April 19, 1960 R. E. STRICKLAND 2,932,916

AQUATIC TOY

Filed April 11, 1957 2 Sheets-Sheet 1

Fig. 1

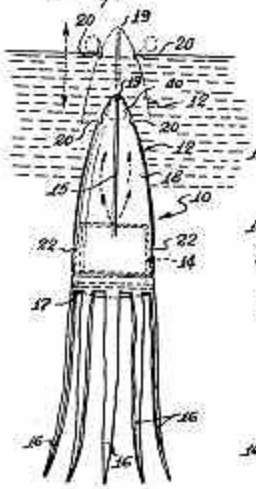


Fig. 2

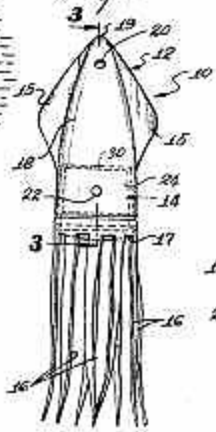


Fig. 3

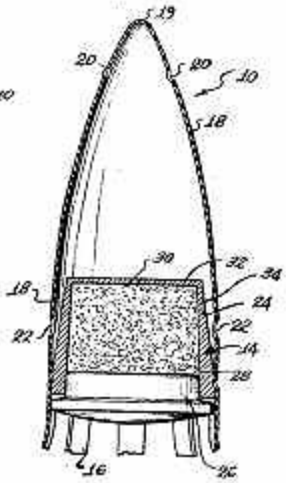
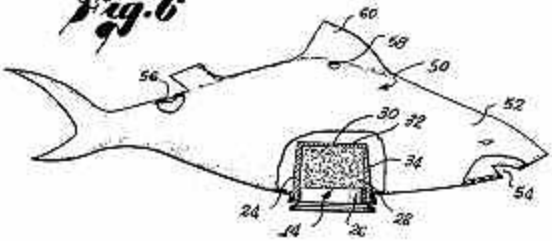


Fig. 6



INVENTOR.
ROBERT E. STRICKLAND
BY Sylvester Matthews & Hundley
Attorneys

April 19, 1960 R. E. STRICKLAND 2,932,916

AQUATIC TOY

Filed April 11, 1957 2 Sheets-Sheet 2

Fig. 4

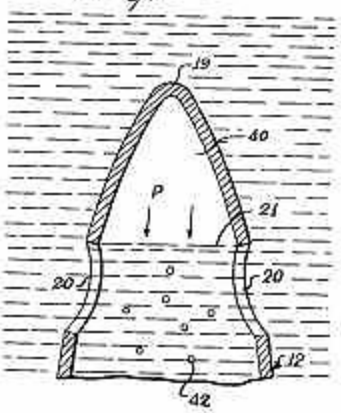


Fig. 5

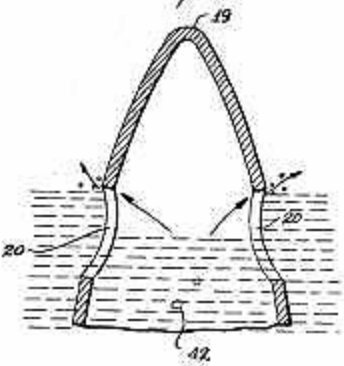
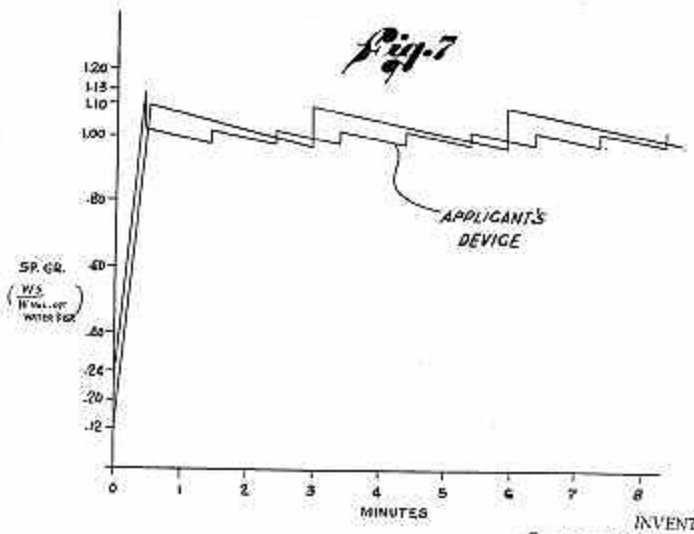


Fig. 7



INVENTOR.
ROBERT E. STRICKLAND
BY Lalowder Mattingly & Huntley
Attorneys

United States Patent Office

2,932,916

Patented Apr. 19, 1960

2,932,916

AQUATIC TOY

Robert E. Strickland, Canoga Park, Calif.

Application April 11, 1957, Serial No. 652,261

5 Claims. (Cl. 46—92)

My invention relates generally to aquatic toys and is particularly concerned with that class of toys which automatically submerge and surface when placed in a body of water.

A major object of my invention is to provide a toy of the class described having a more rapid and uniform submerging and surfacing cycle than has been possible to obtain hitherto.

Another object of my invention is to provide a toy of the class described having a mechanical structure which requires no valves or other moving parts.

Yet another object of my invention is to provide a toy of the class described which utilizes the phenomenon of the relatively high surface tension effects of water at orifices to control the surfacing and submerging cycle.

It is still another object of the present invention to provide a toy of the class described having a body composed of a deformable material.

These and other objects and advantages of the present invention will become more clearly understood by referring to the following description, and to the accompanying drawing, in which:

Figure 1 is a side elevational view of one embodiment of my invention, the solid outline showing an aquatic animal submerged in water, and the phantom outline representing the animal in surfacing position;

Figure 2 is a side elevational view of the animal seen at right angles to the view shown in Figure 1;

Figure 3 is a cross section along the line 3—3 of Figure 2;

Figure 4 is an enlarged view of the upper section of Figure 3 shown submerged in a body of water;

Figure 5 is an enlarged view of the upper section of Figure 3 shown in surfacing position;

Figure 6 is a side elevational view of a second embodiment of my invention showing a second aquatic animal in fragmentary cross section; and

Figure 7 is a graphical representation showing the change of specific gravity with time of applicant's toy as contrasted with a toy of the prior art.

In general, the aquatic toy of the present invention consists of a hollow deformable body having small openings in the upper and lower sections thereof, a material located within the lower section of the body which reacts with water entering through the lower openings to produce a gas, and a means of communication between the gas generating material and the interior of the body.

Upon placing the toy in a body of water, water first enters the interior of the body through the lower ports or openings thereof, causing it to sink slowly beneath the surface. The entry of water forces the air initially contained within the body outwardly through the upper openings or vents. As the water level rises to the level of the vents, the air is trapped in the enclosed space thereabove. Simultaneously, gas is generated by the reaction of the gas-generating material with the water entering through the lower ports. The gas rises through the water in the interior of the body into the air trap

or pocket just described, and forces the water outwardly through the wall openings.

The explanation for this phenomenon is believed to be that the surface tension of the water surrounding the wall openings is sufficient to positively seal the air within the body of the toy while allowing the water within the body to exist. As a sufficient amount of gas is generated the total specific gravity of the toy becomes less than one and the toy therefore rises to the surface. As soon as the toy surfaces sufficiently so that the upper openings contact the air, the trapped gas escapes from the air pocket allowing water to enter. The specific gravity of the toy is thus increased and it again submerges. The toy will thus continue to submerge and surface alternately so long as there is sufficient amount of gas-generating material present.

The flexibility or deformability of the body walls is advantageous in causing a more rapid initial displacement of air from within the main interior of the body as water enters the lower ports. Also, the flexibility of the body walls, generally speaking, renders the toy much more sensitive to changes in the internal air and/or water pressure thereby enabling the toy to undergo a series of more uniform submergings and surfacings than would be possible with rigid walls.

Referring now especially to Figures 1 through 3, an aquatic animal **10** is shown comprising essentially a hollow body **12** of generally conical shape and gas-generating means **14** contained within the lower section thereof. The body **12** has a pair of fins **15** attached thereto and integrally formed therewith. A plurality of tentacles **16** are affixed to the lower edge **17** of the body **12**, which, during submergence of the animal **10**, flare outwardly, and during the upward phase of movement, flares inwardly, thereby imparting a realistic undulating motion to the animal.

The flexible or deformable walls **18** of the body **12**, the fins **15**, and the tentacles **16** may be made of any water-resistant material that is somewhat heavier or lighter than water, two materials found particularly advantageous being polyethylene film (specific gravity 0.95) or vinyl film (specific gravity 1.2).

The body **12** is closed at its uppermost point **19**, its lower end being open to receive the gas-generating means **14**. A pair of small diametrically opposed escape vents or openings **20** are provided in the upper section of the walls **18** near the upper end **19** of the body **12**. A second pair of diametrically opposed inlet ports or openings **22** are provided in the lower section of the walls **18** near the lower edge **17** of the body **12**.

As is best shown in Figure 3, a gas-generating means **14**, comprising an inverted container **24**, a cap **26** therefor, and a gas-generating substance **28** held within the container is affixed within the open lower end of the body **12**.

The inverted container **24** is made of a water-insoluble material such as polyethylene or a vinyl plastic, and has a side wall **34** sloping inwardly to meet the upper wall **32** at a slightly obtuse angle. The upper wall **32** is provided with a small aperture **30** extending therethrough, the aperture forming a communicating passage between the gas-generating substance **28** and the interior of the body **12**. The cap **26**, made of a water-insoluble material such as styrene, is tightly fitted within the widened mouth of the container **24** thereby retaining the gas-generating substance **28** within the container and providing a water-tight seal for the gas-generating means **14**. The specific gravity of the gas-generating means **14** is preferably somewhat above that of water.

The lower section of the side wall **34** of the container **24** is affixed to the lower end of the walls **18** of the body

12 adjacent the inlet ports 22 in any suitable manner, such as by the use of a water insoluble adhesive, thereby completely sealing the lower end of the body.

The gas-generating material retained within the container 24 is preferably a mixture of sodium bicarbonate, cream of tartar, tartaric acid, and starch. The above-described mixture is found in many of the presently commercially available baking powders. The baking powder is preferably compacted to two-thirds of its original volume within the container 24 so that a more uniform generation of gas may occur upon contact with water which enters the gas-generating means 14, through aperture 30, of the container.

It will be understood that upon affixing the gas-generating means 14 within the body 12 in the manner described, the aquatic animal 10 is complete and is capable of achieving the objects of this invention.

The gas-generating means 14 as has been mentioned, has a specific gravity greater than that of water. Therefore, when the animal 10 is placed in a body of water, the gas-generating means 14 will immediately submerge and water will enter the body 12 through inlet ports 22.

As water enters the interior of the body 12, the animal 10 continues to sink and air is forced out of the body through escape vents 20 which are still in contact with the atmosphere above the water surface. The body 12 of the animal continues to sink due to the weight of the water entering the interior of the body, and air is continually being forced from within the body through vents 20 until the vents are below the surface of the water. A small volume of air is then trapped above the vents 20, an air pocket 40, as best seen in Figure 1, being thus formed adjacent the upper end 19 of the animal 10. It is to be noted that the rate at which the initially deflated animal sinks is relatively rapid because less air must be displaced to cause its submergence than would be the case if it possessed relatively rigid walls and a correspondingly larger volume of air to be initially displaced.

Referring now especially to Figure 4, the specific gravity of the animal 10, when filled with water to a level 21, equivalent to the uppermost points of escape vents 20, is such as to be slightly greater than that of water and therefore the animal will continue to sink downwardly beneath the water surface.

From the time of immersion of the animal 10, water enters the interior of the body 12 through ports 22 and communicates with the gas-generating material 28, such as baking powder via aperture 30. The water reacts with the baking powder 28 to generate a series of carbon dioxide gaseous bubbles which rise into, and through, the interior of the body 12. These bubbles 42 rise through the water within the body 12 into the air pocket 40 above the vents 20 and create a downward pressure, designated as *p*, in Figure 4, within the air pocket forcing the water out of the body through either or both the upper or lower vents 20, 22, respectively. The air and carbon dioxide gases, however, do not escape through vents 20, even though the water level within the interior of the body is at some point below level 21, the reason being that the surface tension of the water at the vents 20 is sufficient to prevent escape of the gas from within the interior of the body 12 outwardly, and, in effect, acts as a water seal, entrapping the air within the body. Only when the vents emerge from the water does the surface tension seal break and permit the gas to escape.

Thus, it is seen that as the animal 10 continues sinking downwardly, carbon dioxide gas is continually being generated which displaces the water within the interior of the body 12 thereby lessening the total weight. As a sufficient amount of gas is generated, the total specific gravity of the animal becomes less than one and the animal 10 will then reverse its direction and rise to the water surface.

The animal 10 will continue to rise until its upper end 19 protrudes from the water sufficiently so that a tiny

segment of the escape vents 20 are open to the atmosphere, as is best seen in Figure 5. At this point the effect of surface tension is removed and the gas entrapped within the interior of body 12 escapes into the atmosphere in the direction shown by the arrows because the water seal surrounding the vents 20 has been broken. As the gas escapes, water will again enter the interior of the body 12 thereby causing the weight of the animal 10 to increase to a point above the specific gravity of water. The animal 10 will then begin to sink below the surface of the water. When the level 21 is reached a water seal around vents 20 is again made. Gas generation will continue as described previously, and the submerging-surfacing cycle will be repeated continuously so long as gas-generating material 28 is present.

The positioning of the vents 20 may be accomplished quite readily according to the principles of the invention, the vents being positioned so that when the water level rises within the interior of body 12 to a point just equivalent to the uppermost point of the vents, the specific gravity of the animal is slightly above 1 to cause it to continue submerging. The positioning of the vents 20 may thus be readily mathematically ascertained from the geometry, volume of water displacement, and the total weight in air of the animal.

It may be desirable in some instances, to utilize a single vent instead of the dual vents 20 above-described. In such cases, the positioning of the vent is similarly ascertained in accordance with the calculations above-described.

It is apparent that the plurality of tentacles 16 will undulate outwardly and inwardly as the animal undergoes a submerging and surfacing step respectively. The undulating action imparts a particularly realistic appearance to the movement of the animal 10 in the water.

Referring now to Figure 6, a single-fin shark 50 is shown comprising a body 52 and a gas-generating means 14 contained within the interior of the body.

The gas-generating means 14 has an aperture 30 which acts as a communicating passage between the interior of the body 52 and the gas-generating power 28 and is substantially identical in construction to the gas-generating means 14 previously described with reference to the animal 10. Water inlet ports 54 and 56 are provided in the body 52 near the mouth and tail of the shark, respectively. Escape vent 58 is provided, in the upper section of the shark 50, lying below the extreme upper point of the fin 60.

The body 52 of the shark may be made of vinyl or polyethylene plastic film as previously described. The gas-generating means 14 has a specific gravity above one so that when the shark is placed in the water, it will begin to sink slowly.

The submerging and surfacing action of the shark 50 is substantially similar to the action previously described with reference to the aquatic animal 10. When the shark 50 is placed upon the water surface, it will sink slowly due to the weight of the gas-generating means 14, thereby enabling water to enter the inlet port 54 of the shark. The weight of the shark being thus increased, it will continue to sink slowly until upper inlet port 56 is also submerged, the air then being driven out through escape vent 58. The shark 50 continues to sink expelling air from vent 58 until the vent itself is submerged. An air pocket is then formed within fin 60, the total specific gravity of the shark being, at this point, just above that of water.

As soon as the animal is placed in the water, gas is generated continuously because of the contact of the water with the gas-generating material 28. As a sufficient amount of gas is generated, water is forced from the body 52 outwardly by the gas pressure through either vent 53 and/or ports 54 and 56. When a sufficient amount of water is displaced from within the body of the shark 50 to lower the specific gravity below one,

the shark will begin to rise to the surface. However, as described previously, as soon as a segment of the vent **58** contacts the air the effect of surface tension is removed and the water seal surrounding the vent breaks, the trapped gas simultaneously escaping into the atmosphere, enabling water to enter the body **52** thereby increasing the specific gravity of the shark above one, and causing it to again submerge. It will be readily seen that, as with the aquatic animal **10**, the submerging-surfacing cycle of the shark will continue so long as the gas-generating powder remains.

It will also be seen that the principles of the invention are applicable likewise to substantially vertical objects, such as the aquatic animal **10**, and to substantially horizontal objects as illustrated by the shark **50** of Figure 6.

Aquatic devices or toys of the type described above are known which have a vent hole formed in the uppermost point thereof and a lower inlet port. The vent has, for its purpose, the rapid expellation of the accumulated gases, from within the interior of the toy, to the atmosphere, as the toy surfaces. However, such toys do not have the characteristics of a rapid submerging and surfacing cycle as in applicant's device.

Because the vent is at the extreme upper point of the prior art aquatic toy, no air pocket can be formed therein. In order for the toy to completely submerge, it must have, when filled with water, a specific gravity of over one. That is to say, the body material and the gas-generating material must themselves have a specific gravity of over one. If these solid materials have a specific gravity of, for example 1.2, that of polyethylene, the amount of gas-generation necessary to cause ascent of the toy becomes appreciable, as will be seen in detail from the following example. The toy will therefore remain below the water surface for some time before surfacing. However, by employing the applicant's device the previously-described air pocket renders it possible to achieve a much faster rate of descent than is possible by the toys of the prior art, even though the same body materials are used.

Referring now to Figure 7, a graph is shown wherein the rate of variance of the specific gravity of an aquatic toy is plotted against time in minutes. The solid line denotes the submerging and surfacing cycle of a toy of the prior art having a vent at its uppermost point, its walls and gas-generating means having specific gravity of 1.2.

For the purpose of illustration, assume that the walls and the gas-generating means of applicant's toy have the same specific gravity as that of the prior art toy and that the total weight of each toy is the same and equal to 12 grams. Assume also that each toy is hollow and has the same inner volume of 98 cc. and the same displacement in water (outer) volume e.g. 100 cc. Further assume that the rate of gas generation is the same in both devices, the rate being 0.4 cc. per minute.

Referring now only to the prior art toy, at zero time the toy is placed in water and submerges totally, for example, in 0.5 minutes. In this time the interior of the device is filled with water so that its total weight becomes 110 grams, comprising 98 grams of water and 12 grams of solid materials. Since it displaces 100 cc. of water, its specific gravity becomes 1.1. Thus, its specific gravity increases linearly, as a first approximation from approximately 0.12 to 1.10 in 0.5 minutes.

Since the rate of gas-generation is stipulated to be 0.4 cc. per minute, the specific gravity of the animal will be approximately equal to water in 2.5 minutes after initial total submergence. However, the toy will continue to become lighter, due to continued gas generation, since it cannot immediately surface to expel the generated gas. Assuming a period of 0.5 minute for ascent, the rate of decrease of specific gravity with time is shown, as a first approximation, to be a linear function passing downwardly from a specific gravity of 1.10, through 1.0, to approximately 0.98 the total elapsed cycle time being approximately 3.0 minutes.

Practically instantaneously upon surfacing, the specific gravity of the animal increases to 1.10, as shown by the vertical line extending from specific gravity 0.98 to 1.10, the almost instantaneous increase being caused by the immediate escape of gas from the uppermost vent, thus allowing water to enter the inlet ports to return the specific gravity of the animal to 1.10. The submerging step will then commence again.

Referring now to the applicant's toy **10** the toy **10** is introduced into water at zero time. The weight of the device is 12 grams, and its water displacement and inner volume is somewhat less than 100 cc. because its pliable deformable walls are initially deflated. Assume for example that the outer volume of the deflated toy is initially 50 cc., its initial specific gravity is 0.24. The toy, upon being placed in water, increases in specific gravity as its interior commences to be filled with water; the toy therefore, commences to sink. As the vents **20** reach the water surface, the specific gravity of the animal reaches its maximum as shown by the following calculations:

Assuming the volume of the air pocket formed above the vents to be X cc., then the weight in air of the toy is, at this point (98–X) gms. water plus 12 gms. material, or (110–X) grams. The loss of weight of the toy in water is equal to the volume of water displaced by the toy, or approximately (100–X) gms. Since the specific gravity of the toy is equal to the weight of the body in air divided by the loss of weight in water the specific gravity is

$$\frac{110-X}{100-X}$$

The volume of the air pocket X, is relatively small, for example 8 cc. and the specific gravity as the vents reach the water level is therefore

$$\frac{110-8}{100-8} \text{ or } 1.13$$

As the toy sinks further to the point of complete submergence the weight in air of the toy remains the same, or (110–X) grams, but the volume of water displaced equals the outer volume of the toy or 100 cc. Therefore, the specific gravity becomes

$$=\frac{\text{weight in air}}{\text{volume water displaced}}$$

or

$$=\frac{98-X \text{ plus } 12}{100}$$

and when X equals 8 the specific gravity becomes

$$\frac{98-8+12}{100}=1.02$$

Thus, the curve for applicant's device starts at a specific gravity of 0.24 and, assuming the same rate of submergence as in the prior art device, will be completely submerged in approximately 0.4 minutes having reached the specific gravity peak of 1.13, thereafter dropping suddenly to 1.02.

Since the rate of gas generation was stipulated to be 0.4 cc. per minute, the specific gravity of the animal will be lowered to that of water in approximately 0.5 minute. As described previously, with reference to the prior art device, the animal will continue to become lighter, due to continued gas generation, since it cannot surface immediately to expel the trapped gas. Assuming a like period of ascent as with the prior art device, namely 0.5 minute, the rate of decrease of specific gravity with time is shown, as a first approximation to be a linear function passing downwardly from a specific gravity of 1.02, through 1.0 to approximately 0.98, the total elapsed cycle time being approximately 1.0 minutes.

Practically instantaneously upon surfacing, the specific

gravity of the animal increases to 1.02 as shown by the vertical line extending from specific gravity 0.98 to 1.02. The submerging step will then commence again.

It is seen that the total submerging time of the applicant's device is approximately 0.5 minute contrasted with an approximately 2.5 minute period for the prior art device, both devices having the same inner volume and displacement volume as well as the same weight in air. It can also be readily seen that a more rapid submerging-surfacing cycle results by the use of applicant's device, the specific example illustrating that the applicant's toy makes approximately 3 times the number of cycles that the prior art toy makes in the same time period.

The toy of the applicant's device may be made of a great range of materials, and is not necessarily restricted to those few materials having a specific gravity just above that of water for, by merely regulating the size of the heretofore described air pocket, the total specific gravity of the toy when submerged can readily be adjusted to be just above that of water.

Many modifications and changes may be made that lie within the scope of this invention. Therefore, I do not intend to be limited by the embodiments herein described and illustrated, but only by the appended claims.

I claim:

1. An aquatic toy for immersion in water comprising: a hollow body having a closed top and substantially vertical depending side wall; a water-actuated gas generator supported in said body; means forming a vent in said side wall said vent being located at a level such that when the upper portion of said body is filled with gas above the lower edge of said vent said toy floats and when such gas escapes to a level at the upper edge of said vent said toy sinks and said vent being sufficiently small that the surface tension in the water-gas interface across the same prevents the passage of gas therethrough except when said vent is above the surface of water in which said body is immersed.

2. An aquatic toy comprising: a hollow body having a water actuated gas generator therein and a flotation dome formed in the upper portion thereof in communication with said generator to receive gas therefrom, the volume of said dome being such as to float said body and generator when filled to a pre-determined level with gas generated by said generator; means to admit water to said generator when said body is immersed; means forming a vent in the non-horizontal side wall of said dome adjacent said pre-determined level, said vent being of substantial size and having at least a portion thereof extending above said pre-determined level whereby when said body rises to the surface due to filling of said dome with gas as aforesaid, said vent emerges above the surface breaking the surface tension at said vent and permitting gas to escape from said dome to a level at the top of said vent causing said body to sink.

3. An aquatic toy comprising: a hollow body having a water actuated gas generator therein and a flotation dome formed in the upper portion thereof in communication with said generator to receive gas therefrom; means forming a vent in the non-horizontal side wall of said dome said vent being located in the dome at a point where the gas volume lying above the level of the lower edge of said vent is sufficient to float said body and generator while the gas volume lying above the upper edge of said vent is insufficient to float said body and generator and said vent being sufficiently small that the surface tension in the water-gas interface across said vent is sufficient to prevent the passage of gas through said vent until said vent emerges above the surface of water in which said body is immersed.

4. The construction of claim 3 in which the generator is located below said vent.

5. An aquatic device comprising: a hollowed-out body having a flotation dome formed in the upper portion thereof; a source of gas communicating with said flotation dome for introduction of gas thereinto; and means forming a vent in the non-horizontal side wall of said dome, said vent being located in the dome at a point where the gas volume lying above the level of the lower edge of said vent is sufficient to float said body while the gas volume lying above the upper edge of said vent is insufficient to float said body and said vent being sufficiently small that the surface tension in the water-gas interface across said vent is sufficient to prevent the passage of gas through said vent until said vent emerges above the surface of water in which said body is immersed.

References Cited in the file of this patent

UNITED STATES PATENTS

2,567,180	Bunkowski et al.	Sept. 11, 1951
2,712,710	Hirsch et al.	July 12, 1955