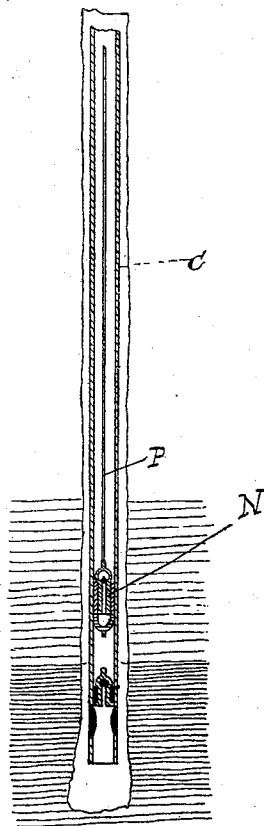
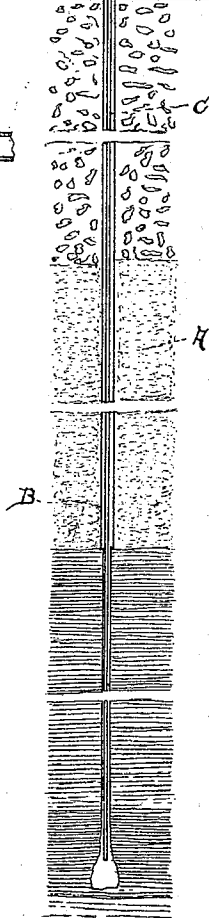
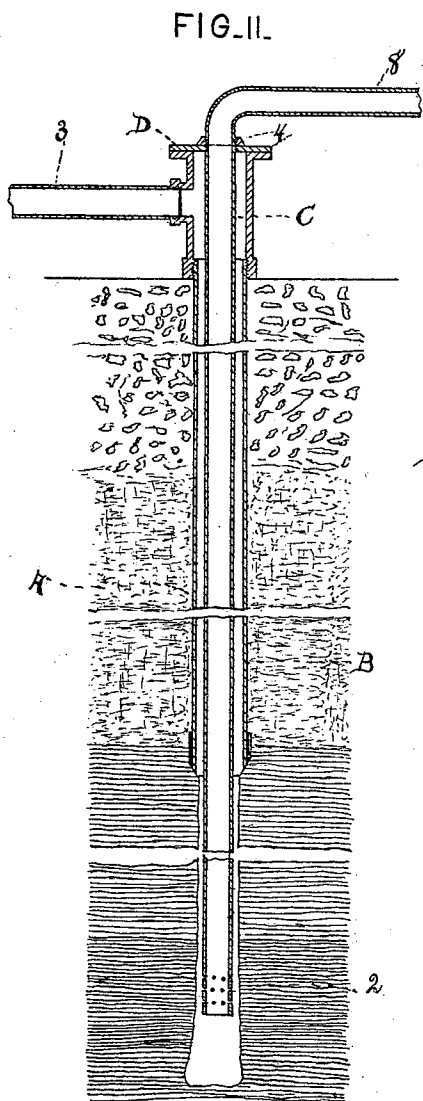
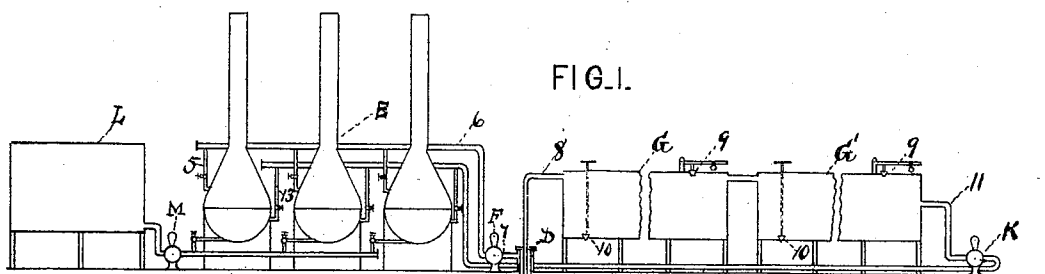


(No Model.)

H. FRASCH. MINING SULPHUR.

No. 461,429.

Patented Oct. 20, 1891.



Inventor

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Witnesses

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UNITED STATES PATENT OFFICE.

HERMAN FRASCH, OF CLEVELAND, OHIO.

MINING SULPHUR.

SPECIFICATION forming part of Letters Patent No. 461,429, dated October 20, 1891.

Application filed October 23, 1890. Serial No. 369,072. (No model.)

To all whom it may concern:

Be it known that I, HERMAN FRASCH, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Mining Sulphur, of which the following specification is a full, clear, and exact description.

This invention relates to the removal of sulphur from deposits in the earth which consist of or contain free sulphur, and is particularly useful in the removal of the sulphur from deposits which are overlaid with beds of quicksand, and which therefore cannot be mined in the usual way by sinking a shaft; but each of the improvements constituting the said invention is included for all the uses to which it may be adapted. By means of the present invention, moreover, a refining of the sulphur is effected in the mining operation.

The invention consists in the fusion or melting of the sulphur in the mine or underground deposit and its removal in a fused or melted condition. To fuse the sulphur, use is or may be made of a heat-conveying fluid or vehicle, preferably a cheap liquid, such as water, although the invention extends to the use of a heat-conveying fluid or vehicle in general.

Further, the invention includes, generally, the fusing of the sulphur in the underground mine or deposit as an aid to its removal from the mine.

The invention also comprises other features, improvements, or combinations, as hereinafter set forth.

What is considered the best mode of carrying out the invention will now be explained, with the aid of the accompanying drawings, which form part of this specification, it being understood that the dimensions and quantities, as also other details, are given by way of example and illustration, and not as restricting the invention precisely thereto.

Figure I is a diagram of a plant for mining sulphur in accordance with the invention. Fig. II is a diagram of the mine or well on an enlarged scale; and Fig. III is a view illustrating a modified arrangement of part of the apparatus.

A well A is drilled, as usual in making salt and oil wells, a casing B (say ten inches in

diameter) being brought to the lime-rock above the sulphur, so as to shut off water and quicksands, and a smaller hole (say eight inches in diameter) being continued to the bottom of the sulphur deposit. Tubing C (say five inches in diameter) is introduced through the sulphur and sulphur-bearing rock nearly to the bottom of the well. The lower part of this tube may be provided with perforations 2 at the side, or may otherwise be provided with a strainer, or it may be left more or less open. There are thus two passages opening at the bottom into the underground deposit. At the surface there is a casing-head D, having a lateral tube 3. The tubing C extends through the casing-head, being, as shown, screwed into the top of said head.

At E are boilers or hot-water heaters, adapted to heat the water under pressure to a suitable temperature, sufficiently above the melting-point of sulphur to remain above that point when forced down the passage outside the tubing C and up the passage in said tubing C. A temperature of from 270° to 280° Fahrenheit, which requires a pressure of about thirty to thirty-five pounds per square inch, will suffice with an appropriate flow. The water-spaces of the heaters are connected by branches 5 and a main 6 with the inlet of a force-pump F, whose outlet is connected by a pipe 7 with the casing-head D. The pump has sufficient capacity to force a stream of hot water through the down-flow passage, consisting of the casing B and the hole in continuation thereof and through the upflow passage in the tubing C with less loss in temperature than will bring the water down to the melting-point of sulphur—say with a loss of about 35° Fahrenheit—supposing the water to enter the casing at a temperature of 280° Fahrenheit. The flow of the water and its temperature should be such that in the sulphur or sulphur-bearing rock and in passing up through the tubing C it remains at a temperature at which the sulphur is liquid.

The pipe 8 forms a continuation of the tubing C to the settlers, of which a series G, G' is shown, each settler or settling-tank being closed and provided with a safety-valve 9, loaded to, say, sixty-five pounds per square inch, and also with a draw-off 10 at the bot-

tom for the sulphur. From the last settler a pipe 11 connects with a boiler-feed pump K, which discharges through the main 12 and branches 13 into the heaters E, or the last settler may be connected directly with the heaters, the duty of feeding the boilers or heaters being thrown upon the force-pump F. It will thus be seen that there is a closed circuit which includes a chamber in the sulphur or sulphur-bearing rock, and through which water at a temperature sufficient to fuse the sulphur is forced. This water imparts heat to the walls of the said chamber, melting the sulphur, which flows to the deepest portion of the well, where it collects and whence it is forced with the water through the tubing C and pipe 8 to the settlers G G'. In these it separates by reason of its greater specific gravity, and when a quantity has settled out it is withdrawn in a liquid state by the draw-offs 10. The water from the settlers G G' is pumped again while still hot into the heaters E, to be therein reheated or raised to its original temperature, and to be thence sent again into the well by the force-pump F. As the chamber in the sulphur-deposit at the bottom of the well enlarges the quantity of water must be increased. The additional supply is drawn from the tank L, wherein it is kept at or near boiling-temperature, (212° Fahrenheit,) and whence it is fed to the heaters by the feed-pump M to maintain the level in the said boilers. The high specific heat of water and the small amount of heat made latent by the melting of sulphur make water specially desirable as a vehicle to carry the heat for fusion of the sulphur, while the pressure of the pump furnishes the cheapest and most ready means of elevating the melted sulphur to the surface of the ground. Saline solutions of such concentration as have a suitable boiling-point above 235° Fahrenheit could be used, also steam superheated or maintained under appropriate pressure, or other fluid (liquid or gaseous) adapted to be circulated at an appropriate temperature. Inasmuch, however, as the sulphur becomes pasty at a temperature not far above its melting-point, a control of the temperature within comparatively narrow limits is necessary, and the conditions of ready and efficient working are most nearly attained with water as the heat-conveying or liquefying vehicle. The liquefied sulphur need not be forced up by the heat-conveying liquid, but may be pumped up in any ordinary or suitable way.

Preferably the working barrel of the pump would be placed at the bottom of the well, as indicated in Fig. 3, where N is the working piston operated by the sucker-rod P in the lower part of the tubing C, which constitutes the working barrel of the pump.

In operating with a current of hot water, as exhibited in Figs. I and II, the circulation may be of, say, three hundred barrels per hour. This amount of water at 280° Fahrenheit should furnish to the settlers G G' about

one hundred barrels of melted sulphur and two hundred barrels of water at 235° Fahrenheit, while one hundred barrels of the water would remain in the well in place of the sulphur removed therefrom in its melted condition. One hundred barrels of water should therefore be supplied to the boilers from the supply-tank L.

In case the temperature should become so low in the well that the sulphur does not melt rapidly enough, water of a higher temperature, say 300° Fahrenheit or over, may be pumped down the tubing C, (instead of down the casing B, as usual,) and this water on its escape at the bottom of the well, and during its ascent to and through the casing, heats the mass and raises the average temperature. When this has reached the desired degree, the hot water, of, say, 280° Fahrenheit, is forced again down the casing B and sulphur is forced up the tubing C. By not allowing the temperature at the outlet of the tubing C to fall below 235° or 240° Fahrenheit, the process may be continued as long as the water is supplied. Instead of the process being continuous, it might be made periodical, hot water or any heat-carrying medium being introduced into the well to melt the sulphur and when enough sulphur has been melted the sulphur may be pumped out.

The apparatus herein described having been adjudged to constitute subject-matter for separate application is not claimed herein, but is reserved to my concurrent application, Serial No. 375,799, filed December 26, 1890. In my said application, Serial No. 375,799, I have included not only the form of apparatus herein described but other forms more or less similar, and in particular have included the apparatus shown and described but not claimed in my other concurrent application, Serial No. 375,800, filed December 26, 1890.

Instead of pumping the vehicle for liquefying the sulphur it may be otherwise made to flow—as, for example, by means of a column of liquid.

The sulphur from the settlers G G' or from other receptacles in which it is recovered will have undergone a refining operation in the mining of the same.

Although, as already stated, it is preferred to work in a continuous manner, to use hot water for the fusing agent, and to lift the melted sulphur by pressure of the fusing-fluid forced into the deposit, and although these preferred features or some one or more of them are hereinafter made elements of special clauses of claim, yet it must be understood that the periodical manner of working, the use of a fusing agent or agents other than water, the lifting of the melted sulphur by means (say, the pump of Fig. III) in addition to or in place of the pressure of fluid forced into the deposit, and other modifications hereinbefore indicated or suggested, are included also in the invention and are within the more general clauses of claim hereinafter written.

For greater certainty it may be here stated that the term "aqueous liquid," as herein-after employed, is intended to include water and liquids containing water, (as saline solutions having water as the solvent or the like,) and that aqueous fluid is intended to cover watery fluids which are gaseous (as steam, for example,) as well as aqueous liquids. The term "pumping" is intended to cover the movement by means of a pump or any known or suitable substitute for a pump. A column of liquid, as hereinbefore indicated, is one such substitute.

I claim as my invention or discovery—

1. The process of mining sulphur, consisting in liquefying the sulphur in the mine by fusion and removing the melted sulphur, substantially as described.
2. The process of mining sulphur, consisting in sinking a well to the underground mine, fusing the sulphur in the mine, and pumping out the melted sulphur, substantially as described.
3. The process of mining sulphur, consisting in fusing the sulphur in the mine by bringing into contact therewith a fluid at a temperature above the melting-point of sulphur and removing the melted sulphur, substantially as described.
4. The process of mining sulphur, consisting in fusing the sulphur in the mine by bringing into contact therewith a fluid under pressure at a temperature above the melting-point of sulphur and removing the melted sulphur, substantially as described.
5. The process of mining sulphur, consisting in fusing the sulphur in the mine by bringing into contact therewith a liquid at a temperature above the melting-point of sulphur and removing the melted sulphur, substantially as described.
6. The process of mining sulphur, consisting in fusing the sulphur in the mine by bringing into contact therewith a liquid under pressure at a temperature above the melting-point of sulphur and removing the melted sulphur, substantially as described.
7. The process of mining sulphur, consisting in fusing the sulphur in the mine by bringing into contact therewith an aqueous fluid at a temperature above the melting-point of sulphur and removing the melted sulphur, substantially as described.
8. The process of mining sulphur, consisting in fusing the sulphur in the mine by bringing into contact therewith an aqueous liquid at a temperature above the melting-point of sulphur and removing the melted sulphur, substantially as described.
9. The process of mining sulphur, consisting in fusing the sulphur in the mine by bringing into contact therewith water under pressure at a temperature above the melting-

point of sulphur and removing the melted sulphur, substantially as described.

10. The process of mining sulphur, consisting in circulating through the underground deposit of sulphur or sulphur-bearing rock a fluid, such as water, at a temperature above the melting-point of the sulphur, thereby liquefying the sulphur by fusion, and removing the melted sulphur, substantially as described.

11. The process of mining sulphur, consisting in introducing a heat-conveying vehicle, such as water, at a temperature above the melting-point of sulphur into the deposit to be mined and in contact with the sulphur therein, and removing the melted sulphur with the vehicle, substantially as described.

12. The process of mining sulphur, consisting in forcing under pressure a vehicle, water or other fluid, at a temperature above the melting-point of sulphur, into the deposit to be mined and in contact with the sulphur therein and removing the liquefied sulphur by the pressure of the fluid, substantially as described.

13. The process of recovering sulphur from underground deposits in a refined or partially-refined condition, consisting in bringing in contact with the sulphur in the underground deposit a heat-conveying fluid, such as hot water, having a temperature above the melting-point of sulphur, removing the melted sulphur along with such fluid or water, and separating it from the fluid or water by settling, substantially as described.

14. The process of recovering sulphur from underground deposits in a refined or partially-refined condition, consisting in bringing water under pressure at a temperature above the melting-point of sulphur in contact with the sulphur in the deposit, removing the melted sulphur and hot water, settling out the sulphur from the water under pressure at a temperature above the melting-point of sulphur, and withdrawing the sulphur from the settlers in a liquid state, substantially as described.

15. The process of recovering sulphur from underground deposits, consisting in bringing water under pressure at a temperature above the melting-point of sulphur in contact with the sulphur in the deposit, removing the melted sulphur and hot water from the underground deposit to the surface, settling out the sulphur from the water, and reheating and returning the water to the underground deposit, substantially as described.

In testimony whereof I have signed this specification in the presence of two witnesses.

HERMAN FRASCH.

Attesting witnesses:

F. W. LOTHMAN,
G. W. BOUDINOT.