

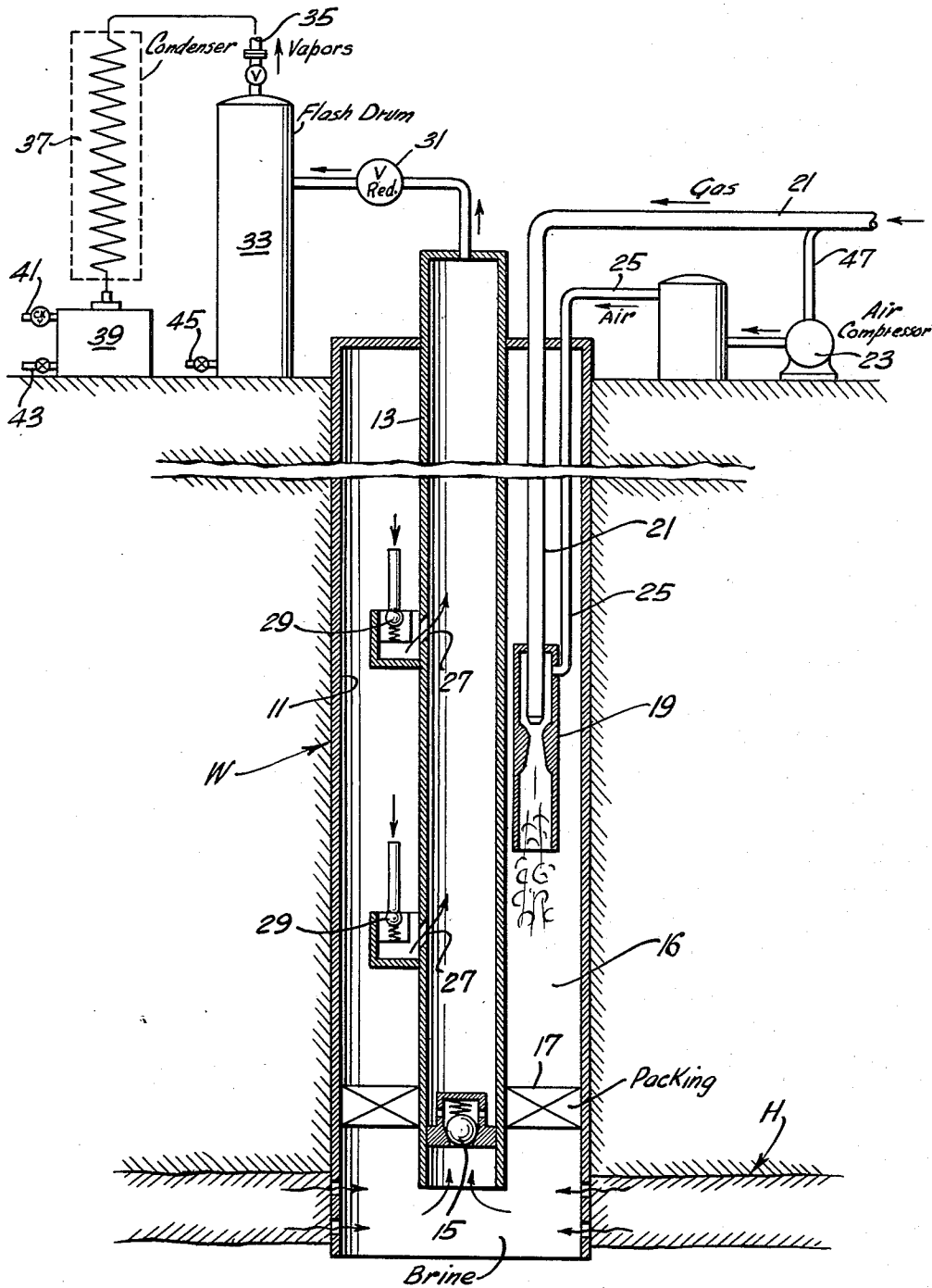
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METHOD FOR OBTAINING FRESH WATER FROM BRINE

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METHOD FOR OBTAINING FRESH WATER FROM BRINE

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The present invention relates to a novel method for obtaining fresh water from the brine that is produced from an underground brine-bearing formation deep below the surface of the earth.

Many oil wells have been drilled in desert areas such as the Sahara and Arabian Deserts. Difficulty often arises because of the lack of fresh water in those desert areas, and such fresh water is needed for operating equipment, for human consumption, and for making up drilling mud. Occasionally, a well is drilled which encounters a formation containing large volumes of brine instead of oil. This brine normally is useless for any of the purposes mentioned above.

Also, oil wells which have been successfully drilled in such desert areas often produce combustible gas which is flared and thus wasted.

In accordance with my invention, I have found that fresh water can be obtained from the brine in a brine well by burning a combustible material in the well and forming hot gases therein while maintaining the well under a first super-atmospheric pressure as the result of the natural underground pressure combined with the pressure of the gases of combustion. As a result, the brine is heated by these hot gases and at the same time their energy is employed for lifting the brine to the surface of the earth. After the hot brine reaches the surface its pressure is reduced to a second relatively low pressure, such as atmospheric, at which substantial quantities of water vapor are driven off. This water vapor, along with gases of combustion, is passed through a condenser in which the temperature is lowered to a point where water vapor condenses to fresh water and is recovered, while the uncondensed combustion gases are discharged.

The principles of the invention will be more specifically described hereinafter with reference to the drawing wherein the single figure is a schematic view, partly in vertical cross section and partly in elevation, of apparatus for performing the method of the invention.

Referring to the drawing, there is shown a brine producing well W lined with a casing 11 and having a central string of production tubing 13 extending from near the bottom of the well up to the surface of the earth. Both the tubing 13 and the casing 11 are sealed at the top so as to preserve a high pressure therein.

The lower end of tubing 13 is open to form a first entrance for brine, and is provided with a check valve 15 for admitting brine from a producing formation H when the pressure exceeds that exerted by the spring of the check valve. In order to assure that the brine enters the bottom of tubing 13 rather than annulus 16, there is provided a packer 17 which fills the annulus 16 between the tubing and casing 11 a short distance above the bottom of tubing 13.

A burner 19 is located within annulus 16 and is supplied with combustible fluid, such as waste oil well hydrocarbon gas, through a conduit 21, and with oxygen as in the air passing from an air compressor 23 through a conduit 25. However, substantially pure oxygen can be used also as the combustion supporting fluid. The combustible fluid and the air mix together within burner 19 and burn therein with a hot flame while producing large volumes of hot gaseous combustion products. These combustion products fill the annulus 16 and build up a high pressure therein, while at the same time heating the outside of

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tubing string 13 so as to raise the temperature of brine therein by indirect heat transfer.

For lifting the brine through tubing 13 there are several second entrances or inlets 27 through the tubing string spaced lengthwise and located above the point of brine entry. Inlets 27 are controlled by check valves 29 which admit combustion gases to the interior of the tubing string whenever the pressure in annulus 16 exceeds the value at which the springs of the check valves are adjusted. When these hot gases enter the tubing string they lift the brine to the surface while at the same time heating it by direct heat exchange.

After hot brine and accompanying gases reach the surface of the earth they leave tubing string 13 and pass through a pressure reducing valve 31 which acts to maintain a high superatmospheric pressure upstream, and to lower the pressure of the fluid passing therethrough to a value substantially below that existing within the well, such that substantial vaporization of water takes place as the hot brine enters a flash drum 33. The lowered pressure may be atmospheric, or above or below atmospheric.

The water vapor and accompanying gases are separated from residual brine, pass off the top of flash drum 33 through a valve-controlled conduit 35, and enter a condenser 37 wherein the temperature of the vapor is reduced below its boiling point at the existing pressure, and the vapor condenses to water which accumulates in a vessel 39. The gases are vented from vessel 39 through a controlled conduit 41 while the fresh water is removed through a conduit 43 near the bottom of the vessel. Condenser 37 may be cooled by the ambient atmosphere, or by any other cooling medium such as cool brine.

Concentrated brine accumulates in the bottom of flash drum 33 and can be withdrawn continuously or periodically through an outlet 45 near the bottom of the flash drum.

The combustible fluid, such as natural gas, can be supplied to conduit 21 from any suitable source, but it is contemplated that for greatest efficiency and economy it will be supplied from nearby oil wells from which under ordinary circumstances it would be wasted to the atmosphere.

The air compressor 23 can be operated with any suitable source of energy, but it is contemplated that greatest efficiency and economy will be obtained when combustible gas from conduit 21 is supplied through a conduit 47 to an internal combustion engine which drives the air compressor.

Example

A well is drilled to a depth of 3,000 feet in a desert area and is found to produce brine. The natural earth temperature near the bottom of the well is 150° F. and the natural pressure at that point is 1200 p.s.i.

Gas from a nearby oil well, and compressed air, are supplied to the burner 19 in an annulus between a 4-inch tubing string and a 7-inch casing. The resulting hot gases of combustion raise the temperature of the brine to 300° F. by direct and indirect heat exchange as it rises through a 4-inch tubing string 13.

As the hot brine liquid and accompanying gases pass through the pressure reducer 31 the pressure is reduced to atmospheric which causes a substantial quantity of water vapor to boil off as the hot brine enters flash drum 33. This vapor is condensed in condenser 37 and recovered as fresh water in the receiver 39.

It is to be understood that this invention also is operative without check valve 15 and packer 17.

Obviously, many modifications and variations of the invention as hereinbefore set forth may be made without departing from the spirit and scope thereof and, therefore, only such limitations should be imposed as are indicated in the appended claims.

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I claim:

1. A method for obtaining fresh water from a brine well which taps an underground brine producing formation, comprising

- (a) burning combustible material in said well and forming hot gases while maintaining said well under super-atmospheric pressure;
- (b) heating brine produced from said formation in said well with said hot gases while lifting said brine to the surface of the earth with said gases;
- (c) reducing the pressure on said brine at said surface to a second pressure at which water vapor is driven off at the temperature of said brine;
- (d) condensing the water vapor thus driven off to fresh water; and
- (e) recovering said fresh water.

2. A method in accordance with claim 1 wherein step (d) is accomplished by separating said water vapor from residual brine, and then cooling the water vapor so separated in a separate zone.

3. A method for obtaining fresh water from a brine well which taps an underground brine producing formation, comprising

- (a) maintaining in said well a production tube spaced from the wall thereof to provide an annulus;
- (b) admitting brine into said tube from said producing formation,
- (c) burning combustible fluid in said annulus and forming hot high pressure combustion gas in said annulus in heating relationship with said tube to heat brine therein;
- (d) admitting a stream of hot combustion gas from said annulus into said tube and raising said brine

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therewith to the surface of the earth while concurrently heating said brine with said hot combustion gas to a temperature which is above the boiling point of brine at a selected relatively low first pressure;

- (e) maintaining said brine under a relatively high second pressure in said production tube sufficient to prevent substantial vaporization of water therein;
- (f) reducing the pressure on said brine at least to said first pressure and driving off water vapor therefrom;
- (g) condensing said water vapor to fresh water; and
- (h) recovering said fresh water.

4. A method in accordance with claim 3 wherein said combustible fluid is hydrocarbon gas from a nearby well.

5. A method in accordance with claim 3 wherein said hot high pressure combustion gases are formed by injecting both combustible fluid from outside said brine well and combustion supporting fluid into said annulus and burning said combustible fluid therein; and wherein said gases enter said tube at a plurality of points spaced lengthwise and located above the point of brine entry into said tube.

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