March 16, 1954 W. R. BURROW ET AL 2,672,412

CONTINUOUS OXIDIZING OPERATIONS

Filed July 17, 1950 3 Sheets-Sheet 1

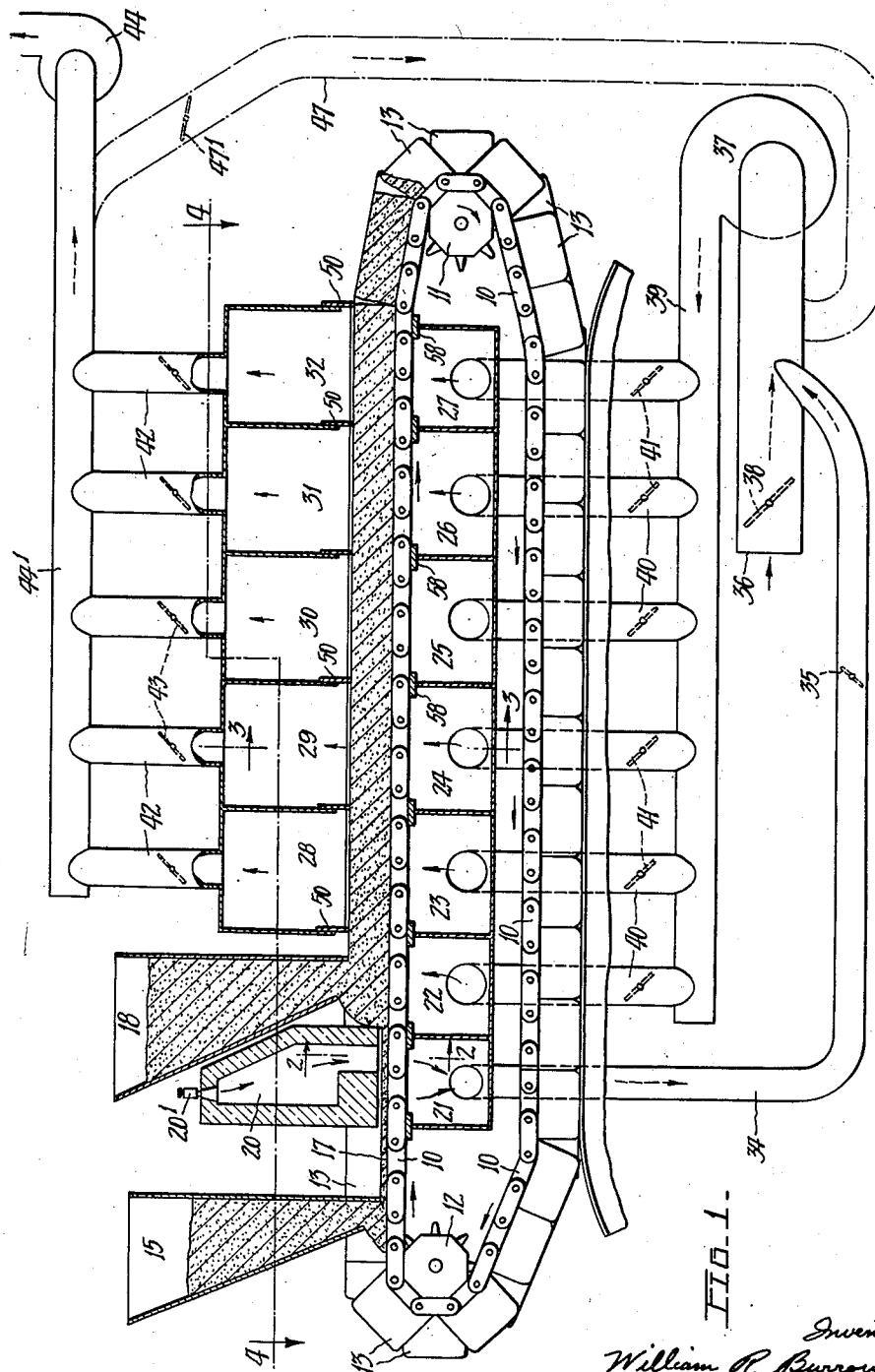


FIG. 1.

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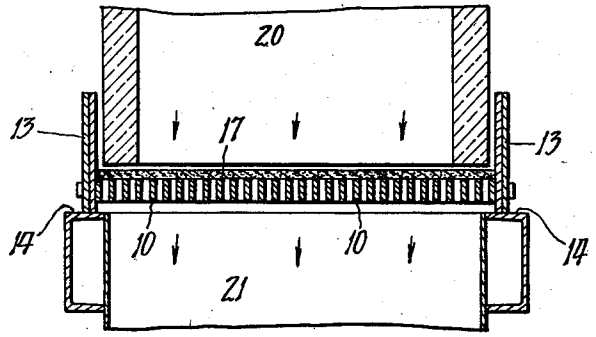



FIG. 2.

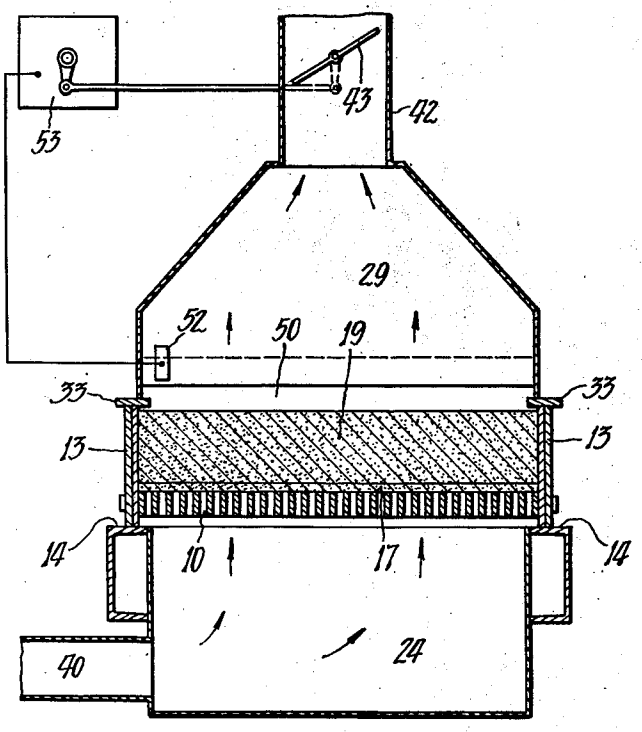



FIG. 3.

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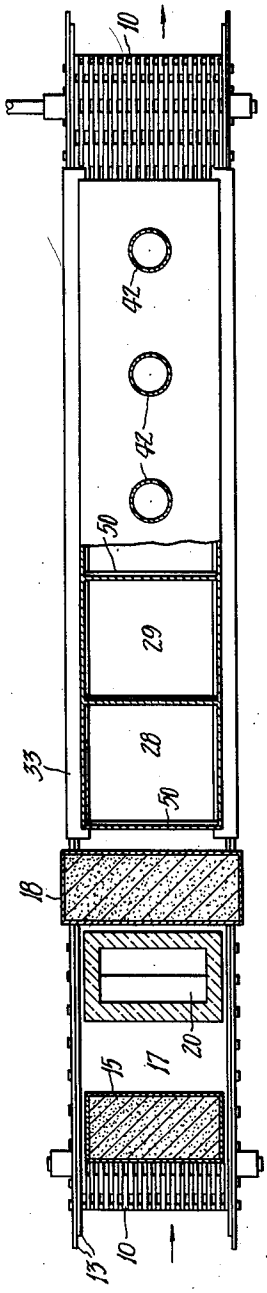



FIG. 4.

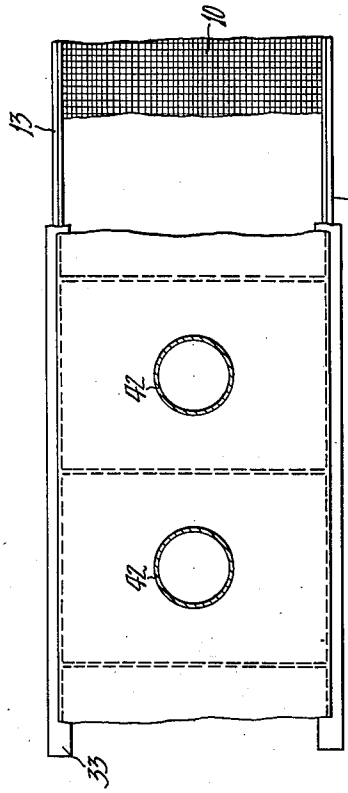



FIG. 6.

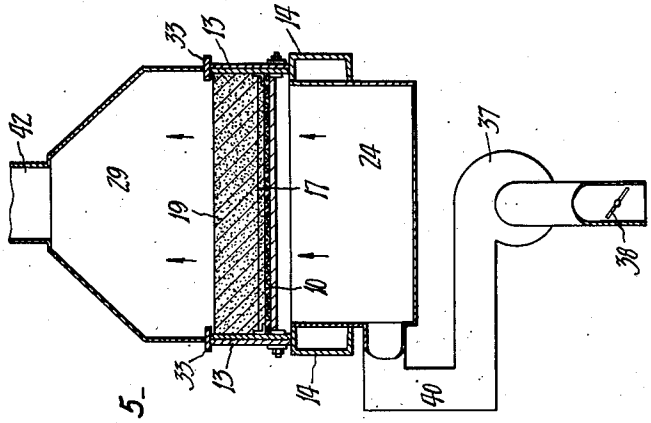



FIG. 5.

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Patented Mar. 16, 1954

2,672,412

# UNITED STATES PATENT OFFICE

2,672,412

## CONTINUOUS OXIDIZING OPERATIONS

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Application July 17, 1950, Serial No. 174,168

Claims priority, application Australia July 18, 1949

1 Claim. (Cl. 75—5)

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This invention relates to the operation of oxidizing or roasting sulphide ores and other combustible materials, particularly lead sulphide ores, to eliminate or reduce the sulphur content and prepare a sintered product for smelting in a blast furnace or the like.

The operation of roasting sulphide ores is now almost universally carried out in the well known Dwight and Lloyd sintering machines which have a plurality of pallets arranged to be moved in succession around endless tracks comprising upper and lower sections, such pallets being so actuated as to form in effect on the upper sections of the tracks, a continuously moving grate on which is formed a charge bed of the material to be sintered.

A series of vacuum chambers, generally termed windboxes, is arranged below the moving grate so that air is drawn downwardly through the porous charge bed as same passes thereover, sealing means being provided to minimise inward leakage of air below the pallets and into said windboxes.

An ignition box is arranged transversely above the charge bed adjacent the receiving end of the moving grate and above the first of said windboxes in the said series thereof, whereby the upper surface portion of the charge bed is ignited as it passes below the ignition box.

Thus the combustion of the sulphur in the ore charge proceeds downwardly through the charge bed as same is moved over the remaining windboxes in the series thereof and towards the discharge end of the machine, thereby forming a sintered and substantially sulphide free product for subsequent treatment in a blast furnace.

While the principal objective of the sintering operation is to produce a strong, well agglomerated sinter, low in sulphur and suitable for smelting in the blast furnace, it is also advantageous to utilise for the production of sulphuric acid, the sulphur dioxide which is produced in the operation.

Although as far as we are aware it is the universal practice to pass the draft downwardly through the charge bed in machines of the moving grate type, we are aware that it has previously been proposed to pass the draft upwardly in machines of that type and we have ascertained that important advantages are obtainable by so doing.

Thus when the draft passes downwards in the usual way, metallic lead, which is produced by the roasting reactions, tends to descend through the bed and grate and accumulate in the windboxes (i. e. suction chambers) below the grate, such accumulated lead being known as "lead fall." Lead fall is disadvantageous because its periodic removal involves troublesome manual work, and loss of operating capacity and is particularly undesirable when it is desired to utilise the sulphur dioxide gas for the production of sulphuric acid, because removal of the lead fall requires the interruption of the draft and the opening of the windboxes, so that the gases are diluted by the ingress of atmospheric air.

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Now we have found that when the draft passes upwardly through the bed, lead fall is almost wholly avoided, so that the said disadvantages consequent thereupon are eliminated.

It has also been found, when the draft is passed upwardly, that it is practicable to employ a charge bed of greater depth so that the production per unit of grate area is increased.

Now the general object of this invention is to provide an improved method of, and apparatus for, roasting a moving bed of combustible material, while one specific object thereof is to provide an efficient method of and apparatus for roasting lead sulphide ores in a manner which substantially eliminates lead fall and another specific object is to provide an improved method of and means for effecting ignition of the charge bed at its lower surface. A further object is to provide an improved method of and means for reducing dilution of the produced gases by the ingress of air.

Accordingly, the invention includes the process of roasting combustible materials such as sulphide ores, comprising continuously forming a shallow layer of combustible material on a moving air-pervious support, igniting said shallow layer at its upper surface while maintaining a reduced pressure therebelow, whereby gases will pass downwards therethrough, thereafter forming a charge bed comprising combustible material on said burning shallow layer and then passing air upwardly through said burning layer and charge bed, whereby the latter will be ignited at its lower surface and combustion will proceed upwardly therethrough.

Preferably the gases drawn downwardly through the shallow ignited layer are mixed with combustion air and are then passed upwardly through the charge bed and a proportion of the gases discharged through the top of the charge bed may also be recirculated upwardly therethrough.

The upward flow of air through the charge bed may be effected either by maintaining a super-

atmospheric pressure therebelow or a sub-atmospheric pressure thereabove or both.

An important feature of the invention resides in maintaining the pressure of the gas immediately above the bed approximately at atmospheric pressure so as to reduce the ingress of diluent air as hereinafter described, while the pressure of the gases above and adjacent the discharge end of the bed is preferably maintained at a slightly lower pressure than the gases above the other portions of the bed. Thus the gaseous combustion products are discharged at the atmospheric pressure side of the system.

The invention also includes sintering apparatus comprising a continuously movable air-pervious support, means adjacent the receiving end of the support for continuously forming thereon a shallow layer of combustible material, means spaced from said last mentioned means in the direction of movement of said support for forming, on top of said layer, a charge bed comprising combustible material, ignition means located in advance of said charge bed forming means for igniting said shallow layer, gas collecting means arranged below the movable support and said ignition means, means for maintaining the interior of said gas collecting means at a lower pressure than the pressure above said shallow layer, whereby gases pass downwardly through the latter in advance of the charge bed, means for maintaining below the support and the charge bed, a pressure of air greater than the pressure above said bed whereby air will pass upwardly through said ignited layer and charge bed and the latter will be ignited and means for collecting the gases discharged through the upper surface of the charge bed.

The invention also includes means as hereafter described for controlling the pressure of the gases as discharged from the charge bed.

For a more particular description of preferred embodiments of the invention, reference will be made to the accompanying drawings which are somewhat diagrammatic in character and in which:

Figure 1 is a view in sectional elevation of a continuous roasting machine incorporating the invention,

Figure 2 is a view in sectional side elevation taken on the line 2—2 of Figure 1 and is drawn to a larger scale,

Figure 3 is a view in sectional side elevation taken on the line 3—3 of Figure 1,

Figure 4 is a view in sectional plan on the line 4—4 of Figure 1,

Figure 5 is a view similar to Figure 3 and shows a modification of the invention, and

Figure 6 is a view in plan of a portion of the modified apparatus shown in Figure 5.

The sintering machine shown in Figures 1 to 4 of the drawings comprises a movable grate 10 which may comprise a series of abutting pallets as used in the aforesaid Dwight and Lloyd machines, but which alternatively and as shown may be an endless conveyor formed of pivoted links, such conveyor being extended around spaced sprockets 11 and 12, one of which is arranged to be driven at a suitable speed from a convenient source of power and in the direction of the arrows shown in Figure 1.

The upper stretch of the conveyor is disposed horizontally and said conveyor is provided with continuous upstanding and substantially vertical side walls, such as are employed in certain constructions of chain grate stokers and comprising overlapping pivoted plates 13, the joints between which are substantially airtight.

The lower edges of the side walls of the upper stretch of the conveyor are slidably supported on tracks 14 incorporated in a frame structure and the sliding joints so formed substantially exclude the passage of air therethrough.

A hopper 15 is arranged transversely above the upper stretch of the conveyor adjacent the receiving end of the latter and same extends downwardly between the side plates 13 and terminates a short distance above the upper surface of the conveyor as shown in Figure 1. This hopper 15 is filled with charge material (comprising sulphide ore), so that as the conveyor passes thereunder, a shallow combustible layer 17 is formed continuously thereon.

A second hopper 18 also arranged transversely above the conveyor is spaced from the hopper 15 in the direction of movement of the said conveyor and same is also filled with charge material (comprising sulphide ore), so that as the conveyor moves thereunder, a charge bed 19 is formed on top of the shallow layer 17, the top of such bed being substantially flush with the upper edges of the side walls 13.

An ignition stove 20 incorporating a burner 20' is arranged between the hoppers 15 and 18 whereby as the shallow layer 17 passes thereunder the upper surface thereof is ignited.

A series of windboxes 21 to 27 inclusive is arranged below the upper stretch of the conveyor and the upper edges of the transverely extending walls thereof are fitted with transversely disposed supporting and sealing plates 58, on which the conveyor is slidably supported and which substantially prevent by-passing of air between the windboxes and below the conveyor. Likewise the aforesaid sliding joints between the lower edges of the side plates 13 and the tracks 14 substantially prevent the escape of air laterally from said windboxes.

A similar series of gas collecting chambers 28 to 32 inclusive is arranged above the conveyor, between the hopper 18 and the discharge end of the machine, and the longitudinal side walls of such gas chambers are fitted with sealing plates 33, which slidably engage the upper edges of the side walls 13 of the conveyor as indicated in Figure 3, so that the passage of air or gases through the joints therebetween is substantially prevented.

Flexible sealing strips 50 of asbestos or other suitable material are secured to the lower edges of the transverse walls of the series of gas chambers, whereby same engage the upper surface of the charge bed and minimise by-passing of the gases therebetween.

The windbox 21 is arranged immediately below the ignition stove 20 and in the illustrated machine same is connected by a gas outlet pipe 34, provided with a regulating valve 35, to the intake pipe 36 of a suction fan 37, such intake pipe being also provided with a regulating valve 38.

Thus a controlled downdraft of air and gases is maintained through the shallow layer 17 of combustible material as same passes below and beyond the ignition stove 20 so as to ensure uniform and reliable ignition and combustion of the material in such layer. As a consequence the subsequent updraft stage is effected efficiently and reliably and lead fall and its attendant disadvantages are obviated.

The suction fan 37 is provided with a discharge pipe 39 which is connected by branches

40, fitted with individual regulating valves 41, to the windboxes 22 to 27 inclusive below the moving grate, while the gas chambers 28 to 32 inclusive above the bed are provided with discharge pipes 42 fitted with regulating valves 43 which connect with a common offtake pipe 44' connected to the intake of a further suction fan 44.

In operation therefore the shallow layer 17 of charge material and which may, for example, be of the order of about 0.75 inch in thickness is formed continuously on the receiving end portion of the grate and same is ignited by the stove 20 assisted by the downdraft induced through such layer by maintaining a sub-atmospheric pressure within the chamber 21 arranged immediately therebelow.

The reduced pressure maintained in the chamber 21 is so related to the speed of movement of the grate that the layer 17 is substantially completely sintered but is not cooled as same passes over the adjacent end of the windbox 22 whereby the direction of the draft therethrough is reversed.

The gases withdrawn from the suction chamber 21 are delivered by the fan 37 together with outside air to the windboxes 22 to 27 inclusive whereby same pass upwardly through the said shallow layer 17 and charge bed 19, which latter may be conveniently of the order of about 7 inches in depth, so that the latter is ignited at its lower surface and combustion proceeds upwardly therethrough until the charge is completely sintered, the sintered product being finally discharged by the conveyor as indicated in Figure 1.

Thus a super-atmospheric pressure is maintained in the windboxes 22 to 27 inclusive and the aforesaid sealing means substantially prevent outward leakage of air therefrom below the grate.

In this connection, however, it will be understood that outward leakage of air from the windboxes below the grate while it lowers efficiency of the machine, is not so important as inward leakage of air into the vacuum chambers arranged below the grate of a conventional downdraft machine, because as already explained, such inward leakage has the effect of reducing the $SO_2$ tenor of the gases discharged from the vacuum chambers.

An important feature of the invention resides in maintaining the pressure of the gases immediately above the charge bed and within the gas chambers 28 to 32 inclusive at about and preferably slightly below atmospheric pressure, so as to avoid outward leakage of such gases to pollute the surrounding atmosphere and also to minimise inward leakage of outside atmospheric air which has the effect of lowering the $SO_2$ tenor of the gases.

The pressure in said suction chambers 28 to 32 inclusive are preferably regulated automatically in any suitable known manner as, for example, in the manner diagrammatically indicated in Figure 3, wherein a suitable pressure responsive device 52 is arranged to control means designated 53 for adjusting the corresponding regulating valve.

These operating conditions therefore are quite different to those which obtain in the conventional downdraft type of machine, in which the downdraft is induced by maintaining in the windboxes below the bed a partial vacum of the order of about 10 inches water gauge, so that there is a considerable pressure drop across the sealing means interposed between such windboxes and the pallets.



Accordingly, during normal operation of the apparatus herein described, the dilution of the combustion gases by inwardly leaking air is materially reduced as compared with existing roasting machines and practices, thereby enabling the average tenor of $SO_2$ to be maintained sufficiently high for the economic production of sulphuric acid.

In addition, however, the updraft roasting method herein described obviates the serious periodic dilution of the gases which occurs when the conventional downdraft process is employed, due to the necessity for opening the windboxes to remove the lead metal which falls thereinto.

The $SO_2$ tenor of the gases may be further increased by recirculating upwardly through the bed any desired proportion of the gases discharged therefrom. Recirculation as already known in connection with downdraft machines may readily be adapted to the updraft method and apparatus herein described and therefore does not require description herein beyond the indication given in broken lines in Figure 1, wherein a by-pass pipe 47 incorporating a valve 47' connects the gas discharge pipe 44' to the inlet of the fan 37.

If desired all of the gases collected in the chamber 32 or in chambers 31 and 32 may be recirculated upwardly through the bed or alternatively delivered to the stack in which case the pressure of gas in such chamber or chambers is preferably maintained somewhat lower than the pressure in the remaining gas collecting chambers to avoid dilution of the gases in the latter by inward leakage from said chamber 32.

It will be evident that the number of gas collecting chambers above the bed and the number of pressure windboxes below the bed may be varied and would usually be influenced by the particular arrangements desired for recirculation.

For example, if desired, a single elongated gas collecting chamber and a single elongated pressure windbox may be employed.

Another advantage of employing updraught sintering is that the grate is not subjected to severe heat conditions, as is the case with the grate of the conventional downdraft machine, so that it is practicable to use a wire fabric conveyor or equivalent perforated plates or the like instead of grate bars for supporting the combustible material.

This modification is shown in Figures 5 and 6 wherein the conveyor which is again designated 10 is formed of wire fabric, such conveyor being provided with side walls comprising pivoted overlapping plates 13 as already described.

While it is preferred to form the shallow layer 17 from the normal charge mixture used for forming the charge bed 19, it is not essential to do so as same may be formed from any suitable combustible material.

What we claim is:

Process of roasting lead containing sulfide ore which comprises continuously forming a relatively shallow porous layer of said ore, continuously conveying said layer laterally, continuously igniting the upper surface of said layer, continuously passing a stream of combustion supporting gas downwardly through said ignited layer for a time sufficient to substantially completely sinter said layer, moving said layer out of said stream of gas while said layer remains

at ignition temperature, continuously depositing a relatively thick layer of said ore on said sintered layer while it remains at ignition temperature, and continuously passing the gas stream that has passed downwardly through said shallow layer in admixture with additional combustion supporting gas upwardly through said shallow layer and said thick layer while maintaining a pressure of about atmospheric pressure above said thick layer.

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