

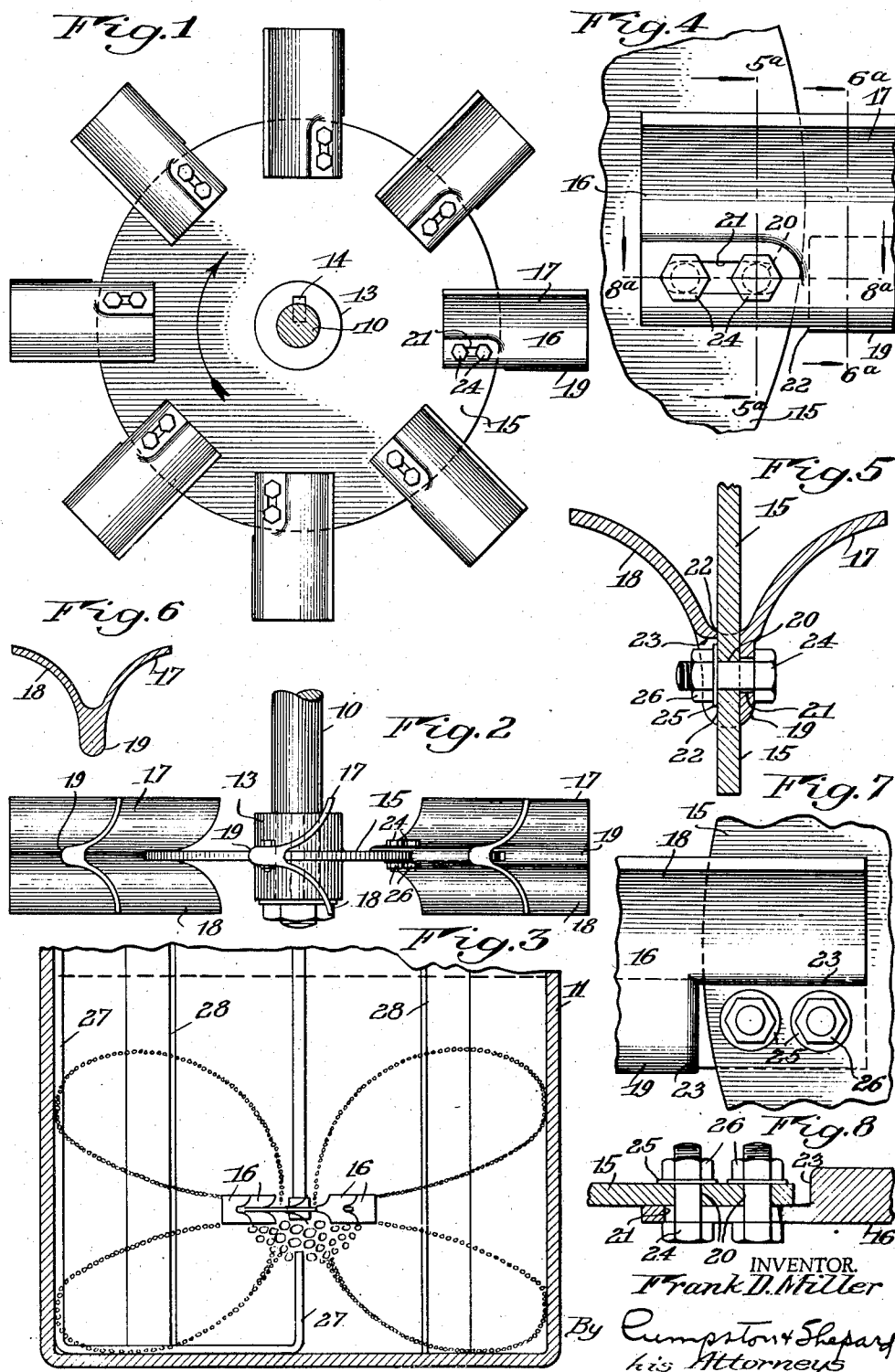
Sept. 18, 1945.

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2,384,952

DISPERSING AGITATOR

Filed Sept. 2, 1942



UNITED STATES PATENT OFFICE

2,384,952

DISPERSING AGITATOR

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Application September 2, 1942, Serial No. 457,025

12 Claims. (Cl. 259—134)

This invention relates to agitators and, more particularly, to the variety adapted for the dispersion of a gas in a liquid or of an immiscible liquid in another. Various processes depend for their efficient performance upon both a fine breaking up and also a wide dispersion of the gas or liquid in the body of the liquid with which they are mixed. These two effects or phases of the problem are equally important, as it will be readily apparent that an agitator capable of producing a small bubble or particle size, but incapable of dispersing the same widely throughout the liquid body, is no better than an agitator which is capable of producing agitation through a wide zone but incapable of producing a small bubble or particle size which is necessary for the fine and thorough dispersion which is often essential. Agitators in the former category are portable homogenizers, hooded turbines and the like, while those in the latter category, for example, are radial paddles, simple turbines, shrouded turbines and marine type propellers.

The turbine type of agitator, for example, has been widely used because of its ability to handle large quantities of liquid in proportion to its diameter. But these are radial flow devices producing current in the container within very narrow vertical limits and, therefore, usually requiring two or more of them arranged in spaced relation to produce sufficiently wide agitation. Moreover, the particle size produced is not small enough to permit their successful use in gas absorption apparatus, since the large gas bubbles pass off too rapidly, while their use with immiscible liquids is inefficient because of the long time required to produce the desired dispersion. An effort has been made to overcome this defect by shrouding the turbine on one or both sides and discharging its radial current against a stationary series of complementary blades, but this expedient has proven to be complicated and expensive in construction, and wasteful of power in proportion to the results accomplished.

Various attempts have been made to devise an agitator capable of accomplishing both of these functions of fine particle size and wide dispersion, as evidenced by the resort in the prior art devices to perforated blades, serrated blade edges and the like, intended to mechanically break down the particles by shearing action, but such devices have been only partially successful because of their low efficiency.

One object of the present invention, therefore, is to provide, for the purposes described, an improved agitator having a type of construction

which is more simple and inexpensive to manufacture, more adaptable in application, and capable of accomplishing the desired dispersion with a high degree of efficiency.

Another object is the provision of an agitator comprising a single impeller capable of rapidly breaking down large bubbles of gas, or drops of immiscible liquid, to minute size and dispersing them repeatedly, intimately and efficiently throughout the liquid contents of a container.

A further object is the provision of an improved agitator such as described, having a construction which is more adaptable to the conditions of particular applications and the power input required.

To these and other ends the invention resides in certain improvements and combinations of parts, all as will be hereinafter more fully described, the novel features being pointed out in the claims at the end of the specification.

In the drawing:

Fig. 1 is a top plan view of a dispersing agitator embodying the present invention;

Fig. 2 is a side elevation of the same;

Fig. 3 is a sectional elevation through a liquid container, showing the agitator therein in side elevation as in Fig. 2;

Fig. 4 is an enlarged top plan view showing the means for attaching one of the blades to the agitator;

Fig. 5 is a sectional view on the line 5a—5a in Fig. 4;

Fig. 6 is a reduced sectional view on the line 6a—6a in Fig. 4;

Fig. 7 is a view similar to Fig. 4 as seen from the opposite side of the agitator, and

Fig. 8 is a sectional view on the line 8a—8a in Fig. 4.

The invention is embodied in the present instance, by way of illustration, in an agitator, or impeller, which is attached to and rotated by the lower end of a driving shaft, 10, preferably arranged to extend vertically and concentrically down into the liquid contents of a cylindrical container 11, the shaft being supported and rotated by motor driving means of any known or suitable variety not requiring illustration. The agitator is preferably positioned well down in the liquid contents of the container, and preferably so that the deep zone of turbulence which it produces is located adjacent the container bottom but without interference thereby.

The agitator comprises preferably, a cylindrical hub 13, Fig. 1, keyed as at 14 to the driving shaft 10. Fixed to the hub is a radially extending

supporting means, or flange, preferably a thin, disk-shaped metal plate 15, which in itself has no appreciable agitating action. The agitating blades are mounted on the periphery of plate 15 and spaced circumferentially from one another, as shown. Any desired number of blades may be employed, depending upon particular conditions, such as the materials employed, the desired intensity of agitation and power input, the relative proportions of the parts, and the like.

In accordance with my invention, each side of the agitator is designed to create a current, or flow, having a radial component and also an axial component, relative to the rotary axis of the agitator and its driving shaft. Each blade 16 is preferably of generally rectangular shape, in plan view, as shown in Fig. 1, comprising a pair of relatively thin plates 17 and 18, which are marginally united as at 19, along the leading edge of the blade, but diverge or flare outwardly from each other toward the trailing edge of the blade, as shown. Such leading edge of the blade is relatively sharp, as shown, and plates 17 and 18 are curved outwardly, for efficiently parting the liquid and causing it to flow in opposite axial directions. The blade may obviously be constructed in various ways, but I prefer to construct it as a one-piece casting of suitable metal, with relatively thin plates 17 and 18 for lightness and economy of material.

The means for securing the blades to the supporting disk 15, is, preferably, a bolted connection, so that each blade is readily detachable, and also radially adjustable on the disk. To this end, disk 15 is formed around its periphery with spaced pairs of bolt holes 20. The holes in each pair are spaced radially a sufficient distance for firmly supporting the blade which is preferably provided with a slot 21, Figs. 4, 5 and 8, for general registration with a pair of holes in the disk. Each blade is slotted inwardly along its leading edge at the end adjacent the disk, as at 22, for insertion on the disk, the periphery of which is received in the slot, with the plates 17 and 18 projecting symmetrically on opposite sides of the plane of the disk. Preferably, one side of the blade is cut away, as at 23, to confine the bearing surface to one side of the disk, and short bolts 24 are inserted through slot 21 and the holes 20 in the disk 24, the parts being secured by washers 25 and nuts 26 which clamp the blades to the disk, as best shown in Figs. 5 and 8.

The slots 21 in the blades for receiving bolts 24 are somewhat longer than the spacing of the bolt sides, to allow for some radial adjustment of the position of the blade on the disk, which affords a convenient means for readily balancing the agitator for smooth rotation, without the grinding or other more difficult expedients commonly employed for that purpose. It will be seen, also, that the blades are readily attached and removed so as to facilitate installation through a relatively small manhole, and also ready repair and replacement.

In the present embodiment, for example, for dispersing a gas in a liquid of substantially the consistency of water, in a container having a diameter of, say, three feet, I prefer to employ a disk having a diameter of about six and one half inches, with eight blades, each having a width in the direction of rotation, of about one and three fourth inches and a length, radially, of about two and one half inches, the overall diameter of disk and blades being about ten inches. It is obvious, however, that a larger number of blades may be

secured to the disk, or, the number here employed may be reduced by omitting one or more pairs of blades selected so as to maintain symmetrical balance of the agitator about its axis. It has been found also that by providing a range of three or more diameters of agitators having substantially the same relative proportions of the parts, the entire range of power input commonly required in this field may be accommodated. Such characteristics make it possible to cover a wide range of power and wide variety of adaptations with a very small investment in patterns and other manufacturing equipment. This adaptable quality of the separately formed and assembled blades effects an important saving also in the quantity of materials required, in addition to the other economies described above.

In operation, the agitator is rotated at speeds preferably between 50 to 300 R. P. M., depending upon the particular work to be accomplished. The outwardly curved blades set up currents on each side of the disk which have both radial and axial components, as schematically indicated in Fig. 3, the outward curvature serving to widen the zone of axial dispersion. On each side of the disk, the currents flow radially and flare away from the plane of the disk, until they strike the sides of the container and circle back to the agitator in response to the reduced pressure adjacent the central portion of the disk caused by such outward currents, the impeller having the action of a centrifugal pump runner of considerable efficiency. It has been found that this type of circulation produces, at the trailing edges of the blades, a state of cavitation, or reduction in pressure, into which the larger bubbles of gas and drops of immiscible liquids are carried by the pressure differences and by incidental eddy currents. The gaseous bubbles are recirculated below the agitator, some of them pass into and are recirculated in the current above the agitator, and, during each passage over the trailing edges of the blades, they tend to be drawn into the cavitation zones behind them where they are repeatedly reduced in size. It has been found that bubbles of gas or drops of immiscible liquid continue to be recirculated by the described currents until they are finely divided and intimately dispersed through the container contents with a high degree of efficiency.

The axial components of the circulation on each side of the agitator result in a turbulent zone of substantial depth, as shown, so that but a single agitator is necessary to accomplish a depth of dispersion requiring two or more vertically spaced agitators of some prior designs, such, for example, as the known type of impeller having vertical, radial blades. The supporting disk 15 permits the lower plates or flanges 18 of the blades to continue dispersion even after the action of the upper flanges 17 is interrupted by the development of a vortex in the liquid contents of the container at low liquid levels.

The gas or liquid to be mixed with the container contents may be introduced in any suitable manner, as for example, through the pipe 27, Fig. 3, discharging centrally below and adjacent the agitator, from which point an added gas, for example, is drawn into the circulation described above.

An agitator so constructed presents, on each of its faces, an unobstructed, open throat for the intake of the fluids along the axis to the supporting plate 15 and thence to the blades, and so handles the fluids much more efficiently, for ex-

ample, than the known fan type agitator in which the radial blades extend to the hub. The present agitator is thus capable of the useful absorption of about 30% more horsepower than a fan type agitator of the same diameter and speed. That is, an agitator of the present construction, with a diameter of twenty-four inches, may be used to replace a fan type agitator of thirty inches, while the detachability of the blades would allow it to pass through a twenty inch manhole, as against the requirement of a thirty inch manhole for an agitator of the fan type.

Vertical baffle plates of known or any suitable nature may be employed, as at 28, to retard circular motion of the container contents as a whole, as well understood in the art.

It will be seen, therefore, that the invention accomplishes its objects, and while I have herein described a preferred embodiment in detail, it is to be understood that such description is intended by way of illustration, rather than by way of limitation, as it is contemplated that various modifications in the construction and arrangement of the parts will readily occur to those skilled in the art, within the spirit of the invention, as set forth in the appended claims.

I claim:

1. A dispersing agitator for rotation in the liquid contents of a container, comprising a driving shaft having a free end extending downwardly into said liquid contents, means for attachment to said shaft, supporting means extending radially from said attaching means, and a series of unshrouded blades mounted in circumferentially spaced relation on said supporting means, each of said blades having radially extending opposite sides diverging from each other from the leading toward the trailing edge of the blade to form currents flowing in radial and opposite axial directions in said contents and a dispersing cavitation zone in rear thereof.

2. A dispersing agitator for rotation by a driving shaft in the liquid contents of a container, comprising means for attachment to said shaft, supporting means extending radially from said attaching means, a series of unshrouded blades mounted in circumferentially spaced relation on said supporting means, each of said blades comprising a pair of radially extending plates marginally connected with each other along the leading edge of the blade and curving outwardly toward the trailing edge thereof to form currents flowing in radial and opposite axial directions in said liquid contents and a dispersing cavitation zone extending inwardly between said plates from the rear thereof, and means for detachably connecting said blades to said supporting means.

3. A dispersing agitator for rotation by a driving shaft in the liquid contents of a container, comprising means for attachment to said shaft, radially extending supporting means, a series of unshrouded blades spaced from each other circumferentially of said supporting means, each of said blades comprising a pair of plates marginally connected with each other along the leading edge of the blade and curving outwardly away from each other toward the trailing edge of the blade to form radially and axially directed currents in said liquid and a dispersing cavitation zone in rear thereof, and means adjacent the leading edge of each of said blades for detachably securing it to said supporting means.

4. A dispersing agitator for rotation by a driving shaft in the liquid contents of a container, comprising means for attachment to said shaft,

radially extending supporting means, a series of unshrouded blades spaced from each other circumferentially of said supporting means, each of said blades comprising a pair of radially extending plates marginally connected with each other along the leading edge of the blade and curving outwardly away from each other toward the trailing edge of the blade to create liquid currents extending in both radial and axial direction and form a dispersing cavitation zone in rear of the blade, and means securing each blade to said supporting means for adjustment radially thereof.

5. A dispersing agitator for rotation by a driving shaft in the liquid contents of a container, comprising a hub for attachment to said shaft, a radially extending disk on said hub, and a series of unshrouded blades mounted on the periphery of said disk in circumferentially spaced relation, each of said blades having opposite sides extending radially outwardly substantially beyond the periphery of said disk and inclined outwardly away from each other in a rearward direction from the leading toward the trailing edge of the blade to create currents in said liquid extending in radial and axial directions and form a dispersing cavitation zone in rear thereof.

6. A dispersing agitator for rotation by a driving shaft in the liquid contents of a container, comprising a hub for attachment to said shaft, a radially extending disk shaped plate on said hub, a series of unshrouded blades spaced circumferentially from each other on the periphery of said plate, each of said blades comprising a pair of radially extending plates marginally connected with each other along the leading edge of the blade and curving away from each other toward the trailing edge thereof to circulate the liquid radially and axially in diverging directions and form a dispersing cavitation zone in rear thereof, and means for detachably securing said blades to said plate.

7. A dispersing agitator for rotation at suitable speed by a driving shaft in the liquid contents of a container, comprising a hub for attachment to said shaft, a radially extending circular plate on said hub, a series of unshrouded blades spaced circumferentially from each other on the periphery of said plate, each of said blades comprising a pair of radially extending plates marginally connected with each other along the leading edge of the blade and curving outwardly away from each other toward the trailing edge thereof to create radially and axially directed currents in said liquid and form a dispersing cavitation zone in rear thereof, and means for detachably securing each of said blades to said disk for adjustment radially thereof.

8. A liquid agitator for rotation by a driving shaft in the liquid contents of a container, comprising a hub for attachment to said shaft, a radially extending flange on said hub, a plurality of blade seats on said flange corresponding to the maximum number of blades to be employed, said seats being spaced from one another about the periphery of said flange and lying substantially in the radial plane thereof and each provided with means for securing a blade thereto, a predetermined number of radially extending unshrouded blades, each provided with a seating portion for cooperation with one of said flange seats, each of said blades having opposite sides extending radially outwardly substantially beyond the periphery of said flange and inclined outwardly away from each other in a

rearward direction from the leading toward the trailing edge of the blade to create currents in said liquid extending in radial and axial directions and form a dispersing cavitation zone in rear thereof, and means cooperating with the securing means of said flange seats for detachably and adjustably securing said blades to said seats to provide for the application thereto of a predetermined number of blades and for varying the radial distances of said blades from said shaft for balancing said agitator thereon.

9. A liquid agitator for rotation by a driving shaft in the liquid contents of a container comprising a hub for attachment to said shaft, a radially extending flange on said hub, a plurality of blade seats on said flange corresponding to the maximum number of blades to be employed, said seats being spaced from one another about the periphery of said flange and lying substantially in the radial plane thereof and each provided with means for securing a blade thereto, a predetermined number of unshrouded, radially extending blades each provided with a seating portion lying substantially in the radial plane of said flange for cooperation with one of said seats thereof, said blades being arranged to produce radially and axially directed currents in said liquid, and means cooperating with the securing means on said seats for detachably and adjustably securing said blades thereto to provide for the application to said flange of a predetermined number of blades and for adjusting said blades to different radial distances from said shaft for balancing said agitator thereon.

10. A liquid agitator for rotation by a driving shaft in the liquid contents of a container, comprising a hub for attachment to said shaft, a radially extending flange on said hub, a plurality of blade seats on said flange corresponding to the maximum number of blades to be employed, said seats being spaced from one another about the periphery of said flange and lying substantially in the radial plane thereof and each provided with means for securing a blade thereto, a predetermined number of unshrouded, radially extending blades each provided with a seating portion lying substantially in the radial plane of said flange for cooperation with one of said seats thereof, said seating portion being located intermediate the opposite sides of said blades with said sides projecting from opposite sides of said flange to produce radially and axially directed currents in said liquid and said blades having the inner ends thereof spaced at a substantial distance from said shaft to provide an unobstructed passage for the intake of said fluid, and means cooperating with the securing means of

said flange seats for detachably and adjustably securing said blades to said seats to provide for the application to said flange of a predetermined number of blades corresponding to the amount of agitation to be produced and for locating said blades at different radial distances from said shaft for balancing said agitator thereon.

11. A liquid agitator for rotation by a driving shaft in the liquid contents of a container, comprising a hub for attachment to said shaft, a radially extending, disk shaped plate on said hub, a plurality of blade seats on a face of said plate corresponding to the maximum number of blades to be employed, said seats being spaced from one another about the periphery of said plate and each provided with bolt receiving holes for securing a blade thereto, a predetermined number of unshrouded, radially extending blades each provided with a seating portion for cooperation with one of said flange seats and with bolt receiving openings therein, said seating portion lying intermediate the opposite sides of said blade with said sides projecting from the opposite sides of said plates to produce radially and axially directed currents in said liquid, each of said blades having the inner end thereof spaced at a substantial distance from said shaft to provide an unobstructed passage for the intake of fluid, and bolt means for detachably and adjustably securing said blades to said flange seats to provide for the application thereto of a predetermined number of blades corresponding to the amount of agitation to be produced and for locating said blades at different radial distances from said shaft for balancing said agitators thereon.

12. Liquid agitating means comprising a vertical cylindrical container, a rotary shaft having a free end depending into the liquid contents of said container, attaching means adjacent the end of said shaft, supporting means extending radially from said attaching means, and a series of unshrouded blades mounted in circumferentially spaced relation on said supporting means, the outer ends of said blades being located at a radial distance from the axis of said shaft not greater than one-half the radius of said container so as to be substantially spaced from the walls thereof, and each of said blades having radially extending opposite sides diverging from each other from the leading toward the trailing edge of the blade to form currents flowing in radial and opposite axial directions in said liquid and a dispersing cavitation zone extending inwardly between said opposite sides from the rear thereof.

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