

Jan. 6, 1942.

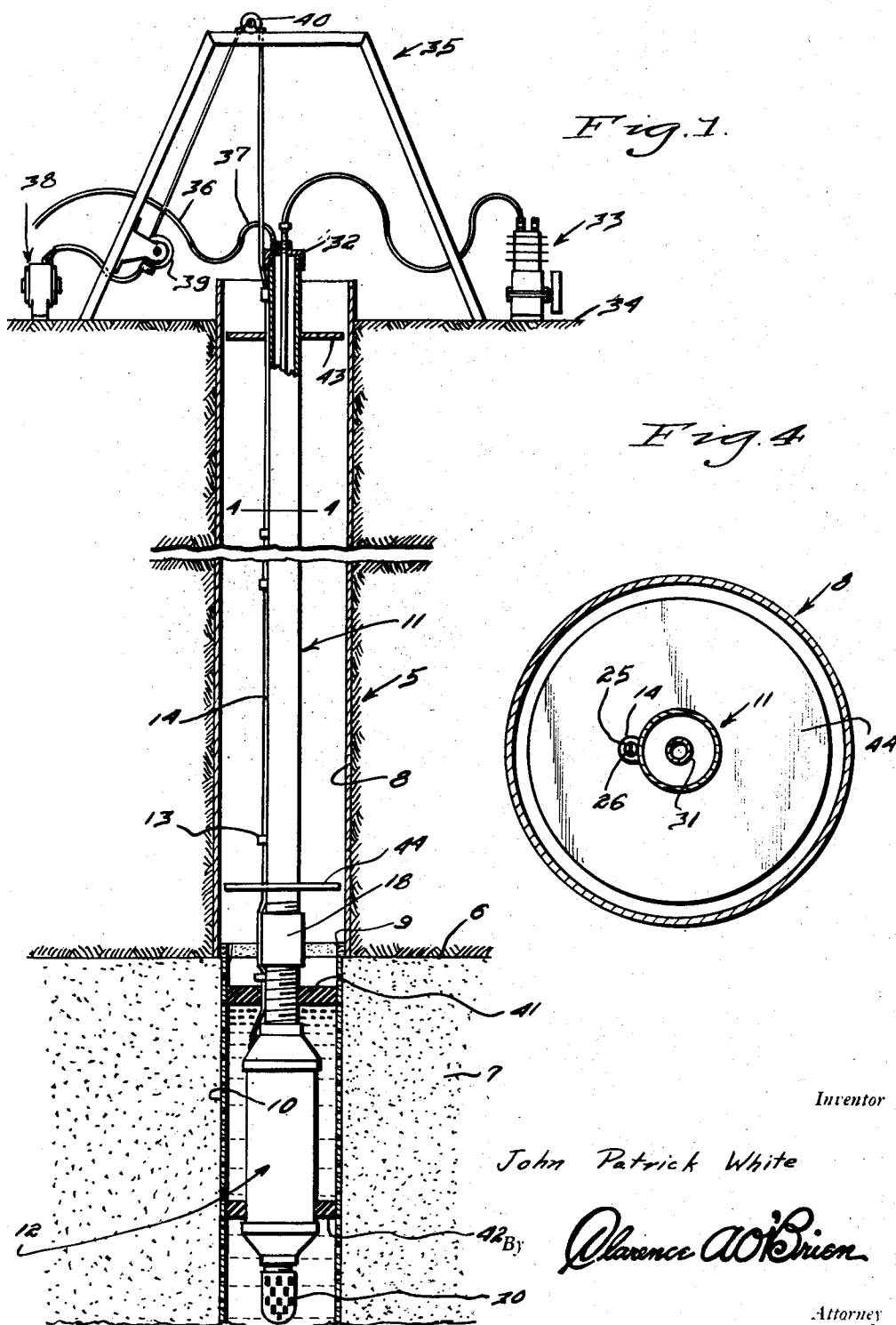
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2,268,978

APPARATUS FOR RECOVERING SULPHUR

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2 Sheets-Sheet 1



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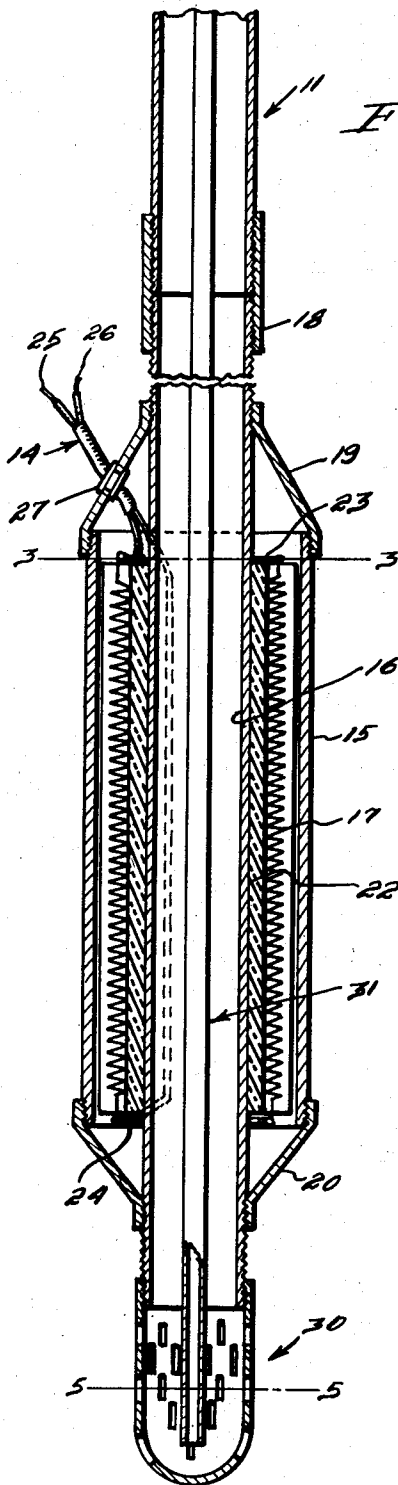


Fig. 2.

Fig. 5.

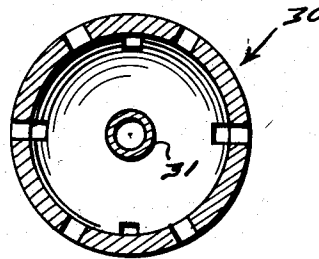
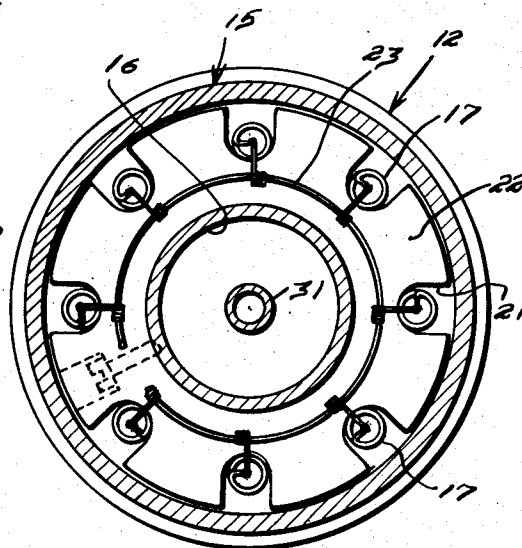


Fig. 3.



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UNITED STATES PATENT OFFICE

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APPARATUS FOR RECOVERING SULPHUR

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2 Claims. (Cl. 262—3)

My invention relates to improvements in apparatus for the recovery of sulphur from wells by combined application of electrically generated heat and fluid pressure to the contents of the well, whereby the sulphur bearing matter is rendered into fluid form and hydraulically lifted to the surface of the earth, and the primary object of my invention is to provide simple and efficient arrangements of this character.

Other important objects and advantages of my invention will be apparent from a reading of the following description taken in connection with the appended drawings, wherein preferred embodiment of the apparatus of the invention is shown.

In the drawings:

Figure 1 is a general fragmentary and vertically contracted sectional elevational view taken through a well and a portion of the casing.

Figure 2 is an enlarged fragmentary longitudinal transverse sectional view taken through the heating means.

Figure 3 is an enlarged horizontal sectional view taken through Figure 2 along the line 3—3.

Figure 4 is an enlarged horizontal sectional view taken through Figure 1 along the line 4—4.

Figure 5 is an enlarged horizontal sectional view taken through Figure 2 along the line 5—5.

Referring in detail to the drawings, and particularly to Figure 1 thereof, the method of the present invention is carried out by drilling a well hole 5 to the top 6 of the sulphur bearing formation 7, the hole 5 being of sufficient diameter to accommodate permanent setting of the steel casing 8 which is preferably 12 inches in diameter. Below and permanently sealed to the lower end of the casing 5 by means of a lead seal 9 is a perforated steel pipe 10, commonly referred to as a liner, which extends into the sulphur bearing formation 7. Within the liner 10 and casing 8 is suspended a pipe 11, preferably about 3 inches in diameter, commonly referred to as tubing, to the lower end of which is attached the heating unit which is generally designated 12. The tubing 11 and the heating unit 12 are arranged to be raised or lowered inside the well casing and liner and suspended at any desired level. Methods in common use for raising and lowering the same, such as used in oil or sulphur well drilling and operating, are satisfactory for the purpose.

Strapped or otherwise attached as indicated by the numeral 13 to the outside of the tubing 11 is a conduit 14 containing two electrical conductor cables for supplying electric current to the

heating unit 12. The conduit protects these cables against fouling or jamming against the sides of the casing or liner, the elements 13 acting as guards and being conveniently spaced along the outside of the tubing.

The heating unit 12 is constructed of two concentrically spaced cylinders 15 and 16 which are hermetically sealed, providing an annular space in which the longitudinally arranged electrical heating coils 17 are supported for generating the heat necessary for the liquefaction of the sulphur in the formation 7. The inner cylinder 16 is similar in form to the tubing 11 and a sleeve 18 threadably connects the upper end of the inner cylinder 16 and the lower end of the tube 11 as shown in Figure 2. The outer cylinder 15 is considerably larger than the inner cylinder, being preferably about 8 5/8 inches inside diameter, being swedged at its top and bottom to the inner cylinder 16, or equivalently is threadably connected by tapering elements 19 and 20, respectively. As indicated in Figure 3 of the drawings the various heating coils 17 are supportably located in flutes or grooves 21 in a suitable cylindrical insulator 22 surrounding the inner cylinder 16, the heating coils being connected in series to upper and lower conductor rings 23 and 24, respectively, to which the conductors 25 and 26 in the cable conduit 14 are respectively connected. The cable 14 passes through a grommet 27 in the upper tapered element 19 shown in Figure 2.

Secured to the lower end of the inner cylinder 16 below the taper 20 is a perforated bull plug 30 to act as a strainer to exclude solids and foreign bodies which might otherwise jam the tubing 11 or the jet line 31 which extends down through the tubing 11 and the inner cylinder 16 to a position within the bull plug shown in Figure 2.

The heating unit attached to the tubing 11 is suspended inside the perforated liner 10 as described above, the perforations in the liner permitting the water in the formation 7 to enter the liner. This sub-surface water being under considerable pressure may consequently be raised to a very much higher temperature than its boiling point at atmospheric pressure, without vaporizing. By contact with the heating unit 12 this sub-surface water is raised to a temperature above the melting point of the sulphur. Therefore, cold water from without will tend to displace the heated water inside the liner, and the circulation thus established will bring the hot water into contact with, and thereby liquefy the

sulphur in place in the sulphur-bearing formation. The molten sulphur, being heavier than the water, will sink to the bottom of the formation, from which point it is raised to the surface of the earth in a manner to be described below.

The jet line 31 extends from the bull plug 30, through the tubing 11 to the top of the well where it traverses the cap 32 closing the upper end of the tubing 11 and is connected to an air compressor 33 supported on the surface 34 of the earth. The compressor 33 is arranged to force hot compressed air, at a temperature above the melting point of the sulphur, down the jet line 31 at a pressure sufficient to raise the molten sulphur in liquid form to the surface of the earth. This molten sulphur is raised through the tubing 11 outside of the jet line. A convenient method of obtaining compressed air at the desired temperature is heating of the air by the same Diesel power unit used for generating electric power for the heating unit. The hot compressed air forced down through the jet line forces the molten sulphur from the bottom of the well upwardly on the same principle that oil or water wells are jetted. As the molten sulphur moves upwardly, a suction is set up which draws more of the molten substance, liquefied by the hot water circulation, to the jet, at the bottom of the heating unit. The numeral 35 generally designates diagrammatically suitable rigging for operating the device described. In addition there is shown a flexible tube 36 connected by a gooseneck 37 to the cap 32 of the tubing whereby the molten sulphur is led off to the flow line, from which the molten sulphur is discharged into pits. The generator of the electric power supply unit is generally designated by the numeral 38, the conduit 14 being shown run over pulleys 39 and 40 on the rig 35.

An upper packer 41 of conventional arrangement is placed around the portion of the inner cylinder of the heating unit extending above the upper taper 19 to seal the unit in the liner 10 and the lower packer or back pressure valve 42 seals the outer cylinder of the heating unit in the perforated liner 10. Vertically spaced spacers

43 and 44 are mounted on the tubing 11 to concentrically space the tubing 11 from the sides of the casing 8 when raising and lowering the heating unit.

Although I have shown and described herein a preferred embodiment of the apparatus and of the method of the present invention, it is to be understood that I do not wish to limit the application of the invention thereto, beyond the scope of the subjoined claims.

Having described the invention, what is claimed as new is:

1. In combination, a drill hole extending to the top of a sub-surface sulphur bearing formation containing water, a casing lining said hole, a perforated liner sunk in said formation and sealed to the lower end of said casing, a heating unit situated within said perforated liner in said formation, said heating unit containing heat generating means for contact heating of the water from said formation entering said perforated liner to a temperature above the melting point of the sulphur, said heating unit comprising an inner cylinder surrounded by said heat generating means and open at its lower end, tubing connected to the upper end of said inner cylinder and extending upwardly in spaced relation to said casing to the surface of the earth, means sealing said unit in said perforated liner, a jetting pipe depending within said tubing and through said inner cylinder, and a source of hot air connected to the upper end of said jetting pipe for applying air to the molten sulphur below said heating unit at a temperature higher than the melting point of the sulphur and at sufficient pressure to force the molten sulphur through said inner cylinder and tubing to the surface of the earth.

2. The combination recited by claim 1 wherein said heat generating means comprises electrical heating coils, a jacket enclosing said heating coils, a protected conduit containing conductors to the coils, said conduit being connected to the outer side of said tubing and extending to the surface of the earth, and current supplying means connected to said conductors.

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