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METHOD OF DRILLING WELLS WITH AIR

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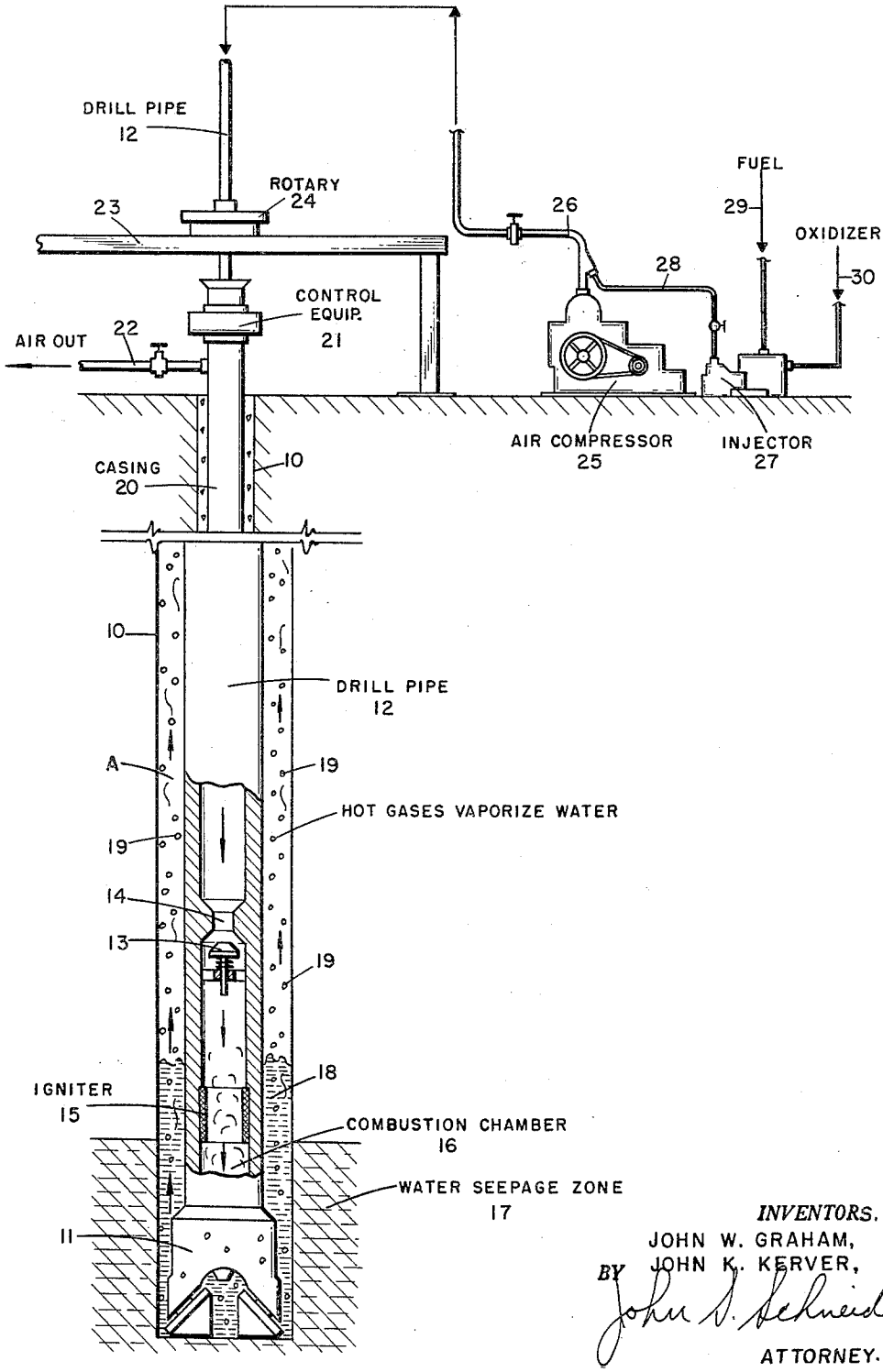

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METHOD OF DRILLING WELLS WITH AIR

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This invention concerns a technique for drilling wells with air and more specifically it concerns injecting slugs of combustible gases into the drilling air stream and burning them in order to vaporize and remove influx water.

Air, although best well drilling fluid, cannot be used in many borehole drilling operations where hydrostatic control of subsurface pressures is required, and in these instances, water or drilling mud must be used as the drilling fluid instead of air. When water influx occurs during air drilling, the water source must be plugged off by chemical or mechanical means or the influx water must be foam-lifted from the borehole in some manner or else air drilling must be discontinued.

However, in many borderline type applications as where water flow into the borehole is relatively small, e.g., 1–30 barrels per hour, air could be used as the drilling fluid even though there is water influx. A primary object of the present invention is to overcome the problem of water influx in such situations by removing large quantities of influx water while drilling proceeds.

In brief, the method of the invention comprises injecting slugs of a combustible mixture, e.g., natural gas, diesel oil or kerosene and air, into the drilling fluid stream at the earth's surface and igniting the combustible slug at the bottom of the borehole in order to remove influx water from the borehole. Alternatively, the fuel may be continuously sprayed into the circulating air stream instead of being injected periodically in slugs.

The above object and other objects of the invention will be apparent from a more detailed description thereof when taken with the drawing wherein:

The sole FIGURE is a schematic view illustrating a well being drilled according to the method of the invention.

The lower portion of the figure shows a borehole 10 in which is arranged a drill bit 11 which is attached to a drill pipe 12. A check valve 13 is mounted within drill pipe 12 and operates to open and close a restricted opening 14 formed in drill pipe 12. A platinum catalyst igniter 15 is affixed to the interior wall of drill string 12 and functions to ignite the combustible gaseous mixture flowing down drill string 12 in a combustion zone designated 16 located below check valve 13. As illustrated, drill bit 11 has penetrated a water seepage zone 17, and influx water 18 from this zone stands in the bottom of borehole 10. Globules 19 represent water vapor being carried upwardly through annulus A between drill pipe 12 and the wall of borehole 10 by hot combustion gases.

The upper part of the drawing shows the surface equipment and the upper portion of the borehole. A conductor casing pipe 20 through which drill pipe 12 extends is shown cemented in borehole 10. Surface control equipment is designated 21, and the drilling fluid return conduit 22 is attached to conductor casing 20 below control equipment 21. The derrick floor 23 and rotary 24 through which drill pipe 12 extends also are shown. An air compressor 25 for supplying drilling fluid to drill pipe 12 has connected to it an outlet conduit 26, which carries air used for drilling to the interior of drill pipe 12. A combustible mixture of a fuel and an oxidizer feeds into conduit 26 through an injector or pump 27 and conduit 28 from a fuel source 29 and air or oxygen source 30.

The operation is as follows. Compressed air from compressor 25 is injected through conduit 26 into the interior of drill pipe 12 and downwardly through check valve 13 and through bit 11 and upwardly through annulus A and out return line 22 according to conventional air drilling techniques. Once water seepage zone 17 is penetrated and influx water is encountered in the vicinity of the bottom of the borehole, then slugs of fuel and air from sources 29 and 30, respectively, are injected into compressed air conduit 26 through the fuel and air injector pump 27 and conduit 28. The combustible slug travels downwardly through the drill pipe and through check valve 13 and is ignited spontaneously by the platinum catalyst igniter in the combustion zone 16. The heat liberated by the combustion reaches influx water 18 in annulus A by conduction through drill pipe 12 (and drill collars) and by intimate mixing of water 18 with the circulating hot combustion gaseous products. The influx water in annulus A may convert to steam, which is easily removed from the annulus by the circulating air drilling fluid, or if sufficient heat to vaporize the water is not available, then the high velocity of the combustion gases through and by the influx water will entrain the water as small droplets in the circulating, drilling air stream and remove the water in this manner.

Check valve 13 functions to prevent pressure pulses from traveling up the interior of drill pipe 12.

The burning rate within the combustible slug, and therefore the resulting pressure level, may be regulated by adjusting the air-fuel ratio.

As an example of the operation, assume that a well being drilled with air begins to make water at a rate of 20 barrels per hour and that the air circulating rate is 1500 s.c.f.m. and the surface pressure is 300 p.s.i. To convert the 20 barrels of water to superheated steam at 300 p.s.i. and 420° F., approximately 1200 B.t.u. per pound are needed. The enthalpy of superheated steam at 300 p.s.i. and 420° F. is 1204.8 B.t.u. per pound. Therefore, the heat required per hour is (20 bbls. per hour) (350 pounds per bbl.) (1200 B.t.u. per pound) =8,400,000 B.t.u. per hour. Since there are approximately 1000 B.t.u. generated by the combustion of 1 s.c.f. of natural gas, the amount of gas required is 8.4 M.c.f. per hour.

In this calculation, it was assumed that all the heat generated went into heating the influx water. Even if that did not occur, the high velocity of hot gases through the influx water would aid in entraining the water as small droplets in the circulating air stream.

Having fully described the method, elements, and objects of our invention, we claim:

1. A method for improving air drilling of wells in which circulation of the drilling air stream is down the drill string and up the annulus between the drill string and the borehole wall comprising the steps of: injecting a combustible mixture into the circulating air drilling stream; and igniting the combustion mixture in the drill string in the vicinity of the bottom of the borehole whereby influx water in the bottom of the borehole is heated and removed.

2. A method as recited in claim 1 in which the combustible mixture is natural gas and air.

3. A method for improving air drilling of wells in which circulation of the drilling air stream is down the drill string and up the annulus between the drill string and the borehole wall comprising the steps of: injecting intermittently into the air drilling stream slugs of a combustible mixture; and igniting the combustible mixture in the drill string in the vicinity of the bottom of the borehole whereby influx water in the bottom of the borehole is heated and removed.

4. A method as recited in claim 3 in which the combustible mixture is natural gas and air.

5. A method for improving air drilling of wells in which circulation of the drilling air stream is down the drill string and up the annulus between the drill string and the borehole wall comprising the steps of: injecting fuel into the circulating air stream to form a combustible mixture with said circulating air; and igniting the combustible mixture in the drill string in the vicinity of the bottom of the borehole whereby influx water in the bottom of the borehole is heated and removed.

6. A method for improving air drilling of wells in which circulation of the drilling air stream is down the drill string and up the annulus between the drill string and the borehole wall comprising the steps of: injecting intermittently into the circulating air stream slugs of fuel to form with said circulating air slugs of a combustible mixture; and igniting the combustible mixture slugs in the drill string in the vicinity of the bottom of the borehole whereby influx water in the bottom of the borehole is heated and removed.

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