

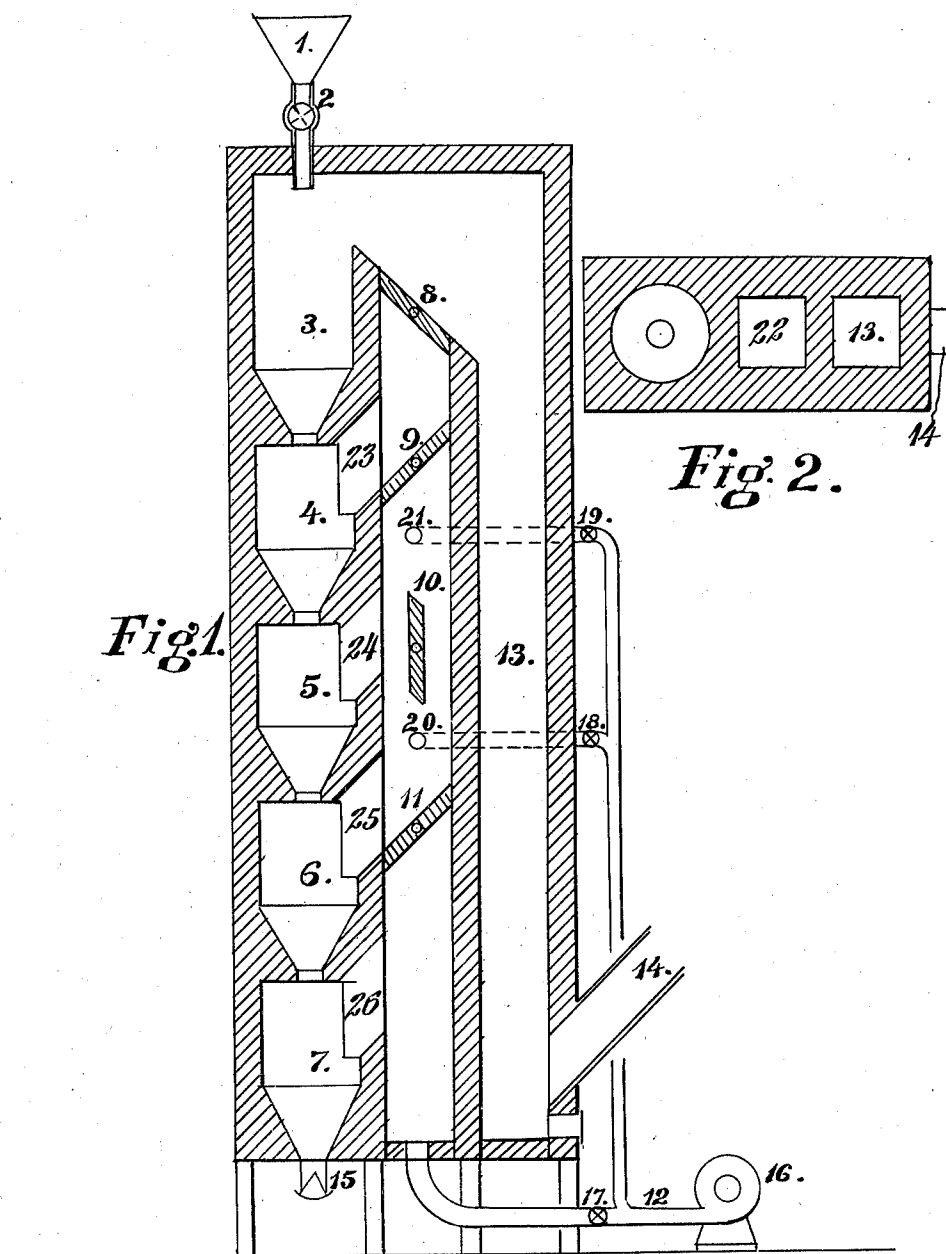
May 5, 1925.

1,536,702

M. F. CHASE ET AL

METHOD OF AND APPARATUS FOR ROASTING ORES

Filed May 4, 1923



INVENTORS
Marsh F. Chase
John Skogmark
by Byrnes Townsend & Buchenstem
his ATTORNEY

UNITED STATES PATENT OFFICE.

MARCH F. CHASE, OF ARDSLEY-ON-HUDSON, AND JOHN SKOGMARK, OF NEW YORK, N. Y.

METHOD OF AND APPARATUS FOR ROASTING ORES.

Application filed May 4, 1923. Serial No. 636,652.

To all whom it may concern:

Be it known that we, (1) MARCH F. CHASE and (2) JOHN SKOGMARK, citizens of the United States, residing at (1) Ardsley-on-Hudson, (2) New York city, in the counties of (1) Westchester, (2) New York, and State of (1) and (2) New York, have invented certain new and useful Improvements in Methods of and Apparatus for Roasting Ores, of which the following is a specification.

This invention relates to a method of and apparatus for contacting materials with each other, for instance for contacting a gas with a liquid, or with a solid, or for contacting a liquid with a solid. Examples of such processes are for instance, the absorption of a gas in a liquid, the roasting of an ore with an oxidizing gas, and the flotation of an ore in a liquid.

The invention broadly consists in passing the material to be treated, for instance the liquid or solid, downwardly step by step through a series of receptacles in each of which it is held by an upward flowing current of the treating gas or liquid and in dropping the material from receptacle to receptacle by control of the suspending current of gas or liquid.

The invention will be described and illustrated hereinafter by reference to the roasting of sulfid ores.

Generally speaking it has not been found to be possible to smelt or otherwise treat sulfid ores for the purpose of extracting their metal values until a considerable portion of the sulfur has been removed. This necessary step of removing the sulfur before metallurgical treatment is usually done by roasting or calcining the ore.

The operation of roasting consists in burning the sulfur occurring in the ore to sulfur dioxide and at the same time oxidizing the metallic elements with which the sulfur was combined. Several well known types of furnaces or burners are used for this purpose. In most furnaces the ore passes through the furnace in a direction opposite to that taken by the air supplying the oxygen for reacting with sulfur, so that the percentage of sulfur in the ore as it passes through the furnace is constantly decreasing and the percentage of SO_2 in the air is increasing and the percentage of oxygen is decreasing. In practically all apparatus used for the purpose of roasting sulfid ore,

the ore is moved from one part of the furnace to another by mechanical means which not only serve the purpose of moving the ore but also stir the ore so that fresh surfaces are constantly exposed to the oxidizing effect of the gas or air passing through the furnace. This is an essential feature of roasting sulfid ores. If the ore is permitted to lie in a quiescent state the SO_2 content of the gas immediately in contact with the ore quickly reaches a concentration which prevents the rapid oxidation of the ore. To obtain the best results in roasting it is desirable

(a) To move the air introduced into the furnace in a direction opposite to that in which the ore is moving;

(b) To constantly stir the ore so that fresh surfaces are exposed;

(c) To keep the gas stream moving at such a rate that the oxygen content of the gas in contact with the ore is not lowered materially below the average oxygen content of the gas in that particular part of the furnace.

It is to this method of roasting that our invention especially relates and, as will be seen from the description that follows we are able to roast, gaining the advantages enumerated above, without the employment of moving parts in the furnace proper.

In furnaces used for roasting ores requiring a high temperature the rabblers and arms moving the ore, being subjected to a high temperature, must, in order to withstand the destructive effect of the heat, be made of refractory materials, such as fire brick, or of metal, (usually iron). If made of refractory materials they are expensive to construct and maintain. If made of metal they must be cooled by air or water. In this case if the roasting operation requires external heat, an additional fuel expense is incurred to make up for heat removed by the cooling.

In roasting certain sulfid ores the heat liberated by the oxidation of the constituents of the ore is more than sufficient to maintain the temperature of the air and the gas in contact with it at a point where the roasting action will continue. When roasting other sulfid ores the quantity of heat liberated while theoretically sufficient to maintain a roasting temperature is not sufficient to do so in the ordinary roasting fur-

nace because of the loss of heat due to radiation and the cooling of the arms and rabbles moving the ore. Zinc sulfid is an example of this class of ore. The heat of combustion of the sulfur and of the zinc with the oxygen of the air is theoretically sufficient to maintain a temperature that will permit the roasting to proceed provided that the ratio of air to ore is kept within certain definite limits. It is difficult, if not impossible, in present types of furnaces to maintain this proper ratio of air to ore. For this reason it is almost always necessary to provide heat from an external source. This is done in two ways—

(a) By passing the air for roasting the ore through a fire box where it is mixed with the gases of combustion of fuel used, to provide the excess heat needed for the roasting process;

(b) By heating the hearth where the ore is roasted by passing combustion gases from an external fire box underneath or around it but not mixing the combustion gases with the gases passing over the ore.

In the first case the gases coming from the roasting furnace in addition to being contaminated by the products of combustion from the burning fuel are so low in percentage volume of SO_2 as to make them unsuitable for use in sulfuric acid manufacture.

In the second case, while the roaster gases are suitable for making sulfuric acid, the amount of fuel used for roasting is much in excess of that used in the first case due to the inefficiency of transferring the heat of combustion gases through the brick work of the hearths and muffles to the ore and roaster gases.

When roasting various classes of ores it is advantageous to make the best possible use of the heat generated in the combustion of the ores, provided the method employed to do this does not decrease the percentage volume of SO_2 in the roaster gases below that obtained when roasting in ordinary types of muffle roasters, as under these circumstances not only will fuel be saved but a waste gas will be obtained suitable for the manufacture of sulfuric acid (a by-product of value).

The object of the present invention, therefore, is to provide as follows:

(a) A condition in roasting sulfid ores where the particles of ore are completely surrounded by gases containing oxygen, thus intensifying the reaction;

(b) A movement of the ore through the furnace without employing moving parts in the path of the ore, thus avoiding high maintenance expense and the cooling effect attendant on such use;

(c) A process which, while it has the advantage of surrounding the particles of ore

with the gas, provides for the general movement of the ore against the current of the gas, thus getting the ore with the lowest sulfur content in contact with gas of highest oxygen content which is conducive to a complete roast;

(d) A method of roasting sulfid ores in which the heat in the roasted ore is utilized to heat the air used for roasting.

In the accompanying drawing we have shown diagrammatically one form of apparatus embodying our invention and suitable for carrying out the process thereof.

Figure 1 is a vertical section; and

Figure 2 is a horizontal section of the apparatus.

Referring to the drawings:

1 is a feed hopper or bin having a valve or feeder 2 for regulating the quantity of ore charged to the furnace.

3, 4, 5, 6 and 7 designate what we shall hereafter term combustion chambers.

8, 9, 10 and 11 represent control valves located in a passage 22 communicating with the combustion chambers through openings 23, 24, 25 and 26.

12 represents the pipe which conducts the air used for roasting from the blower (16) to the furnace. This air may all be admitted at the bottom of the passage 22, or part may be admitted at other points in the passage 22 as indicated by inlets (20) and (21). The relative amount of air furnished at each point may be regulated by means of valves 17, 18, and 19.

13 represents a dust settling chamber.

14 represents an outlet for the gases after passing through the furnace.

15 represents the valve for discharging the roasted ore.

The operation of the furnace is as follows:

The furnace is first heated to a suitable temperature, say between 800° and 1000° centigrade by means of oil burners or gas burners (not shown). Then with all of the valves 8, 9, 10 and 11 closed, the blower or fan 16 is started and a charge of ore is supplied to the combustion chamber 3 through feeder 2. The blast of air passes upwardly through the combustion chambers 7, 6; 5, 4 and 3 successively and its strength through the contraction at the base of combustion chamber 3 is so adjusted that it is sufficient to prevent the ore from passing to the next combustion chamber 4, below. The valve 8 is now opened thus permitting the air to pass at low speed from the combustion chamber 4 through the opening 23 to the dust chamber 13. As a result of the by-passing of the combustion chamber 3 the speed of the air through the aperture at the bottom of this chamber is reduced and the ore is permitted to pass by gravity to combustion chamber 4. The valve 8 is only

kept open for approximately the time necessary for the charge of ore in combustion chamber 3 to fall to combustion chamber 4 and is then closed and a new charge is supplied to combustion chamber 3. The valve 9 is next opened which by-passes the gas from the combustion chamber 5 around combustion chamber 4 to combustion chamber 3; thus allowing the ore in combustion chamber 4 to fall into combustion chamber 5. Valve 9 is then closed and valve 8 is operated and the charge in combustion chamber 3 is passed on to combustion chamber 4. Valve 8 is then closed and chamber 3 recharged and then valve 10 is operated which brings the charge from combustion chamber 5 to combustion chamber 6. Valves 9 and 8 are operated as described above to pass the charges in chambers 3 and 4 into chambers 4 and 5 and chamber 3 is again charged. Next valve 11 is operated, bringing the ore down to combustion chamber 7 where it is accumulated in the bottom and is finally drawn off through valve 15, and the charges in chambers 3, 4 and 5 are passed to chambers 4, 5 and 6 and chamber 3 recharged as described.

From this period on, the operation will consist in operating valves 11, 10, 9 and 8 in sequence, each time dropping a charge from one combustion chamber to the one next below. The time needed to keep the valves open for passing of the ore from one combustion chamber to the next is of the magnitude of two or three seconds and the time for the ore to pass through the furnace will be determined by the frequency of the operation of the valves, thus, if one minute passes between each time a certain valve in the series is operated the ore will remain in each combustion chamber for that period of time. It may, under some circumstances, be desirable to supplement the supply of air to the upper combustion chambers 5, 4 and 3 from the lower chambers 7 and 6. This is accomplished by supplying regulated quantities of air through the openings 20 and 21.

The action of this method of roasting is as follows:

The ore which is fed into combustion chamber 3 encounters the hot gases from the lower chambers and is ignited so that when it passes on to combustion chamber 4 its temperature is elevated and with this higher temperature the roasting action is intensified. Similarly the ore passing to combustion chamber 5 is of a still higher temperature and in encountering a gas current with a higher oxygen content will be completely roasted. The ore passing from 5 to 6 is still heated, but since the sulfur is substantially all removed and the metals oxidized in the chambers above, there is no further reaction taking place, and this ore

in chamber 6 therefore serves to preheat the air passing up through the furnace and thus assists the reaction in the upper combustion chambers. The number of combustion chambers, the time of treatment in each chamber, and other conditions may of course be made to suit the requirements of each particular installation.

The reason this furnace is adapted for complete roasting is that the ore charge in each combustion chamber is suspended in the rapid air current issuing from the bottom of the combustion chamber by which it is carried up a certain height and then falls down to the slope at the bottom of the chamber and at the bottom of the slope it is again caught by this air current. The particles of ore consequently are surrounded by the gas which provides a much more efficient action than is possible in a roasting furnace as constructed according to present practice where the ore generally is present in the form of a bed one to three inches thick where only the particles of ore which are on the surface can be acted on by the oxygen in the gas, such particles being only renewed at the comparatively infrequent stirrings which the ore bed receives when the furnace is raked.

It will be seen from the above that the ore in passing through the furnace is subjected to the oxidization action of the gases in each combustion chamber except the lower ones which perform an entirely different function from that of roasting. Thus, the ore treated in any combustion chamber except the lower ones has less percentage of sulfur in it than the ore in the chamber immediately above it. As the ore progressively passes through the furnace it is subjected to the oxidizing effect of the gas in the successive stages or steps. This permits of obtaining a more uniform temperature throughout the roasting than if the entire oxidation was completed in one stage.

As the ore enters each combustion chamber or stage of roasting it meets the ascending gas current where the action is as described so that it is subjected while in a combustion chamber to periods of suspension in the gas current and in the intervals between such periods of suspension it is still in motion so that it is always presenting fresh surfaces to the atmosphere through which it is moving.

In the foregoing specification we have described in detail an application of the invention for the roasting of sulfid ores. It is clear, however, that the same principles may be applied for other treatments of solids with gases, for instance, for chloridizing ores, etc., and for the treatment of solids with liquids instead of with gases and for contacting gases with liquids, for instance for scrubbing the gas or for absorbing the

gas or a component thereof in the liquid. It is of course evident that the apparatus, although of the same general character, will be modified as to size, shape, materials, kinds of valves and conduits, etc., to suit the materials under treatment.

The terms and expression which we have employed are used as terms of description and not of limitation, and we have no intention in the use of such terms and expressions of excluding any mechanical equivalent of the features shown and described or portions thereof, but recognize that various modifications are possible within the scope of the invention claimed.

We claim—

1. Process of subjecting mobile material to the action of a fluid, which consists in passing the mobile material downwardly through a closed passage way, passing the fluid upwardly through the passage way under conditions to normally hold the column of mobile material suspended and intermittently varying the action of the fluid pressure upon the mobile material to allow the latter to descend in successive stages.

2. Process of subjecting mobile material to the action of a fluid, which consists in passing the mobile material downwardly through a closed passage way, passing the fluid upwardly through the passage way under conditions to normally hold the column of mobile material suspended and intermittently by-passing part of the fluid to different points of the passage way to allow the material to descend in successive stages.

3. Process of subjecting mobile material to the action of a fluid, which consists in passing the mobile material downwardly through a plurality of receptacles, passing a fluid upwardly through the receptacles under conditions to normally hold the mobile material in suspension and successively by-passing part of the fluid around the different receptacles to allow the material to descend in successive stages.

4. Process of roasting sulfur-bearing ores which comprises providing an upward flowing current of gas through a plurality of receptacles, maintaining a charge of the sulfur-bearing material in each of said receptacles by the force of said gas current, and progressing the material downwardly through said receptacles by by-passing said current of gas around each of said receptacles successively from top to bottom.

5. Process of roasting sulfur-bearing materials which comprises establishing a plurality of superposed separate bodies of the material in subdivided condition in suspension in an upwardly flowing current of an oxidizing gas, supplying gas to said current

intermediate at least two adjacent bodies of said material, progressing said bodies downwardly by successively reducing the strength of said current of gas suspending each of said bodies, the roasting operation being so regulated that the oxidation of the ore is completed before it reaches the position of the lowermost body whereby the current of gas supplied to the ore in the upper bodies is preheated by contact with the hot roasted ore in said lowermost body.

6. Apparatus for treating a mobile material with a fluid, comprising a plurality of superposed chambers, each of said chambers communicating with the chamber next beneath through a restricted passage, means for supplying the uppermost chamber with the mobile material, pressure means for passing the fluid into the lowermost chamber and means for independently by-passing the fluid around some of said chambers.

7. Apparatus for roasting ores, comprising a plurality of superposed chambers, each of said chambers communicating with the chamber next beneath through a restricted passage, means for supplying the uppermost chamber with ore in subdivided condition, means for supplying the lowermost chamber with an oxidizing gas, and means for by-passing the oxidizing gas around each of said chambers independently.

8. Apparatus for roasting ores as defined in claim 7 in which the means for by-passing the oxidizing gas around each of said chambers independently comprises a vertical conduit communicating with the upper part of each of said chambers; and valves in said conduit for controlling the passage of gas therethrough.

9. Apparatus according to claim 7 in which the means for independently by-passing the oxidizing gas around each of said chambers comprises a conduit communicating with the upper part of each of said chambers; valves in said conduit for controlling the passage of gas therethrough, and means for supplying the oxidizing gas to the said conduit.

10. Apparatus according to claim 7 in which the means for independently by-passing the oxidizing gas around each of said chambers comprises a conduit communicating with the upper part of each of said chambers; valves in said conduit for controlling the passage of gas therethrough, means for supplying the oxidizing gas to the said conduit and a dust settling chamber in communication with the said uppermost chamber and the said conduit.

In testimony whereof, we affix our signatures.

MARCH F. CHASE.
JOHN SKOGMARK.