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BUBBLE-FORMING METHOD AND APPARATUS

Filed May 10, 1961

Fig. 1.

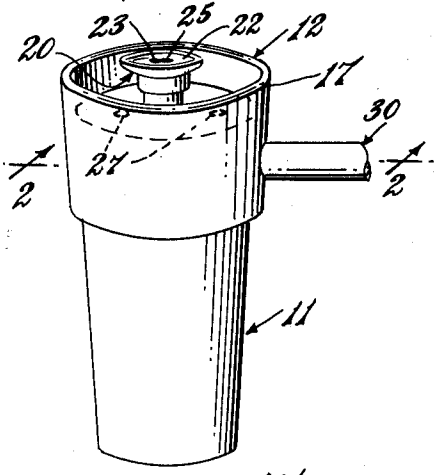


Fig. 3.

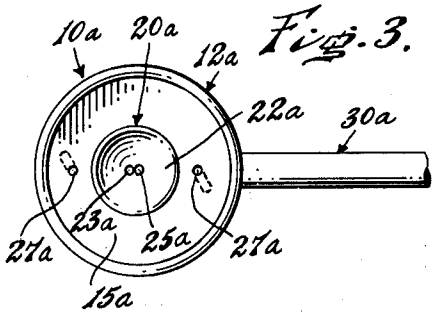


Fig. 2.

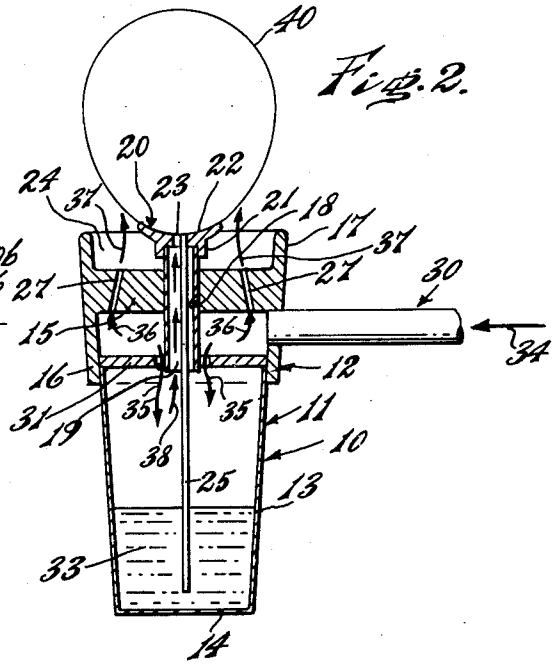
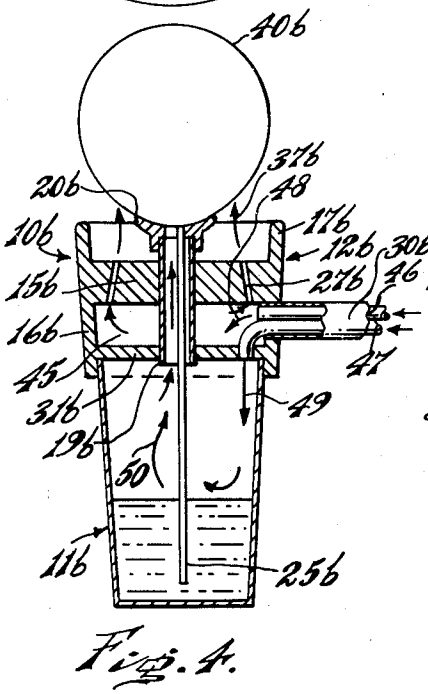


Fig. 4.



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BUBBLE-FORMING METHOD AND APPARATUS

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This invention relates to a method and apparatus for inflating a liquid film, so as to make bubbles from a liquid.

While the method and apparatus of the instant invention are illustrated and described hereinafter, for clarity, in a form suited for use as a toy of the bubble-pipe variety, it is understood that the instant invention is capable of many diverse applications, say in the process industries, and elsewhere, wherever it is desirable to form a thin film of liquid inflated with gas, and all of such applications are intended to be comprehended herein.

It is one object of the present invention to provide a novel method and apparatus for inflating with gas a thin film of liquid, wherein may be produced more accurately controlled bubbles, as to shape, size, film thickness, uniformity of film distribution, etc.

The instant invention further contemplates the provision of unique method and apparatus for forming bubbles, wherein a positively controlled, continuous supply of bubbles may be produced according to desired standards of quality and quantity.

It is still a further object of the present invention to provide a method and apparatus for forming thin liquid films inflated with gas, having the advantageous characteristics mentioned in the preceding paragraphs, which are extremely simple in operation and structure, entirely reliable, and relatively inexpensive in manufacture and use.

Other objects of the present invention will become apparent upon reading the following specification and referring to the accompanying drawings, which form a material part of this disclosure.

The invention accordingly consists in the features of construction, combinations of elements, and arrangements of parts, which will be exemplified in the construction hereinafter described, and of which the scope will be indicated by the appended claims.

In the drawings:

FIGURE 1 is a top perspective view showing apparatus constructed in accordance with the teachings of the present invention;

FIGURE 2 is a sectional elevational view taken substantially along the line 2—2 of FIGURE 1 illustrating the interior of the apparatus;

FIGURE 3 is a top plan view showing a slightly modified form of apparatus constructed in accordance with the instant invention; and

FIGURE 4 is a sectional elevational view similar to FIGURE 2, but showing another slightly modified embodiment of the instant invention.

Referring now more particularly to the drawings, and specifically to FIGURES 1 and 2 thereof, the apparatus is there generally designated **10**, and includes a lower receptacle or container **11** and an upper cover or closure **12** on the container.

As best seen in FIGURE 2, the container or receptacle **11** may constitute an upwardly opening cup having a bottom wall **14**, and a peripheral side wall **13** upstanding from the bottom wall. The cup or container **11** is adapted to receive a quantity of liquid to be inflated in a thin film, as will appear presently.

The closure or cover **12** may be arranged as a lid over the upper open end of the container **11**, and includes a generally horizontal covering portion or wall **15** having depending therefrom a peripheral skirt or wall **16** which may engage about and be secured by any suitable means, say adhesive or cement, to the upper end region of container **11**. Also extending peripherally about the horizontal wall **15** is an upstanding wall or rail **17**, which combines with the upper surface of horizontal wall **15** to define an upwardly facing recess or receptacle **24**.

Located centrally of the horizontal part or wall **15**, and extending vertically therethrough, is a bore or hole **18**. A hollow, open-ended mounting member or tube **19** extends vertically, closely through the bore **18**, having its upper end projecting upward beyond the horizontal wall **15** and located in spaced relation within the upstanding peripheral wall or flange **17**, while the lower end of the mounting tube depends below the wall **15** to a point in spaced relation within the skirt **16**. The mounting tube **19** may be integral with or secured to the horizontal wall **15** by any suitable means, such as cement.

On the upper end of the mounting tube **19** is located a bubble support or pad, generally designated **20**. The pad **20** is disposed generally horizontally and arranged over the upper end of the mounting tube **19**. A sleeve or collar **21** depends from the underside of the pad **20**, being circumposed about and secured by cement or other suitable means to the upper end of the mounting tube **19**. On the upper side of the pad **20** is formed a smoothly arcuate, concave upwardly facing surface **22**, while a through opening or port **23** extends vertically through the central region of the pad communicating between the ambient region over the pad and the upper interior region of the mounting tube **19**. The pad **20** may be of generally circular outline in plan and of a diameter considerably less than that of the upstanding peripheral wall **17**.

Depending from the central region of pad **20**, proximate to the through port **23**, is a feed conduit **25**. More particularly, the feed conduit **25** may have its upper end opening upwardly through the upwardly facing surface **22** of the pad **20**, being secured to the pad by any suitable means, and depends therefrom through and beyond the lower end of mounting tube **19** into a lower region of the container **11**.

Formed in the horizontal cover wall **15** may be one or more generally upstanding through bores, ports or openings **27**, which define nozzles producing gas jets or streams, as will appear more full hereinafter. In the illustrated embodiment of FIGURES 1 and 2, the nozzles or jet openings **27** are two in number and arranged in equally spaced relation, diametrically on opposite sides of the mounting tube **19**. Further, as may be observed in FIGURE 2, the nozzles **27** lie in the same generally vertical plane passing through the axis of mounting tube **19** and pad **20**, and may be inclined upwardly toward each other. Further, the nozzles **27** are located in the cover wall **15** spaced radially outward from the tube **19** beyond the pad **20** and disposed to issue gas jets or streams **37** upward radially or laterally outward of the pad so as not to be obstructed by the latter. Thus, the direction of the nozzles **27** may approach the radial to the center of curvature of the upper pad surface **22**.

A gas-inlet conduit or tube **30** may have one end connected to the skirt **16** of cover **12** by any suitable means, and opening therethrough to the underside of the cover wall **15** for communication with the upper region of container **11**. Also, a generally horizontal restriction plate or baffle **31** may be provided interiorly of the cover skirt **16**, below the gas-inlet tube **30**. The baffle **31** may extend substantially but not entirely across the upper end of container **11**, so as to minimize or restrict the passage of fluid thereby upon inversion of the apparatus, without destroying fluid communication between the inlet conduit **30** and the container **11**.

In accordance with the method of the instant invention, a quantity of liquid **33** is contained in the lower re-

gion of receptacle 11, being sufficient to immerse the lower end of feed conduit 25. Air or other gas in introduced through the inlet conduit 30, as indicated by the arrow 34. The gas enters beneath the cover wall 15 and partially passes downward, by-passing the baffle 31 and into the upper region of container 11, see arrows 35. The remainder of the entering gas 34 passes upward, as indicated by arrows 36 through the nozzles or openings 27 and issues therefrom as jets 37.

The gas flow 35 entering the upper region of container 11 above the level of liquid 33 applies pressure to the liquid to force the feed thereof upward through the conduit 25 to the upper surface 22 of pad 20. The flow, and hence the rate of feed through conduit 25 is constricted by the relatively small diameter of the conduit. From the upper region of the container 11, below the baffle 31, the gas flow 35 may pass upward through the mounting tube 19, as at 38, and thence upward through the port 23 of the pad 20. It is this gas flow 38 through the port 23 that serves to inflate liquid fed to the upper pad surface 22 through the conduit 25, and thereby define a liquid film inflated with gas or a bubble 40.

The bubble 40, of course, grows progressively as liquid is fed through conduit 25 to the pad surface 22, and as the liquid is inflated by gas flow 38 upward through port 23. During inflation of the bubble 40, the gas jets 37 impinge upon the undersurface of the bubble, in the illustrated embodiment impinging generally normal to the bubble surface, to effectively suport the lower weight-carrying wall portions of the bubble. Of course, the number of nozzles 27 and jets 37 may be selected, as desired for the particular purpose. As the pad surface 22 is relatively small, thereby minimizing the tendency of the bubble 40 to adhere, disengagement of the bubble from the pad occurs realtively easily. Further, the precise moment of disengagement, say when the bubble has reached a desired size, may be accurately controlled by the nozzles 27 and their gas jets or streams 37. That is, a slight surge or burst of gas in the jets 37 is sufficient to overcome the adherence of bubble 40 to pad 20 and disengage the bubble from the pad. Not only do the jets 37 serve to disengage the bubble 40 from the pad 20, but the jets further serve to form the shape of the bubble and may be arranged as desired for this purpose. In addition, the jets 37 insure movement of the bubble 40 away from the pad 20 in a desired direction, say vertically upward, or otherwise, according to the direction of the jets. Even further, the jets 37 provide a fluid force, during formation of the bubble 40, tending to more evenly distribute the liquid film of the bubble and resist the tendency of the film to gravitate toward the lower region of the bubble, which results in a stronger bubble structure.

The above-described method may, of course, be repeated indefinitely, assuming a sufficient supply of liquid and gas. Also, subsequent to the formation of the first bubble, a residue of liquid remains on the upper pad surface 22 and flows to the gas port 23, preferably being retained therein by adhesion or capillary action, so as to be ready for the formation of the next succeeding bubble.

In the embodiment of FIGURE 3 is shown bubble-forming apparatus 10*a*, which is substantially identical to the apparatus 10 of FIGURES 1 and 2, except that the nozzles 27*a* formed in the horizontal cover wall 15*a* of cover 12*a* are disposed in a direction having a component generally tangential to the vertical axis of the pad 20*a*.

By this construction, jets issuing against the underside of a bubble include a force component generally tangential to the bubble. This effects rotary action or spinning of the bubble during bubble formation and disengagement to further insure uniform distribution of the liquid film about the bubble.

Referring to the embodiment of FIGURE 4, the apparatus there illustrated is generally designated 10*b* and similar to that of FIGURES 1 and 2, including a lower receptacle or container 11*b* and an upper cover or closure 12*b* on the container.

The closure or cover 12*b* may be arranged as a lid over the upper open end of the container or cup 11*b*, and includes a generally horizontal covering portion or wall 15*b* having a depending peripheral skirt or wall 16*b* engaged about and suitably secured to the upper end region of the container. The horizontal wall 15*b* may be formed with through jet openings or nozzles 27*b*, and provided about its periphery with an upstanding wall or rail 17*b*.

By way of difference from the first-described embodiment, the cover 12*b* may be provided with a separator member or wall 31*b* extending in spaced relation beneath the wall 15*b* and completely across the space within the skirt 16*b* to define a closed chamber 45 within the skirt.

A hollow, open-ended mounting member or tube 19*b* extends vertically through the horizontal wall 15*b*, the chamber 45, and the separator plate or wall 31*b*, having its upper and lower ends communicating, respectively, upward beyond the wall 15*b* and downward beyond the separator 31*b*. A bubble-support pad 20*b* is mounted on the upper end of tube 19*b*, and has depending therefrom downward through and beyond the lower end of the tube 19*b* a feed conduit 25*b*, all being similar to the pad 20 and conduit 25 of the first-described embodiment.

Fluid-inlet means, generally designated 30*b*, may be provided through the skirt 16*b*, and in the instant embodiment may include a pair of separate conduits 46 and 47. The conduit 46 may communicate at its receiving end with one source of fluid supply, say an air source, and may open at its discharge end into the chamber 45, as indicated by arrows 48. Thus, the gas or air entering through supply conduit 46 to the chamber 45 is closed to the container 11*b* below the separator 31*b*, and can only pass upward and outward through the nozzles 27*b* to provide jets 37*b*.

The supply conduit 47 may have its inlet end connected to a separate supply source, say a lightweight gas (not shown) or other desired source, and may have its discharge end communicating directly with the interior of container 11*b* below the separator 31*b* and above the liquid level, as shown by arrow 49. The gas entering through conduit 47 is thus closed to communication with the chamber 45 and may only pass upward through the mounting tube 19*b*, as shown by arrow 50, for upward discharge through the pad 20*b*. Also, the gas entering through conduit 47 serves to feed liquid upward through the conduit 25*b*.

It will now be appreciated that a bubble 40*b* may be inflated in the embodiment of FIGURE 4 by a gas from one source, as supplied through conduit 47, while the nozzle streams or jets 37*b* may be formed by gas or air from a separate source. Further, suitable pressure or flow control may be applied to the conduits 46 and 47 for separately regulating the inflating and jet gases.

From the foregoing it is seen that the present invention provides a unique and advantageous method for inflating liquid films with gas to form bubbles, which fully accomplish their intended objects and are well-adapted to meet practical conditions of manufacture and practice.

Although the present invention has been described in some detail by way of illustration and example for purposes of clarity of understanding, it is understood that certain changes and modifications may be made within the spirit of the invention and scope of the appended claims.

What is claimed is:

1. A device for inflating a liquid film comprising a container for liquid, a cover over and closing said container, a bubble-support pad on said cover and having a port communicating generally vertically through said pad between the interior of said container and the upper side of said pad, a conduit depending from said pad having its upper end opening upward through said pad and its

lower end depending to a lower region of said container for immersion in said liquid, and means for introducing gas into an upper region of said container above the level of said liquid for feeding liquid upward through said conduit to said pad and simultaneously discharging gas through said port to inflate a film of said liquid, said cover being provided with a plurality of nozzles communicating upward through said cover for issuing gas from the said introducing means into lifting engagement with the underside of a bubble on said pad.

2. A device for inflating a liquid film according to claim 1 in combination with separator means separating the region of said container over said liquid from fluid communication with said nozzles, and separate fluid-conduit means communicating with opposite sides of said separator means for independently supplying gases to said container and nozzles.

3. A device for inflating a liquid film according to claim 1, said nozzles being spaced circumferentially about said pad.

4. A device for inflating a liquid film according to claim 3, said nozzles being directed upwardly and inwardly to issue gas streams approximately normal to a bubble.

5. A device for inflating a liquid film according to claim 3, said nozzles being directed to issue gas streams having a component generally tangential to a bubble for rotating the latter.

6. A device for inflating a liquid film according to claim 1, in combination with a baffle extending across the upper

region of said container above the liquid level therein, to minimize spillage.

7. In the method of forming a thin film of liquid inflated with gas, the steps which comprise: providing an upwardly facing support pad, feeding liquid to the upper surface of said pad, simultaneously feeding gas upward through said pad to inflate said liquid and define a bubble, and issuing a gas stream toward the underside of a bubble on said pad to disengage the bubble from said pad, said gas stream being issued obliquely upward to impart a rotational force to said bubble for uniform distribution of the liquid about said bubble.

8. In the method of forming a thin film of liquid inflated with gas, the steps which comprise: providing an upwardly facing support pad, feeding liquid to the upper surface of said pad, simultaneously feeding gas upward through said pad to inflate said liquid and define a bubble, and discharging a plurality of gas streams upwardly and located radially outwardly beyond said pad toward the underside of a bubble on said pad with said streams each having a component generally tangential to said bubble, for imparting rotational and lifting forces to said bubble.

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