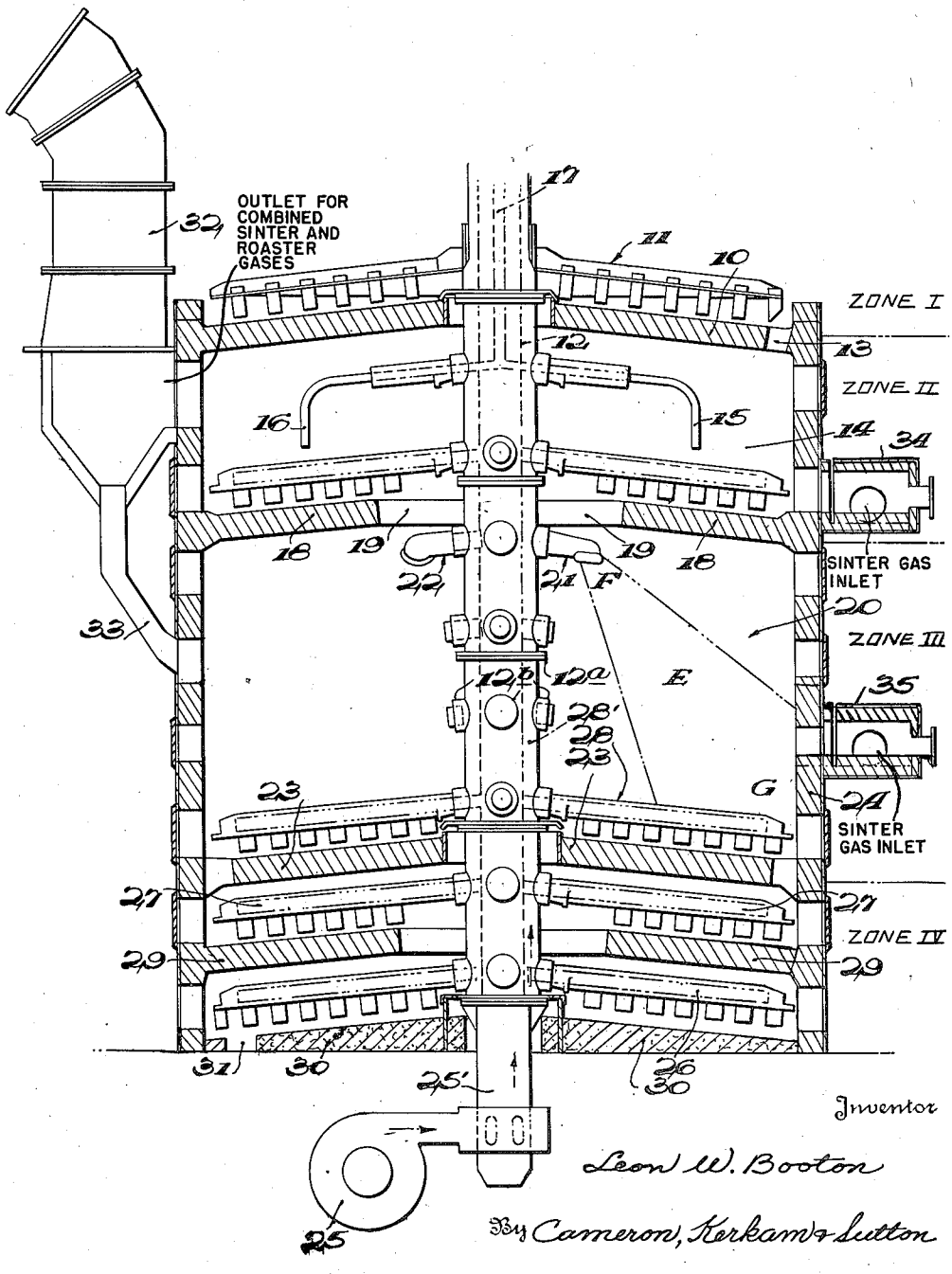
Nov. 6, 1951 L. W. BOOTON 2,573,785

APPARATUS FOR ROASTING SULFIDE ORES

Filed March 17, 1947 3 Sheets-Sheet 1

FIG. 1.



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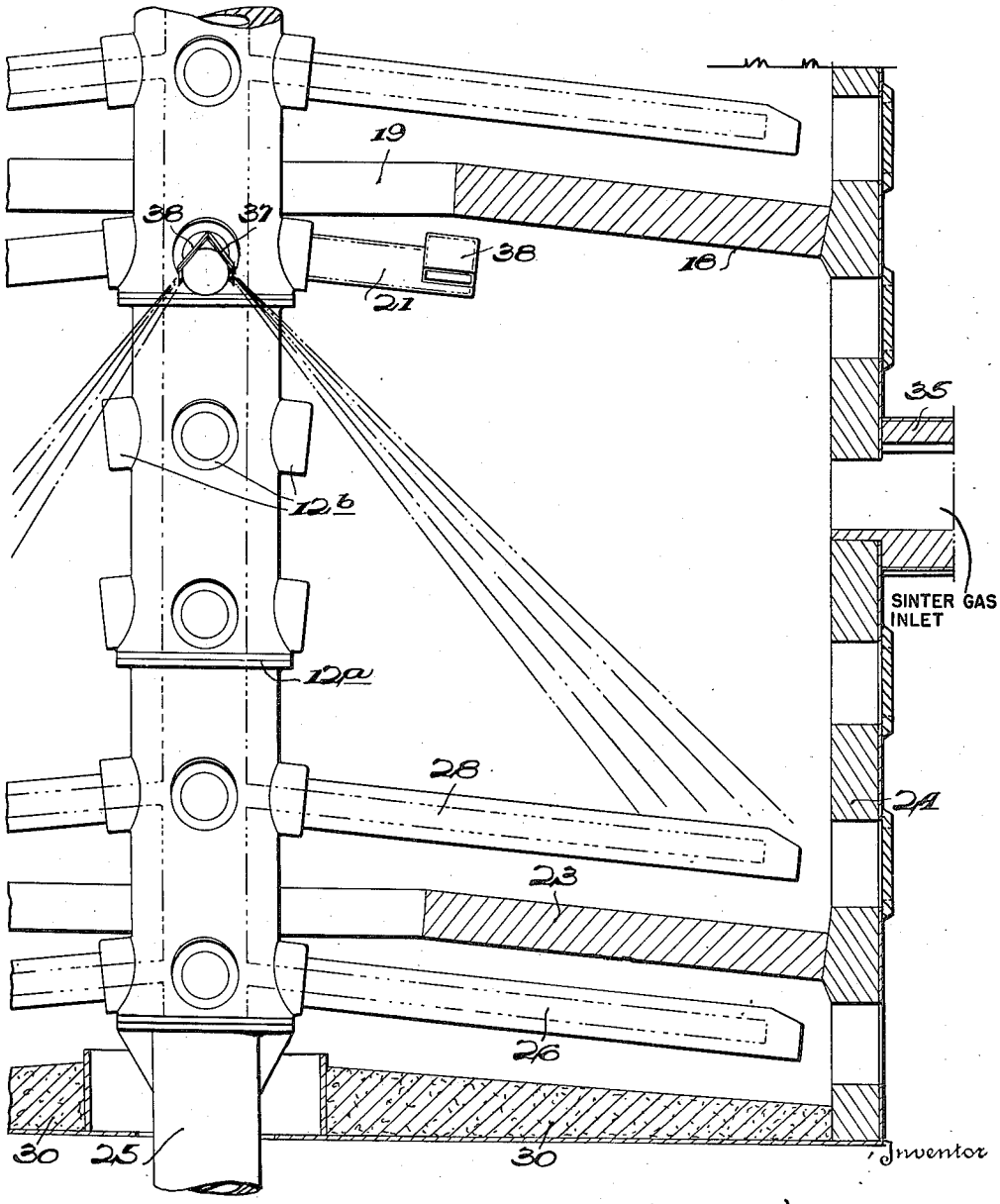
Attorney

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APPARATUS FOR ROASTING SULFIDE ORES

Filed March 17, 1947 3 Sheets-Sheet 2

Fig. 2.



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APPARATUS FOR ROASTING SULFIDE ORES

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Fig. 3.

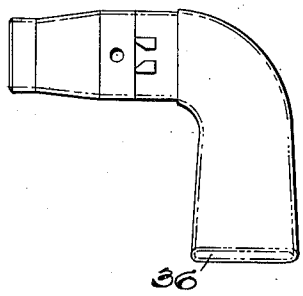


Fig. 4.

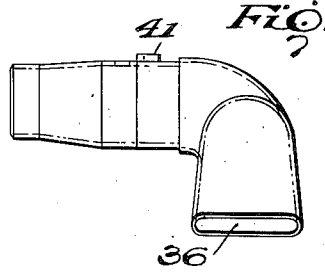


Fig. 5.

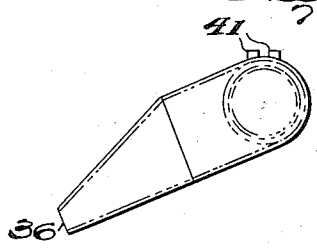


Fig. 6.

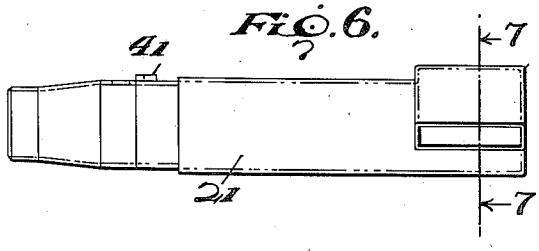


Fig. 7.



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Patented Nov. 6, 1951 2,573,785

UNITED STATES PATENT OFFICE

2,573,785

APPARATUS FOR ROASTING SULFIDE ORES

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Application March 17, 1947, Serial No. 735,149

10 Claims. (Cl. 266—20)

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The present invention is an improved apparatus for roasting finely comminuted sulphide ores.

One object is to avoid the formation of accretions or "warts" on the walls of the furnace which necessitates frequent shutdowns to remove the same and involves much labor and expense.

Another object is to increase the tonnage of comminuted sulphide ore that can be roasted without increasing the size of the roasting equipment.

Another object is to procure economically a gaseous mixture containing higher percentages of sulphur dioxide for use in the manufacture of sulphurous and sulphuric acid and more desirable grades of calcine for iron oxide sinter for use in the manufacture of iron and steel.

Various procedures have been proposed to prevent this formation of accretions or "warts" including the provision of an air shield or curtain between the falling ore particles and the wall of the furnace, and the provision of various means for injecting the particles upwardly into the roasting chamber in such manner that the particles will fall under the influence of gravity before contacting the opposite wall. Such procedures do not efficiently utilize the oxygen in the air supplied to the roaster because such procedures unevenly distribute the air and ore when these are moved countercurrently within the roaster.

The present invention is a simple and efficient apparatus for attaining these objects, and involves the process described in U. S. Patent No. 2,210,479, Booton and Burns which discloses "continually throwing comminuted ore from the hearth of the first roasting chamber into momentary suspension in said oxidizing gas current within the chamber." Such an operation I identify as "semi-flash" roasting. This roasting when applied in conjunction with conventional mechanically rabbled hearth roasting gives improved results in efficiency and capacity of the roasting operation. I have now found that when this "semi-flash" roasting is applied and the actively burning solids resulting from this operation are discharged into and dispersed in a succeeding combustion chamber in which the particles are evenly distributed and suspended, the results obtained are superior to those of known roasting processes in that in a given size furnace the tonnage handled can be doubled without auxiliary equipment, without increase in maintenance costs, and with the production of the desired grade of sulphur dioxide gas and calcine. The burning sulphide particles are rabbled or fed into

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the "flash" roasting chamber through which they fall countercurrent to a rising oxidizing current. The particles fall over or adjacent to a pair of nozzles that are directed or pointed to the remote junction of the hearth and wall and which nozzles project a gaseous stream against the falling particles to evenly distribute the same, to create turbulence, and cause the particles to follow a tortuous path.

The proper period of suspension of the particles in the "flash" roasting chamber to secure controlled and desired desulphurization and prevent accretions on the walls is thus secured by the combined action of gravity, the rising oxidizing stream and the dispersing gas from the nozzles. The oxidation is rapid and distributed as the falling particles are dispersed into the rising current of oxidizing gases. The dispersion of the particles in the rising current is even and uniform and this allows uniform utilization of the oxygen in these gases and the consequent production of the higher and more desirable grades of sulphur dioxide as well as superior capacity for desulphurizing the particles.

Temperature control is important and, if desired, gases from the sintering operation may be used in this control by introduction into the roaster at various points. These gases increase the turbulence of the suspended sulphide particles in the flash roasting chamber without adversely affecting the dispersion of the particles into and through the roasting chamber or causing an impingement of the particles on the walls.

The invention will be better understood by reference to the accompanying drawings wherein

Fig. 1 is a vertical sectional view showing the hollow roaster shaft and rabble arms in elevation;

Fig. 2 is a similar view showing the flash chamber in which the ore particles fall, from the primary roasting chamber over the rotating dispersing nozzles;

Figs. 3, 4 and 5 are views of one form of nozzle in which the discharge orifice is flattened; and

Figs. 6 and 7 are views of the form of nozzle shown in Fig. 2, Fig. 7 being a cross-section on the line 7—7 of Fig. 6.

Referring to the drawings illustrating a multiple hearth roaster of circular cross-section suitably lined with a refractory material, 10 is a drying hearth, indicated generally as zone I, on which the material to be treated, such as iron sulphide flotation concentrate particles, is deposited. This hearth is open to the outside atmosphere. The particles are conveyed across

this hearth by conventional rabbles and rabble arms 11 which are mounted on the rotatable vertically disposed hollow shaft 12. The particles fall through the drop hole 13 into the "semi-flash" roasting chamber 14, indicated generally as zone II.

This chamber 14 in which the particles are ignited and substantially roasted is the same "semi-flash" construction shown in Booton and Burns Patent No. 2,210,472 in which blow pipes 15, 16 are mounted on hollow shaft 12 and are connected to an air source through pipe 17 providing preferably a pressure of about eight pounds that acts to continually throw the ore particles into momentary suspension.

The actively burning sulphide ore particles are fed along hearth 18 of chamber 14 until they fall through drop hole 19 into the flash roasting chamber 20 which is about twice as deep as chamber 14, and which is indicated generally as zone III. The combustion in chambers 14 and 20 is supported without extraneous fuel.

This chamber 20 is substantially larger than the primary roasting chamber 14, the height of the chamber being about ten feet with an interior diameter of about twenty feet. These proportions permit a suspension of the ore particles until desired desulphurization is effected and without deposit of accretions, in a manner to be described.

Shaft 12 carries a plurality of nozzles 21, 22 that project downwardly and discharge a stream of gas, such as air, in the direction F—E—G toward the junction of hearth 23 and the adjacent portion 24 of the chamber wall. The air for these nozzles is supplied by a fan 25 and enters at the lower end 25' of hollow shaft 12, part of the air passes through hollow rabble arms 26, 27 and 28, hereinafter referred to, and part of the air passes upwardly through pipe 28' and is discharged through said nozzles at a low pressure of preferably 9'' water gauge. As shown in Fig. 1 the orifices of nozzles 21, 22, are adjacent the falling particles and the air therefrom impinges thereon causing uniform dispersion of the particles in a tortuous path in the rising current of oxidizing gases.

Rabble arms 27 are associated with a hearth 29 and rabble arms 26 with a hearth 30, generally indicated as in zone IV, and which may be used with "flash" chamber 20 for further roasting of the calcine which is discharged at 31. The sulphide ore as it enters the roaster contains about 43% sulphur, and the calcine discharged at 31 preferably contains about 10% sulphur which sulphur constitutes the fuel in the sintering operation that follows.

The heated air and low grade sulphur dioxide passing over hearth 30, 29 and 23 constitute the current of oxidizing gases which rises in chamber 20 countercurrent to the stream of falling ore particles. The conjoint action of this rising oxidizing stream and the dispersing stream from nozzles 21, 22, maintains the particles in suspension until the desired desulphurization is effected and no particles of high sulphur content remain to be deposited on the walls as accretions or "warts." The sulphur dioxide resulting from this "flash" roasting is of high grade and passes through the primary roasting chamber 14 into the offtake pipe 32 leading to the sulphuric acid plant. A pipe 33 leads from the lowest part of the offtake pipe 32 to flash chamber 20 to return any flue dust that may be present. This is a convenient way of handling such flue dust and has no relation to the roasting.

The calcine issuing at 31 is thereafter sintered; and this sintered product contains such low amounts of sulphur, phosphorus and silica that it is in demand for use in the manufacture of iron and steel, being an iron oxide containing about 0.06% sulphur and about 68% iron. The gases from the sintering operation contain about 5% sulphur dioxide and are useful in manufacturing sulphuric acid. They may be cooled to 60–90° F. by suitable cooling towers and may be introduced into the roaster at various points, as 34 in zone II and 35 in zone III. The introduction of sinter gas in zone II is for controlling the offtake temperature; and in zone III for controlling the temperature of chamber 20. Further the oxygen contained in the sinter gas is used so that the combined gas is of higher sulphur dioxide content than is obtainable by simple mixture of roaster and sinter gas. The introduction of this sinter gas increases the turbulence in flash chamber 20 without adversely affecting the dispersion by the air from nozzles 21, 22 or causing any impingement of particles of high sulphur content on the walls to form accretions.

The nozzles 21, 22, for dispersing the falling sulphide particles may have round discharge orifices (Fig. 1), flattened and elongated orifices 36 (Figs. 3, 4 and 5), or multiple openings (Figs. 2, 6 and 7). The nozzles may point forward or backward or outward when referred to the rotation of the roaster shaft 12 so long as they discharge along one of the longest free paths in the flash chamber to insure sufficient time of suspension for complete desulphurization. Successful operation to avoid accretions is primarily dependent on initially directing the high sulphur content particles toward the point G which is one of the longest free straight paths in the chamber.

The form of nozzle that I prefer is shown in Figs. 2, 6 and 7 and the preferred position of the nozzles with respect to opening 19 is shown in Fig. 2 where the falling particles are divided by the nozzle and pass down the sloping sides 37, 38 over two dispersing openings 39, 40, one opening facing forward and one opening facing backward when referred to the rotation of the roaster shaft 12.

The nozzles may be adjusted to the desired angle and fixed in adjusted position by bolt 41 (Figs. 4, 5 and 6) or other suitable means. As above indicated the best results are obtained when this angle is directed to the intersection of the wall 24 and the hearth 23. This angle can be varied within limits and still avoid building up of accretions on the interior of the chamber. This angle below the horizontal can be smaller as the chamber diameter is increased and larger as the chamber diameter is decreased.

Roaster shaft 12 is preferably made in sections connected by flanges 12*a* and may be provided with extra orifices 12*b* that are plugged when not in use.

The preferred construction of roaster is that shown in Fig. 1 employing a drying hearth 10 (zone I), a primary semi-flash roasting chamber 14 of the Booton and Burns type (zone II), the large flash chamber 20 (zone III) and one or more hearths below the chamber 20, such as the added hearths 29 and 30, Fig. 1, or the single hearth 30 (Fig. 2).

By the present process in addition to the greatly increased tonnage handled, high grade sulphur dioxide and calcine are secured, and the deposit on the walls of particles of high sulphur content that cause accretions or "warts" is prevented. It is found that such deposits that appear are low in sulphur, are readily removed, and do not build up as accretions which would necessitate frequent shutdowns.

I claim:

1. An apparatus for roasting finely comminuted sulphide ores comprising a drying hearth on which said ores are deposited, a primary roasting chamber, a flash roasting chamber, a source of heated air below said flash roasting chamber from which the heated air ascends through said flash roasting chamber, a hollow rotating shaft projecting through said hearth and chambers, rabble arms carried by said shaft and provided with rabbles to feed the ore particles through a drop hole in said drying hearth into said primary roasting chamber and through a drop hole in the hearth of said primary roasting chamber into said flash roasting chamber, blow pipes in said primary roasting chamber mounted on said hollow rotating shaft to throw the burning ore particles into momentary suspension, a plurality of nozzles in said flash roasting chamber mounted on said hollow shaft and projecting downwardly to discharge a stream of gas toward the junction of the hearth and the adjacent chamber wall, said nozzles being arranged below the drop hole in the hearth of said primary roasting chamber, sources of gas for said blow pipes and nozzles, and said flash roasting chamber being about twice as wide as deep and about twice as deep as said primary roasting chamber for suspension of the ore particles until desired desulphurization is effected.

2. An apparatus for roasting finely comminuted sulphide ores comprising a drying hearth on which said ores are deposited, a primary roasting chamber, a flash roasting chamber, a source of heated air below said flash roasting chamber from which the heated air ascends through said flash roasting chamber, a hollow rotating shaft projecting through said hearth and chambers, rabble arms carried by said shaft and provided with rabbles to feed the ore particles through a drop hole in said drying hearth into said primary roasting chamber and through a drop hole in the hearth of said primary roasting chamber into said flash roasting chamber, blow pipes in said primary roasting chamber mounted on said hollow rotating shaft to throw the burning ore particles into momentary suspension, a plurality of nozzles in said flesh roasting chamber mounted on said hollow shaft and projecting downwardly to discharge a stream of gas toward the junction of the hearth and the adjacent chamber wall, said nozzles being arranged below the drop hole in the hearth of said primary roasting chamber, said flash roasting chamber being about twice as wide as deep and about twice as deep as said primary roasting chamber for suspension of the ore particles until desired desulphurization is effected, a source of sinter gas, and means for introducing sinter gas into the primary roasting chamber through the wall thereof.

3. An apparatus for roasting finely comminuted sulphide ores comprising a drying hearth on which said ores are deposited, a primary roasting chamber, a flash roasting chamber, a source of heated air below said flash roasting chamber from which the heated air ascends through said flash roasting chamber, a hollow rotating shaft projecting through said hearth and chambers, rabble arms carried by said shaft and provided with rabbles to feed the ore particles through a drop hole in said drying hearth into said primary roasting chamber and through a drop hole in the hearth of said primary roasting chamber into said flash roasting chamber, blow pipes in said primary roasting chamber mounted on said hollow rotating shaft to throw the burning ore particles into momentary suspension, a plurality of nozzles in said flash roasting chamber mounted on said hollow shaft and projecting downwardly to discharge a stream of gas toward the junction of the hearth and the adjacent chamber wall, said nozzles being arranged below the drop hole in the hearth of said primary roasting chamber for suspension of the ore particles until desired desulphurization is effected, a source of sinter gas, and means for introducing sinter gas into the flash roasting chamber through the wall thereof.

4. An apparatus for roasting finely comminuted sulphide ore comprising a drying hearth on which said ores are deposited, a primary roasting chamber, a flash roasting chamber, a source of heated air below said flash roasting chamber from which the heated air ascends through said flash roasting chamber, a hollow rotating shaft projecting through said hearth and chambers, rabble arms carried by said shaft and provided with rabbles to feed the ore particles through a drop hole in said drying hearth into said primary roasting chamber and through a drop hole in the hearth of said primary roasting chamber into said flash roasting chamber, blow pipes in said primary roasting chamber mounted on said hollow rotating shaft to throw the burning ore particles into momentary suspension, a plurality of nozzles in said flash roasting chamber mounted on said hollow shaft and projecting downwardly to discharge a stream of gas toward the junction of the hearth and the adjacent chamber wall, said nozzles being arranged below the drop hole in the hearth of said primary roasting chamber for suspension of the ore particles until desired desulphurization is effected, a source of sinter gas, and means for introducing sinter gas into the primary roasting chamber and the flash roasting chamber through the walls of said chambers.

5. An apparatus for roasting finely comminuted sulphide ores comprising a primary roasting chamber, a flash roasting chamber, a source of heated air below said flash roasting chamber from which the heated air ascends through said flash roasting chamber, a hollow rotating shaft projecting through said chambers, a drying hearth, rabble arms carried by said shaft and provided with rabbles to feed the ore particles through a drop hole in said drying hearth into said primary roasting chamber and through a drop hole in the hearth of said primary roasting chamber into said flash roasting chamber, blow pipes in said primary roasting chamber mounted on said hollow rotating shaft to throw the burning ore particles into momentary suspension, a plurality of nozzles in said flash roasting chamber mounted on said hollow shaft and projecting downwardly to discharge a stream of gas toward the junction of the hearth and the adjacent chamber wall, said nozzles being positioned adjacent the drop hole in the hearth of said primary roasting chamber to cause uniform disper-

sion of the particles in a tortuous path in the rising current of air, sources of gas for said blow pipes and nozzles, and said flash roasting chamber being about twice as wide as deep and about twice as deep as said primary roasting chamber for suspension of the ore particles until desired desulphurization is effected.

6. An apparatus for roasting finely comminuted sulphide ores comprising a primary roasting chamber, a flash roasting chamber, a source of heated air below said flash roasting chamber from which the heated air ascends through said flash roasting chamber, a hollow rotating shaft projecting through said chambers, a drying hearth, rabble arms carried by said shaft and provided with rabbles to feed the ore particles through a drop hole in said drying hearth into said primary roasting chamber and through a drop hole in the hearth of said primary roasting chamber into said flash roasting chamber, blow pipes in said primary roasting chamber mounted on said hollow rotating shaft to throw the burning ore particles into momentary suspension, a plurality of nozzles in said flash roasting chamber mounted on said hollow shaft and projecting downwardly to discharge a stream of gas along one of the longest free paths in the flash roasting chamber to insure sufficient time of suspension of the ore particles for the desired desulphurization, said nozzles being positioned adjacent the drop hole in the hearth of said primary roasting chamber to cause uniform dispersion of the particles in a tortuous path in the rising current of air, sources of gas for said blow pipes and nozzles, and said flash roasting chamber being about twice as wide as deep and about twice as deep as said primary roasting chamber for suspension of the ore particles until desired desulphurization is effected.

7. An apparatus for roasting finely comminuted sulphide ores comprising a drying hearth on which said ores are deposited, a primary roasting chamber, a flash roasting chamber, a source of heated air below said flash roasting chamber from which the heated air ascends through said flash roasting chamber, a hollow rotating shaft projecting through said hearth and chambers, rabble arms carried by said shaft and provided with rabbles to feed the ore particles through a drop hole in said drying hearth into said primary roasting chamber and through a drop hole in the hearth of said primary roasting chamber into said flash roasting chamber, blow pipes in said primary roasting chamber mounted on said hollow rotating shaft to throw the burning ore particles into momentary suspension, a plurality of nozzles in said flash roasting chamber mounted on said hollow shaft and projecting downwardly to discharge a stream of gas toward the junction of the hearth and the adjacent chamber wall, said nozzles being arranged below the drop hole in the hearth of said primary roasting chamber, sources of gas for said blow pipes and nozzles, and said flash roasting chamber being about twice as wide as deep and about twice as deep as said primary roasting chamber for suspension of the ore particles until desired desulphurization is effected, said flash roasting chamber being provided with a drop hole, and an added hearth beneath the flash roasting chamber.

8. An apparatus for roasting finely communited sulphide ores comprising a primary roasting chamber, a flash roasting chamber, a source of heated air below said flash roasting chamber from which the heated air ascends

through said flash roasting chamber, a hollow rotating shaft projecting through said chambers, a drying hearth, rabble arms carried by said shaft and provided with rabbles to feed the ore particles through a drop hole in said drying hearth into said primary roasting chamber and through a drop hole in the hearth of said primary roasting chamber into said flash roasting chamber, blow pipes in said primary roasting chamber mounted on said hollow rotating shaft to throw the burning ore particles into momentary suspension, a plurality of nozzles in said flash roasting chamber mounted on said hollow shaft and projecting downwardly to discharge a stream of gas toward the junction of the hearth and the adjacent chamber wall, said nozzles being positioned adjacent the drop hole in the hearth of said primary roasting chamber to cause uniform dispersion of the particles in a tortuous path in the rising current of air, sources of gas for said blow pipes and nozzles, and said flash roasting chamber being about twice as wide as deep and about twice as deep as said primary roasting chamber for suspension of the ore particles until desired desulphurization is effected, said flash roasting chamber being provided with a drop hole, and one or more added hearths beneath the flash roasting chamber.

9. An apparatus for roasting finely comminuted sulphide ores comprising a drying hearth on which said ores are deposited, a primary roasting chamber, a flash roasting chamber, a source of heated air below said flash roasting chamber from which the heated air ascends through said flash roasting chamber, a hollow rotating shaft projecting through said hearth and chambers, rabble arms carried by said shaft and provided with rabbles to feed the ore particles through a drop hole in said drying hearth into said primary roasting chamber and through a drop hole in the hearth of said primary roasting chamber into said flash roasting chamber, blow pipes in said primary roasting chamber mounted on said hollow rotating shaft to throw the burning ore particles into momentary suspension, a plurality of nozzles in said flash roasting chamber mounted on said hollow shaft and projecting downwardly to discharge a stream of gas toward the junction of the hearth and the adjacent chamber wall, said nozzles being arranged below the drop hole in the hearth of said primary roasting chamber, sources of gas for said blow pipes and nozzles, and said flash roasting chamber being about twice as wide as deep and about twice as deep as said primary roasting chamber for suspension of the ore particles until desired desulphurization is effected, the angle of the nozzles below the horizontal being made smaller as the diameter of the flash roasting chamber is increased.

10. An apparatus for roasting finely comminuted sulphide ores comprising a drying hearth on which said ores are deposited, a primary roasting chamber, a flash roasting chamber, a source of heated air below said flash roasting chamber from which the heated air ascends through said flash roasting chamber, a hollow rotating shaft projecting through said hearth and chambers, rabble arms carried by said shaft and provided with rabbles to feed the ore particles through a drop hole in said drying hearth into said primary roasting chamber and through a drop hole in the hearth of said primary roasting chamber into said flash roasting chamber, blow pipes in said primary roasting chamber mounted on said

hollow rotating shaft to throw the burning ore particles into momentary suspension, a plurality of nozzles in said flash roasting chamber mounted on said hollow shaft and projecting downwardly to discharge a stream of gas toward the junction of the hearth and the adjacent chamber wall, said nozzles being arranged below the drop hole in the hearth of said primary roasting chamber, sources of gas for said blow pipes and nozzles, and said flash roasting chamber being about twice as wide as deep and about twice as deep as said primary roasting chamber for suspension of the ore particles until desired desulphurization is effected, the angle of the nozzles below the horizontal being made larger as the diameter of the flash roasting chamber is decreased.

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