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(54) **BREATH-HOLD DIVING LIFE-JACKET**

RETTUNGSWESTE FÜR TAUCHEN MIT ANGEHALTENEM ATEM

GILET DE SAUVETAGE POUR PLONGEE EN APNEE

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Description

1. FIELD OF APPLICATION

[0001] The invention relates to life jacket intended to protected divers while breath-hold (free) diving. One of these jackets is known from US-A-5800228.

[0002] In the International Patent Classification, it is classified as Section B - Performing Operations; Group B 63 C - including Life-saving in water; Subgroup 9/08 - including Life-buoys, e.g. rings; Life-belts, jackets, suits or the like.

[0003] The invention also belongs to the Section A - Human Necessities; Group A 62 B - including Devices, apparatus, or methods for life-saving; Subgroup 35/00 - including Safety belts or body harnesses.

2. TECHNICAL PROBLEM

[0004] When breath-take (free) diving, the diver inhales a certain volume of air at the surface, stops breathing and dives. During the dive, an exchange of gases takes place in the divers lungs, where the oxygen partial pressure, required for functioning of the organism, decreases. The oxygen partial pressure is calculated as follows:

$$P(O_2) = V_p(O_2) \times P_{environment} \qquad (1)$$

that is, the partial pressure of oxygen in the lungs equals the product of multiplication of the volume part (percentage) of oxygen in the gas and the environmental pressure.

[0005] In the air there is about 21% of oxygen, wherefore the oxygen partial pressure in the lungs at inhalation amounts to:

$$P_{surface}(O_2) = 0.21 \times 1 = 0.21 \text{ bar}$$

As the dive depth increases, the outer pressure rises and, according to the equation (1), there also increases the partial pressure of oxygen in the diver's lungs. By exchange of gases, the oxygen in the lungs is exhausted and its volume part in the gas decreases, accompanied by decrease of the oxygen partial pressure. When the oxygen partial pressure reaches a given value, the brain receives signal on the lack of oxygen in the organism (the so called air hunger). If the diver does not inhale after this, the inhalation signal is repeated more and more often. If the oxygen pressure in the organism decreased below the critical value, the diver looses consciousness.

[0006] It is evident from the equation (1) that the oxygen partial pressure in the lungs depends on the dive depth. Thus, at the same volume part of oxygen in the gas, the partial pressure at 10 m depth is twice larger than at the surface, at 20 m it is three times larger, etc. Therefore, the diver, who is at a certain depth, apparently has enough oxygen in the lungs and has no feeling of air hunger. At the diver rises to the surface, the environmental pressure decreases and the oxygen partial pressure in the lungs suddenly falls. Thus, a diver who has 10% of oxygen in the lungs at 10 m depth, according to the equation (1) has the oxygen partial pressure $P_{10m}(O_2) = 0.1 \times 2 = 0.2$ bars, and has no feeling of the lack of oxygen. However, while rising to the surface, the oxygen partial pressure falls, the same volume part to result in P surface $(O_2) = 0.1 \times 1 = 0.1$ bars at the surface, this causing a great risk of loosing the consciousness. This change of the outer pressure, therefore also of the oxygen partial pressure in the lungs is strongest immediately below the surface (between O and 1 m of depth), where the risk of unconsciousness is the greatest as well. Often the diver does not surface, however, loosing the consciousness at the very surface, before he takes the first air. This occurs perfectly suddenly and the diver is unable to react.

[0007] At the moment of loosing the consciousness, there occurs muscle spasm and closing of the airway, and there is no immediate inhalation, wherefore no sea water enters the lungs. After a short period of time (20 to 40 seconds), the muscles relax and the diver, unconscious, inhales. If at that moment the diver's face is submersed, the lungs feel with water and the diver drowns. The natural position of an unconscious person is prone, face immersed into the water, wherefore, loosing consciousness most often results in taking water into the lungs, sinking and drowning.

[0008] Since most divers encounter problems in the surfacing stage, at the very surface, it is essential to react quickly, immediately after loosing the consciousness and before the muscles relax and the lungs feel with water. Unfortunately, a large number of breath-take divers dive unescorted, and even when there is another person nearby, that person may fail to notice the unconsciousness because the diver has surfaced normally and is positioned as if watching the sea below, wherefore nothing unusual appears to be going on.

[0009] The described invention deals with solving this problem.

3. STATE OF THE ART

[0010] To the best of the author's knowledge, presently there are no technical solutions that would prevent breath-take divers to inhale water. Most of the existing diving equipment and technical accessories deal with scuba diving. This is a completely different way of diving, making breath-take diving equipment inadequate.

4. DISCLOSURE OF THE INVENTION

[0011] The essence of the invention is the breath-take diving life jacket, designed and built, when inflated, to keep the diver's head above the water. The jacket is activated and inflated automatically when it is detected that the diver is unconscious. It is activated by an electronic device that detects the beginning of the dive by detecting the increase of the outer pressure, turning itself active. When the outer pressure falls below a certain value, the electronic device detects surfacing and automatically starts countdown. At this moment, the diver is at the surface and, if conscious, he stops the countdown by pressing a button. If, after a certain period of time (about 5-10 sec.), the diver did not press the button, the electronic device activates a sound alarm for a few seconds (up to 5 sec.), warning the diver that he did not switch the timer off. If the diver still does not react, it is highly likely that he is unconscious, and the electronic device automatically activates the pressured gas cylinder that inflates the life jacket which, again, positions the diver's head above the water surface.

5. ILLUSTRATION DESCRIPTIONS

[0012]

Figure 1. shows the breath-take diving life-jacket - perspective view.
Figure 2. shows the breath-take diving life-jacket shown in the Fig. 1., on the diver at the surface, in his normal position taken after surfacing.
Figure 3. shows an inflated life-jacket on the diver.
Figure 4. shows block diagram of the life-jacket electronic device.

6. DETAILED DESCRIPTION OF INVENTION EMBODIMENTS

[0013] The critical stage of a breath-take dive is the surfacing. In case of loosing the consciousness, the diver's face remains immersed in the water and, when an uncontrolled inhalation occurs, the lungs are filled with water and the diver drowns. The purpose of the invention is to keep the diver's head above the water surface in case of unconsciousness. In such case, when the muscles are relaxed, the diver starts breathing normally. In great many cases this is sufficient to safe the life of a diver who, after a few inhalations, wakes naturally from the state of unconsciousness.

[0014] The breath-take diving life-jacket comprises: the front and the back air bags, the front one being larger, fixed to the shoulder straps that keep the life jacket on the diver's body; the elastic belt with fastener that fixes the jacket around the diver's waist or chest; the compressed gas cylinder that, in case of drowning hazard, automatically activates and inflates the air bags, the life jacket rising the diver's head above the surface if it is detected that the diver floats unconscious; and the electronic device that controls the life jacket and comprises: the pressure sensor that detects the beginning of the dive and the surfacing, the controlling logics (micro-controller) that controls all functions of the device, the electromagnetic trigger that activates the gas cylinder, the manual switch by which the diver stops countdown of the automatic activation of the electromagnetic trigger, the sound alarm that additionally warns the diver to press the manual switch if he is conscious, and batteries that power the electronic device.

[0015] All the above listed parts of the life jacket, depending on its design, could be distributed on the jacket in various ways, however, the manual switch is to be located on a shoulder strap or another place easily reachable by both the right and the left hands.

[0016] The inflated life jacket is to be shaped to keep the diver's mouth as higher from the surface as possible, providing free inhalation of air and preventing the diver to sink and drown.

[0017] The breath-take diving life-jacket may be embodied as a life-jacket independent from the existing diving equipment, or as a part of the existing diving equipment.

Life jacket independent from the existing diving equipment

[0018] The appearance of the breath-take diving life-jacket 1 as shown in the Figure 1. is not compulsory but illustrates its functioning only. The life jacket comprises: front air-bag 2, back air-bag 3, shoulder straps 4, elastic belt 5, belt fastener 6, compressed gas cylinder 7, and electronic device 8, which again comprises: pressure sensor 9, control logics (micro-

controller) 10, electromagnetic trigger 11, manual switch 12, sound alarm 13, and batteries 14.

[0019] The life jacket is designed to keep, when inflated, the diver 15 in the wanted position (Fig. 3.). The life jacked is not large, because the intention is not to significantly influence the diver's buoyancy, which is always positive at the surface, and it is desirable that the jacket does not hamper the diver in his normal activity.

[0020] The life jacket is put over the diver's shoulders and fastened on the chest. The air bags, the front one being larger, are located at the diver's breast and the back, as high as possible in order to keep, when inflated, the diver's head 16 above the water surface 17. On the right-hand shoulder strap, there is the manual switch for switching the timer off, located so that the diver can switch the timer off easily and quickly, by a simple hand motion. Within the electronic device, there is the sound generator that warns the diver of the timer not being switched off in time.

[0021] Figure 2. presents the life jacket on the diver, at the surface, in his normal position upon surfacing. This is the position the diver takes also in the case of loosing the consciousness. The diver's face is immersed, and he will not, by pressing the switch, deactivate the electromagnetic trigger and, thus, prevent activation of the life jacket.

[0022] The life jacket is provided with a pressured gas (CO_2) cylinder, that is perforated by a needle activated automatically by the electromagnetic trigger if the diver fails to switch the timer off manually after surfacing. The life jacket may also be embodied with an electronically operated valve instead of the needle and the electromagnetic trigger. The electronic device is constructed to prevent switching off by an accidental pressure against the switch, e.g. in contact with the sea bed, because it is activated only when the outer pressure is decreased again, i.e., upon detection of surfacing.

Life jacket independent from the existing diving equipment

[0023] The life jacket is embodied as part of the existing diving equipment. An option is to construct the life jacket as part of the diving weight carried on the back. Divers often use such weight in underwater fishing, in order to distribute the weight of the plumb weights more evenly all over the body. The jacket is placed on the diver's shoulders and fastened at the chest. On the diver's back, as a part of the life jacket, there is a plumb weight. The air bags are in the shoulder straps and at the chest. This enables an even better position of an unconscious diver, since now, because of the load at his back, he leans further back, wherefore his mouth and nose are even farther above the water surface.

[0024] The electronic device and the manual switch for stopping the timer are placed on one of the shoulder straps. The life jacket is provided with a pressured gas (CO_2) cylinder, that is perforated by a needle activated automatically by the electromagnetic trigger if the diver fails to switch the timer off manually after surfacing.

[0025] The life jacked is to be made of usual materials and by the technology that is used in manufacturing jackets presently used on board vessels and aircraft, such as life jackets, buoyancy compensators for scuba diving, etc. It is important that the life jacket is resistant to wear since possible damages could prevent the intended effect.

7. INVENTION APPLICATION

[0026] The invention is produced as separate from the existing breath-take diving equipment, or as part of such equipment. The diver uses it in every breath-diving immersion. In normal circumstances, the device is never activated. In case of activation of the compressed gas cylinder that inflates the jacket, the cylinder is to be replaced and the device is to be inspected before its next use. Upon activation of the life jacket, besides replacing of the gas cylinder, the battery is to be replaced as well.

[0027] The battery is to be replaced at adequate intervals in any case.

Claims

1. Breath-take diving life-jacket, provided with air bags, fixed to the diver's shoulders and fastened around his waist and provided with a compressed gas cylinder (7) **characterised in that** it comprises an inflatable front air bag (2) and a back air bag (3); the air bags are fixed by shoulder straps (4) by which the life jacket is hung on the diver's body; it has the elastic belt (5) with fasteners (6) by which the life jacket is fastened around the diver's waist or chest; whereby in case of danger of drowning, the gas cylinder is activated automatically and inflates the air bags so that, when the diver is detected to be unconscious, it keeps the diver's head above the water surface and it is provided with an electronic device (8) that controls the life jacket, and comprises: a pressure sensor (9) that detects the beginning of the dive and of the surfacing, the controlling logics (10) that controls all functions of the electronic device, an electromagnetic trigger (11) that activates the gas cylinder, a manual switch (12) by which the diver switches off the electromagnetic trigger (11) self-activation timer, a sound alarm (13) that additionally reminds the diver to press the switch if he is conscious, and batteries (14) that power the electronic device.

2. Breath-take diving life-jacket, as claimed in Claim 1., ***wherein,*** its front air bag (2) is larger than the back one (3).

3. Breath-take diving life-jacket, as claimed in Claims 1. and 2., ***wherein,*** it is embodied separate from other diving equipment.

4. Breath-take diving life-jacket, as claimed in Claims 1. and 2., ***wherein,*** it is embodied as part of the diving weight carried at the back.

5. Breath-take diving life-jacket, as claimed in Claims 1. to 4., ***wherein,*** the manual switch (12) is always fixed to a shoulder strap (4) or at another place that is easy to reach by both the left and the right hand.

Patentansprüche

1. Sicherheitsweste, mit Luftkissen ausgerüstet, zum Schutz beim Atemtauchen, die an den Schultern des Tauchers aufgehängt und mit elastischen Riemen um den Stengel des Tauchers befestigt ist, **dadurch gekennzeichnet, dass** es einen Vorderkissen (2) und einen Hinterkissen (3) zum aufblasen gibt, dass die Kissen mit Schulterriemens (4) verbunden sind mit den die Weste auf den Körper des Tauchers aufgehängt ist, dass es einen elastischen Riemen (5) mit Schnallen (6) gibt mit den die Weste um den Stengel oder um die Brust befestigt wird, dass es eine Ampulle (7) mit komprimierten Gas gibt die sich im Fall der Ertrinkungsgefahr automatisch aktiviert und bläst die Kissen auf sodass wenn die Ohnmacht des Tauchers nachgewiesen ist der Kopf des Tauchers über der Wasseroberflache gehalten ist, dass es eine elektronische Gruppe (8) gibt die die Sicherheitsweste steuert, die besteht aus: einem Druckfühler (9) der den Anfang des Eintauchen und des Auftauchen notiert, Steuerlogik (10) die alle Funktionen der elektronischen Gruppe steuert, elektronischer Auslöser (11) der die Ampulle mit Gas aktiviert, Handunterbracher (12) mit dem der Taucher manuell das Zeitabzählen unterbricht, und zwar die automatische Wirkung des elektronischen Auslöser (11), des akustischen Alarm (13) der den Taucher zusätzlih aufmerksam macht den Handunterbrecher anzupressen wenn er bei vollem Bewusstsein ist, und die Batterie (14) zur Versorgung der elektronischen Gruppe mit Energie.

2. Sicherheitsweste zum Schutz beim Atemtauchen, gemäss der Anforderung 1., **dadurch gekennzeichnet, dass** es einen vorderen Kissen (2) grösseres Volumen als der hintere Kissen (3) gibt.

3. Sicherheitsweste zum Schutz beim Atemtauchen, gemass den Anforderungen 1. und 2., **dadurch gekennzeichnet, dass** die Weste getrennt von der sonstigen Taucherausrustung ausgeführt ist.

4. Sicherheitsweste zum Schutz beim Atemtauchen, gëmass den Anforderungen 1. und 2., **dadurch gekennzeichnet, dass** die Weste als Bestandteil des Gewichts ausgeführt ist das der Taucher auf dem Rücken trägt.

5. Sicherheitsweste zum Schutz beim Atemtauchen, gëmass den Anforderungen von 1. bis 4., **dadurch gekennzeichnet, dass** der Handunterbrecher (12) immer an den Schulterriemen (4) oder an einen leicht zugänglichen Platz angebracht ist, in Reichweite der linken oder rechten Hand.

Revendications

1. Le gilet de sûreté pour la protection dans le temps de la plongée à souffle, qui a des coussins gonflable, qu'on suspend à l'épaule du plongeur et attache avec des ceintures élastique autour sa tige, **caractérisée en ce qu'**il y a un coussin gonflable antérieur (2) et un postérieur (3), que les coussins sont liés avec des bretelles (4) avec lesquelles on suspend le gilet sur le corps du plongeur, qu'il y a une ceinture élastique (5) avec des agrafes (6) avec qui on attache le gilet à la tige ou à la gorge du plongeur, qu'il y a une ampoule avec du gaz comprimé (7), qu'en cas du danger de la noyade l'ampoule avec du gaz se met automatique en action et gonfle les coussins de telle manière que quand on a détecté l'état du vertige du plonger les coussins enlèvent sa tête au-dessus de l'eau; qu'il y a un appareil électronique (8) qui surveille le gilet de sûreté, composé d'un senseur de la pression (9) qui detècte le début de l'immersion et de la venue à la surface, logique de controle (10) qui controle toutes les fonctions de l'appareil électronique, la gâchette électromagnétique (11) qui met en action l'ampoule du gaz, un interrupteur manuel (12) avec lequel le plongeur termine avec la main le compter du temps pour l'action automatique de la gâchette électromagnétique (11), l'alarme acoustique (13) qui averte encore le plonger de presser l'interrupteur manuel s'il est conscient, la pile (14) pour l'alimentation d'appareil électronique.

2. Le gilet de sûreté pour la protection dans le temps de la plongée à souffle, selon la demande 1., **caractérisée en**

ce qu'il y a un coussin antérieur (2) du volume plus grand que le coussin postérieur (3).

3. Le gilet de sûreté pour la protection dans le temps de la plongée à souffle, selon la demande 1. et 2., **caractérisée en ce qu'**il y a un gilet qui est réalisé séparé du reste de l'équipement du plongée.

4. Le gilet de sûreté pour la protection dans le temps de la plongée à souffle, selon la demande 1. et 2., **caractérisée en ce qu'**il y a un gilet qui est réalisé comme une partie du poids que le plongeur porte sur les épaules.

5. Le gilet de sûreté pour la protection dans le temps de la plongée à souffle, selon la demande 1. à 4. , **caractérisée en ce que** l'interrupteur manuel (12) est toujours installé sur la bretelle (4) où bien une autre place ou il est facilement accessible avec la main droite ou gauche.

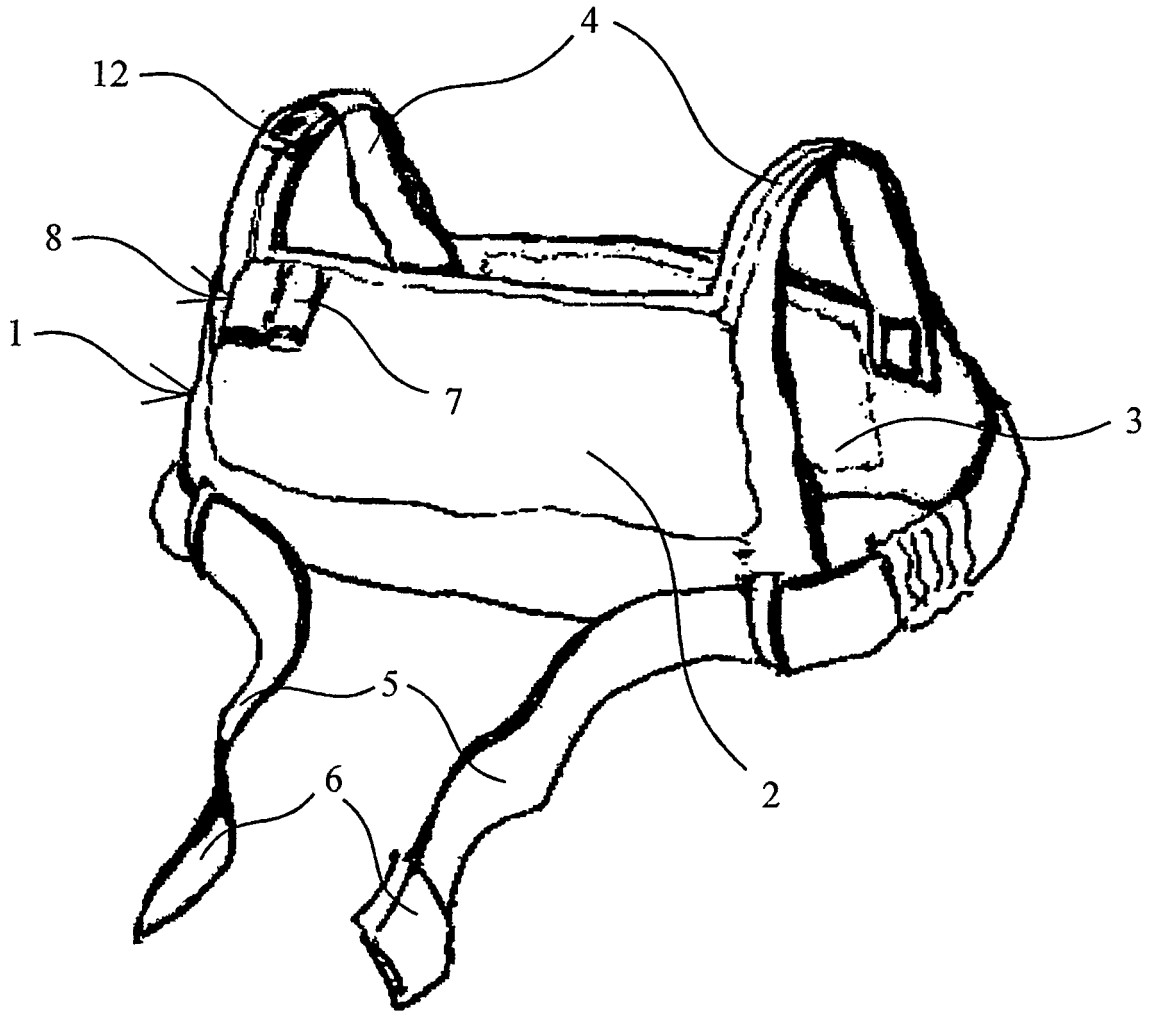

Fig. 1.

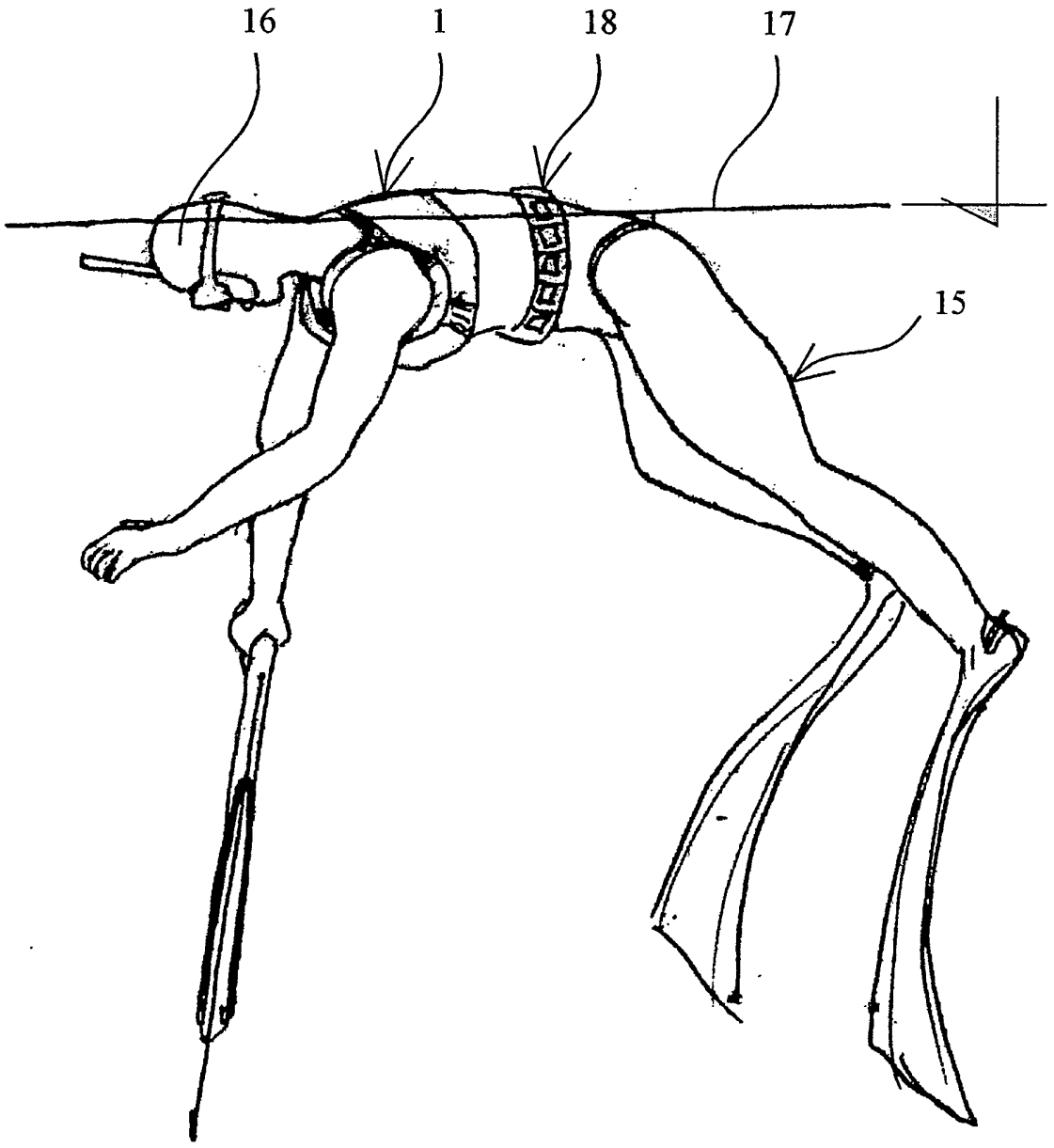

Fig. 2.

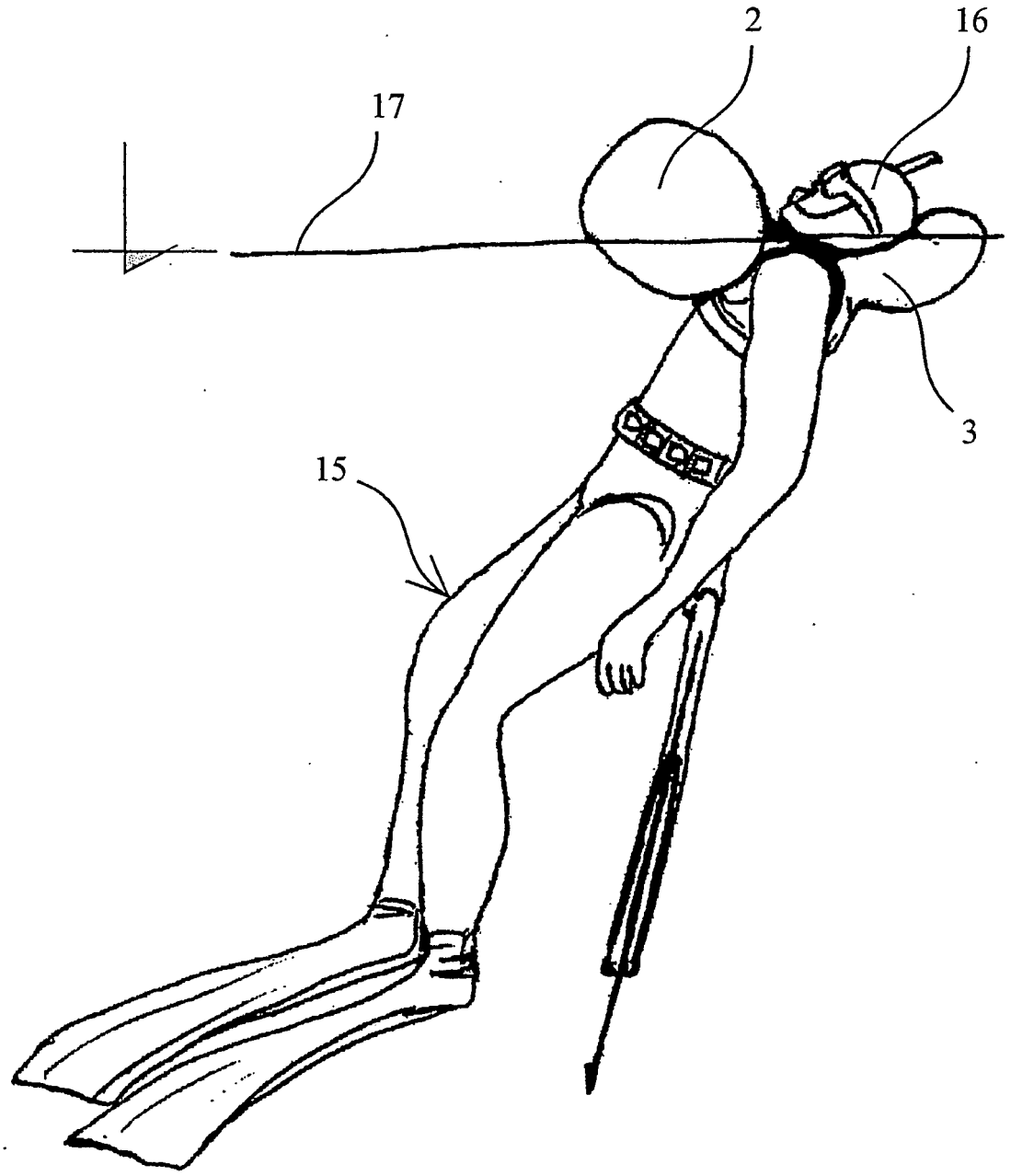

Fig. 3.

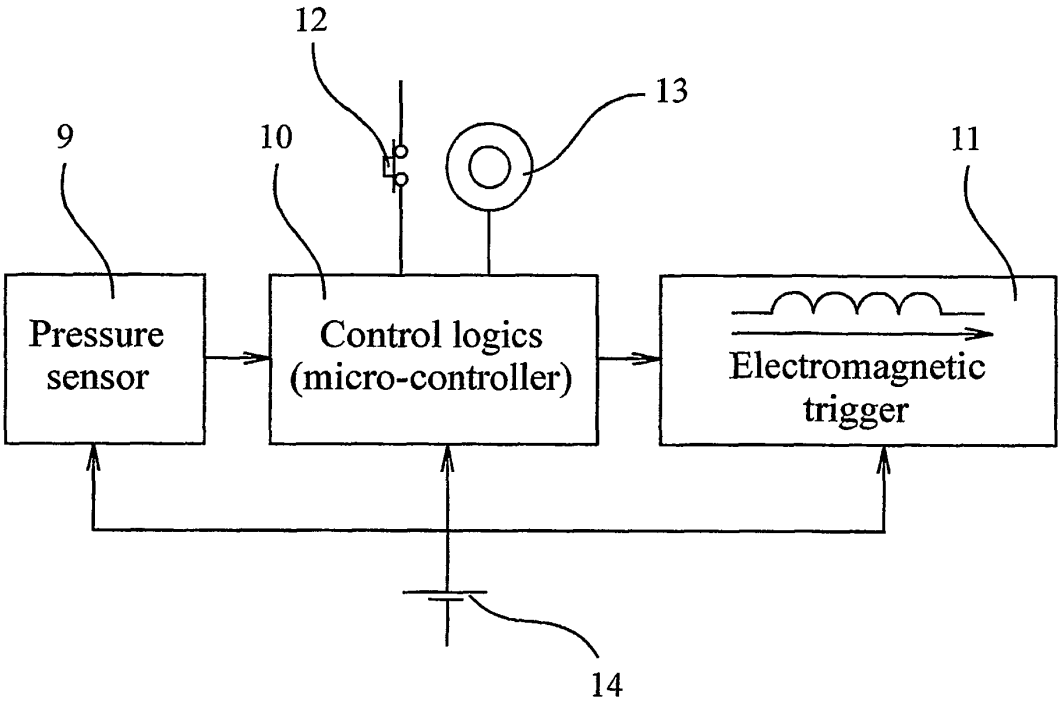
12
13
9
10
11
Pressure sensor
Control logics (micro-controller)
Electromagnetic trigger
14

Fig. 4.