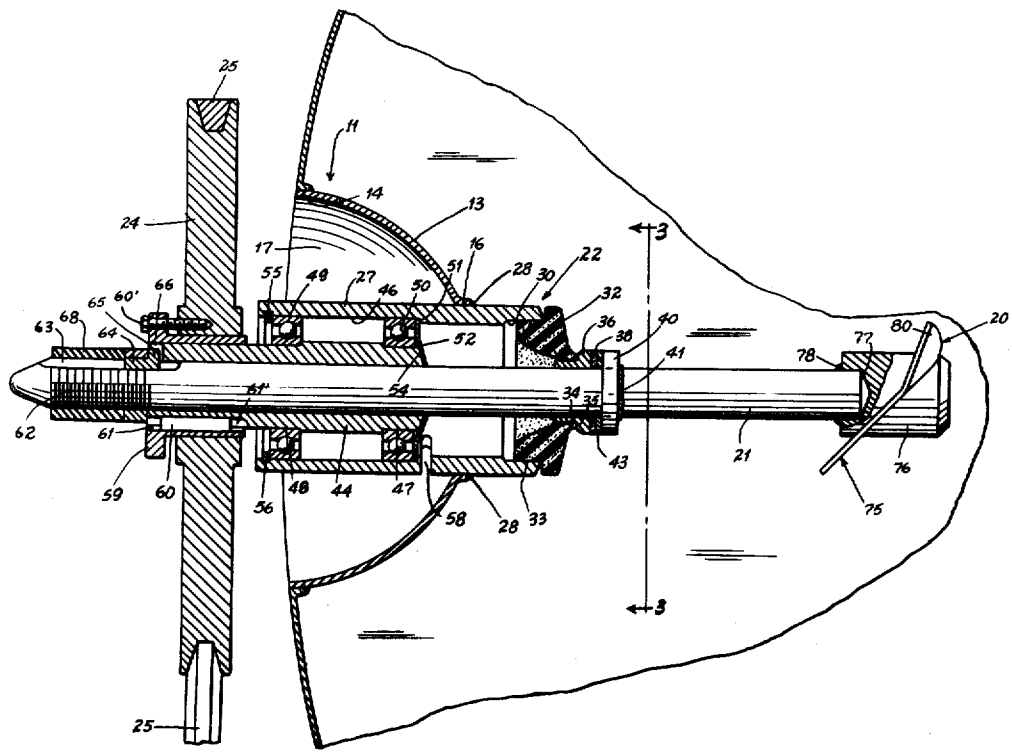


Fig. 1.

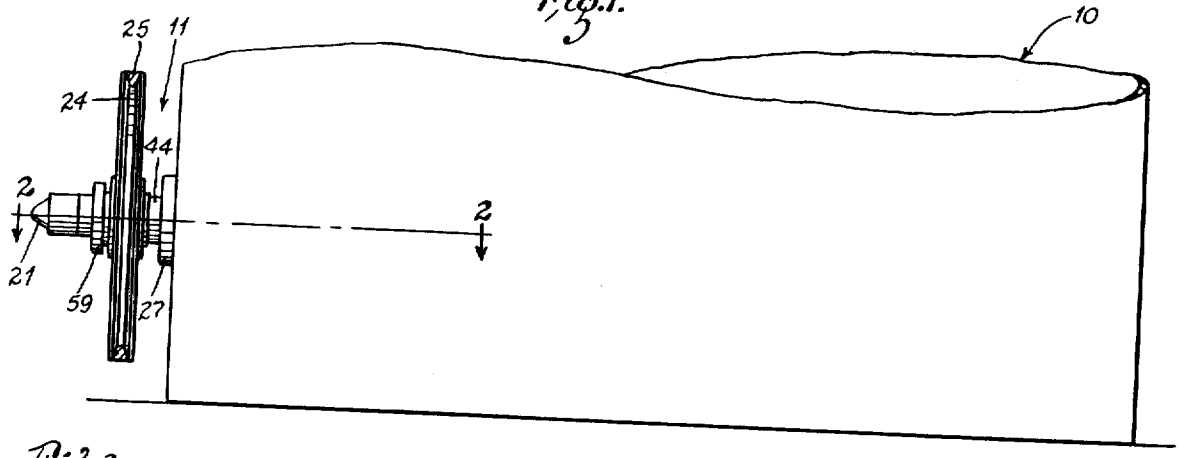


Fig. 3.

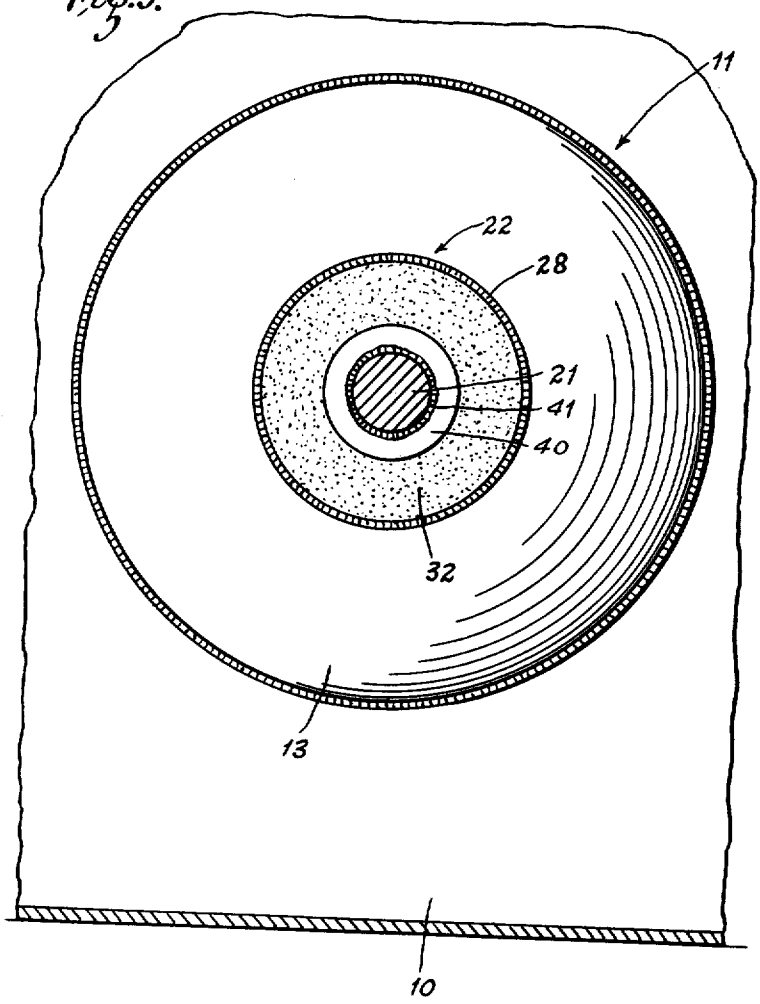


Fig. 4.

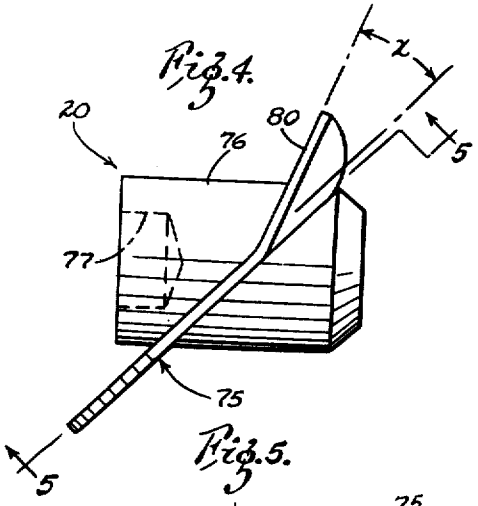
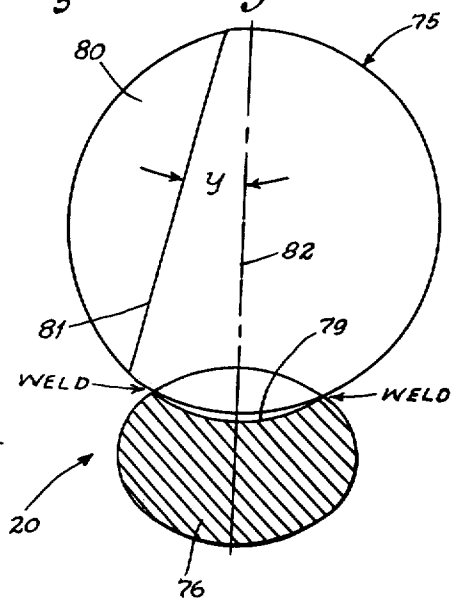


Fig. 5.



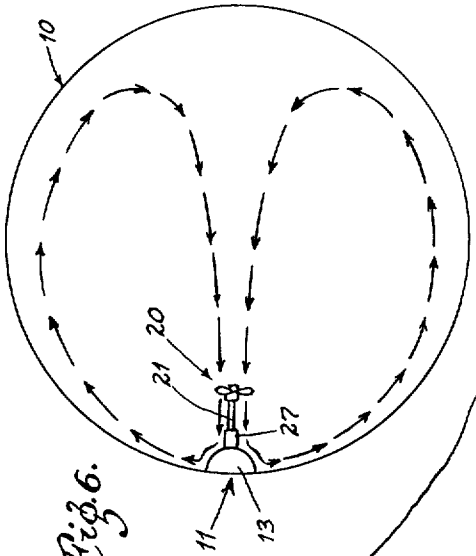

10
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Fig. 6.

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Fig. 2.

AGITATOR AND TANK APPARATUS

SUMMARY OF THE INVENTION

This invention relates to a mixing tank and agitator apparatus, and particularly such apparatus of the horizontal agitator type used for mixing liquid product in relatively large tanks. Such product may for example be sugar solution used in making soft drinks and the like, although the invention could be used to mix other types of liquid product as well.

A problem with mixing large quantities of this type product in relatively large tanks is the difficulty of preventing "dead pockets" where portions of the product remain relatively still as other product moves around it. This makes mixing of the total product difficult and time consuming. This invention solves this problem by providing an agitator and tank assembly which produces movement and agitation of the entire liquid mass to insure thorough mixing.

Generally, the invention comprises a vertical tank having an annular side wall. A housing is mounted in an opening in the side wall of the tank such that the housing extends into the tank and forms a deflecting surface within the tank and a recess in the wall on the outside of the tank. An agitator assembly is mounted partially within the housing recess and includes a shaft extending generally horizontally through the housing. An impeller is mounted on the end of the shaft within the tank. Means are provided for rotating the shaft and impeller in a direction so as to draw the liquid product within the tank from the side of the tank opposite the impeller, past the impeller, and against the deflecting surface of the housing, whereupon the housing directs the liquid in opposite directions around the annular side wall of the tank to meet again at the side opposite the impeller. The result is a continuing flow and thorough mixing of all of the product.

The housing not only provides a deflector for directing the impelled product around the wall of the tank, but also provides a recess in which the mounting means for rotatably mounting the shaft is partially housed. The results are that less of the mounting means extends outwardly from the wall of the tank thus saving space, and the impeller is allowed to extend further toward the center of the tank than would otherwise be possible with a cantilever type shaft.

It is therefore a primary object of this invention to provide a combination tank and horizontal agitator apparatus which produces thorough mixing of a liquid product within a relatively large tank by means of drawing the product into a deflecting surface and directing it in opposite directions around the annular side wall of the tank.

It is another object of this invention to provide such tank and horizontal agitator apparatus that provides an improved means for mounting the agitator in the wall of the tank.

These and other objects of the invention will become apparent from the drawings and detailed description to follow.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation view of a mixing tank and agitator apparatus of this invention;

FIG. 2 is an enlarged view in section taken generally along the line 2—2 of FIG. 1;

FIG. 3 is a view in section taken generally along the line 3—3 of FIG. 2;

FIG. 4 is the side elevation view of the agitator rotor of this invention;

FIG. 5 is a view in section taken generally along the line 5—5 of FIG. 4; and

FIG. 6 is a schematic plan view of a mixing tank and agitator of this invention illustrating, by the arrows shown, the general pattern of movement of the liquid ingredients being mixed within the tank.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

In the drawing there is shown a cylindrical tank **10** for containing the liquid ingredients to be mixed. These ingredients might, for example, include water and sugar for use in the preparation of soft drink syrups, although certainly this invention applies equally to the mixing of other types of liquid product. Mounted in the side of the tank **10** is an agitator assembly **11** of this invention.

A hemispherical housing **13** is mounted in an opening **14** in the side wall of the tank, the housing **13** extending within the tank and having an opening **16** in the center thereof. Thus, viewing the housing **13** from outside the tank wall, the housing defines a generally hemispherical recess **17** in the side wall of the tank **10.** As will be explained, the hemispherical housing **13** acts as a deflector to direct liquid drawn against the deflector by the agitator impeller outwardly around the wall of the tank. It is to be understood that while a hemispherical housing is shown, housings of other shapes could also be used to accomplish this purpose. For example, a frusto-conical section could be used, it being of primary importance that the inner surface of the housing be such as to deflect the liquid around the wall of the tank and also serve as a means for mounting the agitator assembly **11** generally horizontally in the wall of the tank.

The agitator assembly **11** generally comprises an impeller **20** mounted on the end of a shaft **21** extending into the tank. The shaft **21** is mounted in the opening **16** of the housing **13** by means of a mounting assembly **22,** and is rotated in a direction to draw the liquid in the tank against the surface of the housing **13** by means of a pulley **24** and continuous belt **25.** It is to be understood that the belt **25** also engages a pulley of suitable size which, in turn, is connected to the shaft of a suitable motor, such as an electric motor, to supply power for rotation of the shaft **21** and impeller **20.**

The mounting assembly **22** includes an outer cylindrical sleeve **27,** the outer diameter of which is sized to fit the opening **16** in the housing **13,** the sleeve **27** being welded in the opening **16** as shown at **28.** The end of the sleeve **27** toward the impeller **20** is recessed at **30** to receive a seal **32** having an outer surface **33** which sealingly engages the inner surface of the sleeve **27** at the end toward the impeller. The seal **32** has an opening **34** which sealingly engages an outer shoulder **35** of a bearing **36.** The bearing **36** has a surface facing the impeller **20** against which is located a ring **38.**

A flange **40** is attached to the shaft **21** by means of welding **41** or the like, at a location just in front of the ring **38.** A ring **43** is located between the flange **40** and ring **38.** The ring **38** rotates relative to the front surface of bearing **36** upon rotation of the shaft **21** to form a rotating seal therebetween. In a preferred embodiment, the seal **32** may be made of neoprene rubber, the bear-

ing 36 of phenolic graphite, the ring 38 of steel, and the ring 43 of nylon reinforced neoprene rubber, although other suitable materials could be used. The seal 32, bearing 36, and flange 40 cooperate to hold the rings 38 and 43 and flange 40 in rotating engagement and thereby effect the seal.

A second sleeve or quill 44 surrounds and is locked to a portion of the shaft 21 near its back end and extends part way within the back end of the sleeve 27. The sleeve 27 has an inner recess 46 and the sleeve 44 has outer recesses 47 and 48 to receive a rear bearing 49 and a front bearing 50. Between a shoulder 51 formed by the recess 46 in the sleeve 27 and the front bearing 50 is a washer 52 of nylon or other suitable material which prevents any liquid which may get through the front shaft seal, such as when cleaning the agitator assembly, from entering the bearings 49 and 50. The front end of the sleeve 44 is tapered as shown at 54 to push the washer 52 away from the rotating face of the bearing 50. At the back end of the sleeve 27 adjacent the bearing 49 is an annular recess 55 for receiving a retaining ring 56 which holds the bearings 49 and 50 and quill 44 in place. At the bottom of the sleeve 27, at a location just forward of the bearing 50, is an opening 58 for draining any liquid which gets past the shaft seal 32 or rotating seal. The drainage also acts as an indication that the one or both of these seals are leaking.

The pulley 24, a bushing 59, and the quill 44 are locked together by means of a key 60 and bolts 60' (only one such bolt being shown for purposes of illustration) which pass through holes in the flange of the bushing 59 and are threaded into the pulley 24. The key 60 fits into a keyway 61 in the bushing 59 and a keyway 61' in the quill 44. The rear end of the shaft 21 is threaded at 62 and has a keyway 63 for receiving a collar retainer 64. The retainer 64 has a protrusion 65 which extends into a keyway 66 formed at back end of the quill 44 to effectively lock the quill 44 and shaft 21 together in rotational engagement. An internally threaded nut 68 of nylon or other suitable material engages the threaded end of the shaft 21 to hold the retainer 64 in place.

It will be noted that in addition to deflecting the liquid drawn against its surface around the wall of the tank to produce a violent agitation and superior mixing, the hemispherical housing 13 and recess 17 formed thereby allows much of the mounting assembly 22 to be within the recess rather than extending further out from the tank wall. Not only is the result a more compact unit, but also a more efficient agitator. The reason for this is that the bearings can be mounted within the recess 17 and therefore further toward the center of the tank and thus, with the load limitations on a cantilever shaft mounting, allowing the impeller 20 to be positioned further within the tank. This means that the distance between the impeller 20 and the wall of the tank directly behind the impeller is increased by the depth of the housing 13 to provide more room between the impeller 20 and the housing 13 for the liquid to move as it is drawn by the impeller. The result is to produce a more forceful flow of fluid against the housing 13 and thereafter around the wall of the tank.

It will also be noted that the mounting assembly can be disassembled quite easily such as for cleaning the shaft and impeller without disturbing the quill and bearings. This is accomplished by simply removing the nut 68 and retainer 64 while leaving the retaining ring 55 in place. This is particularly important such as where, because of the nature of the ingredients being mixed, strict sanitation laws require frequent cleaning.

In FIGS. 4 and 5 there is shown the impeller 20 of this invention. Although the impeller is preferably of the three-bladed type, the blades located at 120° about the hub, only one blade is shown for purposes of illustration, it being understood that the other two blades are identical to the one shown.

The impeller 20 includes blades 75 mounted about a hub 76 having a recess 77 at one end thereof for receiving the forward end of the shaft 21. The shaft 21 is attached to the hub 76 by any suitable means such as welding 78. The blades 75 are made of circular plates which are mounted in grooves 79 in the side of the hub 76 by such means as welding, the angle of the grooves being preferably no less than approximately 45 degrees relative to the rotating axis of the hub. A portion 80 of the blade 75 is bent backward slightly relative to the plane of the remaining portion of the blade 75. Referring to FIG. 5, the portion 80 is folded along a line 81 which is formed at an angle x relative to a line 82 drawn in the plane of the remaining portion of the blade 75 and connecting the center point of the blade 75 with the center of rotation of the hub 76. The portion 80 is at the forward side of the blade 75 with the folding line 81 extending from approximately the forward end of the groove 79 and in a rearward direction at angle y toward the line 82.

This slight folding of the portion 80 tends to prevent the liquid from sliding outwardly off the blades of the impeller as the impeller is rotated, and instead tends to retain the liquid and move it rearwardly toward the deflector housing 13 for more efficient mixing of the liquid. It has been found, for example, that an angle x of approximately 22½° and an angle y of approximately 13° will produce these desired results.

OPERATION

To operate the tank and agitator assembly of this invention, the impeller 20 is rotated by means of the belt 25, pulley 24 and shaft 21 in such a direction so as to draw the liquid ingredients within the tank 10 from the opposite side of the tank toward the housing 13. Upon striking the housing 13 the liquid ingredients are directed outwardly in all directions and around the cylindrical wall of the tank and back again to the opposite side, whereupon the liquid ingredients meet and are drawn again against the housing 13 by the impeller 20. The general pattern of liquid movement during mixing is illustrated by the arrows in FIG. 6.

The design of the impeller blades 75 tend to retain the liquid and direct it toward the deflector housing 13. Furthermore, the unique construction of the housing 13 and impeller mounting assembly 22 not only provides the deflection necessary to direct the liquid ingredients around the wall of the tank to meet at the opposite side, but also allows much of the mounting assembly to be contained within the recess 17 formed by the housing 13. This allowed the impeller 20 to extend further into the tank 10 on the end of the cantilever mounted shaft 21 so as to provide a greater distance between the impeller 20 and the wall of the tank behind it. This also provides a more compact assembly with less of the mounting assembly extending outwardly of the tank. The result is a very compact and effective agitator assembly which produces violent agitation of the

liquid ingredients within the tank for superior mixing results by means of drawing the liquid against the deflector housing and directing it outwardly around the wall of the tank.

The following table gives the values of certain parameters, namely, impeller diameter, impeller RPM, blade diameter, motor horsepower, and distance from the end of the impeller hub to the tank wall behind the impeller for various quantities of liquid product and tank size for a 61 degree brix solution, which values have been determined to give effective mixing.

Max. Tank Dia.	36"	52"	62"	75"	87"	98"
Max. Tank Volume-Gals.	225	450	900	1400	2600	4150
Approx. Impeller O.D.	8"	9"	10"	11"	12"	13"
Impeller RPM	520–550					
Dia. Each Blade	3.5"	4"	4.5"	5"	5.5"	6"
Motor H.P.	1	1.5	2	3	5	5
Distance From End of Impeller Hub to Tank Wall Behind Impeller	*11"	13"	14"	15"	16"	17"

*Not to Exceed 35% of Tank Dia.

The values shown in this table are by way of illustration and example, and it is to be understood that other parameter values will also work effectively. Also, these values may vary with the brix of the solution.

Hence, there has been described a novel agitator and tank assembly of the horizontal type which produces superior mixing of liquid ingredients within the tank by drawing the liquid by means of a rotating impeller against a deflector housing which directs the liquid outwardly around the wall of the tank.

Various changes and modifications may be made in this invention, as will be readily apparent to those skilled in the art. Such changes and modifications are within the scope and teaching of this invention as defined by the claims appended hereto.

What is claimed is:

1. An agitator and tank apparatus comprising a tank having an annular vertical wall for containing a liquid to be mixed, an agitator having a rotating shaft and an impeller means mounted thereto, means for mounting the agitator in the vertical wall of the tank for rotation of the shaft and impeller means with the impeller means located within the tank and the axis of rotation of the impeller means being generally horizontal, means for rotating the shaft and impeller means in a direction to draw the liquid from the location of the tank opposite the mounting means and move it in a direction toward the mounting means, and deflection means between the impeller and mounting means for directing the impelled liquid outwardly in opposite directions around the annular wall of the tank to meet at the location of the tank opposite the mounting means.

2. The agitator and tank apparatus of claim 1 wherein the mounting and deflector means further comprise a housing mounted in the vertical wall of the tank, which housing extends into the tank, the housing being wider at the location of the wall than that portion of the housing nearest the impeller and having an opening therein, means for mounting the agitator with its shaft extending through the housing opening, the surface of the housing within the tank defining the deflector means.

3. The agitator and tank apparatus of claim 2 wherein the surface of the housing within the tank is a curved convex surface.

4. The tank and agitator apparatus of claim 2 wherein the housing defines a recess in the tank wall within which a portion of the mounting means extends at the exterior of the tank.

5. The tank and agitator apparatus of claim 1 wherein the impeller further comprises a hub mounted to the shaft, and a plurality of blades, each blade having a portion near its leading edge as determined by the direction of rotation of the shaft which is folded back toward the deflection means.

6. The tank and agitator apparatus of claim 5 wherein each blade is pitched at an angle relative to the rotating axis of the shaft of no less than approximately 45°.

7. The tank and agitator apparatus of claim 5 wherein the folded portion of each blade is smaller in area than the remaining portion of the blade, and wherein the folded portion is folded on a line that forms an angle of approximately 13° relative to a line in the plane of the remaining portion of the blade that extends between the center of the blade and the rotating axis of the shaft.

* * * * *