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Mott

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[54] MARINE STRUCTURE

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[52] U.S. Cl. 61/46.5, 52/638

[51] Int. Cl. E02b 17/00

[58] Field of Search .... 61/46.5, 46; 175/7, 8, 175/9, 5; 114/.5 D; 52/638

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[57] ABSTRACT

The invention relates to a marine structure or foundation of a type that rests on, and is firmly fixed to the floor of an offshore body of water. The structure comprises a plurality of substantially vertically disposed legs which are laterally connected by a series of cross members to form an open unit. At least a segment of the respective legs and cross members are controllably buoyant whereby the structure can be floated to a submerging site. The legs and cross members are further interconnected at an enlarged joint adapter which serves to guide piles along the respective legs as the piles are being driven.

5 Claims, 5 Drawing Figures

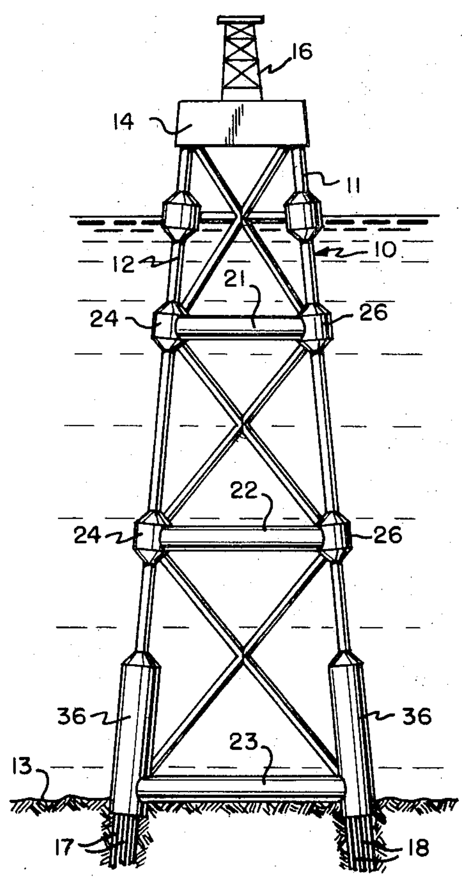


FIG. 1

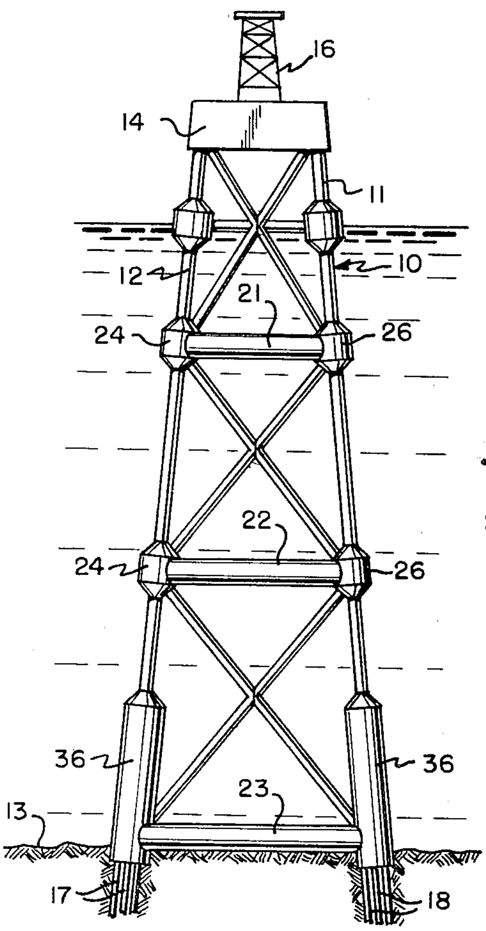
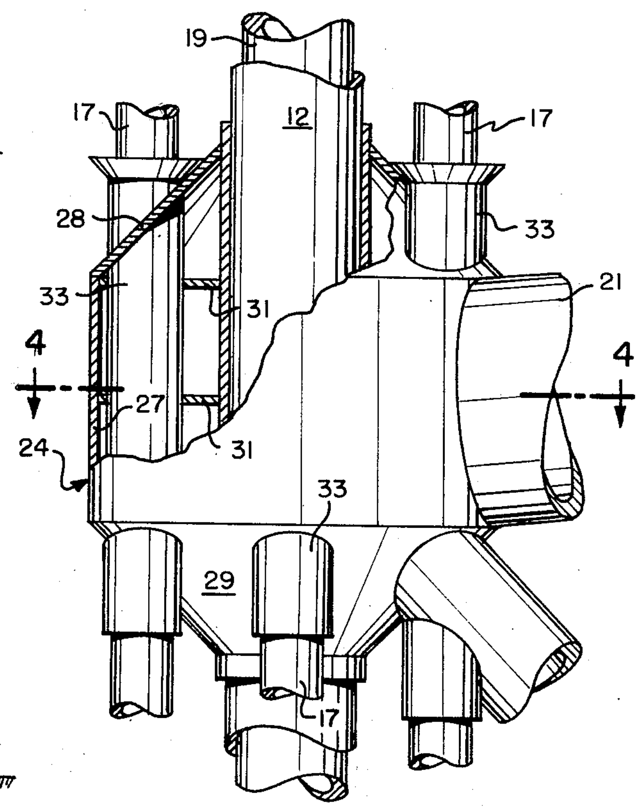


FIG. 3



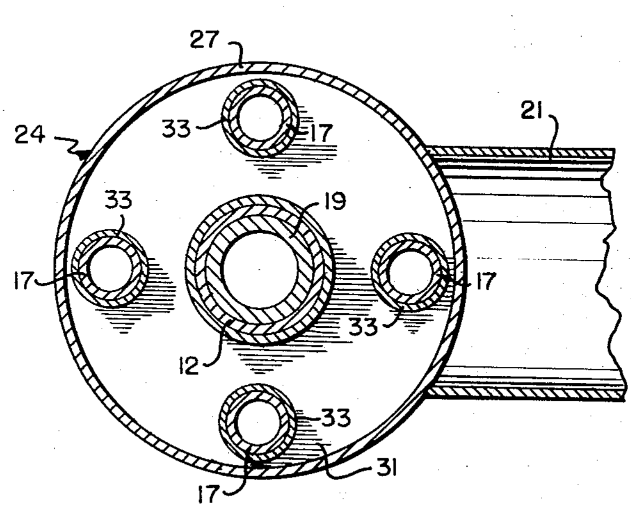
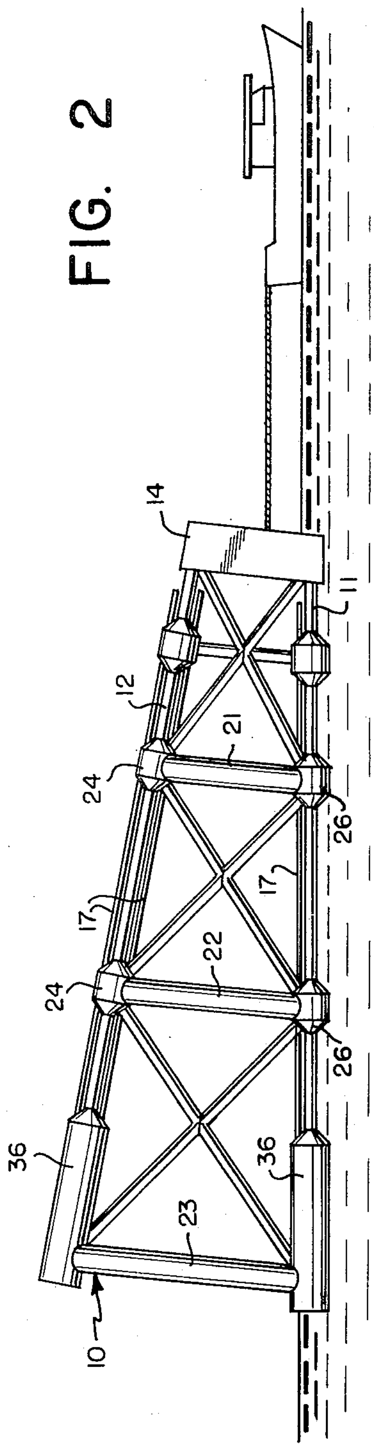


FIG. 4

FIG. 2


14
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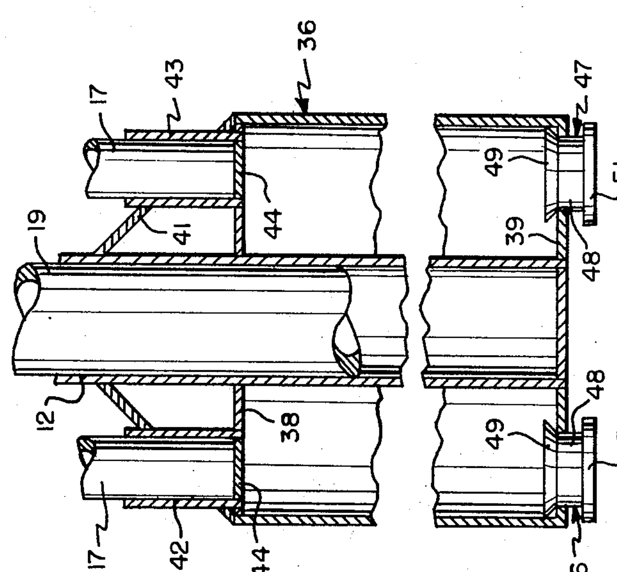
10

FIG. 5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MARINE STRUCTURE

BACKGROUND OF THE INVENTION

In the exploratory drilling for and production of oil from an offshore location, in particular water depths, the fixed type platform is deemed to be most economical and advantageous. The fixed or stationary type platform arrangement not only establishes a firm drilling foundation, but also permits the use of a great many, as well as directionally oriented wells.

As a matter of practicality, for minimal water depths, the fixed type platform can usually be barged to a desired site and thereafter guidably lowered into the water in such manner as to assume its proper vertical orientation. For larger platforms adapted to deep waters however, the size and weight of the structure makes it impractical to barge same to the desired location either on a single vessel or by a plurality of vessels.

To overcome the problems inherent in construction and transportation of such large fixed type marine structures, they are frequently designed with two or more large diameter legs incorporating sufficient buoyancy to float the structure on one frame rather than barging same to the ultimate working site. Thus, the structure legs are usually provided with means whereby they are controllably buoyant such that the unit can be so floated. Large diameter legs running the entire length of a structure concentrates a large mass near the upper portion of the structure which can severely increase the wave and/or eqrthquake forces which the structure must be designed to resist.

The presently disclosed platform comprises a fixed type platform adapted for water depths between about 350 and 1,000 feet and distributes the flotation mass at lower levels in the structure, thereby reducing the wave and earthquake loads. The structure is sufficiently buoyant to be floated on one frame, consisting of two legs and bracing to an offshore site in a generally horizontal orientation at the water's surface. Thereafter, the structure is controllably ballasted to assume a vertical disposition in the water, and to bring the lower end thereof to rest at the ocean floor.

To afford the needed buoyancy, the structure is provided with extra large diameter leg support members along at least one side thereof. Said cross members are tied into the respective legs by means of enlarged, controlled buoyancy joint adapters or cans. The latter function not only as a convenient way of connecting the multi-sized leg members but also serve as piling guides. The structure can thus be designed to support and carry some or all of its own piling made up ready for driving at an offshore site prior to being submerged at the latter. This feature is very desirable for deep water platforms because of the high cost of welding up lengths of piling in the field.

The externally carried piles are retained external to the legs, but within the various joint adapters in a manner to permit their being loosened from the latter and urged into the ocean floor during the anchoring or positioning phase of the operation. The piling on the submerged portion of the legs which provide buoyancy for the structure also provide additional buoyancy thus reducing the amount of buoyancy which would normally be required.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical elevation of a marine structure of the type contemplated shown submerged in a body of water and embedded at the structure's lower end. FIG. 2 is a vertical elevation of the structure shown in FIG. 1 being floatably transported to a working site. FIG. 3 is an enlarged segmentary section in partial cross section showing a joint of the marine structure. FIG. 4 is a cross sectional view taken along line 4—4 in FIG. 3. FIG. 5 is an enlarged segmentary section showing the lower portion of the marine structure.

Referring to FIG. **1**, a marine structure **10** of the type presently contemplated is shown located at an offshore working position in contemplation of drilling a number of wells into the ocean floor. Structure **10** as shown, comprises a plurality of generally vertically arranged support legs **11** and **12** which extend from a point above the water's surface to the ocean floor **13.**

While the respective legs **11** and **12** are shown in a generally battered attitude they can be thus arranged, or alternatively can be disposed vertically. In either instance, the particular arrangement will depend on the depth of water, the forces exerted against the structure and the other factors.

While the present structure **10** is shown as extending for a distance upward beyond the water's surface, it can also terminate some distance below said surface. In the latter instance it will support a working unit such as a submerged storage facility or the like. In any event, in the instant arrangement, a deck **14** is removably carried at the upper end of structure **10** in such a manner as to be elevated a sufficient distance beyond the water's surface to normally remain out of contact with the latter. Deck **14**, in the normal manner, will carry working equipment such as a derrick **16**, draw works and the like. It may however be designed to carry only sufficient producing equipment to receive oil and/or gas from submerged wells or perform other functions.

As shown in FIG. **1**, structure **10** is fixedly positioned at the desired working site by the use of piles **17** and **18** which extend along the respective support legs **11** and **12**, and are embedded for a desired distance into the substratum **13.** The number of support legs used and the number of anchoring piles per leg, are of course functions of the platform space and load requirements, environmental site conditions and the character of the substratum such that the structure and its supported work unit will be adequate to perform the intended function.

As shown in FIG. **2**, the entire unit **10** is normally fabricated at a shore location such as a shipyard or the like. There, the respective elements can be formed and joined together normally by welding to achieve the desired finished configuration. The elongated shape of the structure of course necessitates that the unit be fabricated in a horizontal position such that the various legs are arranged substantially horizontally rather than in the vertical attitude they will assume when erected at the working site.

As further shown in FIG. **1**, the structure is so designed that it can be launched and floated in a body of water in essentially a finished condition and thereafter be towed along the water's surface to the erection site.

While it is generally known in the art that the most convenient way of transporting structures of this type and size is by floatably towing the same, nonetheless the structure is not essentially a vessel and is therefore subjected to undue stresses and strains, particularly when the water condition is turbulent. Further, in order to provide the necessary flotation to support the bulk of the structure beyond the water's surface as shown in FIG. 1, the lower members and legs are either partially or completely submerged. Toward this end, the respective lower members are so structured as to embody controlled buoyancy means as tanks or the like. The latter can thus be either ballasted to reduce their buoyancy, or evacuated to increase their buoyant capabilities.

Referring again to FIG. 1, toward providing the desired degree of buoyancy during the towing phase, the respective support legs **11** and **12** as well as the lateral cross members **21, 22** and **23**, are provided with internal tanks. While not presently shown in particularity, the said tanks are interconnected individually or in discrete units to a pumping system whereby the character of the respective tanks can be varied by transfer of water to or from the same. Since this technique is known in the art and quite often practiced, further explanation of the same will not be required here except to suggest that the system is normally detachable from the structure. Thus, the necessary pumps, compressors and the like can be removed from the working site after structure **10** is in position.

As shown in FIG. 1, the respective lateral cross members **21, 22** and **23** are formed of enlarged tubular sections which interconnect the respective support legs. The enlarged configuration of said lateral cross members permits the structure's unit to embody sufficient buoyancy that the remaining support legs can be elevated beyond the water's surface during the floating phase of the operation.

Toward facilitating the series of connections between the support legs **11** and **12**, as well as facilitating the fabrication thereof, the controlled buoyancy legs, **11** for example, are provided with a plurality of joint adapters or cans, **24**. The latter are spaced longitudinally along each support leg **11**, with sufficient space therebetween to correspond with the requirements of the structure's unit when the latter is in both the upright and horizontal positions.

The respective joint adapters **24** and **26** on adjacent legs function as terminal points for the lateral cross members. Thus, in view of the outer enlarged configuration of the joint adapter center sections, a firm welded connection can be assured between the oversized lateral cross members and said joint adapter. Such a joint could not be achieved were the oversized lateral members connected directly to the smaller diameter support leg.

As shown in FIGS. 3 and 4, each joint adapter **24** comprises in essence a central cylindrical portion **27**, substantially greater in diameter than the support leg **12**, and approximating the diameter of the lateral cross member **21**. Adapter **24** as shown is fastened rigidly to leg **12** by one or more ring stiffeners **31**, spaced longitudinally therealong. An upper frusto conical segment **28** also secures the cylindrical portion **27** of support leg **12**.

A similar frusto conical member **20** secures the lower end of cylindrical portion **27** to leg **12** to define a closed area within adapter **24**. The latter is pierced centrally by leg **12** which also interconnects the respective diagonal members which pierce said upper and lower conical members **28** and **29** as well as the respective ring stiffeners. Leg **12** also receives and guides a pile **19** which may be a larger diameter than piles **17** and **18**.

When ultimately positioned on a support leg **12**, adapter **24** is held in place on the leg by one or more welded seams formed at both the top and the bottom and intermediate ring stiffeners. Vertically oriented stiffener plates **26** may also be used to connect horizontal and diagonal members to leg **12** and adapter **24**.

As noted herein the respective corresponding adapters on adjacent legs are aligned one with the other such that the lateral cross member **21** intersects the adapter at the larger diameter. Thereafter, welds formed at the juncture of legs and adapter rigidly interconnects the respective legs with the lateral cross members.

The various compartments formed within the adapter intermediate the end closures **28** and **29**, and the ring stiffeners **27**, define in effect controlled buoyancy means which can be adjusted to alter the buoyancy of the structure **10**. While not presently shown the respective compartments formed within adapter **24** can be so interconnected and similarly communicated with an external source of air and water to achieve the desired regulated buoyancy.

A second function achieved by adapter **24** is to guidably position the anchoring piles **17** and **18** which are disposed external to support legs **11** and **12**. Said anchoring piles as noted are normally floated to a drilling site with structure **10** in a substantially horizontal disposition. Thus, the piles need only be fastened at the upper end of the structure and guidably positioned at spaced intervals, within the respective adapters **24**.

As shown in FIG. 3, each adapter **24** is provided with a plurality of peripherally arranged pile guides **33** each of which comprises an elongated tubing member disposed longitudinally of, and extending through opposed ends of said adapter **24**. Pile guide **33** thus slidably retains an elongated pile **17** which extends along the length of support leg **12** as the structure is being flotably transported. Subsequent to structure **10** being submerged, pile guide **33** further positions pile **17** as the latter passes therethrough while being lowered to and driven into the substratum. The latter can be achieved through the use of a stinger or other means which will follow the pile downwardly to a desired depth.

The respective pile guides **33** are of course aligned one with the other so as to slidably receive a common pile passing therethropgh without binding. The respective aligned guides can further be firmly welded to each of the adapter components through which it passes as to maintain a number of discrete air or water tight compartments therein. However, the pile guides **33** can similarly be held in a manner such that the entire interior of adapter **24** will in effect define a single buoyancy unit which can be controllably regulated through the pumping system.

Referring to FIGS. 1 and 5, the lower end of each support leg **12** for example, is provided with an enlarged piling connector **36** which extends upward to approximately the first joint and is normally embedded part way into the substratum. Said connector **36** serves the further function of being evacuated of water to aid in floating the structure during transportion of the latter. As shown in FIG. 1, said connector **36** forms an extension to the respective aligned pile adapters **24,** which extend at intervals to the upper end of the structure. Thus, in a similar manner, the pile connector **36** receives the lower end of each of the respective piles **17** to hold them during the transportation operation.

Each pile connector **36** thus comprises an elongated cylindrical member **36** which is disposed concentrically with the support leg **12,** and is positioned with respect thereto by longitudinally spaced ring stiffeners **38** and **39.** The upper end of the cylindrical member **36** as shown is provided with a closure plate **41** in the form of a frusto conical cap with rests on, and is fastened to the casing upper edge and to leg **12.**

A plurality of sleeve-like retainers **42** and **43** are disposed around said frusto conical cap **41** and are spaced about the casing in substantial axial alignment with corresponding guides **33** in adapter **24.** Each of said retainers **42** and **43** thus functions to supportably locate the lower end of piles **17** while the structure is floated in a horizontal position.

As shown in FIG. **5,** each of said retainers **42** and **43** comprises an elongated cylindrical member having a diameter slightly greater than the diameter of the piles **17** to be driven therethrough. In order that the interior of casing **36** can be utilized as a foundation member in the transportation or floating stage, the interior of said casing is made water tight either as a whole, or by compartments. Thus, the lower end of each retainer, such as **42,** is provided with a flanged or similar closure plate **44** which can be welded in place or fastened by bolting or similar means. In either event, the thickness of plate **44** is such that the pile **17,** when it is released from its rigidly held position, will rest on the plate to shear the latter thereby permitting the pile to pass through the plate opening.

The sheared away plates **44** will normally fall freely to the lower end of the casing **36.** However, they may also be provided with a flexible tethering means such as a chain or the like. Thus, when the plate is sheared from its position, it will swing away from the retainer opening and be supported without falling to the floor or the casing.

The lower end of casing **36** is provided in a similar manner with transverse lower panel **39** which embodies a plurality of pile guides **46** and **47.** Each of said guides includes a cylindrical collar **48** having a diameter slightly larger than pile **17.** The upper end of each guide is further provided with a tapered collar **49** and disposed in a line with a pile retainer **42.** Thus, as a pile is released from its retained position and lowered through the casing **36,** the pile lower end will be urged by tapered collar **49,** into abutting engagement with a frangible closure plate **51.**

Said closure plate, similar to the above noted frangible plate **44,** can be welded or bolted in place and is of such a nature that it will yield to the weight of a downwardly passing pile to either shear the holding bolts, or itself be sheared whereby the pile can pass into the substratum.

Alternately, sleeves **41** may completely pierce pile connector **36** similar to sleeves **33** piercings of adapters **24,** thereby eliminating the need for closure plates **44** and **51.**

With each of the leg piles **17** and **18** driven into the substratum in the normal manner, the pile ends are cemented in place in engagement with the structure legs. This is achieved by driving each of said piles a predetermined distance to afford the necessary film foundation. Normally, for such a water depth of several hundred feet, a stinger is utilized at the pile upper end. The stinger thus follows the pile downwardly and is subsequently withdrawn when the pile has reached its desired depth. Each of the respective piles will be similarly driven until the piling operation is completed.

For cementing the piles in place and in engagement with the structure **10,** pile connector **36** is provided with at least one inlet to receive a flow of cement. Said inlet can be formed in and connected with the connector interior, and subsequently withdrawn. Similarly, it may merely be connected externally to the casing such that cement will be directed downwardly through a conduit from a barge or the like at the water's surface to displace water within the casing. The latter of course is discharged through an exhaust port or similar means provided on the casing upper cover plate **41.**

As shown, each support leg **11** and **12** of the structure **10** may further be provided with a central pile **13** which, in the normal course of the anchoring operation, will be introduced to the upper end of the leg and passed downwardly therethrough. This central pile of course is similar to the smaller external piles being prepositioned prior to the structure being floated to its working site. Provision would also be made in pile connector **36** to grout pile **13** to leg **12** by means of grout lines extending from the lower end of said connector **36** to a point above the water surface.

Other modifications and variations of the invention as hereinbefore set forth may be made without departing from the spirit and scope thereof, and therefore, only such limitations should be imposed as are indicated in the appended claims.

I claim:

1. A marine structure adapted to be floated to and subsequently embedded into the floor of an offshore body of water for supporting a work unit, which stucture includes;

a. a plurality of elongated support legs,

b. lateral cross members engaging and interconnecting the respective support legs, which cross members incorporate a controlled buoyancy means therein whereby to regulate the floating attitude of said structure when being transported between working sites,

c. joint adapter means interposed in said support legs being spaced longitudinally therealong to engage the respective edges of said lateral cross members,

d. diagonal bracing connecting support legs and piercing adapter means,

e. prefabricated anchor piling means releasably carried externally of said plurality of elongated support legs engaging said respective joint adapter means, and adapted to be urged into the floor of said body of water whereby to fixedly position said marine structure.

2. In a marine structure as defined in claim **1,** wherein said anchor piling is intermittently, guidably supported by said longitudinally spaced joint adapters.

3. In a marine structure as defined in claim **1,** wherein said joint adapter means includes; a cylindrical portion surrounding said support leg and being substantially greater in cross sectional area along a plane normal to the longitudinal axis of said adapter to the cross sectional area of said lateral cross members connected to said cylindrical portion.

4. In a marine structure as defined in claim **1**, wherein said joint adapter includes discrete fluid tight compartments providing buoyancy to assist in floating said structure to an installation site.

5. In the structure as defined in claim **1** wherein said joint adapter means includes a cylindrical portion spaced from and surrounding the outside of a support

leg,

a. upper and lower members depending from said cylindrical portion being connected mutually to the latter and to a segment of a support leg, and

b. pile guide means within said joint adapter means connected to the respective upper and lower members whereby to receive and position a pile therein.

* * * * *