Dec. 15, 1970 D. O. ALEXANDER 3,548,371

UNDERWATER SPEAKING DEVICE

Filed March 17. 1969 3 Sheets-Sheet 1

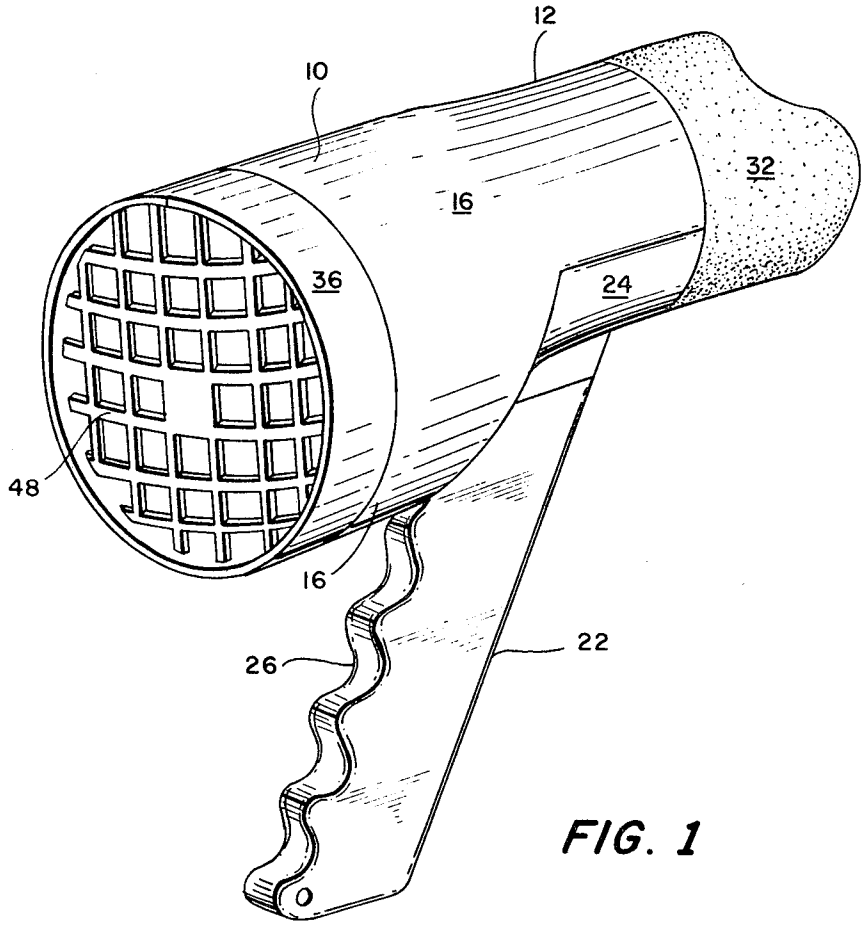


FIG. 1

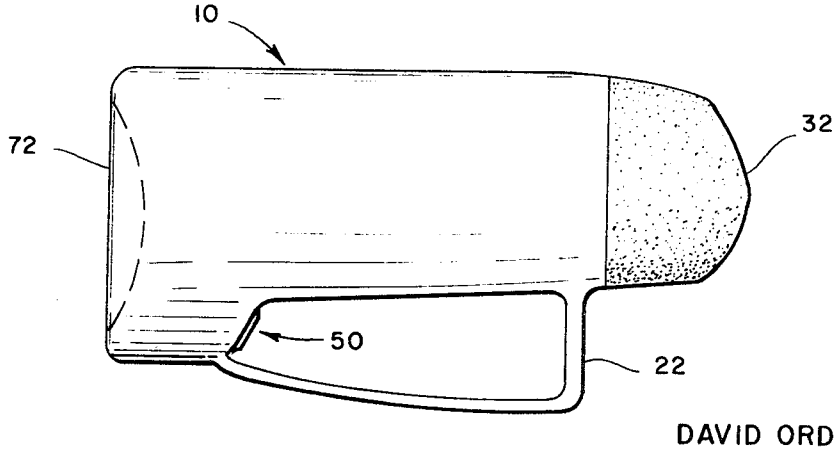


FIG. 8

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UNDERWATER SPEAKING DEVICE

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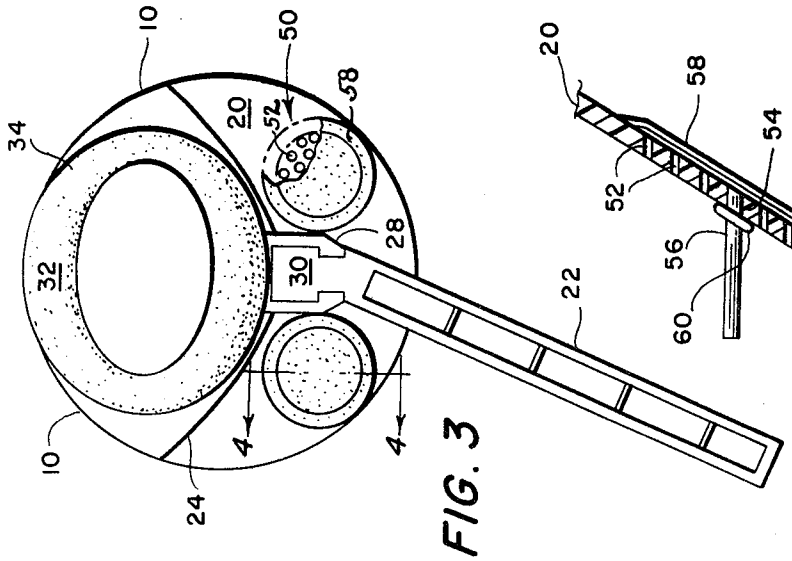


FIG. 3

FIG. 5

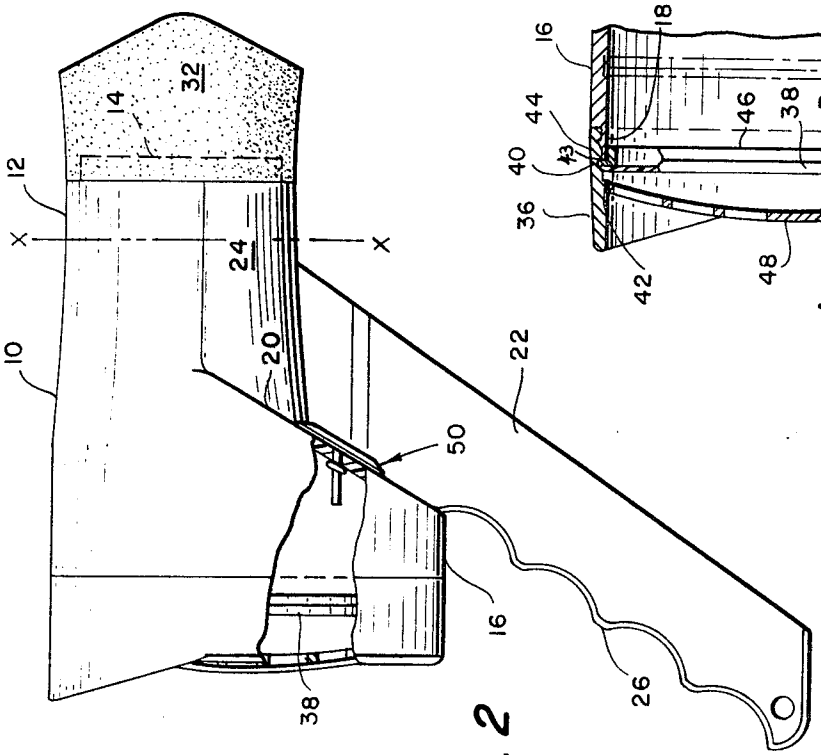


FIG. 2

FIG. 4

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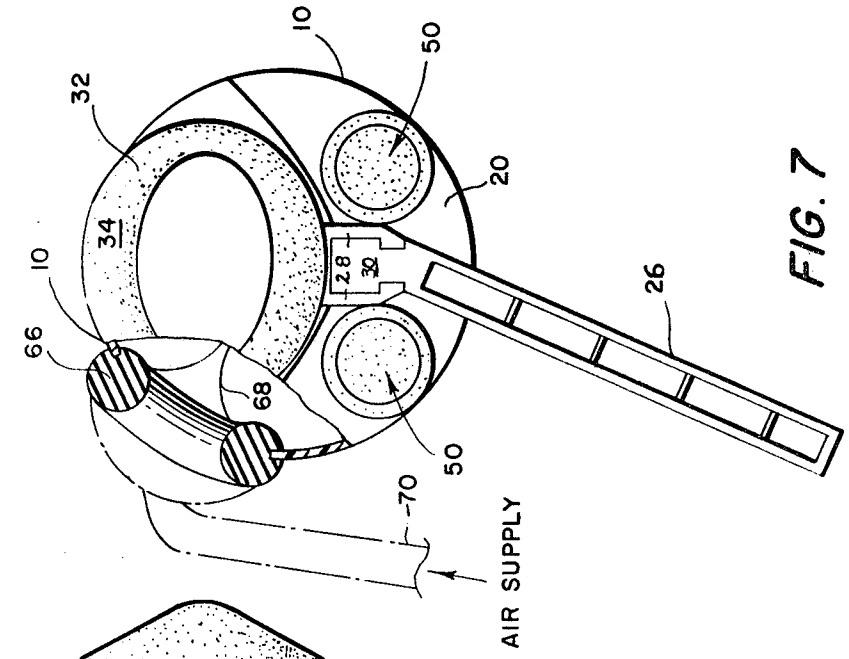


FIG. 7

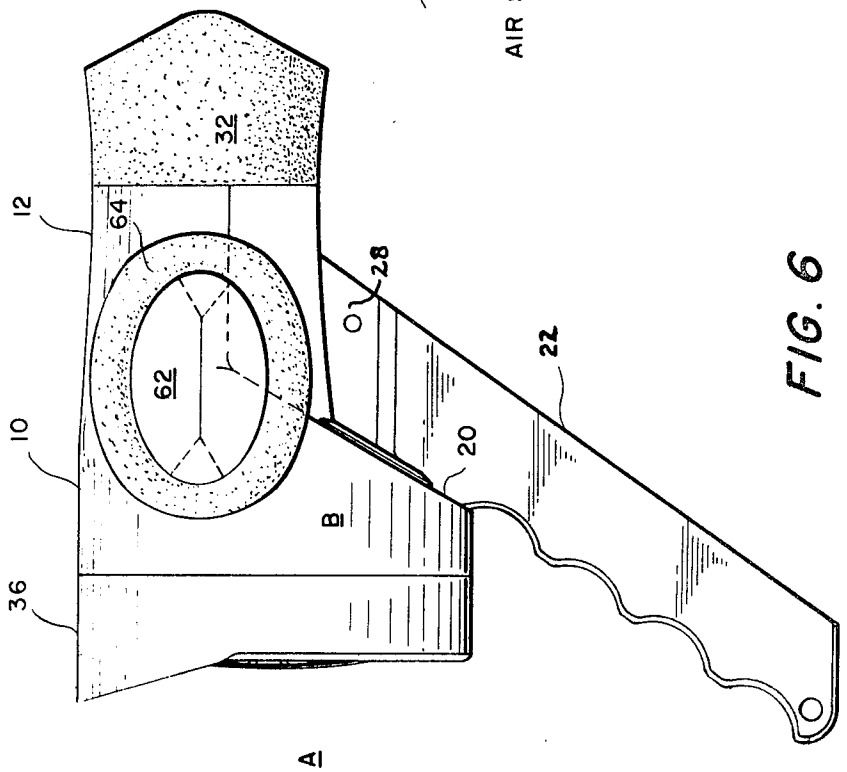


FIG. 6

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3,548,371

UNDERWATER SPEAKING DEVICE

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Continuation-in-part of application Ser. No. 731,774, May 24, 1968. This application Mar. 17, 1969, Ser. No. 807,575

Int. Cl. H04r 23/00

U.S. Cl. 340—12 17 Claims

ABSTRACT OF THE DISCLOSURE

A free water flooding sound receiving and projecting device for use by an underwater diver for projecting sound such as by speaking under water which generally includes a thin, sound resonant walled chamber having an opening which fits about the diver's mouth into which he can blow to displace water, and then speak for resonant transfer of sounds which comprise his voice, a flapper valve in the walls of the chamber through which the water as well as the breath of the speaker is expelled as he speaks; the chamber in alternate structure being provided with or without a sound transfer elastic diaphragm mounted in the walls which is more sensitive to transfer of sound vibrations outwardly of the chamber and which usually is mounted opposite to the sound inlet of the thin walled chamber.

This invention is a continuation-in-part of my copending application, Ser. No. 731,774, filed May 24, 1968, and relates to an underwater sound projecting device for oral communication under water by direct projection of sound waves into the water produced by the speaker.

Underwater speaking devices heretofore produced have been ineffectual in projecting the human voice without electronic assistance for a reasonable distance under water in intelligible quality. Even underwater sound transfer using electrically actuated diaphragms in contact with the water in circuit with a microphone to accept the voice, either within a face mask disposed external of the underwater area, or in muscular contact with the larynx of the speaker, usually develop great sound distortion and have been found unsuitable for efficient underwater voice transfer in acceptable quality. The water tends to damp the diaphragm vibrations of such devices and, in any case, attenuates and distorts the sound to unacceptable quality.

The sound projection device of the present invention comprises a free water-flooding, sound receiving, freely resonating and sound transferring walled chamber including a sound transferring diaphragm in one wall thereof, an opening in the wall communicating with a sound tube, or directly sized to fit about the mouth or lips of the speaker using the device for transfer of sound to said chamber. The chamber walls further include venting means through which water and air may be expelled in use of the device; such fluids being displaced from said chamber by the breath of the speaker in use.

The device usually includes a mouthpiece sized to fit about and seal the mouthpiece against the face and around the lips of the speaker to allow optimum transfer of voice clarity and with superior intelligibility of the sound emitted by the speaker, while also sealing the device against the speaker's face against ingress to the mouthpiece of either water or air, transferred through its edges.

The device may further include improved means for removably sealing the diaphragm for sound transfer to the water from the speaking chamber. The walls of the chamber further include improved check valve means wherein the external water after expulsion and during use is prevented from entering the chamber, while also allowing controlled emission of air evolved during use by the speaker even under substantial water pressures.

The device further includes a handle member for holding, using and carrying the device.

The sound receiving and transferring chamber is preferably formed with enclosing walls of any hard structural material resistant to rust or corrosion in sea water and resistant to rugged usage. It may be formed of rust-resistant metal, but preferably is formed of durable, relatively thin, hard plastic. It can be any shape, but usually is molded to flare outwardly from a mounted mouthpiece speaking section toward a wider diaphragm enclosed sound projection section. While most of the sound is transferred outwardly through the sound-transferring diaphragm in contact with the surrounding water during use; and as described below in greater detail, the sound resonating chamber having thin, hard, resonantly vibrating walls is an important sound projecting element of this invention. It is desirable to form a device of a hard, somewhat resilient, moldable plastic material both for rust-free rugged underwater and general portable use by a diver or swimmer. Such thin, hard plastic also supplies some of the diaphragm-like sound projection by the resonance of all of the walls of the chamber against the surrounding water in use.

A considerable amount of the sound projected into said chamber is transferred through the walls thereof; and, consequently, a desirable property of the chamber material is that it has good resonating and consequent sound transfer qualities directly through the body of plastic comprising the walls of said chamber. That property of sound transfer through the walls is enhanced by somewhat increased hardness of the plastic as well as thin dimensions thereof made so both for this purpose, but also consistant with adequate housing strength for the continued use under sometimes heavy water pressures. Generally the sound transferring qualities of the wall material are improved by the thinness of the wall and the property of resonating with the sound wave impacted thereagainst.

In another modification of this device it is possible to use a very thin, strong walled plastic enclosed chamber having high sound resonating properties combined with a vent valve and a mouthpiece opening, but which omits the sound projection diaphragm as set forth above, useful only for underwater sound transfer for relatively short distances. Such modified device is sufficient to transfer the voice but not as well as the preferred modification including the diaphragm hereof. It may be used as a toy underwater sound transfer device because of it more limited sound projection properties.

In a further modification, a speaking section may be removed a practically long distance from the sound receiving and transferring chamber, the mouthpiece being connected to the chamber by a flexible tube so that the speaker may be a distance from, even outside of the water, and the chamber is only connected by said tube while being located for sound transfer beneath the water.

The moldable plastic materials useful to form the sound chamber hereof may be phenol aldehyde, urea aldehyde, polyamide, polyacrylate, polystyrene, polyester, polysiloxane, polyvinyls, and cellulose esters and copolymer types of such resins and esters.

In a further modification, an underwater air connector opening is additionally provided whereby the mouthpiece of the underwater breathing apparatus, after withdrawal from the mouth of the diver, can be fastened or inserted into the speaking device so that the speaker applying his mouth in the normal speaking position into the speaking mouthpiece can both speak with the device as well as

inhale air therethrough by transfer of air through the mouthpiece as supplied from a usual underwater source.

The invention and its several modifications are further explained with reference to the attached drawings wherein:

FIG. 1 illustrates the device in perspective;

FIG. 2 is a side view of the device;

FIG. 3 is an opposite end view from the mouthpiece end;

FIG. 4 is a detail section showing the diaphragm taken on the line 4—4 of FIG. 3;

FIG. 5 is a detail showing the mounting and structure of the flapper valve;

FIG. 6 is a modification of the device in elevation showing means for mounting or inserting the air supply mouthpiece to the device;

FIG. 7 is an end view of FIG. 6 with a fragment of the breathing mouthpiece fastened thereto; and

FIG. 8 is a further modification of the device in simple cast plastic in which the diaphragm is omitted.

The device comprises a thin walled, usually plastic body **10** preferably shaped as shown to enclose a sound resonating receiving and projecting chamber (not shown). The body at the right hand end is of small diameter to form a mouthpiece end **12** terminating in a mouthpiece receiving collar **14** of smaller dimensions shown in dotted outline in FIG. 2. The body **10** flares at the left side to a large diameter end **16** and there terminates in a slightly smaller diameter collar **18**.

The body **10** may be flared evenly conically from the mouthpiece end **12** to the large flaring diaphragm portion **16**, but it is preferably intercepted in its conically flaring continuity from sound inlet to outlet by mounting thereto of a valve wall **20** and a handle or support **22**, the casting being faired at **24** in preferably smooth streamline curvature to join the upper conical wall with handle member **22** below. The conical handle member **22** as shown, can have a finger gripping means **26** for ready gripping, the handle member preferably being removable and remountable by being inserted into handle member walls **28** which depend from both sides to form a slot or key way for receiving the upper end **30** of a handle member shaped as a slidable mortise or key for removably mounting the handle member to the walls **28**, as shown in FIGS. 3 and 7.

A mouthpiece member **32** usually formed of relatively resilient firm rubber or plastic is shaped to fit against the lower face and cheeks; preferably merely about the outside of the lips of the speaker with its outer edge **34** pressed against the cheeks surrounding the lips for firm lip enclosure, but nevertheless allowing the lips, tongue and teeth to move freely for speaking without constraint by the surrounding sealing surface **34** while sealing the device against the face of the user against ingress or transfer of air or water.

Where as in a modified application the mouthpiece **32** is to be used at a substantial distance away from the sound transferring chamber **10**, it will be separated from the chamber **10** by inserting a connector element such as a flexible hose or tube of desired length between the portions of the device separated along the dividing line X—X of FIG. 2.

As best seen in FIG. 4, the large flaring diaphragm end **16** has a diaphragm collar piece **36** frictionally fit upon the collar **18**. A diaphragm member **38** comprising a flexible rubber sheath found to have optimum acoustic-sound transferring properties, and herein preferred, is desirably entrained about a peripheral elastic stiffening ring **40**. The assembled diaphragm and ring being elastically pressed over a rigid retaining band or sleeve **46** have a flange or rib **43** which holds the distended diaphragm and ring **40** elastically stretched thereon. The diaphragm collar piece **36** has an inner thin walled portion **44** which is dimensioned to press fit securely upon the narrow diameter collar **18** extending outward from the end of the diaphragm portion **16**. The diaphragm **38** mounted as an assembly is dimensioned to lie beneath the inner wall portion **44** of the diaphragm collar **36** and against the collar portion **18**. As the two collar portions **44** and **18** are fitted together, the diaphragm asembly **38** is firmly supported thereby becoming firmly held frictionally between the diaphragm collar members **36** and **16**.

In the construction as shown in FIG. 4, a plastic ring **46** may further reenforce and support the diaphragm stiffening ring **40**, the latter entrained over its outer flange edge, so that the entire diaphragm comprises a plastic stiffened assembly comprising the elastic stiffening ring **40**, the rubber diaphragm sheath **38** stretched thereon and upon the ring **46**, the assembly being firmly secured between the plastic housing members **36** and **16**. A protective grill member **48** may be cast into the outlet section **36** for mechanical impact protection of the diaphragm member **38** against accidental rupture in use under water by striking some extraneous object. The grill **48** further serves to restrain undue distension of the rubber diaphragm beyond its bursting point under air pressure developed within the speaking chamber B.

Moreover, as shown in the dotted line position of FIG. 4, a second diaphragm member **45** may be added, both diaphragms **38** and **45** being separated by a space **47** which is filled with water, air, or other gases, the combinations of diaphragms tending to improve the sound quality, and also supply a safety factor for continuous use.

The diaphragm **38** per se forms a sound interface between the water and the portion marked A of the underwater position for use of the device and the sounding chamber filled with air in which sound waves are first generated for transfer from B to A in the direction of the arrow as shown in FIG. 4 of the device. The diaphragm **38** is suitably reinforced and tightly held between press fitted members **36** and **16**. The diaphragm member **45** will be similarly supported as shown for diaphragm **38**.

The valve wall **20** has one or more flap vent valves **50** adapted to vent the flow of water and air outward of the chamber B in use of the device. The valve comprises a series of perforations **52** cut into the wall **20** over a selected smaller area, usually about one square inch or less, to restrict the total volume of fluid flow therethrough. A central perforation **54** is bored large enough to receive the stem **56** of a flexible rubber valve head **58** attached to or integral with said stem. A stop element **60** extends outward of said stem to engage the wall **20** and retard the valve body from being separated entirly from the device. The stem **56** slides smoothly in the perforation **54** without the restriction so that any fluid flow through the perforations **52** will readily displace the light rubber valve head **58** sliding on the stem **56** outward in the direction of the arow shown in FIG. 5. However, in usual construction the valve head **58** may be of quite resilient rubber so that the total body of the valve and stem do not need to move but merely the edges thereof can be flexibly displaced by fluid flow outward of the perforations **52** to supply the desired fluid venting effect. By this construction, the valve in reverse direction of fluid pressure will seat firmly upon the perforations **52** and prevent water return into the device. In other words, it acts as a check valve with the flexible displacement from the perforations and with or without sliding upon the stem **56**.

In the modification shown in FIG. 6, a further opening **62** is provided in the housing wall **10** of the chamber B with a sealing ring **64** mounted about said opening **62** through a groove **66** cut into its outer edge, said groove engaging the wall **10** surrounding the opening **62** in fluid tight securement. That sealing ring **64** is intended to form a sealing element upon which the regulator or hookah outlet hose or mouthpiece or the like for an underwater diver; or an outlet coupling from some other source of underwater air supply is sealed. The coupling temporarily seals through ring seal element **64** which may itself engage any other supply of air to the

chamber **62** for another extraneous supply of air to the speaker. Such sealing ring **64** may be merely enclosed by a sealing diaphragm or a plastic element to close the opening **64** when an extraneous source of air is not to be used. An air supply ring **66** may be fitted with a razzer valve **68** which generally closes the air supply except for the purpose of inhalation suction while preventing expulsion of air back into an air supply duct **70** in breathing or talking.

As shown in FIG. 8 a modification is possible wherein the diaphragm and diaphragm portion **16** is omitted. The forward outlet end **72** of the device is completely enclosed by a continuous sheet of plastic integral with and forming part of the wall, similar to the body of the sounding device **10** as above described. Consequently, in the modification of FIG. 8 on a flapper valve **50**, it is present as above to comprise a vent opening and an open mouthpiece portion **32** is provided to surround the mouth of the speaker for speaking in the chamber. That mouthpiece portion instead of being removable as shown in FIG. 1, may also be integrally cast as a plastic part sized and shaped to surround the lips of the speaker. A handle member **22** may also be provided for easy use. However, a handle member, while useful in this or any of the modifications hereof, can be omitted.

In operation of the several modifications, the speaker places the mouthpiece against his mouth to surround and enclose his lips and seal the same against passage of water or air between his mouth and the surrounding water. He first blows into the fully flooded device to expel the water through the flapper valve, and then merely speaks into the device, usually pointing it in the direction that the sound is intended to be conveyed. Most of the sound passes through the diaphragm. Much of the sound passes outwardly through the plastic or metal walls. As the diver or swimmer speaks, the air is emitted with the sound from the mouth, and in speaking the sound and air pass outward into the chamber with some necessary speaking restraint, the flow being controlled by the flapper valve. While the device is pressed against his face, no water can reenter the sound chamber. Most of the sound passes outward through the thin sound-transferring diaphragm. Such diaphragm, as described, is usually rubber stretched tightly by the constraining ring over the sound-emitting opening, thus to provide a very highly efficient underwater sound transfer device. Other diaphragm materials such as easy vibrating metal or hard plastic can be used.

Where the underwater user is a diver having an extraneous source of air, he can modify the operation slightly by first taking a deep breath of air from his mouthpiece, removing the mouthpiece from his mouth and then placing the underwater sounding device against his lips as described, expelling water from the freely flooded chamber and then commence speaking.

Where the device has an extra opening for extraneous supply of air to the speaker, the hose supply of air is fitted by a seal over the opening provided for that speaker and the speaker using that device again pressing against the mouthpiece as sealed by his lips to expel the water from the flapper valve, then speaks as well as breaths through the device as held sealed about his lips.

In use of the device as shown in FIG. 8, since it lacks a diaphragm, the direction and distance over which the sound will carry is very greatly limited to the surrounding area of the speaker. Such device may be considered for use merely as a toy or be used for local under water use where divers are working or playing in close proximity to each other. In use of such device of FIG. 8 the user again places the mouthpiece about his lips, blows into it to expel air from the chamber, and then speaks. Again, the sound is emitted only through the walls and can be heard only a short distance and is not nearly so intelligible and clear.

Although the devices shown are shaped relatively conically from the mouthpiece to what appears to be the outlet wall, and there is some directional effect in passing from the mouthpiece toward the wall by pointing the unit in the direction of the listener, the device has very little directional effect upon the projected sound, far less than that available in intensity, quality and directionality of that shown in FIGS. 1 through 7.

Other modifications as apparent may be added according to my parent application identified above, and it will be recognized that the horn provides an additional sound dirigibility and directionality effect. However, the horn can be and usually is omitted in the present construction.

What is claimed is:

1. Underwater speaking device comprising a free flooding chamber enclosed by thin sound resonating walls, a unidirectional vent valve in said walls through which water and the exhaled breath of the speaker may be expelled outwardly of said chamber, and an opening in said walls sized and shaped to fit about the mouth and lips of the speaker while sealing said opening around the mouth to the surrounding face of the speaker against passage of water and gas when in use for transfer of sound by the speaker to said chamber.

2. The device as defined in claim **1** wherein said valve is a flapper valve comprising perforations in the wall of said chamber, a flexible disc-like sealing member mounted to lie upon said perforations sealing the inward transfer of water through said perforations, the water pressure holding said sealing member thereon in fluid-tight relationship, and means supporting said sealing member in said wall in movement toward and away from sealing engagement upon said perforations.

3. Device as defined in claim **1** wherein said walls are faired to a relatively narrow sound-receiving section, a sound receiving mouthpiece frictionally secured about said opening, said mouthpiece being formed of resilient material enclosing a large mouth opening, said mouth opening being shaped to fit about the mouth and lips of the speaker while sealing said opening around the mouth to the surrounding face of the speaker against passage of water and gas when in use for transfer of sound by the speaker to said chamber.

4. Underwater speaking device comprising a chamber enclosed by thin walls, a unidirectional vent valve therein through which air and water may be expelled outwardly of said chamber, an opening surrounded by a mouthpiece sized and shaped to be sealed about the mouth and against the face of the speaker while sealing said opening around the mouth to the surrounding face of the speaker against passage of water and gas, said walls having a sound responsive diaphragm supported in said wall separating the interior of said chamber from the surrounding water in a sound transmissive relationship.

5. The device as defined in claim **4** wherein the walls are formed of thin hard sound-radiating plastic.

6. The device as defined in claim **4** wherein the diaphragm is a tautly stretched rubber membrane.

7. The device as defined in claim **4** wherein said walls have an opening and the diaphragm is supported as a closure and sound transfer member in said wall opening.

8. The device as defined in claim **4** wherein a second diaphragm is mounted in said chamber in a plane parallel to and behind the said first diaphragm which forms and encloses a gas or liquid filled chamber between said diaphragms.

9. The device as defined in claim **4** wherein the device has a handle member fitted thereto.

10. The device as defined in claim **9** wherein the handle member is removable.

11. The device as defined in claim **4** wherein the mouthpiece is formed of a resilient material mounted about a large mouth opening and is sealable about the mouth of the user without inhibiting free movement of the lips for speech and articulation.

12. The device as defined in claim 4 wherein the housing wall has an opening adapted to receive a connecting element of an extraneous source of air for sealed supply of extraneous air to the chamber as a breathing source of air by the speaker while using the device in speaking.

13. The device as defined in claim 12 wherein said connecting element is adapted to receive the mouthpiece of an underwater diving apparatus and supply extraneous air to said chamber enabling the driver to breath into and out of said chamber while speaking through said speaking element.

14. Device as defined in claim 4 wherein said diaphragm is tautly stretched about the periphery of a stiffening ring, sized to be frictionally secured in the sound transfer opening in said wall.

15. The device as defined in claim 4 wherein the walls surrounding said chamber are flared to an enlarged sound projecting section surrounding a sound projecting opening, and means in the periphery of said flared opening frictionally engaging said sound responsive diaphragm and supporting the same in said opening for projection of sound from the chamber to surrounding water.

16. The device as defined in claim 4 wherein the diaphragm mounted in said walls has a rigid grill member

mounted thereabout mechanically protective of said diaphragm.

17. The device as defined in claim 4 wherein said chamber and mouthpiece are separated by an elongated flexible interconnecting duct whereby the mouthpiece may be used at a distance corresponding to the length of said duct by the speaker, and the sound projecting chamber may be disposed under water with the sound passed thereto by way of said connecting duct.

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U.S. Cl. X.R.

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