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MINING SOLUBLE SALT

Filed Nov. 10, 1931

2 Sheets-Sheet 1

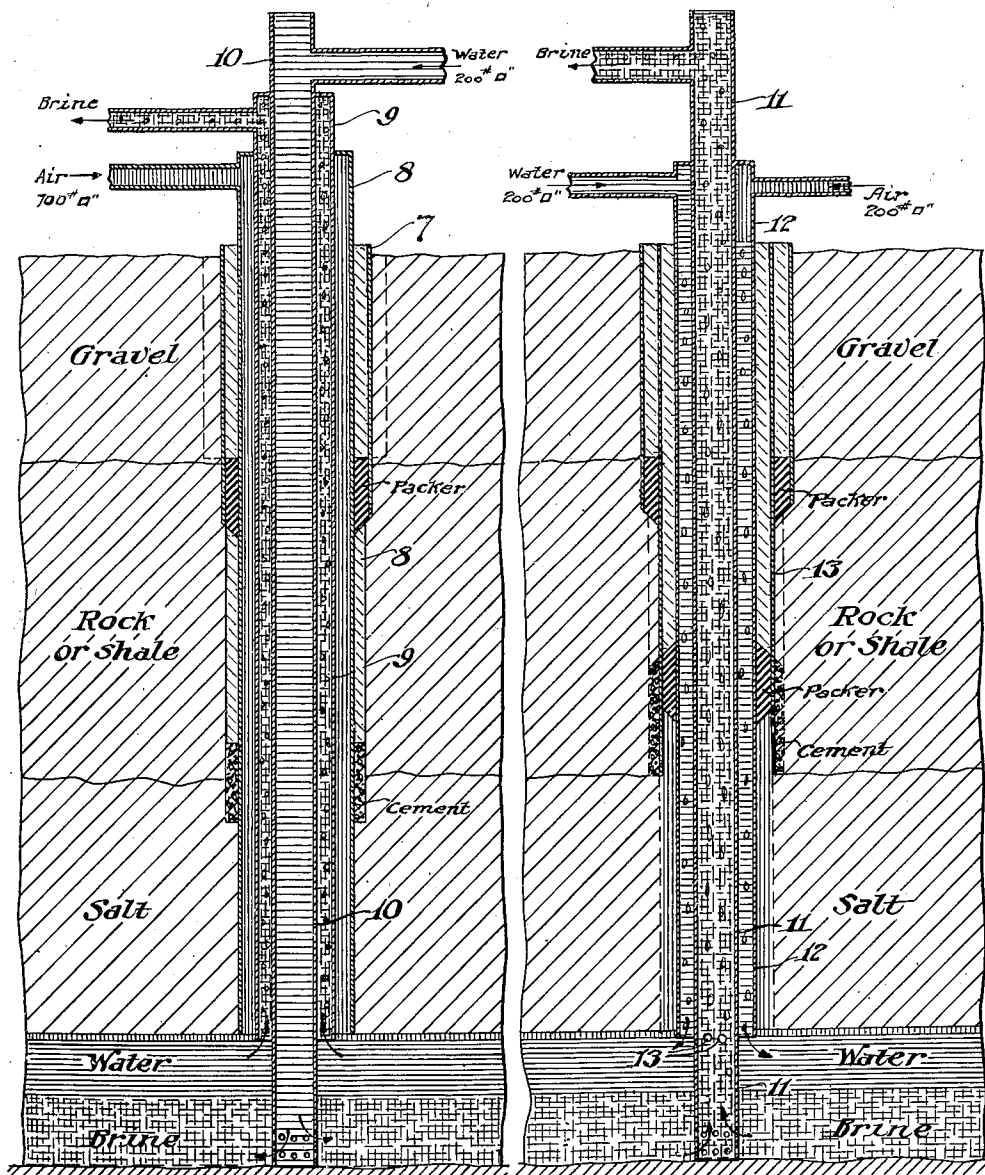


Fig. 1.

Fig. 2.

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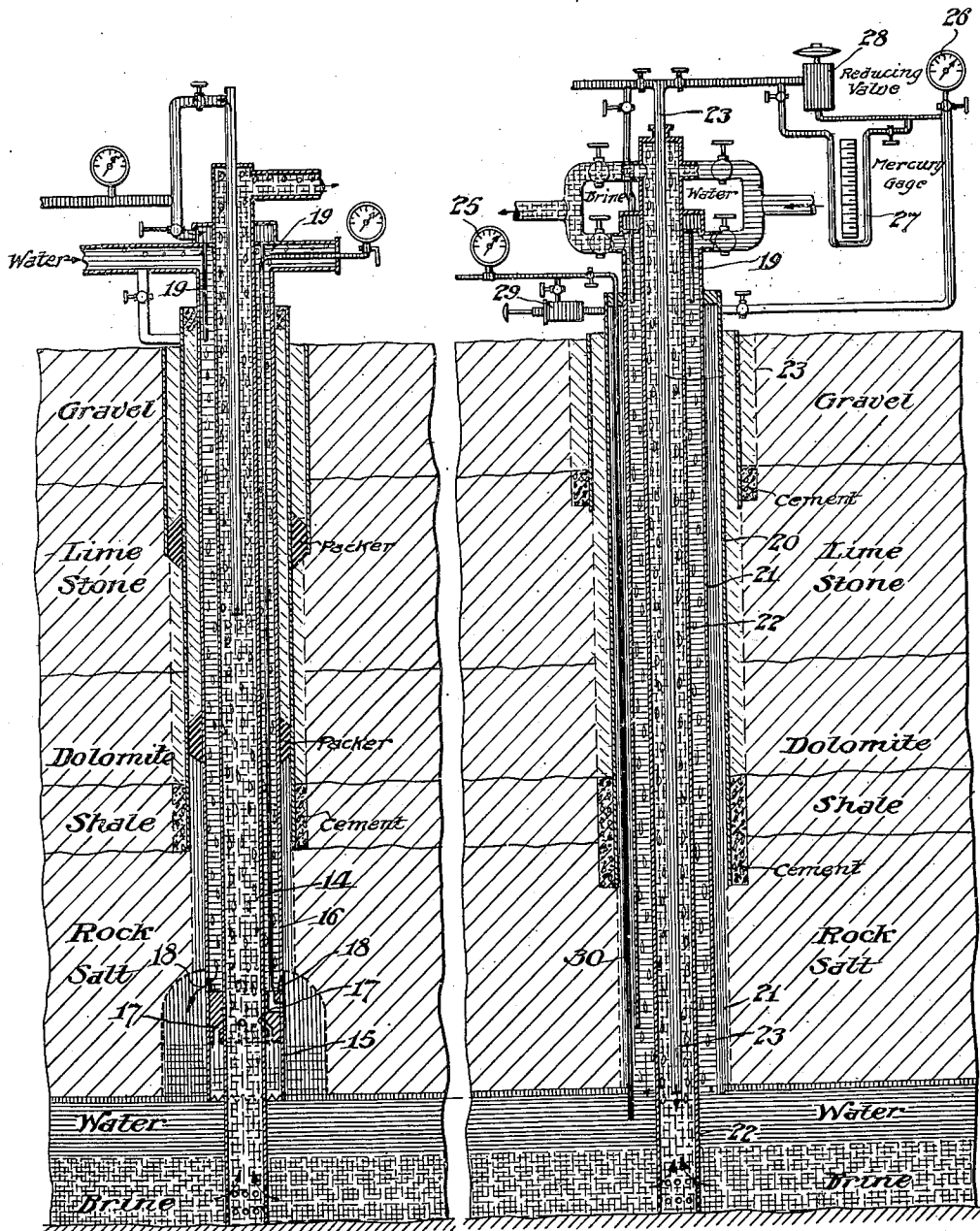
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MINING SOLUBLE SALT

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6 Claims. (Cl. 262—3)

The invention relates to improvements in method and means for mining soluble salts or similar materials.

The object is to provide a new and useful method of operation and arrangement of well casings which will control the level of water or other liquid, while it is dissolving salts or other soluble minerals to produce brine or other solutions.

By means of the control of level, I am enabled to dissolve out a section of the bottom layers of the bed of minerals such as rock salt, sulphur or potash salts and am thus able to afterwards attack succeeding upper layers of the salts from below.

While the following description is given by way of example as applied to operation upon salt beds, it will be understood that it will equally apply to other soluble materials.

The method now in use for dissolving these salts by means of wells drilled through the bed requires the circulation of liquid through casings either to the top or bottom of the bed by superior pressure. If the liquid is introduced at the top of the bed it creeps out under the insoluble roof until it comes in contact with the salt and, becoming heavy with the salt dissolved, falls and is forced back to the center circulating tube and up to the top of the well.

Because the fresh liquid dissolves faster than more saturated brine, the shape of the cavity becomes an inverted cone.

As the top increases in diameter the support of the shale or rock roof is removed and caving takes place which cuts off the tubes and covers the surface of the salt below hindering further dissolving and requiring expensive cleaning and drilling to put back the tubing at the full depth.

With a very thick bed of salt, 200 ft., it is possible to introduce the liquid at the bottom forcing it out the annular space around the center tube, making a ball shaped cavity which will support the roof a longer time.

With a thin bed of salt the liquid rises to the top before it is saturated and the first method must be followed.

If there is considerable insoluble material in the bed, the sides of the cone or ball are covered and protected from the liquid and the well gradually loses capacity and is finally abandoned.

Even if the salt is pure, the saturated brine protects the salt below and it is dissolved very slowly if attacked from above.

If the salt is attacked from below, the saturated brine falls away and fresh liquid reaches the salt so that solution takes place much more rapidly.

The object of my invention is to provide a method of dissolving a section of the lower part of the bed by attacking it radially from the well for a very limited height.

As the fresh liquid dissolves away the wall of the well the radius of the cavity formed increases in all directions, the impurities falling onto the rock below and the liquid which is circulated fast enough to be only about 25% saturated will attack the walls very rapidly.

In rock salt the radius of the cavity will increase about .5 ft. per day, or in one year it will have a diameter of nearly 360 ft. This is about the limit of rock salt roof without caving.

My invention consists of the maintenance of a layer of air, gas or other fluid medium which will float on the liquid protecting the roof of the cavity and preventing the liquid from coming in contact with it. This layer is formed by introducing the medium so as to force the liquid down to the desired level and to provide a surplus over the volume of medium so required which will be absorbed by the liquid so that the escape of the surplus will automatically control the level. The level can also be controlled by the pressure of medium in the cavity.

Referring to the drawings, which illustrate merely by way of example preferred means for effecting the invention:—

Fig. 1 is a diagrammatic vertical section showing one form of embodiment.

Fig. 2 is a similar view of another form.

Fig. 3 is a similar view of another form.

Fig. 4 is a similar view of another form.

Similar numerals refer to similar parts throughout the several views.

Fig. 1. The well is cased with 10" tube 7 through gravel into rock. An 8" casing 8 cemented into lower part of shale roof and upper part of salt bed. A 6" casing 9 to the top of the undercut and a 3" tube 10 to bottom of the salt, to undercut a rock salt bed as an example in a 1500 ft. well with 100 ft. of salt.

With the arrangement shown in Fig. 1, the water, at pressure of about 200 pounds to the square inch, is pumped into the 3" tube or casing 10, passing into the cavity where it circulates and dissolves salt off of the circumference of the cavity and flows upwards through the annular space between the tubes 9 and 10, as partially saturated brine.

To prevent attack of the salt above the end of

the tube 9, air, of about 700 pounds per square inch pressure, is pumped into the annular space between tubes 8 and 9, forcing the water down until the air bubbles under the end of tube 9.

- 5 This will maintain the water level at this level and an air cushion will fill the space between the ripples on top of the brine as long as there is a surplus of air kept moving into the tube 9.

- 10 I have indicated in the drawings the colors red, blue, green and yellow, in accordance with the official chart. The color red indicates air or other fluid medium for separating the solvent from the soluble; blue indicates water or other solvent; green represents sulphur water, and yellow indicates brine or solution.

- 15 In the modification shown in Fig. 2, the well is piped with a 3" tube 11 to bottom of the salt and a 6" tube 12 is packed off in the 8" tube 13 which is cemented in the rock. The 6" tube 12 may be stopped at the top of the salt or extended down into it to top of the undercut. The well is operated by forcing water down annular space between tubes 11 and 12 and brine out of tube 11. Air is forced in with the water and entrained in the form of bubbles which reduce in size by absorption and increase of pressure. The air is therefore compressed to the pressure of the water at the bottom of the well and holds back the liquid to required level.

- 30 Small holes 13 in tube 11 at level of top of undercut allow surplus air to escape into the brine regulating the level of air which fills space around tubes to underside of packer. This arrangement reduces the pressure of air needed to the pressure of the water at top of well instead of the bottom as in Fig. 1.

- 40 In accordance with the modification shown in Fig. 3, the 3" tube 14, reaching to the bottom of the salt, is provided with a bell 15 which is either part of the 6" tube 16 or will slide down through it. This bell receives the surplus air at the level of the top of the undercut and transfers it through small holes or passages 17 to the inside of the 3" tube 14.

- 45 The water is forced down through the annular space between the tubes 14 and 16 and out through holes or space 18 above the bell 15.

- 50 Air is forced through the crown of small tube 19 into the water and is carried down entrained as small bubbles increasing in pressure.

- 55 The amount of air absorbed increases with the depth and pressure of the water. As the salt dissolves it drives out a portion of the air which has been dissolved. If a surplus of air over the amount absorbed, any leakage and the volume required to fill the space around the tube up to the packer is forced in, the surplus escapes under the bell and entering the tube 14, helps elevate the brine passing up this tube.

- 80 In accordance with the modification shown in Fig. 4, the 8" casing 20 is cemented into the rock and the top of the rock salt bed.

- A 6" casing 21 is extended down nearly to the level of the undercut.

- 85 A 3" tube 22 extends to the bottom of the salt. The connections of water and brine and air pipe are arranged so that the well can be operated either way, with brine or water in the 3" tube 22.

- 70 A 1" pipe 23 is suspended inside the 3" tube 22, with its bottom end at the top of desired undercut. This 1" tube 23 may be very readily moved up or down or changed in position, to regulate the level of the air cushion and consequently the top level of the solvent outside of the 3" tube 22.

The air which is forced into the water through the crown of small tubes 19 is carried down and the surplus fills the space between the tubes 20 and 21 to the top of the well.

- 80 This space between 20 and 21 is connected to the 1" center pipe 23 and the surplus air passes out of this space, through the 1" center pipe 23, into the 3" pipe 22.

- 85 If this pipe 23 is wide open, the level of the top of the water outside the 3" tube 22 will be enough below the end of the 1" pipe 23 to overcome the friction of the air passing up the annular space, through the piping and valve and down the 1" center pipe 23.

- 90 If a reducing valve 28 shown in the air pipe is set to obstruct the air, the level of the air cushion will be lowered the amount of the differential pressure measured in feet of water.

- 95 With a 1500 ft. well with weak brine, 18 cu. ft. of air per minute will maintain the level with very little surplus. When the brine is saturated only 6 cu. ft. are required.

- 100 With this amount of air the friction in the tubing will be negligible and the level will be very little below the end of the 1" pipe 23 when the reducing valve is wide open.

- The above amounts are when using 20 cu. ft. of water=200 gal. per min.

- 105 In Fig. 4 are shown air gages 25 and 26, the mercury gage 27 and a reducing valve 28, the hand pump 29 and also a number of valves in the air line, the water line and the brine line, whereby the several flows and the direction of flow may be controlled. Also the center air pipe may be arranged for change of vertical position.

- 110 By the proper manipulation of these several instrumentalities, the level of the solvent may be regulated during the several stages as required.

- 115 This arrangement of well eliminates all packers, uses simple tubing without any connection between them at the bottom, and the regulation is all accomplished at the top of the well. The level can be varied at will.

- 120 The air indicator 30, is suspended in the space between pipes 20 and 21. The bottom end being below the top of the undercut. The hand air pump 29 is operated to force air into the tube 30 until it bubbles under the bottom end. The difference in pressure indicated between gage 25 and gage 26, shows the distance between the water level and the bottom of the air indicator-pipe 30.

- 125 By soluble is meant salt or other mineral capable of being dissolved.

- 130 By solvent is meant any fluid medium capable of dissolving the soluble.

- By non-solvent is meant any fluid medium which will not dissolve the soluble.

What I claim is:—

1. In the operation of mining a soluble, wherein a solvent is introduced into the mine, and a non-solvent is introduced into the mine to form a separating layer between the solvent and the soluble above it, and wherein the solution is discharged from the mine, the method which consists in introducing the solvent admixed with the non-solvent and utilizing the said separating layer of non-solvent for controlling the level of the solvent in the mine cavity.

2. In the operation of mining a soluble, wherein a solvent is introduced into the mine, and a non-solvent is introduced into the mine to form a separating layer between the solvent and the soluble above it, and wherein the solution is discharged from the mine, the method which consists in introducing the solvent and non-solvent

continuously and in utilizing the said separating layer of non-solvent for controlling and changing as required the level of the solvent in the mine cavity.

5 3. In the operation of mining a soluble, wherein a continuous supply of a solvent is introduced into the mine and also a continuous supply of non-solvent which will form a protecting layer between the solvent and the soluble above it, and
10 which will also provide a continuously discharging surplus, and wherein the solution is discharged from the mine, the method which consists in utilizing the discharging surplus of non-solvent to cooperate in the discharge of solution,
15 whereby the required pressures of the introduced solvent and non-solvent at the top of the mine are reduced.

4. In the operation of mining a soluble, wherein a continuous supply of a solvent is introduced
20 into the mine and also a continuous supply of gaseous non-solvent admixed therewith which will form a protecting layer between the solvent and the soluble above it, and which will also provide a continuously discharging surplus, and
25 wherein the solution is discharged from the mine, the method which consists in utilizing the continuously discharging surplus of gaseous non-solvent to cooperate in the discharge of solution

to lighten the ascending column of solution, so that the energy derived from the upward movement of said ascending column may be utilized in connection with the introduction of the solvent.

5. In the operation of mining a soluble, wherein an admixture of a solvent and a non-solvent is introduced into the mine, the non-solvent separating from the solvent to form a protecting layer between the soluble and the solvent, the method which consists in controlling the level
85 of the solvent by the difference in pressure of the non-solvent at a point approximate the level of the solvent and at the point of discharge of a surplus of the non-solvent which escapes into
90 the discharging solution.

6. The method of mining a soluble, which consists in introducing into the mine cavity a supply of solvent, and a supply of gaseous medium in excess of the amount that would be taken up
95 by the solvent so that the surplus gaseous medium will be discharged from the cavity, discharging the solution from the cavity together with the surplus gaseous medium, and controlling as required the level of the solvent in the
100 cavity by controlling the point of discharge of the surplus gaseous medium.

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