

[54] **DRILLING ON WATER AND ICE WITH  
A MOVABLE VESSEL**  
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[51] **Int. Cl.**.....**E21b 7/12**  
[58] **Field of Search** .....**175/5-10, 18, 17;**  
**114/0.5 D; 180/116; 166/0.5, 0.6**

[56] **References Cited**  
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3,222,634 12/1965 Foster .....166/0.5 X  
3,547,189 12/1970 Bielstein .....166/0.5

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[57] **ABSTRACT**

Drilling operations are conducted on water and ice with a movable vessel which moves on shore as water freeze-up approaches and then moves back onto the ice after freeze-up to resume drilling operations, the well location being located by a signal and connection being established between the vessel and the well through the ice.

**22 Claims, 3 Drawing Figures**

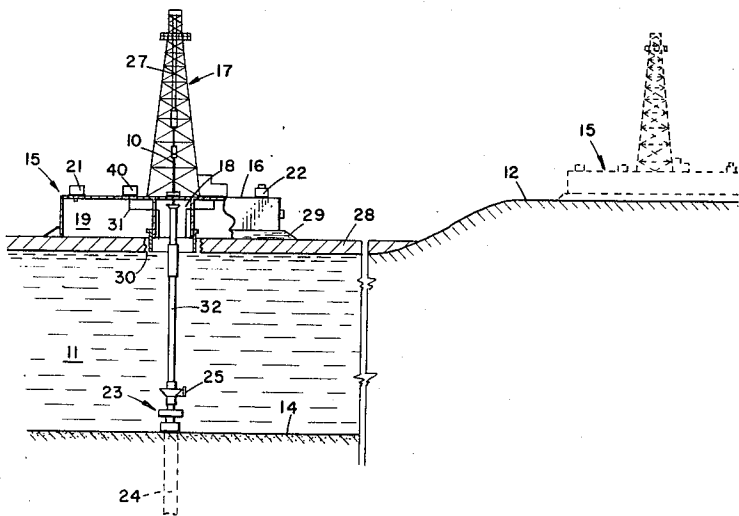


FIG. 1.

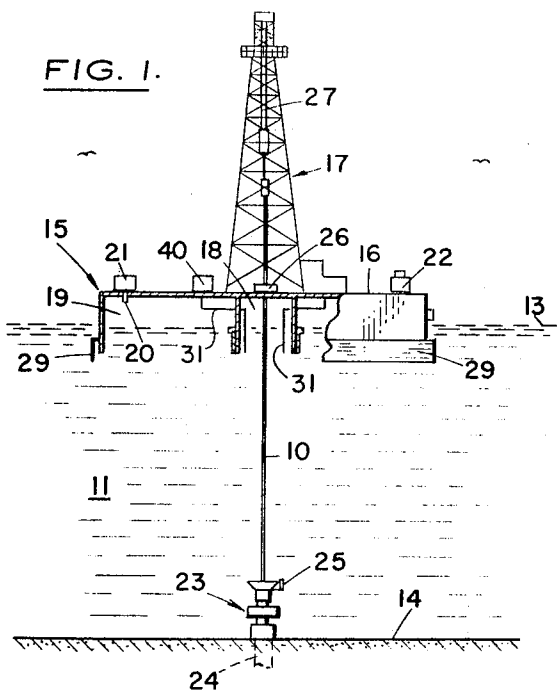
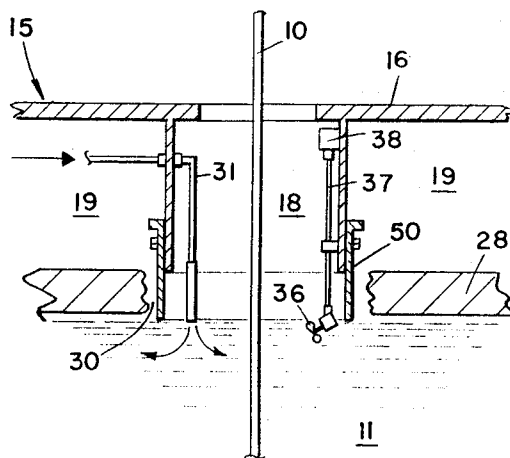


FIG. 3.

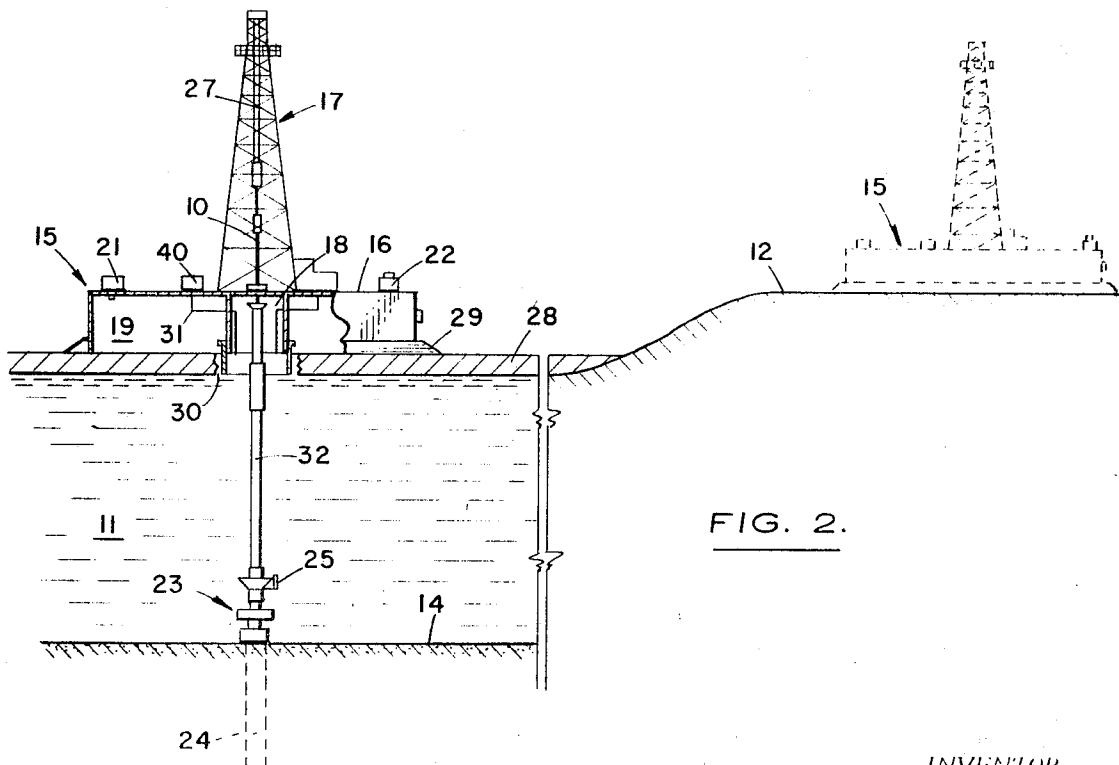


FIG. 2.

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## DRILLING ON WATER AND ICE WITH A MOVABLE VESSEL

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

The present invention is directed to drilling wells on water and ice with a movable vessel which may move across the water onto land and from the land onto ice back to a well location. More particularly, the invention is concerned with drilling wells employing a so-called ground effect vehicle wherein the vessel rides over water or land surface on a cushion of air. In its more specific aspects, the invention is concerned with drilling of wells on water and then on ice and again on water if drilling operations have not been completed during one freeze-up of the water.

#### 2. Prior Art

It has been known for sometime to use vehicles or vessels sometimes called ground effect which will move over water or land supported by air cushion under the vessel. It is also known to move such vessels over water above wave action. Such vessels may have flexible skirts which are provided with vertical slits to enhance flexibility. It has also been known to utilize such ground effect vessels in drilling operations wherein the vessels or vehicle may be maintained above wave action and the deck or decks maintained substantially horizontally. It has also been suggested to move such vessels across ice or water.

It has also been known in the prior art to locate under water wells by using seismic and acoustic signals. It has also been known to locate underwater objects by placing on or next to the underground objects radioactive materials. Thus, during the last World War explosive mines were located by radioactivity. It is known in the prior art to locate and re-enter underwater wells by light radiation and also radiation activity by placing a source of radioactive materials on an underwater well and picking up a signal focused upwardly such that a vessel above the radioactive material may pick up the radioactive signal. In the prior art, a signal which may be seismic, acoustic or radioactive may be picked up by a vessel above or adjacent the water surface such that the location may be detected. Underwater wells have also been located from a drill stem depending from a vessel having receivers therein which transmit the signal to the vessel such that the vessel and drill string may be moved horizontally and vertically so that the well may be re-entered.

The following specific references were considered in connection with the invention:

*Oil and Gas Journal*, Nov. 3, 1969, page 36.

*Ocean Industry*, Jan., 1970, page 10.

*Oil and Gas Journal*, Jan. 5, 1970, pages 52 and 53.

U.S. Pat. No. 2,545,179

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U.S. Pat. No. 3,199,613

U.S. Pat. No. 3,222,634

U.S. Pat. No. 3,336,572

U.S. Pat. No. 3,461,828

### SUMMARY OF THE INVENTION

The present invention may be briefly described and summarized as involving a method for drilling in water subjected to freezing where the well is drilled from water surface from a ground effect vehicle with the drilling being continued until water freezing-up approaches, following which the partially drilled well is shut in. The ground effect vehicle is then moved over the water to land and then onto land until water freeze-up occurs to a sufficient extent to provide ice over the well having a strength sufficient to support the ground effect vehicle which is then moved back over ice from the shore to the well location for resumption of drilling operations from the ground effect vehicle through the ice. If the drilling has not been completed when the ice thaws, then the drilling may be con-

tinued again until water freeze-up approaches and the sequence of steps repeated.

The invention may also be described and summarized as apparatus for drilling wells in water and on ice which comprises a ground effect vehicle; a drill rig arranged on the ground effect vehicle for drilling a well with means being provided on the ground effect vehicle for maintaining open water under the drilling rig when the drilling is conducted from ice surface and means carried by the ground effect vehicle for maintaining a connection between the vehicle and the well.

### BRIEF DESCRIPTION OF THE DRAWING

The present invention will be further described and illustrated by reference to the drawing in which:

FIG. 1 is a view showing a drilling operation being conducted from a ground effect vehicle in water;

FIG. 2 shows the ground effect vehicle moved onto shore during water freeze-up and back over the ice to the well location as water freezes up; and

FIG. 3 illustrates another means besides that shown in FIG. 2 for maintaining open water below the drill rig while drilling from ice surfaces.

### DESCRIPTION OF THE PREFERRED MODES AND EMBODIMENTS WITH REFERENCE TO THE DRAWING

Referring now to the drawing and particularly to FIG. 1, numeral 11 designates a body of water having a water surface 13 and a water bottom 14. The body of water 11 may be of any depth, but suitably may be in the range from 50 to 2,000 or 3,000 feet or more. In the embodiment of FIG. 1 which is in a geographic area where the body of water 11 freezes during the winter season there is a ground effect vehicle 15, sometimes called a Hovercraft, having a deck 16 supporting a drilling rig generally indicated by the numeral 17, which is intended to include all auxiliary equipment, which is arranged over well 18 in the vessel or vehicle 15 or may be arranged over the side of vessel 15.

The vessel 15 is provided with open bottom chambers 19 into which air pressure is introduced by means 20 supplied by compressors or fans 21 and the like. The vessel or vehicle 15 is provided with a signal receiving means 22 which may be a plurality of receiving means for picking up a signal received from an underwater well.

Arranged on water bottom 14 is a wellhead 23 of an underwater well 24 which is provided with a signal transmitting means 25 which may be an acoustic signal means, a seismic signaling means, a light radiation means or radioactive radiation means, and the like. The well 24 and wellhead 23, although shown schematically, are intended to include all auxiliary equipment usually associated with wells and particularly underwater wells and will include means for shutting in such wells such as blowout preventer means, Christmas trees, valves, and the like.

In FIG. 1 the drill string 10 is shown extending through a rotary table 26 of the drill rig 17 with the drill string 10 suitably suspended in the drilling rig 17 by flexible means 27 which may include a wire line, crown blocks, and the like. The rotary table 26 is suitably driven by power means not shown but which are conventional in the art.

Referring now to FIG. 2, it will be noted in the right-hand of FIG. 2 that the vessel 15 in dotted lines has been moved out of water 11 onto the shore 12 because of approaching ice freeze-up, whereas in the center portion of FIG. 2 the vessel 15 has been moved from shore 12 back out on ice 28 after water freeze-up to have a sufficient strength to support the ground effect vehicle 15. After it has moved back from shore 12 over ice 28 to a location above the well 24 which has been suitably located by use of signal receiving means 22 and signal transmitting means 25, the ice is of sufficient strength to support the ground effect vehicle after it is no longer supported by a cushion of air. The ground effect vehicle is provided with a flexible skirt 29 which serves to confine the air in the cham-

bers 19 when the ground effect vehicle or vessel is supported by air cushion supplied to chambers 19.

It is to be noted that the ice 28 has a portion 30 which is free of ice which might impede or interfere with drilling operations. This area 30 immediately under the drilling rig 17 is maintained free of ice by supplying heated air or gas from a source 40 on deck 16 such as from gas combustion which may be a gas combustion engine which supplies power to the drilling rig or drives compressors or fans 21 through conduits 31 which discharge in the bottom of well 18 in the vehicle 15. This heated gas or air is confined in the well 18 above the water surface 13 which serves to maintain this area substantially free of any ice by melting it as it might form or if any ice forms it is of insufficient thickness to impede or interfere with drilling operations which are resumed after the well has been re-entered by drill string 25 and the well opened.

In any event, a retractable conductor pipe 32 is extended from rotary table 26 to the wellhead 23 and may sealingly engage with wellhead 23 to protect the drill string 10. Although not shown, the conductor pipe or riser 32 is supported by the usual tensioning cables and lines connected to the vessel 15. In case the ice 28 should shift or flow, the conductor pipe 32 will protect the drill string 25 and the vehicle 15 may move by riding on a cushion of air to compensate for any ice movement while the heated gas or air will keep the portion 30 free of any ice such that drilling operations may continue. In other words, the ground effect vehicle may move to compensate for any ice movement, and the injection of heated gas or air into the well 18 under the drilling rig 17 will maintain open water for drilling operations to proceed. Of course, other means may be provided for maintaining open water beneath the drilling rig 17 alone or in combination with heated gas. Such means is shown in FIG. 3 to which reference is now made.

In FIG. 3 like in FIGS. 1 and 2 identical numerals designate identical parts and here an agitating means is shown comprised of an impeller 36 arranged on a shaft 37 and powered by a prime mover means 38. The agitating means keeps water 13 below the well 18 in an agitated condition and in combination with heated gas transmitted by conduits 31 maintains the portion 30 free of ice which might impede or interfere with drilling operations.

As shown more clearly in FIG. 3, the well 18 is extendable by means of a skirt or sleeve 50 which is vertically adjustable on the wall forming well 18 so as to extend through the opening 30 of ice 28.

Thus, the present invention allows the obtaining of unobvious and useful results in that a vessel may be used to drill alternately on water and ice such that drilling operations need not be conducted from a fixed platform and the drilling operations are only interrupted during the period when water freeze-up occurs.

Drilling from a ground effect vehicle in accordance with the present invention is advantageous and useful because not only may it be used to move from one water location to another after the well has been drilled but it may be used to move over ice in a body of water to another location and drilling operations initiated from the ice surface and then continued from the same vessel after the ice has thawed.

Thus, the present invention is quite advantageous in that the same vessel may be used for drilling water in geographic locations where climatic conditions are such that the water is periodically subjected to freezing and thawing.

The nature and objects of the present invention having been completely described and illustrated and the best modes and embodiments contemplated set forth what I wish to claim as new and useful and secure by Letters Patent is:

I claim:

1. A method for drilling in water subjected to freezing conditions which comprises:
  - partially drilling a well from the surface of said water from a ground effect vehicle;
  - continuing said drilling until freeze-up of the water approaches;

moving the ground effect vehicle over water to land until water freeze-up occurs to a sufficient extent to provide ice subject to movement having a strength sufficient to support the ground effect vehicle;

then moving the ground effect vehicle over the ice to the location of the well;

resuming drilling operations from the ground effect vehicle; and

moving said ground effect vehicle on the ice over the well to compensate for ice movement.

2. A method in accordance with claim 1 in which the well is located by acoustic signals.

3. A method in accordance with claim 1 in which the well is located by radioactive signals.

4. A method in accordance with claim 1 in which the well is shut in when freeze-up approaches.

5. A method in accordance with claim 1 in which

a. the well is located by a signal transmitted to the vessel; and

b. drilling operations are conducted after ice freeze-up through an opening in the ice maintained substantially free of ice which would impede drilling operations.

6. A method in accordance with claim 1 wherein, before well drilling is completed, when thawing occurs, the ground effect vehicle remains on well location and drilling is continued from water surface and when freeze-up of the water again approaches said sequence of operations beginning with moving the ground effect vehicle over water to land is repeated.

7. A method in accordance with claim 1 in which the drilling operations are conducted through an opening in the ice maintained substantially free of ice which would impede drilling operations.

8. A method in accordance with claim 7 in which the drilling operations are conducted through a tubular connection extending from said ground effect vehicle through said opening to said well.

9. A method for drilling in water subjected to freezing which comprises:

partially drilling a well from the surface of said water from a ground effect vehicle;

continuing said drilling until freeze-up of the water approaches;

moving the ground effect vehicle over water to land until freeze-up occurs to a sufficient extent to provide ice subject to movement having a strength sufficient to support the ground effect vehicle;

then moving the ground effect vehicle over the ice to the approximate location of the well;

locating the well;

connecting the vehicle to the well through an opening in the ice;

resuming drilling operations through said connection and opening from the ground effect vehicle; and

moving said ground effect vehicle on the ice over the well to compensate for ice movement.

10. A method in accordance with claim 9 in which the vehicle is connected to the well by lowering from the vehicle to the well a retractable tubular member.

11. A method for drilling in water subjected to freezing and thawing conditions which comprises:

drilling a well from ice surface in which the ice is subject to movement in a frozen body of water from a ground effect vehicle;

continuing said drilling when said ice thaws by maintaining said ground effect vehicle on location substantially over said well;

continuing said drilling from the surface of said water until freeze-up of the water approaches;

moving the ground effect vehicle over water to land until water freeze-up occurs to a sufficient extent to provide ice subject to movement having a strength sufficient to support the ground effect vehicle;

