Aug. 11, 1964 E. GAGNAN ET AL 3,144,171

ACOUSTIC WARNING ASSEMBLY FOR SKIN DIVING APPARATUS

Filed May 2, 1962 2 Sheets-Sheet 1

Fig. 1

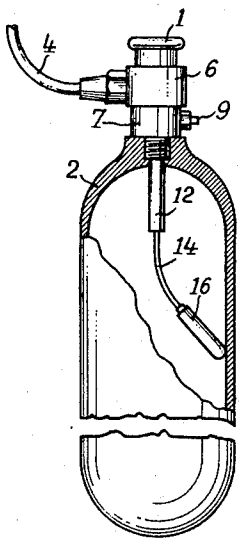


Fig. 2

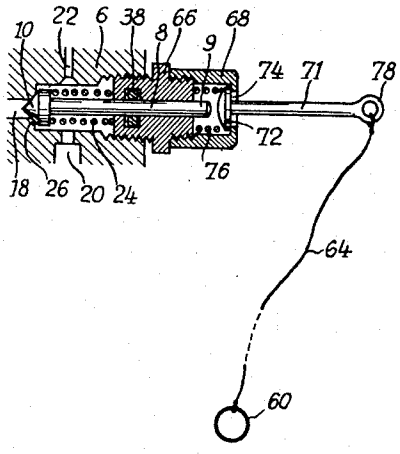
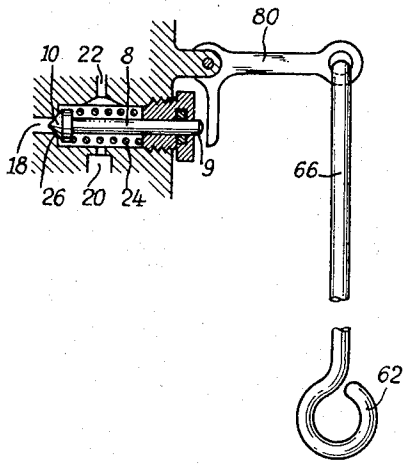


Fig. 3



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Filed May 2, 1962 2 Sheets-Sheet 2

Fig. 10

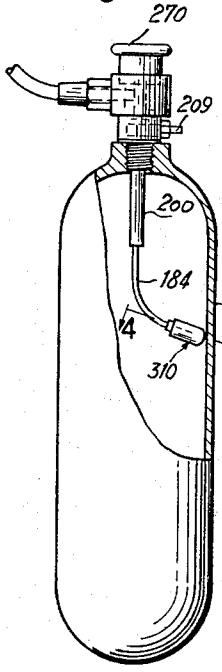


Fig. 4

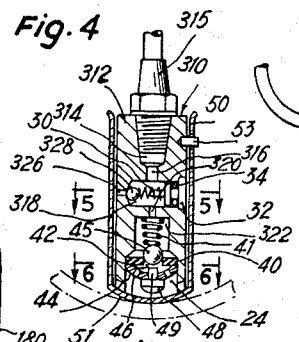


Fig. 9

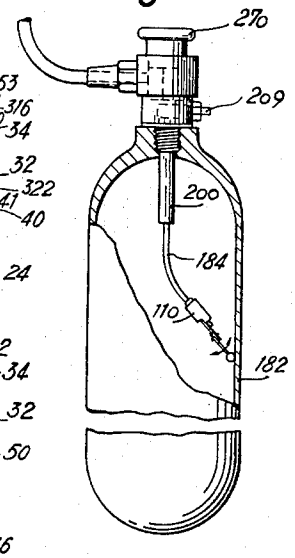


Fig. 5

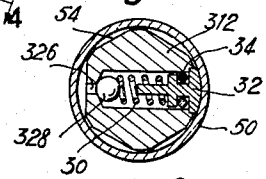


Fig. 6

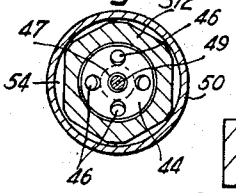


Fig. 11

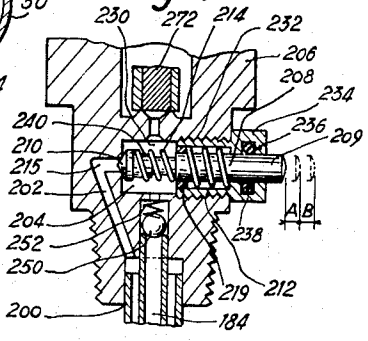


Fig. 7

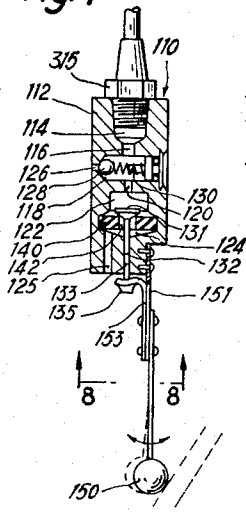


Fig. 8

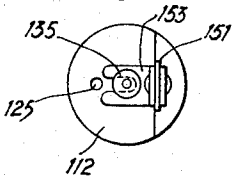
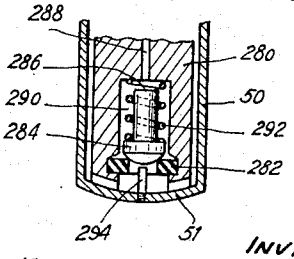


Fig. 12



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3,144,171

ACOUSTIC WARNING ASSEMBLY FOR SKIN DIVING APPARATUS

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Filed May 2, 1962, Ser. No. 191,814
Claims priority, application France May 19, 1961
13 Claims. (Cl. 222—3)

The present invention relates to an acoustic warning assembly for a skin diving apparatus having at least one container for a breathable gas under pressure.

According to the invention, the assembly includes a warning device, a warning control device sensitive to the pressure of gas in said container and arranged automatically to bring said warning device into action when the pressure into the container falls below a pre-determined value and means, accessible to the user of the apparatus when under water or elsewhere, for effecting manual control of the said warning device at any gas pressure above the predetermined value.

One object of this invention is to enable a user of the apparatus by deliberately operating the warning device, to emit acoustic signals for example for communication with another user.

Another object is to make it possible for a diver or other user to test his reserve warning system at any time, provided that the pressure in the container is above the predetermined pressure.

Preferably, the acoustic warning device is operated by the current of gas coming from the breathable gas container and going to the respiratory organs of the user. In this way, the gas which has been used for signalling is not lost for respiration; furthermore, the user can impart a rhythm to his signals simply by suitable control of his breathing.

The warning device proper can be a simple whistle. It is generally preferable to use a device which causes the wall of the container to vibrate at audible frequencies; such a device is, for example, a trembler or vibrator a vibrating part of which imparts blows to the said wall, or a device comprising a small block which transmits blows to the wall.

Several forms of embodiment of the invention are illustrated diagrammatically and by way of example in the accompanying drawings.

FIGURE 1 is a view, partly in section, of a compressed air bottle with an acoustic warning assembly comprising a manual control.

FIGURES 2 and 3 show in sectional view two modified forms of the control of the warning device.

FIGURE 4 is a longitudinal sectional view, along the line 4—4 of FIGURE 10, of a warning device.

FIGURES 5 and 6 are cross-sectional views of the warning device according to FIGURE 4, respectively on the planes 5—5 and 6—6 of this figure.

FIGURE 7 is a longitudinal sectional view of another warning device.

FIGURE 8 is a sectional view taken on the plane 8—8 of FIGURE 7.

FIGURE 9 is an elevational view, partly in section, of a compressed gas bottle provided with a warning device according to FIGURES 7 and 8.

FIGURE 10 is a view similar to FIGURE 9, but wherein the warning device is that illustrated in FIGURES 4, 5 and 6.

FIGURE 11 is a longitudinal sectional view of a valve controlling the operation of a warning device in dependence on the pressure in the gas bottle.

FIGURE 12 is a longitudinal sectional view of another warning device.

FIGURE 1 illustrates a compressed air bottle 2 with cock 6 and pipe 4 leading to the breathing apparatus proper.

The cock is provided with a control wheel 1 in known manner and incorporates, in its base 7, a device referred to herein as a "warning control device" for example one of those illustrated in FIGURES 2 and 3. This device is such that when the air pressure in the bottle 2 is greater than a certain value (20 to 25 kg./cm.^{2} generally) the gas delivered by the cock 6 and tube 4 is taken directly from the bottle by a tube 12. On the contrary, when the pressure is below this value, this device blocks the passage coming from the tube 12 and the gas supplied passes by way of a warning device 16 and tube 14. This warning device, as aforesaid, may be of various types; three types will be described hereinafter.

The warning control device comprises means in the form of an element 9 which can be displaced to make the warning device operate at will, i.e. even when the pressure is greater than the value adopted as the reserve pressure. By acting on this element, the user brings the warning device 16 into operation; the vibrations emitted by the warning device and, if appropriate, by the wall of the bottle 2, are transmitted through the water, in the case of a diver, in all directions, and can be heard by divers near by, and possibly by a ship provided with means for picking up sounds propagated through the water.

It is also possible to act on the element 9 simply in order to verify whether the warning device is working efficiently.

The warning device 16 may, for example, have the form as illustrated in FIGURES 4, 5 and 6, or as illustrated in FIGURE 12.

FIGURES 2 and 3 show on a larger scale two warning control devices; these devices are provided with means which makes it possible to act more easily on the element 9.

In each of these devices, the orifice 18 communicates with the tube 12, the orifice 20 with the tube 14 and the orifice 22 with the plug and plug carrier assembly of the cock 6.

When the pressure in the bottle, which also prevails in the orifice 18, is at a sufficient value it pushes the valve member 10 and its rod 8 towards the right in FIGURES 2 and 3 in opposition to the pressure of the spring 24. The air then passes from the orifice 18 to the orifice 22.

If the pressure is below the value fixed as the reserve pressure, the valve member 10 is displaced towards the left and is applied against its seat 26. The air inhaled by the driver then necessarily passes through the orifice 20 and therefore by way of the warning device 16. This is the position shown in FIGURES 2 and 3.

It will be appreciated that, in the first position, where the rod 8 is to the right of the position illustrated, it is sufficient to press on the end 9 of the rod 8 to make the warning device operate each time the diver inhales.

In the embodiment illustrated in FIGURE 2, a double screw-threaded plug 66 has been screwed into the base of the cock 6. This plug, which forms a guide for the rod 8, contains a packing ring 38 for the said rod.

Screwed on to the outer part of the plug 66 is a small bell-shaped part 68. A push member 71, having a widened head 72 situated within the bell-shaped part, extends with considerable clearance through an orifice 74 pierced in the top of the bell-shaped part; a spring 76 applies the head 72 against the top of the bell-shaped part.

The end of the push member 71 opposite from the head

72 is provided with an eye 78 to which is attached the chain 64 terminating in a ring 60.

When the diver pulls the ring 60 downwards, he lowers the eye 78 and the push member 71 rocks about the upper portion of the head 72, which portion remains in contact with the top of the bell-shaped part. Owing to this rocking movement, the center of the head is displaced towards the left and pushes towards the left the rod 8, so that the warning device operates when the diver inhales, as explained hereinabove.

When the diver releases the ring 60, the valve member 10 returns towards the right if the pressure in the bottles 2 is sufficient and allows the passage of the gas coming from the tube 12 by way of the orifice 18; the warning device then remains silent.

The embodiment shown in FIGURE 3 uses a bellcrank lever 80 so that the diver, by pulling on the ring 62 on the end of the rod 166 pivotably mounted on the lever 80 pushes towards the left the end 9 of the rod 8 of the valve member 10.

Many modifications can be made to the illustrated systems of manually controlling the warning device without departing from the scope of the present invention. For example, the push member 71 can be operated by a rod such as 166 and the lever 80 by a chain such as 64. The lower end (in FIGURE 2) of the chain 64 could also be fixed, the diver then pulling on the chain at any desired point along the chain. Equally the rod 166 could be guided so as to prevent it from swinging about freely. It is also possible to use other manual control systems for the rod 8. Furthermore, all these systems can be applied to apparatus other than the warning control devices represented in FIGURES 2 and 3.

FIGURES 4, 5 and 6 show in detail a first form of acoustic warning device.

This warning device, given the general reference numeral 130, comprises a main body 312 of substantially hexagonal cross-section. This body is perforated axially to form a frusto-conical cavity 314 which is tapped to receive a screw-threaded connection 315 as described hereinafter; after the cavity 314, this bore forms an axial passage 316 for the gas, this passage opening into a transverse hole 318. A further passage 320, which is narrow, connects the hole 318 to a widened axial cavity 322 which widens further into a cavity 324 which leads to the exterior of the body 312. A further narrow passage 326 extends through the body 312 forming an outlet for the hole 318.

A calibrated valve consisting of a ball 328 and a spring 30 is mounted in the hole 318; the latter is closed by a cap 32 which is force-fitted and is sealed by a toroidal packing ring 34 shown in FIGURE 5.

The part of the device 310 which produce shocks comprises an elastic washer 40 having a central orifice 42; a valve members in the form of a ball 45 is pressed against this washer by a spring 41 which enables it to bear against the orifice 42 and to move away therefrom.

A rounded washer 44 having apertures 46 for the passage of gas is mounted below the washer 40 in the widened portion 324; it is used for supporting and guiding a hammer 48, 49. The shank 49 of the hammer can slide with an easy fit in a central orifice 47 of the washer 44, this orifice being shown in FIGURE 6; the centre of the ball 45 is substantially axially of the shank 49.

A cylindrical casing 50 surrounds the body 312; its end 51 prevents the hammer 48 from escaping. This casing is fixed to the body 312 by a screw or stud 53 as illustrated in FIGURE 4.

As illustrated in FIGURE 10, this warning device is mounted in a bottle of compressed breathable gas with the end 51 in contact with the wall 180 of the gas container. The gas descends between the casing 50 and the body 312, through the passages 54 (FIGURES 5 and 6), is deflected by the end 51 and moves up again through the axial bore in the body 312.

It passes through the aperture 46 and presses on the elastic washer 40, causing the latter to yield and lifting the ball 45 from the orifice 42. The gaseous current then moves upwards through the passages 322, 320, 318 and 316, the cavity 314 and the connection 315.

The loss of pressure in the narrow passage 320 causes the pressure to rise in the cavity 322, which reverses the action of the gas on the washer 40; the latter, therefore, reverses the way in which it is bent and the ball 45 returns to block the orifice 42 and strike against the shank 49; the head 48 of the hammer then strikes against the end 51 of the casing. Owing to the contact between the latter and the wall 180 of the gas bottles, the blow is also applied to the latter which emits a clearly audible knocking sound which is repeated at the frequency of the movement of the ball 45.

The valve 328 makes it possible to supply the diver, through the connection 315, with more gas than passes through the narrow passage 320; when the pressure drop in this passage and upstream is sufficient, that is to say when the difference between the pressures in the hole and in the space 54 is sufficient, the ball 328 lifts away from its seat and compresses the spring 30; air can then pass directly from the spaces 54 to the hole 318 through the passage 326.

FIGURES 7 and 8 show another form of embodiment of the warning device, designated by the general reference numeral 110.

The body of the warning device 112 comprises again a tapped frusto-conical cavity 114, a passage 116, a transverse hole 118, a narrow passage 120 and a cavity 122 with a widened portion 124.

The hole 118 contains a calibrated valve with a ball 128 and a spring 130, similarly to the valve in the hole 318 of FIGURE 4 and fulfilling the same function.

In the present case, the widened portion 124 of the cavity is almost completely closed by the lower end of the body 112. This lower body end is, however, perforated with a hole 125 which permits the gas from the bottle to flow into the widened portion 124. Mounted in the latter is an elastic washer 140 with a central orifice 142; a conically headed valve member is applied against this orifice and lifted away therefrom alternately. The head 131 of this valve member is supported and guided by a stem 132 which slides with an easy fit in a bore 133 of the body 112.

A striking head 150 is mounted on one end of a flat spring 151 fixed to the lower end of the body 112; an angle element 153 fixed to this spring bears on the end 135 of the stem 132.

FIGURE 9 shows how this warning device is arranged in a compressed gas bottle 182.

This warning device operates in a manner very similar to the device represented in FIGURES 4, 5, 6 and 10.

The current of gas coming from the bottle 182 arrives through the hole 125 at the widened portion 124 of the cavity and acts on the washer 140 and on the head 131. The bending of the washer 140 and the lifting of the head 131 make the spring 151 yield. The reduction in the gas pressure due to the lifting of the head 131, makes the said head and its stem 132 re-descend rapidly under the action of the spring 151. The latter then causes the wall of the bottle to be struck by the head 150.

The two warning devices described hereinbefore are supported in their respective containers by metal tubes 184 which are shown in FIGURES 9 and 10 and which conduct the gas from the connections 315 to the container cocks. In order that they should not operate at any value of gas pressure but only when the gas pressure falls below a certain value their operation is controlled by a warning control device as aforesaid which is controlled itself by the pressure in the container or bottle. As illustrated in FIGURES 9 and 10, this device can be mounted in the body of the cock, which is provided with a control wheel 270 and which closes the container. The assembly

constituted by a warning control device and a warning device constitutes a system known as a "reserve system" by means of which the diver is warned of the fact that his supply of gas is almost exhausted.

FIGURE 11 shows a further warning control device in longitudinal section; two other examples have already been described, with reference to FIGURES 2 and 3.

A tube **200**, surrounding the top of the tube **184** and opening at the bottom into the container, conducts the gas therefrom through passages **202** and **215** into a cavity **204**, **230** of body **206** of the device. A valve member comprising a stem **208** and a conical head **210** is applied against its seat by springs **212**, **214** so as to close the passage **215** when the pressure in the container is equal to or less than that selected as the "reserve pressure." The gas inhaled by the diver then arrives entirely through the tube **184**.

The tube **184** opens into the cavity **204**; a ball valve member **250**, influenced by a light spring **252**, prevents the gas from passing from the cavity to the warning device when the bottle is being filled. This ball valve member could also be lodged in the tube **184** or in the warning device.

A sleeve **234**, screwed into an internal screwthread **232** of the cavity **230**, guides the valve stem **208**; a toroidal packing ring **238**, mounted in an annular cavity **236** of the sleeve, provides sealing-tightness between the latter and the stem **208**.

The valve **208**, **210** is subjected to pressure by the two springs **212**, **214**, so as to have a considerable travel when the reserve pressure is drawing near, for example when the pressure in the bottle passes from 50 to 25 kg./cm.^{2}. A washer **219** separates the two springs, of which the spring designated as **214** is the most flexible. A sleeve **240** is fitted on to the thinner part of the stem **208**, and abuts against the washer **219** when the valve is displaced towards the right, which prevents the spring **214** from being completely crushed. When the valve is displaced further, it is the spring **212** which is compressed.

When the pressure diminishes, the spring **212** is unloaded first and the end of **209** is displaced; it is displaced by B when the pressure diminishes from the maximum to 50 kg./cm.^{2}. At the end of this displacement, the spring **212** is almost completely relieved of load, and therefore the washer **219** is slightly to the right of its illustrated position, but the spring **214** is compressed to the maximum extent permitted thereto by the sleeve **240**.

If the pressure diminishes further, the spring **214** relaxes and the spring **212** becomes fully relaxed. When the end of the part **209** is displaces by A the two springs are as relaxed as is permitted by the lengths of the cavity **204** and of the large bore in the part **234**.

In this position, the valve head **210** rests on its seat; this is the position for pressures at which the warning device is to operate, for example between 0 and 25 kg./cm.^{2}.

It will be seen that the displacement A, or about half of the maximum displacement, takes place for a pressure difference of 50—25=25 kg./cm.^{2} only. This makes it possible to distinguish more satisfactorily pressures which are slightly higher from the pressure at which the reserve is inhaled.

When the pressure of the gas in the bottle is between the complete filling pressure (150 to 180 kg./cm.^{2} generally) and the reserve pressure (for example 25 kg./cm.^{2}), the springs **212** and **214** are more or less compressed and leave open the passage **215** supplied by the tube **200**. The gas breathed by the diver is therefore supplied both through the tubes **200** and **184**. The necessary flow of gas for operating the warning system is obtained only when the tube **184** delivers at least a substantial portion of the gas which is to be inhaled.

When the pressure in the container falls to the value selected as the reserve pressure value, the springs **212** and **214** preponderate and press the valve head **210** against its seat; the gas then arrive only through the tube **184**, which makes the warning device **310** or **110** operate each time the diver inhales.

The outer part **209** of the stem **208** enables the diver to verify that the warning device is in a good working state when the pressure is above the reserve pressure value, for by pressing on this part, the valve **210** is closed and all the gas is obliged to pass through the warning device; the diver can then see whether the said device can or cannot make the bottle emit vibrations. It is on this part **209** that the diver acts, either directly or by means of some mechanism or other, in order to deliberately emit noises through his warning device, as described hereinbefore.

As shown in FIGURES 9 and 10, the metal tube **184** to which the warning device is fixed is curved so as to apply the latter against the inner surface of the bottle. The tube and the warning device are easily introduced through the neck of the bottle and held in position by the screwthreading of the cock. The closure member of the latter is shown at **272** in FIGURE 11.

FIGURE 12 shows another form of warning device which operates in a similar manner to that illustrated in FIGURES 4, 5, 6 and 10.

The air from the bottle passes between a body **280** of this warning device and the surrounding casing **50**. It begins by lifting an elastic washer **282** and hammer head **284** which, at this instant, closes the orifice of this washer and therefore acts as a valve member; after a certain travel, the hammer is lifted more than the washer, which then resumes its rest position since at this instant it is subjected substantially to the same pressure on both its faces. Since the compressed air blown through the orifice of the washer acts on the head of the hammer whilst the rear face **286** of the hammer shank, being near an outlet duct **288**, is subjected to a relatively low pressure, the hammer continues to rise until it abuts against the end of a cavity **290** in which it moves. In this position, the rear **286** of the hammer shank substantially blocks the entrance of the duct **288** and the pressure in the cavity **290** is equalised. Under the action of a spring **292**, the hammer re-descends violently and strikes a part **294** which is fast with the end **51** of the casing **50**. The part **294** can also be independent of the end **51**, for example in the manner of the hammer **48**, **49** in FIGURE 4, which has the same function.

Each reciprocating movement of the hammer of the warning device in FIGURE 12 produces two shocks on the casing **50**: one when it strikes against the end of the cavity **290**, the other when it strikes against the part **294**.

The bottle can be filled by connecting it by its opened cock to a source of compressed air or some other breathable mixture. The gas under pressure in the chamber **204** repels the valve **208**, **210** towards the right since the cross-section of the stem **208** is greater than that of the duct **215**. The latter is, therefore, put in communication with the chamber **204** and enables the gas to penetrate into the bottle through the passage between the tubes **184** and **200**.

The ball **250** prevents the air from passing through the warning device in the direction opposite to the normal direction. It may not be provided if the warning device is so constructed that it tolerates this inverse air pressure.

There are several important advantages in arranging the warning device within the bottle. The warning device is protected from external elements which could immobilise it or damage it; assembly is very easy and there is not need for a special compressed gas take-off for the warning device, nor for fixing means for the said device; the warning device does not increase the bulk of the breathing apparatus.

The devices described hereinbefore can be modified without departing for the scope of the present invention. For example, the end **51** of the casing **50** (FIGURES 4 and 12) and even all of this casing, may be replaced by

a small part supporting the head 48 of the hammer, the latter striking the bottle directly or by means of this small part. The device illustrated in FIGURE 11 may comprise only a single spring acting on the valve 208, 210, as represented in FIGURES 2 and 3. The pressures specified are only examples intended to be of some guidance in understanding the invention.

These devices can be used in all sorts of positions: If expressions such as "upper" or "descend" have been used hereinbefore, these should be taken as referring to the positions shown in the drawings, and in order to facilitate explanation.

The assemblies according to the invention can be applied in other circumstances than those which have been described; they can be used for other purposes than diving under water, for example they can be used in a radioactive or non-breathable atmosphere. They can also be used when the diving apparatus comprises several bottles and when the gas which is to be breathed is other than pure air.

This application is a continuation-in-part of application Serial No. 77,371 filed December 21, 1960.

What we claim is:

1. An acoustic warning device for skin diving apparatus comprising at least one container containing a breathable gas under pressure and a mechanical vibrations emitter, means sensitive to the pressure in said container for allowing said emitter to operate when said pressure falls below a predetermined value, and means accessible to the diver when under water for manually controlling said emitter at any gas pressure above said predetermined value.

2. An acoustic warning device as claimed in claim 1, wherein said emitter comprises the wall of said container as a vibration spreading element.

3. An acoustic warning device as claimed in claim 1, wherein said emitter comprises a quivering member, said member being adapted to knock the wall of the breathable gas container.

4. An acoustic warning device as claimed in claim 1, wherein the mechanical vibrations emitter is energized by the flow of breathable gas issuing from the container and flowing to the respiratory passages of the diver.

5. An acoustic warning device as claimed in claim 4, comprising a elastic washer fixed by its edges and a ball, the gas energizing the mechanical vibrations emitter passing through the orifice of said washer and said ball being pushed against said orifice by a spring and being adapted to strike a hammer, and said hammer being adapted to strike the wall of the pressurized gas container.

6. An acoustic warning device as claimed in claim 5, wherein a casing partly surrounds the mechanical vibrations emitter, said casing being interposed between said hammer and said wall.

7. An acoustic warning device as claimed in claim 5, comprising a calibrated valve enabling breathable gas of the container to arrive downstream of said ball without passing said ball.

8. An acoustic warning device as claimed in claim 4, comprising an elastic washer fixed by its edges and a hammer, the gas energizing the mechanical vibrations emitter passing through the orifice of said washer and the hammer being urged on to this orifice in the direction opposite to the flow of said gas by a spring and being adapted, at the side towards which the gas pushes it, to substantially block the outlet orifice of the cavity wherein it moves, and at the other side to strike a member, said member being able to strike the wall of the pressurized gas container.

9. An acoustic warning device as claimed in claim 8, wherein a casing partly surrounds the mechanical vibrations emitter, said casing being interposed between said member and said wall.

10. An acoustic warning device as claimed in claim 8, comprising a calibrated valve enabling breathable gas of the container to arrive downstream of said hammer without passing said hammer.

11. An acoustic warning device as claimed in claim 4, comprising an orifice, a valve member and a hammer, the gas energizing the mechanical vibrations emitter passing through said orifice and the valve being pushed against said orifice in the direction opposite to the gas flow and means for mechanically connecting the stem of said valve member to said hammer, the movements of said stem making said hammer strike against the wall of the pressurized gas container.

12. An acoustic warning device as claimed in claim 11, comprising a calibrated valve enabling breathable gas of the container to arrive downstream of said valve member.

13. An acoustic warning device as claimed in claim 1, comprising controlling means for controlling the mechanical vibrations emitter in dependence on the pressure in the pressurized breathable gas container, said controlling means comprising, in a path permitting the gas to avoid passing through said emitter, a valve member applied against its seat by at least one spring and mounted in such direction that the pressure in said container tends to remove the said valve member from its seat, the stem of the valve member extending in sealing-tight fashion through the body of the device and projecting therefrom at least when the valve member is not bearing against its seat.

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