Aug. 6, 1940. L. W. BOOTON ET AL 2,210,479

PROCESS AND APPARATUS FOR OXIDIZING SULPHIDE ORES

Filed Feb. 27, 1939 3 Sheets-Sheet 1

Fig. 1.

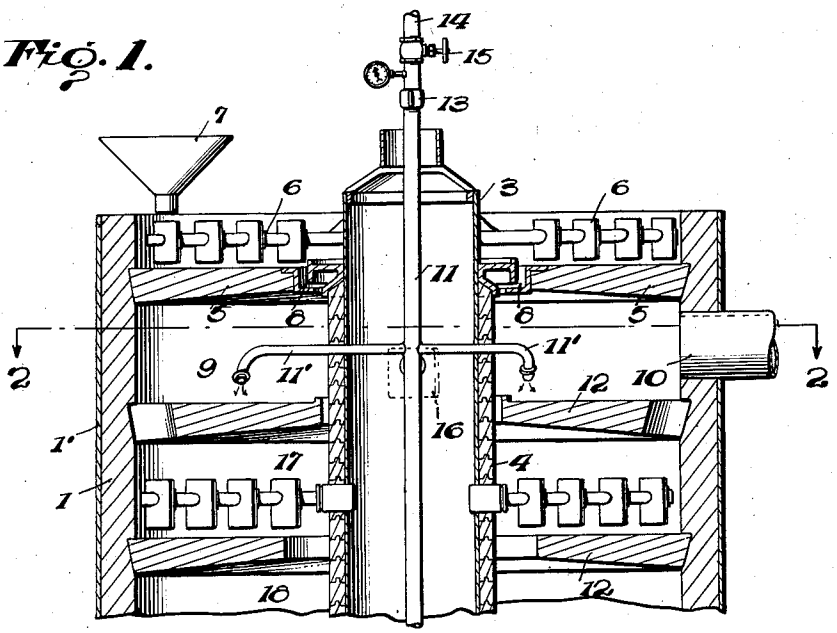
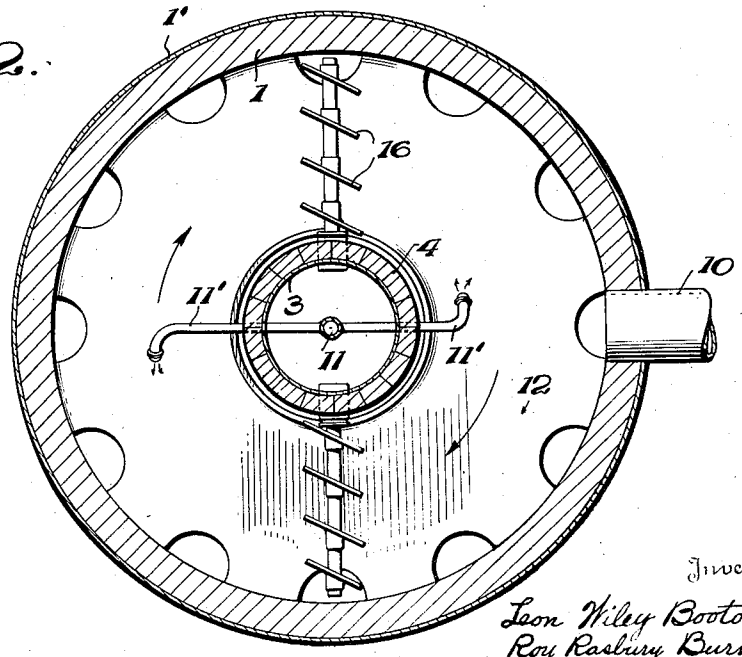


Fig. 2.



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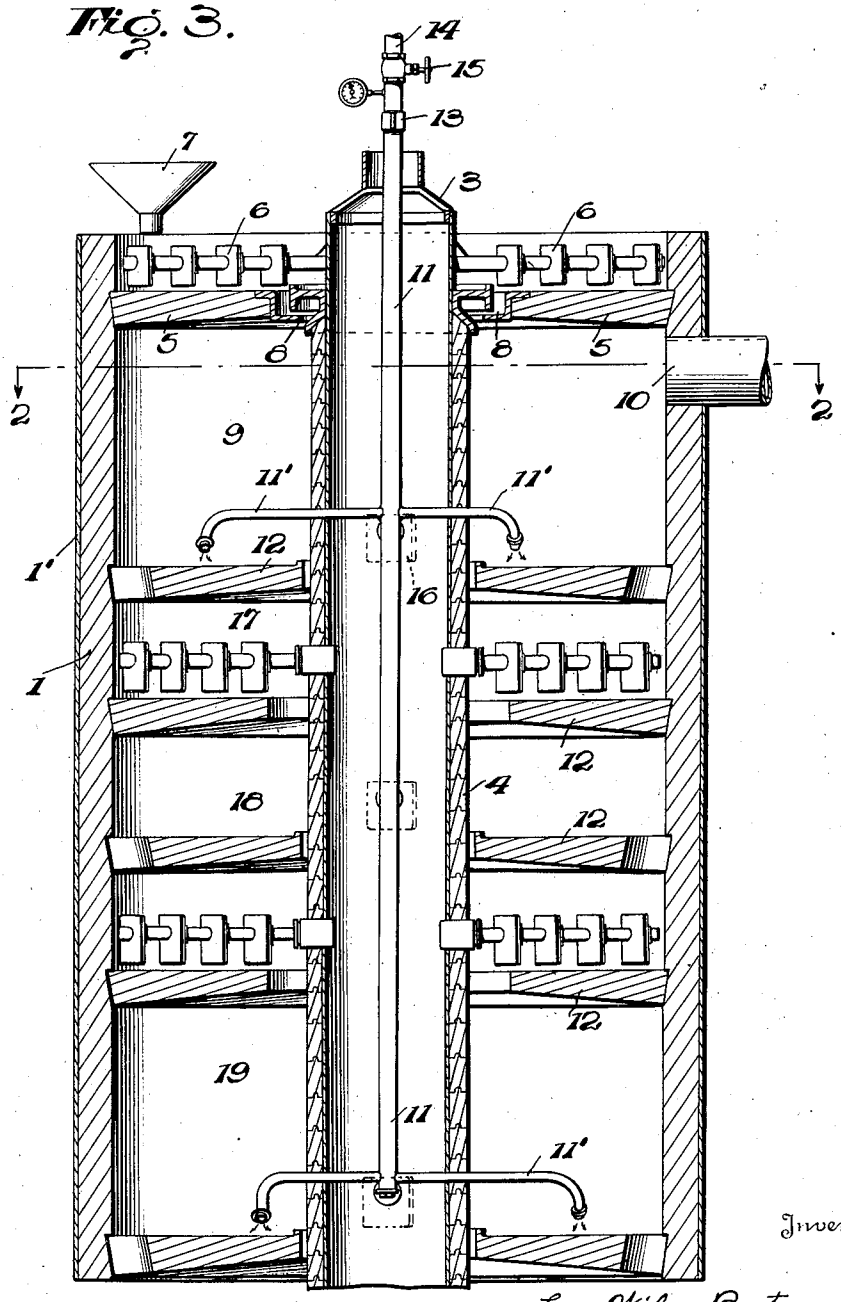
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Filed Feb. 27, 1939 3 Sheets-Sheet 2

Fig. 3.



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Filed Feb. 27, 1939 3 Sheets-Sheet 3

Fig. 4.

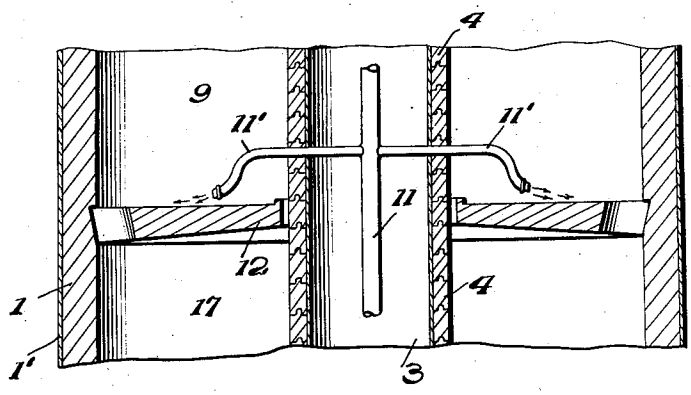
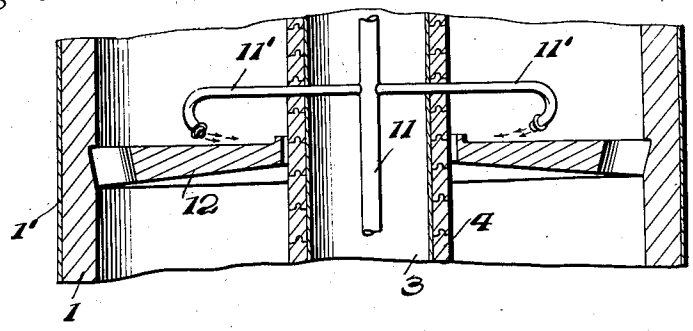


Fig. 5.



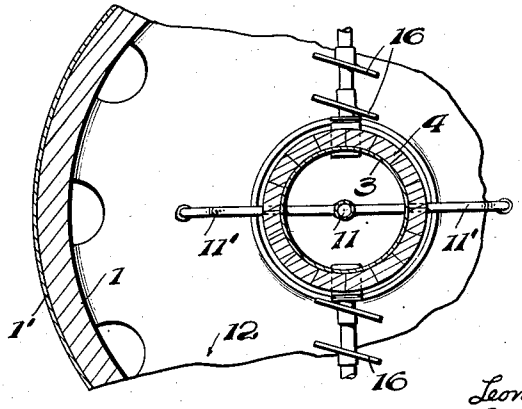


Fig. 6.

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UNITED STATES PATENT OFFICE

2,210,479

PROCESS AND APPARATUS FOR OXIDIZING SULPHIDE ORES

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Application February 27, 1939, Serial No. 258,810

7 Claims. (Cl. 266—20)

This invention relates to the problem of increasing capacity for desulphurizing fine ores and sulphide concentrates as carried out in multiple hearth furnaces, of which the Wedge and Herreshoff are representative types, wherein a plurality of annular hearths are arranged one above the other and define therebetween communicating roasting or desulphurizing chambers. It is particularly adapted to furnaces roasting ores of high sulphur content, the fumes from which are to be subsequently utilized, although not limited in usefulness thereto. The invention also comprises certain improvements in furnace construction, as will be more fully described hereinafter.

An object of the invention is to provide a process and means of economically operating these furnaces with materially higher tonnages than has been heretofore permissible, and at the same time eliminate the difficulties invariably encountered when higher tonnages are attempted. Other objects are to produce a gas of higher SO_2 concentration, and to accomplish more complete desulphurization of the ore.

In the usual process of roasting materials of high sulphur content the common difficulty is the development of an excessive temperature in the ore due to oxidation of the metal sulphides. The heat thus generated, except for a more or less constant quantity taken up by radiation and cooling devices, must be absorbed by the material undergoing oxidation and the gaseous products of oxidation. In roasting by the processes now employed, the generation of heat is considerably faster at certain points in the furnace than is the transfer of heat into the gases, resulting in an elevation of the temperature of the ore. Up to a certain input of potential heat units in the ore tonnage, the distribution of heat to radiation and cooling devices, and to elevation of the gas temperature, is sufficient to prevent the ore from reaching a fusion temperature, but any increase in tonnage beyond this point causes the ore to reach the fusion temperature in which condition it cannot be handled by the mechanical apparatus of the furnace. As the final gas must have a high concentration of SO_2 it follows that it is not feasible to remove heat from the ore merely by increasing the ratio of air to ore. Additional cooling devices are objectionable because they are expensive to operate and maintain, and by localized overcooling tend to reduce roasting efficiency.

Processes and means have been heretofore proposed for retarding roasting on the hearths where the tendency is to overheat, and for increasing roasting capacity of lower hearths. However, in the case of sulphides which are autoroasting and contain excess potential heat units, this is of very small advantage as the heat generated on the lower hearths is rapidly transferred to the colder air which flows counter-current to the ore and in so doing carries a large part of the heat of reaction back to the upper part of the furnace so that substantially the same heat balance is maintained and any additional tonnage serves only to increase the temperature of the ore.

By our invention we substantially increase the capacity of a furnace by providing means of transferring a greater percentage of the heat of reaction into the gas at a point near the egress of the gas so that this heat cannot be re-absorbed by the ore. The invention is based upon a process and means of accomplishing this result, and its application has many other advantages which will be more fully revealed as the description proceeds.

Broadly, the invention comprises a process and apparatus whereby an increased ratio of air to sulphur burned is used on the lower hearths of the furnace to maintain sufficient cooling of the ore, and then employs a means of greatly accelerating roasting on the uppermost roasting hearth, thereby concentrating the SO_2 content of the gas and transferring a larger part of the heat of reaction directly into the final gas which is removed from the furnace at this point.

The process involved may be carried out in a variety of forms of apparatus, but for the purpose of illustrating the invention we have herein shown it as applied to a furnace of the so-called Wedge or Herreshoff type, but it is to be expressly understood that the invention is not limited to the particular form of furnace shown, reference being had to the appended claims for defining the limits of the invention.

In said drawings—

Fig. 1 is a central vertical section of the upper portion of a furnace embodying the invention;

Fig. 2 is a horizontal plan view on the line 2—2 of Fig. 1;

Fig. 3 is a central vertical section showing the furnace in greater detail than the fragmentary showing in Fig. 1;

Fig. 4 is a broken vertical section showing a slight modification;

Fig. 5 is a vertical central fragmentary section showing a still further modification; and

Fig. 6 is a broken plan view of another modification.

Referring to the drawings, in which like reference numerals indicate like parts throughout the several views, the furnace is composed of a vertical chamber, preferably circular in cross section and composed of an interior lining of refractory material 1, provided with a sheet metal casing 1'. Within the furnace chamber there is a central rotating hollow shaft 3 provided with any suitable means for rotating the same, and provided on its exterior with a refractory coating 4 secured to and rotating with the hollow shaft 3. The upper portion of the furnace is provided with a drying hearth 5, and above this hearth 5 are a plurality of rabbles 6 carried by rabble arms connected to the hollow shaft 3 and revolving therewith. The comminuted sulphide ore is fed in in any suitable way, as through a hopper 7 to the hearth 5 and conveyed by the rabbles to suitable gas-tight feed devices 8 through which the ore is fed into the upper portion of the upper roasting chamber 9. The vertical height of this chamber 9 may be and preferably is considerably greater than that of the roasting chambers immediately therebeneath, as is clearly shown in Fig. 3, but said increase in height is not essential. The heights of the respective chambers may be as shown in Fig. 1 or otherwise without departing from the spirit of the invention. Near the upper portion of the roasting chamber 9 there is provided a gas outlet pipe 10 for carrying off the SO_2 gas.

Mounted centrally within the revolving hollow shaft 3 and revolving therewith is a pipe 11 provided with any desired number of branch pipes 11' extending out through the walls of the revolving shaft 3 and into the roasting chamber 9. Preferably these branch pipes 11' are of somewhat different lengths, as illustrated in Figs. 1 and 3, and have the lower ends thereof extending downward to a point adjacent to the hearth 12 forming the floor of the roasting chamber 9.

The exit ends of these branch pipes 11' may have any desired direction imparted to them. They may extend in the reverse direction from that of the revolutions of the pipes therselves, as illustrated in Figs. 1, 2 and 3, but, if desired, they may be directed radially outward (Fig. 4) or radially inward (Fig. 5), directly downward (Fig. 6) or otherwise.

The pipe 11 is connected by a revoluble joint 13 to a stationary pipe 14 provided with means for delivering air or other oxidizing gas therethrough under pressure, the delivery being controlled by the valve 15. As will be seen by referring to Fig. 2 the roasting chamber 9 is provided with rabbles 16, the rabble arms being carried by the hollow shaft 3. In Figs. 1 and 3 these rabbles are indicated in dotted lines.

In operation the furnace is heated to a temperature high enough to insure the ignition of the comminuted ore fed thereinto, and the ore is fed to the drying heart 5 across which it is fed by the rabbles 6 to the gas-tight feed device 8 through which the dry ore is fed into the roasting chamber 9 and rapid roasting is accomplished, by discharging compressed air or other oxidizing gas or vapor through the pipes 11', which discharge the air or other oxidizing gas into the layer of fine ore on the hearth 12, thus causing the fine ore particles to momentarily rise in the gas stream. This brings each particle in perfect contact with the oxidizing gas stream, and as the temperature is above the ignition point of the sulphides, the result is that rapidly and highly efficient roasting is secured. In the faster or more efficient roasting that takes place under these conditions, higher temperatures are generated in the escaped gas, but the temperature of the ore remains below the fusion point, due to the cooling effect of the incoming fresh ore. After this treatment on the first hearth the lower hearths are in effect roasting material of reduced sulphur content, with the result that the gas generated on these lower hearths may be of low SO_2 content, and as this low content SO_2 rises from the lower hearths into the roasting chamber 9 it is enriched to the desired degree in the upper roasting chamber. The draft throughout the furnace is in an upward direction from the lower up through the several hearths into the primary roasting chamber 9 and out through the exit pipe 10, and we have found that the material of appreciably decreased sulphur content discharged from the first roasting hearth will withstand a higher temperature, without fusion, than would be permissible with the original ore treated according to the practice heretofore prevailing. This being the case, the ore can be successfully subjected to a greater degree of roasting on the second and lower hearths in the furnace employed in the present invention. The higher hearth temperatures obtainable without fusion when handling the partially desulphurized ore react to further advantage in that the roasting reaction proceeds more rapidly and efficiently at higher temperatures. This manner of handling the lower sulphur material on the lower hearths has the further advantage of reducing the growth of accretions on the furnace walls and hearths which is a common difficulty in sulphide roasting, where high gas velocities are involved, as would be the case when roasting in increased tonnage. The growth of accretions can be further reduced or even eliminated by enlarging the drop hole areas and thereby reducing the gas velocities. This is made permissible by the present invention, since the resulting short circuiting of air is not objectionable, because of the fact that the final gas is brought up to the desired concentration by the accelerated and more efficient roasting on the first hearth.

Referring to Fig. 3, it will be noted that the top and bottom chambers, where the air jets are used, are deeper than the connecting chambers which in standard furnace construction are only large enough to provide suitable clearance for the rabble arms. In a standard furnace roasting chambers are substantially the same depth except the upper one which is usually made somewhat deeper to accomplish gas offtake. The space between the hearths is normally say about 2 feet. For the deeper chambers, as employed in the present invention, a space between hearths of approximately 5 feet is preferable, although this dimension could be widely varied without departing from the spirit of the invention. The blowing chambers may be approximately twice the dimensions of the normal rabbling chambers, but this is not essential, since highly improved results can be obtained by air jets in a normal rabbling chamber.

Once the furnace is set in operation it will be observed that the roasting effect in the upper roasting chamber 9 drives off a large portion of the SO_2 and the ore, thus deprived of a large portion of its sulphur, descends step by step through the lower roasting chambers, and that when in any one of these chambers additional

amounts of air or other oxidizing gas are introduced, further combustion of the sulphur content of the ore occurs, and the resulting gas rises through the series of roasting chambers into the chamber 9 serving to materially enrich the SO_2 gas generated therein, and this enriched gas passes out of the upper roasting chamber by way of the pipe 10.

It has been found that the tonnage passing through the furnace can be increased over that possible with roasting chambers in common use and still secure efficient roasting and without raising the temperature in the furnace to the fusion point of the ore. This is due to the fact that incoming ore and the incoming current of air or other oxidizing gas under pressure tends to hold down the temperature to a point below that which would result but for such cooling effect, and hence the increased tonnage with increased combustion of sulphur content does not result in a fusion temperature within the roasting chamber.

The accelerated roasting is accomplished by discharging compressed air or other oxidizing gas or vapor through one or more moving jets extending over the hearth and discharging into the layer of fine ore on the hearth. The compressed air or other gas is conducted to the jets by suitable pipes which are connected through the central column of the furnace to a common feeder pipe and are thus made to rotate with the central column. The rotating feeder pipe is connected to a stationary pipe from the compressor by means of a suitable universal pipe joint. The discharging compressed air causes the fine ore particles to momentarily rise into the gas stream during which time each particle is in perfect contact with the oxidizing gas stream, and as the temperature of this gas is above the ignition point of the sulphides the result is that rapid and highly efficient roasting is accomplished.

In the faster and more efficient roasting that takes place under these conditions, higher temperatures are generated in the escaping gas but the temperature of the ore remains below the fusion point due to the cooling effect of the incoming fresh ore. Sufficient sulphur is burned to enrich the gas from the lower hearths but not enough is oxidized to cause the ore to reach the fusion temperature as would be the case with 100% flash roasting. After this treatment on the first hearth, the lower hearths are, in effect, roasting material of reduced sulphur content, which material, as present general practice bears out, can be handled in large tonnages with a favorable heat balance by the standard mechanical furnaces, particularly as it is permissible to generate a gas of low SO_2 content on the lower hearths and by our invention enrich it to the desired degree on the uppermost roasting hearth. Another advantage resulting from the application of this invention has been found in the fact that the material of appreciably decreased sulphur content being discharged from the first roasting hearth will withstand a higher temperature without fusion than the original ore, or the original ore after normal treatment on the first hearth, and therefore can be successfully subjected to a greater degree of hearth roasting on the second and lower hearths than would be the case in a furnace not employing the invention. The higher hearth temperatures obtainable without fusion when handling the partially desulphurized ore react to further advantage in that the roasting reactions proceed more rapidly and efficiently at higher temperatures. The handling of lower sulphur material has the further advantage of reducing the growth of accretions on the furnace walls and hearths which is a common difficulty in sulphide roasting, particularly where high gas velocities are involved as would be the case when roasting a greater tonnage. The growth of accretions can be further reduced or eliminated by enlarging the drop-hole area to reduce gas velocities, which is made permissible by this invention since the resulting short circuiting of air is not objectionable by reason of the fact that the final gas is brought up to the desired concentration by the accelerated and more efficient first hearth roasting.

Having thus described the invention, what is claimed is:

1. In a process of roasting sulphide ores in a series of successive roasting chambers, the step of continuously feeding comminuted ore in succession through said chambers, continuously passing a current of oxidizing gas together with resulting SO_2 gas through said chambers contrawise to the movement of the ore, continually throwing comminuted ore from the hearth of the first roasting chamber into momentary suspension in said oxidizing gas current within the chamber, and continuously withdrawing SO_2 gas from said chamber.

2. In a process of roasting sulphide ores, the steps of continuously feeding the comminuted ore into a primary roasting chamber and onto the hearth thereof, maintaining a reacting gas current through the furnace continuously throwing the comminuted ore from said hearth into momentary suspension in said reacting gas current, continuously feeding the partially roasted ore onto the hearth of a lower roasting chamber, continuously throwing portions of the ore on said last mentioned hearth, into momentary suspension in the reacting gas current thus causing a further portion of the sulphur gas in the ore to be converted into SO_2 gas, mixing this second portion of SO_2, gas with that in the primary chamber and withdrawing the SO_2 gas from the primary chamber.

3. The process of roasting sulphide ores in a multiple hearth furnace, comprising the steps of continuously feeding the comminuted ore onto the hearth of the upper roasting chamber, stirring and conveying the ore across said hearth to an opening communicating with the next succeeding hearth in the series and thence in like manner causing the ore to travel over the remaining hearths in the series, continuously admitting air into the lowermost roasting chamber and causing it to travel as an oxidizing gas in an upward current through the superposed roasting chambers counter-current to the ore travel, continuously throwing portions of the ore from the first roasting chamber whereby continually changing portions of the ore are thrown into momentary suspension in the oxidizing gas current thus causing a substantial part of the residual oxygen in said gas current to be consumed by the roasting reactions thus generated, and continuously withdrawing SO_2 gas from the uppermost roasting chamber.

4. In an ore roasting furnace, a plurality of superposed hearths, means directing a reacting gas current successively over said hearths, means passing the ore from hearth to hearth in a reverse direction to that of said gas current, and

means continually throwing the ore particles from one of said hearths into said gas current.

5. In an ore roasting furnace, the combination of an upper roasting chamber, a rotary rabble operating shaft within said chamber, a conduit carried by said shaft and leading from a source of compressed gas, branch pipes leading from said conduit and directing compressed gas against the hearth of said chamber, the ends of the branch pipes being so positioned that when the furnace is in operation continually changing portions of the ore bed on the hearth are subjected to the action of said gas.

6. In a furnace for roasting sulphide ores, the combination of an upper roasting chamber, a lower roasting chamber, a plurality of rabble chambers connecting said upper and lower chambers, constantly revolving jets directing gas under pressure against the ore on the hearths of each of said upper and lower chambers, means for controlling the pressure and direction of said compressed gas whereby when the furnace is in operation continually changing portions of the ore beds on said hearths are put in momentary suspension in the atmosphere of said upper and lower roasting chambers.

7. In a furnace for roasting sulphide ores, the combination of a rabble chamber having a stationary hearth, means delivering comminuted ore into the top of said chamber, rabbles stirring the comminuted ore on the hearth of the chamber, means continuously throwing portions of the comminuted ore from the hearth of the chamber into momentary suspension in the chamber, and means conducting the resultant SO_2 gas from said chamber.

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