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MINING OF SULFUR

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This invention relates to methods of mining sulfur, the same constituting improvements upon the well-known hot water mining or Frasch process, and has for an object the recovery of larger amounts of sulfur from sulfur deposits than can be recovered by the ordinary and special practices of the Frasch process, and as another object, the recovery of sulfur from deposits which respond inadequately or not at all to such known practices.

In the mining of sulfur by the conventional Frasch process, hot fresh water is introduced at or near the bottom of the sulfur formation or just above the level at which the melted sulfur is expected to collect in a pool. The water introduced maintains the sulfur pool in a molten condition and due to its lower specific gravity than the water in the surrounding formation, flows upwardly and to a smaller extent, outwardly, thus heating the formation in a funnel shaped area at a progressively higher and higher level, and when the temperature in the path of the water is sufficiently raised, the sulfur present in the hot area is melted to a liquid flowable state, and due to the action of gravity, it flows downwardly in the heated region in the direction of, and to, the pool at the bottom of the well. From this pool, the sulfur is withdrawn or forced to the surface of the mine by the action of warm compressed air.

Whereas this process leads to good recovery of sulfur from many formations, it does not work satisfactorily in many instances. In some formations, the introduction of the usual amount of water at the usual temperature results in little or no accumulation of sulfur in a pool from which it can be withdrawn. From such formations, fair amounts of sulfur can, and have heretofore been, recovered by a modified operation involving introducing very substantial amounts of hot water for a period of days during which time no sulfur accumulates in the pool for withdrawal, and then reducing the amount of water introduced to the usual volume whereupon sulfur accumulates in the pool and can be withdrawn over a period of several days. During this period of days, the amount of sulfur in the pool gradually decreases until no more can be withdrawn and productivity can be obtained again only by repeating the introduction of the very large quantities of water for an additional several-day period.

This type of well is expensive to operate, for it employs a larger amount of heat and water and recovers from the well a smaller quantity of sulfur than from normal mines. The processes of

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the present invention may be applied with particularly beneficial results to this type of formation but are equally applicable for obtaining increased yields from the usual type formation wherein the ordinary hot water mining process can be successfully employed.

Two variations in operation of the invention are hereindescribed. The first embodiment of the process is of particular value in formations which do not respond adequately to known Frasch operations and where increased rates of flow of hot water prevent sealing of the molten sulfur. The second embodiment is of value in the recovery of sulfur from all of the usual types of formations encountered and leads to increased yields by melting and collecting the sulfur from a larger area than is possible by present known processes.

According to the first embodiment of the invention, hot brine or other heavy aqueous solution is introduced into the sulfur formation at a high level in the sulfur stratum with the result that the sulfur is melted in a progressively downward direction, the melted sulfur and hot solution flowing in a concurrent direction, the sulfur collecting in a pool at a lower level in or below the sulfur formation from which it is removed by the conventional air lift. This concurrent flow of hot solution and molten sulfur is obtained by the introduction under pressure at a relatively high point in the sulfur stratum, preferably near its top, above, at, or slightly below its upper limit, of a heavy brine or other aqueous solution having a higher specific gravity than the mine water at any temperature above about 230° F., as at the temperature the brine is introduced or at a somewhat lesser temperature.

In this first embodiment, the sulfur melted by the hot solution may be collected at and withdrawn from the bottom of the melting zone which is continuously moving downwardly, but it is preferably collected and withdrawn from near the bottom of the sulfur formation. The flow of melted sulfur (and hence also the hot solution from the melting zone initially near the top of the formation) to the collecting pool at some lower position in or at the bottom of the formation is effected or facilitated by creating a hot channel preferably around an uninsulated heated pipe extending through the melting zone to the bottom of the mine. This pipe may be heated by any suitable fluid introduced inside it, and the heat conducted therefrom into the surrounding sulfur formation will melt the sulfur imbedded there and permit the same as well as the sulfur melted