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FUEL SAVING SULPHUR EXTRACTING METHOD

Original Filed Nov. 13, 1939

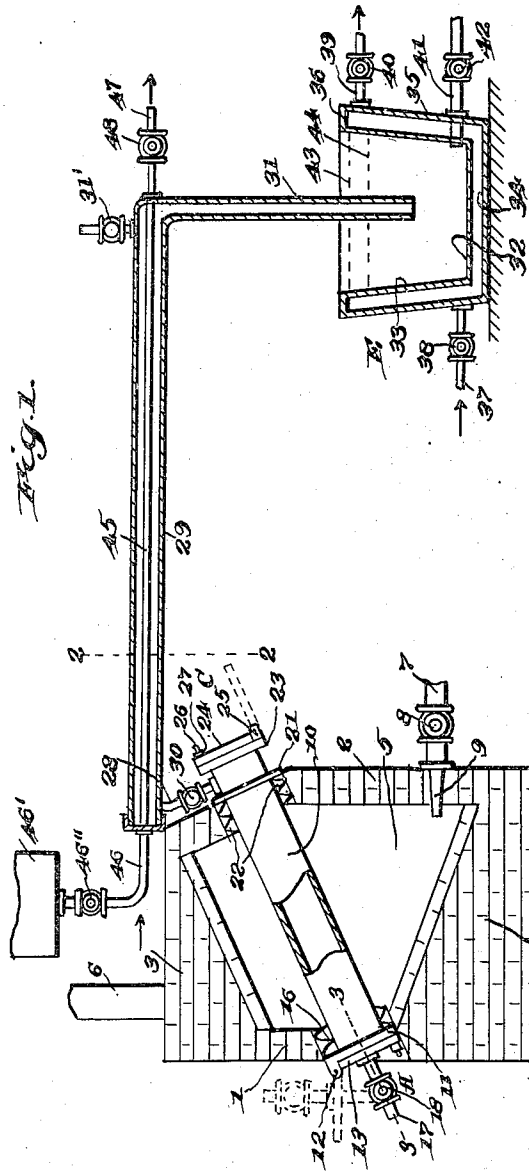

Fig. 1.

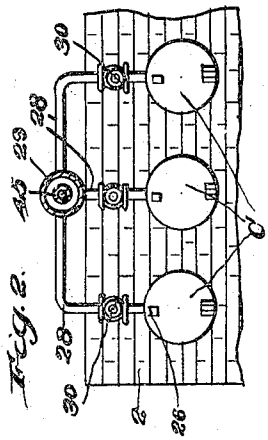

Fig. 2.

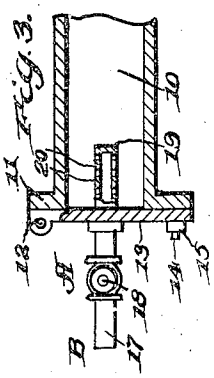

Fig. 3.

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FUEL SAVING SULPHUR EXTRACTING METHOD

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Original application November 13, 1939, Serial No. 304,052. Divided and this application October 1, 1941, Serial No. 413,183

2 Claims. (Cl. 23—293)

The object of this invention is to provide a novel fuel saving method for extracting sulphur from native sulphur ore, and this application is a divisional application carved out of my application filed November 13, 1939, Serial No. 304,052, patented November 11, 1941, No. 2,262,125.

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 method.

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 applying liquid sulphur in the condensing step in the form of 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 on 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 for performing this method, 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 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 a 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 draw-off 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.

When the retort is closed it will be tight enough to exclude either air or gas from entrance to the charge of ore in said retort, and after the initial air content has been eliminated by the starting operation, the charge of ore will thereafter be an aeriform excluded charge. Further, as any moisture will be quickly removed by the initial low temperature when starting the furnace, the charge will thereafter be in a substantially anhydrous condition.

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 the manner in which I perform the condensing steps of the method.

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 surface or 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 or barometrically sealed 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. In other words, I provide a barometric seal at the outlet of the conveyed liquid sulphur, against ingress of air to pipe 29 from the discharge end thereof.

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 what ever condensing medium is employed.

It will now be seen that one of the steps in this

condensing feature consists in applying liquid sulphur in a manner to form a barometric condenser seal to prevent air ingress to the condensing vapor whereby I am able to perform the valuable function of creating and sustaining a partial vacuum that serves to advance the vapor out of the retort and from the change therein, and also advance the condensed vapor toward the vat E, as a point of final deposition. In addition thereto I am also able to create and sustain a partial vacuum in the retort to thereby effect a further saving of fuel.

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 and steam 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. While the charge of ore will periodically gravitate toward the lower end of the retort, it will, normally, be in a state of repose, as it need not be agitated.

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 liquefied. This occurs at a temperature of about two hundred thirty-nine (239) degrees Fahrenheit. This liquefied 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 liquefaction 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 liquefied sulphur, as will now be clear. Further, the sulphur content, which is liquefied, forms a great 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.

It will thus be seen that I provide a condensing medium of an intermediate temperature which may be termed a condensing and non-solidifying medium or heat.

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. Then end A will be closed and end C opened to permit a new charge of ore being inserted into the retort for another operation, which of course will be as previously described.

It will now be clear that with a single confined aeriform excluded charge of ore, I perform five distinct method steps while this single charge of ore is in the retort, namely: I first heat the charge to a sufficient temperature to liquefy a materially great part of the total volume of the charge; second, I draw off the liquid sulphur from the charge while the heat is being applied and thereby greatly reduce the volume of the residue; and third, I further increase the temperature of the charge of ore sufficiently to vaporize the sulphur content of the reduced residue; and fourth, I draw off or release the vaporized sulphur from said single charge while the heat is being applied thereto; and fifth, I condense and thus recover the vaporized sulphur. The fact that the heat applied to the retort may, and in some instances will be continuously increased from a liquefying to a vaporizing temperature, without interruption, does not alter the fact that from a patentable standpoint two distinct and separate functions are performed, the one being to heat the charge to a liquefying temperature, and the other to heat the charge to a vaporizing temperature. It is also apparent that combinations less than all of the foregoing steps may be both operative and advantageous.

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.

It is believed my improved method will be fully understood from the foregoing description and I do not wish to be limited thereto except for such limitations as the claims may import.

I claim:

1. In a fuel saving method of extracting sulphur vapor and liquid from native sulphur ore and condensing the vapor, the steps of heating an aeriform excluded single charge of sulphur ore while normally in repose to a temperature sufficient to liquify a materially great part of the total volume of the single charge of ore, in drawing off the liquid sulphur from said charge while the heat is being applied to thereby greatly reduce the volume of said charge and save fuel, in further increasing the temperature of said charge sufficiently to vaporize the sulphur content of the remaining residue of said charge, in continuously conveying off the vaporized sulphur from the charge during heating thereof, in producing a partial vacuum by applying a condensing temperature to the conveyed vapor to condense the latter with the condensing temperature sufficiently high to prevent solidification of the condensed vapor, and in barometrically sealing the conveyed sulphur at its outlet by discharging the condensed sulphur into a heated body of liquid sulphur below the level thereof to render said partial vacuum effective, whereby said partial vacuum in said charge will save fuel and will continuously advance the vapor out from said charge and will advance the condensed sulphur toward said body of liquid sulphur.

2. In a fuel saving method of extracting sulphur liquid and sulphur vapor from native sulphur ore and condensing the sulphur vapor, the steps of heating a closed single charge of sulphur ore to a gradually increasing temperature sufficient first to liquify and then vaporize the sulphur content of said single charge, in drawing off the liquid sulphur while heat is being applied to thereby materially reduce the total volume of the charge and save fuel, in conveying off the sulphur vapor during heating of said charge, in producing a partial vacuum by applying a condensing temperature to the conveyed vapor to condense the latter and the temperature being sufficiently high to prevent solidification of the condensed vapor, and in barometrically sealing the conveyed sulphur at its outlet to render said partial vacuum effective, whereby the partial vacuum in said charge will save fuel and will advance the vapor out from said charge and will advance the condensed sulphur toward said barometric seal.

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