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Carter

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(54) **VARIABLE STORAGE VESSEL AND METHOD**

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(58) **Field of Search** 114/256, 257, 114/230.1, 230.2, 293, 264; 405/210

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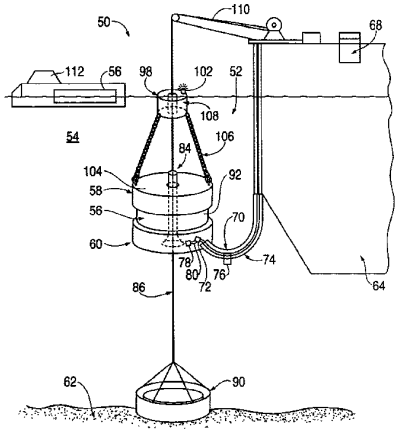
(57) **ABSTRACT**

A method and apparatus for storing bulk materials in a marine environment is provided. The apparatus includes a flexible pod configured for fluid communication to a host vessel. The pod stores materials under water.

37 Claims, 7 Drawing Sheets



VARIABLE STORAGE VESSEL AND METHOD

FIELD OF THE INVENTION

The present invention relates generally to storing materials in a marine environment. More particularly, the present invention relates to storing materials underwater.

BACKGROUND OF THE INVENTION

Storing large amounts of fluids and dry bulk material on offshore floating and fixed structures to support day-to-day operations is becoming increasingly more challenging. Large offshore operations such as drilling for oil, natural gas, or other offshore operations require large amounts of bulk materials and various chemicals to perform tasks associated with these offshore operations. Bulk volumes, otherwise termed in this document as variable loads or bulk materials, may pertain to volumes of material, wet or dry, used by a host in a body of water for its day-to-day operations. Examples of well bulk materials include potable water, drilling water, drilling muds, well completion fluids, sewage, waste water, chemicals, diesel fuel, and the like. Dry bulk materials can be products such as barite, cement, drill cuttings and viscosifiers. The bulk materials include stored volumes of a product produced by the host such as oil, or other produced products. As those operations are being performed in deeper and deeper water, as well as deeper well depth, cost effective means to assist in supporting these large volumes of materials are becoming more and more important.

Storing large bulk items requires support vessels or structures to support the weight of the materials. Currently, supporting heavy volumes of materials require either floating vessel hulls to support the weight of the bulk materials or large fixed structures based at the bottom or floor of body of water. These support vessels or structures add greater cost to exploration and production projects potentially stifling the viability of further deep well or deep water exploration. The increased equipment for larger bulk volumes extends into other industries such as fishing, shipping, geoscience surveying, aqua farming and potentially offshore habitats.

Storing large amounts of bulk material on board a vessel requires a large amount of vessel hull and associated support structure dedicated to the support of the bulk materials. Reducing the amount materials supported by a vessel hull reduces the amount of vessel hull required to support not only the bulk materials, but the associated support structure also. Vessels can only support limited amounts of weight. In order to store more weight, either more vessels or larger vessels are required. Either option dramatically increases costs. Thus, reducing the amount of bulk materials supported by a vessel hull will result in a large savings in investment of vessel hull dedicated to supporting the materials.

SUMMARY OF THE INVENTION

It is therefore a feature and advantage of the present invention to provide a cost effective method of storing large volumes of heavy bulk materials in offshore and other underwater applications.

The above and other features and advantages are achieved through the use of a novel storage system as herein disclosed. In accordance with one embodiment of the present invention, a submersible for storing bulk materials is provided. The submersible includes: a substantially watertight resilient container for storing the materials under water, and a mooring line slidablely engaged with the submersible, so the container positions itself along the mooring line in response to environmental conditions and a buoyancy associated with the container.

In accordance with another embodiment of the present invention, a system for storing materials under water is provided. The system includes: a host vessel, a pod for storing the material under water attached to the host vessel by at least one hose and the hose configured to transfer the material between the pod and the host, a buoy attached to the pod for marking a location of the pod, a mooring line attached to the pod for limiting movement of the pod, wherein the pod is configured to store the materials in a watertight manner.

In accordance with another embodiment of the present invention, a storage vessel for storing a material underwater is provided. The vessel includes: a flexible means for storing in a substantially watertight configuration the material supported by a buoyancy force created by displacing water, a mooring means connected for mooring the flexible storing means, a communication means for providing fluid communication between the storing means and a host vessel; and means for moving the material between the storing means and the host vessel via the communication means.

In accordance with another embodiment of the present invention, a method of storing materials under water is provided. The method includes: deploying a storage pod under water, moving the materials between the pod and the host vessel while the pod is under water, mooring the storage pod to at least one of a buoy and host vessel via a mooring line, and permitting the storage pod to travel along the mooring line.

In accordance with another embodiment of the present invention, a method of storing materials under water is provided. The method includes: attaching a storage pod to a host vessel, deploying a storage pod under water, providing fluid communication between the host vessel and an interior of the storage pod, and supporting the pod entirely by its own buoyancy.

There has thus been outlined, rather broadly, the more important features of the invention in order that the detailed description thereof that follows may be better understood, and in order that the present contribution to the art may be better appreciated. There are, of course, additional features of the invention that will be described below and which will form the subject matter of the claims appended hereto.

In this respect, before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and to the arrangements of the components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments and of being practiced and carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein, as well as the abstract, are for the purpose of description and should not be regarded as limiting.

As such, those skilled in the art will appreciate that the conception upon which this disclosure is based may readily be utilized as a basis for the designing of other structures, methods and systems for carrying out the several purposes of the present invention. It is important, therefore, that the claims be regarded as including such equivalent constructions insofar as they do not depart from the spirit and scope of the present invention.

FIG. 2

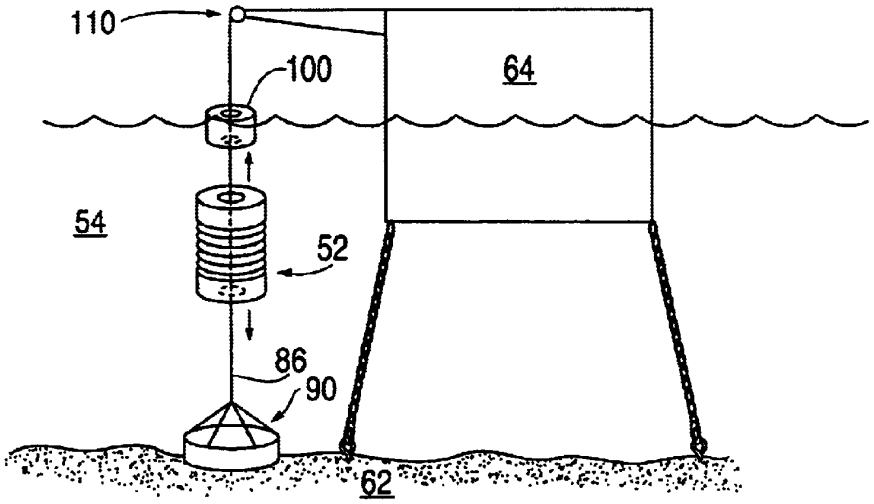

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FIG. 3

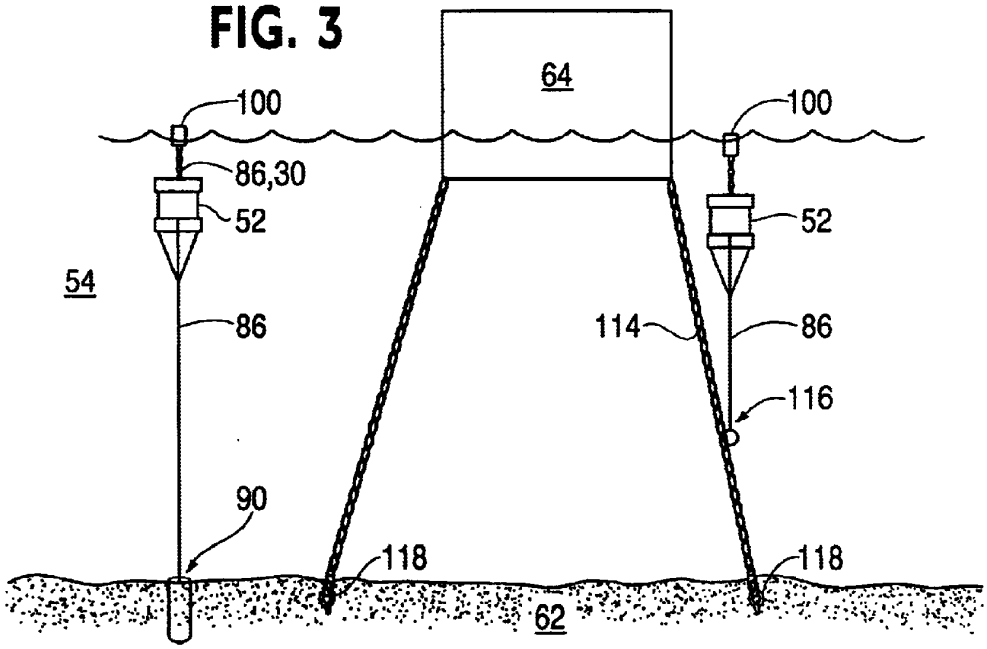
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FIG. 4

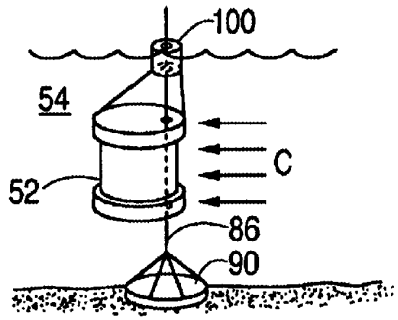

FIG. 5

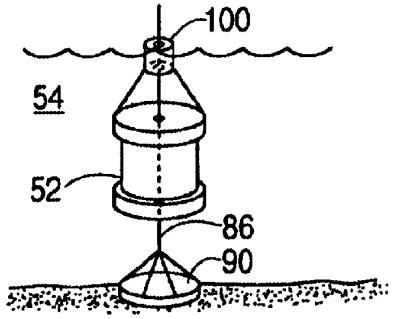

FIG. 6

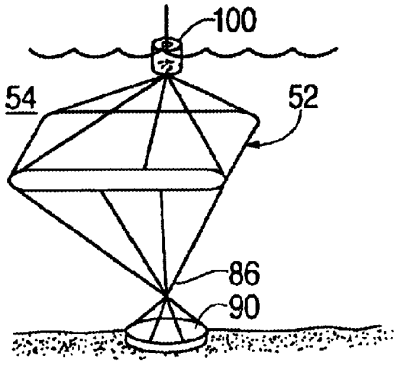

FIG. 7

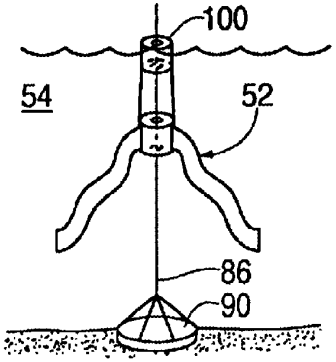

FIG. 8

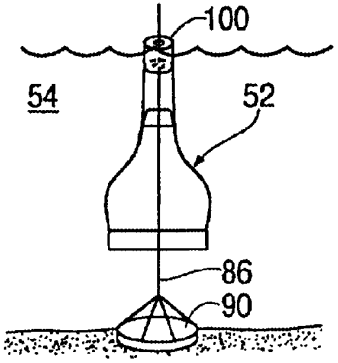

FIG. 9

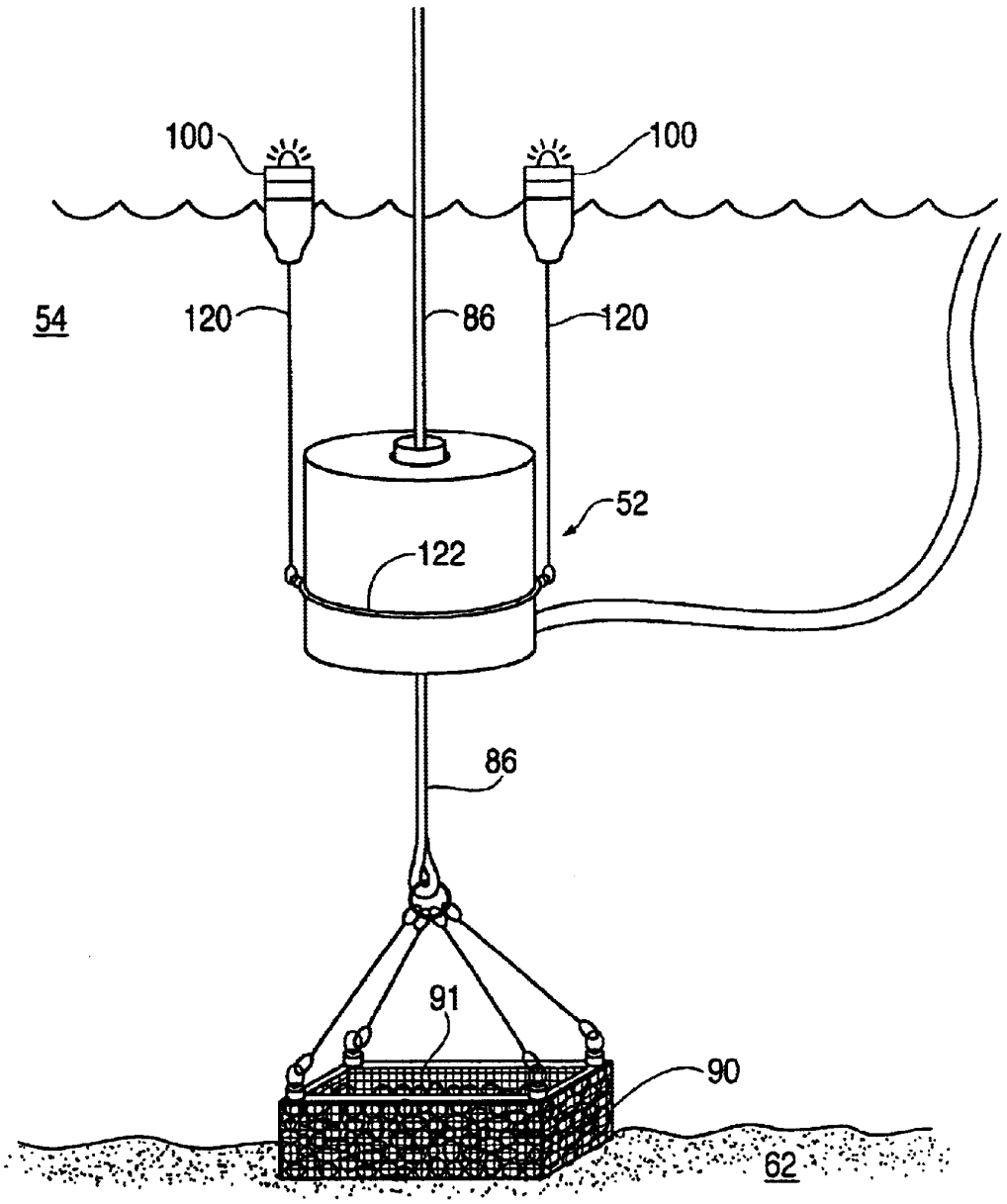

FIG. 10

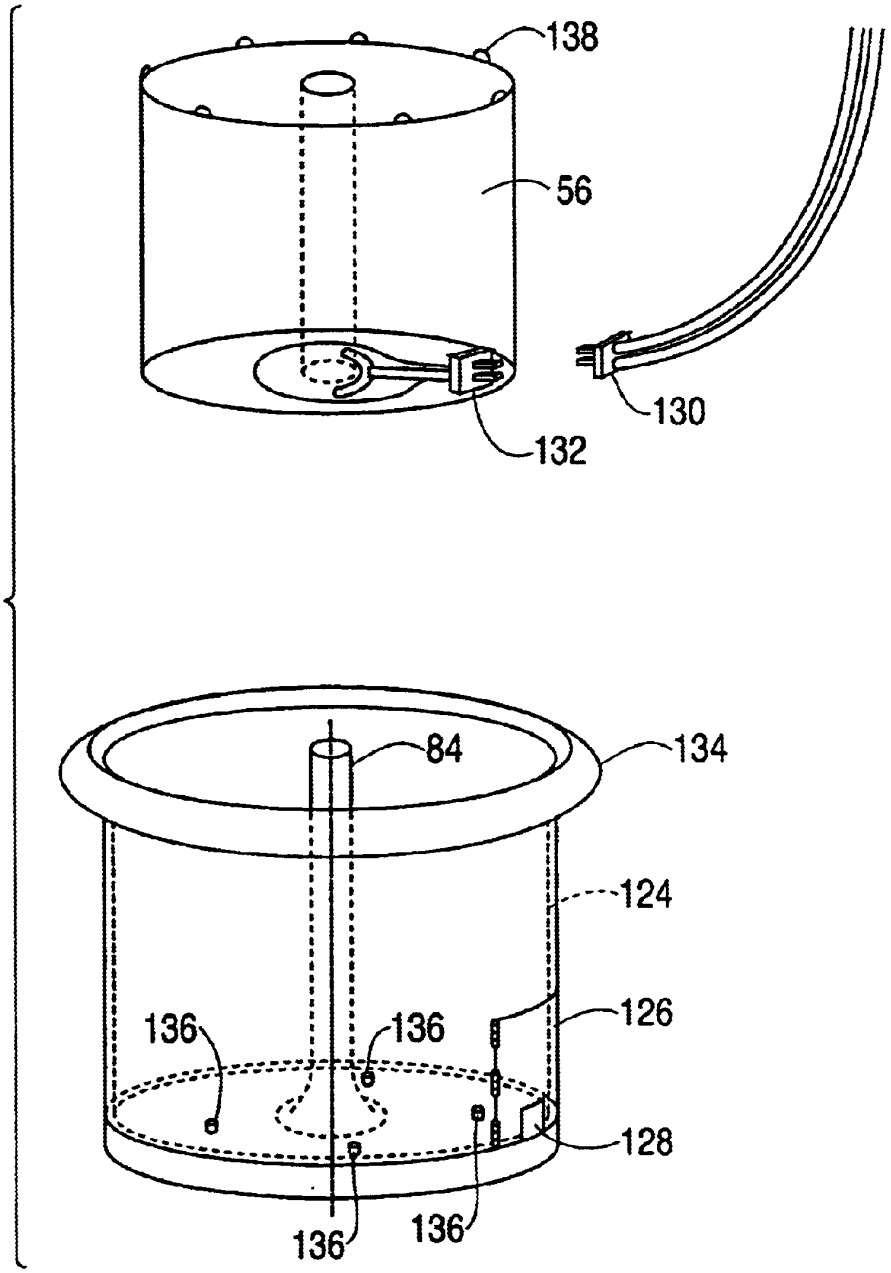

FIG. 11

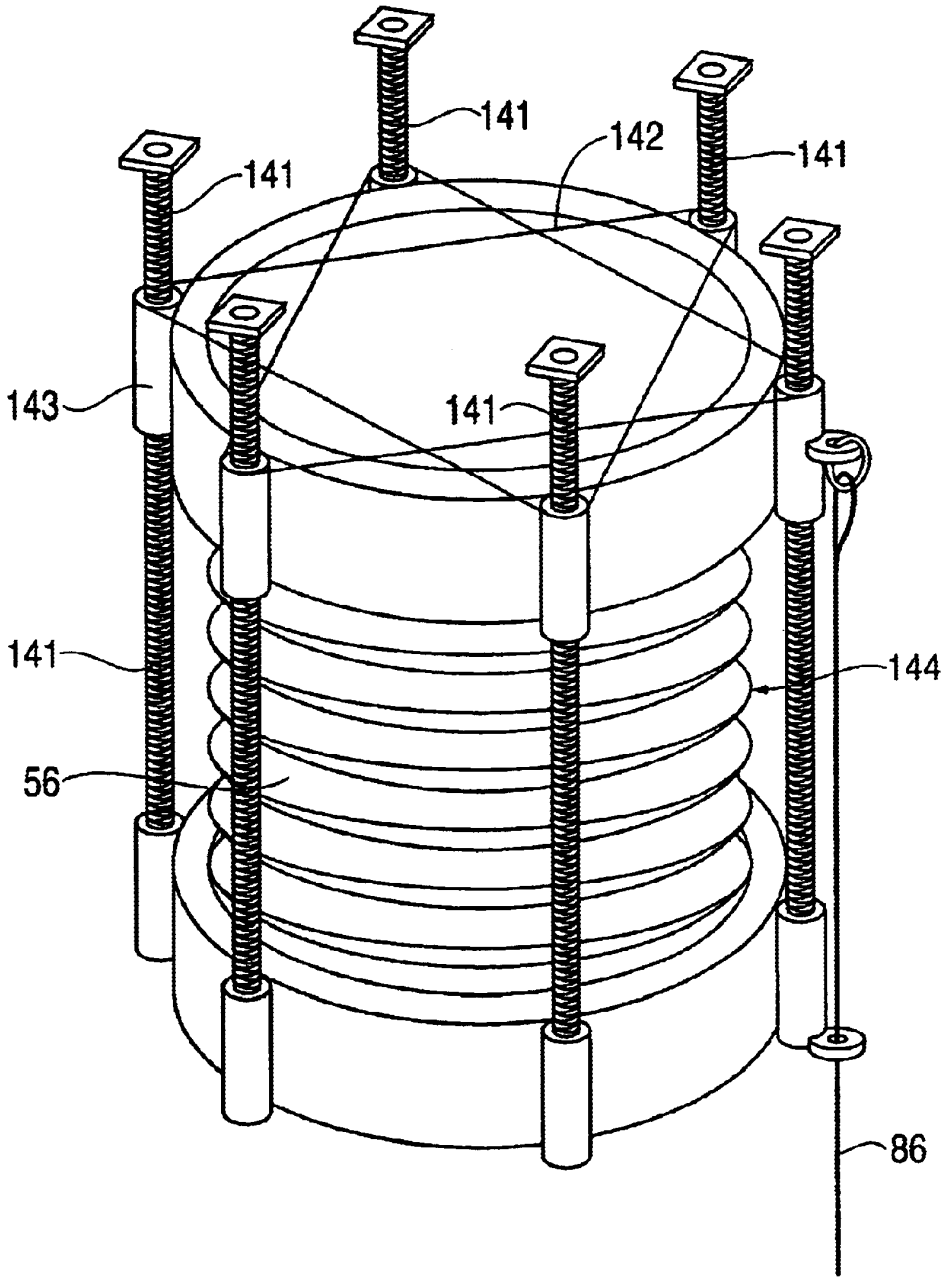

FIG. 12