

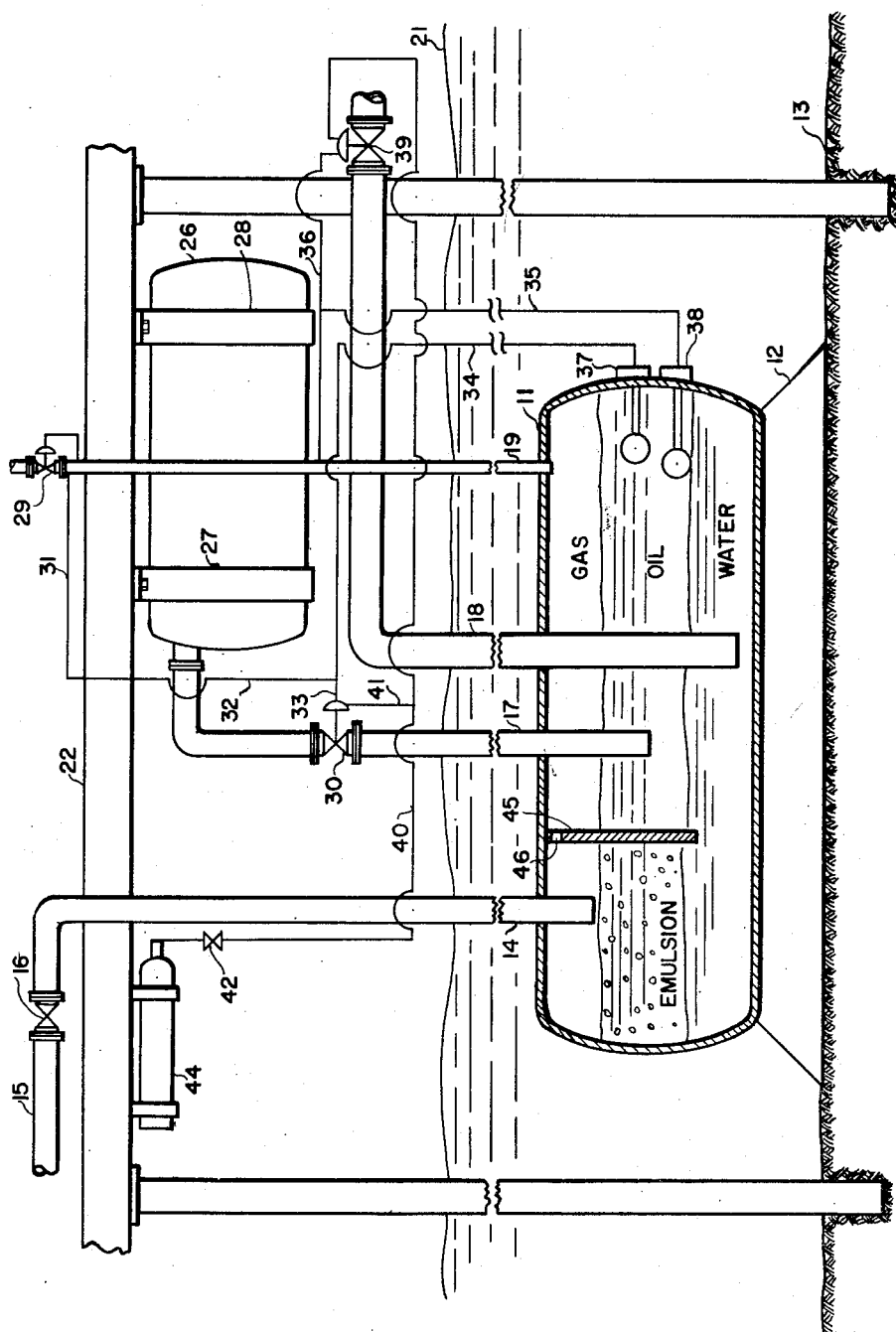
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J. E. ORRELL

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UNDERWATER OIL PRECIPITATOR

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INVENTOR

J. E. ORRELL

BY *J. H. McCarthy*
HIS AGENT

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UNDERWATER OIL PRECIPITATOR

John E. Orrell, New Orleans, La., assignor to Shell Development Company, New York, N. Y., a corporation of Delaware

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This invention relates to apparatus for producing oil and gas wells and pertains more particularly to apparatus adapted to be submerged in the water at offshore oil well locations for treating the fluid produced by the well and separating it into its various components.

The fluid produced by offshore oil wells generally comprises a mixture of oil, gas and water which are often in emulsion form. One way of separating production fluid into its various components at the offshore location is to mount a separating tank on a platform which is adapted for this purpose. In the event that the produced fluid is in emulsion form, an emulsion treating tank is employed instead.

The main drawback to mounting a separator or other treating tanks on a platform at an offshore location is the considerable expense involved for the required platform space. Instead of mounting a treating tank at the wellhead or central field location, the mixture of oil, gas and water can also be transferred to shore through a pipeline and be treated in a separator situated on land. Economic and operating difficulties often arise with this procedure, due to the necessity of handling a major portion of the water with the oil.

It is therefore a primary object of this invention to provide an oil-water-gas separator or precipitator that is adapted to be positioned and operated beneath the level of a body of water, thus obviating the need for an expensive offshore platform.

A further object of this invention is to provide an underwater precipitator adapted to separate the oil and water and to vent the entrained gas or air from a three-phase oil-water-gas emulsion at the well sites or geographically near the producing wells, and, at the same time, preclude the added cost for larger than required pipelines as well as pumping equipment to transport the produced emulsion to shore.

Another object of this invention is to provide an underwater precipitator for separating an oil well emulsion (substantially gas free) into its oil, gas and water components, said precipitator being adapted to be filled with air or gas when it is desired to float and move it from one location to another, or to raise the precipitator tank for servicing or cleaning purposes.

These and other objects of this invention will be understood from the following description taken with reference to the drawings, wherein the figure is a diagrammatic side view, taken in partial cross-section, of the present oil precipitator which is schematically illustrated as being positioned on the ocean floor adjacent an offshore well or field producing installation.

Referring to the drawing, the present underwater oil precipitator comprises an elongated cylindrical tank 11 provided with a suitable base 12 which is positioned on the ocean floor 13. The base 12 for the tank 11 may or may not be necessary depending upon the character of the ocean floor on which the tank is to be positioned. The tank base 12 may be an elongated unit as shown, or

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may merely comprise a pair of tank saddles well known to the art. Preferably, the base 12 is made of sheet metal, which may be reinforced as desired, or may be made of concrete if it is not desired to transport it to another location.

The tank 11 is provided with inlet line 14 which may be connected to the production line 15 from a producing well (not shown) for introducing the production fluid, comprising a mixture of oil, gas and water, into the tank 11. Flow through the inlet line 14 may be shut off by valve 16. The production fluid inlet line 14 enters the tank 11 near one end thereof so as to maintain the production stream, as it enters the tank, behind special baffle plates, as will be described hereinbelow.

The tank 11 is further provided with three discharge lines 17, 18 and 19, which may be partially flexible for discharging oil, water and gas therefrom, respectively. The inlet line 14, by which production fluid is flowed into the tank, and the oil, water and gas discharge lines 17, 18 and 19, respectively, are all of substantial length so that they extend well above the water level 21 and preferably above a wellhead or other location as may be desired. The extent to which the discharge pipelines 17, 18 and 19 extend into the tank 11 is determined by the conditions under which the tank is to be used. However, in general, the suitably-controlled (i. e., by a back pressure, float, remote-controlled or other valve) outlet end of the gas discharge line 19 inside the tank is near the top thereof to release the gas that rises to the top of the tank, and the intake end of the water discharge line 18 is located close to the bottom of the tank and suitably controlled. Since the oil layer in the tank 11 will be between the gas and water layers located at the top and bottom of the tank respectively, the intake end of the oil discharge line 17 will be preferably located between the liquid interfaces and suitably controlled.

The oil and entrained gas discharge line 17 opens, above the water level, to conduit 25 connected to a suitable receptacle 26, which if desired, may be supported on or under the platform 22 by means such as straps 27 and 28. The discharge water line 18 is preferably suitably controlled at all times, the effluent water being discharged into a receiver. The upper end of the gas discharge line 19 is normally closed by a pressure regulating valve 29 which is selectively set to maintain a gas pressure in the tank 11 sufficient to drive the other fluids in the tank, up their respective discharge lines 17 and 18.

As a safety measure, to prevent contamination of the oil in the storage tank 26, the oil discharge line 17 is preferably provided with a power-actuated valve 30. The power actuated valve 30 may be of any suitable type well known to the art, and may be operated electrically, pneumatically, hydraulically or mechanically. A diaphragm operated valve 30 is illustrated as being maintained in a normally opened position by gas pressure supplied through conduits 31, 32 and 33 which are connected to the gas discharge line 19 on the high pressure side of the pressure regulating valve 29. Liquid level indicating devices 37 and 38, such for example, as those of the float-operated type, are mounted in the tank 11 at the maximum levels to which the oil is to be allowed to drop and rise, respectively. Thus, the liquid level indicating device 37, between the gas and oil layers is connected to control valve 30 by conduits 33 and 34 and is positioned in the tank so as to be tripped before the gas level drops below the intake of oil discharge line 17, thus causing valve 30 to close and preventing gas from being discharged into the storage tank 26. The float level indicating device 38 is positioned in the tank 11 at a level just below the intake end of the oil discharge line 17 and is connected to a water control valve 39 through conduits 35 and 36.

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Thus, when the water level rises above the float switch 38, the float switch 38 will actuate valve 39 to maintain the water level below the oil discharge line 17 and the flow of water to the storage tank 26 is prevented. In the event that sufficient gas pressure is not present in the tank 11 to operate the liquid level controllers 37 and 38, the control valves 30 and 39 may be connected through conduits 40 and 41 and through valve 42 to a suitable source of a pressure fluid, for example, a gas cylinder 44. In practice, the pressure conduits 34 and 35 are preferably mounted alongside the discharge lines 17 and 18.

The tank 11 is provided with at least one vertical baffle plate 45 which extends downwardly into the tank from the top thereof to a point well below the discharge end of the inlet flow line 14 and the inlet end of the oil discharge line 17 and also preferably below the center of the tank. The baffle plate 45 is provided with one or more openings 46 near the top of the tank to permit accumulated gas at the top of the tank to move through the baffle plate. The baffle plate 45 must be located in the tank so that it is between the inlet line 14 and the discharge lines 17, 18 and 19. If desired, further baffles, not shown, may be installed in the tank 11 in a manner similar to that of plate 45.

The size of the tank 11 is determined by the capacity needed to handle the production from the well or wells adjacent which the present oil precipitator is sunk. It is extremely important, when constructing the tank, to adjust the buoyancy of the tank so that it will float in the water when it is filled with air and will sink and remain on the ocean floor when it is partially filled with oil.

In operation, the present oil precipitator is filled with air and towed by barge to the proposed offshore well location, or it may be transported by other means. At the well location the tank 11 is filled with water causing it to sink and rest firmly on the ocean floor. The inlet line 14 is then connected to the production line 15 from the well while the oil discharge line 17 is connected to suitable storage. Valve 16 in the production line 15 is then opened allowing production fluid to be pumped or flowed into the tank 11. This causes water to be forced out of the tank 11 until the water level therein drops below the level indicator 38. The pressure regulating valve 29 in the gas discharge line 19 is set at a value such that the pressure maintained in the tank by the production fluid is sufficient to raise the oil and water out of their respective discharge pipes. At the same time, the pressure regulating valve 29 must be set so that a sufficient amount of gas does not collect in the tank to cause it to float.

As the production fluid or emulsion is discharged through inlet pipe 14 into the tank 11, the water therein drops out to the bottom of the tank while the oil and gas rise above it. After sufficient oil has accumulated around the inlet pipe 14 within the tank, a layer of oil will escape under the baffle 45 and accumulate near the top of the tank below the gas layer on the other side of baffle 45. When sufficient oil has accumulated around the lower end of oil discharge line 17 and when the gas pressure in the tank 11 has built up sufficiently, the oil will be forced out through line 17 while the water is forced out through conduit 18.

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In the event that it becomes necessary to move the tank, or to raise it for cleaning or maintenance purposes, the inlet line 14 is disconnected from the production line 15 and the oil discharge line 17 is disconnected from conduit 25. All other lines and connections which may interfere with the flotation of tank 11 are likewise removed. The liquid in the tank is then displaced by introducing gas or compressed air from any suitable source down the gas vent line 19, which is preferably flexible, until all of the fluid has been forced out of the water discharge line 18.

I claim as my invention:

1. Apparatus adapted to be submerged on the ocean floor at an offshore well or production platform location for separating an oil-gas-water well production fluid into its components, said apparatus comprising a submersible tank having a buoyancy adjusted so that the tank floats when it is substantially empty and sinks when it is partially filled with liquid, a transverse vertical baffle plate extending partially across the tank from the top thereof, said baffle plate having openings therethrough near the top thereof for venting gases therethrough, production fluid conduit means in communication with said tank on one side of said baffle, separate oil, gas and water discharge conduits extending from said tank on the other side of said baffle plate, said inlet and discharge conduits extending substantially vertically from said tank when it is submerged on the ocean floor to a point above the water level, and pressure regulating means in said gas discharge line for maintaining a pressure in said tank sufficient to force the oil and gas out through said oil and gas discharge conduits.

2. Apparatus adapted to be submerged on the ocean floor at an offshore well or production platform location for separating an oil-gas-water well production fluid into its components, said apparatus comprising a submersible tank having a buoyancy adjusted so that the tank floats when it is substantially empty and sinks when it is partially filled with liquid, a transverse vertical baffle plate extending partially across the tank from the top thereof, said baffle plate having openings therethrough near the top thereof for venting gases therethrough, production fluid conduit means in communication with said tank on one side of said baffle, separate oil, gas and water discharge conduits extending from said tank on the other side of said baffle plate, the intake end of said oil discharge conduit extending into the tank at least one-quarter the distance from the top thereof, the intake end of the gas discharge conduit being positioned near the top of the tank, the intake end of said water discharge conduit being positioned near the bottom of said tank, said inlet and discharge conduits extending substantially vertically from said tank when it is submerged on the ocean floor to a point above the water level, and pressure regulating means in said gas discharge line for maintaining a pressure in said tank sufficient to force the oil and gas out through said oil and gas discharge conduits.

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