Feb. 23, 1932. W. B. REED 1,846,358

PROCESS OF MINING SULPHUR

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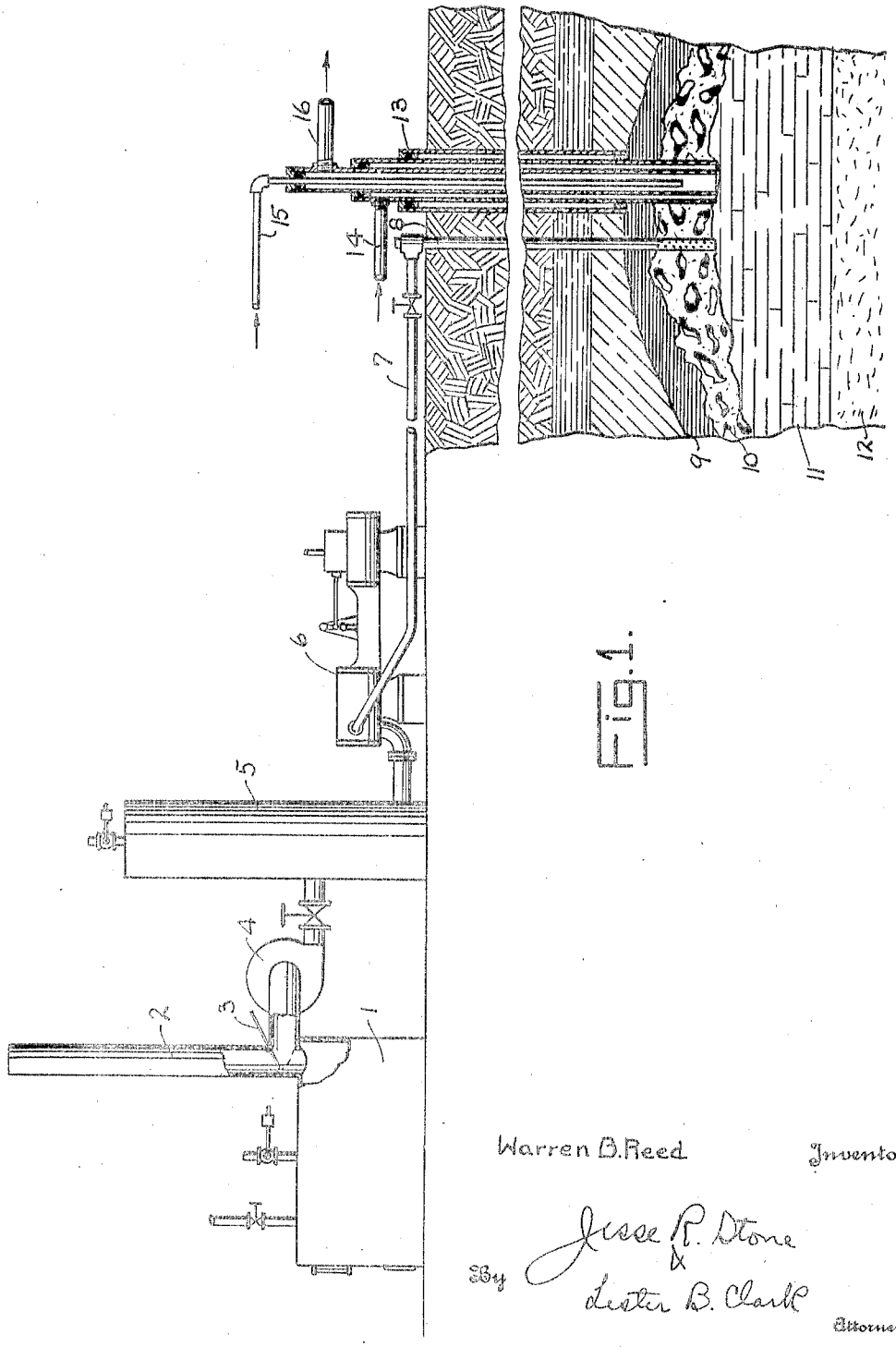


Fig. 1.

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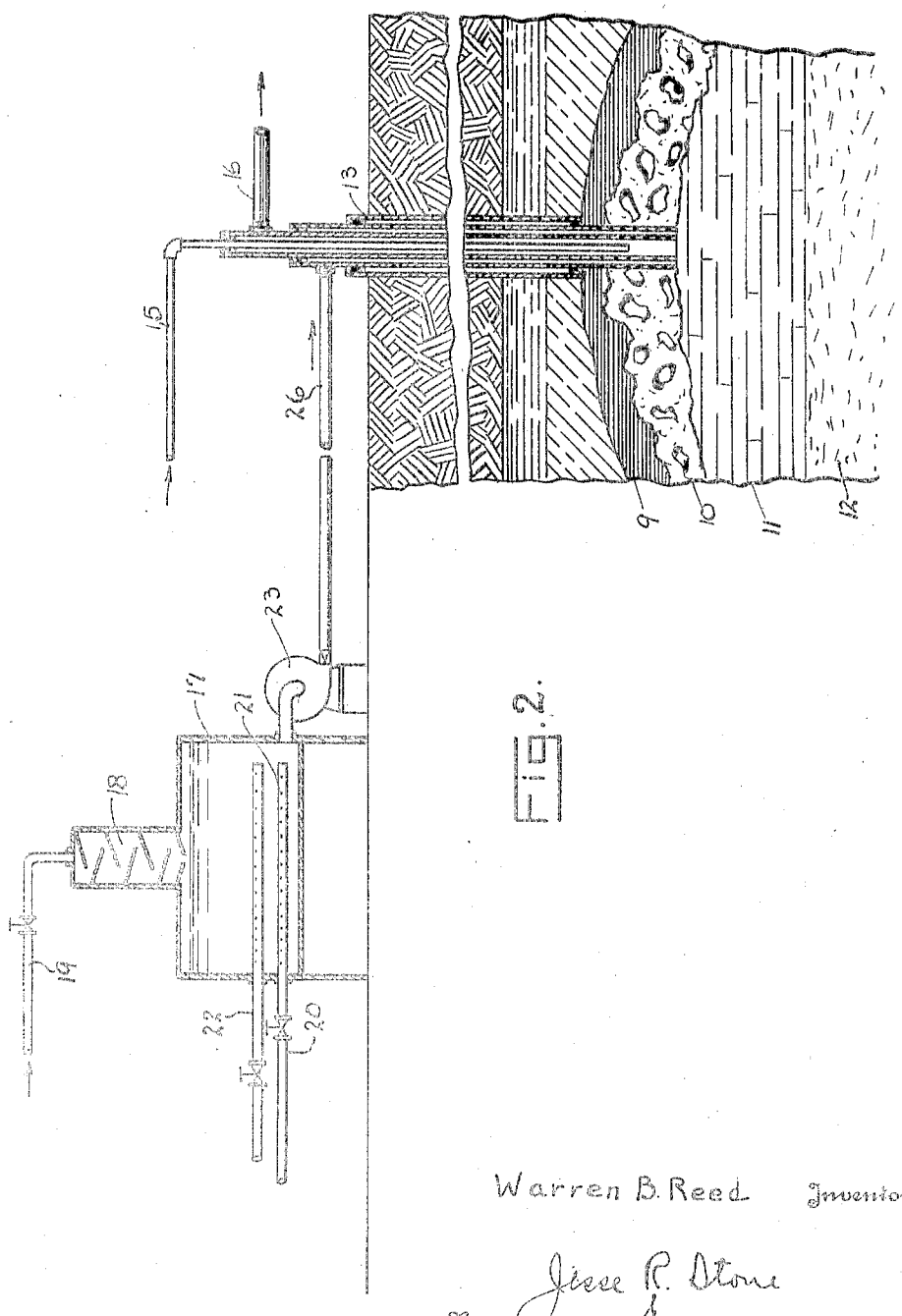


Fig. 2.

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UNITED STATES PATENT OFFICE

WARREN B. REED, OF MORGAN CITY, LOUISIANA

PROCESS OF MINING SULPHUR

Application filed October 27, 1930. Serial No. 491,461.

My invention relates to a process embodying new and useful improvements in the mining of sulphur, or more particularly to the mining of the subterranean deposits of sulphur occurring in the caprock of salt domes by means of what is generally known as the Frasch process, which in essence, consists of injecting hot water into the sulphur-bearing zone of the caprock portion of the salt dome, which water being at a temperature above the melting point of sulphur, melts the sulphur which in turn is raised to the surface by means of compressed air.

There are many hypotheses regarding the origin of the native sulphur found in the caprock formation of certain sulphur domes. Much research into the origin of the reactions and the chemical combinations within the sulphur-bearing areas of the caprock, has not definitely determined the source of the sulphur or its method of deposition. It is conceded by many students of the subject, however, that the anhydrite mass, calcium sulphate, is the probable immediate source of the free sulphur.

In general, it may be stated, that the original caprock before mining operations, consists mainly of calcite, gypsum, anhydrite, celestite and strontionite, pyrite, hydrogen sulphide, brine, methane gas and other hydrocarbons.

After the ordinary mining process has been in operation, the bleed waters (the excess waters drawn from the mining operations) show that the original brines plus the heated waters injected for the purpose of mining, give a resultant which carries in solution varying quantities of calcium sulphate, calcium bicarbonate, calcium chloride, magnesium chloride, sodium chloride, small amounts of silica, iron and aluminum oxide and hydrogen sulphide.

It is evident, therefore, that the waters preheated above the melting point of sulphur injected into the caprock, perform the function of not only melting the sulphur, but also of dissolving the calcium carbonates and sulphates, as well as smaller proportions of other minerals.

In the process of mining of sulphur by means of injecting water above the fusing point of sulphur, the sulphur lying in fissures or veins that can be reached freely by the hot circulating waters, is the first sulphur to be melted and made available, and as the porosity of the rock permits the further infiltration of hot waters, other particles of free sulphur are reached and enabled to flow to points of accumulation.

It is very evident, however, from the examination of the specimens of caprock containing sulphur, that much sulphur is so sealed that it cannot be reached by circulating waters without the necessity of the rock in which it is imprisoned being dissolved.

Unquestionably a great deal of the sulphur contained in the caprock area is not available until such time as solution takes place.

The most potent available solvent of lime, is hot carbonated waters, and my invention consists primarily of a process improving the present mining of sulphur by the use of carbonated waters in the place of natural waters not so artificially treated. The object of this process is two-fold:

First: To inject, into the area being mined, carbon dioxide in superabundance for the purpose of furnishing a solvent for the calcium rocks, and an excess of carbon and oxygen for such chemical reactions as may come about.

Second: To utilize the carbon dioxide with or without its heat content from the gases of combustion of the boiler plant.

The object of my invention can be carried out either:

1. By forcing carbon dioxide under pressure through a well or wells drilled into the zone being mined, and discharging the carbon dioxide directly into the area where it will be a reagent either as gas, or absorbed in the waters of the mining operations, or both.

2. To combine the carbon dioxide from the combustion gases of the boilers used in the production of steam, for the purpose of heating the waters of injection, by means of bypassing all or a portion of the gases of combustion from the boilers before they enter the stack or chimney, and forcing them under proper heat and pressure into the water that

is being heated for pumping into the wells for the purpose of melting the sulphur.

It is evident that the gases of combustion containing carbon dioxide may be scrubbed or purified before use, and that they may be injected directly into the zone of mining operations or the water to be used at reduced temperature or increased temperature, and that the carbon dioxide so obtained may be injected into the water to be used before or after the heating thereof by steam or simultaneously with the injection of steam.

It is also apparent that the use of reservoirs to contain the gas; the use of compressors to compress the gas; the design of the apparatus for commingling of carbon dioxide with the waters before or after heating may be of manifold design and utility, but the detail of arrangement, the design of apparatus for carrying out the object of my invention, does not in any way restrict the invention precisely thereto, but what I wish to cover by this invention is:

1st. The process of injection of carbon dioxide into the heated waters of the sulphur-bearing zone, whether the gas be injected directly into the sulphur zone itself, or whether the carbon dioxide be injected into the heated waters to be used for melting the sulphur before these waters are injected into the sulphur zone.

2nd. The use of the heated dioxide taken from the gases of combustion of the boilers of the steam plant used in connection with the mining operations, which use embodies the conservation of the heat of these gases of combustion, as well as the carbon dioxide content.

3rd. The use of carbon dioxide without limitation as to quantity or percentage of carbon dioxide to the amount of water used in the mining operations.

In order to show diagrammatically a theoretical arrangement of this process, Fig. 1 illustrates the process of injecting hot carbon dioxide directly into the sulphur-bearing zone being mined, through a well drilled and utilized for that purpose.

Fig. 2 illustrates a possible means of injecting heated carbon dioxide into the water to be used for mining operations by means of a heater into which water, steam and carbon dioxide are injected, and from which the hot carbonated water is removed by pump and forced into the sulphur zone by means of a well drilled and designed for that purpose, such as used in the present methods of mining for sulphur.

Referring to the Fig. 1 embodiment the numeral 1 indicates a boiler with a stack 2 and damper 3 with a by-pass to blower 4, which discharges a variable portion of the gases of combustion into reservoir 5, from whence they are taken into gas compressor 6 and discharged at predetermined pressure through pipe line 7 to well 8, and thence injected downward into sulphur zone 10, which is being mined by the hot water system, as illustrated by well 13. The gases discharged through well 8 mingle with and are absorbed and otherwise chemically react within a variable range in the zone of operations.

Well 13 is illustrative of the present method of injecting hot water into the sulphur zone to be mined. Such a well is equipped with concentric pipes with hot water intake at 14, compressed air intake at 15, and liquid sulphur discharge pipe at 16, being diagrammatic illustration of the present system in use.

When this installation is operated it is to be understood that the sulphur mining operation will be performed by means of the wells equipped as shown in 13 to 16, inclusive, and the sulphur will be removed from the well in a molten state and discharged into a bin or tank not shown. During the operation of the well I contemplate forcing into the sulphur bearing strata, and at a point adjacent the sulphur mine, a quantity of carbon dioxide. This element may preferably be obtained, as shown, from the stack of the furnace by means of which the water is heated for the sulphur mine. It will be forced into the mine under pressure and will be delivered laterally into the sulphur stratum where it will come in contact with sulphur compounds present therein. The CO_2 will increase the amount of sulphur which will be melted under the heat of the liquid in the well and will thereafter flow down to the lower part of the mine where it will be withdrawn through the sulphur well.

In the apparatus shown in Fig. 2 the carbon dioxide is shown as being introduced into the sulphur mine through the hot water inlet pipe 26 thereby dispensing with the use of an additional well penetrating the sulphur stratum. In this embodiment the heater, which is ordinarily employed in heating the water delivered into the sulphur mine is shown diagrammatically at 17.

This heater is shown as comprising a container, the upper end of which is formed into a chamber 18 with inclined baffles therein over which the water is introduced through the pipe 19. Steam under pressure is introduced into the container through a steam pipe 20 having a perforated nozzle 21 within the container. Adjacent the steam pipe 20 is the pipe 22, through which the carbon dioxide gas is introduced into the heater. It is to be understood that this carbon dioxide may be obtained from the products of combustion in the furnace or may be a commercial gas introduced under pressure into the heater where it is forced through the water and steam in the heater and passes with the superheated water through the pump 23 into the pipe 6 leading to the well. In this manner the carbon dioxide is forced into the mine along

with the heating element which melts the sulphur and will come in contact with the sulphur and other compounds in the well.

It is to be understood that in the diagrams shown the calcite caprock is indicated by the numeral 9. The sulphur-bearing zone 10 is shown as immediately under the caprock and the anhydrite mass 11 is below the sulphur, said anhydrite resting upon the salt stratum 12. This is, of course, only illustrative as the formations differ in each individual sulphur mine.

By the use of my invention it is possible to ultimately increase to a great extent the amount of free sulphur produced in a particular locality. The sulphur combined with other elements closely adjacent the main sulphur zone may be released for removal from the well. Where the carbon dioxide is obtained directly from the furnace there will be no large element of expense in the use of the carbon dioxide and the combination of the hot gases with the water assists in heating the same and therefore furnish a further element of economy in the production of sulphur.

What I claim as new is:

1. In mining sulphur by injecting hot water into the subterranean sulphur stratum to melt the sulphur and withdrawing the melted sulphur, the improvement consisting of forcing carbon dioxide into the mine to act upon mineral constituents present therein and free some of the sulphur, and withdrawing said sulphur.

2. In mining subterranean sulphur by the Frasch method, the improvement comprising forcing hot carbon dioxide into the mine to free some of the sulphur in said mine and then removing the free sulphur.

3. In mining sulphur by the Frasch process the improvement comprising bringing hot carbon dioxide into contact with the water forced into the mine, carrying said carbon dioxide in solution into the mine, acting upon the compounds present with said carbon dioxide and withdrawing the free sulphur.

4. In mining sulphur by the Frasch process, the improvement including charging the hot water employed in mining with carbon dioxide by bringing the gases of combustion from the furnace stack into contact with the said water and then forcing said water into contact with the compounds in the well and then removing the free sulphur.

In testimony whereof I hereunto affix my signature this 17th day of October, A. D. 1930.

WARREN B. REED.