

Aug. 22, 1933.

I. HECHENBLEIKNER
SULPHUR BEARING ORE FURNACE

1,923,866

Filed Oct. 26, 1929

2 Sheets-Sheet 1

Fig. 1.

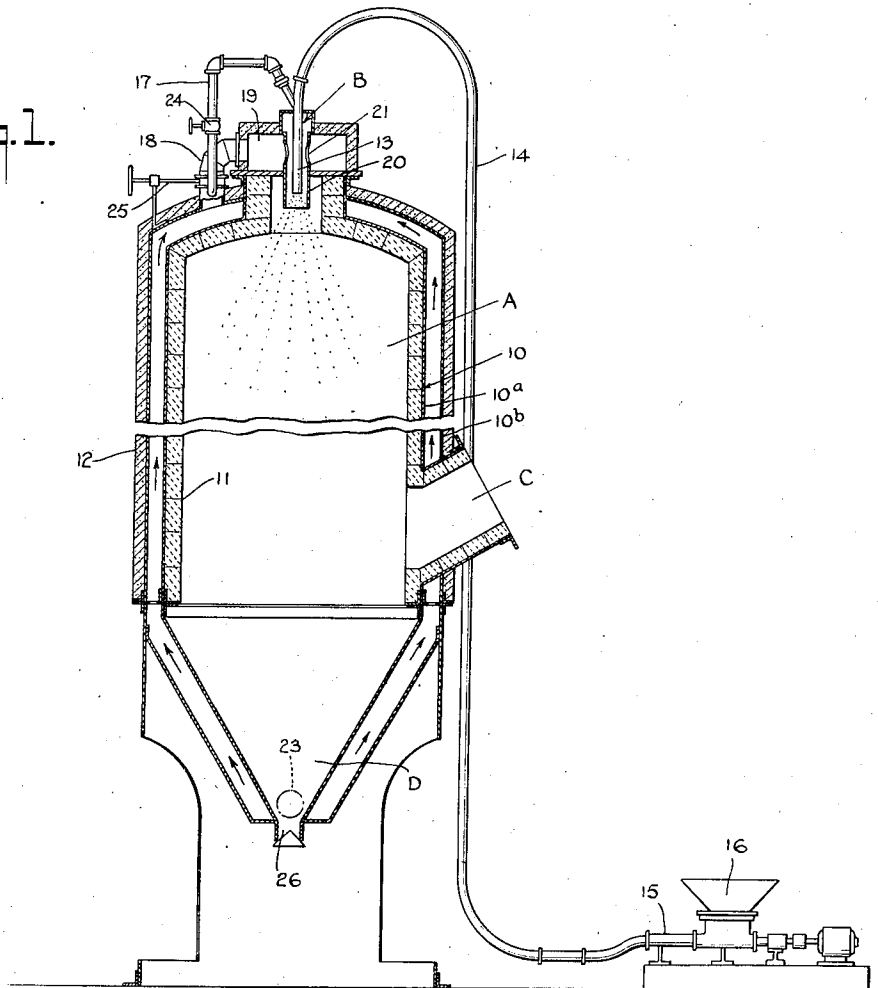
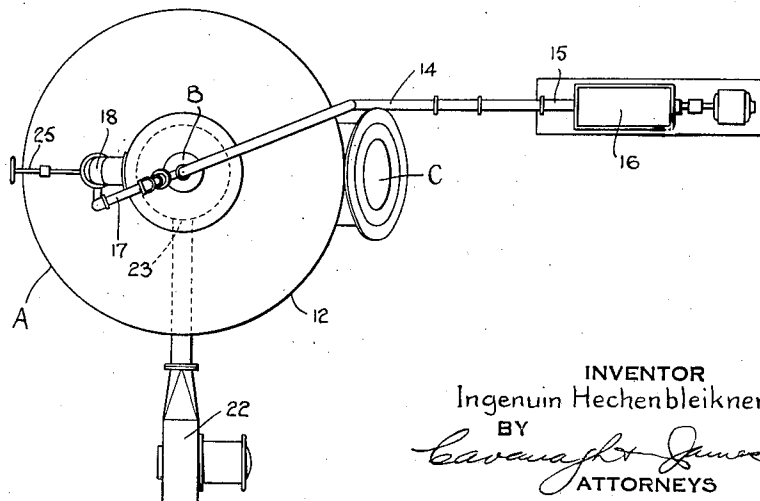


Fig. 2.



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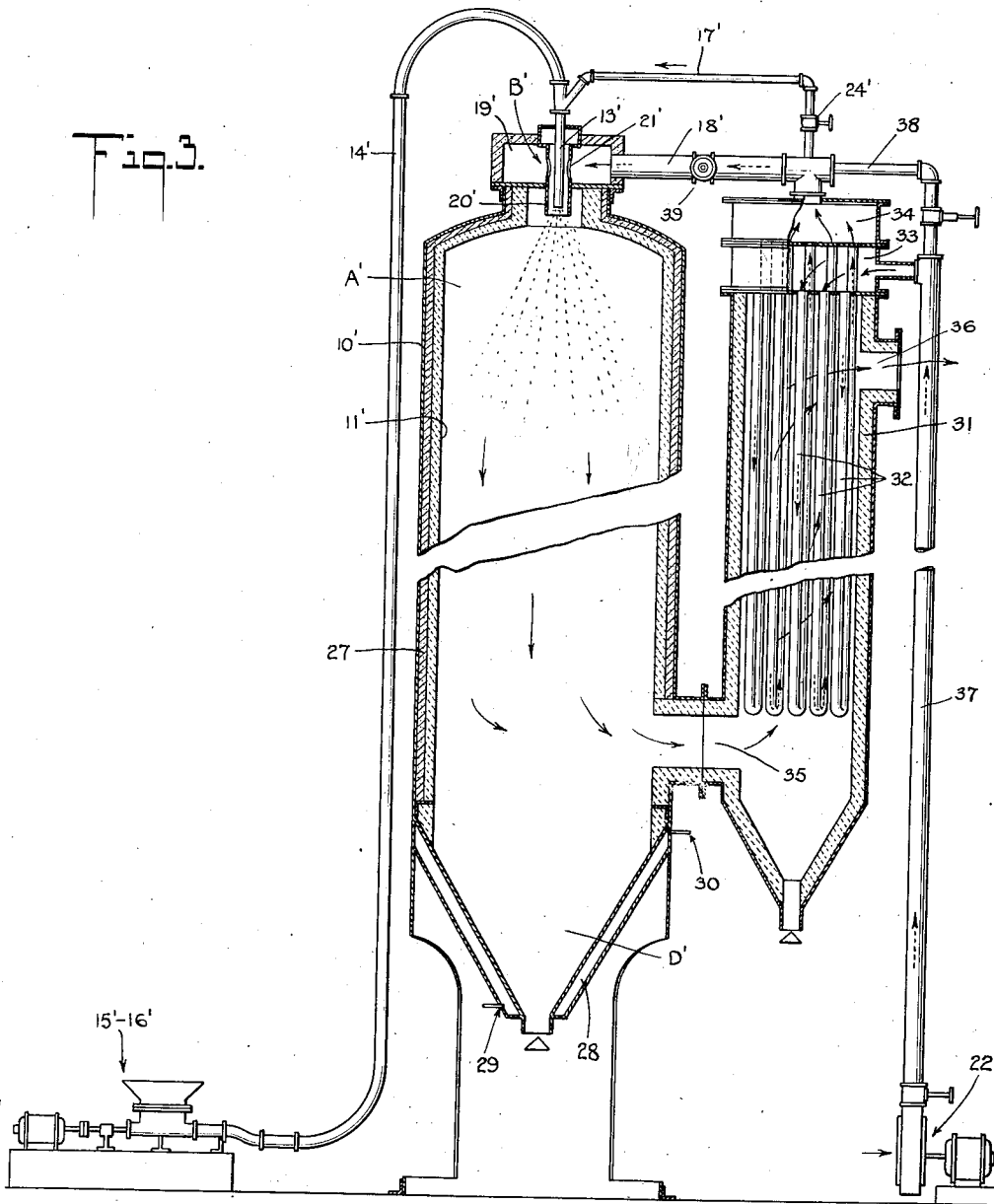
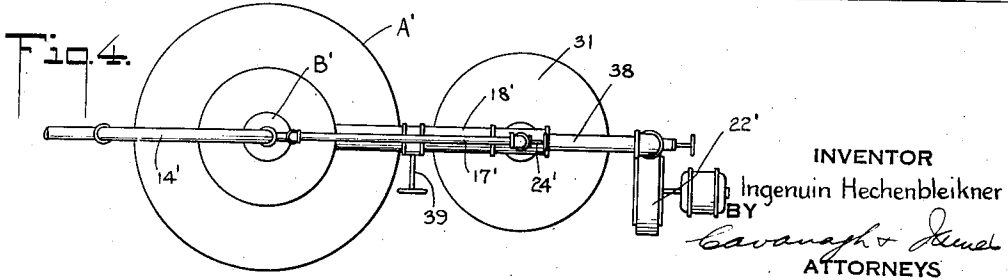
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UNITED STATES PATENT OFFICE

1,923,866

SULPHUR BEARING ORE FURNACE

Ingenuin Hechenbleikner, Charlotte, N. C., assignor, by mesne assignments, to Chemical Construction Corporation, a Corporation of Delaware

Application October 26, 1929. Serial No. 402,595

18 Claims. (Cl. 23—278)

This invention relates to a furnace for burning sulphur bearing ore, and has special reference to the provision of a furnace for oxidizing or burning sulphur bearing ore fines or dust.

In mechanical furnaces for burning sulphur ore smalls, fines or dust now in use, the comminuted or ground sulphur bearing ore is fed in spread form through a series of hearths, and in said spread form is subjected to the action of an oxidizing medium such as air flowing through the hearths. These hearths are communicatingly arranged horizontally one above the other; and the feeding of the ore through the series of hearths is effected by first introducing the ore onto the bed of the uppermost hearth, by then rabbling the ore over the bed in either increasing or decreasing spirals, after which the ore thus partly treated in one hearth is dropped onto the bed of the hearth therebelow, where the rabbling process and treatment is continued, the ore fines going through a similar cycle in each hearth section, the resulting cinders being collected in and removed from the bed of the lowermost hearth section. For rabbling the ore, each hearth section is provided with a plurality of rabble arms on which are mounted rabbling teeth, and the arms of all of the hearth sections are usually fixed to a central motor driven shaft which extends vertically through the mechanical furnace.

These mechanical furnaces for burning sulphur bearing ore fines or smalls are attended in use with a number of draw-backs or disadvantages. Due to the inherent design of these furnaces, the structures are relatively large, particularly when built to yield a relatively large output or high capacity, and this results in a comparatively high initial or installation cost. In operation, this type of furnace suffers some irregularities, due first to slagging and cinder of the ore which takes place and which interferes with the operation of the rabble arms, and due second to excessive dust production, which necessitates cleaning of the flues and consequent service interruptions. To minimize slagging or fusing of the cinders, special constructions of rabbling means have to be devised, and to overcome the trouble of excessive dust production, the flue dust must be specially treated. The regulation or control of the concentration of the combustion gases is relatively difficult with these furnaces, the choice lying generally between minimizing the loss of sulphur in the cinder with the consequent production of weak

sulphur dioxide gases on the one hand, and the production of strong sulphur dioxide gases with the consequent incomplete reduction of the ore and substantial loss of sulphur in the resulting cinder on the other hand.

The prime object of my present invention centers about the provision of a novel furnace for treating or burning sulphur ore fines or dust operating on a principle different than that governing the operation of these known mechanical furnaces, and in which the objections incident to and inherent in the design and use of known mechanical furnaces are effectively obviated. In accordance with my present invention, the sulphur bearing ore fines or dust are ground or granulated to a degree of fineness such that the same may be fed in a stream through a nozzle for producing a spray of the ore dust, the stream or/and spray being intimately intermixed with an oxidizing medium such as air conditioned to effect combustion of the ore spray and production of the sulphur dioxide gases. The invention, therefore, has as its prime object the provision of a furnace in which the ore is burned in spray form.

The desiderata in any sulphur burning process is two-fold; first, it is desired that the sulphur contained in the ore be burnt as far as possible, thus resulting in efficient reduction of the ore, and second, it is desired that the quantity of air or other oxidizing fluid be controllably such as to properly oxidize the sulphur to sulphur dioxide, and such as to effect the proper intermixture between the sulphur dioxide or combustion gases and additional air to produce a resulting gas mixture having a desired concentration depending upon the further use to which the gases may be put. I have found that the desired ore reduction, sulphur oxidation and gas concentration may be efficiently obtained by burning the comminuted or pulverized sulphur bearing ore in stream or spray form, and I have found that this may be accomplished by properly conditioning the atmosphere in which the dust spray is burnt and by suitably regulating or controlling the temperature and the flow of the oxidizing and other air used in the process. The principal object of my present invention, therefore, resides in the provision of a spray sulphur burner constructed and designed for producing these results.

Further principal objects of the invention include the provision of a sulphur burning furnace in which the ore is burned in the form of a spray, and in which the oxidizing medium or

air is properly conditioned by being pre-heated to relatively high temperatures through heat exchanging relation with the combustion gases produced in the furnace; the further provision of a sulphur burning apparatus of this nature in which the ash or cinders produced in the burning process are collected without interfering with the proper operation of the combustion zone of the furnace; the further provision of an ore spray burning furnace provided with means for suitably treating the cinder or ash so as to prevent coagulation or fusion thereof and so as to permit efficient removal of the formed cinders in and during the continuing operation of the furnace; and the further provision of a furnace of this kind which is comparatively simple in construction, subject to relatively facile operation, and capable of easy regulation and control.

To the accomplishment of the foregoing and such other objects as will hereinafter appear, my invention consists in the elements and their relation one to the other, as hereinafter more particularly described and sought to be defined in the claims; reference being had to the accompanying drawings which show the preferred embodiments of my invention, and in which:

Fig. 1 is a vertical elevational view partly in cross-section of a simplified form of the apparatus or sulphur burner of my invention,

Fig. 2 is a plan view thereof,

Fig. 3 is a vertical elevational view partly in cross-section of a modified form of the apparatus or burner, and

Fig. 4 is a plan view of this modified form.

Referring now more in detail to the drawings and having reference first to Figs. 1 and 2 thereof, the sulphur burning furnace of my invention comprises a combustion chamber generally designated as A provided with a means generally designated as B for introducing a spray of sulphur bearing ore fines or dust into the combustion chamber and for effecting combustion of said spray, thereby producing sulphur dioxide gases, an exit flue means generally designated as C for the combustion gases, and a collecting means generally designated as D for collecting the cinders or ash produced in the combustion process.

The combustion chamber A comprises preferably a vertically elongated unit which may consist of a cylindrical metal shell 10, which in the form of the invention shown in Figs. 1 and 2 is double walled to provide an intermediate air chamber for a purpose to be explained hereinafter, the inner wall 10^a being interiorly surfaced with a lining 11 of fire resisting brick and the outer wall 10^b being exteriorly surfaced with a heat insulating lining 12, both linings extending over the combustion end of the furnace or combustion chamber and terminating a distance above the bottom section D of the furnace, as clearly shown in Fig. 1 of the drawings. The spray producing means B is arranged at the top or the head of the furnace, the cinder collecting means D is arranged at the lowermost region of the furnace, and the exit flue C for the combustion gases is preferably arranged adjacent the bottom of the combustion section of the furnace, and therefore at a point intermediate the ends of the furnace. The furnace, if built for a capacity to treat 500 pounds of ore fines or dust per hour, may have an over-all height of about 30 feet and a diameter of 6 feet. The inner fire resisting brick lining functions to protect the

furnace shell and to aid combustion by heat radiation, and the insulating lining 12 functions to insulate the air space formed between the walls 10^a and 10^b of the furnace shell.

The sulphur ore fines or dust to be used with the furnace is pulverized or ground to a degree of fineness corresponding say to 60 mesh, and a stream of this spray dust or fines is fed into the combustion chamber at the top thereof through a nozzle 13, with which may communicate a feed pipe 14 extending from the nozzle 13 to a pumping apparatus 15 located at a low level, and which pumping apparatus serves to feed the spray dust from a feed hopper 16 to and through the nozzle 13. For effecting combustion of the ore stream and for assisting in injecting the same through the nozzle 13, a stream of oxidizing fluid such as air is introduced into the system by means of a valved pipe line 17 at a point or region which may be considered the junction between the nozzle 13 and the feed pipe 14, as clearly shown in Figs. 1 and 2 of the drawings. This stream of oxidizing air constitutes a primary flow of oxidizing medium. For effecting completion of the oxidation or combustion and for producing additional air for intermixture with the combustion gases so as to produce resulting gases of desired concentrations, there is provided a secondary stream of oxidizing fluid or air which is introduced into the combustion chamber A in a region surrounding the ore stream or the spray produced. This secondary air stream is introduced through a conduit 18 into the head 19 at the top of the furnace, and moves from this head into and through a tube or cylinder 20 which surrounds the nozzle 13, the said tube being provided with a plurality of circumferentially arranged holes or openings 21 for this purpose.

Both the primary and secondary air streams are first suitably conditioned to effect combustion of the sulphur ore; and to this end the air is preheated to relatively high temperatures, as for example about 1000° F. Desirably the pre-heating of the air is effected by heat exchange with the hot combustion gases, and this may be accomplished by designing the furnace structure so that a part thereof forms a heat exchanging apparatus for this purpose. In the construction shown in Figs. 1 and 2, this is accomplished by the double walled shell structure hereinbefore referred to, the space between the shell walls 10^a and 10^b forming a circulating passage for the air which is fed into the system by means of a blower 22 communicating with the air space between the shell walls through an entrant opening 23 arranged adjacent the bottom of the furnace, and which air moves upwardly in said space, as shown by the arrows on the drawings, the air being pre-heated to the desired temperatures by contact with the heated interior shell wall 10^a of the furnace. At the head of the furnace this pre-heated air divides into the primary and secondary streams, the primary air stream piping 17 and the secondary air stream conduit 18 being for this purpose connected to the arched top of the air space, as clearly shown in the drawings. The primary and secondary air streams may be suitably controlled by means of the valve 24 in the piping 17 and the damper structure 25 in the flue 18.

For minimizing or preventing coagulation or fusion of the cinders which gravitate onto and collect upon the interior wall of the hopper-shaped bottom D of the furnace, it is desirable

to provide cooling means for this collecting hopper D. To this end the collecting hopper may be either water or air cooled; and in the construction exemplified in Figs. 1 and 2 of the drawings, I utilize the circulating air of the system as the cooling means for the collecting hopper. It is for this reason that I prefer to introduce the cool air at the nethermost portion of the hopper through the entrant opening 23, the air in this region serving to chill or cool the inner wall of the collecting hopper and thereby functioning to minimize fusion difficulties. The air, as it rises in the air space between the walls of the furnace shell, is gradually heated, and the inner fire resisting brick lining 11 is made to terminate at a point or region of the furnace so as to permit sufficient pre-heating of the air to the desired high temperatures. The outer insulating lining 12, it will now be understood, functions to prevent heat loss of the pre-heated air. The ash or cinder is removed through a discharge passage 26.

In the modification of the invention shown in Figs. 3 and 4 of the drawings, the oxidizing air is pre-heated by heat exchange apparatus which is separated from the furnace proper, the heat exchange apparatus functioning, however, for utilizing heat of the combustion gases for effecting the pre-heating of the oxidizing medium. The furnace structure in this modification may then comprise a vertically elongated preferably cylindrical metal shell 10' surfaced interiorly with a lining 11' of fire resisting brick laid onto an inner lining 27 of insulating material and forming the combustion chamber generally designated as A'. The head or top of the furnace is constructed similarly to that already described in connection with Figs. 1 and 2 of the drawings, in which head is mounted the ore spray producing means generally designated as B', and the bottom of the furnace forming the hopper-shaped cinder collecting receptacle generally designated as D' is also constructed in a manner similar to that already described in connection with the construction of Figs. 1 and 2 of the drawings, and is provided with a cooling chamber or compartment 28 surrounding the cinder hopper, into which compartment cooling air flows from an entrant opening 29 and out of an exit opening 30.

Similar to the construction already described, the ore is introduced through a nozzle 13' communicating with a feed pipe 14' which is connected to a combination hopper and pump mechanism 15', 16'.

The heat exchange means in this modified form of the invention comprises a brick lined chamber 31 in which are arranged a plurality of U-shaped tubes 32, one end of each of which communicates with an air entrant head 33 and the other end of each of which communicates with an air exit head 34, both heads forming part of the chamber structure. The chamber 31 has a combustion gas entrant flue 35 which communicates directly with the furnace chamber A' and has a combustion gas exit flue 36 adjacent the top of the chamber 31. The combustion gases produced in the furnace chamber A' move through the same and through the heat exchange chamber in the manner indicated by the full arrowed lines in the drawings. The air for the system is forced by means of a blower apparatus 22' through a stand pipe or conduit 37 and into the air entrant head 33, the air then moving from this head through the piping 32

and into the air outlet head 34. From this air outlet or exit head the air may be divided into the two streams, the primary stream moving through the piping 17' and the secondary stream moving through the conduit 18', this piping and conduit being connected into the furnace system in a manner similar to that heretofore described in connection with the construction of Figs. 1 and 2 of the drawings and by means identified by similar and primed reference characters. The flow of the air through the stand pipe heat exchange chamber and into the furnace is indicated by the arrows in Fig. 3 of the drawings. By the means described, the combustion air can be preheated to any temperature between 400° and 1000° F., the desired temperature of the pre-heated air at the nozzle of the furnace being preferably about 1000° F. For regulating the temperature of the hot or heated air into the air chamber or tube 20' around the spray nozzle 13', there is provided the valved bypass 38 connecting the stand pipe 37 with the secondary air conduit 18'. For further controlling the air flow a valve 39 may be provided in the conduit 18'.

In both modifications of the invention, the ore dust or fines is introduced into the furnace chamber in the form of a spray which is oxidized or burned in an atmosphere of pre-heated air. This air is pre-heated by heat exchange with the hot combustion gases either in the furnace proper or in apparatus auxiliary to or separate from the furnace structure. The oxidizing medium or air is preferably divided into streams so as to carry out a completion of the oxidation, thereby minimizing sulphur loss in the resulting cinders and thereby effecting maximum oxidation of the sulphur, the flow of the streams being so regulated or controlled as to permit the obtaining of sulphur dioxide gases of desired concentration or strength. The cinder is readily collected and removed, and is so treated as to minimize coagulation troubles. The apparatus in either form of the invention is of relatively simple design and may be built at a comparatively small or low initial cost. The apparatus may be readily regulated and easily controlled, and may be repaired at small cost. Other advantages will be obvious to those skilled in the art.

While I have shown and described my invention in the preferred forms, it will be apparent that other changes and modifications may be made in the structure disclosed without departing from the spirit of the invention, defined in the following claims.

I claim:

1. A furnace for burning sulphur bearing ore to produce sulphur dioxide for sulphuric acid manufacture comprising a combustion chamber, means for producing a spray of sulphur bearing ore fines and introducing said spray into said combustion chamber, means to pre-heat the oxidizing medium by means of the heat of combustion of the sulphur ore, and means for introducing the thus heated oxidizing medium into co-mixing relation with said spray for combustion of said ore and for the production of sulphur dioxide gases.

2. A furnace for burning sulphur bearing ore to produce sulphur dioxide for sulphuric acid manufacture comprising a combustion chamber, means for introducing a spray of sulphur bearing ore fines into said combustion chamber, means for introducing an oxidizing medium into

co-mixing relation with said spray for combustion of said spray thereby producing sulphur dioxide gases, and means arranged in heat exchange relation with the combustion gases for preheating the oxidizing medium.

3. A furnace for burning sulphur bearing ore to produce sulphur dioxide for sulphuric acid manufacture comprising a combustion chamber, means for introducing a spray of sulphur bearing ore fines into said combustion chamber, means for heating an oxidizing medium to relatively high temperatures, and means for introducing the said heated oxidizing medium into co-mixing relation with said spray for combustion of said spray and for the production of sulphur dioxide gases.

4. A furnace for burning sulphur bearing ore to produce sulphur dioxide for sulphuric acid manufacture comprising a combustion chamber, means for continuously feeding a stream of sulphur bearing ore fines into said combustion chamber, means for injecting an oxidizing medium directly into said ore stream, and means for introducing additional oxidizing medium into said chamber in a stream surrounding said ore stream.

5. A furnace for burning sulphur bearing ore to produce sulphur dioxide for sulphuric acid manufacture comprising a combustion chamber, means for continuously feeding a spray of sulphur bearing ore fines into said combustion chamber, means for injecting an air stream directly into said ore spray, means for introducing additional air into said chamber in a stream surrounding said ore spray, and means for preheating said air streams to relatively high temperatures.

6. A furnace for burning sulphur bearing ore to produce sulphur dioxide for sulphuric acid manufacture comprising a combustion chamber, means for continuously feeding a spray of sulphur bearing ore fines into said combustion chamber, means for injecting an air stream into said ore spray, means for introducing secondary air into said chamber in a stream surrounding said ore spray, means for controlling said air streams to effect combustion of said ore and production of sulphur dioxide gases of predetermined concentrations, and means arranged in heat exchange relation with said combustion gases for preheating at least one of said air streams to relatively high temperatures.

7. A furnace for burning sulphur bearing ore to produce sulphur dioxide for sulphuric acid manufacture comprising a vertically elongated combustion chamber including top, intermediate, and bottom portions, a spray nozzle arranged at the top portion of said combustion chamber, means for feeding a stream of sulphur bearing ore fines into said spray nozzle and producing a spray of said ore fines, means for intermixing a heated oxidizing medium with said stream of ore fines for combustion of said spray and for the production of sulphur dioxide gases, means at the intermediate portion of said combustion chamber defining an exit for the combustion gases, and the bottom portion of said combustion chamber being arranged for collecting and discharging the ore cinders.

8. A furnace for burning sulphur bearing ore to produce sulphur dioxide for sulphuric acid manufacture comprising a vertically elongated combustion chamber including top, intermediate, and bottom portions, a spray nozzle arranged at the top portion of said combustion chamber,

means for feeding a stream of sulphur bearing ore fines into said spray nozzle and producing a spray of said ore fines, means for intermixing heated air with said stream of ore fines for combustion of said spray and for the production of sulphur dioxide gases, means at the intermediate portion of said combustion chamber defining an exit for the combustion gases, the bottom portion of said combustion chamber being arranged for collecting and discharging the ore cinders, and means for cooling said cinder collecting portion to prevent fusion of said cinders.

9. A furnace for burning sulphur bearing ore to produce sulphur dioxide for sulphuric acid manufacture comprising a vertically elongated combustion chamber including top, intermediate, and bottom portions, a spray nozzle arranged at the top portion of said combustion chamber, means for feeding a stream of sulphur bearing ore fines into said spray nozzle and producing a spray of said ore fines, means for introducing a stream of heated air with said stream of ore fines for combustion of said spray and for the production of sulphur dioxide gases, the bottom portion of said combustion chamber being arranged for collecting the ore cinders, and means for cooling said collecting portion to prevent fusion of said cinders and for heating said air stream by causing heat exchange therebetween.

10. A furnace for burning sulphur bearing ore to produce sulphur dioxide for sulphuric acid manufacture comprising a vertically elongated combustion chamber including top, intermediate, and bottom portions, a spray nozzle arranged at the top portion of said combustion chamber, means for feeding a stream of sulphur bearing ore fines into said spray nozzle and producing a spray of said ore fines, means for introducing a stream of an oxidizing medium with said stream of ore fines for combustion of said ore spray and for the production of sulphur dioxide gases, heat exchange means utilizing heat of said combustion gases for preheating said stream of oxidizing medium to relatively high temperatures, and means to cool the bottom portion of said combustion chamber for collecting the ore cinders.

11. A furnace for burning sulphur bearing ore to produce sulphur dioxide for sulphuric acid manufacture comprising a vertically elongated combustion chamber including top, intermediate, and bottom portions, a spray nozzle arranged at the top portion of said combustion chamber, means for feeding a stream of sulphur bearing ore fines into said spray nozzle and producing a spray of said ore fines, means for introducing a stream of an oxidizing medium into said stream of ore fines and for introducing a secondary oxidizing medium into said chamber into a stream surrounding said spray, said streams of oxidizing medium functioning for combustion of said ore spray and for the production of sulphur dioxide gases of desired concentrations, heat exchange means utilizing heat of said combustion gases for pre-heating said streams of oxidizing medium to relatively high temperatures, and means to cool the bottom portion of said combustion chamber for collecting the ore cinders.

12. A furnace for burning sulphur bearing ore to produce sulphur dioxide for sulphuric acid manufacture comprising a vertically elongated combustion chamber including top, intermediate, and bottom portions, a spray nozzle arranged at the top portion of said combustion chamber,

means for feeding a stream of sulphur bearing ore fines into said spray nozzle and producing a spray of said ore fines, means for introducing a stream of an oxidizing medium with said stream of ore fines for combustion of said ore spray and for the production of sulphur dioxide gases, means arranged at the intermediate portion of said combustion chamber defining an exit for said combustion gases, heat exchange means utilizing heat of said combustion gases for pre-heating said stream of oxidizing medium to relatively high temperatures, the bottom portion of said combustion chamber being shaped to act as a hopper for collecting the ore cinders, and means for cooling said hopper or bottom portion.

13. A furnace for burning sulphur bearing ore to produce sulphur dioxide for sulphuric acid manufacture comprising a vertically elongated combustion chamber including top, intermediate, and bottom portions, a spray nozzle arranged at the top portion of said combustion chamber, means for feeding a stream of sulphur bearing ore fines into said spray nozzle and producing a spray of said ore fines, means for feeding a stream of air with said stream of ore fines for combustion of said spray in order to produce sulphur dioxide gases, means at the intermediate portion of said combustion chamber defining an exit for the desired combustion gases, the bottom portion of said combustion chamber being arranged for collecting and discharging the ore cinders and impurities remaining after the combustion of the sulphur.

14. A furnace for burning sulphur bearing ore to produce sulphur dioxide for sulphuric acid manufacture, comprising a vertically disposed greatly elongated combustion chamber including top, intermediate, and bottom portions, means at the top portion of said combustion chamber for feeding sulphur bearing ore fines into said combustion chamber, means for introducing a stream of an oxidizing medium into said chamber for combustion of said ore and for the production of sulphur dioxide gases, an exit duct for the combustion gases at the intermediate portion of the chamber, the bottom portion of said chamber being shaped to act as a hopper for the collection and discharge of ore cinders.

15. A furnace for burning sulphur bearing ore to produce sulphur dioxide for sulphuric acid manufacture, comprising a vertically disposed greatly elongated combustion chamber including top and bottom portions, means at the top portion of said combustion chamber for feeding sulphur bearing ore fines into said combustion chamber, means for introducing a stream of an oxidizing medium into said chamber for combustion of said ore and for the production of sulphur dioxide gases, the bottom portion of said

chamber being shaped to act as a hopper for the collection and discharge of ore cinders, and means to cool the bottom portion of said combustion chamber.

16. A furnace for burning sulphur bearing ore to produce sulphur dioxide for sulphuric acid manufacture, comprising a vertically disposed greatly elongated combustion chamber including top, intermediate, and bottom portions, means at the top portion of said combustion chamber for feeding sulphur bearing ore fines into said combustion chamber, means for introducing a stream of an oxidizing medium into said chamber for combustion of said ore and for the production of sulphur dioxide gases, an exit duct for the combustion gases at the intermediate portion of the chamber, the bottom portion of said chamber being shaped to act as a hopper for the collection and discharge of ore cinders, and means to cool the bottom portion of said combustion chamber.

17. A furnace for burning sulphur bearing ore to produce sulphur dioxide for sulphuric acid manufacture, comprising a vertically disposed greatly elongated combustion chamber including top, intermediate, and bottom portions, means at the top portion of said combustion chamber for feeding sulphur bearing ore fines into said combustion chamber, means for introducing a stream of an oxidizing medium into said chamber for combustion of said ore and for the production of sulphur dioxide gases, an exit duct for the combustion gases at the intermediate portion of the chamber, the bottom portion of said chamber being shaped to act as a hopper for the collection and discharge of ore cinders, and heat exchange means utilizing heat of said combustion gases for pre-heating the oxidizing medium to relatively high temperatures.

18. A furnace for burning sulphur bearing ore to produce sulphur dioxide for sulphuric acid manufacture, comprising a vertically disposed greatly elongated combustion chamber including top, intermediate, and bottom portions, means at the top portion of said combustion chamber for feeding sulphur bearing ore fines into said combustion chamber, means for introducing a stream of an oxidizing medium into said chamber for combustion of said ore and for the production of sulphur dioxide gases, and an exit duct for the combustion gases at the intermediate portion of the chamber, the bottom portion of said chamber being shaped to act as a hopper for the collection and discharge of ore cinders, said bottom portion being provided with heat exchange means for bringing the oxidizing medium into contact therewith, in order to pre-heat the oxidizing medium and cool the bottom portion.

INGENUIN HECHENBLEIKNER.

DISCLAIMER

1,923,866.—*Ingenuin Hechenbleikner*, Charlotte, N. C. SULPHUR BEARING ORE FURNACE. Patent dated August 22, 1933. Disclaimer filed May 21, 1935, by the assignee, *Chemical Construction Corporation*.

Hereby enters this disclaimer to claims 3, 7, 13, and 14 of said patent reading as follows:

"3. A furnace for burning sulphur bearing ore to produce sulphur dioxide for sulphuric acid manufacture comprising a combustion chamber, means for introducing a spray of sulphur bearing ore fines into said combustion chamber, means for heating an oxidizing medium to relatively high temperatures, and means for introducing the said heated oxidizing medium into co-mixing relation with said spray for combustion of said spray and for the production of sulphur dioxide gases."

"7. A furnace for burning sulphur bearing ore to produce sulphur dioxide for sulphuric acid manufacture comprising a vertically elongated combustion chamber including top, intermediate, and bottom portions, a spray nozzle arranged at the top portion of said combustion chamber, means for feeding a stream of sulphur bearing ore fines, means for inter-mixing a heated oxidizing medium with said stream of ore fines for combustion of said spray and for the production of sulphur dioxide gases, means at the intermediate portion of said combustion chamber defining an exit for the combustion gases, and the bottom portion of said combustion chamber being arranged for collecting and discharging the ore cinders."

"13. A furnace for burning sulphur bearing ore to produce sulphur dioxide for sulphuric acid manufacture comprising a vertically elongated combustion chamber including top, intermediate, and bottom portions, a spray nozzle arranged at the top portion of said combustion chamber, means for feeding a stream of sulphur bearing ore fines into said spray nozzle and producing a spray of said ore fines, means for feeding a stream of air with said stream of ore fines, means for feeding a stream of air with said stream of ore fines for combustion of said spray in order to produce sulphur dioxide gases, means at the intermediate portion of said combustion chamber defining an exit for the desired combustion gases, the bottom portion of said combustion chamber being arranged for collecting and discharging the ore cinders and impurities remaining after the combustion of the sulphur."

"14. A furnace for burning sulphur bearing ore to produce sulphur dioxide for sulphuric acid manufacture, comprising a vertically disposed greatly elongated combustion chamber including top, intermediate, and bottom portions, means at the top portion of said combustion chamber for feeding sulphur bearing ore fines into said combustion chamber, means for introducing a stream of an oxidizing medium into said chamber for combustion of said ore and for the production of sulphur dioxide gases, an exit duct for the combustion gases at the intermediate portion of the chamber, the bottom portion of said chamber being shaped to act as a hopper for the collection and discharge of ore cinders."

[*Official Gazette June 18, 1935.*]