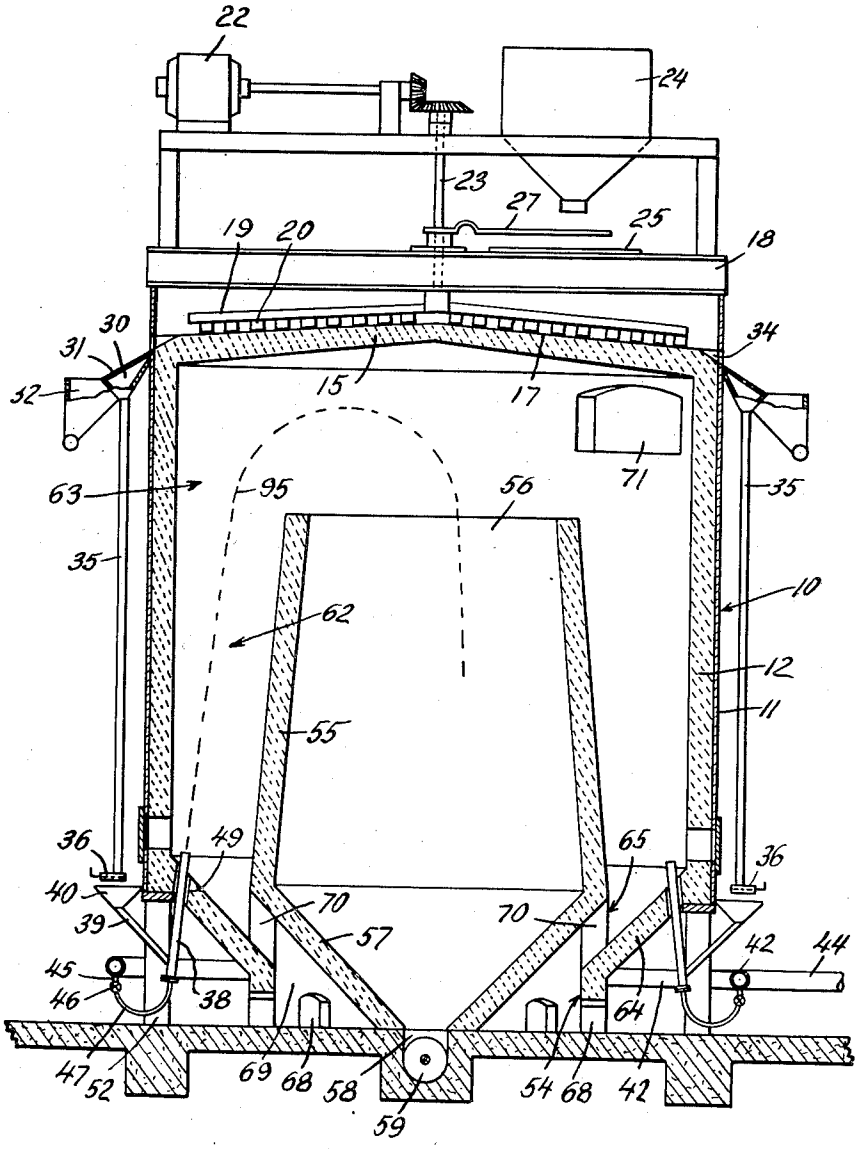
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PRODUCTION OF SULPHUR DIOXIDE

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Fig. 1.



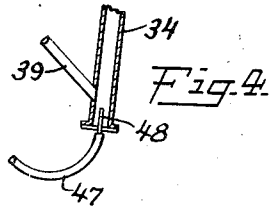




Fig. 4.

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Fig. 2.

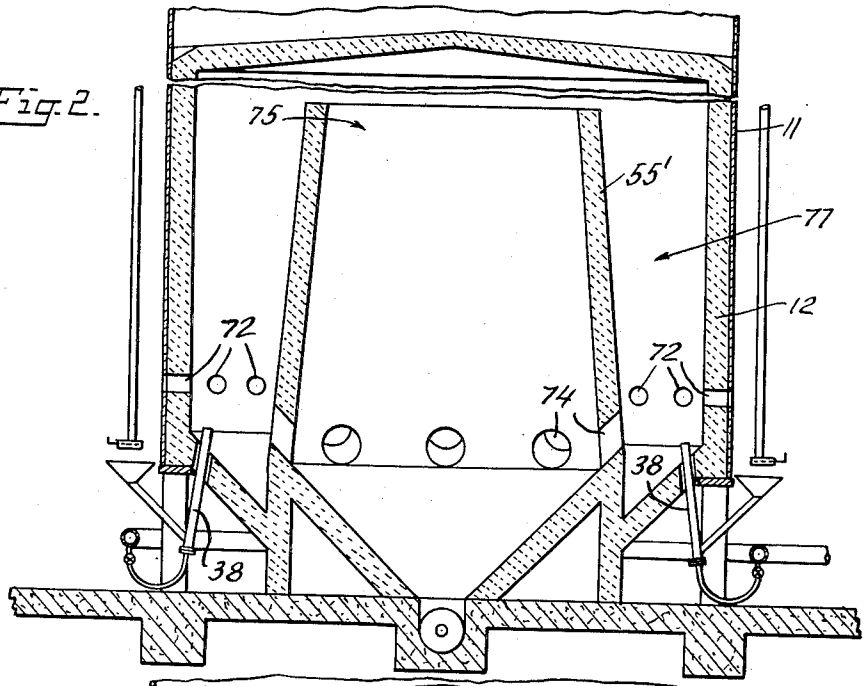
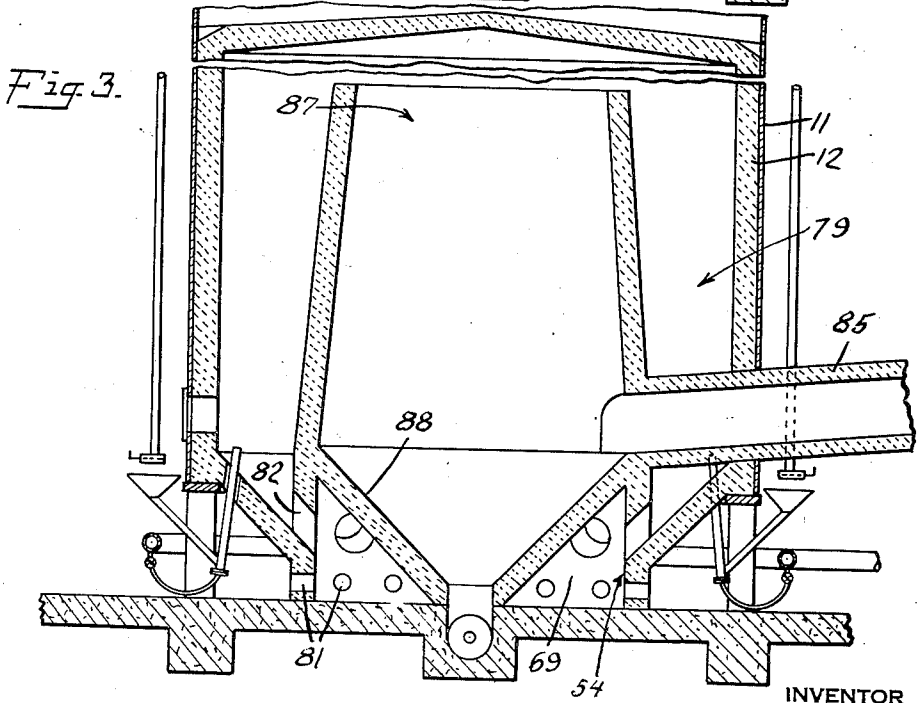



Fig. 3.




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Patented Feb. 9, 1937 2,070,237

# UNITED STATES PATENT OFFICE

2,070,237

## PRODUCTION OF SULPHUR DIOXIDE

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Application December 31, 1934, Serial No. 759,875

5 Claims. (Cl. 75—9)

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

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

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

Fig. 2 is a vertical section of the lower portion of a modified burner;

Fig. 3 is a vertical section of the lower portion of another modified burner, and

Fig. 4 is a vertical section of a fines injector.

Referring particularly to Fig. 1 of the drawings, 10 designates a shaft burner comprising a steel shell or casing 11 within which is placed the furnace lining 12 made of suitable refractory material such as firebrick. The upper part of the burner is formed 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 framework 18 which in turn supports ore feeding and rabbling mechanism for the drying hearth.

The surface of 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 above the surface of the drying hearth. 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 with shaft 23.

Attached to shell 11 by suitable brackets, not shown, are hoppers 30 covered by sloping screens 31. Oversized 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. Cut through shell 11 near the upper end are downwardly sloping passages or conduits 34 through which ore is passed from drying hearth 17 into hoppers 30. It will be understood the number of conduits 34 and hoppers 30 used in conjunction with the burner correspond with the number of fines injectors employed. On rotation of rabble arms 19, the sulphide fines are gradually fed through openings 34 into hoppers 30, which discharge fines into feed pipes 35 having at their lower ends suitable means such as slide valves 36 for controlling flow of fines out of the lower ends of pipes 35.

The fines injectors, one of which is shown in vertical section in Fig. 4, comprise principally an elongated pipe section or nozzle 38 providing an ore inlet conduit. A pipe 39, carrying on the upper end funnel 40, is arranged to feed fines into the lower end of nozzle 38. Air or other gas used to inject the fines into the burner is supplied from a bustle pipe 42 surrounding the lower end of the burner. Bustle 42 may be connected to a blower or other source of air through pipe 44. Adjacent each injector, pipe 42 is provided with a nipple 45 having a control valve 46. Numeral 47 indicates a flexible hose connection attached at one end to nipple 45 and at the other end to air jet 48 in the bottom of nozzle 38. The upper end of each nozzle 38 extends through an opening 49 and projects into the lower end of the burner. Each injector unit, comprising a nozzle 38, feed pipe 39, funnel 40 and connection 47, may be held approximately in the position shown in the drawings by a suitable bracket not shown made in such a way as to permit adjustment of nozzle 38 toward and away from the vertical axis of the burner. Each opening 49 is made sufficiently larger than the diameter of a nozzle to permit the desired adjustment. The burner may be provided with any desired number of injectors; in the embodiment of the burner illustrated in Fig. 1, two injectors are shown.

The outer circular furnace lining 12 and casing 11 are carried by a plurality of pillars 52. A short cylindrical wall 54, positioned concentrically with respect to outer casing 11, forms a support for a vertically elongated, somewhat frusto-conical shaped shell 55 made of brickwork of substantial thickness. The vertical lengths of shell 55 and outer furnace lining 12 are desirably about in the proportions shown in the drawings. Shell 55 provides on the inside thereof a sedimentation chamber 56 having a hopper-shaped bottom formed by an inverted cone-like hearth 57 terminating in a cinder discharge trough 58 provided with a screw conveyor 59, or other suitable means for discharging cinder from the burner.

The outer surface of shell 55 and the inner

surface of the lower part of furnace lining 12 form an annular chamber 62 which together with the space between the upper end of the shell 55 and the under side of crown 15 constitute a combustion chamber designated generally by 63. The bottom of annular chamber 62 is formed by an inverted frusto-conical shaped wall section 64 and the upper end 65 of a cylindrical supporting wall 54. Circumferentially spaced about the lower edge of wall 54 are several openings 68 through which air is introduced into the air preheating chamber 69 formed by the inner surface of circular wall 54 and the under side of sedimentation chamber hearth 57. In the upper edge of circular wall 54 are passages 70 affording communication between chamber 69 and the lower end of annular chamber 62. Each opening 70 is of substantial size and is located in a vertical plane including a nozzle 38 and the vertical axis of the burner.

The bulk of the air used to support combustion in the burner is introduced through openings 68, chamber 69, and passages 70. A gas main 71 for withdrawing gaseous products of combustion from the burner opens into the upper end of the combustion chamber 63 at a point preferably just beneath the under side of crown 15.

The burner shown in vertical section in Fig. 2 is in most respects the same as described in connection with Fig. 1. The major differences of construction of the burner of Fig. 2 are that the air inlet ports 72 are circumferentially spaced about the lower end of outer casing 11 and lie in a horizontal plane positioned substantially above the upper end of nozzles 38 and also above the outlet ends of a plurality of openings 74 in shell 55' which openings afford communication between the lower end of sedimentation chamber 75 and the lower end of annular chamber 77. In the burner of Fig. 2, the gas main, for withdrawing gaseous products of combustion from the burner, opens into the top of the combustion chamber as shown in Fig. 1.

The construction of the burner of Fig. 3 is generally similar to that of Fig. 1. In Fig. 3, the air for supporting oxidation of the fines passes into the lower end of annular chamber 79 through openings 81 in the lower edge of circular wall 54, chamber 69, and passages 82. The major structural difference between the burners of Fig. 3 and of Fig. 1 is that in the furnace of Fig. 3, the combustion gas offtake conduit 85 passes through the lower ends of outer casing 11 and lining 12, through the lower end of annular chamber 79, and opens into the bottom of sedimentation chamber 87 at about the upper edge of hearth 88.

In the burners of both Figs. 2 and 3, it will be understood the relative proportions between the vertical lengths of the sedimentation chambers and the outer burner casings 11 and linings 12 are substantially the same as 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.

Referring to Fig. 1, a supply of sulphide fines is maintained in the bin 24 by a suitable conveyor or elevator mechanism not shown. Before roasting is begun, the inside of the burner is preheated to the ignition point of the particular ore to be roasted as 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 concentrates are gradually worked across the surface of the hearth 17 and into the several passages 34. 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.

Valves 36 in pipes 35 are adjusted so that substantially steady streams of fines of required volumes run into the lower ends of nozzles 38 through funnels 40 and pipes 39. 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 nozzles 38 through jets 48 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 with respect to the horizontal of the axes of nozzles 38 is dependent upon such features as the size of the burner, the height of the combustion chamber, the height of shell 55 and the distance between shell 55 and the furnace lining 12. The angle of the axes of nozzles 38, the amount of fines fed into the injectors through pipes 35, and the air pressure in jets 48, adjusted by valves 46, are all regulated with respect to the proportions of the particular roasting chamber so that there is imparted to the sulphide fines 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 nozzle 38 and the rate of supply of fines 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 of sedimentation chamber 56, does not exceed, say, two-thirds and preferably about one-half the diameter of the burner. The dotted line 95 of Fig. 1 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 first over a trajectory having an initially short horizontal component and a relatively large vertical component, then a relatively large horizontal component and a short vertical component, and thereafter a relatively short horizontal component and large vertical component. In this way, the fines are caused to pass over substantially the longest possible path of travel considering the proportions of the combustion chamber.

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 drawings, the diameter and height of the burner within furnace lining 12 are approximately equal. While this proportion is preferred, it is understood that the diameter 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 burner should be relatively large. The large diameter of the combustion chamber in conjunction with the desired manner of introducing the fines 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 process of the invention also permits use of burners of relatively low height which is an important feature with respect to cost reduction both with respect to the burner and the building within which it is housed.

A major portion of the total quantity of air or other oxidizing gas, necessary to support the oxidation reaction is drawn into the combustion chamber 63 at the bottom through ports 68, chamber 69, and passages 70. The incoming air enters the combustion chamber at a velocity substantially less than the velocity of the ore particles introduced through nozzles 38. Where air is employed for injecting the fines through nozzles 38, not more than about 10% of the total air required for oxidation would ordinarily be introduced through the several air jets 48, 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 preheating chamber 69 as described, and initially flows upwardly through the combustion chamber.

The described method of introducing the sulphide fines and the main stream of oxidizing gas into the burner at different velocities is a feature of relative importance. By imparting to the ore particles, independently of the main stream of oxidizing gas, sufficient velocity to cause them to pass over a trajectory such as described, the path of the ore particles can be controlled and maintained as desired to substantially avoid contact of ore particles with the hot furnace walls 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 interrupt 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 reduced.

It is to be observed that during the latter part of the upward travel of the fines and during that portion of downward travel say prior to entry into the top of subsidence chamber 56, the rate of vertical 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 vertical dimension, the roasting of relatively coarse ore, and increased capacity of the burner.

Since the sulphides are injected into the bottom of the combustion chamber and as the air to support roasting is drawn in through openings 70 at the bottom of the combustion chamber, it will be seen the fines are immediately charged into an atmosphere rich in oxygen. Ignition of the upwardly moving ore particles takes place rapidly owing to the high temperatures existing in the combustion chamber. Prompt ignition of the fines is also facilitated by heat contained in the incoming air which is preheated to a substantial extent in chamber 69 surrounding hearth 57. The fines, following ignition, continue to rise to approximately the top of the combustion chamber, the temperature of the particles increasing because of rapidly progressing roasting. Part of the air stream entering the combustion chamber from openings 70 moves upwardly generally between the fines and the outer surface of shell 55 and aids in preventing scarring on the outer surface and top edge of shell 55. Combustion of the fines particles is substantially complete by the time the particles fall back and enter the top of sedimentation chamber 56.

The sulphur dioxide gases formed are withdrawn from the combustion chamber through main 71, and 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 known by those skilled in the art. Gases containing 10% and upwards of sulphur dioxide may be made by this process. Cinder particles drop through a quiescent zone maintained in sedimentation chamber 56, the cinder collecting in a free-flowing condition on hearth 57 and running continuously into trough 58 from which the cinder is removed by conveyor 59.

In accordance with the present invention, provision of inner shell 55 and the associated chamber 56 provide several operating advantages, some of which are as follows:

In the preferred construction, shell 55 is made of such height and diameter as to provide about 25 to 40% more wall surface within the burner than would be the case in the absence of the shell. As has been noted, the preferred relative proportions between the shell 55 and the outer walls of the burner are about as illustrated in the drawings in which instance the outside face of shell 55 provides about 30% more wall surface inside the burner. The outer face of shell 55 acts to reflect radiant heat to the combustion zone 63 and also to air and fines entering the lower part of annular chamber 62. The result of this is to raise the temperatures in the combustion zone above those which would exist in the absence of shell 55. Temperatures prevailing in the combustion zone may be of the order of 1700 to 1900° F. Higher temperatures in chamber 62 and in the combustion zone as a whole in turn cause more rapid ignition of fines and insure substantially complete combustion and desulphurization before the fines enter the top of sedimentation chamber 56. The presence of the added heart reflecting surface afforded by the shell 55 materially enhances rapidity of ignition and completion of combustion and desulphurization which are to a large de-

gree dependent upon the amount of radiant heat emanating from the heated walls.

Introduction of air through chambers such as 69 of Fig. 1 absorbs heat from hearth 57 and preheats the incoming combustion supporting air. Admission of this preheated air into the zone of initial introduction of the fines aids in rapid ignition and completion of combustion of the fines.

In the embodiment of the burner illustrated, refractory shell 55 is made about eight to ten inches thick, and consequently is a poor conductor of heat from chamber 62 to sedimentation chamber 56 which thus forms a zone substantially insulated from the high combustion temperatures in the burner. Shell 55 accordingly provides the further important advantage of shielding the burnt-out or desulphurized ore particles from the radiant heat and high temperatures of the combustion zone outside sedimentation chamber 56. Cinder produced in the process is an excellent absorber of radiant heat being about 95% as effective as lamp black. After desulphurization and entry of the cinder into the top of chamber 56, shell 55 protects the iron oxide cinder from a great part of the heat radiated in the combustion chamber, and hence the cinder reaches the bottom of the sedimentation chamber at considerably lower temperature than if exposed to intense radiant heat on its downward path in the absence of refractory shell 55, thus resulting in prevention of clinkering of cinder on hearth 57 and facilitating removal of cinder from the burner in a free-flowing condition. On account of the insulating effects of shell 55, the temperatures in sedimentation chamber 56 may be of the order of about 250 to 400° F. less than those prevailing in the hottest parts of the combustion zone.

In suspension roasting, a condition of turbulence tends to exist in the combustion chamber caused by rapid burning of the ore particles and changes in air and gas volumes by abrupt changes in temperature. This tends to maintain burnt ore particles in suspension and to interfere with settling of such cinder particles. In some instances this may cause suspension of substantial quantities of cinder and dust in the sulphur dioxide gas stream leaving the burner. Such condition is prevented to a large extent by sedimentation chamber 56 which provides a quiescent zone in which the cinder is not influenced by gas movements in the ore burning zone. Provision of chamber 56 permits fine burnt ore particles to readily settle out of the combustion zone in the burner.

In addition to the above advantages outlined in connection with the apparatus of Fig. 1, in the burner of Fig. 2, there are provided in the lower end of sedimentation chambers 75 ports 74 which permit relatively slow circulation of hot sulphur dioxide gases through the sedimentation chamber 75 and annular chamber 77. The comparatively slow downward gas movement in chamber 75 prolongs the time of contact of the ore particles with a more or less oxidizing atmosphere thus creating a condition conducive to complete desulphurization. The same slow down-flow of gas in chamber 75 aids in settling the roasting ore particles. The induced upward flow through annular chamber 77 of sulphur dioxide bearing gases from the lower part of sedimentation chamber 75 operates to transfer some of the heat from the iron oxide particles in zone 75 to the lower end of chamber 77, thus further aiding in avoiding clinkering of cinder in sedimentation chamber 75, and enhancing the rapidity and completeness of roasting of ore introduced into the lower end of chamber 77.

In the burner of Fig. 3 in which the sulphur dioxide combustion gases are withdrawn through conduit 85 from the lower end of sedimentation chamber 87, co-flow of cinder and gases through chamber 87 provides long contact of the roasted ore particles with the sulphur dioxide and oxygen containing gases, while at the same time shielding the cinder from the high temperatures of the primary combustion zone. This procedure is conducive to desulphurization and avoidance of clinker formation.

I claim:

1. The method for roasting finely divided metal sulphide material to produce sulphur dioxide which comprises injecting the sulphide material upwardly at the outer periphery and at the base portion of a combustion zone by means of air at superatmospheric pressure, introducing a stream of oxidizing gas into the base portion of the combustion zone, roasting the material in suspension in the oxidizing gas while passing the material and the gas upwardly in co-current flow relation, withdrawing sulphur dioxide from the top of the combustion zone, passing the material, while suspended, downwardly through an inner sedimentation zone communicating at the top with and arranged concentrically with respect to the outer combustion zone, said sedimentation zone being relatively insulated from high combustion temperatures whereby the material is shielded, while suspended, from high combustion temperatures and absorption of heat by the material is minimized, and discharging solid material from the bottom of the sedimentation zone.

2. The method for roasting finely divided metal sulphide material to produce sulphur dioxide which comprises injecting the sulphide material upwardly at the base portion of a combustion zone so as to cause the material to move upwardly through the combustion zone to a point approaching the upper end thereof, introducing a stream of oxidizing gas into the base portion of the combustion zone, roasting the material in suspension in the oxidizing gas while passing the material and the gas upwardly in co-current flow relation, withdrawing sulphur dioxide from the top of the combustion zone, passing the material, while suspended, downwardly through a sedimentation zone communicating at the top with and arranged substantially concentrically with respect to the combustion zone, said sedimentation zone being relatively insulated from high combustion temperatures whereby the material is shielded, while suspended, from high combustion temperatures, absorption of heat by the material is minimized, and whereby the material is permitted to settle through a zone substantially undisturbed by the gas currents of the combustion zone; and discharging solid material from the bottom of the sedimentation zone.

3. The method for roasting finely divided metal sulphide material to produce sulphur dioxide which comprises injecting the sulphide material upwardly at the base portion of a combustion zone so as to cause the material to move upwardly through the combustion zone to a point approaching the upper end thereof, introducing a stream of oxidizing gas, moving at a velocity

substantially less than that of the initial rate of movement of the fines material, into the base portion of the combustion zone, roasting the material in suspension in the oxidizing gas while passing the material and the gas upwardly in co-current flow relation, withdrawing sulphur dioxide from the top of the combustion zone, passing the material, while suspended, downwardly through a sedimentation zone communicating at the top with and arranged substantially concentrically with respect to the combustion zone, said sedimentation zone being relatively insulated from high combustion temperatures whereby the material is shielded, while suspended, from high combustion temperatures, absorption of heat by the material is minimized, and whereby the material is permitted to settle through a zone substantially undisturbed by the gas currents of the combustion zone; and discharging solid material from the bottom of the sedimentation zone.

4. The method for roasting finely divided metal sulphide material to produce sulphur dioxide which comprises injecting the sulphide material upwardly at the outer periphery and at the base portion of a combustion zone by means of gas at superatmospheric pressure, introducing a stream of oxidizing gas, moving at a velocity substantially less than that of the initial rate of movement of the fines material, into the base portion of the combustion zone, roasting the material in suspension in the oxidizing gas while passing the material and the gas upwardly in co-current flow relation, withdrawing sulphur dioxide from the top of the combustion zone, passing the material, while suspended, downwardly through a sedimentation zone communicating at the top with and arranged substantially concentrically with respect to the combustion zone, said sedimentation zone being relatively insulated from high combustion temperatures whereby the material is shielded, while suspended, from high combustion temperatures, absorption of heat by the material is minimized, and whereby the material is permitted to settle through a zone substantially undisturbed by gas currents of the combustion zone; and discharging solid material from the bottom of the sedimentation zone.

5. The method for roasting finely divided metal sulphide material to produce sulphur dioxide which comprises injecting the sulphide material upwardly at the outer periphery and at the base portion of a combustion zone by means of gas at superatmospheric pressure, introducing a stream of oxidizing gas moving at a velocity substantially less than that of the initial rate of movement of the fines material into the base portion of the combustion zone, roasting the material in suspension in the oxidizing gas while passing the material and the gas upwardly in co-current flow relation, withdrawing sulphur dioxide from the top of the combustion zone, passing the material, while suspended, downwardly through an inner sedimentation zone communicating at the top with and arranged concentrically with respect to the outer combustion zone, said sedimentation zone being relatively insulated from high combustion temperatures whereby the material is shielded, while suspended, from high combustion temperatures, absorption of heat by the material is minimized, and whereby the material is permitted to settle through a zone substantially undisturbed by gas currents of the combustion zone; and discharging solid material from the bottom of the sedimentation zone.

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