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APPARATUS FOR ROASTING MINERAL BEARING PARTICLES

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Fig. 2.

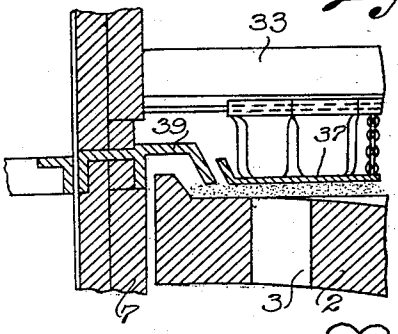


Fig. 1.

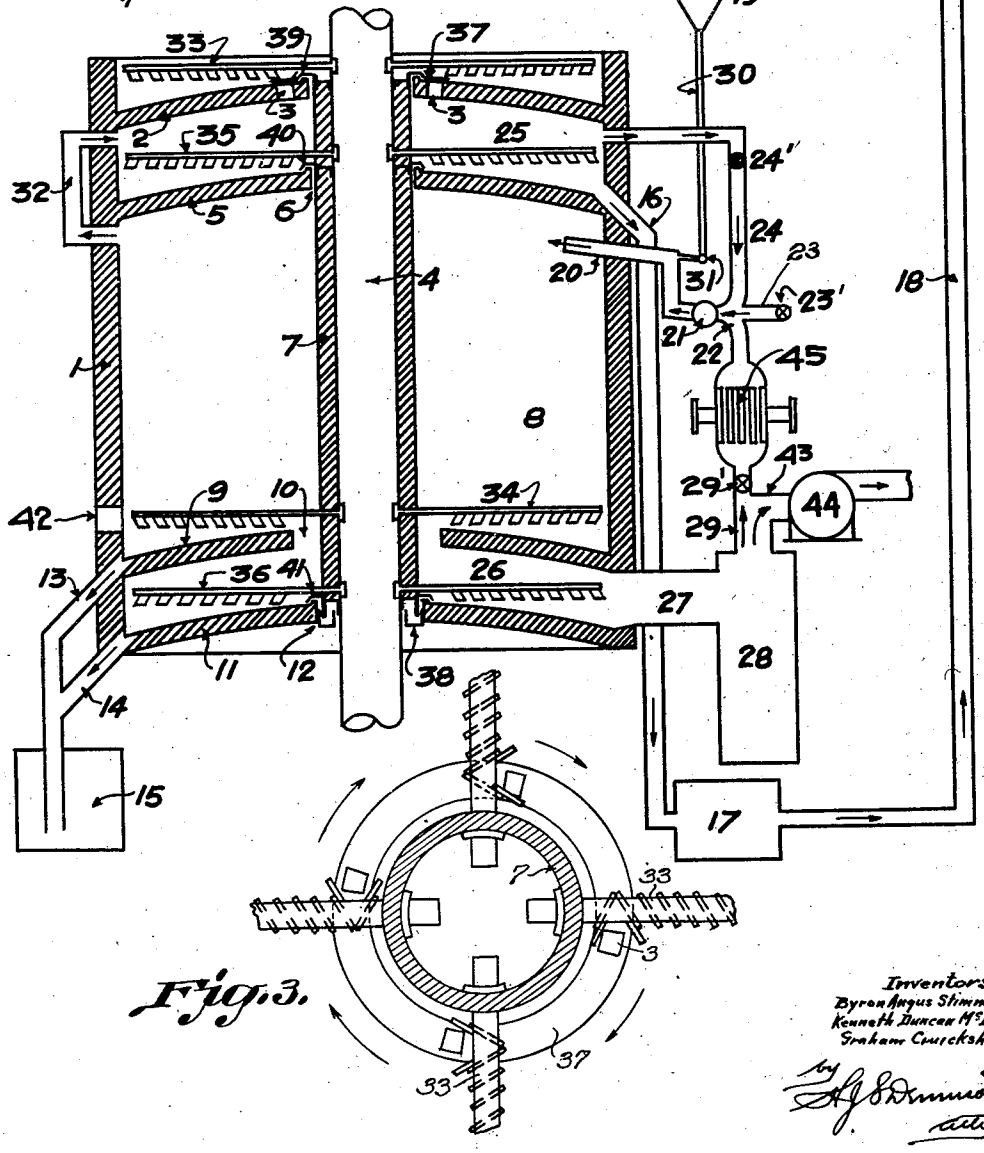


Fig. 3.

Inventors.
Byron Angus Stimmel.
Kenneth Duncan McBean.
Graham Cruickshank.
by
Attorney

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APPARATUS FOR ROASTING MINERAL BEARING PARTICLES

Byron Angus Stimmel, Kenneth Duncan McBean, and Graham Cruickshank, Trail, British Columbia, Canada, assignors to The Consolidated Mining and Smelting Company of Canada Limited, Montreal, Canada, a company of Canada

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10 Claims. (Cl. 266—20)

The principal objects of this invention are to effect a material saving in the cost of the recovery of mineral values from ores and particularly mineral sulphides and to provide an apparatus, the use of which will enable the recovery of practically all of the mineral values.

A further and important object is to provide an apparatus by means of which a process may be put into effect which will avoid the dissemination of noxious gases and which will enable such to be used to commercial advantage.

A further and very important object is to effect the oxidation of the sulphides with the formation of the minimum amount of ferrates in the roasting of ore containing zinc and iron sulphides.

The principal features of the invention consist in the novel construction of the roasting chamber and the arrangement of means for handling the material whereby sulphide particles in a finely divided state are completely disseminated and oxidized in gaseous suspension and whereby the temperature of the roasting chamber is controlled by the return of cooled inert combustion gases, and whereby concentration of sulphurous gases may be effected when sulphide materials are being roasted.

A further feature of importance consists in the novel method of utilizing the combustion gases in the preliminary drying of the material to be treated.

A still further feature consists in the novel arrangement of means for retaining the oxidized mineral particles in physical contact in the presence of the furnace gases and at a regulated temperature for a controlled period.

In the drawings, Figure 1 is a diagrammatic vertical sectional detail of an apparatus constructed in accordance with this invention.

Figure 2 is a vertical fragmentary sectional view on an enlarged scale illustrating the mounting of one of the rabble arms above the drying hearth and the plate for opening and closing the hearth discharge openings.

Figure 3 is a part diagrammatic plan view showing the disposition of the rabble arms and outlet control plate.

In the apparatus herein shown the furnace 1 which is preferably cylindrical in its form with an upper hearth 2, preferably of arched formation, fitting snugly around the insulating covering 7 of the shaft 4 with a lute-ring 39 to seal the joint between said hearth and said shaft, said hearth having four openings, two of which 3 and 3, are shown spaced at regular intervals around the vertical shaft 4 with suitable coverings 37 which are closed when the mineral bearing material is not being charged therethrough by the rabble arms 33, the said covering consisting of a circular metal plate 37 attached to the rabble arm 33 with an opening therein so placed that during the revolutions of the said rabble arm the opening in the covering plate will coincide with the opening in the hearth allowing the passage of the mineral bearing material through said opening. The vertical shaft 4 extends axially through the furnace. Spaced below the hearth 2 is an arched hearth 5 which fits snugly around the insulating covering 7 of the shaft 4 with a lute-ring 40 to seal the joint between said hearth and said shaft.

Below the hearth 5 is arranged an unobstructed roasting chamber of large cross-sectional area and relatively great depth so proportioned that the finely divided mineral sulphides blown into the upper portions thereof have ample room for complete dispersal throughout the chamber area and will have sufficient space for unimpeded downward movement through an oxidizing atmosphere to permit the complete oxidation of the mineral sulphides in gaseous suspension.

A successfully operated furnace for carrying this process into effect measures approximately twenty-three feet in diameter and fifteen feet, six inches in height.

At the bottom of the chamber 8 is arranged an arched hearth 9 having a central circular opening 10 which forms an annular opening around the insulating casing 7 of the central shaft 4.

A hearth 11 also arched and spaced below the hearth 9 is provided with a central opening 12 between said hearth and the shaft and casing 4 and 7, which opening is covered with a lute-ring 41 and sealed with a sand seal 38.

A conduit 13 leading from the outward portion of the hearth 9 communicates with a conduit 14 leading from the outward portion of the hearth 11 and both conduits lead to a storage bin 15.

A conduit 16 leads from the outward portion of the lower hearth 5 of the two upper hearths and conducts the material fed thereto to a grinding mill 17.

An elevator 18 of any suitable type leads from the grinding mill to a hopper 19 arranged above the furnace roasting chamber.

A conduit 20 extends through the side wall of the furnace in an upwardly inclined position and is arranged to discharge parallel to the underside of the hearth 5. This conduit connects with a blower 21 which has its intake 22 con-

nected with an air conduit 23 and also with a conduit 24 communicating with the upper part of the chamber 25 arranged between the hearths 2 and 5.

The chamber 26 arranged between the hearths 9 and 11 is connected by a flue 27 to the gas cooler and flue dust collector 28 and a conduit 29 leads from the cooler 28 to the fan inlet 22.

A valve 23' is arranged in the air conduit 23 and a valve 29' is arranged in the gas conduit 29.

A conduit 30 leads downwardly from the hopper 19 to an air injector 31 which discharges the pulverized ore into the conduit 20.

A conduit 32 leads from the upper portion of the chamber 8 and connects with the chamber 25 between the hearths 2 and 5 and directs hot gases from the roasting chamber into the drying chamber 25.

Suitable forms of rabble arms 33 and 34 are mounted on the shaft 4 above the hearths 2 and 9 respectively. These rabble arms are adapted upon the rotation of the shaft 4 to take the material inwardly to the openings 3 and 10 respectively.

Rabble arms 35 and 36 mounted on the shaft 4 and extending radially therefrom into the chambers 25 and 26 respectively are adapted to force the material falling through the openings 3 and 10 respectively outwardly over the hearths 5 and 11.

In the operation of this furnace the finely divided material which is usually in the form of sulphide concentrates is deposited in a wet state on the uppermost hearth 2.

Heated gases from the chamber 8 pass through the conduit 32 to the chamber 25 between the hearths 2 and 5 and heat is thus applied to drive off the moisture.

The concentrates are rabbled through the opening 3 and fall on to the hearth 5 and the rabble arms 35 force the cencentrates outwardly over the surface of the hearth 5, which is heated on both sides, and the finally dried material is directed into the conduit 16 which carries it to the grinding mill 17.

Gases arising from the heating and drying of the material in the chamber 25 are carried through the conduit 24 being drawn from the chamber 25 by the fan 21. These gases are mixed with the desired quantity of air drawn through the conduit 23 and regulated by the valve 23' and they are forced through the conduit 20 which blows into the upper part of the roasting chamber 8. This blast of mixed air and gas has fed into it the desired quantity of finely pulverized dried material carried from the grinding mill 17 by the elevator 18, hopper 19 and conduit 30.

The mixture thus blown into the chamber is ignited and maintains a temperature sufficient to effect the proper roasting of the sulphide particles. The sulphurous gases mixed with a proper quantity of air will sustain a combustion sufficient to effect the desired result. This mixture can of course be readily regulated.

The diameter of the furnace roasting chamber is such as to permit the flotation of the sulphide particles in the atmosphere therein so that they will spread out from a concentrated jet to a freely floating dust, the particles of which will be so separated that they will fall through the atmosphere within the roasting chamber free of contact with each other. This unimpeded slow downward movement of the particles through the roasting chamber effects the complete oxidation in gaseous suspension by means of the sulphur content of the sulphides without the use of extraneous fuel.

The roasted product which settles upon the hearth 9 is preferably rabbled through the opening 10 on to the hearth 11 from which it is rabbled outwardly to pass to the conduit 14 and storage 15. The pitch of the rabble blades as well as the speed of operation of the rabble arms will accurately determine the period of rest of the particles on the lower hearths and variation in the speed may readily be effected by regulating the speed of the motive drive of the shaft 4 as will be readily understood.

If it is found that the products of combustion settling on the hearth 9 have been retained in physical contact with each other and in the presence of the combustion gases a sufficient length of time, they may be discharged through the conduit 13 to the storage bin by reversing the rabbles instead of carrying same over the hearth 11.

The main bulk of the furnace gases passes downwardly and out through the outlet conduit 27 at the bottom of the furnace and it is directed through dust collectors, precipitating devices or centrifugal separators to precipitate the dust therefrom.

The gas, if already of the desired concentration of sulphur dioxide for use in the manufacture of sulphuric acid or other products, is taken from the chamber 28 for further processing. For this purpose an outlet conduit 43 is provided which preferably connects with the conduit 29 below the valve 29' and a fan 44 associated with the conduit 43 aids in the withdrawal of the concentrated gas out of the roasting circuit for further treatment. If, however, the gas is not of sufficiently high concentration all or part of it, as desired, may be re-cycled back through the furnace by the opening of the valves 29' which will permit it to be drawn upwardly by the action of the fan 21 and blown again into the roasting chamber.

This arrangement is very desirable and by the use of the air valve 23' and gas valve 29' the quantity of air and gas may be so regulated as to accurately control the temperature of combustion within the roasting chamber.

If the gas discharged from the roasting chamber is of too high a temperature it can be passed through suitable heat exchanging means 45 to bring it to the temperature desired before re-entering the roasting chamber.

It is an important feature of this invention to supply heated gases to the chamber 25 between the hearths 2 and 5 to effect the drying of the mineral sulphide. This gas circulating between the drying hearths is evacuated therefrom by the pipe 24 connected to the fan 21 by means of which it is returned to the furnace, and such returned gas both concentrates and cools the body of gas in the chamber 8.

A suitable valve 24' may be arranged in the conduit 24 to control the gas flow therethrough.

The manipulation of the air valve 23' controls the flow of air added to that flowing through the injector 31 for forcing the dried material into the conduit 20 and this provides for the complete oxidation of the charge and may, if desired, be regulated to supply oxygen for the later conversion of the sulphur dioxide formed in the roasting chamber to sulphur trioxide with the later processing of the gas in the manufacture of sulphuric acid with a margin for contingencies that might arise in the furnace.

Adjustment of the valve 29' provides for the return of roasting chamber gases which have been evacuated from the furnace and passed through dust collectors, and when necessary through coolers.

An apparatus such as described eliminates the necessity of fuel for roasting or oxidizing finely divided mineral sulphides. The unobstructed roasting chamber of large cross sectional area and relatively great depth permits of the complete dissemination of the finely divided mineral sulphides which practically eliminates the formation of insoluble zinc ferrates.

The passage of the sulphides from the drying chamber to the grinding mill and from there to the injector dissipates the heat imparted thereto in the drying process and this feature together with the feature of recycling the sulphur dioxide gas enables the controlling of the temperature in such a manner that the roast may be conducted to handle from two and a half to four times the ordinary tonnage. Further, the recycling of the gas enables the concentration of sulphur dioxide gas.

In the roasting of mineral sulphides consisting substantially of the sulphides of zinc and iron in the above described apparatus, it has been found possible to retard the formation of zinc ferrates which, being insoluble, would if allowed to form, lower the percentage of extraction of zinc. Zinc ferrate forms when the particles of zinc and iron come in contact with each other in the high temperature of the roasting chamber. In this apparatus the efficient dispersal of the particles at the top of the large area roasting chamber ensures a minimum amount of contact between the particles of zinc and iron in the high temperature of the roasting chamber.

In the roasting of mineral sulphides containing zinc and iron, it is desirable to obtain the maximum quantity of zinc oxide and if required in the later processing some zinc sulphate, for instance, if the later processing consisted of the recovery of zinc by the electrolytic method some zinc sulphate would be required to make up the wastage of sulphuric acid. Zinc sulphate is not formed to any appreciable degree in the high temperature of the roasting chamber but tends to be formed in the lower temperature found on the hearth or hearths beneath the roasting chamber and while remaining in contact with the ferric oxide formed in the oxidizing of the iron sulphide and in contact with the sulphur gases formed.

The arresting of the oxidized particles at the bottom of the roasting chamber is of considerable importance and by properly adjusting the speed of operation and the pitch of the rabbles, the period of time during which the zinc oxide remains in contact with the sulphur gas and with the ferric oxide in a temperature below that of the roasting chamber, can be definitely regulated to control the quantity of zinc sulphate produced.

The apparatus described above is shown in part in our co-pending application Serial No. 427,414, filed February 10, 1930, for Method of roasting minerals containing the sulphides of zinc, iron, lead and copper, singly or in combination, of which the present application may be considered a continuation in part.

What we claim as our invention is:—

1. An apparatus for roasting mineral bearing particles, comprising, a furnace having a roasting chamber of a cross sectional area sufficiently large to permit the thorough dispersal of finely divided particles and of a depth sufficient to permit the oxidation of such particles in gaseous suspension, means for dispersing the particles upwardly with a regulated quantity of air within the upper portion of the roasting chamber, means for conducting a portion of the gases from said roasting chamber, means for cooling such portion of gases, means for directing a regulated quantity of the cooled gases to said dispersing means, and means for removing the roasted particles from said roasting chamber at a predetermined rate.

2. An apparatus for roasting mineral bearing particles, comprising, a furnace having a roasting chamber of a cross sectional area sufficiently large to permit the thorough dispersal of finely divided particles and of a depth sufficient to permit the oxidation of such particles in gaseous suspension, an injector conduit terminating in the upper end of said roasting chamber and discharging a restricted flow without avoidable turbulence upwardly into the upper portion thereof, a blower discharging into said conduit, a controlled air conduit leading to said blower, means for injecting finely divided particles into said injector conduit to be dispersed thereby in an upwardly and lateral direction, means for conducting a portion of the gases from the roasting chamber, means for directing a regulated quantity of such gases to said blower, and means for removing the roasted particles from said roasting chamber.

3. An apparatus for roasting mineral sulphides, comprising, a furnace having a roasting chamber of a cross sectional area sufficiently large to permit the thorough dispersal of finely divided particles and of a depth sufficient to permit the oxidation of such particles in gaseous suspension, means terminating within the upper end of the chamber for dispersing the particles upwardly within the upper portion of the roasting chamber to avoid objectionable turbulence within the main roasting chamber and to achieve a prolonged and uniform suspension of particles before settling within said chamber, a hearth forming the bottom of the roasting chamber on which the suspended particles eventually settle, said hearth having an opening therethrough, a hearth spaced below the aforesaid hearth, means for agitating the roasted particles on said hearths, and means for regulating the temperature of the roasting chamber.

4. An apparatus for roasting mineral sulphides, comprising, a furnace having a roasting chamber of a cross sectional area sufficiently large to permit the thorough dispersal of finely divided particles and of a depth sufficient to permit the oxidation of such particles in gaseous suspension, means for upwardly dispersing the particles within the upper portion of the roasting chamber, a drying chamber arranged above the roasting chamber, a plurality of hearths arranged at the bottom of the roasting chamber, a shaft extending vertically through said chambers, and rabble arms extending from said shaft within said drying chamber and within said roasting chamber and adapted to effect the discharge of the particles in regulated time periods.

5. An apparatus for roasting mineral sulphides, comprising, a furnace having a roasting chamber of a cross sectional area sufficiently large to permit the thorough dispersal of finely divided particles and of a depth sufficient to permit the oxidation of such particles in gaseous suspension, means terminating at the upper end of said

chamber for dispersing the particles with an initial upward movement along with a quantity of air within the upper portion of the roasting chamber to avoid objectionable turbulence within the main roasting chamber and to achieve a prolonged and uniform suspension of particles before settling within said chamber, means for discharging the resultant gases from the bottom of said roasting chamber, a receiver for said gases, and means connected with said receiver for conducting a regulated quantity of said gases from said receiver and returning same to the roasting chamber along with said dispersed particles and accompanying quantity of air.

6. An improved apparatus for roasting mineral sulphides, comprising in combination a spacious roasting chamber, means upwardly effecting a wide dispersal of finely divided mineral particles within the upper region of said chamber without creating appreciable turbulence of the main roasting atmosphere, such dispersal assuring a prolonged and uniform suspension of the particles, means for removing the resultant settled solids at a predetermined rate, means for conducting the resultant gases from the bottom of the roasting chamber, a drying chamber immediately above said roasting chamber, a conduit connecting the interior of the roasting chamber with said drying chamber, said dispersing means including a blower having its inlet connected with said drying chamber whereby a circulation of gases is maintained therethrough and the generated gases utilized.

7. In an apparatus for roasting mineral sulphides in gaseous suspension, the combination of a spacious roasting chamber, a drying chamber thereabove, a gas receiver connected to the roasting chamber, an impeller device having its suction side controllably connected to said drying chamber and to said gas receiver, a controllable air supply also connected to the suction side of said impeller device, means for feeding finely divided minerals, means receiving the finely divided minerals and the resultant discharge of said impeller device and upwardly directing the said particles therewith into the upper region of the roasting chamber to effect their wide dispersal at the top of said chamber and their subsequent suspension in said chamber, means connecting the interior of the roasting and drying chambers, means for removing the resultant roasted particles, and means for conducting the resultant gases from said chamber.

8. An improved apparatus for the suspended roasting of mineral bearing particles, comprising in combination, a furnace having a roasting chamber of a cross sectional area sufficiently large to permit the thorough dispersal of finely divided particles and of a depth sufficient to permit the oxidation of such particles in gaseous suspension, means for releasing an upwardly directed stream of gaseous supporting medium directly into the upper region of said roasting chamber along with a quantity of the particles to be roasted to effect their dispersion and suspension with the minimum of turbulent interference, means for accurately regulating the quantity and quality of said supporting medium to control the resulting action on said particles and to regulate the temperature to which they are subject, means for arresting the oxidized particles in the lower region of the roasting chamber, and means for constantly agitating the arrested particles for a period in the presence of the temperature and gases prevailing in said lower region.

9. An improved apparatus for the suspended roasting of mineral bearing particles, comprising in combination, a furnace having a roasting chamber of a cross sectional area sufficiently large to permit the thorough dispersal of finely divided particles and of a depth sufficient to permit the oxidation of such particles in gaseous suspension, means for releasing an upwardly directed stream of gaseous supporting medium directly into the upper region of said roasting chamber along with a quantity of the particles to be roasted to effect their dispersion and suspension with the minimum of turbulent interference, means for accurately regulating the quantity and quality of said supporting medium to control the resulting action on said particles and to regulate the temperature to which they are subject, said latter means consisting in part of means for permitting an accurately regulated volume of combustion gases from the roasting chamber to return thereto in a cooled condition, means for arresting the oxidized particles in the lower region of the roasting chamber, and means for constantly agitating the arrested particles for a period in the presence of the temperature and gases prevailing in said lower region.

10. An improved apparatus for the suspended roasting of mineral bearing particles, comprising in combination a furnace having a roasting chamber of a cross sectional area sufficiently large to permit the thorough dispersal of finely divided particles and of a depth sufficient to permit the oxidation of such particles in gaseous suspension, means for releasing an upwardly directed stream of gaseous supporting medium directly into the upper region of said roasting chamber along with a quantity of the particles to be roasted to effect their dispersion and suspension with the minimum of turbulent interference, means for accurately regulating the quantity and quality of said supporting medium to control the resulting action on said particles and to regulate the temperature to which they are subject, said latter means consisting in part of a cooling chamber receiving a portion of the gases of combustion from the roasting chamber, means for returning an accurately regulated quantity of the cooled gases to said roasting chamber in association with fresh particles to be roasted, and means for agitating the settled oxidized particles for a period within the lower region of the roasting chamber in extended influential relation to the gas and temperature conditions prevailing in such region.

BYRON ANGUS STIMMEL.
KENNETH DUNCAN McBEAN.
GRAHAM CRUICKSHANK.