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[54] SUBMERGED WELL PLATFORM

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[51] Int. Cl. **E02d 27/38,** B63b 35/44
[58] Field of Search 61/46.5, 46, 0.5; 175/9, 0.5, 175/10

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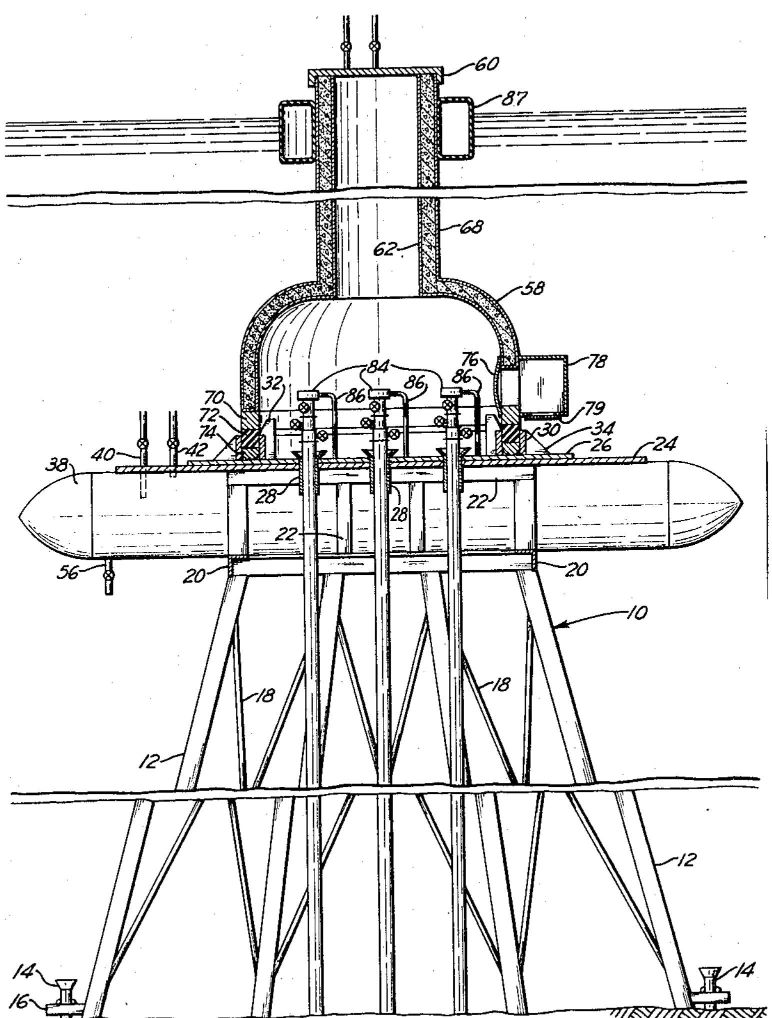
[57] **ABSTRACT**

A platform supports off-shore wellhead assemblies below the surface of the water at a depth adequate to eliminate danger from surface vessels or storms. Buoyancy tanks reduce the weight supported by the platform and thereby combine with the reduced weight above the ocean floor to reduce the cost of the platform. A seat is provided on the deck of the platform to receive and seal the lower end of a removable access tube that extends upwardly above the surface of the water to allow work at the wellhead to be performed at atmospheric pressure.

6 Claims, 5 Drawing Figures



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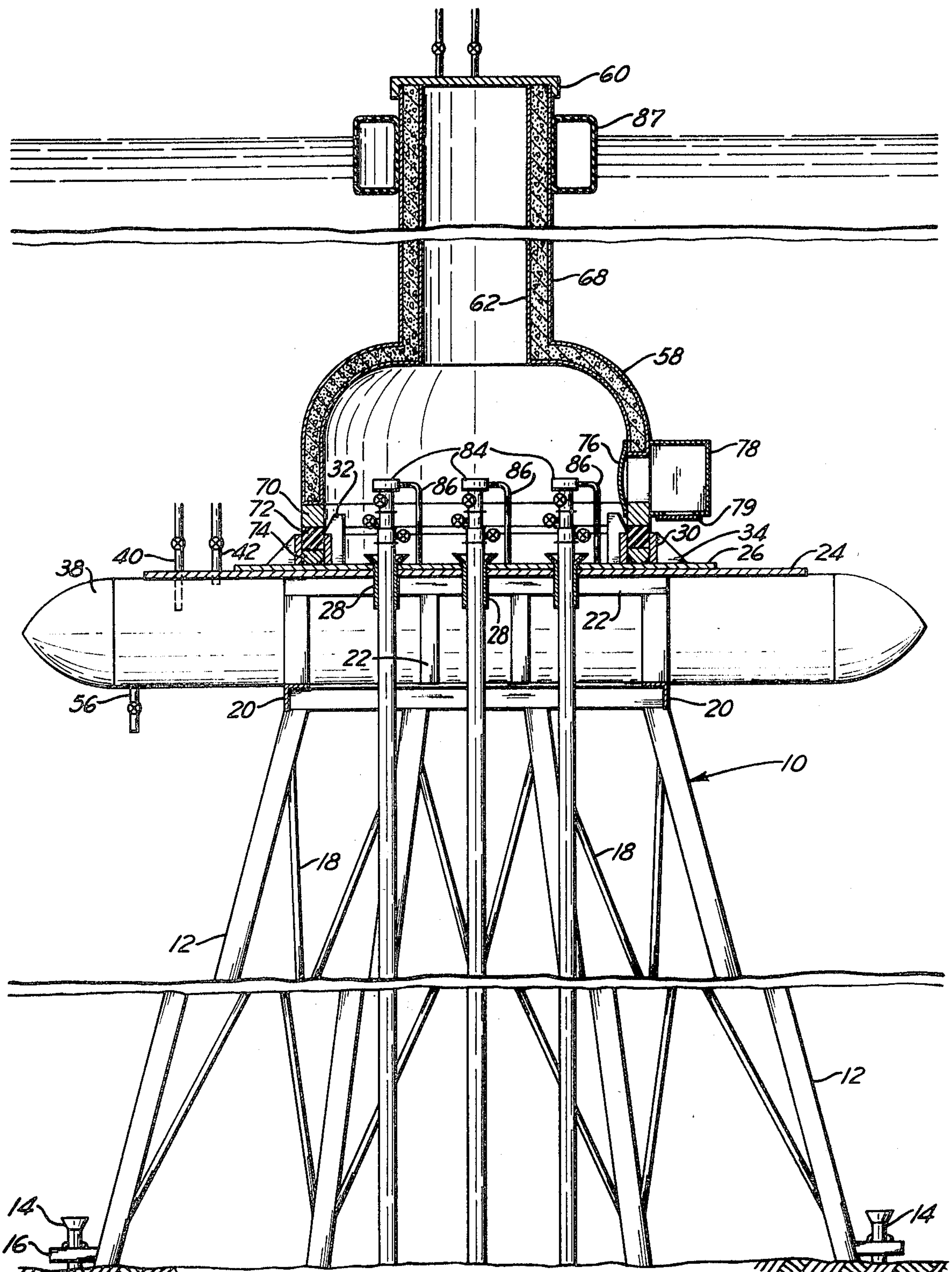

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Fig. 1

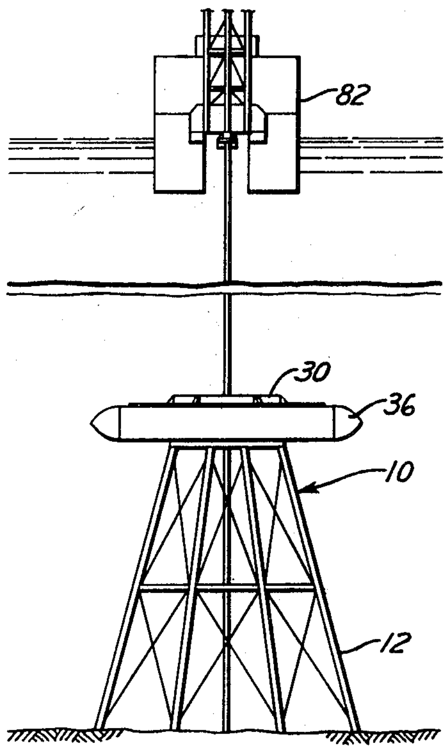

Fig. 2

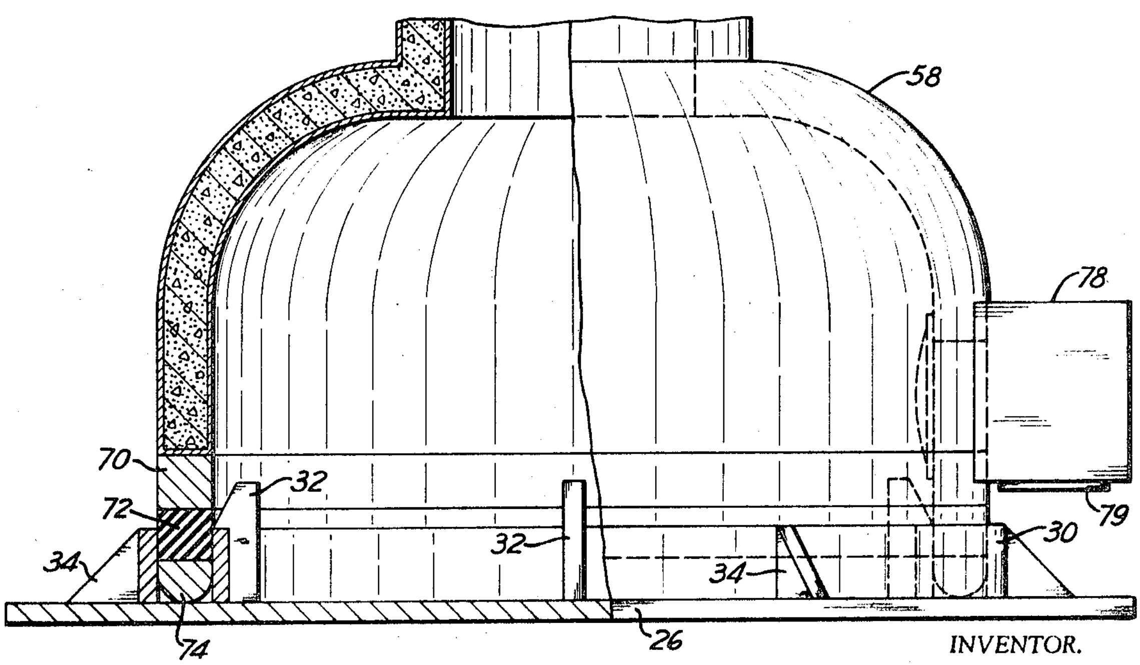

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Fig. 5

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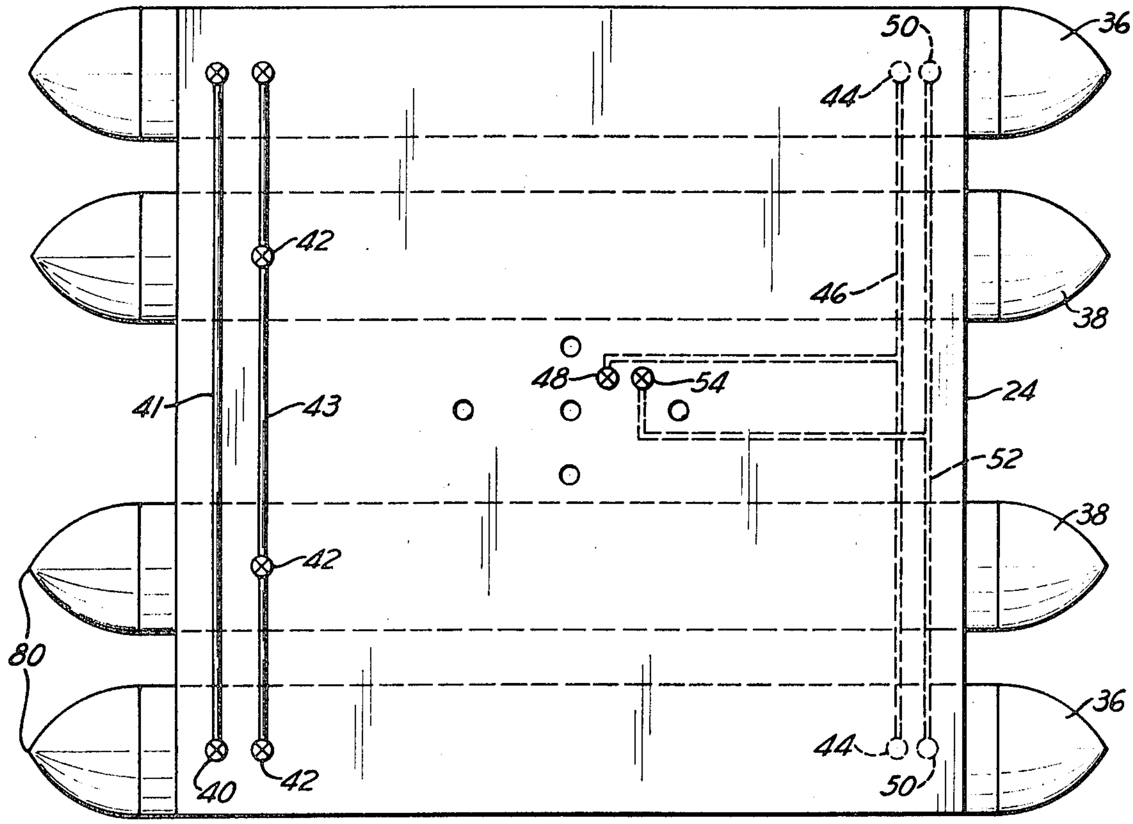

Fig. 3

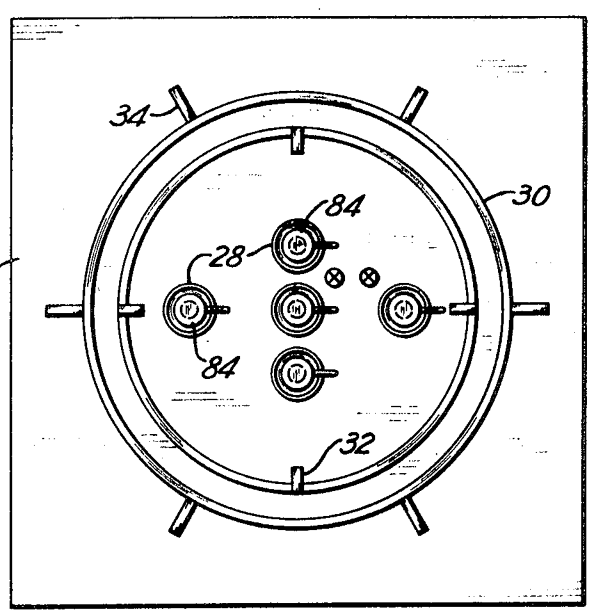

Fig. 4

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SUBMERGED WELL PLATFORM

This invention relates to the production of oil from offshore wells and more particularly to a platform for supporting the wellhead of offshore wells below the surface of water.

Much of the oil now produced is produced from wells located offshore. The wellheads of most of such wells are supported on platforms that are located at a distance above the surface of the water such that the platform will not be subjected to pounding by waves. As the search for oil continues, wells are drilled at continually increasing water depths. The cost of platforms for supporting wellheads above the water surface increases very rapidly with an increase in depth of water.

One method that has been suggested for reducing the cost of platforms for wells in deep water is to use floating platforms. Such structures require a complicated riser and anchoring system and have not been widely used. Moreover, floating platforms are exposed to the same hazards from storm damage and collision as conventional platforms.

This invention resides in a bottom-supported platform for wells. The platform is located at a distance below the surface of the water adequate to isolate the platform from wave action and eliminate danger of a surface vessel colliding with the platform. The platform is provided with storage tanks and buoyancy tanks with suitable connections for varying the weight of fluid in such tanks to adjust their buoyancy and thereby reduce the load on the platform. A seat encircling wellheads on the platform is adapted to receive a removable access tube that extends from the platform above the surface of the water and permits work on the wellheads at atmospheric conditions.

In the drawings:

FIG. **1** is a diagrammatic elevational view, partially in vertical section, of a platform supporting completed wells and with an access tube in position to permit work on the wells.

FIG. **2** is a diagrammatic elevational view of the platform of this invention during the drilling of a well showing a floating drilling rig in position above the platform.

FIG. **3** is a plan view of the platform with the base for the access tube removed.

FIG. **4** is a plan view of the base for the access tube.

FIG. **5** is a fragmentary elevational view, partially in vertical section, of the lower end of the access tube.

Referring to FIG. **1**, a platform indicated generally by reference numeral **10** is illustrated having legs **12** driven or washed into the ocean floor. Legs **12** slope outwardly to increase the stability of platform **10**. Additional stability may be obtained by means of piling **14** driven into the ocean floor through brackets **16** secured to legs **12**. Suitable cross-bracing **18** is provided to increase the rigidity of the platform.

Beams **20** are supported at the upper end of legs **12** and combine with other vertical and horizontal structural members **22** to support a deck **24** and an access tube base plate **26**. The deck **24** of platform **10** is located at a depth below the surface of the water adequate to avoid wave action during storms and to eliminate any danger of being damaged by surface vessels. It is desirable that the platform be located at a depth at which divers can work conveniently. Ordinarily, the platform is located at a depth of 50 to 200 feet below the surface of the water, and preferably is located at a level 100 to 150 feet below the surface. A plurality of guide sleeves **28** extend through deck **24** and base plate **26**. Guide sleeves **28** are welded to base plate **26** to prevent entry of water between the guide sleeve and base plate into the space above the base plate.

Extending upwardly from the upper surface of the access tube base plate **26** is a circular channel which forms a seat **30** for the access tube. Seating guides **32** slope upwardly and inwardly from the inner upper surface of access tube seat **30** to guide the access tube into the seat **30** as the access tube is lowered onto the platform. Reinforcing webs **34** are located at intervals around the access tube seat **30** to provide support for the outer wall of the access tube seat **30**. Access tube base plate **26** has holes extending through it in position to match the holes in the deck **24** to receive the guide sleeves **28**.

Supported on the platform **10** by beams **20** are a plurality of tanks. In the arrangement shown in FIG. **3** of the drawings, the outermost tanks **36** are used as storage tanks and the inner tanks **38** serve as buoyancy tanks. Since the oil stored in the tanks is less dense than sea water, the storage tanks provide a buoyant force contributing to the buoyant effect of the tanks **38**. While the storage tanks have a buoyant effect, it is important to have buoyancy tanks that at no time will be filled with sea water to maintain at all times a buoyant effect reducing the load on the platform.

Storage tanks **36** are provided with valved oil outlets **40** and the storage tanks **36** and buoyancy tanks **38** have valved air outlets **42** that extend upwardly through the deck **24** to permit connection by divers to lines to the surface. Lines **41** and **43** above the surface of the deck **24** provide interconnection between the tanks. In some instances, it may be desirable to have lines to the surface permanently attached to the outlets **40** and **42** and supported at the surface by a buoy. Tanks **36** are also provided with air outlets **44** that are connected by lines **46**, that extend below the deck **24** and rise through the deck **24** and the base plate **26**, to suitable air connections **48** within the space bounded by the access tube seat **30**. Similarly, oil outlets **50** are connected by delivery lines **52** below the deck **24** to suitable fittings **54** above the base plate **26** within the area bounded by the access tube seat **30**. A normally open outlet **56** is provided in the bottom of the storage tanks **36** to permit flow of sea water into or from the tank as the amount of oil in the tank changes. Tanks **38** have similar outlets.

Access tube **58** is bell shaped at its lower end to fit the access tube seat **30**. The larger lower end of the access tube extends upwardly a distance adequate to provide sufficient head room for working on wells enclosed within the lower end of the access tube. The lower end of the access tube may have a diameter of the order of 25 to 30 feet. The upper portion of the access tube **58** is of reduced diameter of approximately 6 to 10 feet to provide sufficient space for passing men and equipment necessary to perform service work on the wells. Access tube **58** has a length adequate to place the upper end **60** of the access tube high enough above the surface of the water to prevent water splashing into the open access tube. It is contemplated that the access tube **58** will have an inner wall **62** spaced from an outer wall **68** and the intervening space filled with concrete. Concrete 6 inches thick will provide a structure of sufficient rigidity even though the platform is as much as 300 feet below the surface of the water. The lower end of the access tube has a steel base **70** to the bottom of which is secured a deformable sealing element **72** of rubber or similar material. A steel shoe **74** is secured to the lower surface of sealing element **72** and bears against the upper surface of the base plate **26** within the access tube seat **30**. The weight of the access tube deforms sealing element **72** against the walls of the seat **30** to prevent flow of water around the lower end of the access tube into the space within the access tube.

Access tube **58** is provided with an escape hatch **76** which allows entry into an escape chamber **78** mounted on the outer surface of the access tube. The escape chamber is provided with a suitable exit **79** and self-contained breathing apparatus to allow a man to leave the chamber and go to the water surface without having to go through the access tube.

The platform of this invention will preferably be built onshore, transported to the site on a barge and lowered into position by a derrick. It is preferred that the storage tubes **36** and buoyancy tubes **38** have pointed ends **80**, and the pointed ends extend in the direction of flow of the currents to reduce the forces exerted on the platform by currents below the surface of the water. The weight of the platform can be adjusted by control of the amount of water in the storage tanks. Water is jetted from the bottom of the legs **12** to lower the legs into the ocean floor. The platform can be maintained in an upright position while being secured to the ocean floor by selectively jetting water from the different legs of the platform. After the legs have been jetted the desired depth into the ocean floor, a cement slurry is preferably pumped down the legs and forced upwardly around the legs to anchor the platform. Other methods of securing the platform to the ocean floor can be used. For example, piling can be driven down through the legs **12** of the platform or can be driven through brackets **16** secured to the legs.

A drilling rig is moved into place over the platform. In FIG. **2** of the drawings, a floating drilling rig **82** is illustrated in position over the well. If the water depth at the well site is not too great, a jack-up rig can be used. Conductor pipe is run through the guide sleeves **28** and either washed or driven to the desired depth in the ocean floor. The conductor pipe is then welded to the guide sleeves **28** to prevent flow of water upwardly between the guide sleeves and the conductor pipe. The well is then drilled and completed by conventional techniques. In the embodiment of the invention illustrated in the drawings, guide sleeves are provided for five wells having wellheads indicated by reference numeral **84**, but obviously any reasonable number of wells can be drilled through a single platform. Because of the relatively low cost of the platform made possible by this invention, it is possible to use more platforms with a small number of wells supported by each platform to give greater flexibility in well spacing.

Flow lines **86** from the wells are connected to the storage tanks for delivery of oil from the wells into the storage tanks, and the outlets at the bottom of the storage tanks opened to permit displacement of water from the storage tanks by the oil produced in wells **84**. Oil can be delivered from the storage tanks to a barge for transport to shore by a diver making connections from a barge to outlets **40**. The differential in the density of sea water and oil will allow the sea water to displace the oil upwardly into the barge.

If the well should need workover, or access to the top of the well is desired for any reason, the access tube **58** is transported to the site of the well and lowered into position with the shoe **74** in the access tube seat **30**. It is contemplated that the ends of the access tube will be covered and the access tube floated to a location above the platform **10**. The cover from the lower end of the access tube is then removed. The lower end of the access tube sinks until the access tube is in an upright position, and air is allowed to escape at a controlled rate through the cover on the upper end of the access tube to lower the access tube onto seat **30**. Placement of the access tube on the seat **30** can be facilitated by a float **87** secured to the upper end of the access tube. After the access tube is directly above the seat **30**, air is discharged from the float **82** to lower the access tube.

Before removing the cover **60** from the upper end of the access tube **58** to place the full weight of the access tube on the platform, it may be desirable to reduce the load on the platform to allow for the weight of the access tube. That can be accomplished by adjusting the buoyancy by displacing water from the storage and buoyancy tanks. Air can be delivered from a line through outlet **42** into the buoyancy tanks or in some instances into the storage tanks for such displacement. The cover **60** is then removed and water pumped from within the access tube. The bell shape of the access tube results in a large net downward force on the access tube by the difference in pressure inside and outside of the tube. That force eliminates the necessity of lock-down means to hold the access tube in place and improves the seal against the access tube seat. If desired, delivery of oil from the storage tanks can be accomplished through a line extending down the access tube and connected to fittings **54**. Workmen are lowered through the access tube to perform the desired work on the wells. When the work on the wells has been completed and the workmen have left the access tube, the cap **60** is replaced and compressed air injected into the access tube and into the float **86** to lift the access tube from the seat **30**.

The platform of this invention reduces the danger of damage to the platform and wells supported by the platform from storm or collision with vessels by locating the platform 50 feet or more below the surface of the water. The reduction in the height of the platform and the reduced stresses to which the platform is exposed because of its location contribute to an important reduction in the cost of the platform. The buoyancy tanks on the platform reduce the load placed on the platform and further reduce the cost of the structure. Because of the reduced costs of the platform of this invention, the use of more platforms with improved well spacing becomes economically feasible.

I claim:

1. A platform for supporting wellheads of offshore wells at a depth of 50 – 200 feet below the surface of the water comprising a plurality of substantially vertical rigid legs extending into and supported by the ocean floor, a deck mounted on the upper end of the legs, the length of the legs locating the deck at a depth of 50 – 200 feet below the surface of the water, buoyancy tanks connected to and supported by the upper ends of the legs to reduce the weight on the legs, oil storage tanks mounted on the upper end of the legs, an upwardly opening access tube seat on the upper surface of the deck surrounding a plurality of wellheads supported above the deck by the platform and adapted to removably receive an access tube of a length to extend above the surface of the water, flow lines from the wellheads to the storage tanks, oil fittings above the deck within the access tube seat, oil delivery lines extending from the storage tanks to the oil fittings, air lines opening into the upper portions of the buoyancy tanks, and openings in the lower portions of the storage and buoyancy tanks to permit displacement of liquid from the tanks into the surrounding water.

2. A platform as set forth in claim **1** including oil outlets from the storage tanks opening above the deck outside of the access tube seat and air connections above the deck outside of the access tube seat opening into each of the storage and buoyancy tanks.

3. A platform for supporting wellheads of offshore wells comprising legs supported by the ocean floor, a deck mounted on the upper end of the legs, buoyancy tanks connected to the upper end of the legs to reduce the weight on the legs, the length of the legs placing the deck below the surface of the water **50 – 200** feet, oil storage tanks supported by the upper end of the legs, an access tube base plate on the deck, an access tube seat on the base plate comprising an upwardly opening channel of circular plan surrounding the wellheads supported by the platform and guide surfaces sloping upwardly and inwardly from the inner edge of the channel, flow lines from the wellheads to the storage tanks, oil fittings above the base plate within the access tube seat, and oil delivery lines extending from the storage tanks to the oil fittings.

4. A platform supporting the wellheads of offshore wells below the surface of water comprising rigid legs extending downwardly into the ocean floor to support the platform with its upper surface at a depth of 50 – 200 feet below the water surface, oil storage tanks supported by the legs at their upper end, buoyancy tanks supported by the legs at their upper end, a deck supported by the legs above the level of the tanks and supporting the wellheads, an access tube seat supported by the deck and surrounding the wellheads, an access tube constructed and arranged to seat releasably in the access tube seat and seal its lower end, said access tube having a length such that it extends above the surface of the water when seated on the access tube seat, means for guiding the lower end of the access tube into the access tube seat, the lower end of the access tube having an enlarged diameter to increase the force exerted by hydraulic pressure urging the access tube against the seat when water is removed from the access tube, and means for controlling the buoyancy of the buoyancy tanks.

5. A platform supporting the wellheads of offshore wells below the surface of water comprising legs extending downwardly into the ocean floor to support the platform at a depth of 50 – 200 feet below the surface of the water, oil storage tanks supported at the upper end of the legs, buoyancy tanks supported at the upper ends of the legs, a deck supported by the legs above the level of the tanks and supporting the wellheads, an access tube seat comprising an upwardly opening channel on the upper surface of the deck surrounding the wellheads, an access tube removably seated in the access tube seat and extending upwardly above the surface of the water, a ring of deformable material at the lower end of the access tube adapted to be deformed against the walls of the channel by the weight of the access tube to seal the lower end of the access tube, the lower end of the access tube having an enlarged diameter to increase the force exerted by hydraulic pressure urging the access tube against the platform.

6. A platform for supporting wellheads of offshore wells below the surface of water comprising a plurality of platform legs engaging the ocean floor and extending upwardly therefrom to a level in the range of 50 to 200 feet below the surface of the water, buoyancy tanks secured to the platform legs at the upper end thereof, oil storage tanks supported by the legs at the upper ends thereof, a deck supported above the tanks by the platform legs, an access tube base plate supported by the deck, a plurality of guide tubes extending downwardly through the access tube base plate and the deck, wellhead structures connected to casing extending through the guide tube, an access tube seat on the access tube base plate encircling the wellhead structures and opening upwardly to receive an access tube, oil lines extending from above the access tube base plate within the access tube seat to the oil storage tanks, air lines extending from within the access tube seat above the access tube plate to the buoyancy tanks, and outlets in the lower portion of the storage tanks and buoyancy tanks to permit the flow of water into and from such tanks.

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