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SULPHUR EXTRACTING MEANS

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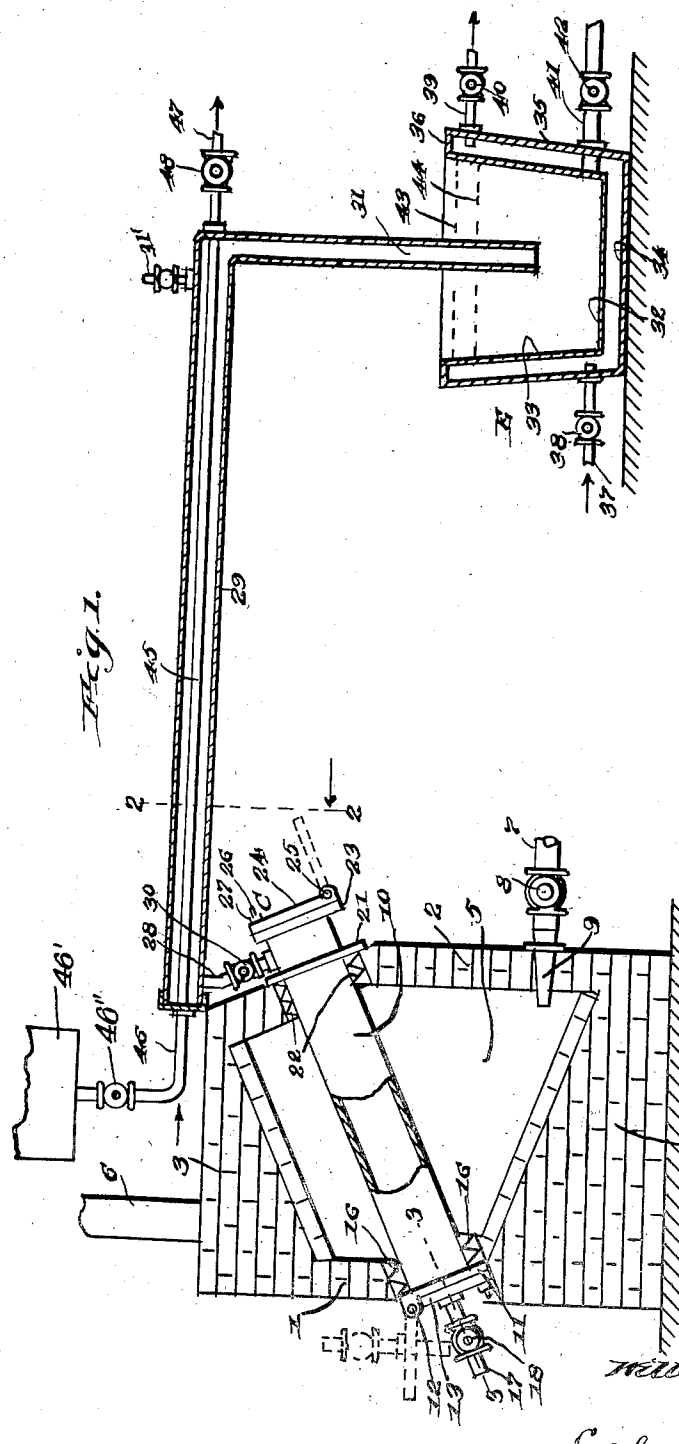


Fig. 1.

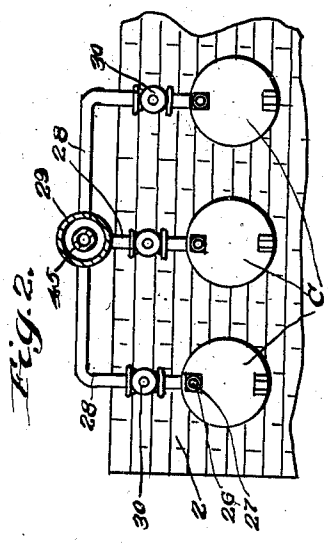


Fig. 2.

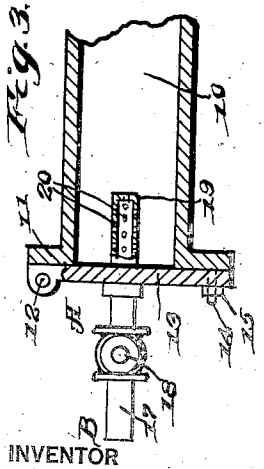


Fig. 3.

INVENTOR
William Rogers Wade
BY
Carl H. Crawford
ATTORNEY

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SULPHUR EXTRACTING MEANS

William Rogers Wade, Libby, Mont.

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4 Claims. (Cl. 23—280)

The object of this invention is to provide a novel means for extracting sulphur from native sulphur ore.

It is a feature of this invention to heat a charge of sulphur ore to an increasing temperature sufficient first, to liquify the sulphur content, and secondly, to continue to increase the temperature of the charge sufficiently to vaporize the sulphur content, this heating step being applied to a single and confined charge of sulphur ore, irrespective of the fact that the treatment may be carried out in a battery of retorts.

Among the several objects achieved in releasing the sulphur in liquid and vapor form, is to enable me to conserve fuel costs, to increase the ultimate sulphur recovery and to eliminate the necessity of fine grinding of the ore, as the vapor escapes from the centers of larger pieces by its explosive force, and a recovery of 99% has been made in experimental tests, by the use of this apparatus.

Therefore, it is a feature of this invention to draw off or remove the liquid sulphur as soon as it is produced, or as soon as there is an accumulation of it, whereby the volume of the charge will be reduced practically one-half. This reduces the amount of heat (B. t. u.) necessary to reduce the residue or remaining content of the charge to a vapor and saves (B. t. u.) latent heat in the vaporization of the sulphur.

A further feature consists in subjecting the charge to heat in the absence of air, or in other words, providing an air excluded charge of ore, and performing the heating step with the ore charge under a partial vacuum, which additionally facilitates volatilizing the sulphur in the charge with a material saving of fuel.

It is a further feature of this invention to draw off the sulphur vapor and condense the same to form liquid sulphur, and to maintain a temperature condition whereby this condensed vapor cannot solidify.

A further feature resides in an air trapped storage body of liquid sulphur into which the condensed vapor is discharged, whereby the final disposition, as far as this invention is concerned, will be such that the sulphur will, in each withdrawal, be in liquid form.

A feature of material importance is that in excluding the outer air from the entire method, I am able to effectively utilize the vacuum created by the condensing step, to not only advance the vapor and liquid toward the body of stored liquid, but in so doing, I also withdraw the vapor from the retorts with sufficient suction to create and sustain a partial vacuum in the retorts thereby effecting a material saving in fuel.

The invention has many other objects and features which will be more fully described in connection with the accompanying drawing and will be more particularly pointed out in and by the appended claims.

In the drawing:

Fig. 1 is a vertical sectional view of one form of a complete apparatus for performing the functions of my invention.

Fig. 2 is a sectional view on line 2—2 of Fig. 1, looking in the direction of the arrow, of Fig. 1.

Fig. 3 is an enlarged sectional view of line 3—3 of Fig. 1.

Like characters of reference designate similar parts throughout the different figures of the drawing.

In the accompanying drawing I have illustrated a simple form of installation omitting all non-essentials, and it will be understood that wide variations may be made from this disclosure, in practical plant installations, without departing from the scope of this invention, providing that the essentials, shown and claimed, are retained in substance.

I have shown a simple form of brick furnace in which the front wall is designated at 1, the back wall at 2, and upper and lower walls at 3 and 4, respectively. Within these walls a combustion chamber 5 is formed and an outlet for the products of combustion is indicated at 6. Any source of supply of fuel may be used, and I have shown, for convenience, a simple form of oil burner which involves a supply pipe 7 having a valve 8 and a nozzle 9, which latter extends into the combustion chamber 5. Since the path of the products of combustion is not important to this invention it is not detailed.

Reference will next be made to the means for enclosing a charge of ore to be heated, and since such means is in the form of a retort, and since all the retorts are identical in form and function, only one need be described in detail, as it is well known engineering practice in plant installation to employ retorts in batteries.

A retort is indicated at 10 and the same may be formed of any available tubular material capable of withstanding the heat applied thereto, and it will be seen that the retort is interposed in the combustion chamber 5, in a manner to be subjected to the action of the products of combustion.

In addition to the fact that the retort is so arranged that both the intake and discharge

ends are accessible from the exterior of the furnace, it will also be seen that the retort is disposed at a sufficient angle from the horizontal, with the intake end uppermost, so that the ore charge and liquid contents will settle toward the discharge end by gravity, and will also discharge from said discharge end by gravity, and while this is a very important advantage over a horizontally disposed retort, it is not an absolutely essential requirement for effective operation of the invention.

The lower discharge end is shown provided with closable means which may include a flange 11 on the retort, to which is hinged at 12, a lid or cover 13, which may be opened in the manner shown in dotted lines in Fig. 1. Any suitable means such as a stud and nut, 14 and 15, respectively, may be used to hold the cover securely in an air tight closed position. It will be seen from Fig. 1, that this lower end extends through a suitable opening in wall 1, and that it may be supported by plastic or any suitable means indicated at 16, in a manner not to insulate the wall enclosed portion of the retort against the heat from the combustion chamber. In other words, it is advantageous not to expose anything more than a minimum area of the retort to the outer air.

A draw-off means for liquid sulphur is provided, and as shown, this means may take the form of a tap-pipe 17, having a suitable closure such as a valve 18, the pipe extending through and being rigidly mounted in the cover 13. The inner end 19, which is disposed in the retort, may be perforated, as at 20, to act in the capacity of a foraminous screen and prevent discharge of sand or comminuted ore particles along with the liquid sulphur.

Thus it will be seen that the cover 13 permits of discharge of treated ore, and the tap 17 permits the discharge of liquid sulphur, and for convenience in the description of the operation, I have generally designated the cover or ore discharging means at A, and the tap or sulphur discharging means at B.

I have shown the remaining end provided with a flange 21, for engagement with the outer wall 2 of the furnace, and suitable material 22 serves to support the retort free from engagement with the brick work in the usual manner, so as to close the furnace against air ingress. The retort is shown as extending beyond flange 22 and is provided with closable means which may include a flange 23 to which a cover 24 is hinged at 25, so that it may be opened as shown in dotted lines in Fig. 1. A suitable stud and nut, 26 and 27, respectively, may serve to close cover 24 tightly, and in accordance with the usual practice both covers 13 and 24 may be marginally bordered with a suitable plastic material, such as clay, which will harden because of the heat, and which instead of being forced away from the area of application, will, on the contrary, be drawn toward such area because of the partial vacuum in the retort, as will later appear.

A vapor egress pipe 28 leads from the projecting portion of the retort to what is in practice a header, but which I will specifically term a vapor conveying pipe 29, which in this case also functions as one portion of a condenser. Said pipe 29 is shown provided with a valved bleeder 31', which may be connected with a source of supply of suction. In most installations the furnace will contain a plurality of retorts, as shown in Fig. 2, where the ends of the latter are indicated generally by the reference letter C, and wherein the pipes 28, each having a valve 30, all lead to the header 29.

It will now be clear that when the cover 24 is opened, the retort can be charged with ore, and to this extent, this will be an ore ingress end, which for convenience I will designate by the reference letter C, as just previously stated. To the extent that this end C permits withdrawal of the vapor through pipe 28, it is a vapor egress end. It may also be stated that the projecting end of the retort may be suitably covered to prevent heat radiation in any desired manner, not shown.

Reference will next be made to my improved condenser and to the means of final disposition of the condensed vapor.

The conveyer pipe 29 is shown inclined downwardly toward the right of Fig. 1, although this inclination is not essential to successful operation. The discharge end 31 is shown bent downwardly and it extends below the liquid level of a storage or draw-off tank generally indicated at E. This tank or vat has inner bottom and side walls 32 and 33, respectively, and is provided with a steam or hot water jacket consisting of bottom, side and top walls 34, 35 and 36, respectively, the latter joining wall 33, as clearly shown. Steam or super-heated water may be supplied through a pipe 37, provided with a valve 38 and an outlet pipe 39, having a valve 40, is also provided. A draw-off pipe 41, having a valve 42, leads from the tank containing the liquid sulphur. I have shown liquid levels at 43 and 44, below which the discharge end 31 is disposed so that air will be trapped against ingress to the product of the furnace at any point in the progress of said product from the furnace to the storage tank E.

As thus far described, the conveyer pipe 29 functions wholly as such, and I will next describe the manner and means whereby said pipe 29 is equipped to function as a condenser.

A pipe 45 is associated with pipe 29 in a manner to affect the temperature of the latter, and as shown, said pipe 45 extends through the substantially horizontal portion of pipe 29, and is adapted to be connected at its ingress end with a means or source of supply of a condensing medium, such for instance as superheated steam or water, which may be supplied by pipe 46, from a source indicated at 46'. A controlling valve 46'' is interposed in pipe 46. At its egress end 47 said pipe is provided with a valve 48 to control circulation of whatever condensing medium is employed.

While the operation of the invention may be clear from the foregoing, it will be briefly recapitulated as follows:

The cover 24 will be opened to charge the retort 10 with ore, and in practice the latter will be filled to about nine-tenths of its capacity to allow for swelling of the ore. One advantage of the inclined position of the retort will now be clear since the charge of ore will gravitate toward the egress end A.

At the start the tank E will be supplied with liquid sulphur, and valve 30 will be closed while bleeder valve 31' will be opened to exhaust air from pipe 29 and then closed. Likewise, valve 18 will be opened to permit escape of air from retort 10. When vapor appears, valve 18 will be closed and valve 30 will be opened to permit of the vapor entering pipe 29. Of course valve 18 will be opened to permit withdrawal of the

liquid sulphur from the retort, either as soon as the liquid sulphur is produced, or after it accumulates, it being understood that these starting operations will vary under different conditions, and under judgment of the operator. Thus this description of starting operations is for general guidance.

Heat is applied by starting the burner 9, and the retort 10 will be gradually heated until it reaches a temperature of about one thousand (1000) degrees Fahrenheit, and this temperature will, roughly, be maintained. However, before this maximum temperature has been attained the sulphur content of the charge will be liquified. This occurs at a temperature of about two hundred thirty-nine (239) degrees Fahrenheit. This liquified sulphur, because of the inclined position of the retort, will gravitate toward end A thereof, and as soon as the temperature reaches a point where liquid sulphur is produced, or has accumulated, it will be drawn off through tap 17. This may be done in accordance with operative conditions, either early in the heating step, or at any period thereof, as long as this draw-off is effected in a manner to reduce the volume of the charge and thereby insure fuel saving.

However, in the matter of real substance, the important fact is that during this retort heating step, and without interruption in any way of the continuity of this heating step, I am able to perform this draw-off step of eliminating the liquid sulphur, and hence I avoid an expenditure of fuel that would otherwise be wasted in uselessly raising the temperature of this liquid sulphur to the vaporizing point. By first removing the liquid sulphur I make effective use of the latent heat of vaporization.

In this connection it is important to note that the specific heat of sulphur is two-tenths ($\frac{2}{10}$). Latent heat of vaporization of sulphur is six hundred fifty one (651) B. t. u. per pound of sulphur. Thus each pound tapped off in liquid saves $600 \times .2 = 120$ B. t. u., plus 651, or a total of 771 B. t. u. of heat per pound of sulphur removed.

Since liquifaction of the sulphur is one desideratum of the invention, in any event, and is achieved in part in an early stage of the treatment, I provide for its effective completion by drawing off the liquified sulphur, as will now be clear. Further, the sulphur content, which is liquified, forms the materially greater part of the total volume of the charge, which is thereby reduced nearly one-half when this liquid sulphur has been drawn off. Obviously, after this very great reduction in volume of the ore charge it will not require as great an expenditure of fuel to heat the reduced volume of the balance of the ore charge up to the point of vaporization. Hence, it will now be clear that I not only speed up the operation, as regards recovery of the liquid sulphur, but I also obtain a very great fuel saving which amounts to about one-half of what would be required if this intermediate step of liquid withdrawal were not achieved. There is also the added advantage of not interrupting the continuity of the operation.

Of course this liquid sulphur will be subsequently removed to a vat or other point of final deposition to harden in the usual manner, which is not important to this invention.

As the temperature of the retort 10 rises, the balance of the charge of sulphur ore will be heated to a temperature whereby the remaining sulphur content will be vaporized, which occurs when the temperature reaches eight hundred thirty-eight (838) degrees Fahrenheit, as a minimum. However, in actual practice the retort 10 is heated to practically one thousand (1000) degrees Fahrenheit.

Because sulphur vapor becomes liquid below eight hundred thirty-eight (838) degrees Fahrenheit, it will be seen that when the vapor leaves the retort 10, it will be sufficiently higher in temperature than the above named minimum to insure its entry into pipe 29 in vapor form.

Therefore, since the valve 30 has been opened, the vapor will enter pipe 29, through which it is to pass, and after being condensed it will enter the storage tank E. This super-heated water or steam in pipe 45 is at a temperature of from two hundred forty (240) to two hundred fifty (250) degrees Fahrenheit, which is so far below the minimum of the vapor, namely, eight hundred thirty-eight (838) degrees Fahrenheit, that it will absorb enough heat from the vapor, or in other words act to cool the vapor sufficiently so that the latter will be condensed into a liquid. However, the temperature of pipe 45 will be sufficiently high, at the temperature given, to prevent solidification of the condensed vapor, which of course would clog the pipe 29.

Because air ingress is prevented this condensation of vapor will perform two important functions: namely, first, it will serve to advance the vapor out of the retort into and along pipe 29, because of the partial vacuum created and sustained by the condensing process, and second, this partial vacuum will be set up and sustained in the retort 10, and because of this fact less fuel will be necessary to heat the contents, as it is well known that the boiling point or temperature is lowered in a partial vacuum. Thus, a higher heating efficiency can be maintained in an air sealed container where a partial vacuum is maintained than in the absence of a vacuum because the boiling point or temperature required is lowered.

The extent through which the vapor will travel in pipe 29 toward vat E, before it is condensed, will of course vary and need not be specified, but it will be clear that the vacuum created will not only advance the vapor but also the condensed liquid, although the precaution of inclining pipe 29 will also assist in the latter capacity.

The level of the liquid sulphur in tank E will of course vary, but it may be regulated in any desired manner, as by the draw-off pipe 41 so that any variation will not expose the terminal end of pipe 31 to ingress of the outer air, thereby serving to maintain the vacuum condition previously described. Further, the draw-off pipe 41, constitutes a means for delivery of the treated product, namely liquid sulphur, as well as a regulating means for maintaining the liquid level at a height to trap the discharge end 31 of the vapor pipe 29.

When it is determined that the ore in retort 10 has been completely treated and the sulphur content entirely extracted, which will be indicated by from one and one-half (1½) to three (3) hours cooking, dependent upon the diameter of the retort and the heat supplied, then the valve 30 will be closed and end A will be opened. Thus the treated ore can be evacuated from the retort, mostly by gravity, although the interior may have to be scraped. The end A will be closed and end C opened to permit a new charge of ore being inserted into the retort for another op-

eration, which of course will be as previously described.

It will now be clear that with one confined or air excluded charge of ore, I perform three distinct method steps while this ore is in the retort, namely: I first heat the charge, second, I draw off the liquid sulphur, and third, I draw off or release the vaporized sulphur, the second and third steps being sequentially performed during a continuation of the heating, or first step.

It is a primary object of this invention to treat low to medium grade native sulphur ore having a content of substantially sixty percent (60%) to forty percent (40%) or less of sulphur, as these grades of ore present the greatest problems to efficient recovery.

It is important to understand that I can efficiently treat sulphur ore just as it comes from the mine without grading, screening or crushing the same, which is a factor of great value.

While I have illustrated and described one specific form of my improved apparatus, I do not wish to be limited thereto except for such limitations as the claims may import.

I claim:

1. As a means for extracting sulphur from sulphur ore, a furnace structure having a combustion chamber, means for producing combustion in said chamber, an air excluded retort interposed in said chamber for melting and vaporizing a charge of sulphur ore and having ore discharge and intake ends accessible from the exterior of said structure and said retort having a continuously smooth and unobstructed interior and being disposed at a sufficient angle from the horizontal with the intake end uppermost whereby the charge of ore will settle toward said discharge end and discharge therefrom by gravity, openable means for closing said discharge end, means for drawing off liquid sulphur from said charge by gravity through said openable means while the latter is opened and the retort is otherwise closed to atmosphere, openable means for closing said intake end when said retort has been charged with ore, and means leading from the upper end of said retort and closed to atmosphere for conveying off sulphur vapor from said charge during vaporization of the latter.

2. The herein-described mechanism for treating sulphur ore, comprising, means for volatilizing the sulphur content of the ore, a condenser comprising a vapor pipe connected with said means and having a discharge end, a condenser pipe associated with said vapor pipe and connected with a source of supply of a condensing medium, and a vat in receiving relation with the discharge end of said vapor pipe and adapted to contain storage liquid sulphur to a depth sufficient to immerse and trap the discharge end of said vapor pipe, whereby condensation in the latter will create suction to advance the vapor and liquid sulphur toward said vat and sustain suction in said means.

3. The herein-described mechanism for treating sulphur ore, comprising, means for volatilizing the sulphur content of the ore, a condenser comprising a vapor pipe connected with said means and having a discharge end, a condenser pipe associated with said vapor pipe and connected with a source of supply of a condensing medium, a vat in receiving relation with the discharge end of said vapor pipe and adapted to contain storage liquid sulphur, a draw-off means for said vat for also regulating the liquid level in said vat to immerse the discharge end of said vapor pipe and trap the same against ingress of air thereto, whereby condensation in said vapor pipe will create and sustain suction to advance the vapor and liquid sulphur toward said vat and sustain suction in said first named means, and means for applying heat to said vat to maintain the sulphur therein in liquid form.

4. As a means for extracting sulphur from sulphur ore, a furnace structure having a combustion chamber, an air excluded retort interposed in said chamber for melting and vaporizing a charge of sulphur ore and having an ore discharge and intake ends accessible from the exterior of said furnace, openable means for closing said discharge end and having a tap for drawing off liquid sulphur from said retort, a vapor pipe leading from said retort and having a discharge end, a condenser pipe associated with said vapor pipe to condense the vapor therein and being connected with a source of supply of a condensing medium, a draw-off vat in receiving relation with said discharge end of said vapor pipe and adapted to contain a quantity of liquid sulphur at a level to immerse said discharge end of said vapor pipe and trap the latter against ingress of air thereto, whereby condensation in said vapor pipe will create and sustain suction in said vapor pipe to advance the vapor and liquid sulphur toward said vat and sustain suction in said retort, draw-off means for said vat for delivering the treated sulphur and regulating the level in said vat, and means for supplying a heating medium to said vat to maintain the sulphur content liquid.

WILLIAM ROGERS WADE.