June 11, 1963 J. A. GRAND ETAL 3,093,107

EXPENDABLE AMMONIA NOISEMAKER

Filed Jan. 25, 1945

FIG. 3

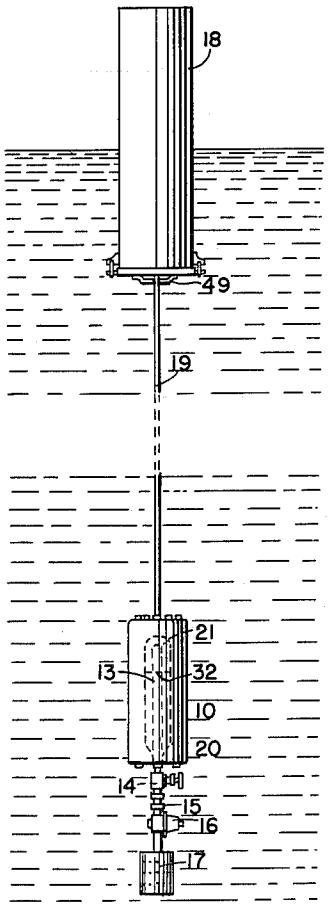


FIG. 2

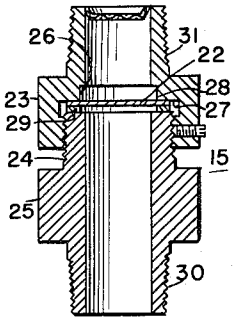
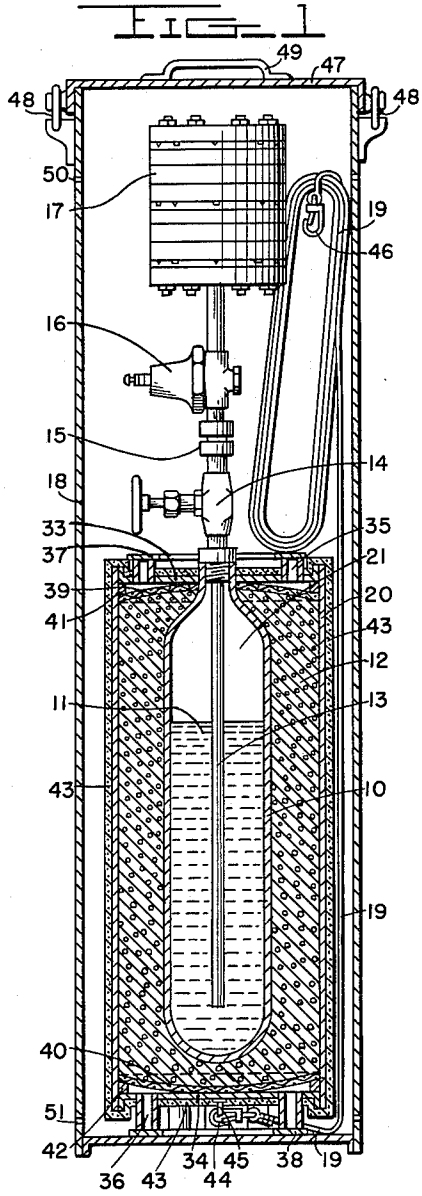


FIG. 1



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3,093,107

EXPENDABLE AMMONIA NOISEMAKER

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9 Claims. (Cl. 116—27)
(Granted under Title 35, U.S. Code (1952), sec. 266)

The present invention relates to methods of and means for the generation of underwater sound, particularly the generation of underwater sound by the collapse of vapor bubbles through expendable means and useful as a counter measure against acoustic torpedoes and mines, or an underwater sound beacon or the like.

In the generation of underwater sound by collapse of vapor bubbles the pressure at which the vapor must be injected into the surrounding body of water and the volume necessary in order to produce sound of an adequate level of intensity, demands a large capacity high pressure source, a requirement ordinarily unobtainable in a readily wieldable compact embodiment such as would be necessary for a practical expendable device especially where such is to be used as a counter-measure.

It is therefore an object of the present invention to provide such a source in a form compact and readily wieldable for launching into the water by one or a crew of a few men and operable fully independently of the mother ship after being launched.

An important phase of this invention is the discovery that the vapors of gaseous substances readily soluble in water such as ammonia, hydrogen chloride and sulfur dioxide, which may be produced much more readily and with lighter apparatus than steam, may be used very effectively in the production of underwater sound by collapse of vapor bubbles.

Another object is the provision of a large capacity high pressure source of vapor highly effective in the production of underwater sound by the collapse of vapor bubbles due to rapid solution of the vapor in a surrounding body of water embodied in a device which, together with other elements constituting a complete expendable underwater sound generator, shall be light, compact, sturdy and capable of being stored for indefinite periods of time in condition for being very readily and quickly primed for use.

A further object is the provision in an underwater device of means for supplying an adequate quantity of heat of evaporation to a body of liquid gas at a controlled, variable rate of application whereby to avoid undue lag in the attainment of substantially full operating pressure and rate of supply and to maintain adequate pressure and rate of supply throughout the operating period.

Various other objects and advantages of the invention will become apparent upon a perusal of the following specification and the drawings accompanying the same.

In the drawings: FIG. 1 is a side elevation partly in section showing the device in stored condition. FIG. 2 is an enlarged sectional view of the blow-off patch holding element. FIG. 3 is a small scale view showing the device in operative position in a body of water.

The device comprises in general a container **10** for storage of the vapor supply in the form of a liquified gas **11**, in the present instance liquid ammonia, heating means **12** in the form of a substance capable of generating heat upon contact with water; vapor supply pipe **13**; pressure control devices **14**, **15** and **16** and a distributing nozzle **17**, the whole assemblage being contained in a storage casing **18** together with a supporting cable **19** for connecting the noise generating device with the storage case for use of the latter as a float when the whole is launched into the water. In operation in a body of water, the whole assemblage assumes the position shown in FIG. 3 in which

the parts are inverted with respect to their position in FIG. 1. As shown in FIG. 3, the device consists of the three main parts, a floating part **18**, a submergible part consisting of the underwear noise making equipment, and means **19** for suspending the submergible part from the floating part in predetermined submerged position. The distributing nozzle **17** may be of any known or other suitable form capable of distributing the gas or vapor into a surrounding body of water in the form of small bubbles, and is preferably of the kind shown and described in the application of Richard F. Post for Expendable Vapor Noise Maker, Serial No. 574,602, filed January 25, 1945.

The storage container **10** is mounted within a heater-casing **20** wherein it is surrounded by the heating means **12**. Preferable a chemical mixture operable in the presence of a water to generate heat.

Thus pressure within the storage container **10** may be rapidly built up to a desired working pressure and thereafter a supply of heat maintained sufficient to compensate for heat absorbed in the evaporation of liquid gas in supplying vapor to the nozzle **17**. It will be understood that with the parts inverted from the position of FIG. 1 into the position of FIG. 3 when in operation, the vapor space **21** will be transferred from the position shown in FIG. 1 to that shown in dotted lines in FIG. 3, so as to surround the inlet end of the vapor supply pipe **13**, with the result that only vapor may pass out through the supply pipe. To prevent escape of vapor before the pressure has built up to a predetermined value, a blow-off patch holding element **15** is inserted between the blocking valve **14** and pressure reducing valve **16** to interpose a blow-off patch **22** (FIG. 2) in the line of supply to the nozzle.

The blow-off patch holding element **15** as will be seen from FIG. 2 is in the general form of the usual pipe union and is comprised in the main of a recessed member **23** internally threaded to receive the externally threaded end **24** of a plug member **25**. A shouldered portion **26** within the recessed member forms a seat **27** for the blow-off patch disc **22** the valve seat having a sharp shearing inner edge **28**. A gasket **29** seals the junction between the plug member and the blow-out patch disc and transmits the pressure evenly over the marginal edge of the blow-out patch disc against the patch disc seat **27**. An externally threaded extension **30** on the other end of the plug member connects with the outlet end of the blocking valve **14** while a similarly externally threaded extension **31** on the outer end of the recessed member **23** connects with the automatic pressure reducing valve **16**. Thus with the blow-out patch sealed across the connection between the blocking valve and the automatic pressure reducing valve, such connection is sealed against the flow of vapor until the pressure on the inlet side of the blow-off patch holder **15** increases to a magnitude sufficient to force the blow-off patch against the shearing edges of the seat, shearing out the patch and clearing the passage-way to the pressure reducing valve. In the present embodiment the blow-off patch is of thin sheet copper of a thickness in the neighborhood of five thousandths of an inch, with a diameter at the shearing edges **28** of the seat of approximately one half inch. It will be understood of course that the blow-off patch may be made of any known or other suitable material capable of sealing off the vapor under pressure until the shearing pressure is reached. Thus the blow-off patch functions as a time delay means of postponing operation until the vapor pressure has built up to a predetermined working pressure, the delay being determined by two factors, the pressure at which the patch is designed to shear, and the rate at which the pressure builds up.

The automatic pressure reducing valve **16** may be of any known or other suitable form operable automatically to reduce the high pressure delivered to the valve to a

lower pressure of given value above ambient pressure, delivering the vapor at such controlled pressure to the distributing nozzle **17**. Vapor under pressure is supplied from a body of liquified gas, in the present instance, ammonia, nearly filling the cylinder **10**, for example to the level **32** so as to allow a vapor space **21** (FIG. 3) around the inner end of the vapor supply pipe **13** when the device in use is inverted with respect to conditions shown in FIG. 1. Pressure is built up in the vapor space by the application of heat to the body of liquid ammonia within the cylinder **10** through the cylinder wall from the chemical heating substance **12** surrounding the cylinder **10** in the heater casing **20**. This heating casing is in the form of a cylindrical can having in its end walls **33** and **34** a series of vent tubes **35** and **36**, and filled with a chemical mixture **12** of any known or other suitable kind capable of generating heat upon contact with water, preferably a combination of two such mixtures, one a fast operating mixture in relatively small proportion and the other a relatively slow operating mixture in relatively larger proportion and operable in combination to effect first a rapid generation of heat for a relatively short time and later a relatively slower generation of heat for a longer time whereby the pressure is rapidly built up to the desired working pressure, and thereafter maintained at working pressure without substantial increase in pressure. In the present embodiment this is accomplished by a mixture as follows:

NaOH, 5,940 grams,
Na_2O, 600 grams,
Aluminum shavings, 600 grams.

The sodium hydroxide is used in the form of lenticular pellets of approximately a quarter inch in diameter and one eighth inch thick. The sodium oxide is used in the form of cylindrical pellets of approximately one-half inch in length by a little less than one-eighth inch in diameter. With the mixture thus formed the reaction of the sodium oxide with rapid production of heat continues for about 50 seconds after which the sodium hydroxide formed by the action of the sodium oxide with the water, together with the initial supply of sodium hydroxide in pellet form, continues to react with the aluminum turnings to generate heat at the lower rate. Readily removable sealing strips **37** and **38**, in the present embodiment strips of adhesive cellophane, close the outer ends of the vent tubes **35** and **36**. To prevent loss of the heating chemicals and to prevent the vent from being clogged up by the pellets of heating chemicals, screen diaphrams **39** and **40** are placed within the casing **20** at either end between the charge of chemical mixture **12** and the inner end of the vent tubes and spaced from the vent tubes by means of suitable spacing rings **41** and **42** maintaining the screens out of contact with the vent tubes thus assuring a continuous flow of water and gaseous end-products through the screen to the vent tubes, even should a portion of the screen opposite the vent tubes become clogged. The vent tubes **36** which in operation functions as outlets for water vapor and gas are greater in number than vent tubes **35** which in operation function as inlet openings for water. In the present embodiment there are eight of the vent tubes **36** and four of the vent tubes **35**. A thermal insulating jacket **43** in the form of an adhering coating of plastic material covers the entire surface of the heater casing **20**.

The device is stored in the storage casing **18** as shown in FIG. 1 with one end of the supporting cable **19** terminating in the hook **44** secured through such hook to a supporting eye **45** in the end wall **34** with the remainder of the cable extending up along the inner side of the casing and stored in a roll near the top of the casing so that the cable may be used to aid in withdrawing the noise generating device from the casing, the free end of the cable **19** terminating in a fastening hook **46**. A lid **47** clamped on by means of clamps **48** covers the storage casing and is provided with a suitable handle **49** for ready handling of the casing and for attachment of the cable hook **46** for use of the empty casing as a float. A more complete understanding of the device and the cooperative relation of its constituent parts will be had from the description of operation which follows:

In operation, the lid clamps **48** are released, the lid removed and the noise generating device withdrawn from the casing with the aid of the distributing nozzle **17** and the supporting cable **19**. The case now being empty the lid is replaced and clamped on with the clamps **48** whereupon the cable hook **46** at the free end of the cable is hooked on to the handle **49**. The empty storage case **17** being now sealed except for the very small bleed openings **50** and **51**, is ready for use as a supporting float for the noise generating device. The device is now primed for operation by opening the blocking valve **14** and withdrawing the sealing strips **37** and **38**, and is immediately launched into the body of water into which it is to be used.

The noise generating device entering the body of water sinks to the depth determined by the length of supporting cable **19**, the upper end of which is maintained near the surface by the floating, empty storage casing **18**. The assemblage now assumes the position indicated in FIG. 3 where it will be noticed that the sound generating device is in a position inverted with respect to that shown in FIG. 1. This of course causes the body of liquid gas to gravitate toward the now lower end of the gas storage cylinder **10** placing the vapor space **21** at the closed end of the cylinder above the inlet of the vapor outlet pipe **13**. Water now entering the inlet vent tubes **35** rises upwardly mixing with the chemical mixture **11** whereupon chemical action takes place resulting in first a very rapid generation of heat for a short period of time followed by a slower generation of heat for a longer period of time the gaseous end products rising out of the interior of the heater escaping through outlet vent tubes **36**. During the rapid heating period of this operation, the liquid ammonia **11** in the storage tank **10** is rapidly heated raising the pressure in the vapor space around the inlet end of the vapor supply pipe **13** until in about 50 seconds or less the pressure reaches approximately 600 pounds per square inch whereupon the central portion of the blow-off patch is sheared out along the edge **28** and either blown clear of the edge into the passage between the blow-off patch holder and the pressure reducing valve in a substantially unobstructing position, or severed from the marginal portion on the seat **27** except for a small portion by which it may be held, but in a position to permit only a negligible resistance to the flow of operating vapor. Thus the blow-off patch functions both as a time delay to postpone operation during proper positioning of the device in the water relative to the mother ship, and as a means for preventing the escape of vapor before the proper operating pressure has been reached. The vapors now passing to the automatic reduction valve are acted on by such valve to pass them on to the distributing nozzle at a pressure reduced to a given amount above ambient pressure, in the present instance a difference in the neighborhood of 100 pounds per square inch. The vapor delivered to the nozzle at this pressure is distributed into the water in the form of discrete bubbles which, rapidly collapsing, generate the underwater noise or sound desired.

Shortly after the building up of the vapor pressure to the maximum determined by operation of the blow-off patch, the rapid heating phase of the cycle ceases, followed by the continuing action of the NaOH on the aluminum in the presence of water to maintain a relatively slower application of heat to the liquid ammonia sufficient to keep the pressure up to a point well above the working pressure desired at the nozzle, for an indefinite time according to the storage capacity of the device. After a time amply sufficient for completion of a full operation the water which in the meantime has been very slowly entering the storage casing through the bleed holes reaches an amount

sufficient to sink the casing 18 so that the entire assemblage is lost to sight.

While but one specific embodiment of the invention has been shown and described herein for the sake of disclosure, it is to be understood that the invention is not limited to such specific embodiment but contemplates all such modifications and variants thereof as fall fairly within the scope of the appended claims.

The invention described herein may be manufactured and used by or for the Government of the United States of America for Government purposes without the payment of any royalty thereon or therefor.

What is claimed is:

1. An expendable underwater sound generating device comprising a floating part and a submergible part, means suspending the submergible part from the floating part in a predetermined submerged position, said submergible part including a container, a body of liquid gas partially filling the container and leaving a liquid-free gas-filled space above the liquid in the submerged position, means operable upon submergence in a body of water to supply heat to the said body of liquid, a nozzle positioned to be submerged in the water when the device is floated for injecting gas into a surrounding body of water for generating compressional waves by collapse of the gas volume, means forming a gas conducting passage between said space and said nozzle, pressure responsive means for connecting said space with the nozzle upon attainment of a given pressure in said space, and an automatic pressure regulating valve connected in said conducting passage between the said pressure responsive means and the nozzle.

2. An expendable underwater sound generating device comprising a floating part and a submergible part, means suspending the submergible part from the floating part in a predetermined submerged position, said submergible part including a container, a body of liquified gas partially filling the container to leave a liquid free, gas filled space in the upper part of the container in the submerged position, a distributing nozzle positioned to be submerged in the water when the device is floated for discharging bubbles of gas into the water for generating compressional waves by collapse of the bubbles, means forming a gas-conducting passage between said space and said nozzle, and means positioned to be submerged in the water when the device is floated and operable upon submergence in water to supply heat to said container first at a relatively rapid rate and later at a relatively slower rate.

3. An expendable underwater sound generating device comprising a floating part and a submergible part, means suspending the submergible part from the floating part in a predetermined submerged position, said submergible part including a container, a body of liquified gas partially filling the container to leave a liquid free, gas filled space in the upper part of the container in the submerged position, a distributing nozzle positioned to be submerged in the water when the device is floated for discharging bubbles of gas into the water for generating compressional waves by collapse of the bubbles, means forming a gas conducting passage between said space and said nozzle, means normally closing said passage and pressure responsive to open the passage upon attainment of a given pressure in said space and means positioned to be submerged in the water when the device is floated and operable upon submergence in water to supply heat to said container first at a relatively rapid rate and later at a relatively slower rate.

4. An expendable underwater sound generating device comprising a floating part and a submergible part, means suspending the submergible part from the floating part in a predetermined submerged position, said submergible part including a container, a body of liquified gas partially filling the container to leave a liquid free, gas filled space in the upper part of the container in the submerged position, a distributing nozzle positioned to be submerged in the water when the device is floated for discharging bubbles of gas into the water for generating compressional waves by collapse of the bubbles, means forming a gas conducting passage between said space and said nozzle, a mixture of two chemical substances surrounding said container, one a chemical substance operable in the presence of water to effect a relatively rapid generation of heat and the other a chemical substance operable in the presence of water to effect a relatively slower generation of heat, said first substance being in larger proportion than the latter, and means admitting water to said chemical substances when the device is floated.

5. An expendable underwater sound generating device comprising a floating part and a submergible part, means suspending the submergible part from the floating part in a predetermined submerged position, said submergible part including a container, a body of liquified gas partially filling the container to leave a liquid free, gas filled space in the upper part of the container in the submerged position, a distributing nozzle positioned to be submerged in the water when the device is floated for discharging bubbles of gas into the water for generating compressional waves by collapse of the bubbles, means forming a gas conducting passage between said space and said nozzle, a heater casing having vent openings therein, containing the said liquified-gas container, a mixture of chemical heating substances surrounding the liquified-gas container, said mixture comprising sodium oxide, sodium hydroxide and comminuted metallic aluminum in the following proportions: sodium oxide 600 grams, sodium hydroxide 5940 grams and aluminum 600 grams, and means admitting water to said chemical substances when the device is floated.

6. An expendable underwater sound generating device comprising a floating part and a submergible part, means suspending the submergible part from the floating part in a predetermined submerged position, said submergible part including a container, a body of liquified gas partially filling the container to leave a liquid free, gas filled space in the upper part of the container in the submerged position, a distributing nozzle positioned to be submerged in the water when the device is floated for discharging bubbles of gas into the water for generating compressional waves by collapse of the bubbles, means forming a gas conducting passage between said space and said nozzle, a heater casing having vent openings therein, containing the said liquified-gas container, a mixture of chemical heating substances surrounding the liquified-gas container, said mixture comprising sodium oxide, sodium hydroxide and comminuted metallic aluminum in the following proportions: sodium oxide 600 grams, sodium hydroxide 5940 grams and aluminum 600 grams, said sodium oxide being in the form of lenticular pellets of approximately one-fourth inch in diameter and one-eighth inch thick, and said sodium hydroxide being in the form of cylindrical pellets approximately one-half inch long and one-eighth inch in diameter, and means admitting water to said chemical substances when the device is floated.

7. An expendable underwater sound generating device comprising a floating part and a submergible part, means suspending the submergible part from the floating part in a predetermined submerged position, said submergible part including a container, a body of liquified gas partially filling the container to leave a liquid free, gas filled space in the upper part of the container in the submerged position, a distributing nozzle positioned to be submerged in the water when the device is floated for discharging bubbles of gas into the water for generating compressional waves by collapse of the bubbles, means forming a gas conducting passage between said space and said nozzle, means normally closing said passage and pressure responsive to open the passage upon attainment of a given pressure in said space, and means positioned to be submerged in the water when the device is floated and operable upon

submergence in water to supply heat to said container first at a relatively rapid rate and later at a relatively slower rate.

8. An expendable underwater sound generating device comprising a floating part and a submergible part, means suspending the submergible part from the floating part in a predetermined submerged position, said submergible part including a container, a body of liquified gas partially filling the container to leave a liquid free, gas filled space in the upper part of the container in the submerged position, a distributing nozzle positioned to be submerged in the water when the device is floated for discharging bubbles of gas into the water for generating compressional waves by collapse of the bubbles, means forming a gas conducting passage between said space and said nozzle, a heater casing having vent openings therein, containing the said liquified-gas container and a mixture of chemical heating substances surrounding the liquified-gas container, said mixture comprising sodium oxide, sodium hydroxide and comminuted metallic aluminum in the following proportions: sodium oxide 600 grams, sodium hydroxide 5940 grams and aluminum 600 grams, said sodium oxide being in the form of lenticular pellets of approximately one-fouth inch in diameter and one-eighth inch thick, and said sodium hydroxide being in the form of cylindrical pellets approximately one-half inch long and one-eighth inch in diameter, together with a blocking valve in said passage between said liquified gas container and said pressure responsive means, an automatic pressure reducing valve connected in said passage between said pressure responsive means and said nozzle, and means admitting water to said chemical substances when the device is floated.

9. An expendable underwater sound generating device comprising a floating part and a submergible part, means suspending the submergible part from the floating part in a predetermined submerged position, said submergible part including a storage container, a body of liquified gas partially filling the upper part of the container in the submerged position to leave a liquid free, gas filled space in the storage container, a distributing nozzle positioned to be submerged in the water when the device is floated for discharging bubbles of gas into the water for generating compressional waves by collapse of the bubbles, means forming a fluid conducting passage between the interior of said container and the nozzle, a blow-off patch normally closing said passage and rupturable upon the attainment of a given pressure in said space to open said passage, and means positioned to be submerged in the water when the device is floated and operable upon submergence in water to supply heat to said container first at a relatively rapid rate and later at a relatively slower rate.

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