Oct. 28, 1952 K. S. VALENTINE 2,615,697

DISPERSION APPARATUS

Filed Dec. 10, 1949 2 SHEETS—SHEET 1

FIG. 1

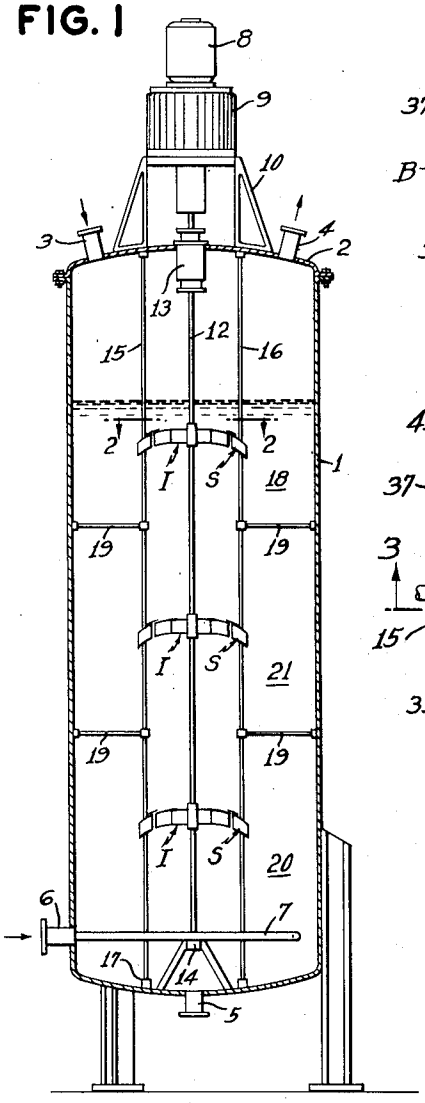


FIG. 3

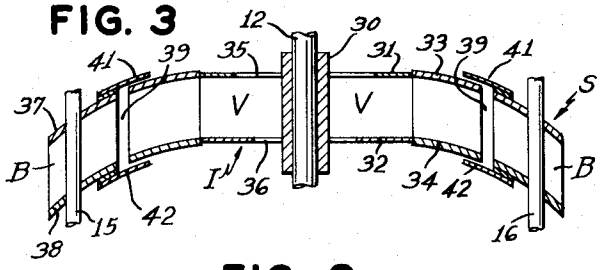


FIG. 2

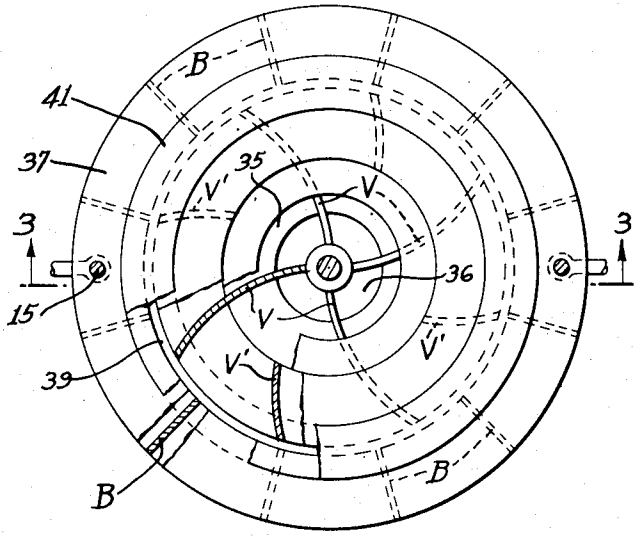
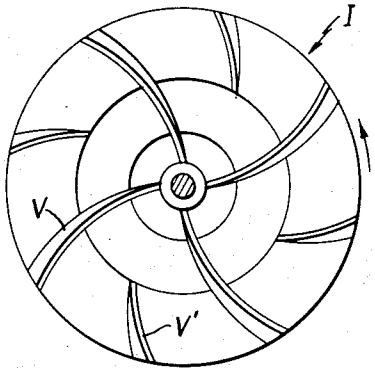


FIG. 4



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FIG. 5

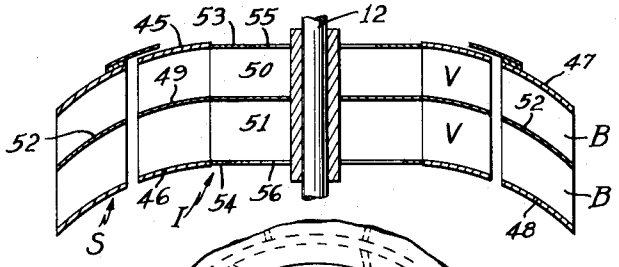


FIG. 6

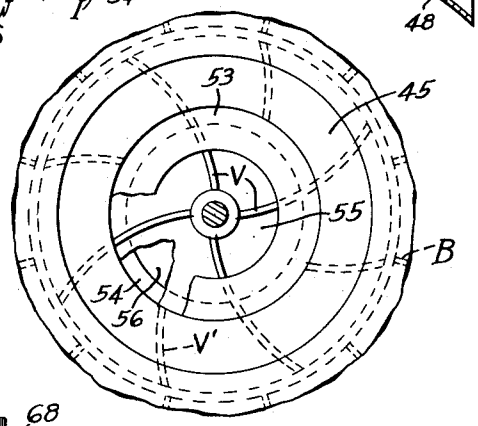


FIG. 7

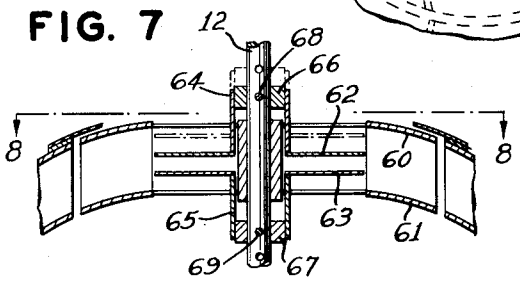
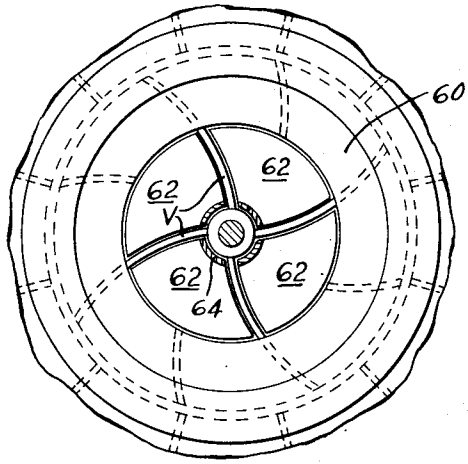


FIG. 8



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UNITED STATES PATENT OFFICE

2,615,697

DISPERSION APPARATUS

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Application December 10, 1949, Serial No. 132,231

6 Claims. (Cl. 261—93)

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This invention relates to apparatus for the dispersion of gas in liquids and has for its object the provision of an improved apparatus for this purpose. My invention provides apparatus including at least one impeller-stator unit or combination operatively mounted within a confining vessel for the gas and liquid which effects an efficient mixture of gas and liquid resulting in improvements in dispersion. The unit of my invention comprises an efficient impeller disposed to discharge the liquid and gas radially into a surrounding stator having a downwardly curved peripheral portion and stationary blades which shear the liquid and gas, causing great turbulence and intermixing.

The invention comprises a container for the liquid and gas having mounted therein at least one, and preferably several, impeller-stator units each comprising an impeller rotatably mounted on an upright shaft, and a surrounding stator. The impeller-stator combination is characterized by spaced plates mounted on the impeller and stator in mating relation and providing contiguous lateral spaces. The impeller plates are more or less horizontally disposed and the plates of the stator are preferably curved downwardly at its periphery and the liquid and gas are forced to flow outwardly and downwardly. The plates of the impeller have centrally disposed openings for the entrance from below and above of the liquid and gas mixture which is sucked into the central part of the impeller and forced to flow through the lateral spaces. The invention comprises any suitable means to vary the sizes of the openings. To this end I may provide a hub for the impeller on which are mounted interior segmental plates at the openings with means for adjustment to vary the sizes of the openings and the rate of flow of liquid. I may provide any other suitable means to vary the openings in the plates, such as the diaphragm opening of a camera, or rings of suitable width disposed over the openings. The openings may be adjusted individually or jointly and from a means at the exterior of the container, if desired.

I prefer to employ an impeller having blades which are slightly curved and covered from the periphery to the central opening which is smooth to effect a non-turbulent whirling of the liquid at the intake. The whirling intake creates a good flow of liquid without turbulence and therefore induces a smooth high rate of flow of gas into the top of the impeller. The curved impeller blades induce a smooth flow of the mixture into the lower opening of the impeller. The impeller

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blades may be set at a small angle, say, 5° to 6°, to deflect the liquid downwardly. By regulating the areas of the upper and lower intake openings in the impeller, the zones of liquid and gas located above and below the impeller level may be given any desired degree of mobility or quiescence. Also, the top and bottom intake quantities may be balanced.

In order to effect a better control over the flow of liquid through the contiguous spaces of the impeller-stator, I prefer to provide a lip over the area between the impeller and stator plates, preferably attached to the stator, and I may attach a lip to either the upper plate or the lower plate, or to both. The shrouds prevent an upper escape of gas and cause all material discharged from the impeller to be directed through the space between the stator plates, thus providing a maximum of shear.

In another embodiment of the invention, I provide one or more partitions between the plates of the impeller and stator to form upper and lower sections therein. I may extend the partition to, or approximately to, the hub to serve as a baffle to prevent undue intermingling of the impeller streams entering from above and below.

The partition may be provided with means for vertical adjustment upward or downward to vary the relative amounts of gas-liquid mixture circulated and a central opening may be provided in the partition which may be adjustable to vary the rate of exchange of flow between the upper and lower parts of the impeller. It is very often desirable to use a double impeller-stator unit instead of two single ones; for instance, in containers where the height is much less than the diameter and there is no room for two impeller-stator units.

While the apparatus of the invention is intended for general application in the dispersion of a gas in a liquid, it is especially efficacious for use in operations in which the gas is absorbed by, or reacts with, the liquid as in the hydrogenation of fats and oils, or with a solid suspended in the liquid.

The apparatus of the invention effects a depressing and re-depressing of the gas, overcoming its natural tendency to rise and to separate partially from the liquid, by causing all or the major portion of the mixture including the finely dispersed gas to circulate rapidly and repeatedly in an outward and downward direction and thence in an inward and upward direction in a broad sweep, thus following an extended path of travel.

These and other objects of the invention will

be better understood after considering the following discussion taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a sectional elevation of a gas dispersion apparatus embodying the invention;

Fig. 2 is an enlarged plan view at 2—2 of Fig. 1;

Fig. 3 is an enlarged sectional view taken at 3—3 of Fig. 2;

Fig. 4 is a plan view, with the upper plate removed, of a modified form of impeller blades;

Fig. 5 is a vertical sectional view of a modified form of impeller-stator unit of the invention;

Fig. 6 is a plan view of the unit of Fig. 5;

Fig. 7 is a vertical sectional view of another embodiment of impeller-stator unit of the invention, and

Fig. 8 is a plan view of the impeller-stator unit of Fig. 7.

The apparatus illustrated in Figs. 1, 2, and 3 comprises a container 1 closed at the top with a removable cover 2 in which are ports 3 and 4 for the supply of liquid and the removal of gas respectively. The port 5 at the bottom is for the removal of treated liquid and the port 6 with its connected manifold 7 are for introducing a gas into a liquid.

The motor 8 and speed-reduction gear unit 9 are mounted by the frame structure 10 on the top of the cover. The drive shaft 12 passes through the stuffing box 13 in the cover and is held in a fixed position at the bottom by the bearing 14. At spaced intervals along the shaft the impellers I are mounted to rotate therewith. The supporting rods 15 and 16 are attached to the cover with the lower ends secured in openings in the blocks 17 and 18. The stators S are attached to the rods and the horizontally disposed rods 19 extend from the wall of the container and are attached to the rods 15 and 16 which they support in proper alignment. The entire assembly of elements attached to and supported by the cover are removable upwardly from the container on removal of the cover.

Figs. 2 and 3 illustrate an impeller-stator unit such as is used in Fig. 1. The impeller comprises a hub 30 keyed to the shaft 12 with radially disposed and preferably curved impeller vanes V to which the flat interior annular cover plate sections or rings 31 and 32 are attached. The exterior annular upper and lower cover plate sections 33 and 34 are also attached to the vanes. The short peripheral intermediate vanes V' are merely attached to the plates 33 and 34. The rings 31 and 32 have centrally located inlet holes or openings 35 and 36 respectively for the entrance of liquid and gas from above and below. The size of the openings 35 and 36 may be changed by substituting the rings for rings having different sizes of openings.

The stators comprise a plurality of radially and vertically disposed blades B which are secured inside the upper and lower cover plates 37 and 38. The rods 15 and 16 are attached to these cover plates and hold the stators in position. The downwardly curved shape of the stator is a continuation of the downwardly curved peripheral portion of the impeller, the respective cover plates being in mated relation with a small clearance space 39 therebetween. In order to prevent an undue passage of gas through the space 39 the upper and lower lips 41 and 42 are attached to the plates 37 and 38 respectively.

The uppermost stator is preferably located in the container so as to provide for an appreciable depth of liquid thereabove and a relatively greater depth of gas. The lowermost impeller-stator unit is located a sufficient distance above the bottom of the container to permit relative quiescence where the treated liquid leaves through port 5.

In the modified form of impeller shown in Fig. 4, the vanes V and V' are inclined from the vertical a slight amount, for example, from 5° to 6°, to aid in directing the downward movement of the mixture.

In the modification of impeller-stator unit illustrated in Figs. 5 and 6, the upper and lower cover plates 45 and 46 for the impeller and the upper and lower cover plates 47 and 48 for the stator are similar to those illustrated in Figs. 1 to 3. In this modification, however, a partition 49 is mounted in the impeller and extends from the hub to the periphery. I may, however, provide an annular opening at the hub for the flow of some liquid and gas between the two lateral spaces 50 and 51 in the impeller. The partition 52 is mounted in the stator and is shaped and located to effect a continuation of the curved shape of the peripheral portion of the partition 49. Partitions 49 and 52 may be spaced at different positions with respect to cover plates 45 and 46 and 47 and 48 respectively. The exterior covers and partition are preferably in substantial parallelism. The removable rings 53 and 54 provide a means for adjusting the sizes of the openings 55 and 56 respectively. The space between the impeller and stator may be covered at either the top or bottom, or both, with lips 57 as in Fig. 2. A double impeller-stator unit of the type illustrated in Figs. 5 and 6 is particularly useful in relatively short containers in which but a single stage is used. For example, in a container having a height about one-third the height of container 1, one double impeller-stator unit may be used very effectively.

Figs. 7 and 8 illustrate a modification of the impeller of Figs. 1 to 3 in which the central openings of upper and lower cover plates 60 and 61 are each individually adjustable by closure means movable upward and downward to vary the flow of gas-liquid mixture into the impeller from above and below. As best shown in Fig. 8, the closure means are in the form of segments 62 and 63 shaped and proportioned to be moved upward and downward in the quadrants between the vanes V. The inner edge portions of the segments are attached to sleeves 64 and 65 which are in turn attached to rings 66 and 67 in close slidable contact with the shaft 12. These rings may be slid to any desired position and secured to the shaft by pins 68 and 69 inserted in holes at spaced intervals on the shaft. It will be apparent from the foregoing discussion that the segments may be moved away from each other to provide the minimum openings at the top and bottom of the impeller and may be moved towards each other to provide the maximum openings.

In the operation of the apparatus of the invention illustrated in Fig. 1, liquid or a liquid-solid mixture enters the container through port 3 and the treated liquid leaves through port 5. The liquid is maintained at a level above the upper impeller-stator unit. Gas enters through port 6 and manifold 7 and the gas which has not combined with, or been absorbed by, the liquid passes out through port 4. In each unit the mixture of liquid and gas enters the impeller from both the top and bottom and is discharged outwardly and downwardly. Some of the liquid from each unit flows upwardly and both streams flow in a loop back to the center of the impeller creating a moving body of fluid somewhat in the shape of a doughnut. The uppermost impeller draws the liquid into the cen-

ter creating a vortex which draws gas from the space above the liquid and intermixes it with the liquid. As the general mass of the liquid moves downwardly and the gas moves upwardly in countercurrent relation, the liquid and gas are subjected to several stages of very violent and effective intermixing which is repeated many times depending on the retention time in the container. The invention may also be used for batch operations.

I claim:

1. Apparatus for the dispersion of a gas in a liquid which comprises a container, means for introducing gas into the lower portion of the container and a liquid into the upper portion of the container, at least one combination stator and impeller unit in the container, upper and lower plates on the impeller with the impeller blades between, a shaft for the impeller, segmental plates adjustable upward and downward on the shaft between the impeller blades to vary the size of upper and lower openings for the impeller at its center for the entrance of liquid and gas, annular upper and lower plates for the stator which are spaced apart to provide a lateral space contiguous with the space between the plates of the impeller, blades mounted between the plates of the stator which effect a shearing of the liquid discharged outwardly from the impeller, the peripheral portion of the stator being spaced inwardly from the container and curved downwardly to direct the liquid from the stator in an outward and downward direction, and an annular lip over the space between the impeller and the stator to suppress upward escape of fluids.

2. Apparatus according to claim 1 which comprises an annular lip attached to the stator and extending a short distance inwardly over the upper plate on the impeller.

3. Apparatus for the dispersion of a gas in a liquid which comprises an impeller-stator unit, the impeller having removable upper and lower rings which are substantially parallel and generally horizontally disposed and impeller blades mounted between the rings, said rings having upper and lower inlet openings for gas and liquid at their centers respectively which are variable on changing said rings, upper and lower impeller plates attached to the blades and concentrically disposed with respect to said rings,

a space therebetween, the stator having upper and lower plates which are curved downwardly and spaced apart, the space being contiguous with the space of the impeller, the impeller plates and rings being mounted exteriorly of the impeller blades and disposed centrally of the stator plates, upper and lower annular spaces between the plates of the impeller and the plates of the stator, a lip over the space between the upper plates of the impeller and the upper plates of the stator to prevent an undue passage of gas through the space, and a container in which the unit is mounted having a wall portion spaced from the peripheral portion of the stator, whereby rotation of the impeller sucks liquid and gas through the openings and discharges a mixture thereof through the space between the stator plates and in the direction of the container wall portion.

4. Apparatus according to claim 3 which comprises a lip over the space between the lower plates of the impeller and the lower plates of the stator.

5. Apparatus according to claim 3 which comprises a lip attached to the stator which extends over the space between the stator and the impeller.

6. Apparatus according to claim 3 which comprises an impeller with the peripheral portion of the blades and plates curved downwardly and the blades inclined.

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