May 15, 1945. T. C. BAKER 2,376,221

METHOD OF AND APPARATUS FOR DEGASSING LIQUIDS

Filed April 8, 1942 2 Sheets-Sheet 1

Fig. 1.

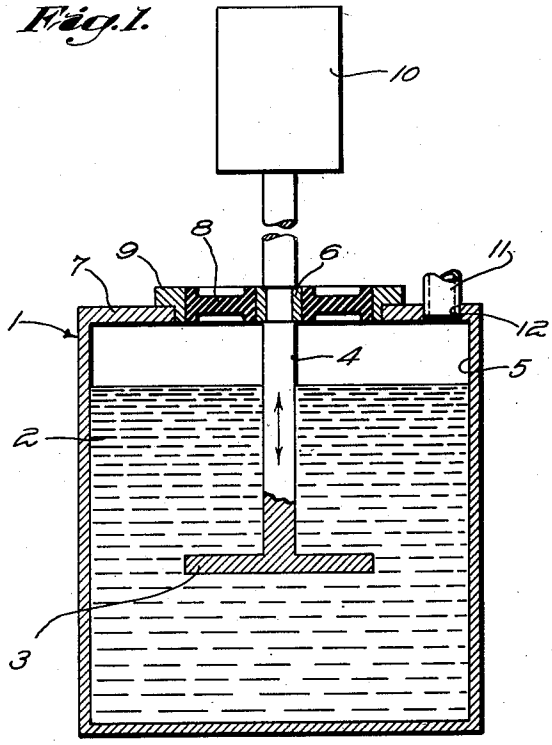
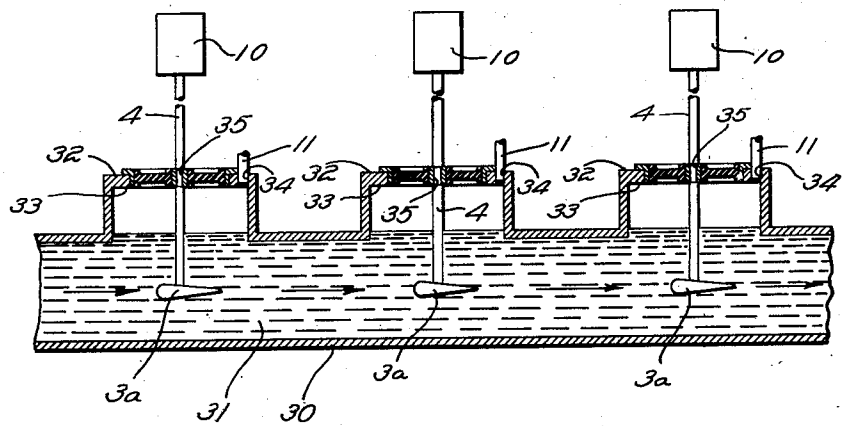


Fig. 4.



Witness
W. B. Chayer

Inventor
Theodore C. Baker
by Brown & Parham
Attorneys

May 15, 1945. T. C. BAKER 2,376,221

METHOD OF AND APPARATUS FOR DEGASSING LIQUIDS

Filed April 8, 1942 2 Sheets-Sheet 2

Fig. 3.

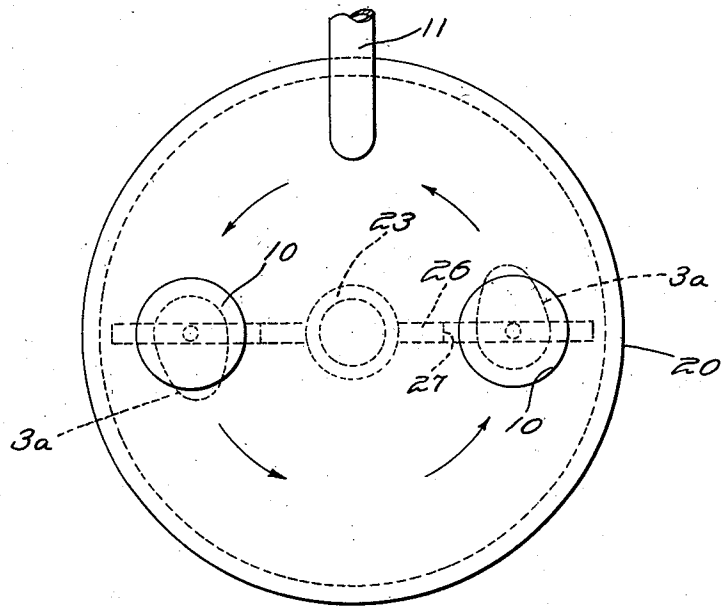
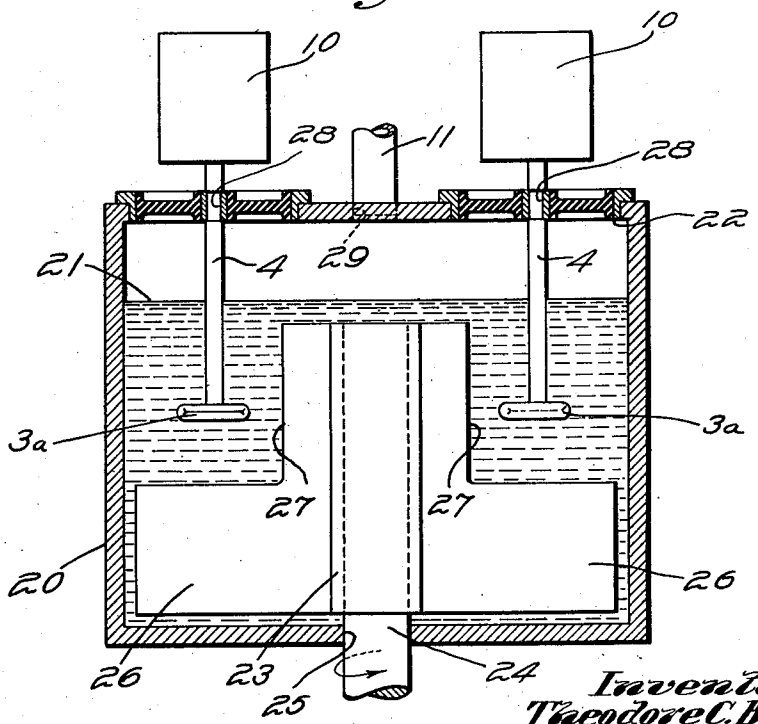


Fig. 2.



Witness
W. B. Thayer

Inventor
Theodore C. Baker
by Brown & Parham
Attorneys

Patented May 15, 1945 2,376,221

UNITED STATES PATENT OFFICE

2,376,221

METHOD OF AND APPARATUS FOR DEGASSING LIQUIDS

Theodore C. Baker, Newington, Conn., assignor to Hartford-Empire Company, Hartford, Conn., a corporation of Delaware

Application April 8, 1942, Serial No. 438,139

4 Claims. (Cl. 183—2.5)

Many liquids, such as liquid food products, fruit juices, etc., contain dissolved gases which it is desirable to remove before such liquids are placed in bottles, cans or other containers for marketing. It is usual to attempt to remove such gases from liquids by stirring the liquids, but the stirring methods and devices heretofore employed do not remove gases from the liquids completely or with the desired rapidity.

An object of the present invention is to effect degassing or removal of gases from liquids more rapidly and completely than has been done by the methods and devices that have been used for this purpose prior to the present invention.

A further object of the invention is to provide a readily usable and relatively simple method of and economical and efficient apparatus of relatively simple construction for effecting better and more rapid degassing of liquids.

The present invention proposes to make use of cavitation in the liquid to be degassed to effect removal of gases therefrom. According to this proposal, a suitable implement, termed a "cavitator," is supported and operated so as to vibrate or reciprocate in the liquid at a speed and frequency such that cavitation is effectively set up in the liquid, producing vacuum cavities of relatively large size, as one cc. in volume or more, next to the cavitator, with a consequent rapid production in the liquid of a relatively great many bubbles of the gases to be removed. These bubbles will rise rapidly to the surface of the liquid and will there collapse or explode, thereby releasing the gases to the space above the liquid, from which they may be removed continuously, as through a suitable exhaust vent or passage.

The collapse of the large vacuum cavities produce intensely high pressures of over 50,000 lbs. per square inch, causing explosive sound waves to be sent off. As in all sound waves of extremely high intensities, they are followed by a rarefaction which, in some cases, would be a negative pressure, i. e., better than a perfect vacuum. This rarefaction tears apart the liquid surfaces at which the gases may come out.

A further object of the invention is to make use of cavitation for the removal of gases from a liquid without causing or permitting the vacuum cavities produced to collapse against a surface of the cavitator or against a wall of the liquid container, whereby to prevent cavitation erosion or pitting of these parts.

Other objects and advantages of the invention will hereinafter be pointed out or will become apparent from the following description of the structure and operation of illustrative specifically different forms of apparatus for carrying the invention into effect, as shown in the accompanying drawings, in which:

Figure 1 is a view, mainly in vertical section and partly diagrammatic, showing a container for liquid to be degassed and a suitable vertically reciprocable or vibratory cavitator for producing cavitation in the liquid in the container;

Fig. 2 is a view similar to Fig. 1, showing a modified form of apparatus;

Fig. 3 is a plan view of the apparatus of Fig. 2; and

Fig. 4 is a longitudinal section through a portion of a continuous conduit for a liquid to be degassed, showing means provided in accordance with the present invention for effecting removal of gases from a flowing stream of liquid in the conduit at intervals along the length of such conduit.

In Fig. 1, a container 1 holds a liquid 2 that is to be degassed. A cavitator 3 is in the form of a flat plate-like head at the lower end of a vertical rod 4 which projects upwardly from the liquid through a head space 5 in the container 1 and through the bore of a suitable bushing 6 at the center of the top or cover 7 of the container. It will be understood that the container may be made of any suitable material that will not be affected by, or detrimentally affect, the liquid to be degassed. This material may vary with the liquid to be degassed.

In the example shown in Fig. 1, the bushing 6 has a close non-sliding fit with the rod 4 and is vulcanized at its outer periphery to a flexible rubber annular intermediate top or cover section 8. The latter is in turn joined by vulcanization to an externally flanged bushing 9 which fits snugly within, and may be joined to, the outer annular portion of the container top 7. The annular member 8 thus constitutes a diaphragm which may be flexed sufficiently to permit the desired vertical reciprocation or vibration of the attached cavitator rod 4. In lieu of this arrangement, the rod 4 may have a close, leak-proof, sliding fit with the wall of the top opening through which such rod extends.

The vertical rod 4 may be vibrated or reciprocated longitudinally with strokes of the desired amplitude, frequency, speed and character by any suitable rod supporting and operating mechanism. Such mechanism may consist of or comprise a fluid pressure motor, an eccentric, an electric solenoid, a cam or any other suitable known device for reciprocating such a rod. Such a mecha-

nism is indicated by the diagrammatic showing at 10 in Fig. 1.

The head space may be placed under a partial vacuum. An exhauster or vacuum creating mechanism, which may be of any suitable known construction, is shown diagrammatically at 11 in Fig. 1 in communication with an outlet opening 12 in the top of the container.

When the cavitator 3 is vibrated or reciprocated vertically in the liquid, vacuum cavities will be produced at the upper and lower surfaces of the cavitator 5. Bubbles containing the gases to be removed will form in the liquid from a level below the limit of the downward strokes of the cavitator and extending to the surface of the liquid as the vacuum cavities are produced and rapidly collapse in such liquid. The arrangement and operation preferably are such as to produce vacuum cavities of one cc. or more in volume.

The cavitator preferably is vibrated or reciprocated vertically in cycles so that there is a dwell of 50 per cent or more of the total time period of each cycle, this dwell being at least one-tenth of a second in duration. The object of this dwell is to avoid interference with desirable upward movements of the bubbles which result from the formation and collapse of the vacuum cavities. Such dwell may occur at either the upper or lower end of the vertical path of movement of the cavitator in the liquid or at an intermediate place along such path or in part at each of two or more of these places.

In the form of the device shown in Figs. 2 and 3, a container 20 contains a liquid 21 to be degassed, so that a head space 22 is provided within the container above the liquid therein. The liquid may be kept in circulation by a rotating impeller 23 which is mounted within the container on a rotary shaft 24 that projects into the container through a suitable opening 25 in its bottom. This rotary impeller 23 may have one or more radial vanes 26. These may be partially cut away at their upper portions, as at 27, to afford adequate room for the operation of one or more of the cavitators.

As shown in Figs. 2 and 3, there are two of the cavitators, each designated 3a and carried and operated by its rod 4 which extends vertically through a suitable opening 28 in the top portion of the container. Each cavitator may be operated by a suitable supporting and operating mechanism 10, as hereinbefore described. As shown, the two cavitators are located at opposite sides of the vertical axis of the rotating impeller 23 or, in other words, are spaced at approximately 180° F. apart within the container.

The rotary shaft 24 may be rotated at the desired speed of rotation by any suitable means, none being shown. It will be understood that the container may be suitably constructed at the places where the shaft 24 and the rods 4 extend through openings in walls of the container, so as to permit the desired movements of these parts without leakage of liquid from the container, in the case of the shaft 24, or leakage of air into the container from the atmosphere, in the case of the rods 4. An exhauster or vacuum creating device 11 may be provided for facilitating withdrawal of gases from the head space 22, such exhauster communicating with such head space through a suitable outlet or exhaust port 29 in the top of the container 20.

The operation of this form of the device is substantially like that hereinbefore described. In addition, the rotary movement of the liquid within the container will sweep the vacuum cavities away from the cavitators as such vacuum cavities are formed, so that they cannot collapse against the surface of the cavitator. The cavitator may be streamlined with respect to the flow of the stream to avoid spurious cavitation and to lessen resistance to the flow of the stream. This will positively prevent cavitation erosion of the cavitator. In addition, the location of each of the cavitators is such with relation to the liquid circulating rotary impeller and the walls of the container that the vacuum cavities will not be swept into contact with any of these walls, but instead will be kept sufficiently far away from them to avoid cavitation erosion of such walls, as well as of the cavitators themselves.

In the form of device shown in Fig. 4, the container for the liquid to be degassed is in the form of a substantially horizontal pipe or liquid conduit 30. A stream or body of liquid 31 to be degassed flows through this pipe or conduit, as by the action of gravity or in response to the actuation of a suitable pump or any other suitable impelling means, none shown. The conduit 30 is provided at intervals along its length with upwardly off-set or raised wall portions 32, so as to define head spaces 33 above the portions of the flowing stream of liquid therebeneath. Each of these head spaces may be in communication with an exhauster 11 through a suitable exhaust outlet or port 34 in the wall 32. A cavitator 3a is provided in the portion of the liquid in the conduit beneath each of the head spaces 33, the rod 4 of each cavitator extending through a suitable opening 35 in the wall 32 to an overhead cavitator supporting and operating device 10. The flow movement of the liquid stream in the conduit 30 will sweep the vacuum cavities from the cavitators 3a as such vacuum cavities are formed, so that they cannot collapse and cause cavitation erosion of the cavitators. This arrangement permits the escape of gases through head spaces at intervals along the length of the conduit 30, and the several exhaust devices 11 may be operated as desired, as to facilitate exhaust of gases from the several head spaces to the same extent or to different degrees for the different head spaces. The vacuum cavities are swept from the cavitators at places removed substantial distances from the several walls of the conduit, so that cavitation erosion of these walls is avoided.

It will be obvious that relative movement between the liquid and the cavitator may be effected in ways and by means other than those illustrated in the examples shown in the drawings.

The invention is not limited to the details shown in the accompanying drawings and as herein described. Various modifications thereof and changes therein will readily occur to those skilled in the art.

What I claim is:

1. The method of degassing a liquid in a container which comprises reciprocating a cavitator vertically in said liquid in rapidly repeated cycles to cause cavitations in the liquid, and causing the cavitator to dwell in the liquid in each of said cycles for a substantial part of the total time required for the complete cycle, including such dwell.

2. The method of degassing a liquid in a container which comprises reciprocating a cavitator vertically in said liquid in rapidly repeated cycles to cause cavitations in the liquid, and causing the

cavitator to dwell in the liquid in each of said cycles for more than 50 per cent. of the total time required for the complete cycle, including such dwell.

3. The method of degassing a body of liquid in a container which comprises reciprocating a cavitator vertically in said liquid to cause cavitation therein and rotating the body of liquid horizontally in said container relative to said cavitator at a velocity sufficient to obviate cavitation erosion of said cavitator.

4. Apparatus for degassing liquids comprising a container, a rotary impeller in said container for rotating a liquid therein, a vertically reciprocable cavitator in the liquid in said container, and means for reciprocating said cavitator vertically in said liquid to cause cavitation therein.

THEODORE C. BAKER.