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APPARATUS FOR ROASTING ORE

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Fig. 1.

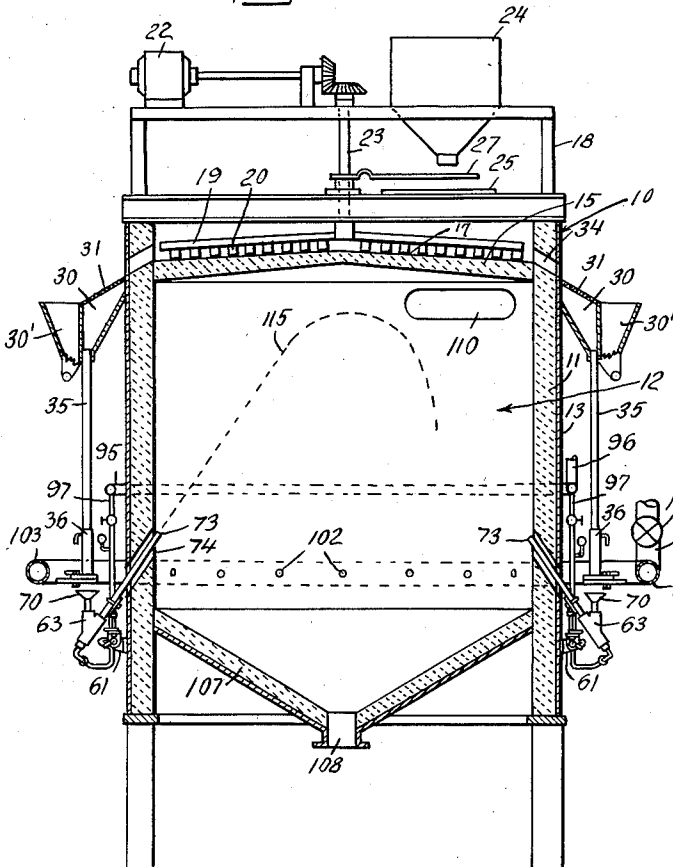


Fig. 2.

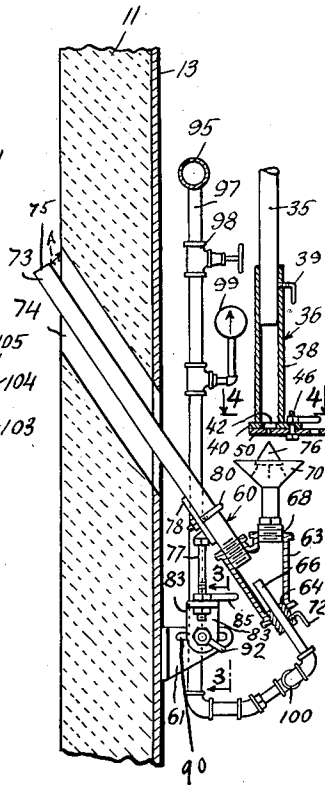


Fig. 3.

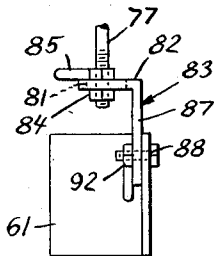
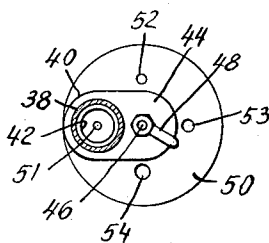


Fig. 4.



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APPARATUS FOR ROASTING ORE

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3 Claims. (Cl. 263—21)

This invention is directed to apparatus for roasting metallic sulfides, and more particularly for roasting finely divided sulfide ores to desulfurize the same and to produce sulfur dioxide for use in the manufacture of sulfuric acid, or for any other purpose desired.

To a large extent, present practice in sulfide fines roasting includes use of mechanically operated multiple hearth constructions, such, for example, as the well known MacDougal, Herreshoff, and Wedge burners, and while such burners provide effective roasting, the complicated construction and operation thereof involve considerable initial and maintenance expense. To some degree, roasting of sulfide fines while in gaseous suspension has more or less recently displaced the "bed" roasting operations carried out in the above mentioned hearth burners.

Suspension roasting is best applicable when the fines are in a relatively finely divided state, and this method presents the notable advantage over the mechanical multiple hearth operation of considerably lowering the cost of production, by reason of the elimination of the relatively complicated and moving parts, expensive rabbling and other apparatus inherent in the construction and operation of such mechanical burners. In the practice of suspension roasting, however, and particularly as applied to roasting metallic sulfide fines, difficulties are encountered which must be overcome before the theoretical advantages of this type of operation are practically available.

The invention is directed generally to improvements in burners for suspension roasting of sulfide fines, and more especially to feed mechanisms for injecting the fines into burner combustion chambers and for forming therein a dispersion of the fines in gaseous suspension. It is one of the objects of the invention to provide flexible and easily adjustable injector mechanisms so constructed as to permit feeding of fines in the burner combustion chamber in such a way as to substantially prevent contact of fines with the heated inner walls of the combustion chamber to thus avoid accumulation on the walls of accretions or "scar" formation, a well known difficulty encountered in suspension roasting. Another object of the invention is to provide feed mechanisms affording improved dispersion of fines over the cross-sectional area of the combustion chamber. The invention additionally aims to provide feed injectors including mechanisms by means of which the quantity of fines

fed into the furnace may be accurately controlled and fluctuations of ore feed avoided.

The invention accordingly comprises the features of construction, combinations of elements, and arrangement of parts, which will be exemplified in the construction hereinafter set forth. The nature of the invention and the objects and advantages thereof may be more fully 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 sulfide ore burner for use in connection with which the improved injectors of the invention are particularly designed;

Fig. 2 is an enlarged view, partly in section and partly in elevation, showing one preferred form of the improved injector;

Fig. 3 is an elevation taken substantially on the line 3—3 of Fig. 2, and

Fig. 4 is a plan taken on the line 4—4 of Fig. 2.

Referring particularly to Fig. 1 of the drawing, numeral 10 designates generally a shaft burner comprising a shell 11, constructed of suitable refractory material such as firebrick, defining a roasting chamber 12 of cylindrical cross-section. Surrounding shell 11, is a steel casing 13 acting as a protective reinforcement for the furnace. The upper end of the combustion chamber is closed off by a crown 15, the top side of which forms a drying and preheating hearth 17. The cylindrical shell 11 and casing 13 project upwardly beyond the crown 15, and carry a steel framework 18 which in turn supports ore feeding and rabble 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 sulfides 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 properly 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 fines are intermittently dropped onto approximately the center of hearth 17 by a sweep 27 rotating with shaft 23.

Attached to steel shell 13, by suitable brackets not shown, are hoppers 30 covered by sloping screens 31. Cut in shell 11 near the upper end are downwardly sloping passages or conduits 34

through which ore is passed from the drying hearth 17 into the hoppers. It will be understood the number of conduits and hoppers used in conjunction with the burner is dependent upon the number of injectors employed. On rotation of rabble arms 19, sulfide fines are gradually fed through openings 34 into the hoppers 30 which discharge fines through pipe 35 into an adjustable feed device indicated by reference numeral 36.

10 Feed regulator 36 comprises a vertically disposed cylindrical sleeve or casing 38 fitting slidably over the lower end of pipe 35. A bolt 39 is threaded through the upper part of sleeve 38 and provides means by which the vertical position of
15 feed regulator 36 may be adjusted. Welded or otherwise attached to the lower end of sleeve 38 is a plate 40 having an opening 42 in alignment with the axis of sleeve 38 and also having an extension 44 shown in plan in Fig. 4. Extension
20 or bracket 44 is drilled to accommodate bolt 46 headed on the lower end and threaded on the upper end to receive winged nut 48. Adapted to rotate about bolt 46 on loosening of nut 48 is a circular plate 50 having openings 51, 52, 53 and
25 54 of progressively increasing size, orifice 54 being of about the same diameter as opening 42 in plate 40. These openings are spaced from the center of plate 50 so that each opening on rotation of the plate may become axially aligned with opening
30 42 in plate 40. It will be seen that by loosening the clamp and rotating plate 50, the effective size of the opening in the bottom of feed regulator 36 may be changed to regulate the capacity of the burner.

35 The adjustable injectors of the invention, indicated generally by reference numeral 60, are each supported by a bracket 61 attached to the steel shell 13. Referring particularly to Fig. 2, each injector comprises a Y-fitting 63 the bottom of
40 which is threaded to accommodate an externally threaded bushing 64 which slidably receives a gas jet 66. One branch of the Y-fitting is threaded as at 68 to provide for attachment to the fitting of the lower discharge end of the funnel 70 adapted
45 to be positioned directly beneath the feed regulator 36. A winged bolt 72 passing through bushing 64 provides means for adjusting the end of jet 66 with reference to the axis of funnel 70. The other branch of fitting 63 is threaded to receive one end of a metallic nozzle 73 which projects
50 through an opening 74 in the furnace wall 11 and provides an ore inlet conduit 75 through which fines are injected into the combustion chamber 12. A dispersing cone 76, positioned
55 beneath orifice 42, is supported as indicated in the drawing by three short legs engaging the inner surface of funnel 70.

Welded to the upper end of bolt 77 (Figs. 2 and 3) is a trough-like plate 78 to which nozzle
60 73 may be clamped by means of a U-bolt 80, the ends of which pass through plate 78. Referring particularly to Fig. 3, the lower threaded end of bolt 77 is adapted to pass through an elongated slot 81 in the horizontal leg 82 of an angle bracket
65 83. Slot 81 permits sidewise adjustment of nozzle 73. The vertical position of bolt 77 with reference to bracket 83 may be adjusted by set nut 84 and winged nut 85. The lower end of vertical leg
70 87 of bracket 83 is drilled to accommodate a bolt 88 which may be slid back and forth in a horizontal slot 90 in bracket 61. Bracket 83 is held tightly in any desired position with reference to bracket 61 by means of winged nut 92 threaded onto the end of bolt 88. From the foregoing, it will be seen the weight of fitting 63 and the as-

sociated parts is supported by bracket 61 fixed to the furnace casing 13.

A bustle 95 having an inlet 96 provides for gas supply to injector jet 66, the bustle 95 communicating with jet 66 through pipe 97 including a
5 control valve 98, a pressure gauge 99 and a double universal joint indicated at 100.

The burner may be provided with any suitable number of injectors. In the illustrated embodiments of the invention, the two injectors shown
10 in Fig. 1 are diametrically opposed. In some instances it is desirable to employ say three or more injectors equally spaced about the circumference of the burner. It will be understood where three
15 or more injectors are included in the furnace construction, a hopper 30 and a feed mechanism 36 are provided for feeding ore thereto.

Oxidizing gas to support the roasting operation is introduced into the chamber 12 through
20 circumferentially spaced ports 102, positioned adjacent the ore injectors, and connected through short pipe sections, not shown, with a bustle 103, communicating with an air inlet connection 104, open to the atmosphere and having a control
25 valve 105.

The bottom of the combustion chamber 12 is formed by a hopper-shaped brick-faced hearth
30 107 terminating in an outlet 108 through which cinder may be continuously discharged into a conveyor. A gas main 110, opening into the combustion chamber, just beneath the crown 15, is connected to the suction side of a fan which effects withdrawal of gaseous combustion products from the burner.

The apparatus of the invention may be employed in connection with the roasting of finely
35 divided metal sulfides such as iron pyrites, pyrrhotite, zinc sulfide or arsenopyrite. The adaptability and operating advantages of the improved apparatus may be more clearly understood from
40 the following in which the apparatus is described in connection with the roasting of iron pyrites.

A supply of sulfide fines is maintained in the bin 24 by suitable conveyor or elevator mechanism, not shown. Before roasting is begun,
45 combustion chamber 12 is preheated to temperatures above the ignition point of the particular ore to be roasted, as by the use of oil burners inserted through conveniently located work-holes,
50 not shown. When the desired degree of preheat is obtained in the combustion chamber, the 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
55 out of the bin 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
60 heated surface of hearth 17 and into passage 34. The dry or partly dry ore runs onto sloping screens 31, which remove lumps, and then into hopper 30. The finely divided particles drop through pipe 35 into cylindrical sleeve 38 of feed
65 regulator 36. The oversize material discharged by screens 31 is collected by receptacles 30' and conveyed by any suitable means not shown to a crusher, or used in a bed roaster or otherwise used or disposed of.

The adjustable ore feed regulator 36 comprising part of the invention affords means by which
70 a regulated quantity of fines may be constantly fed into funnel 70. As indicated above, the openings 51, 52, 53, and 54 in plate 50 are of 75

variable size, and in accordance with the fineness of the ore, the size of the combustion chamber, the desired capacity of the burner, and other variable operating conditions, the plate 50 may be positioned by adjustment of nut 48, so as to place an orifice of the desired size beneath the opening 42 in the bottom of sleeve 38. As will be hereinafter observed, the vertical position of funnel 70 may vary, and to provide for this, the position of feed regulator 36, with respect to pipe 35, may be regulated by adjustment of winged bolt 39 to insure discharge of fines into the funnel. The plate 50 thus provides a fixed opening for accurate feed control preventing fluctuation in ore supply which may readily take place with other types of adjustable valves.

The fines accordingly flow steadily from regulator 36 into funnel 70, which conveys the ore stream directly and preferably without any decrease in velocity of the particles into Y-fitting 63 in which the fines are swept up by the air introduced through jet 66 and carried through pipe 73 into the combustion chamber. Conical surface 76 in funnel 70 serves to divide the stream of ore falling from the orifice in plate 50. The inner end of jet 66 is preferably located inwardly of the axis of funnel 70 so that the flow of air from the jet induces a slight minus pressure in the vertical leg of Y 63 and results in an actual suction drawing in air and ore through funnel 70. Orifice plate 50 regulates the flow of ore to the feed nozzle and does not permit ore to build up in the funnel. In operation, ore and air are sucked in the throat of funnel 70, become more or less uniformly dispersed by cone surface 76, pass through Y 63 and are given an additional impulse on passing the end of jet 66, resulting in a very homogeneous dispersion of the finely divided ore in air at the outlet of the feed nozzle. Streaky or fluctuating feed is avoided, roasting of the ore is more complete and gas strength is more easily kept uniform by operating in this manner.

To effectively carry out the roasting process, the manner of introducing the fines into the combustion chamber is of major importance. The fines should be fed into the chamber so that each particle is suspended in the roasting atmosphere for a maximum period of time, and also so that contact of the fines with the walls of the combustion chamber is substantially avoided. To this end, by means of the feed mechanism of the present invention, the horizontal and vertical angles of the axes of nozzles 73, the amount of fines fed into the injectors from pipes 35, and the air pressure in jets 66, adjusted by valves 98, may be conveniently regulated with respect to the particular size of the roasting chamber so that the ore particles from each injector rise through the combustion chamber, away from the walls thereof, to an elevation just below the underside of crown 15. The horizontal and vertical angular position of nozzles 73 and the rate of supply of ore and air thereto may be likewise adjusted 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. In this manner, a commercially satisfactory dispersion of fines in the combustion chamber may be obtained, and contact between any substantial quantities of ore particles and the hot walls of the roasting chamber is prevented, thus avoiding accumulation of scar on the walls.

In Fig. 1, the dotted line 115 indicates the approximate path of travel of an ore particle of average size introduced through the injector on the left side of the burner.

From the previous description, it will be understood nozzle 73 and the Y-fitting 63 are rigidly connected to the upper end of bolt 77. By loosening the winged nut 92, the vertical angle between the axis of the nozzle and the horizontal may be adjusted, thus permitting swinging of the nozzle through an arc lying in a vertical plane and extending longitudinally of and disposed at a right angle with the burner wall. Also, by loosening nut 92, by means of the horizontal slot 90, movement of the injector back and forth relative to the wall of the burner may be effected. Nozzle 73 and the Y-fitting may be moved bodily up or down by moving set nut 84 and winged nut 85 to permit vertical movement of bolt 77 through the horizontal section 82 of bracket 83. Also by means of slot 81 the nozzle may be adjusted side-wise.

Under some operating conditions, there may be instances where it is desired to introduce the fines into the roasting chamber in a direction other than radially. It will also be understood that by loosening set nut 84 and winged nut 85, the injector may be moved through a horizontal angle about bolt 77 as an axis. By means of this adjustment fines may be injected into the combustion chamber radially or in a direction off a given radius. To permit the desired movement of nozzle 73, opening 74 in the furnace wall 11 is made large enough so that angle A (Fig. 2) may vary for example between 15 and 45 degrees, and so that nozzle 73 may be swung horizontally through an arc of say 45 degrees.

The major portion of the total quantity of air, or other oxidizing gas, necessary to support roasting is drawn into the combustion chamber at the bottom thereof from bustle 103 through ports 102. Where air is employed for injecting the fines through the nozzles, not more than about 10% of the total air required for oxidation would ordinarily be introduced through air jets 66, although larger amounts may be used if desired. The position of the ends of jets 66 with respect to the axes of funnels 70 may be adjusted by manipulation of tail nut 72, and if necessary bushings 64 and jets 66 may be removed from fittings 63 to permit cleaning of the latter or of the nozzles 73.

By suitable adjustment of the injectors, a relatively uniform distribution of partially roasted particles is formed over the major portion of the upper end of the combustion zone. The particles thereafter drop to the bottom of the combustion chamber. The blower in gas line 110 is operated so as to draw sufficient air into the combustion chamber to supply enough oxygen to effect substantially complete oxidation of the fines, and also so that the velocity of the rising stream of air through the combustion chamber is not sufficient to interfere with the free gravity fall of the fines. Because of the adjustable features of the injectors, a satisfactory dispersion of ore particles over a major portion of the top of the combustion chamber is obtained, and ore particles during the upward movement are not thrown against the walls of the roasting chamber, thus avoiding contact of fines with the hot walls of the combustion chamber when the fines are in a state conducive to scarring. As the downward flow of the fines is in substantially

straight lines or at a high angle, subsequent contact of fines with the walls of the combustion chamber is avoided, thus further preventing conditions under which scarring might take place, the iron oxide cinder falling on hopper-shaped hearth 107 runs through opening 108 into a suitable conveyor.

We claim:

1. The combination with a reaction chamber having an opening in a wall thereof, of means for feeding into said reaction chamber finely divided material in dispersed condition, said means comprising a movable injector having a material inlet passage open to the atmosphere and a nozzle disposed in angular relation with respect to the inlet passage and extending through said opening, means in said injector inlet passage for dispersing in atmospheric air material fed into said injector inlet passage, a feed regulator for feeding material into the injector and for controlling such feed so as to prevent stopping up of said inlet passage to flow of atmospheric air, means for changing the position of the feed regulator to accommodate changes of position of the injector material inlet passage, means including an air jet in said nozzle for inducing in the inlet passage a minus pressure to form in and draw through the inlet passage preliminary dispersion of material in air and for introducing into the preliminary dispersion an additional stream of air under positive pressure to cause the material to flow through the nozzle and form at the outlet thereof a relatively homogeneous dispersion of material in air, means for swinging the nozzle through an arc lying in a plane extending longitudinally of and disposed at a right angle with the wall, means for swinging the nozzle through an arc lying in a plane at a right angle with said first mentioned plane and means for holding the nozzle in a fixed position in each of said arcs.
2. The combination with a reaction chamber having an opening in a wall thereof, of means for feeding into said reaction chamber finely divided material in dispersed condition, said means comprising a movable injector having a material inlet passage open to the atmosphere and a nozzle disposed in angular relation with respect to the inlet passage and extending through said opening, a cone in said injector inlet passage arranged to disperse in atmospheric air material fed into said injector inlet passage, a feed regulator for feeding material onto said cone and for controlling such feed so as to prevent stopping up of said inlet

passage to flow of atmospheric air, means for changing the position of the feed regulator to accommodate changes of position of the injector material inlet passage, means including an air jet in said nozzle for inducing in the inlet passage a minus pressure to form in and draw through the inlet passage preliminary dispersion of material in air and for introducing into the preliminary dispersion an additional stream of air under positive pressure to cause the material to flow through the nozzle and form at the outlet thereof a relatively homogeneous dispersion of material in air, means for universally changing the position of the injector nozzle in the wall opening, and means for holding the nozzle in a fixed position.

3. The combination with a reaction chamber having an opening in a wall thereof, of means for feeding into said reaction chamber finely divided material in dispersed condition, said means comprising a movable injector having a material inlet passage open to the atmosphere and a nozzle disposed in angular relation with respect to the inlet passage and extending through said opening, a cone in said injector inlet passage arranged to disperse in atmospheric air material fed into said injector inlet passage, a feed regulator for feeding material onto said cone and for controlling such feed so as to prevent stopping up of said inlet passage to flow of atmospheric air, means for changing the position of the feed regulator to accommodate changes of position of the injector material inlet passage, an air jet in the injector in alignment with said nozzle and having the end thereof positioned inwardly of the axis of the material inlet passage and arranged to induce in the inlet passage a minus pressure to form in and draw through the inlet passage preliminary dispersion of material in air and to introduce into the preliminary dispersion an additional stream of air under positive pressure to cause the material to flow through the nozzle and form at the outlet thereof a relatively homogeneous dispersion of material in air, means for universally changing the position of the injector nozzle in the wall opening, means for holding the nozzle in a fixed position, means for moving the injector bodily toward and away from said opening, and means for moving the injector longitudinally with respect to said wall.

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