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(54) **A METHOD TO SUPPLY AIR AND PROPELLANT TO A VESSEL IN WATER AND A DEVICE FOR
BALANCING THE VESSEL ACCORDING TO THE WATER DEPTH**

VERFAHREN ZUR VERSORGUNG EINES WASSERFAHRZEUGES MIT LUFT UND KRAFTSTOFF,
UND GERÄT ZUM AUSBALANCIEREN DES SCHIFFES IN ABHÄNGIGKEIT VON DER
WASSERTIEFE

PROCEDE D'ALIMENTATION D'UN NAVIRE IMMERGE EN AIR ET EN CARBURANT, ET
DISPOSITIF D'EQUILIBRAGE DU SOUS-MARIN EN FONCTION DE LA PROFONDEUR D'EAU

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EP 0 646 082 B1

Description

The invention concerns a device for supplying air and operating means to a vessel located at a great depth and a device for balancing a vessel in water, e.g. a salvage dock, barge, submarine, pump stations, sub-sea devices etc.

The ascent and descent of a vessel at great depths entails major problems with regard to air supply. Due to the considerable difference in pressure between the surface and the depth concerned, it will be necessary to bring along large quantities of air. When manoeuvring a vessel in water it can be difficult to achieve a stable descent and ascent, due, amongst other factors, to possible bias, erratic air supply, etc.

Thus it is desirable to provide a device for balancing and positioning of vessels in water which, e.g., are biased and to provide a device for further transport of air down to the depth concerned.

The object of the invention is therefore to provide a device for supply of air and operating means to a vessel, wherein the device enables the air supply to be replenished, thus avoiding the transport of large quantities of air on board the vessel. A further object, especially during the employment of such a method, is to provide a device for balancing, submerging and positioning of such a vessel in water.

The object of the present invention is achieved by a device according to claim 1. A special object of the device is obtained when a compressed air supply is provided which is connected to a service tank with an overpressure chamber. Further features are obtained by means of the sub-claims.

The invention will now be described in more detail by means of an embodiment which is illustrated by means of the drawing. The drawing comprises the following:

- Fig. 1 is a cross section of a pump station according to the invention,
- fig. 2 is a cross section of a pressure supply according to the invention,
- fig. 3 illustrates pump stations provided between a surface vessel and a submerged vessel,
- fig. 4 is a schematic representation of the principles of the invention used for controlling the ascent and descent of a vessel, balancing the vessel independently of depth and supplying air.

Fig. 1 of the drawing shows a pump station 1 with a ballast chamber 2. Through the pump station 1 there are passed means 3, e.g. connection elements for cables or air input 16. The pump station 1 comprises an electrical compressor 4, which is controlled by an adjustable pressure sensor 8 which maintains a desired exit pressure 12, e.g. at 500m, of approximately 55 bar, i.e. at overpressure. There are further provided propulsion means 5, 9, e.g. electrical motors for, amongst other things, operation of the compressor 4 and cooling

devices 13, 14. A pressure controller 6 is connected to the compressor 4 for pressure control and the adjustable pressure sensor 8 is further connected to the pressure controller 6. For manoeuvring, the pump station 1 is equipped with hydraulically driven propellers 17, operated by a hydraulic pump 7 which is connected to an oil cooler 14. Inside the pump station 1 there is provided an overpressure chamber 11 with a two-way valve 10. The pump station 1 is further equipped with an air cooler 13 and control means in the form of a control centre 15 with transmitting and receiving devices 18.

Fig. 2 illustrates a compressed air supply in the form of an air storage bottle 19 with a pressure-actuated bottom 20 consisting of an orifice 21 for pressure equalization with a grid 22 and a first end cap 23 which is threaded on the air storage bottle 19. At the other end there is provided a second end cap 24 with an air inlet 25. Inside the air storage bottle 19 there is provided a moveable bottom 20, with packing rings 26, which can be moved between the first end cap 23 and an end stop 27.

Fig. 3 illustrates an example of the use of pump stations 1 between a surface vessel and a vessel in water. These pump stations are provided spaced at a specified distance apart, e.g. 500 metres.

Fig. 4 illustrates the device for balancing a vessel in water consisting of a compressed air supply 29, e.g. according to fig. 2, or air supply from the surface 39, possibly via pump stations 1, connected to a service tank 30 with an overpressure chamber 31, where between the pressure chamber 31 and the service tank 30 there is provided a two-way valve 32. There is further provided a compressor 33 between the compressed air supply 29 or surface air 39 and the service tank 30. Buoyancy tank(s) 28 with overpressure sensors 34 are connected to the device. These are designed to control the pressure difference between an internal pressure in the buoyancy tank(s) 28 and an ambient water pressure. The compressor 33 is provided in such a manner that it maintains the pressure in the service tank 30. In the buoyancy tank 28 there is provided a bottom valve 35 which is opened during both ascent and descent and the pressure sensor 34 also controls a pressure relief valve 36 during ascent. The pressure sensor 34 reads and determines the pressure difference between the buoyancy tanks 28 and an ambient water pressure. The pressure difference can be adjusted continuously in order to achieve the desired rate of descent or ascent. Furthermore pressure sensors 34 are installed at the same height on all the buoyancy tanks to enable the vessel to be trimmed in the desired or a horizontal position. Water-sensitive equipment such as electrical motors, cameras, relays and contacts, etc. are installed in the overpressure chamber 31 with an automatic control, by means of the two-way valve 32, of a predetermined overpressure regardless of depth. There are further provided air supply valves 37, which are connected to the air supply from the surface or the pump station, on both sides of the service tank 30, and check

valves 38 are provided between the air supply 29 and the service tank 30. During descent and ascent the compressor 33 will automatically upgrade the air supply 29 and keep the volume of air in the air supply 29 constant in relation to the ambient water pressure.

The method for supply of air and operating means to a vessel which is located at a great depth is implemented by providing one or more pump stations at suitable distances between the surface and the vessel. The pump station(s) 1 with, e.g., an elliptical shape, comprises an electrically operated compressor 4, which is controlled by the adjustable pressure sensor 8 which keeps the exit pressure 12 at approximately 55 bar overpressure. The pump station 1 is equipped as an overpressure chamber, and is controlled by the two-way valve 10 and maintains a predetermined overpressure in relation to the ambient pressure. For maneuvering, the pump station 1 is equipped with hydraulically operated propellers 17. These are operated by an electrically-driven hydraulic pump 7, which is cooled by an oil cooler 13. The overpressure chamber 11 is equipped with an air cooler 12. For positioning, the pump station 1 is equipped with a control centre 15 and signal transmitter and receiver 18. The compressed air supply constitutes a reserve supply in the event of faults in the air supply from the surface or the pump station.

The pressure supply is not limited to the air storage bottle embodiment. It will also be possible to employ other forms of compressed air supply. Conversely, it will also be possible to employ the air storage bottle embodiment in other connections, such as a gas supply.

A device, e.g. in the form of a salvage dock, can control the nearest pump station, which in turn controls the next, an so on up to the surface. The positioning system will be capable of positioning both the salvage dock and pump stations in a vertical position over the salvage object. A salvage dock which can be used in connection with the invention is described in Norwegian patent application no. 92 1774.

The device according to the invention can be equipped with automatically controlled ascent, if any faults should arise in the signals from the surface. It can also be remotely controlled from the surface or from a mini-submarine.

Claims

1. A device for supplying air and operating means directly from a surface location to a vessel which is located at a great depth, e.g. at 500 m, or more, beyond the surface level, characterized in that from a surface location to site at a great depth there are provided one or more pump stations (1) at suitable distances in a cable or a pipe between the surface and the vessel at the great depth, and that the pump stations (1) are equipped with means for balancing to water depth and pumps and possibly other means for transporting air and operating means to the next station or vessel, in that at the

same level as the vessel there are provided a station with the same function as the pump stations to establish necessary working pressure.

2. A device according to claim 1, characterized in that the pump station (1) comprises cooling devices (13, 14) for, e.g., air and oil, that the pump station (1) comprises control means consisting of, amongst other things, a control centre (15), a signal transmitter and a receiver (18), and that it comprises pumps (7) and/or operating means for propellers (17).
3. A device according to claim 1, characterized in that the pumpstations (1) and the device for supplying air and operation means to the vessel at the great depth, respectively, comprises a compressed air supply (29) or surface air supply (39), connected to a service tank (30) with an overpressure chamber (31), that there is provided a compressor (33) between the supply (29) or the surface air supply (39) and the service tank (30), that buoyancy tank(s) (28) with overpressure sensors (34) are connected to the device, and that the overpressure sensors (34) are designed to control the pressure difference between an internal pressure in the buoyancy tank(s) (28) and an ambient water pressure.
4. A device according to claim 3, characterized in that the compressed air supply (29) is a bottle element (19), preferably with a pressure-actuated bottom (20).
5. A device according to claim 3, characterized in that the service tank (30) has an overpressure of approximately 50 bar in relation to the ambient pressure.
6. A device according to claim 3, characterized in that there is provided a compressor (33) in order to maintain the pressure in the service tank (30).
7. A device according to claim 3, characterized in that there is provided a bottom valve (35) which is opened both during ascent and descent.
8. A device according to claim 3, characterized in that the overpressure chamber (31) has a two-way valve (32), which independently of the depth automatically maintains a constant predetermined pressure.
9. A device according to claim 3, characterized in that the buoyancy tanks (28) have pressure sensors (34) provided at the same height, and which control pressure relief valves (36) during

ascent.

10. A device according to claim 3 or 9, characterized in that the pressure difference between the internal pressure in the buoyancy tanks (28) and the ambient pressure in the water controls both the ascent and the descent.

Patentansprüche

1. Vorrichtung zum Versorgen eines Wasserfahrzeuges, das sich in einer großen Tiefe, z. B. bei 500 Metern oder mehr, unter dem Oberflächenniveau befindet, mit Luft und Betriebsmitteln direkt von einer Stelle an der Oberfläche aus, dadurch gekennzeichnet, daß von einer Stelle an der Oberfläche zu einem Ort in einer großen Tiefe eine oder mehrere Pumpstationen (1) in geeigneten Abständen in einem Kabel oder einer Leitung zwischen der Oberfläche und dem Wasserfahrzeug in der großen Tiefe bereitgestellt sind und daß die Pumpstationen (1) mit Einrichtungen zum Ausbalancieren in der Wassertiefe und mit Pumpen sowie möglicherweise anderen Einrichtungen zum Transportieren von Luft und Betriebsmitteln zu der nächsten Station oder zum Wasserfahrzeug ausgerüstet sind, wobei auf dem gleichen Niveau wie das Wasserfahrzeug eine Station vorgesehen ist, die die gleiche Funktion wie die Pumpstationen hat, um einen notwendigen Arbeitsdruck aufzubauen.
2. Vorrichtung gemäß Anspruch 1, dadurch gekennzeichnet, daß die Pumpstation (1) Kühlvorrichtungen (13, 14) für z. B. Luft und Öl aufweist, daß die Pumpstation (1) Steuereinrichtungen aufweist, die unter anderem aus einem Steuerzentrum (15), einem Signalübertrager und einem Empfänger (18) bestehen, und daß sie Pumpen (7) und/oder Betriebsmittel für Schiffsschrauben (17) aufweist.
3. Vorrichtung gemäß Anspruch 1, dadurch gekennzeichnet, daß die Pumpstationen (1) und die Vorrichtung zum Versorgen des Wasserfahrzeuges mit Luft und Betriebsmitteln in der großen Tiefe jeweils eine Zufuhr von komprimierter Luft (29) oder eine Zufuhr von Oberflächenluft (39) aufweist, die mit einem Servicetank (30) mit einer Überdruckkammer (31) verbunden sind, daß ein Kompressor (33) zwischen der Zufuhr (29) oder der Zufuhr für die Oberflächenluft (39) und dem Servicetank (30) bereitgestellt ist, daß ein oder mehrere Auftriebsbehälter (28) mit Überdrucksensoren (34) mit der Vorrichtung verbunden sind und daß die Überdrucksensoren (34) so entworfen sind, daß sie den Druckunterschied zwischen einem Innendruck in dem (den) Auftriebsbehälter(n) (28) und einem umgebenen Wasserdruck steuern.
4. Vorrichtung gemäß Anspruch 3, dadurch gekenn-

zeichnet, daß die Zuführung für komprimierte Luft (29) ein Flaschenelement (19), vorzugsweise mit einem durch Druck betätigten Boden (20) ist.

5. Vorrichtung gemäß Anspruch 3, dadurch gekennzeichnet, daß der Servicetank (30) einen Überdruck von ungefähr 50 bar bezüglich des Umgebungsdrucks aufweist.
6. Vorrichtung gemäß Anspruch 3, dadurch gekennzeichnet, daß ein Kompressor (33) bereitgestellt ist, um den Druck in dem Servicetank (30) aufrechtzuerhalten.
7. Vorrichtung gemäß Anspruch 3, dadurch gekennzeichnet, daß ein Bodenventil (35) bereitgestellt ist, das sowohl während dem Aufsteigen als auch während dem Absinken geöffnet ist.
8. Vorrichtung gemäß Anspruch 3, dadurch gekennzeichnet, daß die Überdruckkammer (31) ein Zwei-Wege-Ventil (32) aufweist, das unabhängig von der Tiefe automatisch einen konstanten vorbestimmten Druck aufrechterhält.
9. Vorrichtung gemäß Anspruch 3, dadurch gekennzeichnet, daß die Auftriebstanks (28) Drucksensoren (34) aufweisen, die in der gleichen Höhe bereitgestellt sind und die die Überdruckventile (36) während dem Aufstieg steuern.
10. Vorrichtung gemäß Anspruch 3 oder 9, dadurch gekennzeichnet, daß der Druckunterschied zwischen dem inneren Druck in den Auftriebstanks (28) und dem Umgebungsdruck im Wasser sowohl das Aufsteigen als auch das Absinken steuert.

Revendications

1. Un dispositif pour délivrer de l'air et des moyens opérants, directement d'un point en surface à un navire qui est situé à grande profondeur, par exemple à 500 m, ou plus, au-dessous du niveau de la surface, caractérisé en ce que, d'un point en surface au site à une grande profondeur, on prévoit une ou plusieurs stations de pompage (1) à distances appropriées dans un câble ou un tuyau entre la surface et le navire à la grande profondeur, et en ce que les stations de pompage (1) sont équipées de moyens d'équilibrage à la profondeur d'eau et de pompe et éventuellement d'autres moyens pour transporter de l'air et des moyens opérants à la station suivante ou au navire, en ce que, au même niveau que le navire, on prévoit une station avec la même fonction que la station de pompage pour établir la pression de travail nécessaire.
2. Un dispositif selon la revendication 1, caractérisé en ce que la station de pompage (1) comprend des

dispositifs de refroidissement (13, 14) pour, par exemple, de l'air et de l'huile, en ce que la station de pompage (1) comprend des moyens de contrôle consistant, entre autres choses, en un centre de commande (15), un émetteur de signal et un récepteur (18), et en ce qu'elle comprend des pompes (7) et/ou des moyens opérants pour des hélices (17). 5

3. Un dispositif selon la revendication 1, caractérisé en ce que les stations de pompage (1) et le dispositif pour fournir au navire à la grande profondeur de l'air et des moyens opérants comprennent, respectivement, une alimentation en air comprimé (29) ou une alimentation en air de surface (39), reliées à un réservoir de service (30) avec une chambre de surpression (31), en ce que l'on prévoit un compresseur (33) entre l'alimentation (29) ou l'alimentation d'air de surface (39) et le réservoir de service (30), en ce qu'un (des) réservoir(s) de flottaison (28) avec des capteurs de surpression (34) est (sont) 10
20
25

4. Un dispositif selon la revendication 3, caractérisé en ce que l'alimentation en air comprimé (29) est un élément de bouteille (19), de préférence avec un fond actionné par la pression (20). 30

5. Un dispositif selon la revendication 3, caractérisé en ce que le réservoir de service (30) présente une surpression d'approximativement 50 bars en rapport avec la pression ambiante. 35

6. Un dispositif selon la revendication 3, caractérisé en ce que l'on prévoit un compresseur (33) afin de maintenir la pression dans le réservoir de service (30). 40

7. Un dispositif selon la revendication 3, caractérisé en ce que l'on prévoit une vanne de fond (35) qui est ouverte aussi bien pendant la remontée que pendant que la descente. 45

8. Un dispositif selon la revendication 3, caractérisé en ce que la chambre de surpression (31) possède une vanne à deux voies (32) qui, indépendamment de la profondeur, maintient automatiquement une pression constante prédéterminée. 50

9. Un dispositif selon la revendication 3, caractérisé en ce que les réservoirs de flottaison (28) possèdent des capteurs de pression (34) disposés à la même hauteur, et qui commandent des vannes de relâchement de pression (36) pendant la remontée. 55

10. Un dispositif selon la revendication 3 ou 9, caracté-

risé en ce que la différence de pression entre la pression interne dans les réservoirs de flottaison (28) et la pression ambiante dans l'eau commande aussi bien la remontée que la descente.

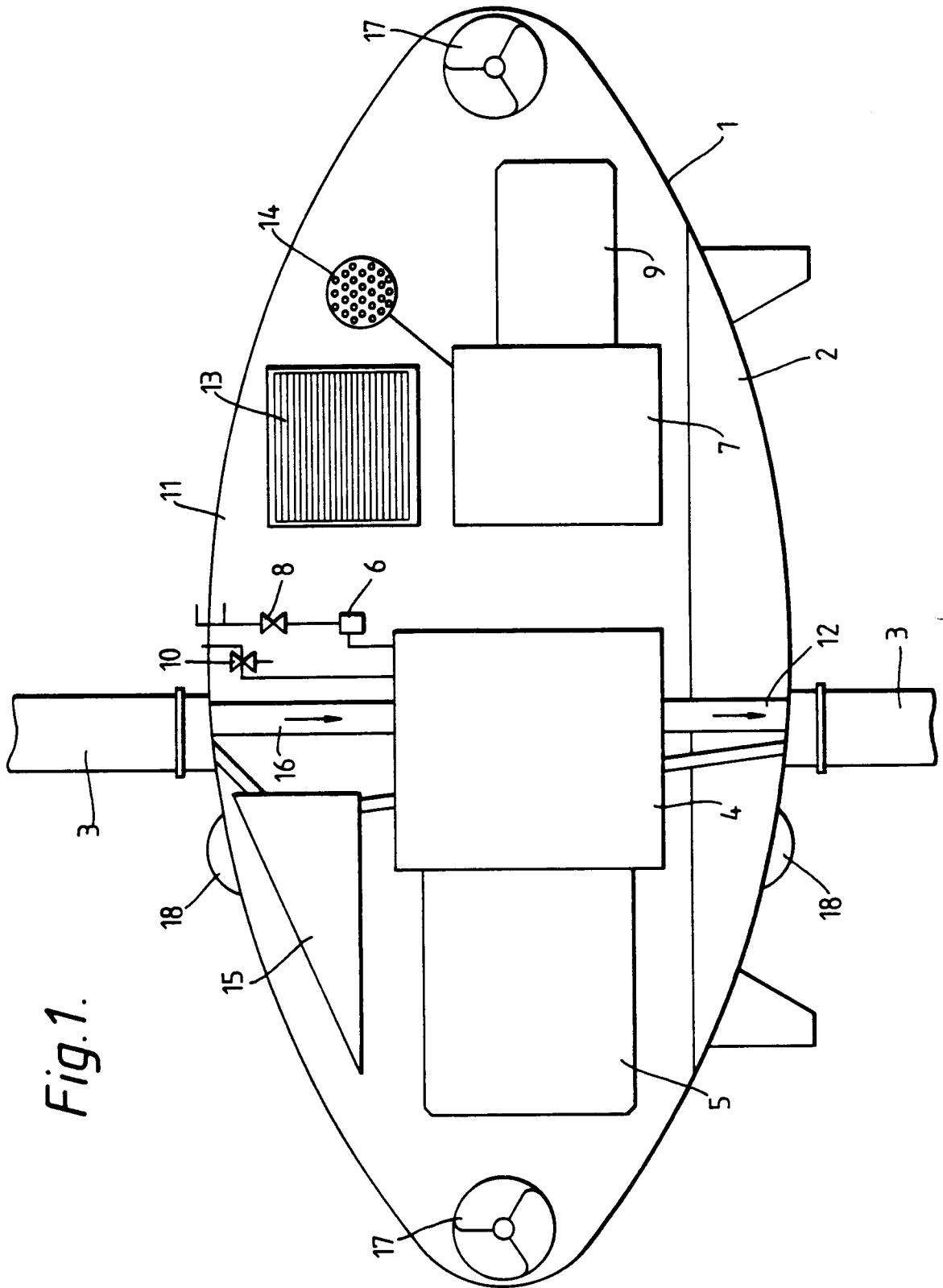


Fig. 1.

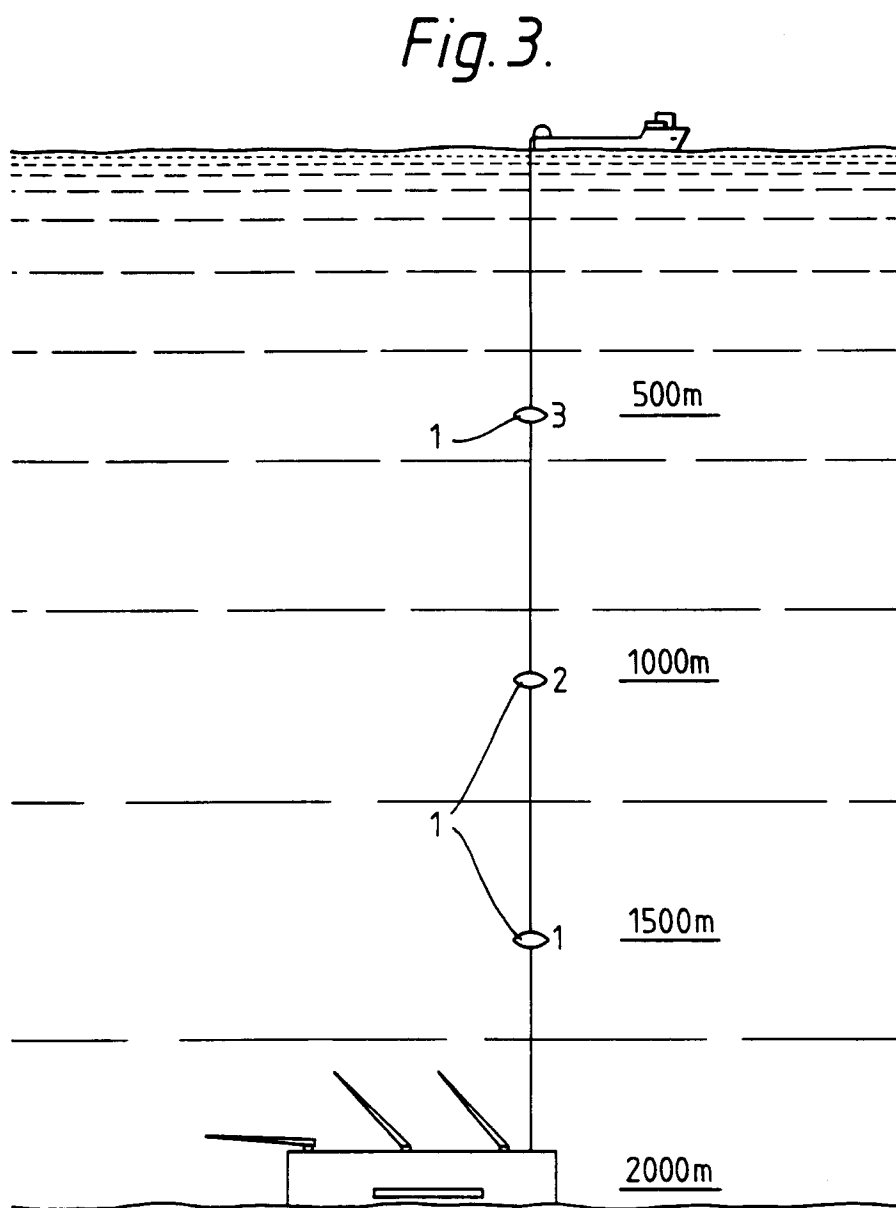
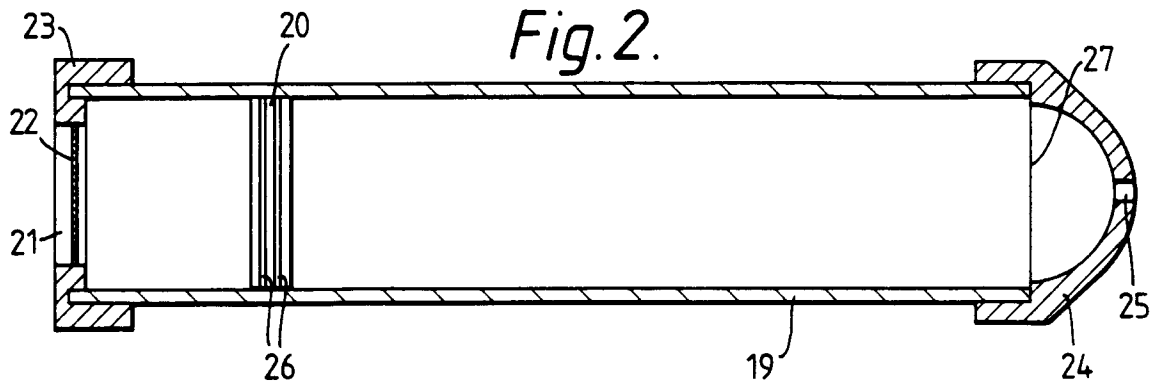


Fig.4.

