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(54) Sea-going self-propelled vessels for transport of prefabricated offshore structures.

(57) A sea-going self-propelled vessel (10) can load and transport prefabricated offshore structures (43) on a main deck (14) thereof. A raised deck (22) on one end portion and one or more stabilization tanks (34) on the other end portion of the vessel (10) are provided to afford stability for submergence of the main deck (14) for loading of an offshore structure. The stabilization tanks (34) are portable so that they may be removed for loading of a large prefabricated offshore structure from a fabrication yard.

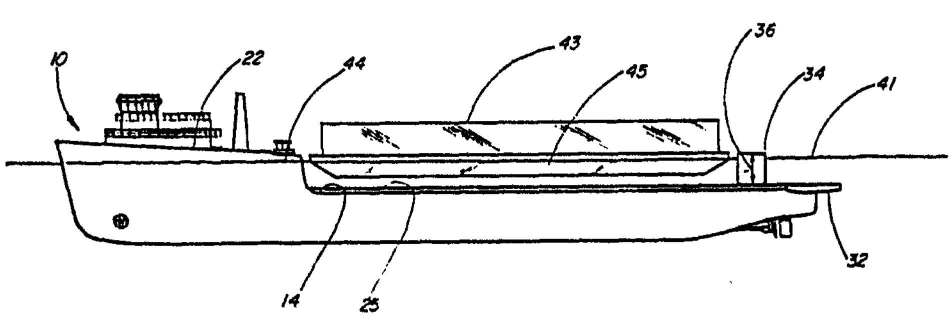

FIG. 3

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Croydon Printing Company Ltd

SEA-GOING SELF-PROPELLED VESSELS FOR TRANSPORT OF PREFABRICATED OFFSHORE STRUCTURES

The present invention relates in general to the transport of prefabricated offshore structures and, more particularly, to self-propelled sea-going vessels for loading and transport of prefabricated offshore structures such as drill jackets, and to methods of submerging vessel main decks.

A drill jacket is an elongated offshore structure made up of a plurality of tubular members with cross bracing, which structure is installed by lowering it to rest on the sea bottom. The jacket is secured in this position and functions to support a deck unit and hydrocarbon production equipment above the water line. The deck unit, which usually comprises a flat deck area with a plurality of legs extending downwardly therefrom, provides support for the oil drilling and recovery equipment. These components make up an offshore facility.

The manufacture of prefabricated components of such an offshore facility has in the past required that the fabrication yards or sites be built relatively close to a final desired location for the facility. Most of these yards are located near shallow water areas. When components are fabricated in such yards, the components may be loaded onto barges having shallow drafts. The barges are then towed to the final location for installation of the facility. Such a procedure may be reliably accomplished safely if the seas are calm and if the duration of such a tow is no more than a day or two since weather forecasts for such short durations are usually fairly reliable. However, even though a tow may be of short duration, long delays may be experienced while waiting for calm seas. When these tows do arrive at the installation site, the barges may be moored in shallow water alongside the construction equipment at the site, which equipment may include, for example, cranes mounted on flat barges.

Offshore facility components may often be built more economically at fully integrated fabrication yards. However, due to existing favorable conditions at such fabrication yards and the quantity thereof being limited by the cost of building them, such fabrication yards may be located at extreme distances from the final offshore facility locations. The technical and safety risks of long tows, however, make it difficult for these remote yards to compete with fabrication yards located near the final offshore facility sites. Shallow draft barges for loading offshore structures in the typically shallow waters, because of the size and bulk of such structures, may not have enough stability for the open sea, thus requiring periods of calm weather for towing safety and, therefore, long delays may be experienced while waiting for these calm conditions. On long tows such as over an ocean, there is also no assurance, as previously noted, that good weather and calm seas will prevail throughout the transport. Rough seas may in addition cause severe fatigue or other damage to the offshore components during a tow by barge.

The fatigue stresses during such transport are increased with higher accelerations during the roll of the transport structure. Barges typically have a low period of roll with resulting high accelerations during the roll as compared to a self-propelled sea-going vessel. Furthermore, the total fatigue stresses on an offshore structure during a transport of specified length is related to the duration of transport. The speed of a barge being towed is typically slow as compared to the speed of a self-propelled sea-going vessel resulting typically in more than twice as many fatigue cycles when an offshore structure is towed by barge. Thus, in calm seas as well as rough seas, the number of and severity of fatigue stresses on an offshore structure being towed by barge may be much greater, resulting in increased risk of damage over what would be the case if the offshore structure were being carried by a sea-going vessel over the same distance.

In addition to loading of prefabricated offshore structures at such fabrication yards for transport over the ocean, it is also desirable that the same vessel have the capability of loading prefabricated offshore structures that are floating in the ocean for transport to another area of the ocean. For example, jack-up drilling rigs are commonly used for exploratory drilling, and are therefore designed for transport from one location to another as the exploratory needs determine.

In order to maneuver the vessel into position at a fabrication yard for loading of a prefabricated offshore structure, it is desirable that the main deck on which the structure is to be loaded extend all the way to either the forward or after end and that therefore there not be a raised deck on either the forward or after end of the vessel. However, in order to load a floating offshore structure, it is necesary that the main deck be sunk to permit floating thereof onto the main deck. In order to accomplish this objective, the vessel must have sufficient stability such as may otherwise be provided by forward and after raised decks to maintain the vessel afloat.

In order to achieve the foregoing objectives, a transport vessel and method for long distance ocean transport of such prefabricated offshore structures is desirable which is both fast and safe, thus ensuring that the components will arrive undamaged and on time, and which affords the flexibility of loading such components which are either at a fabrication yard near shallow water or floating in deep water.

The present invention provides a sea-going self-propelled vessel for loading and transporting of prefabricated offshore structures, the vessel comprising a main deck for supporting at least one prefabricated offshore structure, means for submerging the main deck to a selected depth for floating of prefabricated offshore structures onto and off of the main deck for loading and off-loading thereof, a raised deck at one end portion of the vessel, and means for mounting at least one portable stabilization tank on the main deck at the other end portion of the vessel.

The present invention also provides a sea-going self-propelled vessel for loading and transporting of prefabricated offshore structures, the vessel comprising a main deck for supporting at least one prefabricated offshore structure, means for submerging the main deck for floating of prefabricated offshore structures onto and off of the main deck for loading and off-loading thereof, a raised deck at one end portion of the vessel, and at least one portable stabilization tank mountable on the main deck at the other end portion of the vessel.

Further, the invention provides a method of submerging a vessel main deck to a selected depth for loading or off-loading a structure, the method comprising providing the vessel with a raised deck on one end portion thereof, mounting at least one stabilization tank on the other end portion of the vessel, the raised deck and the stabilization tank each having a height to provide freeboard when the main deck is submerged to the selected depth, and submerging the main deck to the selected depth whereby the structure may be floated onto or off of the main deck.

A preferred embodiment of the present invention described hereinbelow provides quick, safe, and reliable transportation over an ocean of prefabricated offshore structures from a fabrication yard near shallow water, minimizes the number and severity of fatigue stresses on an offshore structure during ocean transport thereof so as to minimize the risk of damage to the offshore structure, and provides flexibility in the transport vessel for loading of offshore structures from a fabrication yard near shallow water and for loading floating offshore structures in deep water.

The invention will now be further described, by way of illustrative and non-limiting example, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a sea-going self-propelled vessel embodying the present invention, carrying a prefabricated offshore structure;

Figure 2 is a side view of the vessel loading a prefabricated offshore structure from a fabrication yard near shallow water;

Figure 3 is a side view of the vessel with a main deck thereof submerged and receiving a floating offshore structure thereon;

Figure 4 is a plan view of the vessel as depicted in Figure 3;

Figure 5 is a plan view of a portion of the main deck of the vessel, showing means thereon for mounting a stabilization tank;

Figure 6 is a plan view illustrating the mounting of a stabilization tank to the main deck; and

Figure 7 is a side view, partially in section, of the means for mounting the stabilization tank.

Figure 1 shows a sea-going self propelled vessel 10 for transporting large, bulky prefabricated offshore structures such as, for example, a drill jacket 12. The vessel 10 includes a suitable power plant for propulsion, and a main deck 14 disposed rearwardly of the vessel and extending between the sides 16 and 18 thereof, as shown in Figure 4, and to the after end 20 of the vessel for receiving and supporting prefabricated offshore structures. The vessel 10 also includes a raised forward deck 22 upon which is located various crew quarters, the bridge, and the like. For the purposes of this description and the claims, a main deck is defined as the uppermost continuous deck of a vessel, and a raised deck is defined as a deck which is higher than the main deck and to the height of which the vessel portion over which is extends is water tight.

Figure 2 illustrates the loading onto the vessel 10 of a prefabricated offshore structure 12 from a fabrication yard 24 which is adjacent to shallow water 26. The vessel 10 is maneuvered to a point as illustrated where its after end 20 is adjacent the fabrication yard 24 and its main deck 14 is at substantially the same height as the fabrication yard 24. The offshore structure 12 can then be loaded onto the vessel 10 by skidding using suitable skid means, illustrated schematically at 25 in Figure 4, commonly known to one of ordinary skill in the art to which this invention pertains. In Figure 2, the offshore structure 12 has been partially skidded onto the vessel 10.

As shown in Figure 2, the depth of the vessel, illustrated at 28, is suitably small enough to allow the vessel 10 to maneuver in the typically shallow waters near fabrication yards. The depth 28 (that is, the depth of the main deck at mid-length of the vessel) is preferably less than 35 feet (10.7 metres). For example, the depth 28 at the main deck may be 32 feet (9.8 metres), and the vessel may have a maximum operating draft loaded of 22 feet (6.7 metres).

A typical cargo vessel may have a width equal to 1½ times its depth. However, for the shallow waters in which a transport vessel embodying the present invention is expected to operate, it is expected that the width of the vessel (i.e., the greatest width overall of the hull in a direction parallel to the pitch axis as illustrated at 30) should be at least 2½ times the depth 28 in order to provide suitable stability for the depth of the vessel and to furthermore provide greater stability to the vessel than would be the case if it were necessary to have a typical ocean going ship carrying prefabricated offshore structures. For example, for a vessel having a depth of 32 feet (9.8 metres), the width may be 104 feet (31.7 metres). Such a vessel may also have a length overall of 380 feet (115.9 metres), 745 shaft kW (1000 shaft horsepower), a cargo deck space of 215 feet X 104 feet (65.6 metres X 31.7 metres), a maximum deck loading of 3000 lbf/in^2 (20.7 MPa), and an operating speed of 14 knots (7.2 m/s). The major frames and bulkheads are on 10, 20 and 40 foot (3, 6 and 9 metre) spacing to provide an advantageous hull space loadout condition. Alternately, the length overall may be 500 feet (152.5 metres). Such a vessel with a speed of 14 knots (7.2 m/s) can move over twice as fast as a typical tug/barge combination, thus reducing the number and severity of fatigue stresses on the offshore structure.

The vessel 10 is suitably outfitted with a pair of pivot supports 32 which extend rearwardly from the skids 25 for launching the jacket 12 when it has been transported to the desired location. This is accomplished in a manner commonly known to those of ordinary skill in the art to which this invention pertains by sliding the jacket 12 rearwardly so that its center of gravity moves onto the support 32. With suitable ballasting while maintaining stability in accordance with principles of common knowledge to those of ordinary skill in the art to which this invention pertains, jacket 12 is rotated into the water through the pivoting of support 32 thereby launching it into the sea at the desired location. Smaller structures may typically be lifted for launching with a derrick from a derrick barge.

The jacket 12 illustrated in Figure 1 covers the entire area of the main deck 14. Thus, the main deck 14 should be clear of any raised structures during loading and transport of such a jacket. In addition, the main deck 14 should be clear of any raised structures during launching of barge jackets. However, if it is desired to submerge the main deck for floating an offshore structure such as a generator plant carried by a barge or an exploratory jack-up drilling rig onto it for loading and for transport to another offshore location, the vessel 10 will typically require water plane area at both the forward and after ends to afford sufficient stability during the submergence of the main deck 14 and the loading of the offshore structure thereon. In the preferred embodiment shown, such water plane area is suitably provided forward of the vessel 10 by raised deck 22.

Referring to Figures 3 and 4, such water plane area is afforded, in accordance with the present embodiment, aft of the vessel 10 by one or more stabilization tanks such as the pair illustrated at 34. Such tanks 34 may each weigh typically 20 tons and are portable such that they can be mounted and dismounted with cranes and removably affixed to the main deck in a manner which will be described hereinafter. For the purposes of the description and claims, a "stabilization tank" is defined as a member which is watertight up to the water level when the vessel on which it is located is submerged to a selected depth and which is sized to provide waterplane area for stabilizing the vessel during such submergence of the main deck thereof. Although such a tank may typically be hollow so that it weighs less and is easier to handle, it may also be of solid construction. The height, illustrated at 36, of a tank 34 is sufficient if it provides some freeboard when the main deck 14 has been submerged to the desired depth. For the vessel the characteristics of which were previously described, there may be provided two such tanks 34, as shown in Figures 3 and 4, the height 36 of each of which is 18 feet (5.5 metres), and the length and width of which are each 19 feet (5.8 metres), for example. The specific dimensions and shapes of such stabilization tanks may vary and can be calculated for a specific vessel using principles of common knowledge to those of ordinary skill in the art to which this invention pertains. For example, the tanks 34 may be rectangular or circular in plan view.

In a preferred embodiment of the present invention, as shown in Figure 4, the vessel 10 is provided with two such portable stabilization tanks 34, one on each side to thus allow room or space illustrated at 38 between the tanks, which in the typical example previously described may be 60 feet (18.3 metres) for loading and unloading of smaller offshore structures such as those having a width less than 60 feet (18.3 metres) while the tanks 34 remain attached to the vessel should that be necessary or desirable.

With the stabilization tanks 34 securely attached to the main deck 14 at the after end portion 40 thereof as shown in Figures 3 and 4, the vessel 10 may then be ballasted by means of suitable ballast tanks some of which are schematically illustrated at 42 to submerge the main deck 14 to a suitable depth, as shown schematically by the water surface 41 in Figure 3, for loading a floating offshore structure or for off-loading a structure such as, for example, a generator plant schematically illustrated at 43 carried by barge 45. Such ballasting may be accomplished utilizing principles of common knowledge to those of ordinary skill in the art to which this invention pertains.

In the example which has been provided, the vessel 10 may be ballasted to a depth which will allow 16 feet (4.9 metres) of water above the main deck 14, the forward structure 44 up to the raised deck 22 of the vessel as well as the stabilization tanks 34 are sealed to a super structure height of 5.5 m above the main deck thus allowing about 0.6 m of freeboard during submergence of the main deck, and the forward structure 44 and stabilization tanks 34 thereby act as stabilizers for the vessel 10. For a vessel having an overall length of 152m and as otherwise previously described, the distance between the tanks 34 and forward superstructure may be sufficient to load a floating structure having a length up to about 285 feet (86.9 meters).

A preferred means for mounting a portable stabilization tank 34 on the main deck 14 is shown in Figures 5, 6, and 7. A housing 46, welded or otherwise fixedly attached to the main deck 14 and extending below the surface 48 of the main deck a suitable distance and reinforced by member 50, is constructed to provide apertures 52 and 54 opening upwardly for receiving a stab point member 56 and a pin 58 respectively of the respective tank 34 for each corner thereof as will be hereinafter described.

The stab point member 56 is welded or otherwise suitably fixedly attached to the tank 34 by members 60 and 62 and has a lower frustro-conical tip 64 converging to a smaller cross-sectional area at its lower end for insertion in similar shaped apertures 52 for lining aligning tank 34 at the desired position on the main deck 14 for securing it to the main deck as will now be described.

Welded or otherwise suitably fixedly attached to the tank 34 is a member 66 which has a slot 68 which slot is positioned directly over the aperture 54 of the main deck when the tank 34 has been properly aligned therewith and which receives the shank portion of a hold-down pin 58. The hold-down pin 58 is threaded to receive a lock-nut 71 and a nut 70 along with washer 73 on the end portion 72 which is to protrude upwardly from the slot 68. Pin 58 is provided with a T-shaped other end portion 74 for engaging the aperture 54 in the main deck 14. Extensions 76 and 78 of housing 46 extend partially over the upward opening of aperture 54 to provide a slot 80 in the main deck 14 for engaging the hold-down pin shank 82 with the T-shaped end portion 74 below the extensions 76 and 78 whereby the hold-down pin 58 may secure the tank 34 to the main deck 14 by engagement of slots 68 and 80 by the hold-down pin shank 82 and by securely tightening hold-down nut 70. Such a tank mounting means may be provided at each corner of a tank 34 for firmly securing the tank 34 to the main deck 14 whereby the tank 34 may easily be dismounted therefrom for removal from the main deck 14 and for storage.

In order to load a floating offshore structure on to the above-described vessel, the stabilization tanks 34 are hoisted to the general location for mounting on the main deck 14 by a derrick or other suitable means after which the tank stab point members 56 are aligned with and inserted in the respective apertures 52. The hold-down pins 58 may then be inserted in the respective slots 68 and 80 of the tank 34 and main deck 14 respectively, and the washers 73, lock-nuts 71, and nuts 70 mounted and tightened to firmly mount the tanks on the main deck. The vessel 10 is then ballasted so that the main deck 14 is submerged to a suitable depth for loading the offshore structure but wherein the forward structure 44 and the stabilization tanks 34 have some freeboard and thus provide suitable stability to the vessel 10 during the submerging of the main deck 14 and the loading of the offshore structure. Then, the offshore structure is floated onto the main deck 14 afterwhich the vessel 10 is deballasted and the main deck 14 with its load is raised above the water for transport. As long as they are not in the way, the stabilization tanks 34 may be allowed to remain mounted on the main deck 14. However, if it should become necessary to load an offshore structure at a fabrication yard near shallow water or should it become necessary for any other reason such as for launching an offshore structure, the tanks 34 may then be dismounted and stored for use at a later time.

Certain features of this invention may sometimes be used to advantage without a corresponding use of other features. While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles. For example, the raised deck may be on the after end of the vessel and the stabilization tanks may be mounted or mountable on the forward end of the vessel resulting in the main deck extending to the forward end of the vessel for loading of offshore structures at the forward end thereof. For another example, a different means for mounting the tanks 34 other than the specific means described may be employed.

CLAIMS

1. A sea-going self-propelled vessel for loading and transporting of prefabricated offshore structures, the vessel (10) comprising a main deck (14) for supporting at least one prefabricated offshore structure (12; 43), means for submerging the main deck (14) to a selected depth for floating of prefabricated offshore structures onto and off of the main deck (14) for loading and off-loading thereof, a raised deck (22) at one end portion of the vessel, and means for mounting at least one portable stabilization tank on the main deck (14) at the other end portion of the vessel.

2. A vessel according to claim 1, which has a width which is at least 2½ times its depth (28).

3. A vessel according to claim 1 or claim 2, which has a depth which is less than 10.7 m.

4. A vessel according to claim 1, claim 2 or claim 3, comprising means (25) for skidding a prefabricated offshore structure onto the vessel.

5. A vessel according to any one of the preceding claims, wherein the tank mounting means comprises an aperture (52) in the main deck (14) for receiving a stab point member (56) attached to the tank for aligning the tank for attachment to the main deck.

6. A vessel according to claim 5, wherein the tank mounting means comprises a slotted second aperture (54) in the main deck (14) for engagingly receiving one end portion of a hold-down pin (58), the other end of which pin is engageable with the tank for securing the tank to the main deck.

7. A vessel according to claim 6, comprising at least one portable stabilization tank (34) mounted on the main deck (14) at said other end portion of the vessel, the tank (34) including at least one stab point member (56) for engaging the first-mentioned aperture (52) and a hold-down pin (58) attached between the slotted second aperture (54) and the tank to attach the tank to the main deck.

8. A vessel according to any one of claims 1 to 4, comprising at least one portable stabilization tank (34) mounted on the main deck (14) at said other end portion of the vessel.

9. A vessel according to claim 7 or claim 8, wherein the raised deck (22) and the stabilization tank (34) each have an height to provide freeboard when the main deck (14) is submerged to the selected depth.

10. A vessel according to any one of the preceding claims, wherein the raised deck (22) is located on the forward portion of the vessel.

11. A vessel according to any one of the preceding claims, comprising means including a pivot support (32) for launching an offshore structure.

12. A vessel according to any one of the preceding claims, comprising a pair of stabilization tanks (34) spaced from the raised deck (22) for floating of at least one offshore structure (43) onto the main deck (14) between the raised deck and the pair of stabilization tanks, the pair of stabilization tanks being spaced apart for loading of offshore structures from a fabrication yard (24) between the pair of stabilization tanks.

13. A sea-going self-propelled vessel for loading and transporting of prefabricated offshore structures, the vessel (10) comprising a main deck (14) for supporting at least one prefabricated offshore structure (12; 43), means for submerging the main deck (14) for floating of prefabricated offshore structures onto and off of the main deck (14) for loading and off-loading thereof, a raised deck (22) at one end portion of the vessel, and at least one portable stabilization tank (34) mountable on the main deck (14) at the other end portion of the vessel.

14. A method of submerging a vessel main deck to a selected depth for loading or off-loading a structure, the method comprising providing the vessel (10) with a raised deck (22) on one end portion thereof, mounting at least one stabilization tank (34) on the other end portion of the vessel, the raised deck (22) and the stabilization tank (34) each having a height to provide freeboard when the main deck (14) is submerged to the selected

depth, and submerging the main deck (14) to the selected depth whereby the structure may be floated onto or off of the main deck (14).

15. A method according to claim 14, wherein the step of mounting the stabilization tank (34) comprises inserting a stab point member (56) from the tank (34) into a first aperture (52) in the main deck (14) to thereby align the tank for attachment to the main deck, inserting one end of a hold-down pin (58) in a second aperture slot (54) to engage the second aperture slot, and attaching the other end of the pin (58) to the tank (34).

16. A method according to claim 14 or claim 15, comprising dismounting the stabilization tank (34) from the main deck (14) so that a prefabricated offshore structure (12) may be skidded onto the main deck from a fabrication yard (24).

17. A method according to any one of claims 14 to 16, comprising providing the vessel (10) with a width which is at least 2½ times its depth.

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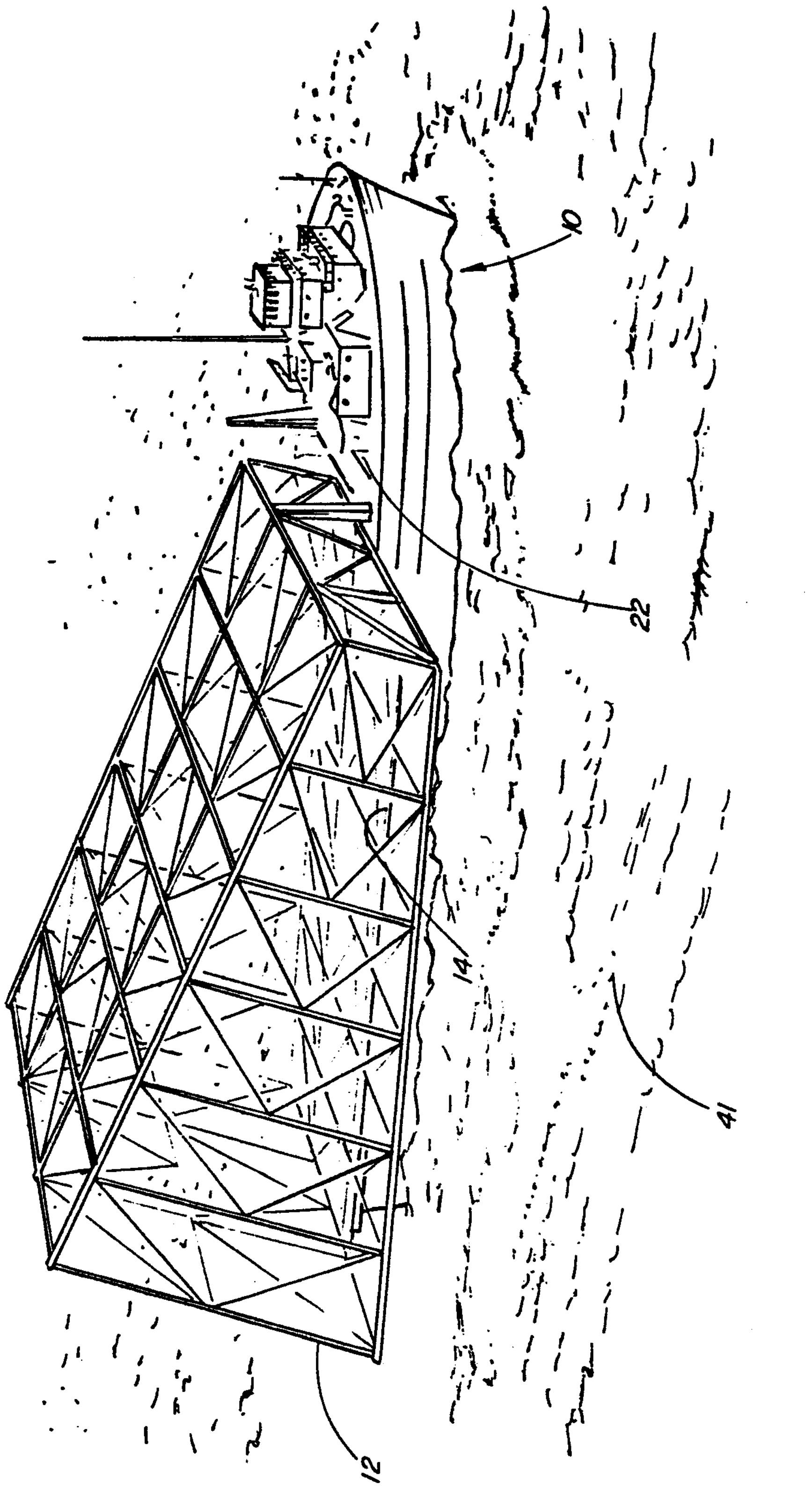

FIG. 1

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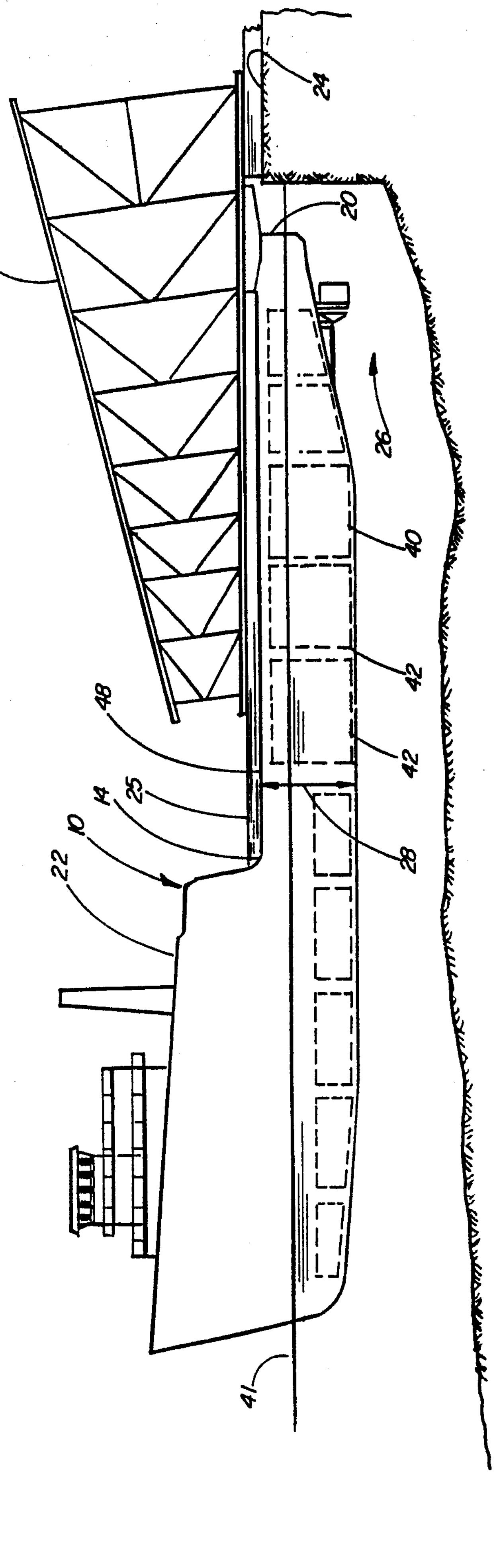

FIG. 2

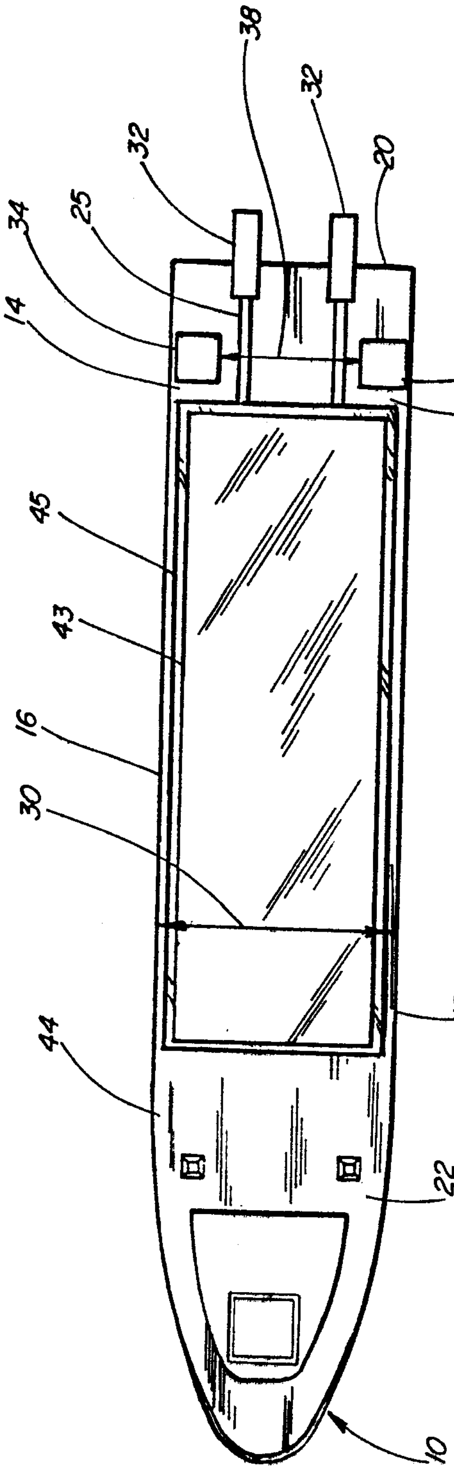
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FIG. 4

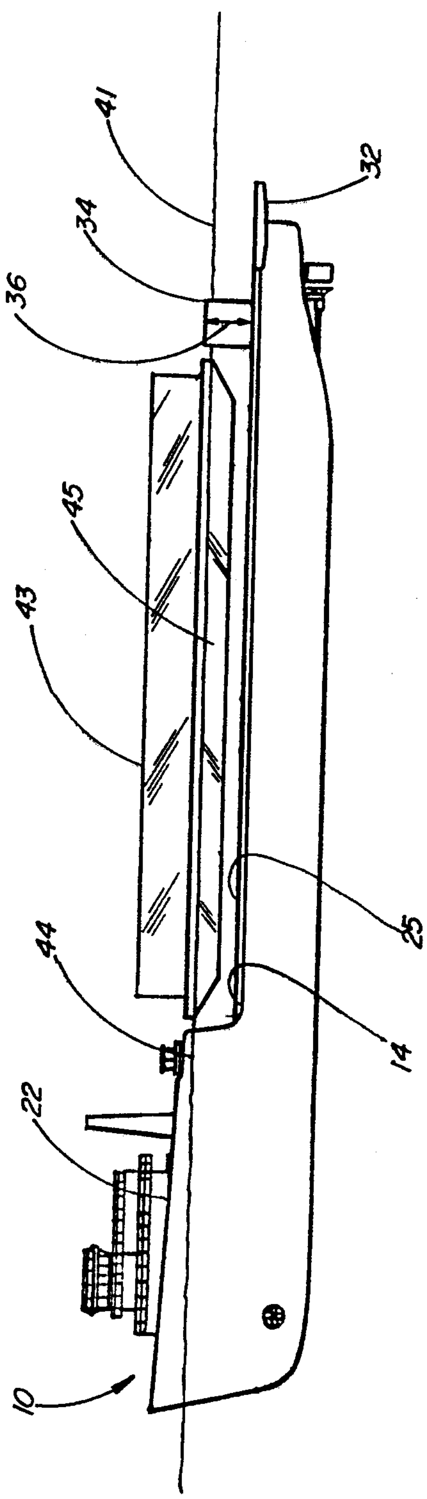
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FIG. 3

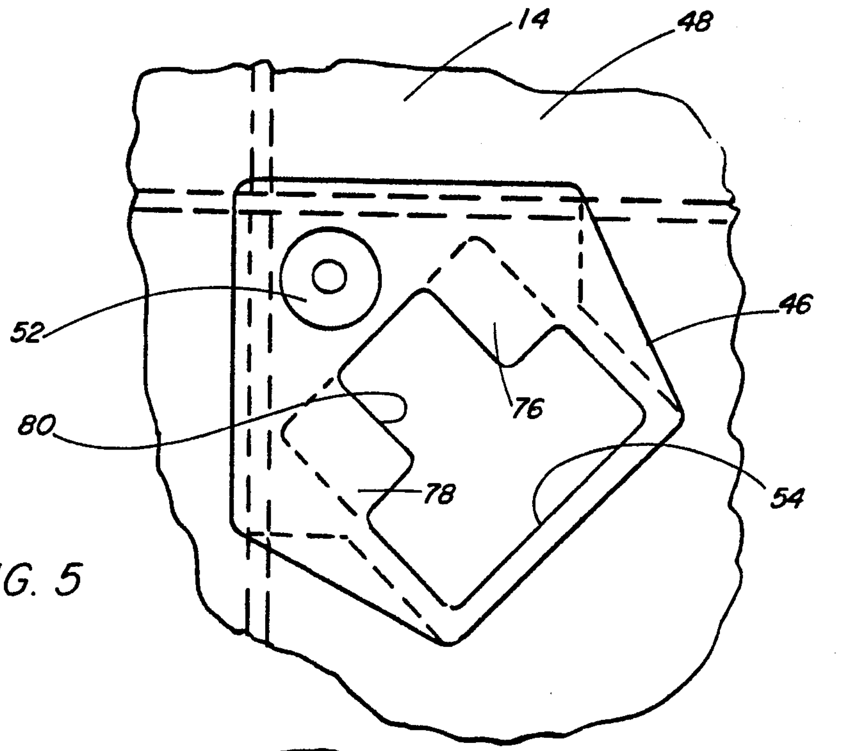

FIG. 5

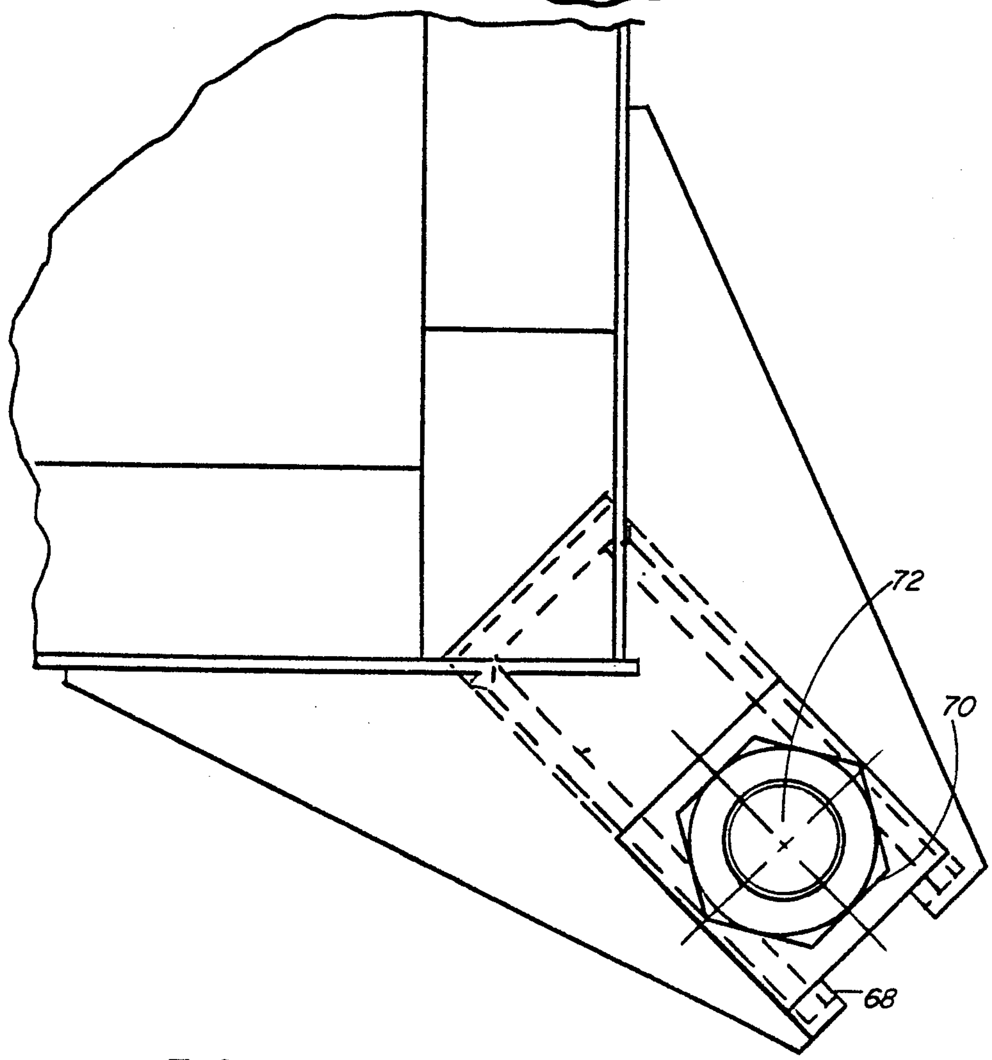

FIG. 6

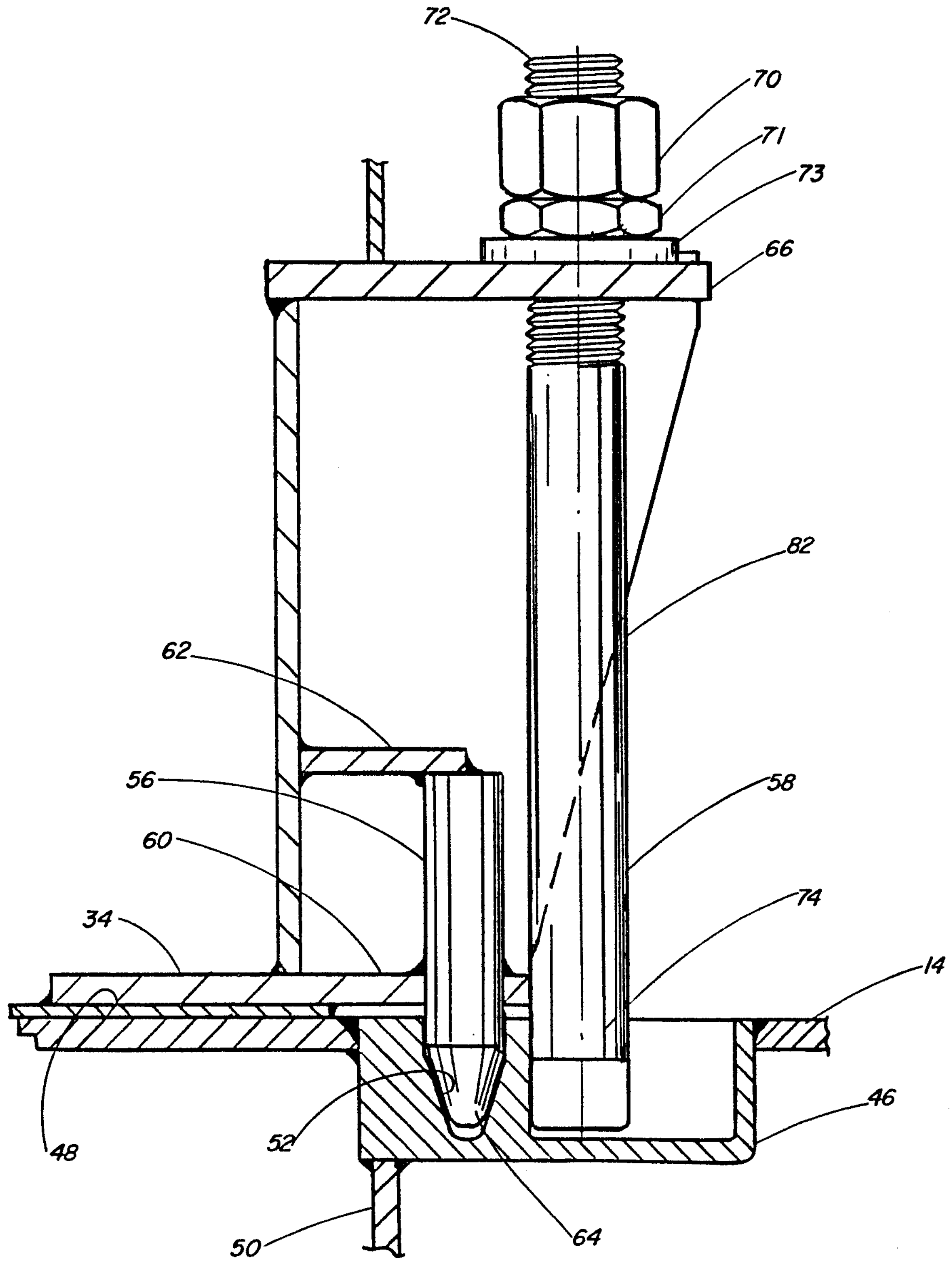

FIG. 7