

[54] UNDERWATER IN SITU PLACEMENT OF CONCRETE

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[22] Filed: Nov. 22, 1971

[21] Appl. No.: 201,016

[52] U.S. Cl.: 61/46, 61/30, 61/63

[51] Int. Cl.: E02b 3/00

[58] Field of Search: 61/46, 63, 59, 35, 61/30, 50; 52/2

[56]

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[57]

ABSTRACT

A flexible container filled with dry concrete which will quickly set upon the addition of moisture. Because of the container's flexibility, it may be formed into any desired container to fit available space after which moisture is added.

5 Claims, 6 Drawing Figures

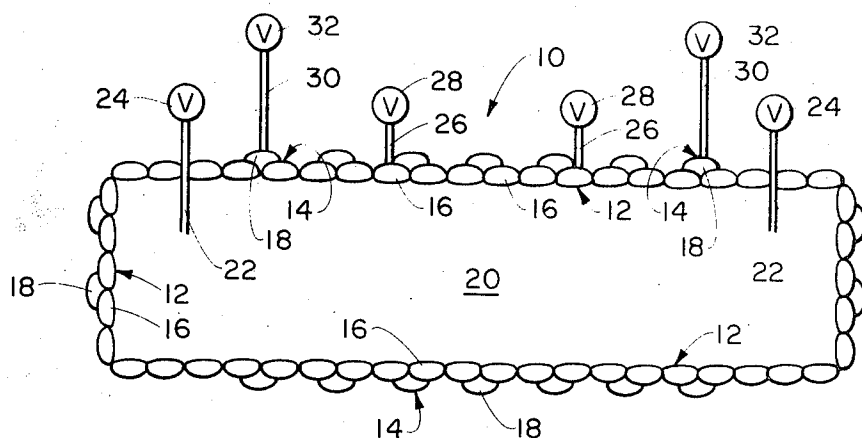


Fig. 1.

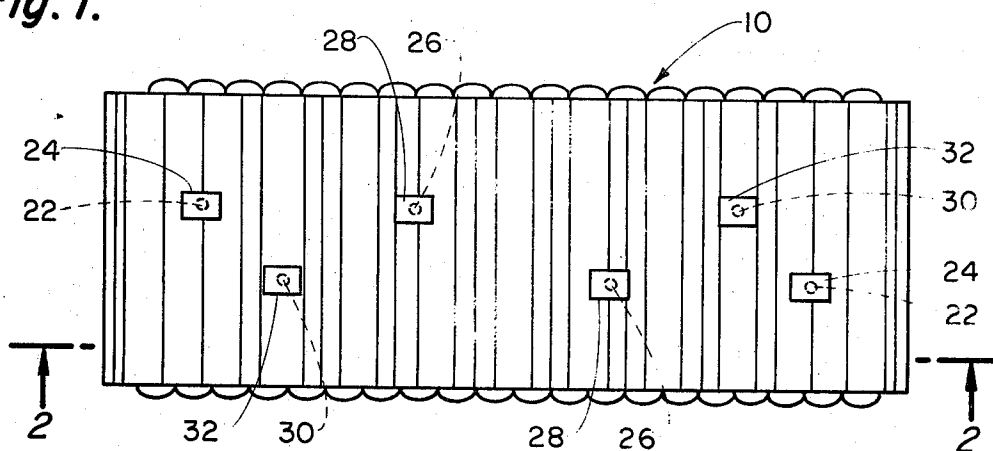


Fig. 2.

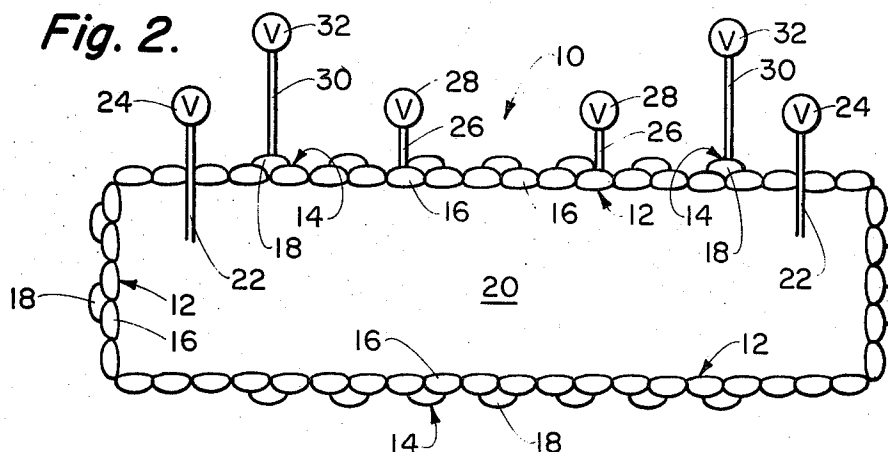


Fig. 3.

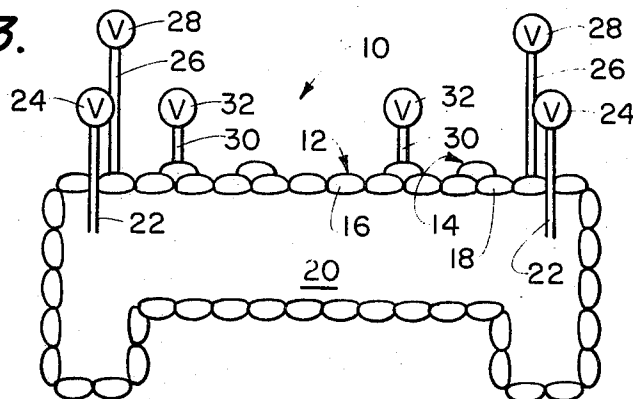


Fig. 4.

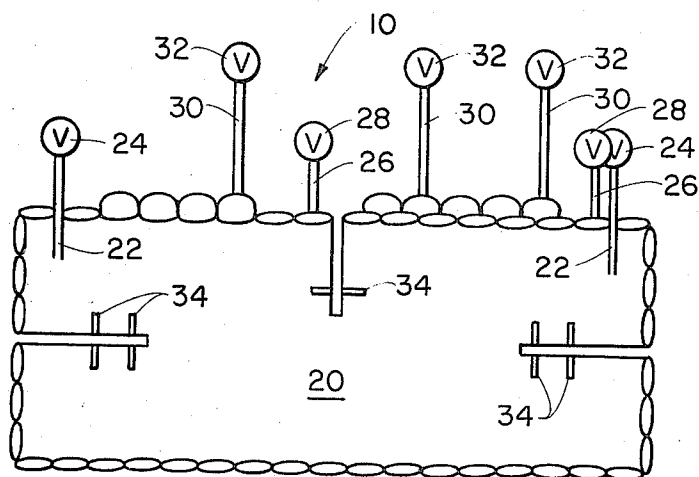


Fig. 5.

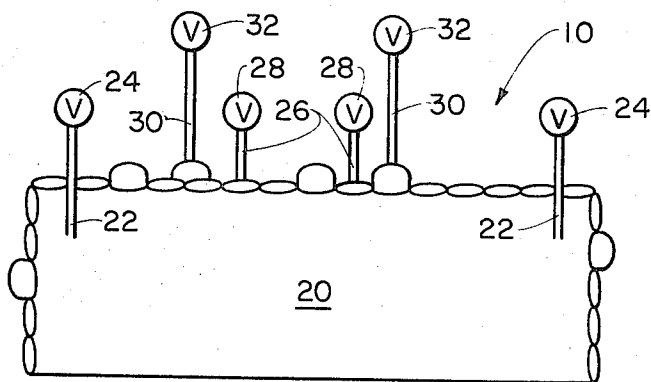
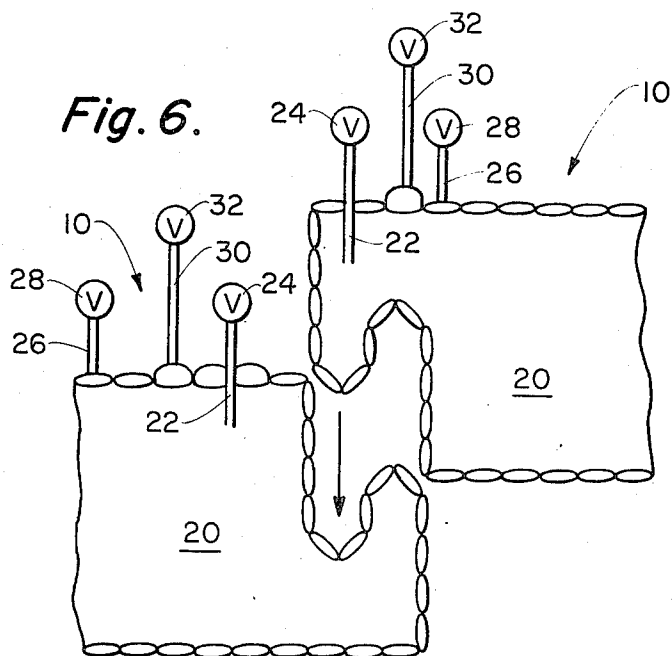


Fig. 6.



UNDERWATER IN SITU PLACEMENT OF CONCRETE

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

1. Field of the Invention.

This invention relates generally to techniques for placing concrete underwater and more particularly to flexible containers filled with concrete which resist wetting until the containers are in their underwater position.

2. Description of the Prior Art.

Current techniques for the subaqueous placement of concrete and their disadvantages are as follows:

The tremie method is a common technique for placing fresh concrete underwater. Concrete is poured from the surface through a hollow tube into a submerged form. Disadvantages of the method are that (1) pouring is controlled from the surface, (2) a separate formwork must be constructed and placed underwater, (3) the method is limited in the depth to which concrete may be poured, (4) the sea state must be relatively calm, and (5) strict control must be maintained to avoid segregation of the concrete. A second method of placing freshly mixed concrete underwater is to use dump buckets. A bucket filled with concrete is lowered on a line into submerged forms, the concrete is dumped. The disadvantages of this method are the same as those of the tremie method. Further disadvantages include fouling of the guide lines for controlling the bucket, non-continuous pouring, setting of the concrete before it is placed, and leeching of the cement from the concrete.

A third method of underwater concreting is preplaced aggregate concrete, a process known as Intrusion Prepack concrete. Aggregate is placed into submerged form, grout is then pumped into the forms either through hoses attached to the forms or through pipes embedded in the aggregate. The grout fills the voids and displaces the water. Although prepacking has advantages over other methods, disadvantages of this method are that (1) a separate underwater form must be constructed and placed, (2) preplacing the aggregate by bucket is time consuming, (3) the grout flow must be accurately controlled, (4) the placement of aggregate and the grouting are dependent on the sea state, and (5) operations must be controlled from the surface.

A fourth technique is the Fabriform system which consists of pumping a porous nylon-fabric form full of grout. Pumping pressures expel excess water through the pores while a lower water/cement ratio grout remains behind. This technique is currently being used to line canals with concrete. The principal disadvantage with this method is that it is surface controlled. In the deep ocean, accurate placement of the flexible bag by a surface ship would be difficult, and the grout must be pumped from the surface.

Using precast concrete elements underwater is an alternative to placing freshly mixed concrete on the ocean floor. Even though precast elements show great promise for structural applications underwater, disadvantages

do exist. The principal disadvantage of the precast element is that it does not conform to the ocean floor. Where the ocean floor is irregular, a foundation mat, overlay, or structure resting directly on the floor should conform to the shape of the floor.

SUMMARY OF THE INVENTION

The foregoing as well as other attendant disadvantages have been overcome in the present invention by a waterproof flexible container filled with dry concrete which will quickly set upon the addition of moisture. The container is of substantially neutral buoyancy so that it may readily be transported to an underwater location by a diver. Because it is not yet rigid it may be molded and formed into a desired contour to fit the available space. After being fitted into place moisture is introduced, with or without agitation, and the bag contents quickly harden into a rigid monolithic block of the shape previously imparted thereto. Moisture may be added in several ways as by bag puncture to admit ambient water, opening of passages ported into several portions of the bag, or release of entrained moisture capsules.

Accordingly an object of this invention is to provide a flexible container filled with concrete which will rapidly set upon the addition of water. Another object of the invention is to provide a dry concrete module which is neutrally buoyant for easy underwater emplacement.

A further object of the invention is to provide a simple, economical yet efficient arrangement wherein a dry concrete mix may be transported to a subaqueous position and water incorporated after the concrete has been positioned.

Other objects, advantages and novel features of the invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic plan view of the invention constructed in accordance with the present invention.

FIG. 2 is a schematic sectional view along the line 2-2 of FIG. 1.

FIG. 3 is a schematic sectional view similar to FIG. 2 showing a varied design of the invention to meet particular requirements.

FIG. 4 is a schematic sectional view similar to FIG. 2 illustrating a mechanism for internal vibration.

FIG. 5 is a schematic sectional view similar to FIG. 2 showing the bag with less than all sides being double walled.

FIG. 6 is a sectional view similar to FIG. 2 illustrating a keying arrangement between adjacent bags.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1 and 2, there is indicated a bag 10 having an inner wall 12 and an outer wall 14 which form attached but separate inner and outer compartments 16 and 18 respectively. The bag 10 as shown has a rectangular cross-section and a square plan, however, it may have any desired dimension or configuration as illustrated in FIGS. 3 and 4.

The through vents 22 controlled by valves 24 provide gas and liquid access from the exterior to the interior chamber 20 of bag 10. In the same way bag vents 26

controlled by valves 28 provide gas and liquid access to inner wall compartment 16. Vents 30 with valves 32 also provide access between the exterior and outer wall compartment 18.

In use the bag 10 is pressurized to a rigid state enclosing a bag interior chamber 20 by pumping a gas into compartments 16 and 18 through vents 26 and 30 and by controlling valves 28 and 32. Such pressurization causes the bag walls 12 and 14 to become rigid and enclose a bag interior chamber 20.

The interior chamber 20 is filled with a dry concrete mixture blown into bag 10 through vent 22. The concrete mixture is so proportioned that when ocean water is added to it, a high quality concrete is obtained. In the preferred embodiment, the porosity of the dry mixture is sufficient to allow water to flow through without the need for internal or external vibration. Other types of cement mixtures could be used in place of the concrete mixture used in the preferred embodiment including quick set cement, water curing adhesives and the inclusion of reinforcing materials in the cement mixture.

The pressurized and rigid bag 10 filled with a dry concrete mixture is neutrally buoyant when placed in the ocean and may be easily handled by divers or work submersibles. The degree of initial buoyancy may be altered as required by slight changes in design of the wall compartments 16 and 18.

Thus, when the rigid bag 10 filled with concrete mixture is placed on the ocean surface in the area where it is to be used subaqueously, the valves 32 are actuated which allow water to flow through vents 30 into wall compartment 18. This addition of water causes the bag 10 to become negatively buoyant. The bag 10 descends to the subaqueous site. It is still rigid because valves 28 providing access to inner wall compartment 16 through vents 26 have remained closed. However, once in its subaqueous position, valve 24 is opened allowing sea water to flow through vent 22 thereby penetrating the dry concrete mixture. In time the concrete cures and hardens after which the bag 10 and valves may be removed if desired.

In another embodiment of the invention, vibrator fingers 34 may be incorporated into the bag 10 as shown in FIG. 4. A vibration generator is attached to the fingers at the proper time, preferably when valve 24 is actuated to allow sea water to enter vent 22 wetting the cement mixture therein, thereby permitting vibrator fingers 34 to agitate the concrete.

As shown in FIG. 5 all the sides of the bag 10 need not be double walled if lower flexibility or less rigidity in the bag is required. Sufficient rigidity or stiffness is maintained to accurately form the concrete and the buoyancy will remain neutral.

The ability to vary the shape of the bag 10 permits key connections between bags, one of which is illustrated in FIG. 6. Keying together of modules enables large areas of the ocean floor to be covered with concrete for varying purposes such as foundations for large structures and landing areas for submersibles. Other keying arrangements can obviously be used if desired including the use of drift pins. Other varying shapes of bag 10 may obviously be used, one of which is illustrated in FIG. 3.

The use of sea water as a mixing agent for concrete is satisfactory in most instances. However, there is some evidence that sea water having a very high concentration of chloride and sulfate ions may result in

poor quality concrete if mixed therewith. To obviate such a condition, fresh water or water treated to remove the destructive ions may be placed in one of the wall compartments of bag 10 and then released as required into the enclosed concrete.

It is clear that any type of valve or similar arrangement may be used to fill the various compartments and chambers in the several embodiments without changing the original concept of this invention.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

I claim:

1. A flexible device for the subaqueous emplacement of concrete comprising:

a bag having a double wall, said double wall forming attached but separate inner and outer wall compartments;

vents positioned in each of said inner and outer compartments, said vents adapted to provide gas and liquid access from the exterior to the interior thereof;

valves controlling the opening into said vents; thus upon inflating the bag wall compartments, the bag retains a form and is neutrally buoyant;

a dry concrete mix positioned in the bag chamber; a bag vent extending through said double wall into said chamber of the bag and;

a bag vent valve controlling the opening in said bag vent;

said bag vent being opened after emplacement of the bag to permit water to enter and mix with the cement material therein.

2. A flexible device having a dry concrete mix positioned therein and designed for the subaqueous emplacement of concrete comprising:

a bag having a double wall, said wall forming attached but separate inner and outer wall compartments;

means located in each of said inner and outer compartments to provide controlled access from the exterior to the interior thereof;

thus upon inflating said bag wall compartments, the bag retains a form and is neutrally buoyant;

bag venting means located in said bag double wall and adapted to provide controlled access from the exterior to the interior of the chamber in said bag;

said means positioned in said inner and outer compartments to provide controlled access thereto and the bag venting means include.

vents located in each of said inner and outer compartments with cooperating valves to control the openings therein and;

a vent located in said double wall of the bag and extending into the bag chamber, said vent having a valve to control the opening therein;

thus when the bag is positioned at its underwater location said bag venting means is opened to allow water to mix with the dry concrete therein.

3. The device of claim 2 wherein the double wall having separate inner and outer compartments is present on less than all sides of said bag.

4. The device of claim 2 wherein:

a vibrator finger is incorporated into the chamber of said bag, said vibrator finger adapted to be attached to a vibrator generator when increased mixing of the concrete mix and water is required.

5. The device of claim 2 wherein each flexible bag contains interlocking key connections so as to permit adjacent bags to be keyed together over large expanses of the ocean floor.

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