Aug. 20, 1968 C. M. LEAVITT 3,397,545

MARINE STRUCTURE

Filed Oct. 11, 1965 2 Sheets-Sheet 1

Fig. 1

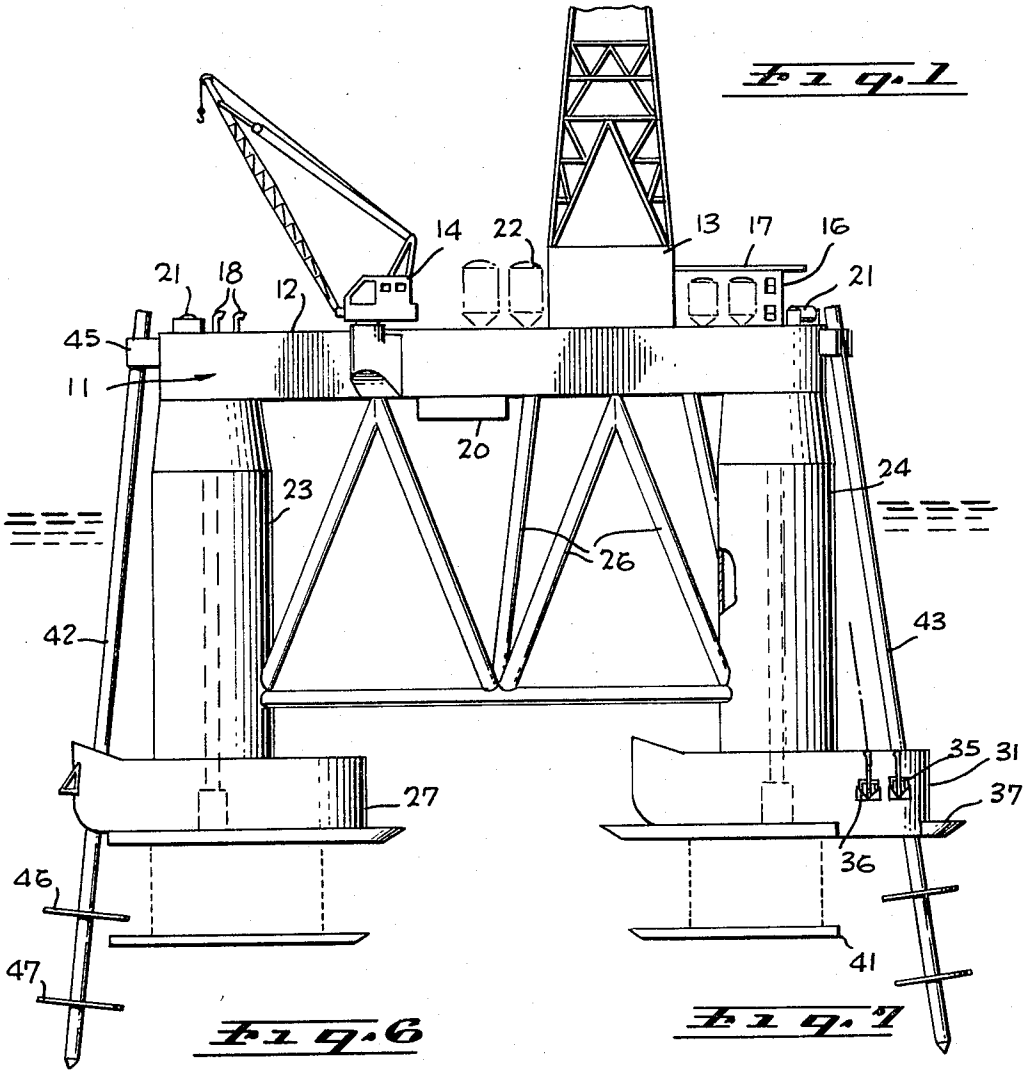


Fig. 6

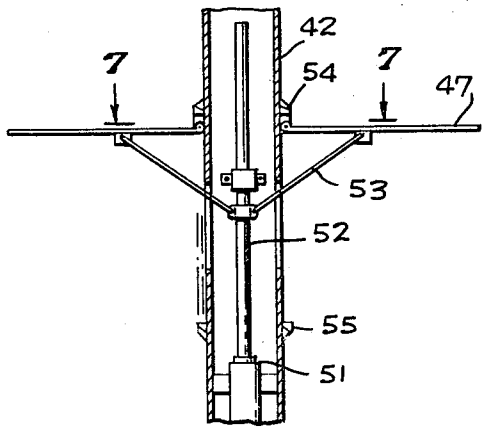
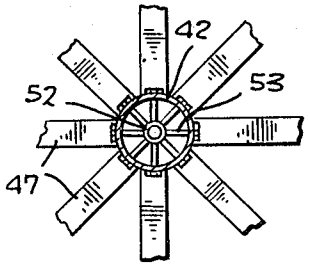


Fig. 7



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MARINE STRUCTURE

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Fig. 2

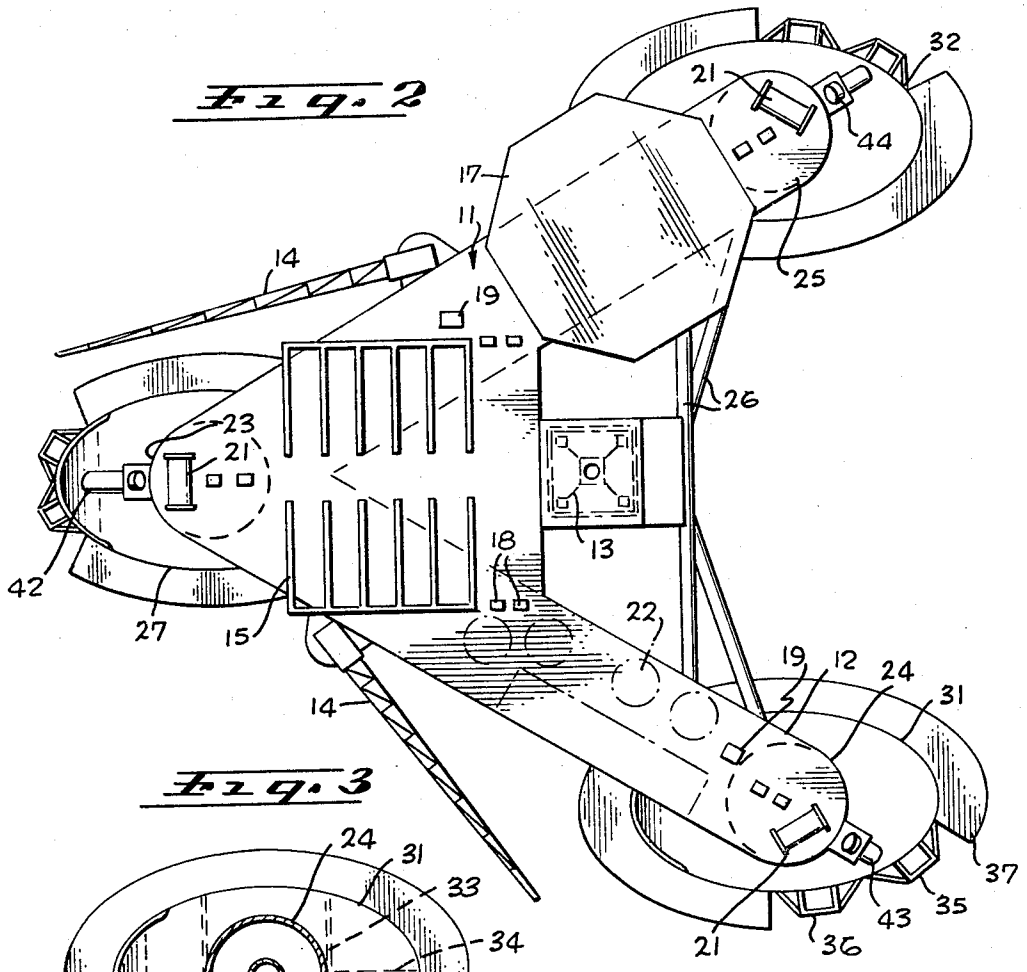


Fig. 3

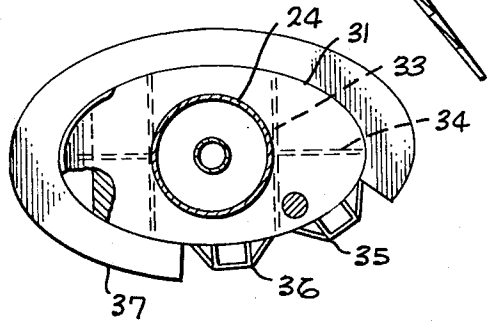
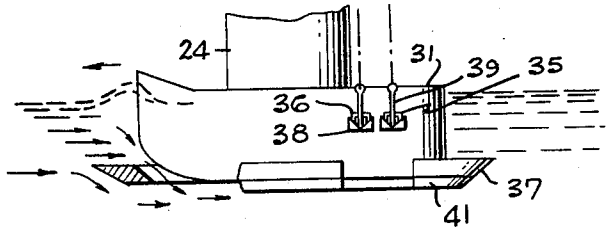


Fig. 4



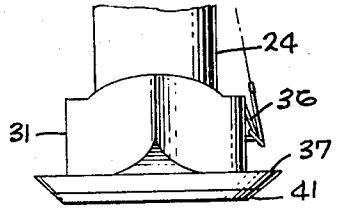


Fig. 5

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3,397,545

MARINE STRUCTURE

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Filed Oct. 11, 1965, Ser. No. 494,507
15 Claims. (Cl. 61—46.5)

ABSTRACT OF THE DISCLOSURE

A movable marine structure developed primarily for offshore oil drilling. The structure has been designed so that it may be towed to the oil drilling site and, if desired, anchored at the site or submerged into contact with the ocean floor. The structure has a triangular shape, including at the apices buoyant columns supported on separate boat-shaped footing members, each having damping plates and fins to increase the stability of the structure. The boat-shaped footing members are oriented with one of the members defining a bow of the structure and the two members define a stern. The two stern members each have their longitudinal axes inclined to the center line of the structure to facilitate the towing of the structure.

This invention relates to stable marine platforms and more particularly, to a stable marine platform which may easily be towed into a desired position, which may, in relatively shallow water, be emplaced on the sea bottom or in relatively deep water, may be placed in a stable floating mode. Such stable marine platforms are particularly required in the drilling of oil and gas wells in deep water, as on the continental shelf off the coast of California or in the Gulf of Mexico.

Various types of stable platforms have been employed in the past in the drilling of such offshore oil wells. The most obvious approach has been the construction of a platform with the foundations on the sea bottom. This approach is obviously limited to comparatively shallow water, since the structure must support a working platform a considerable distance above the normal water level to avoid damage by storm caused waves. As the depth of the water increases, the cost of erecting such a platform on the ocean bottom quickly becomes prohibitive.

Various floating arrangements have been proposed for operation in water too deep to enable construction of a platform. One such arrangement in the prior art is a barge with the necessary operating deck constructed on a framework above the barge. The barge is towed into the desired position and sunk to the ocean floor. The operating platform must be high enough, of course, so that it is substantially above the normal water surface. As will be apparent, the high heavy structure on such barges make them inherently unseaworthy. Extremely favorable weather conditions are required for towing such a barge into position and sinking it.

Various floating drilling rigs have also been proposed in the prior art. Some of these are conventional ships carrying drilling equipment which are anchored in the desired position. As will be apparent each vessel is subjected to wave action, and drilling can be carried on only under favorable sea conditions. Two hulled catamaran and outrigger type structures have also been employed. These are as subject to wave action as conventional ship hulls. The structures most adaptable for drilling in deep water have been discovered to be those that float on a number of buoyant columns which extend a considerable distance below the surface and support a platform a considerable distance above the surface. However, such devices as known in the prior art are extremely difficult to tow into position and are limited to this one mode of operation.

In contrast to these prior art devices the present invention contemplates a marine structure which is readily towed into the desired position, exhibits inherent seaworthiness, and may be emplaced at the desired location by resting on the bottom in comparatively shallow water. In deeper water, the structure is placed in a stable floating mode with an operating platform a considerable distance above the normal water level. One illustrative embodiment of the invention employs a substantially A-shaped watertight superstructure resting on three columnar floats. At the base of each float a buoyant footing is provided and it may be boat-shaped and have a flared cut away bow to enable towing at comparatively high speeds. By flooding the footings and columns, the structure is adapted to rest on the bottom in a bottom sitting mode of operation. While the structure is transparent to wave action, swells may cause heaving. To obviate this problem, heave damping means may be provided. To further stabilize the platform a spud may be provided at each column to fix the structure in position while operating in the bottom sitting mode. Additional heave dampers are provided in each spud, extendible when operating in the floating mode. If one of the columnar floats were to be damaged, destroying its watertight integrity, there would be danger of capsizing. However, the superstructure in the present invention is watertight, enabling the structure to remain afloat even if one of the columnar floats is holed and flooded. Since only three floats are required and the remaining understructure is quite simple, there is a high degree of wave transparency, assuring independence of any normal surface conditions. Stability in swells is provided by the heave damping means.

It is, therefore, an object of the present invention to provide an improved marine structure of the offshore platform type.

Another object of the present invention is to provide a stable offshore platform which may easily be moved from place to place.

Another object of the present invention is to provide an offshore platform having a bottom sitting mode and a stable floating mode.

Another object of this invention is to provide a marine structure adapted to to float on boat-shaped footings facilitating movement.

Another object of this invention is to provide a floating marine structure with heave damping means to minimize heaving in swells.

Another object of this invention is to provide a marine structure with spuds for anchoring the structure when sitting on the bottom and with extendible heave damping plates for minimizing heaving in swells.

Another object of this invention is to provide an offshore drilling platform which is versatile, efficient, and safe.

Other objects and advantages of the present invention will become apparent from the following description and accompanying drawings, wherein:

FIGURE 1 is a side elevation of marine structure of the present invention;

FIGURE 2 is a plan view of the structure of FIGURE 1;

FIGURE 3 is a plan view of one of the footings;

FIGURE 4 is an elevation of one of the footings;

FIGURE 5 is front view of one of the footings;

FIGURE 6 is a cross-sectional view of one of the spuds illustrating suitable means for extending and retracting the heave damper placed thereon;

FIGURE 7 is the cross section of the spud of FIGURE 6 taken along the line 7—7, illustrating the extended heave dampers.

Referring now to the drawings, and particularly to FIGURES 1 and 2, a watertight superstructure 11, hav-

ing a generally A-shaped configuration, is covered by a substantially triangular working platform **12**. As employed for drilling, the working platform **12** includes a drilling derrick **13**, cranes such as **14**, pipe racks **15**, a deck house **16** providing crew quarters, and a helicopter platform **17**. Additional equipment carried on working platform **12** may include winches **21** and tanks **22** for storing drilling mud and cement.

Ballast pumps, mud pumps, engine driven generators, air conditioning machinery, supplies, etc., are carried within watertight superstructure **11**. Engine exhaust and intake air and ventilation is provided to the interior of watertight superstructure **11** by gooseneck ventilators **18**, having closable watertight doors (not shown). Access to the interior of watertight superstructure **11** is provided by watertight hatches **19**, FIGURE 2. A control room **20** is suspended beneath deck **12**, wherein drilling operations may be viewed and controlled.

Superstructure **11** is carried on three substantially cylindrical columns **23**, **24**, and **25**. Tubular brace members **26** are provided between columns **23**, **24**, and **25** and superstructure **11**. At the base of columns **23**, **24**, and **25** are footings **27**, **31**, and **32**, respectively. Footing **31**, at the base of column **24**, is illustrated in detail in FIGURES 3, 4, and 5. The basic structure of footing **31** is a modified right elliptical cylinder. The bow is cut away in a "dutch-shoe" configuration and a flare having the same volume as the cut away portion is added to the upper bow. Footing **31** is hollow, and the interior is partitioned by watertight bulkheads such as **33** and **34**. The spaces formed by the bulkheads may be employed as ballast tanks and to store liquids such as diesel fuel, as will be disclosed more fully hereinbelow.

Anchor racks **35** and **36** supporting anchors **38** and **39** are provided on the outside of footing **31**. Substantially surrounding the base of footing **31** is a heave damping fin or plate **37**. The portion of heave damping plate **37** in way of the bow of footing **31** is cut away to reduce towing resistance as illustrated in FIGURES 3 and 4. An additional heave damping plate **41**, illustrated in retracted position in FIGURES 4 and 5, may be extended below footing **31** during the floating mode of operation in order to provide additional damping in long swells. Damping plate **41** is illustrated in the extended position in FIGURE 1.

As illustrated in FIGURE 2, stern footings **31** and **32** are toed in approximately five degrees with respect to the center line to facilitate towing. As will be apparent, a yaw in platform **11** due to wind or current displacing the stern to starboard will tend to place footing **31** in a straight ahead position and footing **32** at a considerably greater towed-in position with respect to the direction of movement. Footing **32** will, therefore, have a considerably increased drag, tending to force the structure back into the straight ahead position. A yaw to port will increase the drag of footing **31**.

Spuds **42**, **43**, and **44** associated with columns **23**, **24**, and **25**, respectively, are provided to anchor the structure in position while in the bottom sitting mode. As illustrated in FIGURE 1, spud **42** is held to superstructure **11** by upper guide bracket **45**. Spud **42** passes through a guide in footing **27** and in bottom-sitting mode will be forced into the bottom to assist in anchoring the structure. While in the towing mode, the spuds are raised so that the bottom end is inclosed within footing **27**. A rack on the spud and a motor driven pinion inclosed within bracket **45** may be conveniently employed for extending and retracting spud **42**. Near the bottom of spud **42** are placed heave damping structures **46** and **47**. As illustrated in FIGURES 6 and 7, these are a plurality of petal-shaped plates, which may be retracted flush to the sides of spud **42**. Hydraulic jack **51**, operating rod **52**, raises hinged links **53** to open petals **47**. Protective collars **54** and **55** placed adjacent the top and bottom of retracted petal-shaped heave dampers **46** and **47** protect the heave dampers in the retracted position when the spud **42** is raised through footing **27** or is forced into the bottom. Spud **43** is illustrated in FIGURE 1 in the retracted position, as it would be when the structure of the present invention is being towed.

As discussed, hereinabove, the structure of the present invention may readily be towed to a desired position. Boat-shaped footings **27**, **31**, and **32** are provided with flared cut away bows, enabling towing with relatively little resistance, and toed-in stern footings **31** and **32** provide natural towing stability. Heave damping plates **41**, and spuds **42**, **43**, and **44** are retracted when under tow. Upon attaining the desired position, the structure may be placed on the bottom if the water is shallow, or anchored in the floating mode if the water is deep. In the bottom sitting mode heave dampers **41**, **46**, and **47** remain retracted. To reduce buoyancy the tanks in the footings are flooded as well as the portions of columnar floats **23**, **24**, and **25**. If the bottom is relatively soft, spuds **42**, **43**, and **44** are forced into the bottom to provide a firm anchorage.

However, in the event that the water in the desired drilling position is too deep for bottom sitting, the structure is partially flooded to float at the waterline indicated in FIGURE 1. Heave dampers **41** are lowered. Spuds **42**, **43**, and **44** are lowered and spud heave dampers such as **46** and **47** are extended. The anchors such as **38** and **39** are carried out a distance from the structure by accompanying work boats and lowered to the bottom to prevent drift from the desired position.

Since the structure is inherently transparent to wave action, it will be little affected, thereby. The up and down motion, resulting from long swells, will be reduced to a negligible amount by heave dampers **41**, **46**, and **47**. After work in the desired site has been completed, the structure may be placed in towing position by retrieving the anchors, retracting the spud heave dampers such as **46** and **47**, retracting spuds **42**, **43**, and **44**, and the heave damping plates such as **41**. Footings and columns are pumped out, and as a result, footings **27**, **31**, and **32** again float the structure, which may then be readily towed to another location.

What I claim is:

1. A marine structure having a towing mode, a floating mode, and bottom sitting mode comprising an operating platform, a superstructure, buoyant means to support said operating platform and superstructure a substantial distance above water level, said buoyant means including three triangularly arranged columns, a boat-shaped footing at the base of each column, selective buoyancy adjusting means whereby said structure floats on said boat-shaped footings in said towing mode, on said columns in said floating mode, and with said footings resting on the bottom in said bottom sitting mode, a spud mounted on sitting mode, and extendible heave dampers on said spud spud in said towing mode and extension of said spud in said floating mode and into the bottom in said bottom sitting mode, and extendible heave dampers on said spud for minimizing heaving in said floating mode.

2. A marine structure having a towing mode, a floating mode, and bottom sitting mode comprising an operating platform, a watertight superstructure, buoyant means to support said operating platform and superstructure a substantial distance above water level, said buoyant means including three triangularly arranged columns, a boat-shaped footing having a flared, cut away bow at the base of each column, selective buoyancy adjusting means whereby said structure floats on said boat-shaped footings in said towing mode, on said columns in said floating mode, and with said footings resting on the bottom in said bottom sitting mode, a spud mounted on each of said columns, means enabling retraction of said spud in said towing mode and extension of said spud in said floating mode and into the bottom in said bottom sitting mode, and extendible heave dampers on said spud for minimizing heaving in said floating mode.

3. A marine structure having a towing mode, a floating mode, and a bottom sitting mode comprising an operating platform, a watertight superstructure, buoyant means to support said operating platform and superstructure a substantial distance above water level, said buoyant means including a bow column having a bow boat-shaped footing at the base of said bow column, two spaced apart stern columns having a stern boat-shaped footing at the base of each stern column, said stern boat-shaped footings toeing inwardly, selective buoyancy adjusting means whereby said structure floats on said boat-shaped footings in said towing mode, on said columns in said floating mode, and with said footings resting on the bottom in said bottom sitting mode, a spud mounted on each of said columns, means enabling retraction of said spud in said towing mode and extension of said spud in said floating mode and into the bottom in said bottom sitting mode, and extendible heave dampers on said spud for minimizing heaving in said floating mode.

4. A marine structure having a towing mode, a floating mode, and a bottom sitting mode comprising an operating platform, a watertight superstructure, buoyant means to support said operating platform and superstructure a substantial distance above water level, said buoyant means including a bow column having a bow boat-shaped footing at the base of said bow column, two spaced apart stern columns having a stern boat-shaped footing at the base of each stern column, said stern boat-shaped footing toeing inwardly, said bow and stern boat-shaped footings having a flared, cut away bow, selective buoyancy adjusting means whereby said structure floats on said boat-shaped footings in said towing mode, on said columns in said floating mode, and with said footings resting on the bottom in said bottom sitting mode, a spud mounted on each of said columns, means enabling retraction of said spud in said towing mode and extension of said spud in said floating mode and into the bottom in said bottom sitting mode, and extendible heave dampers on said spud for minimizing heaving in said floating mode.

5. A marine structure having a towing mode, a floating mode, and a bottom sitting mode comprising an operating platform, a watertight superstructure, buoyant means to support said operating platform and superstructure a substantial distance above water level, said buoyant means including a bow column having a bow boat-shaped footing at the base of said bow column, two spaced apart stern columns having a stern boat-shaped footing at the base of each stern column, said stern boat-shaped footings toeing inwardly, said bow and stern boat-shaped footings having a flared, cut away bow and a substantially circumferential horizontal heave damping plate, selective buoyancy adjusting means whereby said structure floats on said boat-shaped footings in said towing mode, on said columns in said floating mode, and with said footings resting on the bottom in said bottom sitting mode, a spud mounted on each of said columns, means enabling retraction of said spud in said towing mode and extension of said spud in said floating mode and into the bottom in said bottom sitting mode, and extendible heave dampers on said spud for minimizing heaving in said floating mode.

6. A marine structure comprising:

a watertight superstructure;

variable buoyant means supporting said superstructure and including three column members, each affixed at one end to said superstructure and at the other end to a different footing member;

one of said footing members defining a bow of said marine structure and having a bow oriented in the desired direction of motion of said structure and the other two footing members defining a stern and each having a bow and toed in with respect to the direction of orientation of said bow member.

7. The marine structure of claim 6 wherein the two footing members defining the stern of said marine structure each have their longitudinal centerline inclined approximately 5° from the longitudinal centerline of the marine structure.

8. The marine structure of claim 6 wherein each of said footing members includes an upper surface having a flared portion and a tapered bow having a cutaway portion wherein said upper surface has a greater cross-sectional area than the cross-sectional area of the column member adjacent to said upper surface and the flared portion defines a volume of the same magnitude as that defined by said cutaway portion.

9. The marine structure of claim 6 wherein each of the footing members include a first damping plate affixed to the periphery thereof and extending radially therefrom, for reducing heaving movement of said structure.

10. The marine structure of claim 9 wherein each of the footing members include a second damping plate movably affixed to the lower surface of the footing members and adapted to be supported rigidly away from the footing member to provide additional damping of the heaving movement of the structure.

11. The marine structure of claim 6 including a plurality of anchors each supported in an anchor rack affixed to one of the footing members, said anchors being adapted to be positioned in engagement with the bottom of the ocean for holding said marine structure relatively immobile.

12. The marine structure of claim 6 including a selective buoyancy adjusting means cooperating with said variable buoyant means to vary the draft of said structure.

13. A marine structure having a towing mode, a floating mode and a bottom sitting mode comprising:

an operating platform;

a watertight superstructure;

buoyant means supporting said operating platform and superstructure above the surface of the water, said buoyant means including three separate column members each having a footing member affixed to the base thereof and each of said footing members having a greater cross-sectional area than the adjacent column member;

a selective buoyancy adjusting means cooperating with said buoyant means to control the buoyancy thereof to enable said structure to float on said footings in said towing mode, on said columns in said floating mode and with said footing members resting on the bottom in said bottom sitting mode; and

means cooperating with each of said footing members to damp heaving movement of said structure when in the floating mode and to fix the structure in position when in said bottom sitting mode.

14. The marine structure of claim 13 wherein said separate column members include a bow column and two spaced apart stern columns and said footing members have a streamlined shape.

15. The marine structure of claim 13 wherein each of said footing members has a boat shape, a flared cutaway bow and a substantially circumferential horizontal heaving damping plate extending laterally therefrom.

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JACOB SHAPIRO, *Primary Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,397,545 August 20, 1968

Clyde M. Leavitt

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 54, cancel "sitting mode, and extendible heave dampers on said spud" and insert -- each of said columns, means enabling retraction of said --.

Signed and sealed this 13th day of January 1970.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents