United States Patent

Nold

[15] **3,676,983**

[45] **July 18, 1972**

[54] **APPARATUS AND METHOD FOR DEGASSING A LIQUID**

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[22] Filed: **Feb. 14, 1971**

[21] Appl. No.: **112,698**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 59,110, July 29, 1970.

[52] **U.S. Cl.** **55/192,** 23/259

[51] **Int. Cl.** **B01d 19/00**

[58] **Field of Search** 23/253, 259; 55/15, 36, 52, 55/55, 56, 199, 203; 259/DIG. 46

[56] **References Cited**

UNITED STATES PATENTS

2,908,652	10/1959	Forrester	55/52
2,376,221	5/1945	Baker	55/52 X
2,350,534	6/1944	Rosinger	259/DIG. 46
3,160,138	12/1964	Platzman	55/52 X
2,180,051	11/1939	Hickman	55/52 X
2,518,758	8/1950	Cook	259/DIG. 46
2,784,150	3/1957	Rose et al.	259/DIG. 46
3,211,433	10/1965	Chrostowski et al.	259/DIG. 46
3,529,405	9/1970	Ashbrook	55/277 X

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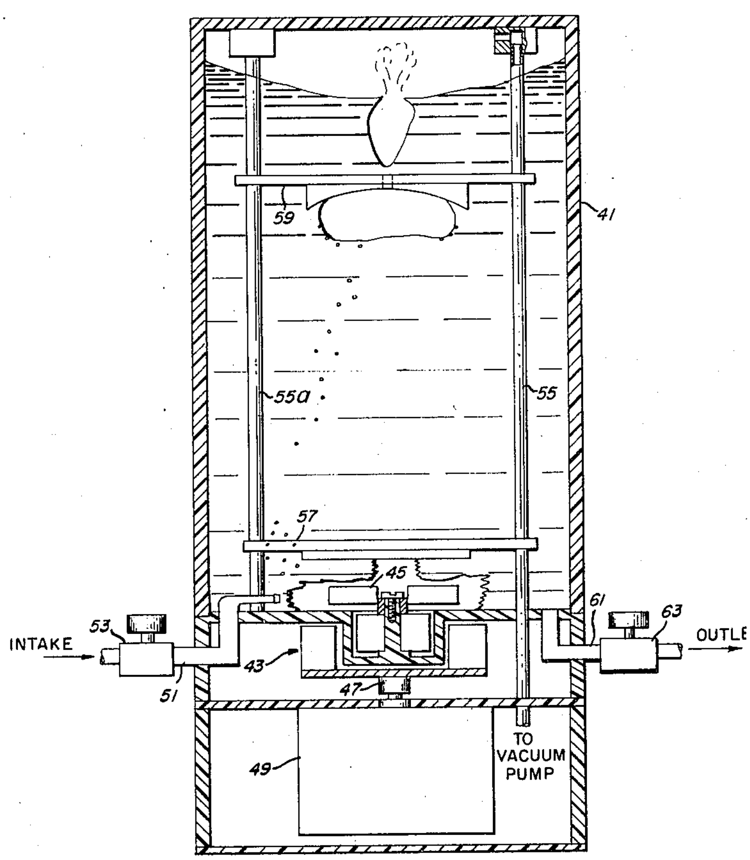
[57] **ABSTRACT**

Apparatus and method for removing entrapped gases from liquids by, simultaneously, mechanically agitating the liquid to be processed and drawing a partial vacuum over the free surface of such liquid.

2 Claims, 4 Drawing Figures



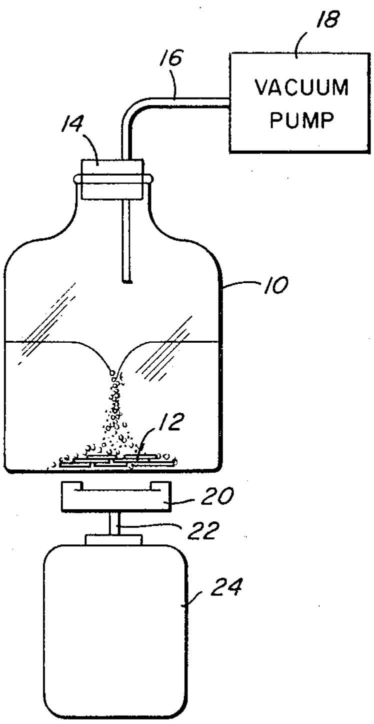


FIG. 1

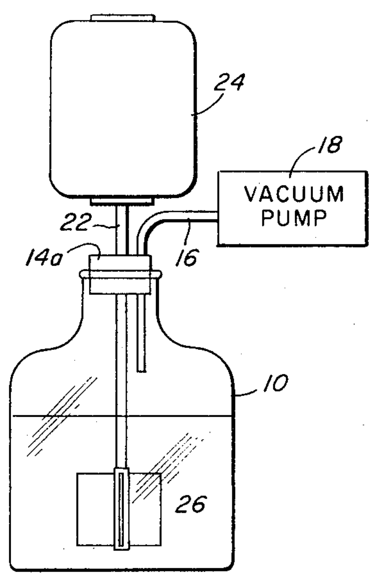


FIG. 2

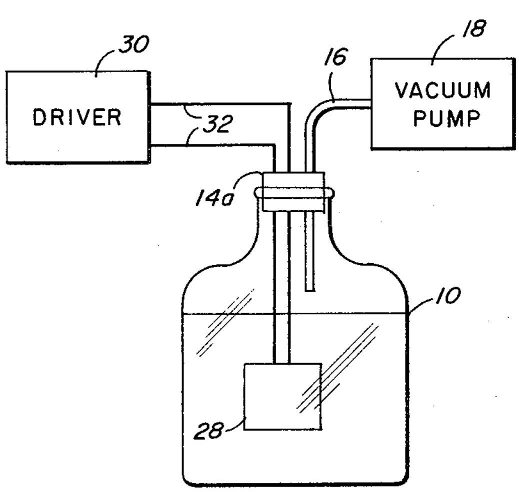


FIG. 3

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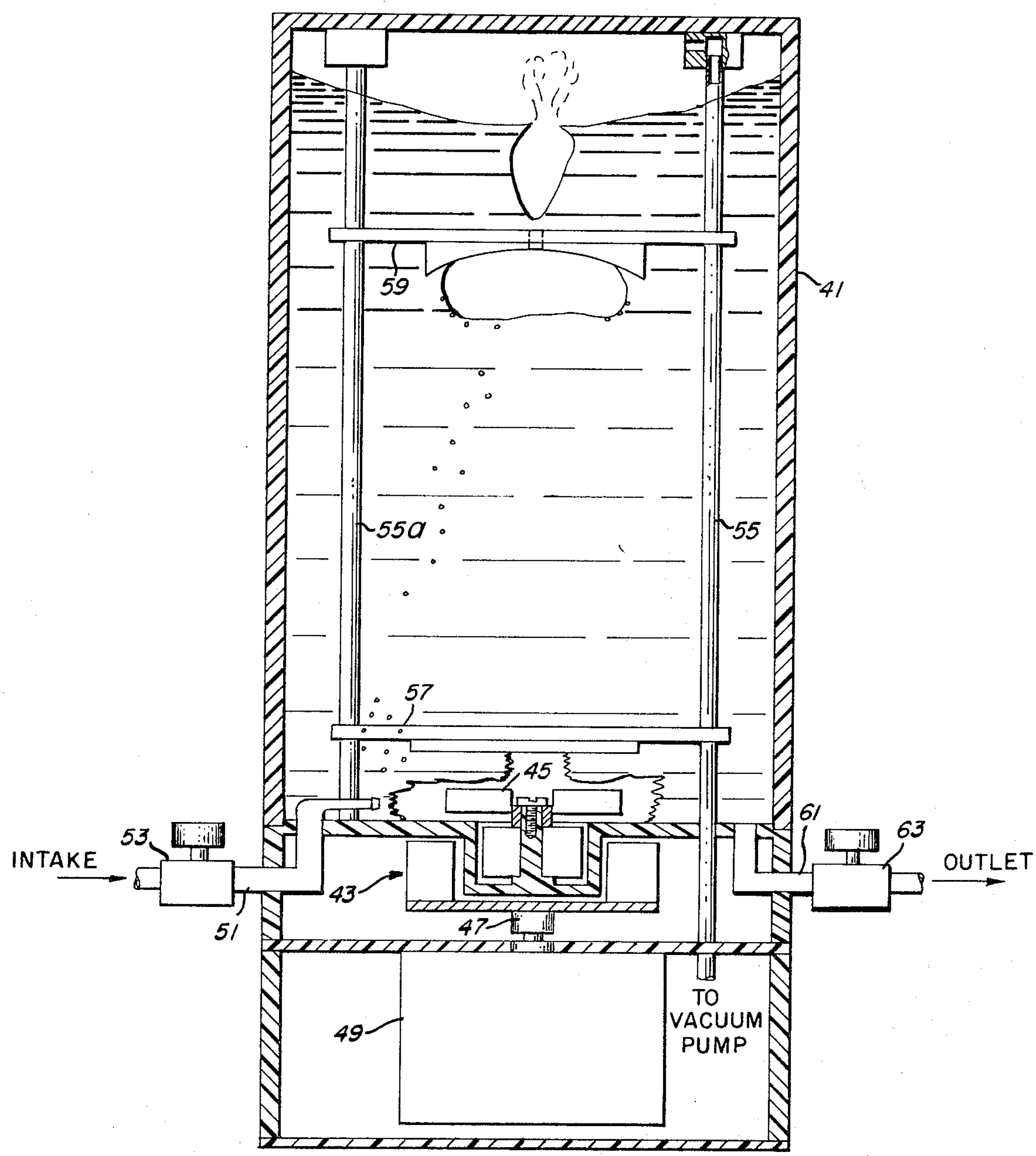

FIG. 4

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APPARATUS AND METHOD FOR DEGASSING A LIQUID

CROSS-REFERENCES TO RELATED APPLICATIONS

This is a continuation-in-part of application Ser. No. 59,110, filed July 29, 1970.

BACKGROUND OF THE INVENTION

This invention pertains generally to purifying apparatus and method and particularly to apparatus and method for degassing liquids.

It is known in the art that air, or other kinds of gases, may be removed from liquids, such as water, whenever the concentration of a gas in a liquid must be reduced. For example, in the testing of hermetic seals it is common practice to immerse a sealed device in water and then to observe whether or not air bubbles originate at the seal. In such an application it is, of course, highly desirable that any air in the liquid be removed before testing begins in order to avoid masking of the effect being observed.

The removal of most of the entrapped gases from a liquid is ordinarily accomplished by placing the liquid in a vacuum flask and then, simultaneously, heating the liquid and drawing a vacuum. In practice such a process permits the concentration of entrapped gases to be reduced to the order of three to four parts per million without too much difficulty. While such a concentration is sufficiently low for many applications, it is sometimes necessary to reduce the concentration even more. To accomplish such an end with known processes it is necessary to recycle and to use a hard vacuum. Even when 3 to 4 parts per million of entrapped gas is tolerable, the fact that the liquid is heated normally causes difficulty, it being evident that the de-aerated liquid must usually be cooled before use. Such a requirement obviously makes it necessary to provide a heat exchanger of some type or other in the system.

It is a primary object of this invention to provide improved apparatus and method for removing entrapped gases from a liquid.

Another object of this invention is to provide apparatus and method for removing entrapped gases from a liquid which operate without any requirement of heating the liquid.

SUMMARY OF THE INVENTION AND DESCRIPTION OF THE DRAWING

These and other objects of this invention are attained generally by placing the liquid to be processed in a vacuum flask and then, while drawing a vacuum, violently agitating the liquid. For a more complete understanding of this invention, reference is now made to the detailed description of the accompanying drawings in which:

FIG. 1 is side view of a preferred embodiment of this invention illustrating the contemplated principle of agitating and drawing a vacuum to de-aerate a liquid;

FIG. 2 is an alternative embodiment of this invention;

FIG. 3 is still another alternative embodiment of this invention; and

FIG. 4 is a cross-sectional view of another embodiment of this invention, such view showing a quantity of partially processed liquid.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, it may be seen that a liquid (not numbered) to be processed is placed in a vacuum flask **10** along with a number of magnetizable rods **12**. A stopper **14**, through which a tube **16** passes as indicated, closes the mouth of the vacuum flask **10**. The tube **16** in turn is connected to a vacuum pump **18**. Adjacent to the bottom of the vacuum flask **10** is a C-shaped permanent magnet **20** which in turn is mounted in any convenient manner on the rotor shaft **22** of a motor **24**.

It may be seen that when the motor **24** is energized, the C-shaped permanent magnet **20** is caused to rotate and that the magnetic field therefrom couples through the bottom of the vacuum flask **10** to the magnetizable rods **12**. The latter then are caused to rotate, thereby causing the liquid within the vacuum flask to be agitated. The speed of the motor **24** may be varied within wide limits; I have found, however, that a speed between 1,200 and 1,800 rpm gives good results. In any event, as the liquid is agitated, gases entrapped in the liquid are freed and are removed by the vacuum pump **18** through the tube **16**. The vacuum pump **18** may be of any conventional construction; I have found even that satisfactory results may be attained by using tube **16** as a Venturi tube to provide suction. With such an arrangement I have found that the concentration of gases in water may be reduced to approximately 1.2 parts per million.

Referring now to FIG. 2, wherein elements common to elements in FIG. 1 are correspondingly numbered, it may be seen that the alternative embodiment illustrated in FIG. 2 differs from the preferred embodiment by reason of the way in which the liquid is agitated. Thus, in the embodiment shown in FIG. 2, the rotor shaft **22** of the motor **24** is passed through the stopper ***14a*** and is connected to vanes **26**. Therefore, when the motor **24** is energized the vanes **26** are caused to rotate to agitate the liquid. It is noted here in passing that special care need not be taken to provide a perfect air seal between the rotor shaft **22** and the stopper ***14a*** because any air which may leak through such bearing is removed by operation of the vacuum pump **18**.

Referring now to FIG. 3, wherein elements common to FIGS. 1 and 2 are correspondingly numbered, it may be seen that the manner in which agitation of the liquid is accomplished may be varied in still another way. Thus, in FIG. 3 an ultrasonic transducer **28**, as a piezo-electric crystal, is suspended in any convenient manner (not shown) in the liquid within the vacuum flask **10**. A driver **30** for the ultrasonic transducer **28** is connected, through the stopper ***14a***, by wires **32** to the such transducer. Thus, when the driver **30** is energized, the ultrasonic transducer **28** is caused to vibrate to effect agitation of the liquid.

Referring now to FIG. 4, still another embodiment of my invention, wherein agitation of the liquid to be degassed is accomplished through utilization of the phenomenom of cavitation, is shown. Thus, in FIG. 4, a sealed tank **41** is provided, such tank corresponding to the sealed flask of the embodiments described hereinbefore. The bottom (not numbered) of the sealed tank **41** is, preferably, formed as shown, to provide a bearing (not numbered) for the driven part of a magnetic clutch **43** (to which is affixed, in any convenient manner, an impeller **45** which has a number of vanes (not numbered). The driving part of the magnetic clutch **43** is attached to a shaft **47** of an electric motor **49**. It is evident, therefore, that whenever the electric motor **49** is energized from a power source (not shown), the magnetic clutch **43** is operative to rotate the impeller **45** without requiring a vacuum seal for a rotating member passing through the bottom of the sealed tank **41**. Liquid to be degassed is admitted to the sealed tank **41** through a pipe **51** from a source (not shown) whenever an intake valve **53** is opened. It should be noted here that it is much preferred, although not essential to my invention, to shape the pipe **51** within the sealed tank **41** to direct the liquid to be degassed against the impeller **45**. Spacer rods, as rods **55**, ***55a***, (one of which is hollow and extends through the bottom of the sealed tank **45** to provide a way of drawing a vacuum within the sealed tank **41** by a vacuum pump, not shown) are disposed in any convenient manner inside the sealed tank **45** to support a pair of vortex spoilers **57**, **59**. The latter simply are plates, the former being solid and supported in proximity to the upper surface of the impeller **45** and the latter having an opening (not numbered) formed therethrough. The position of the vortex spoilers **57**, **59** within the sealed tank **41** is not critical. To complete the embodiment shown in FIG. 4, a pipe **61** and outlet valve **63** are disposed as indicated to permit degassed liquid to be withdrawn from the sealed tank as desired.

In operation, a partial vacuum (say a vacuum of 28 to 29.5 inches of mercury) is drawn in the sealed tank **41** before any liquid to be degassed is introduced thereto. The electric motor **49** is energized to cause the impeller **45** to be rotated as described hereinbefore. If the pipe **51** is bent so as to direct the liquid to be degassed on to the impeller, such liquid initially is broken into droplets, thereby increasing the surface area of such liquid to the partial vacuum. Such an increase, in turn, permits any gases entrapped in the liquid to be removed rapidly. As the level of the liquid within the sealed tank **41** rises above the level of the impeller **45**, cavitation in the liquid starts. As that phenomenom builds up, the space immediately surrounding the vanes of the impeller **45** cannot be filled with the liquid to be degassed. Rather, a partial vacuum exists in such space and liquid to be degassed thereafter introduced is violently agitated and broken into a mist-like spray. The surface area of the droplets in such a spray is, obviously, very much greater than the surface area of the liquid out of the pipe **51** so the entrapped gases in the spray are quickly moved into the partial vacuum in the space in which cavitation occurs. Such air then leaks around the vortex spoiler **57** as a train of bubbles, passing upwardly through the liquid in the sealed tank **41** to collect under the vortex spoiler **59**. The gas under the latter spoiler then rises through the opening therein, through the surface of the liquid to the partially evacuated space above such surface. The so released gas is then withdrawn from the sealed tank **41** through spacer rod **55**. With a sealed tank having a capacity of 1 gallon, gases entrapped, i.e. dissolved, in water may be removed at a rate of 4 gallons per hour. That is, the concentration of gases dissolved in water may be reduced from about 10 to 0.2 parts per million.

It will be recognized that, in the absence of the vortex spoilers **57, 59**, the motion of the impeller **45** would cause a vortex to be formed in the liquid in the same manner as in the embodiments previously discussed. Such a vortex obviously does not serve any useful purpose in the present case but rather, if anything, reduces the amount of liquid which may be processed in a sealed tank of a given size.

It should be noted here that the phenomenom of cavitation in a liquid may be induced by sound waves as well as by a moving impeller as shown in FIG. **4**. Therefore, it will be obvious that the embodiment of my invention shown in FIG. **3** may, with a proper ultrasonic transducer, be operated in essentially the same manner as the embodiment shown in FIG. **4** to take advantage of cavitation.

While I have chosen to illustrate my invention by means of several simple alternate embodiments of apparatus, it is felt that such embodiments also illustrate my contemplated method, which is: (1) placing a liquid to be degassed in a vacuum chamber; and (2) simultaneously mechanically agitating the liquid and drawing a partial vacuum on the exposed surface of the liquid. Further, it is felt that the many changes may be made in the illustrated apparatus without departing from my inventive concepts. For example, it is evident that liquid intake and outlet piping and valves may be provided to permit at least a semi-continuous process to be carried on. Further, it is evident that the principles of the illustrated invention would be applicable to degassing any liquid. It is felt, therefore, that this invention should not be restricted to its illustrated embodiments, but rather should be limited only by the spirit and scope of the appended claims.

What is claimed is:

1. Apparatus for removing gases from a liquid comprising:

a. a vacuum flask for holding the liquid to be processed;

b. means for introducing such liquid within the vacuum flask;

c. a vacuum pump having its intake connected to the vacuum flask for removing gases freed from such liquid;

d. means for agitating such liquid to induce cavitation therein including at least one vane rotatably mounted within the vacuum flask and immersed in such liquid;

e. means for rotating the at least one vane to induce cavitation in such liquid;

f. means, including at least one disposed within such liquid, for inhibiting the formation of a vortex in such liquid.

2. Apparatus as in claim **1** wherein the means for introducing liquid to be processed within the vacuum flask includes a pipe passing through a wall of such flask, the end of such pipe within such flask being disposed adjacent to the means for agitating such liquid as it is introduced into such flask.

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