

[54] **SUBSEA BUNKER CONSTRUCTION**

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[58] Field of Search.....166/.5, .6;
175/5-10; 61/69, 46

[56] **References Cited**

UNITED STATES PATENTS

3,520,358	7/1970	Brooks et al.....	166/.5
2,747,840	5/1956	Miles.....	175/9
3,004,602	10/1961	Kofahl.....	175/8 X
3,202,217	8/1965	Watts et al.....	175/5 X
3,063,500	11/1962	Logan.....	166/.5
3,211,223	10/1965	Hoch.....	166/.6

3,247,672	4/1966	Johnson.....	166/.5 X
3,543,846	12/1970	Smith.....	166/.5

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[57] **ABSTRACT**

A protective, oil leak sensitive, subsea well bunker and template construction adapted to be floated, carried, barged or transported to a proposed well site and lowered to a sea floor without special equipment. The bunker construction provides an enclosed chamber for well equipment, the well chamber being adapted to be filled with liquid for maintaining subsurface ambient pressures, and treated for reducing and inhibiting marine life and corrosion, and to provide a selected environment within the well chamber different than the environmental conditions without the chamber to facilitate and enhance working and service conditions within the chamber. The bunker construction includes means for sensing the presence and absence of oil in the chamber.

8 Claims, 6 Drawing Figures

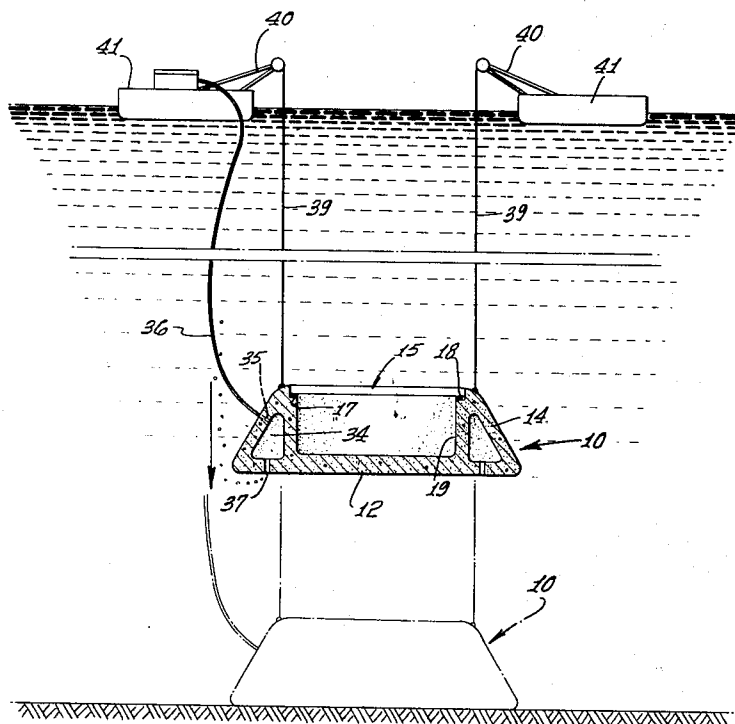


FIG. 1.

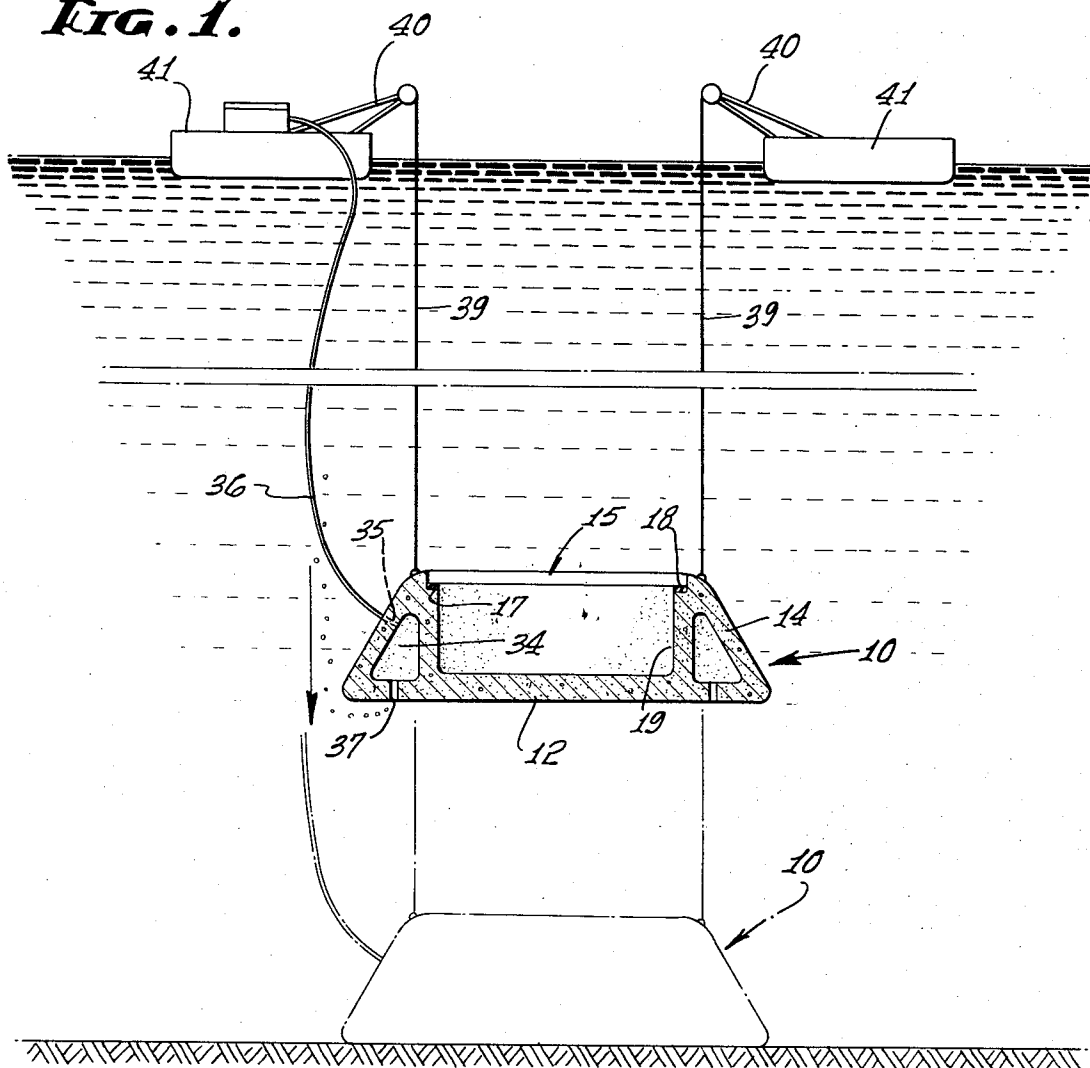
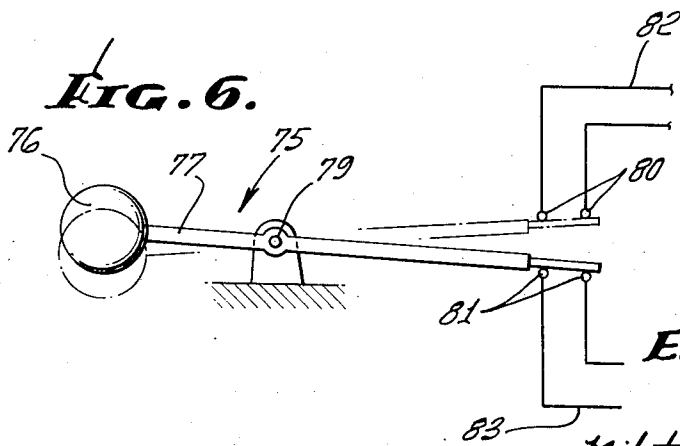
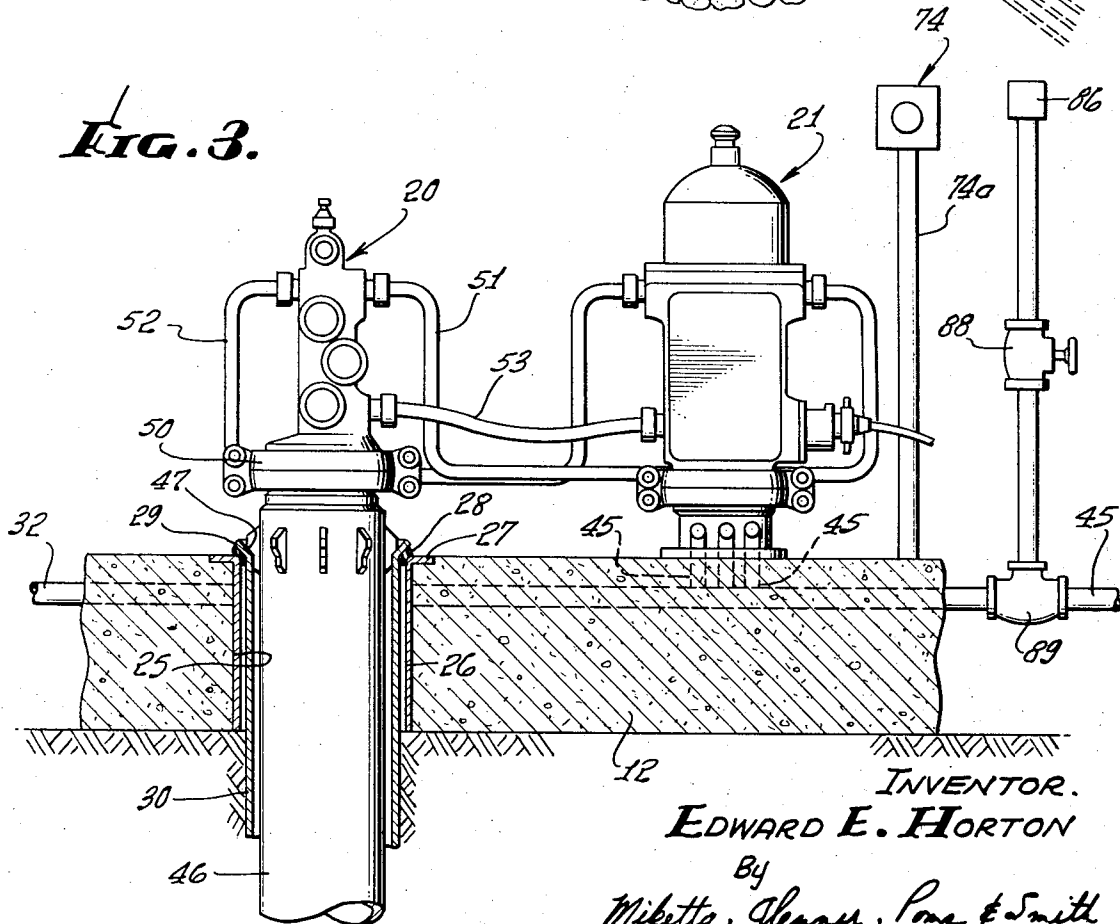
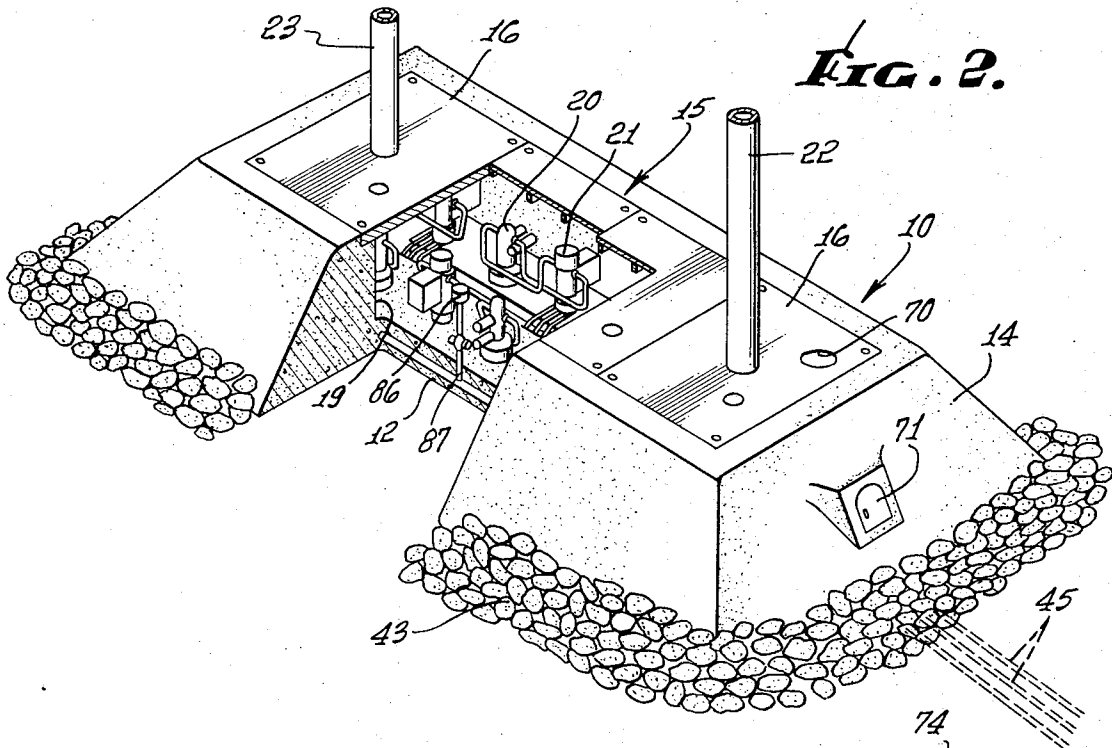


FIG. 6.

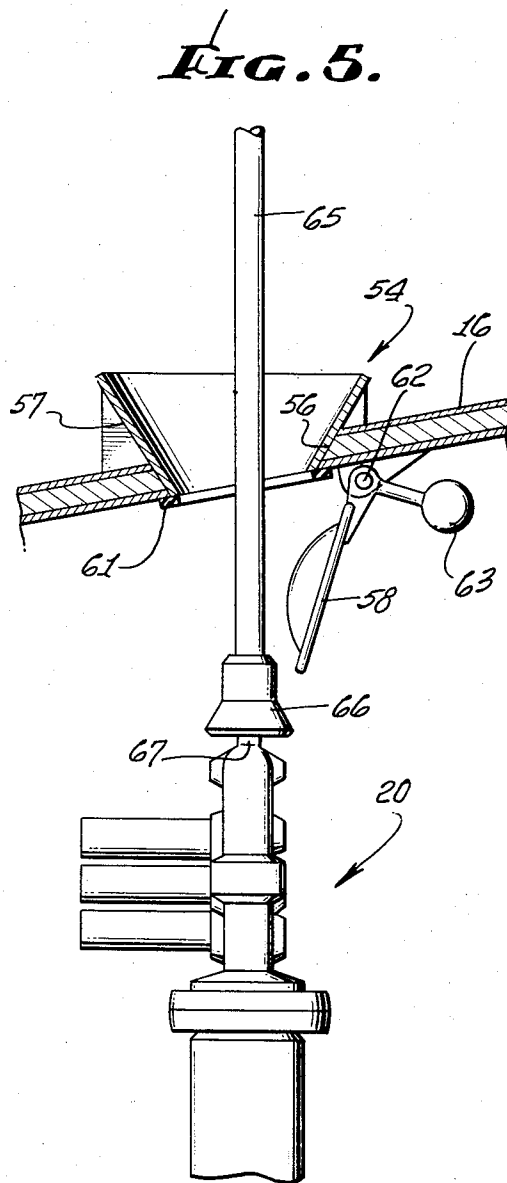
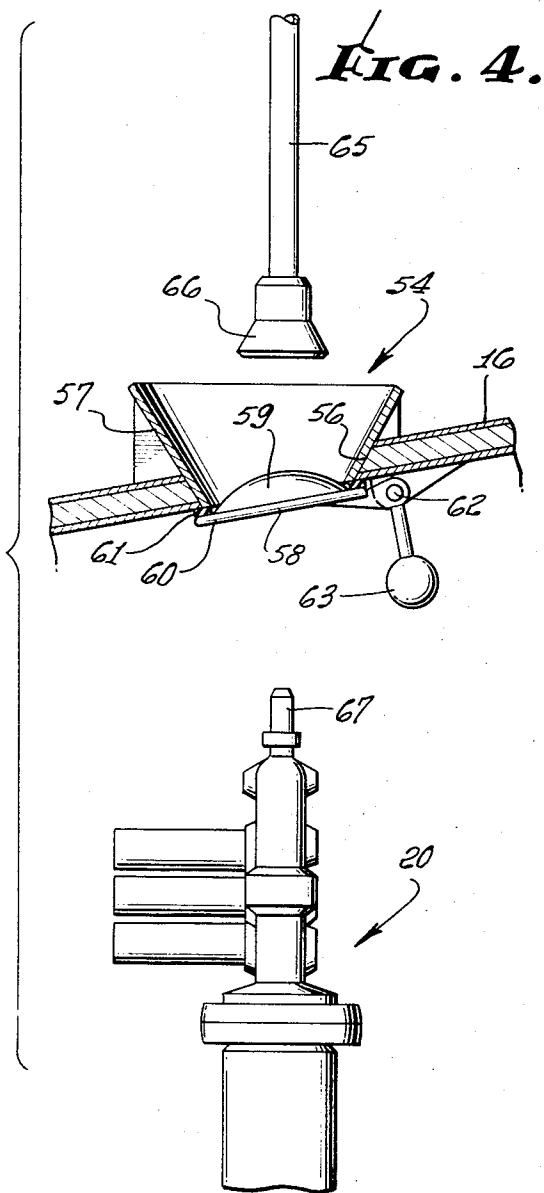


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SUBSEA BUNKER CONSTRUCTION

BACKGROUND OF THE INVENTION

Offshore drilling, completion and production of oil wells have presented numerous problems caused by depth of well sites, well locations such as in Artic, Anartic, or tropical regions, and marine conditions. Environmental conditions at the bottom of the ocean and adjacent to the floor may vary greatly at different locations in the ocean bed. Extremely cold or low water temperatures in Polar regions make working and servicing conditions at subsea installations very difficult and the length of time a worker can be exposed to such cold is limited and short.

Offshore well installations have included drilling of relatively widely separated spaced single well holes which were then equipped with a suitable wellhead and connected by relatively long flow lines to a suitably located offshore platform or rig, such as shown in Knapp U.S. Pat. No. 3,327,780. In other arrangements, well templates have provided a cluster of well holes relatively closely adjacent, each well hole being provided with a wellhead unit and a production control unit such as disclosed and claimed in my copending application Ser. No. 882,992. In such prior proposed subsea installations, the wellhead units were exposed to the surrounding ocean water, marine life, and various subsea conditions and sometimes became difficult to maintain and service. In other prior proposed subsea well installations, such as shown in Johnson U.S. Pat. No. 3,247,672, an onshore fabricated concrete encasement was partially buried in a hole excavated in the sea bottom, the encasement providing a plurality of well units for well holes drilled through openings provided in the bottom floor of the encasement.

SUMMARY OF THE INVENTION

The present invention contemplates a novel bunker and template construction which is readily adaptable for installation under varying environmental conditions at the sea bottom to provide a selected interior environment surrounding wellhead and production units whereby many advantages and benefits are achieved as compared to prior proposed subsea well structures. The present invention contemplates a bunker construction having a well equipment chamber in which one or more wellhead units are readily connected to a conductor guide provided in an opening in the floor of the bunker construction at locations for drilling the well holes. The well equipment chamber may be provided with suitable rails or guide ways for movement of a suitable diving or subsea working chamber or capsule for convenient transportation of personnel and tools between wellhead and production control units associated with different well holes within the chamber for purposes of repair, maintenance, inspection, and service of such equipment. The well equipment chamber is designed to be substantially sealed against intrusion of the surrounding sea water so that a selected environmental liquid condition can be maintained within the chamber for purposes of inhibiting marine growth and for providing water conditions relating to temperature and turbidity which will improve and enhance working conditions within the well chamber and which will confine any oil which might leak from the well hole and from equipment within the well hole.

A device responsive to the presence of oil or other unwanted or undesired conditions within the well chamber is also provided so that an oil leak may be immediately detected and noticed at remote locations such as offshore or onshore installations.

Generally speaking, the bunker construction includes buoyant chambers which are so arranged as to facilitate the lowering in a controllable manner of the bunker construction to the sea floor. The bunker construction also provides means for changing the water within the well chamber to provide warm water to enhance working and servicing conditions, treated water to deter and inhibit marine growth, and clear water to improve visibility within the chamber.

The principal object of the present invention, therefore, is to provide a novel bunker and template construction for use at a subsea well site to provide a selected bunker interior environment.

An object of the invention is to disclose and provide a novel method of installing and providing a subsea installation which provides an environment suitable for maintenance and service of wellhead and production control equipment.

An object of the invention is to disclose and provide such a bunker construction which is inexpensive, readily constructed on shore and easily transported to the well site and lowered to the ocean floor at the well site.

Another object of the invention is to disclose and provide a well bunker and template construction made of concrete and provided with buoyancy chambers whereby the bunker construction may be floated to the well site and may be readily lowered under desired control by maintaining air in the buoyancy chambers at approximately ambient pressure.

Still another object of the present invention is to disclose and provide a bunker and template construction wherein wellhead and production units installed within the bunker chamber are readily protectable by treatment of water contained within the equipment chamber and shielded from external objects and conditions.

A further object of the invention is to disclose and provide a well bunker construction including means in the bunker well chamber responsive to the presence of oil in the water.

A still further object of the invention is to provide means responsive to conditions within the bunker chamber for indicating the chamber condition at a remote location.

A still further object of the invention is to disclose and provide a subsea bunker construction provided with means for changing the conditions within the bunker chamber.

Other objects and advantages of the present invention will be readily apparent from the following description of the drawings in which exemplary embodiments of the present invention are shown.

IN THE DRAWINGS

FIG. 1 is a schematic view of a bunker construction embodying this invention being lowered to an ocean floor, the bunker being shown in section, the section being taken in a vertical plane passing through the longitudinal axis of the bunker;

FIG. 2 is a perspective view of the bunker construction installed on the ocean floor, a portion of the bunker construction being cut away to illustrate the well equipment installed within the bunker chamber;

FIG. 3 is an enlarged fragmentary sectional view of a well hole and bunker floor showing wellhead and production control units, flow lines and suction lines;

FIG. 4 is a fragmentary sectional view illustrating an exemplary hatch through which a riser pipe may be lowered and cooperably connected to a wellhead unit;

FIG. 5 is a view similar to FIG. 4 showing a riser pipe connected to a wellhead unit; and

FIG. 6 is a schematic diagram of an exemplary oil responsive float arrangement for detecting the presence of oil within the bunker chamber.

A bunker and well template construction embodying this invention is generally indicated at 10 in FIGS. 1 and 2. Bunker construction 10 may comprise a generally rectangular elongated structure sufficient to accommodate a predetermined arrangement of a cluster or a group of a plurality of well holes to be drilled in the ocean formation. In this example, the cross-sectional configuration of the bunker is trapezoidal with relatively steeply pitched exterior side surfaces to minimize the lodgment and deposit of unwanted marine debris on the bunker construction and to avoid and minimize entanglement with anchors or lines used in the immediate vicinity of the bunker.

Bunker construction 10 may comprise a floor 12, sidewalls 14 extending continuously around the periphery of said floor and top wall means, generally indicated at 15, which may comprise one or more cover plates 16 supported on a peripheral shoulder 17 provided on upper portions of sidewalls 14. Shoulder 17 may provide a seat for a suitable gasket 18 upon which the cover plates 16 may rest to provide virtually sealed relation with sidewalls 14. Gasket 18 may be designed to withstand heavy shock loads to cushion impact forces from heavy objects falling on the cover plate. The floor 12 and sidewalls 14 define a well equipment chamber 19 adapted to contain various selected well equipment such as wellhead units 20 and production control units 21 (FIG. 3).

Cover plates 16 may be of selected thickness and material and in this instance are illustrated as being of metal provided with suitable structural reinforcement. Each cover plate 16 may be provided with suitable means such as an eye or a hook (not shown) for connection of said cover plates to a line or cable for removing and installing each cover plate. Fluid conducting pipes 22 and 23 may enter end cover plates 16 to introduce and remove fluid from within the bunker chamber 18 as described hereafter. Pipes 22 and 23 may be connected to suitable fittings provided in sidewalls 14 if desired for this purpose.

Bunker construction 10 may be made of a suitable reinforced concrete material. Since fluid pressures within the chamber 19 will be ambient pressures of the depth at which the bunker construction is located, special bunker construction is not required. The bunker construction may be fabricated with holes 25 in floor 12, the holes being suitably lined with a metal sleeve 26 having a top flange 27 providing a seat and seal face for a seal member 28 to support the upwardly and outwardly flared end flange 29 of a conductor pipe 30. In

addition, floor 12 may have precast and embedded therein a suitable arrangement of flow lines 32 and other types of piping desired for operation of a subsea well assembly. The spaced arrangement of holes 25 in floor 12 is made to provide a wellhead template especially designed for a well site and for well equipment to be installed in the bunker.

In this exemplary bunker construction, sidewalls 14 at ends of the bunker construction are provided with buoyancy chambers 34 of selected capacity, each chamber 34 being provided with an inlet fitting 35 for connection to an air pressure line 36. Discharge ports 37 are provided in floor 12 for chambers 34 to discharge pressure air or fluid therefrom in accordance with pressure differentials between the buoyant chamber interior and the exterior of the bunker.

It will thus be apparent that in the bunker construction above described filling of buoyant chambers 34 with pressure air and closing holes 25 in equipment chamber 18 (without water therein) will permit the bunker construction to be floated at the surface of the water and thereby readily transported to the selected well site. At a well site (FIG. 1) suitable cables 39 connected to the bunker construction and controlled by derrick rigs 40 on a pair of barges or other like vessels 41 will permit lowering of the bunker construction in the water. By introducing pressure air to said chambers during lowering and permitting excess air therewithin to be discharged through the bottom air bleed ports 37, the air within said buoyant chambers is maintained at about ambient pressure. The main chamber 18 may be also filled with water so that bunker 10 may be lowered with a minimum of force to the well site at the bottom of the ocean. A controllable descent is thereby provided without special lowering equipment.

When the bunker construction has come to rest upon the ocean bottom at a selected location and is leveled and properly positioned, riprap 43 may be placed along the bottom of the sidewalls 14 to prevent scouring or undermining of the bunker construction caused by undersea currents and water movement. Before such riprap is placed around the bunker construction, it will be readily understood that flow lines 45, which may be located below the mud line or surface of the sea floor, may be connected to pre-installed flow line ends in the bunker so that such lines of gas, production oil, and test oil will be in communication with the wellhead units within the bunker construction.

During a well drilling operation commenced after installation of bunker 10, cover plates 16 may be removed to provide access to holes 25 provided in floor 12 so that a well drilling operation may be conducted through such holes. In the drilling operation, conductor guides 30 are landed or seated on the floor 12 as indicated in FIG. 3, an outer well casing 46 may be landed as at 47 on landing flange 29 of the conductor tube and selected suitable wellhead equipment indicated by the wellhead unit 20 may be connected to the well casing as by clamp means 50 in well-known manner. Wellhead unit 20 may be connected in a manner described in my copending application Serial No. 882,992 with a production control unit 21 supported by floor 12. Such connecting lines may include gas and oil lines 51, 52 and control lines 53. Production control unit 21 serves through remotely located means

to control and regulate the production of oil through the flow lines.

Each cover plate 16 above a selected wellhead unit and production control unit may be provided with a hatch means 54 shown in FIGS. 4 and 5. In FIGS. 4 and 5, the cover plate 16 includes an opening 56 supporting an upwardly flaring funnel-shaped guide 57. Opening 56 is provided with a circular hatch cover 58 having an upwardly dome-shaped or part-spherical configuration as at 59 and having an annular flange 60 adapted to seat against a resilient seal ring 61 fixed to the bottom annular marginal surface on the cover plate 16. Hatch cover 58 is mounted on a pivot shaft and axis 62 and is normally held in closed position by a depending counterweight 63. When a riser pipe 65 is lowered through the funnel-shaped guide 57, the bottom end of pipe 65 will contact the dome surface 59 of hatch cover 58 to pivot the hatch cover about axis 62 so that the packer 66 will slide over and engage a mating connection 67 provided on top of the wellhead unit 20. Riser pipe 65 and its connection to the wellhead unit provides means for conducting tubing operations in the well after completion.

Bunker construction 10 may be provided with access openings at 70 and 71 for permitting a diver to enter well chamber 18 without removing a cover plate 16. The hatches for openings 70 and 71 may be suitably pivotally supported and opened in well-known manner (not shown).

Means 74 for determining selected conditions in the fluid environment of the chamber 18 is generally indicated in FIG. 3 and may be supported at a selected elevated location by any suitable means such as a standard or vertical pipe 74a. Means 74 may include a suitable float means 75, FIG. 6, the float means comprising a float ball 76 and carried on one end of an arm 77 pivoted intermediate its ends at 79. The opposite end of arm 77 is positioned for operable contact with a pair of electrical contacts 80 and 81 for making or breaking circuits 82 or 83 which indicate the position of the float. The float ball 76 in upper position may designate presence of seawater in chamber 18, and in lower position may indicate the presence of oil or gas because of the differences in specific gravity of the water and oil. The circuits 82, 83 may be connected to an indicating device or alarm (not shown) at an offshore station, vessel, or some other remote location.

It is understood that other examples of environmental responsive and sensitive devices may be used and are contemplated by the present invention. For example, a waterproof T.V. camera arrangement may be installed within chamber 19 for scanning the wellhead and production control equipment by remote control for the purpose of detecting changes in the clarity of the water in the chamber. In somewhat similar manner, an arrangement of a suitable waterproof light source and a photoelectric cell spaced therefrom may be used to detect changes in the clarity of the water, such changes being caused by oil or other unwanted marine growth. In such instance, the loss or change of light intensity produces a change in the response of the photoelectric cell which is communicated to a remote location. Since oil has a different electrical resistance than water, the resistance between open electrodes suitably placed in the chamber 19 would also indicate

and detect the presence of oil. Such electrodes would be connected to a circuit for transmitting the response to the selected remote location.

It will be understood that chamber 18 is normally filled and flooded with water when it is installed on the ocean bottom. Water in chamber 18 may be withdrawn therefrom through an intake strainer 86 supported on a vertical pipe 87 provided with a valve 88 which may be controlled by suitable means from a remote location. Valve 88 permits communication with a selected flow line by the T fitting 89 so that, if desired, fluid within the chamber 18 may be piped through one of the flow lines.

Thus, the bunker construction 10 provides a well equipment chamber normally flooded with water and enclosing wellhead and production control units and other desired well equipment which may be readily controlled and operated from a remote location while being in an enclosed local environment which may also be controlled. For example, in some situations the fluid within the enclosed well chamber may be treated with suitable chemicals or other materials for inhibiting and destroying marine life and activity within the equipment chamber. Inlet and discharge pipes 22 and 23 provide means for connection to pipes or conduits lowered to the bunker construction whereby the seawater normally in equipment chamber 19 may be withdrawn and replaced with clear water, and even heated water so that the temperature conditions within the well equipment chamber may be regulated or established within a certain temperature range to facilitate service and maintenance of the well equipment within the chamber. Thus, warm water may be introduced into the equipment chamber in extremely cold water locations to facilitate not only service and maintenance of the equipment, but to enhance operability of the equipment.

It will also be apparent that the water condition normally within the chamber may be continuously sensed by the sensing means 74 so that in the event an oil leakage occurs and the oil floats to a position adjacent the ceiling of the bunker, the presence of such oil will be immediately sensed by the means 74 and a warning given that such condition exists.

In the present example of the invention, buoyant chambers are provided in the sidewalls of the bunker and it is understood that means providing buoyancy may include such chambers or other buoyant means which will impart an upwardly directed force to the bunker when it is in the water. Such buoyant means may include not only pressure air, but also any fluid medium which is lighter than sea water, as fresh water. Thus under some conditions, it may be desirable that the well chamber contain fresh water not only for its buoyant effects, but also for its reduced corrosive effect as compared with sea water.

While the bunker is shown resting upon a sea floor, it may be readily utilized with a submerged platform in order to provide an enhanced environment for operation and service of well equipment within the well chamber.

It will be readily understood that various modifications and changes may be made in the construction of the bunker, that the well equipment placed within the interior environmental chamber may be modified and

changed, the intake and discharge pipes may be differently arranged or constructed with respect to the bunker construction, and the environmental condition within the well chamber may be selected and maintained to achieve an optimum working and maintenance environment.

All such changes coming within the scope of the appended claims are embraced thereby.

I claim:

1. In a protective and leak sensitive, subsea bunker and template construction for selectively providing and detecting environmental conditions within the said bunker construction, comprising in combination:

a bunker construction having means providing buoyancy therefor and provided with a well equipment chamber normally containing a fluid medium which is maintained at approximately ambient pressure during and after installation on a sea floor;

said bunker construction including a floor, top and sidewalls of impervious material;

said floor including one or more well hole openings therein providing a well hole template pattern;

said top wall including removable cover plates over the well holes; and

means located within said well equipment chamber for determining the environmental condition of a fluid medium in said chamber without removal of fluid from said chamber.

2. In a bunker construction as stated in claim 1 wherein said means located within said well chamber includes mechanical means for detecting the presence of oil in said chamber.

3. In a method of installing a subsea bunker and well template construction, the steps of:

transporting a bunker construction including a well equipment chamber between end buoyancy chambers to a wellhead site;

lowering said bunker construction to the sea bottom by introducing pressure air to buoyancy chambers and for discharge of pressure air from said buoyancy chambers to control the descent of said bunker construction to the sea floor;

drilling one or more well holes through well openings in the floor of said construction;

providing a wellhead unit and a production control unit within said equipment chamber for each well hole;

sealing said well equipment chamber;

introducing selected liquid to said equipment chamber to maintain ambient pressure therewithin during lowering of said bunker construction to the sea bottom and while at the sea bottom to inhibit marine and corrosive growth on well equipment within the said chamber; and

continuously sensing within said equipment chamber for the presence and absence of oil in said equipment chamber.

4. In a subsea bunker and template construction, the combination of:

a bunker construction including a housing of impermeable material and provided with an equipment chamber;

means for introducing and for exhausting a selected fluid medium into and from said equipment

chamber to modify environmental conditions within said equipment chamber;

said equipment chamber being filled with a fluid medium and maintained at approximately ambient pressure during lowering of the bunker construction to the sea bottom and while at the sea bottom; and means located within said chamber for sensing and responding to environmental conditions within said equipment chamber,

said last-mentioned means being connected to a remote location for indicating at such location the condition within said chamber.

5. In a protective and leak sensitive subsea bunker and template construction for selectively providing and detecting environmental conditions within said bunker construction, comprising in combination:

a bunker construction having means providing buoyancy therefor and provided with a well equipment chamber normally containing a fluid medium which is maintained at approximately ambient pressure during and after installation on a sea floor;

said bunker construction including a floor, top, and sidewalls of impervious material;

said floor including one or more well hole openings therein providing a well hole template pattern;

said top wall including removable cover plates over the well holes; and

means within said well equipment chamber for determining the fluid environmental condition in said chamber and including means for detecting the presence of oil in said chamber,

said means for detecting the presence of oil in said chamber including a pivoted float means within said chamber.

6. In a method of installing a subsea bunker and well template construction, the steps of:

transporting a bunker construction to a wellhead site;

lowering said bunker construction to the sea bottom by introducing pressure air to buoyancy chambers and for discharge of pressure air from said buoyancy chambers to control the descent of said bunker construction to the sea floor;

drilling a well hole through each well opening in the floor of said construction;

providing a wellhead unit and a production control unit for each well hole within an equipment chamber;

sealing said well equipment chamber;

introducing selected liquid to well equipment chamber to maintain ambient pressure and to inhibit marine and corrosive growth on well equipment; and

continuously sensing for the presence and absence of oil in said equipment chamber; and

maintaining a selected working temperature within said equipment chamber to enhance working conditions therein by introducing and circulating warm water therein.

7. In a protective and leak sensitive subsea bunker and template construction for selectively providing and detecting environmental conditions within said bunker construction, comprising in combination:

a precast concrete reinforced bunker construction having end chamber means providing buoyancy therefor and having end chamber for well equipment normally containing a fluid medium which is maintained at approximately ambient pressure during and after installation on a sea floor; 5
said bunker construction providing a floor, top, and sidewalls of impervious material;
said floor being adapted to rest on a sea bottom and including one or more well openings therein 10
providing a well hole template pattern;
pipe means embedded in said floor and provided with connecting means to well equipment in said

equipment chamber;
said top wall including removable cover plates over the well holes; and
means located within said well equipment chamber for determining environmental condition of a fluid medium in said chamber.

8. In a subsea bunker and template construction as stated in claim 7 wherein said top wall includes a normally closed inwardly opening hatch means above each wellhead unit for passage therethrough of a riser pipe for conducting tubing operations on said wellhead unit.

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