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FOAM GENERATING AND DISPENSING DEVICE

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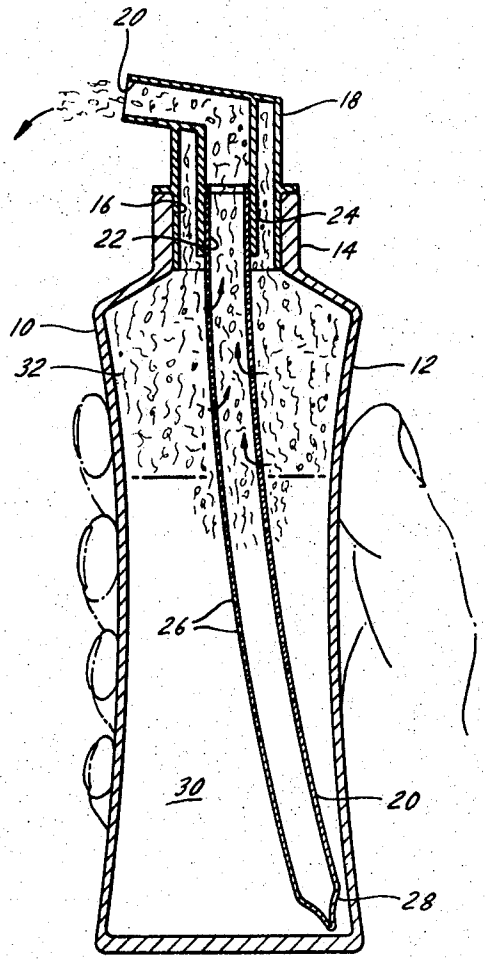

FIG. 1

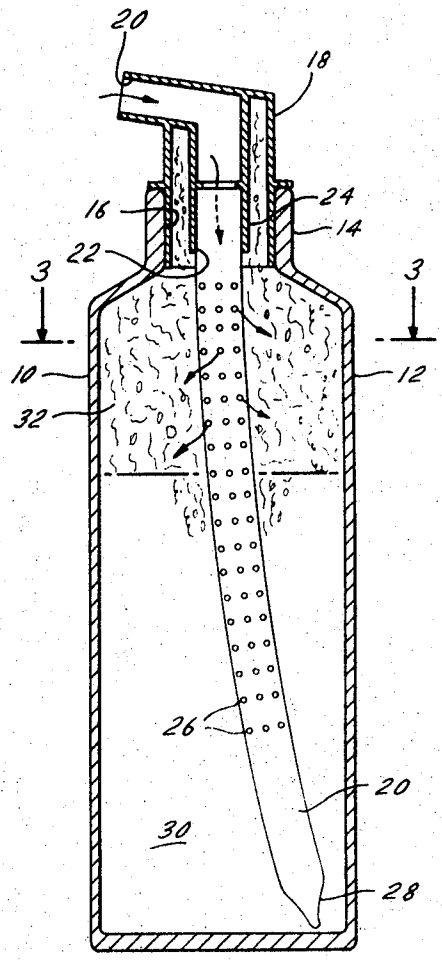

FIG. 2

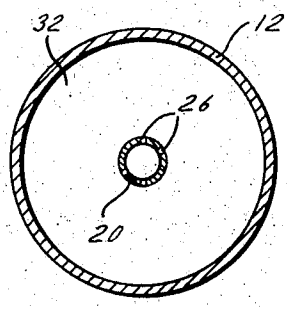

FIG. 3

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FOAM GENERATING AND DISPENSING DEVICE

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ABSTRACT OF THE DISCLOSURE

A foam generating device is provided which includes a cylindrical squeeze bottle having an outlet spout at its upper open end for the generated foam. A foamable liquid is disposed in the bottle. A tube extends downwardly from the spout into the liquid. A plurality of holes are in the side wall of the tube and over a major portion of the upper end of the tube to provide communication between the head space within the bottle above the liquid and the interior of the tube. In order to generate foam, either the bottle is agitated for purposes of wetting the tube so that the holes are covered by the liquid or, as will occur during normal operation, the foam generated in the head space will serve to keep the tube wetted over prolonged periods. As the bottle is squeezed, air from the head space is forced through the holes in the tube whereupon the air mixes with the liquid disposed across the holes to form individual bubbles which collectively make up the desired foam. This foam continues up the tube into the spout and out through its opening as the bottle is squeezed or compressed. Repeated squeezing of the bottle generates more foam which eventually is dispensed out through the spout opening. After each squeezing and when the bottle is released, air is sucked back through the spout into the tube and out through the tube opening into the head space further foaming the liquid in the head space. This serves as a supplemental supply of the liquid to wet the tube for purposes of generating more foam upon subsequent squeezing of the bottle. Maintaining the tube wet in this fashion or by tilting or agitating the bottle at periodic intervals will assure the continued generation of foam as the bottle is squeezed and then released.

Foams may generally be defined as a dispersion or suspension of finely divided gas bubbles in a liquid. The individual gas bubbles are separated from one another by a closed continuous thin film of the liquid. A foam, under these circumstances, will contain a relatively small but somewhat evenly distributed quantity of the liquid for a relatively large volume of foam. Under these circumstances, a relatively large surface area may be uniformly covered by foam so that a relatively small amount of the liquid is actually applied to this surface.

Accordingly, foams have many useful applications as a vehicle for industrial, household, cosmetic and other personal application fields. Heretofore, foams or aerated products have experienced success as shaving creams, lotions, shampoos and detergents to mention a few. In these cases, the foam was generated and dispensed by means of an aerosol type of container in which the foamable product was packed under pressure along with a suitable propellant and thereafter released in its foamable state through a valve controlled opening. However, several inherent problems are necessarily present in the form of special filling equipment as well as valves which increase the cost of the pressure packed product. Not only is the cost of the propellant a contributing factor but its chemical effect on the other constituents and container walls and valve must be taken into consideration.

It is, therefore, a principal object of this invention to provide a relatively simple low-cost foam generator which eliminates the disadvantages of the prior art while providing a relatively efficient foam producing technique.

Another object is to provide a foam generator of this type which while being capable of being refilled and reused, is sufficiently low in cost to render it disposable after the foamable material has been consumed.

A further object is to provide a foam generator of the above type which is capable of being filled and dispensed without requiring propellants, special filling equipment or valves and containers.

Other objects and advantages will become apparent from the following detailed description which is to be taken in conjunction with the accompanying drawings in which:

FIG. 1 is a longitudinal sectional view through the foam generator of this invention showing the manual generation of foam by means of the internally mounted perforated tube;

FIG. 2 is a similar longitudinal sectional view showing the foam generator after the squeezing operation has stopped and the walls of the bottle or container have resumed their normal position showing the manner in which foam is thereby built up in the head space; and

FIG. 3 is a cross-sectional view taken along the line 3—3 of FIG. 2.

In the drawings, a typical squeeze-type of bottle **10** is shown and may be formed of conventional materials such as polyethylene, cellulose acetate and other suitable materials which permits squeezing of the bottle's side walls **12** on the application of manual pressure and return to its initial substantially cylindrical shape upon release of this pressure. The top **14** of the bottle **10** is provided with an opening **16** into the container interior and across which a spout **18** is sealed and secured. The spout **18** includes the usual dispensing outlet **20** which may be closed by means of a plug (not shown) during storage and shipping. Of course, a protective overcap of suitable form and construction may also be provided for such purposes. All of the caps of this type are well known in the trade.

A foam generating perforated tube **20** is mounted interiorly of the bottle **10** and includes an opened upper end **22** fixedly mounted to a concentric substantially downwardly extending apron **24** of the spout **18**. Under these circumstances, a direct conduit extends between the interior of the tube **20** and the outlet **20** substantially as shown in FIG. 1. A plurality of holes or openings **26** is provided in the side walls of the tube **20** over a major portion of the upper part of the tube **20**. These openings are relatively small in size and may assume a circular or other geometrical configuration formed by punching or other production techniques. Optimum results have been found to be achieved by closing the lower end **28** of the tube in a suitable fashion and by means of a plug or pinching and sealing as typified in the illustrated embodiment.

A successful commercial application of the present invention will include a filled bottle **10** with the selected foamable material **30** to a level at which a predetermined amount of head space **32** is provided. In this manner, the perforated part of the tube **20** is adapted to be wetted with a relatively thin film of the foamable material **30**. This wetting may be accomplished by shaking or agitating the bottle **10** or merely tipping it to secure the desired wetting. In this connection, both the inner and outer face of the tube **20** will with repeated use contain a film of the foamable product **30**. In this connection, the mere squeezing of the side walls of the bottle **10** will force the foamable liquid **30** upwardly to wet a part of the tube **20**. In addition, as foam is generated and built up

within the head space **32**, the upper part of the tube **20** will be constantly wetted. In addition, as foam is produced and dispensed, the unperforated part of the tube **20** which will have been wetted will serve as a reservoir or supply for liquid which because of the liquid surface tension and dripping as a result of gravity will close or extend across the perforated or pierced opening to permit once again the formation of more foam.

In order to produce a satisfactory foam, several factors must be taken into consideration including the number and size of openings **26**, the size of the inner bore of the tube **20**, the nature and level of the foamable product and the size and shape of the bottle **10** otherwise excessive air will exit from the spout opening **20** or excessive product will be discharged therefrom which in the extreme would be unaerated or unfoamed liquid **30**. Of particular interest is that when all of the factors are balanced properly, foam will be generated whether the bottle **10** is being squeezed or is recovering; and in the latter case, the foam builds up on the outside of the tube **20** in the head space **32**. Within that portion of the tube **20** adjacent the tube lower end **28**, a foamable liquid reservoir is provided which after repeated use will become filled with non-aerated product **30** which is utilized for wetting the inside of the tube **20**.

In actual use, the bottle is squeezed and released, foam is formed on both the inside and outside of the tube **20**. The light foam in the head space breaks down slowly and as it mixes with the new form that is created when the bottle is squeezed, upgrades the quality of the final product by producing a finer grained and drier foam. During the decrease of the cross-sectional area of the bottle incident to squeezing, the level of the product **30** will be raised, covering some of the perforations **26**, this does not detract from the effectiveness of the generator since it is producing foam during the time the bottle is initially squeezed and by the time the liquid **30** reaches the level where it could effect the balance of air to liquid within the bottle **10**, but at this juncture, the limit to which the bottle **10** can be squeezed has generally been reached. In this connection, cylindrical bottles are preferred because they have the maximum displacement potential; and in such cases, the bottles were filled to between two-thirds and three-quarters capacity.

It should be understood by optimum foam is meant the quality of the foam which should be dry and substantially long lasting, the need for minimum consumer instruction and the lessening of restrictions as to the type and size of squeeze bottles employed.

It has been found that in order to successfully practice the present invention, the internal diameter of the tube **20** should be in the order of one-quarter of an inch with a nominal diameter being of the order of five-sixteenths of an inch. With respect to the diameter of the tube **20**, the controlling factor is the availability of enough surface area to accommodate the number of holes **26** which, when present, will produce the optimum foam. In this connection, the reduced size holes **26** permits the production of a venturi action which, together with the surface tension of the foamable liquid, results in the formation of quality foam.

With respect to the number of holes **26** provided in the tube **20**, a minimum of about 400 and a maximum of about 1,000 is suggested with a range of between 750 and 950 being preferred. With respect to the arrangement of holes **26**, it is found that in a convenient counter-balanced arrangement down the length of the tube to a depth of about one-half to three-quarters of the tube's total length as worked satisfactorily. In this connection, a balanced arrangement is intended to mean an even distribution of holes about the periphery of the tube **20**. A greater concentration of holes in the upper end of the tube **20**, will raise the ratio of air to product, a greater concentration of holes near the lower end of the perforated part of the tube will raise the ratio of product to air. The diameter of the holes **26** should be from .005 inch to .015 inch

with .010 inch being preferred. Holes of this magnitude with the foamable products contemplated tend to hold the film across the openings while cooperating to maintain a slight increase in the velocity of fluid movement which is felt in the form of a slight resistance as the bottle **10** is manually squeezed.

With respect to the tube **20** of the illustrated embodiment in which the lower end **28** is closed, the number of holes **26** of a diameter of .010 inch does not noticeably improve the quality of the foam as the number is increased above the maximum limit defined in the above. The size of the openings **26**, as aforenoted, should take advantage of the natural surface tension of the film of foamable product that is formed on the inner and outer surface of the tube **20**. A lesser number of holes than the minimum mentioned in the above will produce a foam, but the problem created is in the ability of the bottle **10** to recover when squeezing and release of manual pressure has stopped. The holes **26** will, in effect, operate as a brake offering resistance to the passage of air from the ambient back into the bottle head space. Thus, the number of holes has a direct bearing on the speed at which the bottle recovers its shape after it has been squeezed. A minimum of 400 holes permits the bottle to recover in an acceptable fashion. As the number of holes is increased above 400, the quality of the foam improves, at about 900 there is a levelling off until about 1,000 holes. At this point, the ratio of air to product begins to increase sufficiently so as to cause the quality of the foam to deteriorate.

The general rule in determining the number of holes is that the aggregate value should allow for a slight resistance to fluid flow as the bottle is squeezed. Of course, the internal diameter of the tube **20** should define an internal cross-sectional area of the tube which approaches the aggregate open area provided by the openings **26**. For example, the aggregate area of 800 holes **26** having a diameter of .010 is approximately .06 inch whereas a tube with a five-sixteenths inch internal bore has an area of about .08 inch which is well within the broad comparative analysis where velocity of product through the holes **26** and out through the spout opening **20** matches the aerating ability of the holes **26**. This range has been found to be about 20 percent. As the diameter of the holes **26** increase beyond the maximum limit, a leak is in effect provided whereupon a greater volume of combined air within the head space will be expelled upon squeezing of the bottle **10**. This leakage phenomenon is particularly noticeable when the bottom end **28** of the tube **20** is opened. As stated in the foregoing, it is preferred that this bottom end be closed for optimum results. It should be understood that if the holes **26** were arranged on the entire length of the tube **20**, they would offset the effect of this sealed lower end **28** which is to preclude raw foamable product **30** from rising in the tube **20** as the bottle is squeezed. It has been found that with a tube **20** having an open lower end **28** there is the danger of raw product **30** being dispensed up through the tube and out of the outlet **20** particularly if the bottle **10** is squeezed too hard and too rapidly. Under these circumstances, it is preferred that the lower end of the tube **20** be sealed and the holes **26** extend across only about one-half of the tube length.

In selecting the tube **20**, its wall thickness is important. It is preferred that this thickness be held at a minimum and a thickness of one-thirty-second of an inch has been found to perform satisfactorily. In this connection, the least expensive and fastest way of making a large number of small diameter holes **26** is to execute a piercing operation. Since a clean cut hole is not essential, a sharp point of the proper diameter is all that is required. Punching these holes would require a male and female die with a greater risk of tool breakage and the problem of disposing of the punched out slugs. A thin tube wall facilitates piercing with a needle or the like and, at the same time, permits the points to be kept relatively short thereby reducing the possibility of breakage.

The present invention contemplates several alternative embodiments or supplementation of the basic contribution to the foam generating art. In this connection, a wick-like arrangement may extend around the perforated tube to insure wetting of the tube and offsetting the requirement for agitation in one form or another for purposes of wetting the tube. Accordingly, an absorbent material may be employed for enclosing the tube within the bottle **10** but which will permit passage of air therethrough. This material may be in the form of a perforated paper cloth or the like capable of acting as a wick which constantly keeps the surface of the tube **20** damp or wet.

Furthermore, the pierced tube **20** of suitable resinous material and although preferred could be replaced by a fine mesh screen which could be rolled into a tube. A limiting factor with the use of a fine mesh screen is that the number of holes in a given area will be fixed whereas with a tube of the type contemplated, the number of holes pierced can be varied according to the particular requirements and specifications. Of course, with the use of a fine mesh screen, a coating or laminate can be employed to close off that part of the screen that would be undesired or not necessary. With this approach, the cost of the finished product would necessarily be increased. Similarly, a coating of inert material will generally be required for the screen to prevent or minimize any interaction between the screen material and the foamable liquid **30**. Flocking of one form or another can be employed for such purposes and one advantage of this is that it would serve as an absorbent for keeping the tube wet.

In addition, a binary or multiple tube arrangement is envisioned in which one or more of the tubes is pierced in accordance with the preferred embodiment and one or more of the other tubes arranged in concentric relationship would serve as wicks or capillary channels for taking up and holding the foamable product **30** and, in this manner, keeping the pierced tubes wet for purposes of generating foam and minimizing the requirements for bottle agitation.

It will be appreciated by those skilled in the art that when the squeezing pressure on the bottle **10** is released, a non-drip type of dispenser is provided in which the product that is not consumed at the discharge opening **20** and within the spout **18** is withdrawn back into the tube **20** and container **10**. An attractive aspect of the present invention is the self-purging effect produced when the bottle is released which will in actual practice tend to maintain the spout **18** and its discharge opening **20** clear and the foam or bubble producing openings **26** essentially non-plugged and cleared for purposes of producing quality foam. This cleaning and self-purging is further enhanced by agitation of the bottle for purposes of keeping the tube **20** wet and, in this manner, essentially clean.

Thus, the several aforenoted objects and advantages are most effectively attained. Although several somewhat preferred embodiments have been disclosed and described in detail herein, it should be understood that the invention is in no sense limited thereby and the scope is to be determined by the appended claims.

I claim:

1. A device for producing and dispensing foam comprising in combination: a hollow container means adapted to contain a foamable liquid in a non-foaming state, said container means being of flexible material and capable of being compressed so as to have its volume reduced and capable of being self-expanding back to its original volume, said container means having an upper open end, a dispensing outlet means mounted on the upper open end of the container means for directing the foam to be dispensed to the selected location, a tube mounted interiorly of the container means and having an open upper end communicating with the dispensing means for passage of the foam from the tube into the dispensing means, the tube having a longitudinally extending tubular side wall defining an internal bore extending to and communicating with the tube upper end, the tube side wall having a plurality of openings communicating with the interior of the container means and the bore of the tube, the openings in the tube side wall being capable of being covered by the foamable liquid in its non-foaming state whereupon compression of the container means generates foam in the tube bore which is adapted to be ultimately forced upwardly out through the tube upper opening into and eventually out of the dispensing means.

2. The invention in accordance with claim **1** wherein the tube side wall openings are disposed along a major part of the upper end of the tube.

3. The invention in accordance with claim **1** wherein the tube is provided with sealing means at its lower end for sealing the tube bore at the tube lower end.

4. The invention in accordance with claim **1** wherein the container means is adapted to expand back to its original volume upon removal of the compressive forces whereupon foam is generated in the head space within the container means above the level of the foamable liquid to thereby maintain the upper surfaces of the tube side walls wet with the foamable liquid and provide for a reserve of the foam for dispensing upon subsequent compression of the container means.

5. The invention in accordance with claim **1** wherein the container means is substantially circular in section over the major portion of its length.

6. The invention in accordance with claim **1** wherein the side wall openings of the tube are dispersed substantially uniformly about the periphery of at least the upper portion of the tube.

7. The invention in accordance with claim **1** wherein the openings in the tube are pierced.

8. The invention in accordance with claim **1** wherein the openings extend approximately over one-half of the length of the tube.

9. The invention in accordance with claim **1** wherein the number of holes or openings is between 400 and 1,000.

10. The invention in accordance with claim **1** wherein the number of holes or openings is between 750 and 950.

11. The invention in accordance with claim **1** wherein the internal diameter of the tube is about one-quarter of an inch.

12. The invention in accordance with claim **1** wherein the internal diameter of the tube is approximately five-sixteenths of an inch.

13. The invention in accordance with claim **1** wherein the size of the tube openings is between .005 inch to .015 inch.

14. The invention in accordance with claim **1** wherein the diameter of the tube openings is approximately .010 inch.

15. The invention in accordance with claim **1** wherein the lower end of the tube is closed.

16. The invention in accordance with claim **1** wherein the tube has a wall thickness no greater than one-thirty-second of an inch.

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