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[54] SUBMERGED STORAGE VESSEL

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[51] **Int. Cl.** **E02b 17/00**, E02d 7/24

[58] **Field of Search** 61/.5, 46, 46.5, 61/53.74; 220/13, 18

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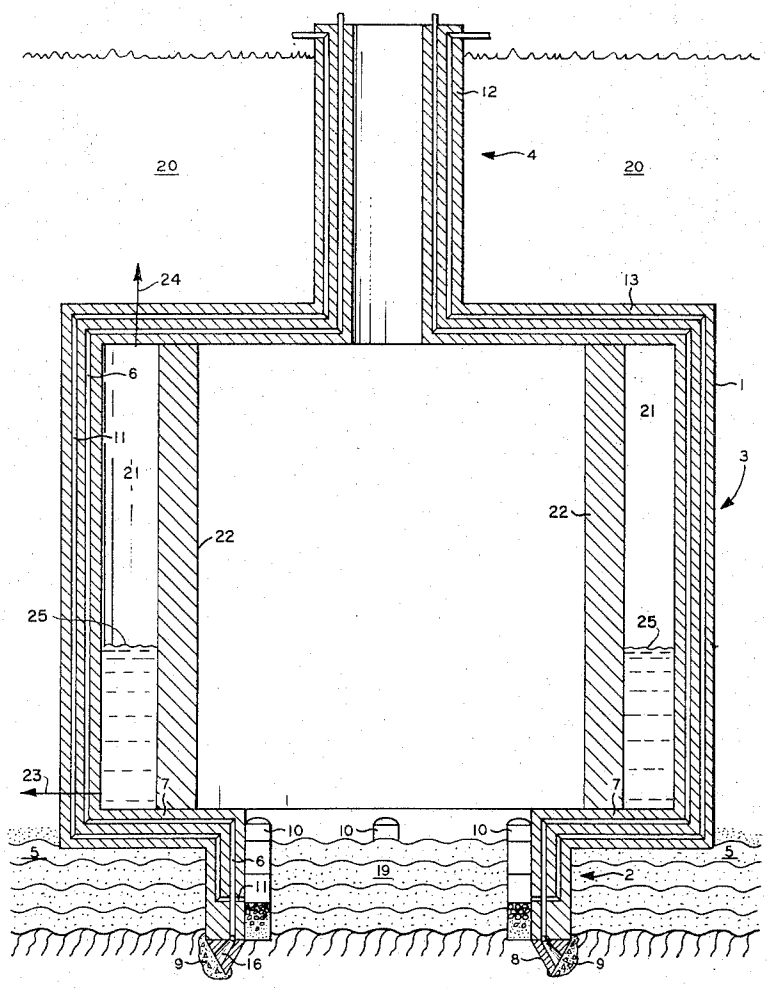
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[57] **ABSTRACT**

A submarine storage vessel comprised of at least a lower section and an upper section, the lower section being adapted for positioning into the underwater formation to an extent such that a substantially horizontally disposed wall comprising the upper section, is positioned in contact with the formation.

10 Claims, 3 Drawing Figures



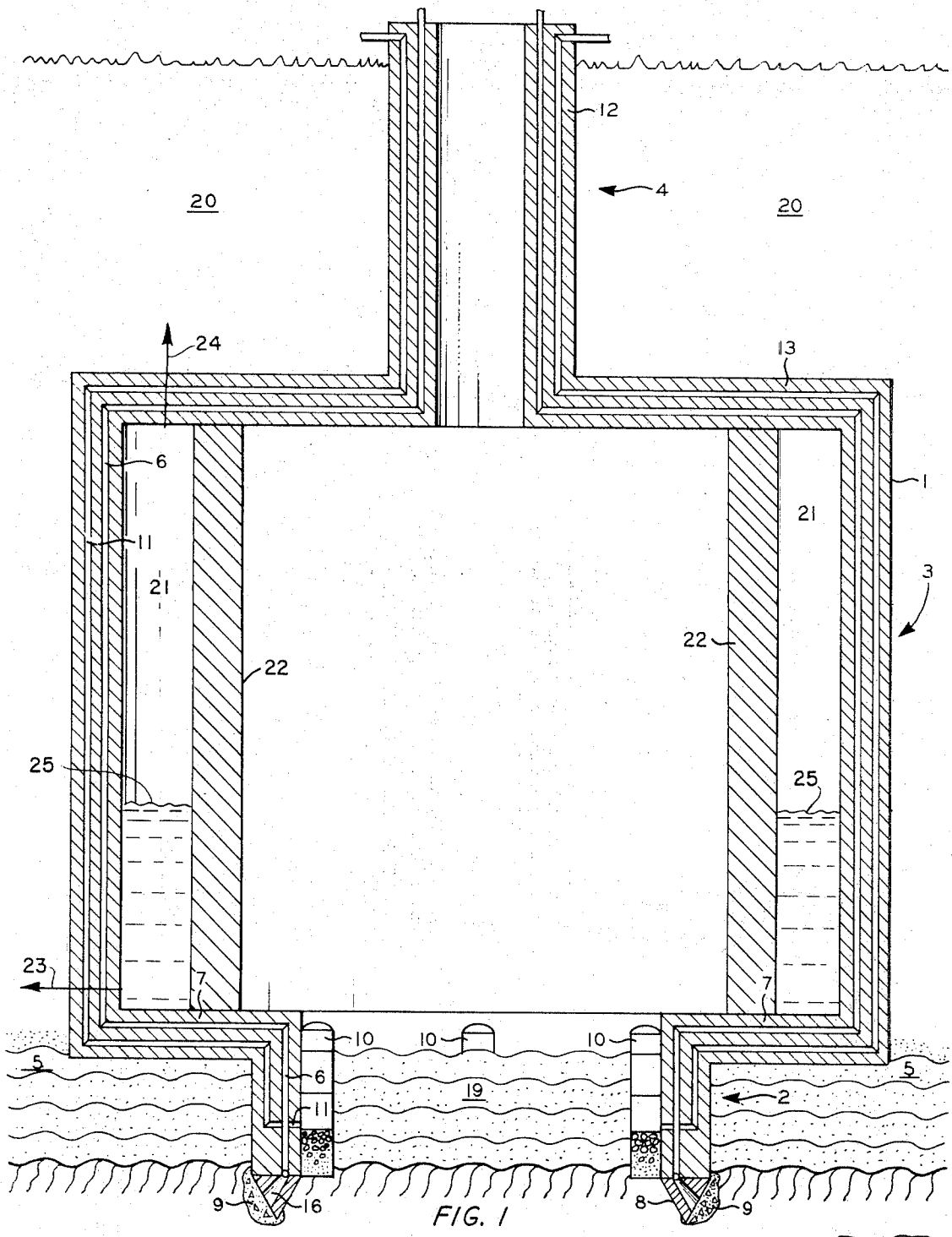


FIG. 1

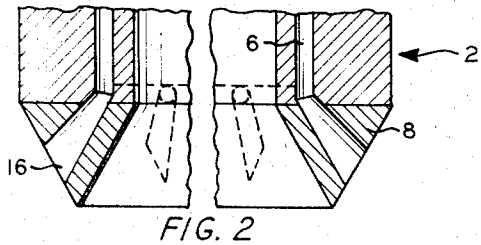


FIG. 2

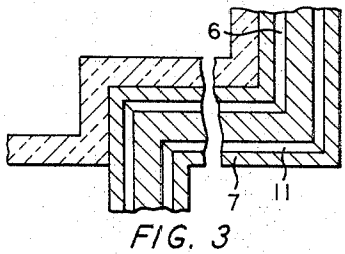


FIG. 3

SUBMERGED STORAGE VESSEL

This invention relates to submerged storage vessels.

In one of its more specific aspects, this invention relates to a vessel particularly suitable for offshore situating for the purpose of storing the products of offshore production operations.

One of the problems encountered relative to offshore drilling operations has to do with production disposal. Conduits which transfer the recovered products to shore are cumbersome and subject to damage. Accordingly, it is desirable to provide offshore storage, and preferably submerged storage, for such products. However, because of the size of the storage facilities involved, offshore weather conditions, the buoyance effect on submerged storage vessels and the corrosive conditions involved, it is difficult to provide suitable storage vessels. The submerged storage vessel of this invention acts to solve this problem.

According to this invention there is provided a storage vessel suitable for underwater storage which comprises at least two sections, and preferably three. The lower section is adapted at its lowermost edge for positioning into the underwater formation to a depth such that a substantially horizontally disposed wall forming the second or middle section is positioned in contact with the formation. The lower section is open ended and positioned into the formation.

The vessel of this invention is comprised of a plurality of sections, preferably cylindrical. Each serves a definite purpose. While these sections need not be cylindrical, they will be treated herein as such without intending to limit the invention thereto.

The lower section of the vessel is open at its bottom. The lower edge of the walls forming the cylinder are adapted with one or more positioning means spaced around the circumference of the cylinder. These facilitate the cutting of the bed into which the vessel is lowered and positioned. They also allow introduction of sealing materials into contact with the bed to stabilize the vessel and to seal the vessel around the lower edge of the cylinder walls, the vessel walls, if desired, being adapted with conduit means for removal of water from the vessel.

Superimposed on, and connected to, the lower cylinder is a second section, or middle section, in open communication therewith. This middle section provides the principal storage capacity of the vessel and, for this reason, it has at least at some point a diameter greater than that of the first, or lower, cylinder. Also, the greater diameter of the second cylinder in conjunction with a substantially horizontal wall interconnecting the second cylinder to the lower cylinder provides substantial support for the vessel.

The middle section need not be uniform in diameter along its height although it is preferable that it be so. However, it can be of a conical configuration, truncated at its upper extremity to form the inlet to the vessel.

The inlet section to the vessel which can be integral with the middle section can be of any configuration but is preferably cylindrical and of smaller diameter than that of the middle section. Inasmuch as some portion of this inlet section will advantageously project above the level of the water in which the vessel is submerged, this section can conveniently be adapted with means for supporting platforms and related services.

The storage vessel of this invention will be more readily understood if explained in conjunction with the attached drawings in which FIG. **1** is a view in sectional elevation of the submerged vessel; FIG. **2** is a view of the lower edge of the wall of the lower section, and FIG. **3** shows one embodiment of the wall of the vessel.

Referring now to FIG. **1** there is shown vessel **1** comprised of lower section **2** positioned under water **20** in underwater bed **5**, middle section **3** and upper section **4**.

The vessel of this invention is adapted for positioning in a formation such as mud, sand or clay. For this purpose, the lower edge **8** of the lower section can be armored with a desirable material to facilitate its penetration of the formation. While the walls of the entire vessel can be made of any substance suitable in view of underwater conditions, such materials including steels, concrete or combinations thereof, this tapered leading edge preferably will be formed of high strength steel.

Encapsulated in the wall of the lower section as shown in FIG. **2** will be conduit **6** from which jet nozzles **16** can be caused to impinge upon the formation to provide the necessary excavation into which the walls of the lower section are positioned.

The lower section will be positioned in the formation to such a depth that the vessel is stabilized, that the seepage of water into the vessel around the lower edges is minimized and such that the substantially horizontally-disposed wall **7** of the middle section rests on, and is supported by, the underwater formation. Conduits **6** can also be employed for the ejection of grout or sealant **9** proximate the lower edge of the lower section to further limit seepage into the vessel.

Penetrating the formation with the lower section until the substantially horizontally-disposed wall of the middle sections rests on the formation provides a stable base for vessel and provides a formation plug **19** extending upwardly into the vessel. The horizontal wall of the middle section also provides a bearing surface on which water, which can be pumped into the vessel or which seeps thereinto, acts to create a negative buoyancy within the vessel, that is, to offset the natural buoyancy thereof. To facilitate the achievement of negative buoyancy, the area of the horizontal wall can be sized as desired.

With the vessel so placed there can be positioned within the vessel, and preferably within the lower section, one or more water evacuation means, such as submergible pumps **10**, electrically or otherwise operated. These remove water from the vessel either through conduits **11** formed in the wall or through conduits passing upwardly through the contents of the vessel. These pumps can be operated to pump out the water as it enters the vessel or they can be operated, if buoyancy considerations are paramount, to maintain a desired level of water superimposed above the lower horizontal wall of the middle section. If desired, these pumps can be positioned in dewatering wells formed within the formation extending up into the lower section of the vessel, these wells being formed any place therein but preferably adjacent to the vertical walls of the lower section.

Superimposed on the middle section and preferably formed by walls **12** extending vertically upward from horizontal walls **13** of the middle section is upper section **4**. This section will be terminated by any suitable closure, not shown, projecting, preferably, above the

water level. Its walls can contain those conduits which have been previously described. Relatedly, the vertical walls of the middle section can also be employed to support appurtenances to the vessel.

Since the vessel of this invention can be employed as storage for any material or for habitation, its walls can be insulated internally consistent therewith. If insulated, the lower section can be closed off by a wall interposed between the lower section and the middle section.

The vessel of this invention can be installed simply by being submerged with the upper section open and being positioned in the formation by means of the described facilities. Thereafter, it is evacuated and the pumps positioned therein as desired. In certain instances, where buoyancy forces dictate, buoyancy chambers **21**, comparable to ballast tanks, can be positioned as at least a portion of the vertical wall **22** of the middle section. These chambers can be open at their lower extremity **23** to allow the entrance of water and can be equippped in their upper section with openings **24** to allow the escape of air or for the introduction of gases to remove water **25** therefrom.

While the sections of the vessel of this invention can be of various dimensions depending upon the storage capacity desired, a suitable storage vessel would have a cylindrical lower section having a wall height of about 30 feet and a diameter from about 0.2 to about 0.6 the diameter of the middle section. The height of the middle section will be sufficient to provide the storage capacity required in consideration of the diameter of the vessel.

The upper section can, of course, be of any suitable diameter and have an opening of any size desired.

For example, a suitable vessel of the type contemplated will have a lower section having a wall height of about 30 feet and a diameter of about 125 feet. The middle section will be about 250 feet in diameter with a wall height of about 100 feet. The top or inlet section will be 30 feet in diameter with a height of about 140 feet. The walls will be of sufficient thickness to withstand the hydrostatic forces to which they are subjected.

It will be evident that various modifications can be made to this invention. Such modifications are considered, however, to be within the scope of the invention.

What is claimed is:

1. A submarine storage vessel comprising:

a. a first chamber formed of a continuous side wall and a substantially horizontal lower wall, said chamber having an opening into its upper portion;

b. a second chamber formed of a continuous side wall, said chamber being open at its lower end and intersecting said lower horizontal wall of said first chamber at the upper end of said second chamber to form open communication with said first chamber said second chamber of sufficiently less diameter than said first chamber to provide the horizontal wall connecting the chambers as a bearing surface for support of said vessel and for regulation of the bouyancy of said vessel; and

c. excavation means positioned proximate the lower end of said side wall of said second chamber.

2. The vessel of claim **1** in which said second chamber is adapted with water removal means.

3. The vessel of claim **1** in which the lower end of said side wall of said second chamber is armored.

4. The vessel of claim **1** in which said second chamber is adapted with sealant placement means to position sealant proximate the lower edge of the wall of said second chamber.

5. The vessel of claim **1** in which said first chamber and said second chamber are cylindrical.

6. The vessel of claim **1** in which said opening into said first chamber is in the form of a third chamber in open communication with said first chamber.

7. The vessel of claim **2** in which the walls of said first and second chambers are adapted with conduit means in open commuication with said water removal means.

8. The vessel of claim **1** in which a wall is interposed within said first chamber and the walls of said first chamber are insulated.

9. The vessel of claim **2** in which the lower end of said side wall of said second chamber is armored and said second chamber is adapted with sealant placement means.

10. The vessel of claim **7** in which buoyancy chambers are incorporated in the walls of said second chamber.

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