Jan. 5, 1937. C. F. SILSBY 2,067,027

PRODUCTION OF SULPHUR DIOXIDE

Filed Sept. 20, 1934

Fig. 1.

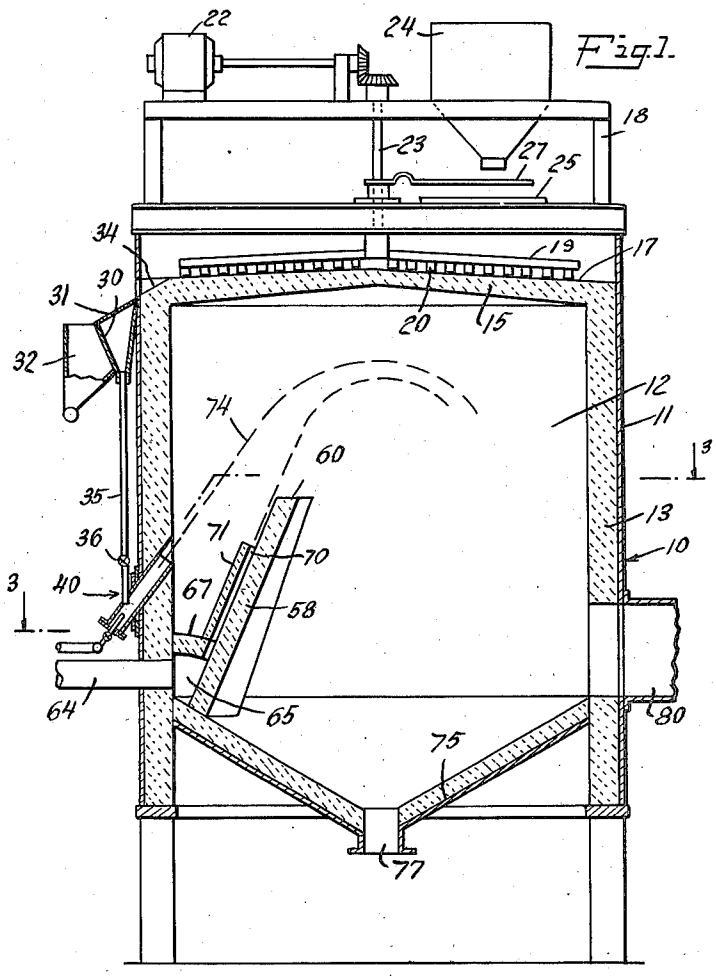


Fig. 2.

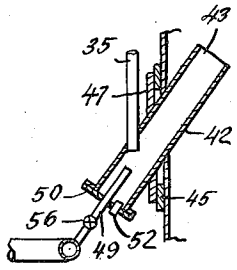
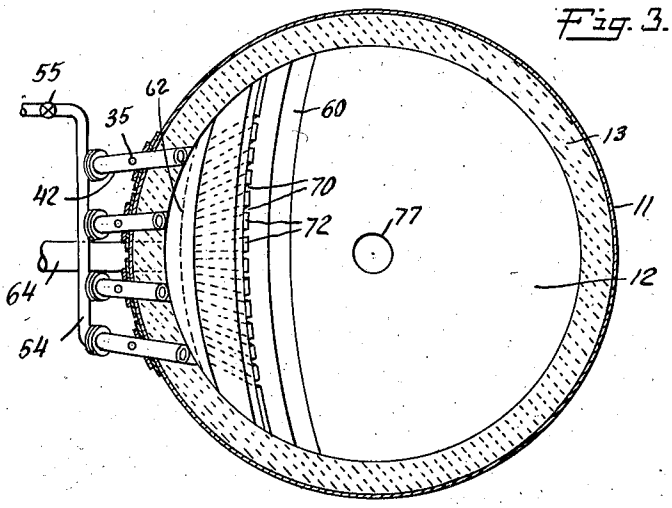


Fig. 3.



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PRODUCTION OF SULPHUR DIOXIDE

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7 Claims. (Cl. 75—9)

This invention is directed to methods and apparatus for roasting metal sulphides, and more particularly for roasting finely divided sulphide ore to desulphurize the same and to produce sulphur dioxide for use in the manufacture of sulphuric acid, or for any other purpose desired.

The nature of the invention, the objects and advantages thereof may be understood from a consideration of the following description taken in connection with the accompanying drawing in which

Fig. 1 is a vertical section of a preferred burner for carrying out the improved process;

Fig. 2 is an enlarged vertical section of a preferred type ore feeding mechanism; and

Fig. 3 is a horizontal section taken approximately on the line 3—3 of Fig. 1.

Referring particularly to Fig. 1 of the drawing, 10 designates a shaft burner, comprising a steel shell or casing 11 within which is placed the furnace lining 13 constructed of suitable refractory material such as fire-brick, and defining a roasting chamber 12 of cylindrical cross-section. The upper part of the combustion chamber is closed off by a crown 15, the top side of which forms a drying or preheating hearth 17. The shell 11 projects upwardly beyond the crown 15 and carries a steel framework 18 which in turn supports ore feeding and rabbling mechanism for the drying hearth.

The surface of the drying hearth 17 is slightly cone-shaped and slopes downwardly toward the shell of the burner. Lying above the hearth are rabble arms 19 having downwardly projecting plows 20 pitched to work sulphides gradually toward the circumference of the drying hearth. Arms 19 are rotated by a motor 22 through shaft 23 supported in bearings so as to maintain the lower ends of the plows 20 spaced with respect to the surface of the drying hearth 17. An ore bin 24, mounted on framework 18 discharges ore onto a platform 25 from which the fines are intermittently dropped onto the center of hearth 17 by a sweep 27 rotating on shaft 23.

Attached to shell 11 by suitable brackets, not shown, are hoppers 30 covered by sloping screens 31. Cut through the steel shell 11 and also in the upper edge of lining 13 are downwardly sloping passages or conduits 34 through which ore is passed from the drying hearth 17 into hoppers 30. It will be understood the number of conduits and hoppers used in conjunction with the burner may correspond with the number of injectors 40 employed. On rotation of rabble arms 19, the sulphide fines are gradually fed through opening 34 into hoppers 30 which discharge fines into feed pipes 35 having control valves 36.

An ore injector, shown in vertical section in Fig. 2 and also shown for convenience in vertical section in Fig. 1, comprises principally a metallic pipe section 42, the inner end of which is set into the shell of the burner in the lower end of the combustion chamber, tube 42 providing an ore inlet conduit 43. Tube 42 is held in position, as indicated in Fig. 2, by a circular plate 45 and a flange 47 bolted to the steel shell 11. The axis of tube 42 is directed upwardly at a relatively sharp angle which may be about 75° from the horizontal.

As shown in Fig. 2, valve-controlled feed pipe 35 projects into the upper side of tube 42. A gas inlet pipe 49 passes through end plate 50 closing the bottom of conduit 43 and terminates beneath the discharge end of pipe 35. Plug 52 provides a means for cleaning out conduit 43 should the same become stopped up.

The burner may be provided with any suitable number of injectors. In the embodiment of the burner illustrated in the drawing four injectors are employed as shown in Fig. 3. The injectors are preferably positioned fan-like as indicated in Fig. 3, and the outer injectors are set at a somewhat higher elevation than the center injectors. The air jet 49 of each injector is connected to an air inlet header 54 provided with a control valve 55. The rate of discharge of air into each conduit 43 may be separately controlled by a valve 56.

The combustion chamber is provided with a fire-brick partition or bridge wall 58 sloping inwardly toward the vertical axis of the combustion chamber. The wall 58, shown in vertical scetion and in plan in Figs. 1 and 3, is built arch-like across the combustion chamber, and is constructed so that any horizontal section through the wall is more or less crescent-shaped. As seen in Fig. 3, the upper edge 60 is only slightly bent horizontally toward the burner wall, whereas the curvature of a horizontal section becomes more pronounced toward the bottom of the wall, for example as indicated by 62, Fig. 3. The greater part of the air used to support combustion in the roasting chamber is introduced through a main 64 opening into a chamber 65 formed by an arch 67, the partition 58 and the inner burner wall. Formed on the upper face of wall 58 is a plurality of relatively small, diverging air ducts 70 opening at the bottom into chamber 65 and terminating at the upper end short of the top of wall 58. Ducts 70 may be formed by suitably placed cover and spacer bricks 71 and 72 respectively. Air dis-

charged from ducts 70 flows upwardly over the surface of partition 58 to the top end thereof.

The bottom of combustion chamber 12 is formed by a hopper-shaped, brick-faced hearth 75 terminating in an outlet 77 through which cinder continuously discharges into a conveyor. As desired, the surface of hearth 75 may be pitched at an angle less or greater than the angle of repose of the cinder. A gas main 80, for withdrawing gaseous products of combustion from roasting chamber 12, opens into the latter at a point just above the hopper-shaped bottom as shown in Fig. 1.

The invention is applicable to the roasting of finely divided metal sulphides such as iron pyrites, pyrrhotite, zinc sulphide or arsenopyrite, but for convenience the operation of the process may be described in connection with the roasting of iron pyrites.

A supply of sulphide fines is maintained in the bin 24 by a suitable conveyor or elevator mechanism not shown. Before roasting is begun, combustion chamber 12 is preheated to the ignition point of the particular ore to be roasted by means of oil burners inserted through conveniently located workholes, not shown. When the desired degree of preheat is obtained, motor 22 is started, and rabble arms 19 and sweep 27 may be rotated at a rate of, say, one revolution in two minutes. Fines run continuously out of hopper 24 onto platform 25, and on each revolution of shaft 23 a regulated quantity of fines is swept off the platform to approximately the center of hearth 17. During rotation of the rabble arms 19 the sulphide fines are gradually worked across the surface of the hearth 17 and into the several passages 34, each of which communicates with a hopper 30. The dry or dry and partly preheated ore runs onto sloping screens 31, which remove lumps, and thence into hoppers 30 and feed pipes 35. Oversize material discharged by screens 31 is collected by receptacles 32 and conveyed by means not shown to a crusher, or used in a bed roaster or otherwise disposed of.

Valves 36 in pipes 35 are adjusted so that a substantially steady stream of fines runs into feed conduits 43. Air, steam, or other gas, not adversely affecting oxidation of the sulphide, may be employed to charge the fines into the combustion chamber. For this purpose it is preferred to employ air which may be admitted to the lower ends of conduits 42 through valve-controlled jets 49 at pressures of, for example, about 5 pounds per square inch.

If the ore being roasted is of such nature that extraneous fuel is required to maintain proper roasting temperatures, such fuel in any suitable form may be introduced into the combustion chamber through the ore feed mechanism. For example, a combustible gas might be employed to inject the fines.

The particular angle of the axes of conduits 42 is dependent upon the size and type of combustion chamber which may be employed. The angles of the axes of conduits 42, the amount of fines fed into the injectors through pipes 35, and the air pressure in jets 49, adjusted by valves 56, are all regulated with respect to the particular size of the roasting chamber so that there is imparted to the ore particles from each injector sufficient velocity to rise through the combustion chamber, away from the walls thereof, to an elevation preferably just below the underside of crown 15. The angular position of a particular conduit 42 and the rate of supply of ore and air thereto are likewise controlled so that the horizontal travel of the ore particles while reaching the top of the combustion chamber and after dropping to the bottom thereof, preferably does not exceed, say, three-quarters of the diameter of the roasting chamber. Referring to Fig. 1, the dotted line 74 indicates the approximate path of travel of an ore particle of average size introduced through one of the injectors. Thus it will be seen the ore particles move in a trajectory having initially a large vertical component, then a large horizontal component and thereafter a large vertical component. In this manner the fines are caused to pass over substantially the longest possible path of travel considering the proportions of the combustion chamber. A plurality of injectors are used preferably to effectively cover the area of the combustion chamber. As previously mentioned, the outer injectors are set at a somewhat higher elevation than the inner injectors, as the horizontal component of the arch of ore particles admitted through the outer injectors is less than in the case of the inner injectors.

In conjunction with other aspects, one of the important features of the invention relates to the relative proportions of the combustion chamber. In the specific embodiment of the burner illustrated in the drawing, the diameter and height of the combustion chamber are approximately equal. While this proportion is preferred, it is understood that the diameter of the chamber may in some instances desirably be less than or exceed the height by a substantial amount. In any event, to obtain the full benefits of the invention, the horizontal cross-section of the combustion chamber should be relatively large. The large diameter of the combustion chamber in conjunction with the described manner of introducing the fines and combustion supporting air prevents contact between any substantial quantities of ore particles and the hot walls of the roasting chamber, thus avoiding accumulation of scar on the walls. As known to those skilled in the art, scar formation is one of the most serious operating difficulties encountered in suspension roasting.

The major portion of the total quantity of air or other oxidizing gas, necessary to support the oxidation reaction, is drawn into the combustion chamber at the bottom through main 64 and ducts 70 and enters the combustion chamber at a velocity substantially less than the velocity of the ore particles introduced through the conduits 42. Where air is employed for injecting the fines through conduits 42, not more than about 10% of the total air required for oxidation would ordinarily be introduced through the several air jets 49, although larger amounts may be used if desired. In the preferred operation, where only a relatively small proportion of total air is introduced through the injectors, it may be considered that substantially all the air is introduced into the combustion chamber through the main 64 and ducts 70, and initially flows upwardly through the combustion chamber. It should be noted that in accordance with the preferred construction ducts 70 are made of sufficiently restricted cross-section so that incoming air is flowed through the ducts at a velocity sufficient to maintain a film of air over that portion of wall 58 above the ends of ducts 70 and to cause the air to rise substantially above the edge 60 of wall 58, but the velocity of this main body of air will be materially less than the velocity of

the air and ore introduced through the ore injectors.

The method just described of introducing the sulphide fines and the main stream of oxidizing gas at different velocities contributes materially to the successful operation of the present invention. By imparting to the ore particles, independently of the main stream of oxidizing gas, sufficient velocity to cause them to pass through the desired trajectory, the latter can be controlled and maintained as desired to avoid substantial contact of the ore particles with the walls of the furnace to which the ore particles might adhere with resulting scar formation. Inasmuch as the ore particles have a velocity greater than that of the main air stream, the tendency of the latter to disrupt the desired path of travel of the ore particles and cause them to impinge on the walls or other surfaces of the combustion chamber is minimized.

It is to be observed during the latter part of the upward travel of the fines, the rate of vertical movement of the particles rapidly decreases to zero, and thereafter, during the initial part of the descent of the fines, the rate of downward movement of the fines is relatively small. Hence, while passing upwardly and downwardly through the upper zone of the combustion chamber, the average rate of movement of the fines is low, and this slow rate of travel increases the time the particles are in the roasting atmosphere, thereby giving a relatively long time for the reaction to proceed, thus permitting use of a roasting chamber of relatively short longitudinal dimension, the roasting of relatively coarse ore, and increased capacity of the burner.

The sulphides are injected into the bottom of the combustion chamber through the several injectors **40**, and, as substantially all of the air to support roasting is drawn into the combustion chamber through ducts **70**, it will be seen the fines are immediately charged into an atmosphere relatively rich in oxygen. Ignition of the upwardly moving ore particles takes place rapidly owing to the high temperatures existing in the combustion chamber. The large amount of air flowing upwardly over the upper surface of the baffle **58**, prevents contacting of any substantial quantity of fines with the surface of baffle **58** and accumulation of scar thereon is thus prevented. The fines, following ignition, continue to rise to approximaetly the top of the combustion chamber, the temperature of the particles increasing because of rapidly progressing roasting. As previously explained, the average rate of travel of the ore particles upwardly and downwardly through, say, the upper half of the combustion chamber is relatively low. Since the air for roasting is drawn into the combustion chamber as described in a stream moving upwardly along with the incoming fines, there is a substantial concentration of oxygen in the upper end of the roasting chamber. Hence, the ore particles, during the relatively long time of suspension in the upper half of the combustion chamber, are in an atmosphere relatively rich in oxygen. The air current from ducts **70**, flowing upwardly underneath the stream of fines, tends to form a support or cushion for the fines and aids in dispersing the fines in the upper part of the combustion chamber beyond the top edge of the baffle. During the fall of the particles through the lower half of the combustion chamber roasting proceeds to completion, the cinder collecting on hearth **75**.

Conduit **80** preferably communicates with the inlet side of a blower so that the burner operates under a slightly negative pressure. When so operating, it is desirable to have partition **58** extend a substantial distance toward the top of the combustion chamber so as to cause the incoming air stream from ducts **70** to flow initially upward a substantial distance to insure the presence of a relatively large amount of oxygen in the top of the combustion chamber. If it is desired to operate the burner under a positive pressure, the cinder discharge **67** may be provided with an air lock. If desired, the air introduced through main **64** may be preheated.

The iron oxide cinder falling on hopper-shaped hearth **75** is free-flowing and continuously runs out through opening **77** into a suitable conveyor.

The sulphur dioxide gas withdrawn through gas main **80** may be used in the manufacture of sulphuric acid. The sulphur dioxide content of the burner gas may be regulated as desired by adjusting the amount of air fed into the combustion chamber as is known by those skilled in the art. Gases containing 10.0–12.5 per cent sulphur dioxide may be readily made by this process.

By injecting the fines and combustion supporting gas into the lower edge or periphery of a relatively unobstructed roasting chamber of large cross section, causing the fines and air to pass upwardly to adjacent the top of the combustion chamber and then downwardly toward the bottom of the combustion chamber so that the fines and combustion supporting gas pass substantially co-currently through the roasting zone, controlling introduction into and passage of the fines through the enlarged chamber so that the fines do not contact the roasting chamber walls, and withdrawing gaseous combustion products from the bottom of the roasting chamber, the invention provides a high capacity suspension roasting process in which the fines are passed over a long path of travel and maintained in the roasting atmosphere for a maximum period of time, scar formation on the roasting chamber walls is avoided. One of the important advantages of the invention is the provision of a large capacity process affording roasting of large quantities of fines per unit of time per unit of apparatus. This advantage and that of avoiding scar formation on the burner walls may not be had when operating in accordance with other generally similar prior proposed methods in which fines and air are introduced into and gaseous combustion products withdrawn from the bottom of the roasting chamber.

In the above description and in the appended claims the term "fines" is intended to designate material in such a degree of subdivision as may be roasted while suspended in oxidizing gas.

I claim:

1. The method of roasting finely divided metal sulphides to produce sulphur dioxide which comprises introducing sulphide fines into the lower portion of a combustion chamber of relatively large horizontal cross-section at a velocity such as to carry the fines particles into the upper portion of the combustion chamber, then causing the said fines to pass downwardly through the said combustion chamber while out of contact with the walls of said combustion chamber, separately introducing a stream of combustion supporting gas moving at a velocity less than that of said fines particles into the portion of the combustion chamber adjacent the point of introduction of the fines, and passing the combus-

tion supporting gas upwardly and then downwardly through the combustion chamber in substantially co-current flow with the fines and withdrawing sulphur dioxide-containing gases from the lower portion of the combustion chamber.

2. The method of roasting finely divided metal sulphides to produce sulphur dioxide, which comprises introducing sulphide fines adjacent a side wall and also the base portion of a substantially unobstructed combustion chamber of relatively large horizontal cross-section and heated to a emperature above the ignition point of the fines by means of a stream of air under superatmospheric pressure, causing the fines to pass upwardly and away from said wall, then causing the said fines to pass downwardly through the said combustion chamber while out of contact with the walls of said combustion chamber, separately introducing a stream of combustion supporting gas moving at a velocity less than that of said fines particles into the portion of the combustion chamber adjacent the point of introduction of the fines and passing the oxygen-containing gas upwardly and then downwardly through the combustion chamber in substantial co-current flow with the fines, discharging the cinder from the bottom portion of the combustion chamber, and separately withdrawing sulphur dioxide-containing gases from the bottom portion of the combustion chamber.

3. Apparatus for roasting finely divided metal sulphides comprising a shell forming a substantially cylindrical, vertically disposed, substantially unobstructed combustion chamber of relatively large horizontal cross-section, a fines ore feeding conduit in the periphery of the shell adjacent the base thereof, said conduit being inclined at a relatively high angle to the horizontal and opening into the combustion chamber at a point higher than the inlet end of the said ore feeding conduit, means for feeding fines ore into the feed conduit to charge ore into the combustion chamber in an upwardly direction, a gas inlet port in the periphery adjacent the base of the shell and the ore feeding conduit, a baffle in the combustion chamber arranged to direct gas introduced through said port in an upward direction substantially co-current with the fines ore, means for discharging cinder from the bottom of the combustion chamber, and a gas outlet at the bottom for withdrawing gaseous products of combustion.

4. Apparatus for roasting finely divided metal sulphides comprising a shell forming a substantially cylindrical, vertically disposed, substantially unobstructed combustion chamber of relatively large horizontal cross-section, a plurality of adjacently disposed fines ore feeding conduits in the periphery of the shell near the base thereof, said conduits being inclined at a relatively high angle to the horizontal and opening into the combustion chamber at points higher than the inlet ends of the said ore feeding conduits, means for feeding fines ore into the feed conduits to charge ore into the combustion chamber in a plurality of upwardly directed streams, a gas inlet port in the periphery adjacent the base of the shell and the ore feeding conduits, means comprising a relatively vertically disposed partition extending across a portion of the combustion chamber and sloping toward the center thereof for directing gas introduced through said port in an upward direction substantially co-currently with the fines ore, means for discharging cinder from the bottom of the combustion chamber, and a gas outlet at the bottom for withdrawing gaseous products of combustion.

5. The method of roasting finely divided metal sulphides which comprises introducing sulphide fines adjacent a side wall and also the base portion of a substantially unobstructed combustion chamber of relatively large horizontal cross-section and heated to a temperature above the ignition point of the fines, introducing said fines by means of a stream of gas of such superatmospheric pressure and so directed as to cause the fines to pass upwardly away from said wall over a path having a horizontal component and to points adjacent the top of the combustion zone and to then cause the said fines to pass downwardly through the said combustion zone while out of contact with the walls of said combustion chamber, separately introducing oxidizing gas in quantity sufficient to support combustion of the fines into the portion of the combustion chamber adjacent the point of introduction of the fines and passing the combustion supporting gas upwardly and then downwardly through the combustion chamber in substantially co-current flow with the fines, maintaining the fines in suspension in the oxidizing gas for a period of time sufficient to effect substantially complete desulphurization of the fines, withdrawing suphur dioxide-containing gases from the lower portion of the combustion zone, and discharging metal oxide cinder from the lower portion of the combustion zone.

6. The method of roasting finely divided metal sulphides which comprises introducing sulphide fines adjacent a side wall of a substantially unobstructed combustion chamber of relatively large horizontal cross-section and heated to a temperature above the ignition point of the fines, introducing said fines by means of a stream of gas of such superatmospheric pressure and so directed as to cause the fines to pass upwardly away from said wall over a path having a horizontal component and to points adjacent the top of the combustion zone and to then cause the said fines to pass downwardly through the said combustion zone while out of contact with the walls of said combustion chamber, introducing oxidizing gas in quantity sufficient to support combustion of the fines into the portion of the combustion chamber adjacent the point of introduction of the fines and passing the combustion supporting gas upwardly and then downwardly through the combustion chamber in substantially co-current flow with the fines, maintaining the fines in suspension in the oxidizing gas for a period of time sufficient to effect substantially complete desulphurization of the fines, withdrawing sulphur dioxide gases from the bottom of the combustion zone, and discharging metal oxide cinder from the bottom of the combustion zone.

7. The method of roasting finely divided metal sulphides to produce sulphur dioxide which comprises introducing sulphide fines into a combustion chamber of relatively large horizontal cross-section, causing the sulphide fines to move through a trajectory having initially a large horizontal and a large vertical component, then a predominating horizontal component and thereafter a large vertical component, said trajectory being such as to avoid substantial contact of the sulphide fines with surfaces in the combustion chamber throughout the movement of the sulphide fines, introducing a stream of oxygen con-

taining gas into the combustion chamber separately from said sulphide fines and causing said stream of oxygen containing gas to pass upwardly and then downwardly in the combustion chamber in substantially co-current flow with the sulphide fines whereby the particles of sulphide fines are maintained in a zone of high oxygen concentration in the upper portion of the combustion chamber for a maximum period of time, and maintaining the fines in suspension in the oxidizing gas for a period of time sufficient to effect substantially complete desulphurization of the fines.

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