

## DESCRIPTION

### **Title of Invention: DIVING WORK SUPPORT SYSTEM AND DIVING WORK SUPPORT METHOD**

#### **Technical Field**

[0001] The present disclosure relates to a diving work support system and a diving work support method.

#### **Background Art**

[0002] When performing diving work at a deep depth, a method called saturation diving has been used. In the saturation diving, by supplying an inactive gas to a deck decompression chamber (DDC) mounted on a mother ship, the pressure in the deck decompression chamber and the pressure in an underwater decompression chamber coupled to the deck decompression chamber are increased to be equal to the pressure at a target depth, and this makes the body of a diver in the deck decompression chamber absorb the inactive gas until the body of the diver becomes a saturation state. Then, the underwater decompression chamber including the diver is separated from the deck decompression chamber and is made to move down to the target depth. The underwater decompression chamber is also called an underwater elevator or a bell. To reduce breathing resistance and prevent nitrogen poisoning when the target depth is deep, helium is typically used as the inactive gas for pressurization (see Non Patent Literature 1, for example)

#### **Citation List**

##### **Patent Literature**

[0003] Non Patent Literature 1: “Sensui no sekai - Hito wa Dokomade Mogureruka (World of Diving - How deep can a human dive?)” written by Tomosumi IKEDA, published by TAISHUKAN Publishing Co.,Ltd., October 20, 2002, pages 146-152

#### **Summary of Invention**

##### **Technical Problem**

[0004] When using helium as the inactive gas for pressurization, a large number of gas bombs filled with helium are mounted on the mother ship. Therefore, the mother ship requires a large space where the gas bombs are mounted, and this increases the size of the mother ship.

[0005] An object of the present disclosure is to provide a diving work support system and a diving work support method which can reduce the size of a mother ship.

### **Solution to Problem**

[0006] The present disclosure provides a diving work support system including: a mother ship; a deck decompression chamber mounted on the mother ship; an underwater decompression chamber that is coupleable to the deck decompression chamber and is made to move down from the mother ship to a target depth; and a nitrogen producer that is mounted on the mother ship, separates nitrogen from air, and supplies the nitrogen to the deck decompression chamber.

[0007] The present disclosure also provides a diving work support method including: supplying nitrogen as an inactive gas for pressurization to a deck decompression chamber to which an underwater decompression chamber is coupled; separating the underwater decompression chamber including a diver from the deck decompression chamber and making the underwater decompression chamber move down to a target depth that is 40 meters or less; and making the diver perform diving work at the target depth.

### **Advantageous Effects of Invention**

[0008] The present disclosure provides the diving work support system and the diving work support method which can reduce the size of the mother ship.

### **Brief Description of Drawings**

[0009] FIG. 1 is a side view showing a mother ship, a deck decompression chamber, and an underwater decompression chamber in an underwater work support system according to one embodiment.

FIG. 2 is a schematic configuration diagram of the underwater work support system.

### **Description of Embodiments**

[0010] FIGS. 1 and 2 show an underwater work support system 1 according to one embodiment. The underwater work support system 1 includes: a mother ship 2, a deck decompression chamber (DDC) 3 mounted on the mother ship 2; and an underwater decompression chamber 4 that is coupleable to the deck decompression chamber 3.

[0011] The mother ship 2 may be a ship (barge, for example) that does not have a self navigation ability. However, it is desirable that the mother ship 2 be a ship that has the self navigation ability and can maintain its position at a fixed position by itself. In FIG. 1, the deck decompression chamber 3 is located on an upper deck of the mother ship 2. However, the deck decompression chamber 3 may be located in a hull.

[0012] The deck decompression chamber 3 includes: a main chamber and an auxiliary

chamber where divers live; and a transfer chamber coupled to the underwater decompression chamber 4. In FIG. 1, the underwater decompression chamber 4 is coupled to the transfer chamber from above. However, a direction in which the underwater decompression chamber 4 is coupled to the transfer chamber may be a lateral direction.

[0013] After the underwater decompression chamber 4 including the diver is separated from the deck decompression chamber 3, the underwater decompression chamber 4 is made to move down from the mother ship 2 to a target depth. In the present embodiment, the target depth is 40 meters or less. Typically, an anchor is placed at the seabed before the underwater decompression chamber 4 moves down, and then, the underwater decompression chamber 4 is made to move down along a guide wire connecting the mother ship 2 and the anchor.

[0014] When the underwater decompression chamber 4 reaches the target depth, the diver performs diving work. For example, when the diving work is rescue work for a sunken ship, the rescued person is transferred to the deck decompression chamber 3 through the underwater decompression chamber 4 and is subjected to a recompression treatment in the deck decompression chamber 3.

[0015] The mother ship 2 also includes an oxygen supply source 7 and a nitrogen producer 5. The oxygen supply source 7 can supply oxygen to the deck decompression chamber 3 and the underwater decompression chamber 4. The nitrogen producer 5 can supply nitrogen as an inactive gas for pressurization to the deck decompression chamber 3 and the underwater decompression chamber 4. The oxygen supply source 7 and the nitrogen producer 5 may be able to supply oxygen and nitrogen to the diver who is performing the underwater work at the target depth.

[0016] The oxygen supply source 7 may be an oxygen bomb filled with oxygen or may be an oxygen producer that separates oxygen from air. As the oxygen producer, for example, a device of a PSA (Pressure Swing Adsorption) system is adoptable.

[0017] The nitrogen producer 5 separates nitrogen from air. As the nitrogen producer 5, a device of the PSA system is adoptable. However, the nitrogen producer 5 is not limited to the device of the PSA system and may be a different type of device.

[0018] When the underwater decompression chamber 4 is coupled to the deck decompression chamber 3, the oxygen supply source 7 and the nitrogen producer 5 supply oxygen and nitrogen to the deck decompression chamber 3. After the underwater decompression chamber 4 is separated from the deck decompression chamber 3, the oxygen supply source 7 and the nitrogen producer 5 supply oxygen and nitrogen to both of the underwater decompression chamber 4 and the deck decompression chamber 3.

[0019] More specifically, the nitrogen producer 5 is connected to the deck decompression chamber 3 and the underwater decompression chamber 4 by a nitrogen supply line 6. The nitrogen supply line 6 includes: a main channel 61 extending from the nitrogen producer 5; and branch channels 62 and 63 that extend from the main channel 61 and are connected to the deck decompression chamber 3 and the underwater decompression chamber 4, respectively. Flow control valves are located at the respective branch channels 62 and 63.

[0020] A buffer tank 64 is located at the main channel 61. A gas analyzer 65 is located at the buffer tank 64 and measures the concentrations of respective components of the gas in the buffer tank 64.

[0021] On the other hand, the oxygen supply source 7 is connected to the deck decompression chamber 3 and the underwater decompression chamber 4 by an oxygen supply line 8. The oxygen supply line 8 includes: a main channel 81 extending from the oxygen supply source 7; and branch channels 82 and 83 that extend from the main channel 81 and are connected to the deck decompression chamber 3 and the underwater decompression chamber 4, respectively. Flow control valves are located at the respective branch channels 82 and 83.

[0022] A buffer tank 84 is located at the main channel 81. A gas analyzer 85 is located at the buffer tank 84 and measures the concentrations of respective components of the gas in the buffer tank 84.

[0023] Moreover, a gas analyzer 31 is located at the deck decompression chamber 3 and measures the concentrations of respective components of the gas in the deck decompression chamber 3. A gas analyzer 41 is located at the underwater decompression chamber 4 and measures the concentrations of respective components of the gas in the underwater decompression chamber 4.

[0024] When supplying nitrogen and oxygen to the deck decompression chamber 3, the flow control valve located at the branch channel 62 of the nitrogen supply line 6 and the flow control valve located at the branch channel 82 of the oxygen supply line 8 are controlled based on measurement results of the gas analyzers 31, 65, and 85. When supplying nitrogen and oxygen to the underwater decompression chamber 4, the flow control valve located at the branch channel 63 of the nitrogen supply line 6 and the flow control valve located at the branch channel 83 of the oxygen supply line 8 are controlled based on measurement results of the gas analyzers 41, 65, and 85.

[0025] When the target depth is not so deep, i.e., 40 meters or less, nitrogen can be used as the inactive gas for pressurization in the deck decompression chamber 3. Therefore, as in the underwater work support system 1 of the present embodiment, when the nitrogen producer 5 that

separates nitrogen from air is mounted on the mother ship 2, the mother ship 2 can be made smaller than when a large number of gas bombs filled with helium are mounted on the mother ship 2.

[0026] In addition, in the present embodiment, after the underwater decompression chamber 4 is separated from the deck decompression chamber 3, nitrogen as the inactive gas can be supplied from the nitrogen producer 5 to not only the deck decompression chamber 3 but also the underwater decompression chamber 4.

[0027] **Modified Example**

The present disclosure is not limited to the above embodiment, and various modifications may be made within the scope of the present disclosure.

[0028] **Conclusion**

As a first aspect, the present disclosure provides a diving work support system including: a mother ship; a deck decompression chamber mounted on the mother ship; an underwater decompression chamber that is coupleable to the deck decompression chamber and is made to move down from the mother ship to a target depth; and a nitrogen producer that is mounted on the mother ship, separates nitrogen from air, and supplies the nitrogen to the deck decompression chamber.

[0029] When the target depth is not so deep, i.e., 40 meters or less, nitrogen can be used as the inactive gas for pressurization in the deck decompression chamber. Therefore, as in the above configuration, when the nitrogen producer that separates nitrogen from air is mounted on the mother ship, the mother ship can be made smaller than when a large number of gas bombs filled with helium are mounted on the mother ship.

[0030] As a second aspect, the diving work support system may be configured such that in the first aspect, the nitrogen producer supplies the nitrogen to the underwater decompression chamber separated from the deck decompression chamber. According to this configuration, nitrogen as the inactive gas can be supplied from the nitrogen producer to not only the deck decompression chamber but also the underwater decompression chamber.

[0031] As a third aspect, the present disclosure provides a diving work support method including: supplying nitrogen as an inactive gas for pressurization to a deck decompression chamber to which an underwater decompression chamber is coupled; separating the underwater decompression chamber including a diver from the deck decompression chamber and making the underwater decompression chamber move down to a target depth that is 40 meters or less; and making the diver perform diving work at the target depth. According to this configuration, the mother ship on which the deck decompression chamber is mounted can be reduced in size.

## CLAIMS

[Claim 1] A diving work support system comprising:

a mother ship;

a deck decompression chamber mounted on the mother ship;

an underwater decompression chamber that is coupleable to the deck decompression chamber and is made to move down from the mother ship to a target depth; and

a nitrogen producer that is mounted on the mother ship, separates nitrogen from air, and supplies the nitrogen to the deck decompression chamber.

[Claim 2] The diving work support system according to claim 1, wherein the nitrogen producer supplies the nitrogen to the underwater decompression chamber separated from the deck decompression chamber.

[Claim 3] A diving work support method comprising:

supplying nitrogen as an inactive gas for pressurization to a deck decompression chamber to which an underwater decompression chamber is coupled;

separating the underwater decompression chamber including a diver from the deck decompression chamber and making the underwater decompression chamber move down to a target depth that is 40 meters or less; and

making the diver perform diving work at the target depth.