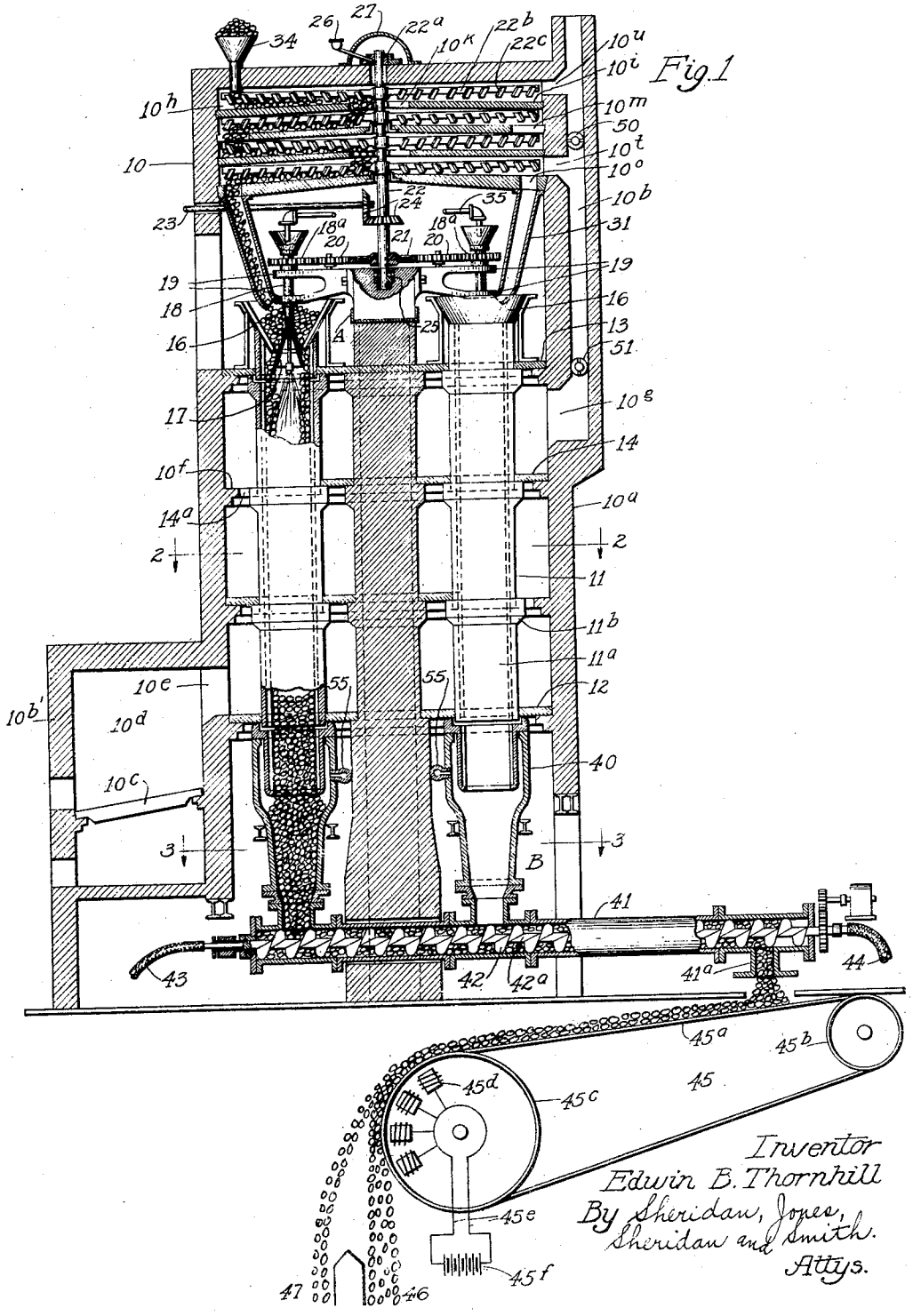
Nov. 25, 1924. 1,516,934

E. B. THORNHILL

APPARATUS FOR TREATMENT OF ORES

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Fig. 2

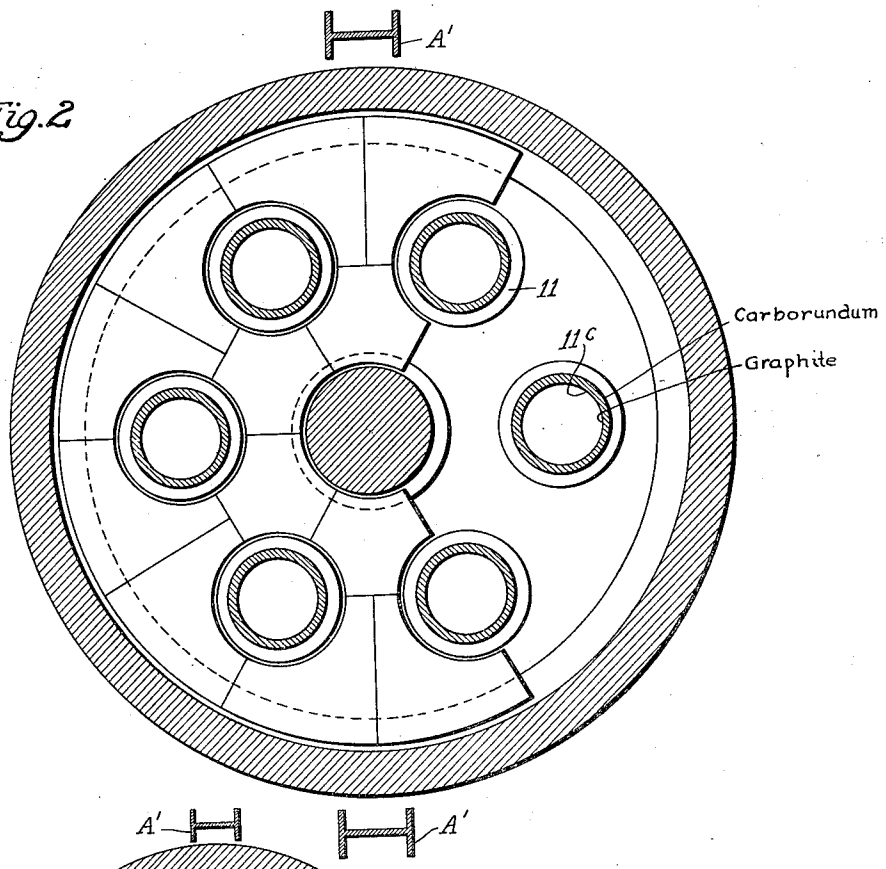
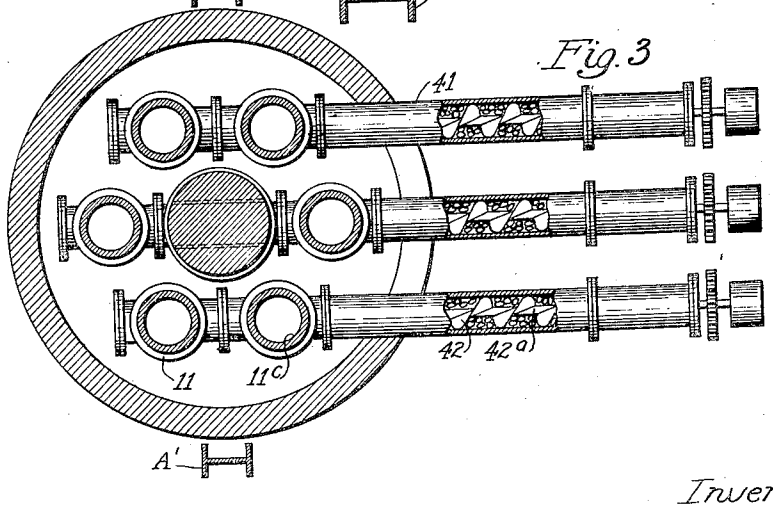


Fig. 3



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UNITED STATES PATENT OFFICE.

EDWIN B. THORNHILL, OF HURLEY, NEW MEXICO.

APPARATUS FOR TREATMENT OF ORES.

Application filed January 8, 1920. Serial No. 350,173.

To all whom it may concern:

Be it known that I, EDWIN B. THORNHILL, a citizen of the United States, residing at Hurley, in the county of Grant and State of New Mexico, have invented certain new and useful Improvements in Apparatus for Treatment of Ores, of which the following is a specification.

This invention relates to improvements in apparatus for treatment of ores and has for its object to provide an improved apparatus, especially adapted for the reduction of oxides of metal to obtain the metal therefrom.

An object of my invention consists in the provision of a retort for treatment of ores which is constructed of a silicon-carbon refractory such as SiC popularly known as carborundum and providing the same with a lining of carbon, as graphite, to prevent adherence of iron, for example, in the reduction of iron ores and thereby eliminating clogging of the retorts.

My apparatus is particularly adapted to reduction of iron oxides to obtain sponge iron, as it is termed, for use in copper concentration operations. These and other advantages will be more fully described and set forth in the following specification and shown in the accompanying drawings in which—

Figure 1 is a vertical section through a furnace, portions of the retorts and discharge tube being shown in elevation, the magnetic separating unit being shown diagrammatically.

Fig. 2 is a horizontal section along the line 2—2 of Fig. 1.

Fig. 3 is a horizontal section along the line 3—3 of Fig. 1.

Like numerals refer to like elements throughout the drawings in which 10 designates generally a furnace having the main vertical casing 10^a provided with a vertical flue 10^b, the same constituting a chimney flue. At one side of the main casing 10^a at the bottom thereof is the furnace $10^{b'}$ having the grate 10^c and fire box 10^d, a passage 10^e leading from the latter to the interior of the casing 10^a. It will be understood that I contemplate the use of any satisfactory heating means in lieu of the furnace shown. Located in the casing 10^a and spaced therefrom and from each other are a plurality of vertical retorts 11, each of said retorts being constructed of the sections 11^a, each section having a socket or seat end 11^b in which seats the opposite end of the superimposed section 11^a, as seen in Fig. 1. These retorts are preferably constructed of carbonaceous material, such as carborundum or other carbon refractory, and have a lining of carbon, such as graphite, indicated by numeral 11^c for a purpose to be hereinafter described.

Closely fitting the retorts 11 at the bottom of the casing 10^a is the plate 12 and the corresponding cover plate 13 is provided at the top of the section of the casing 10^a. Intermediate the plates 12 and 13 are provided horizontal baffle plates 14 supported upon suitable ledges 10^f projecting inwardly from the casing 10^a, these baffles 14 being constructed to provide suitable circulation apertures 14^a, such openings being preferably staggered to insure thorough circulation of the heating gases around the retorts 11. A duct 10^g leads from the interior of the casing 10^a to the chimney duct or flue 10^b.

At the upper ends of the retorts 11 are provided conical charging hoppers 16 with which coact rotatable frusto-conical distributors 17 carried by the tubular shafts 18. These shafts are suitably journalled in the bracket bearings 19, which in turn are suitably supported upon the cross beam A in turn carried by vertical beams or uprights A′ located outside the furnace. Gears 18^a carried upon the tubular shafts 18 transmit rotation thereto, being in turn actuated by the idler gears 20 and the drive gear 21 carried upon the rabble shaft 22, to which rotation is transmitted through the medium of a drive shaft 23 and coacting baffle gears 24. This rabble shaft 22 is shown as supported by the step or thrust bearing 25 of conventional construction and suitably journalled at its upper end at 22^a to which bearing lubricant is transmitted by means of a lubri-

cating cup 26, or the like, extending through the cap 27 which protects the upper end of the shaft 22, see Fig. 1. Located above the casing 10^a and constituting in effect an extension thereof is the preheating or calcining chamber 10^h having the shelves 10^i shown as convexed, as viewed from above. A suitable charging hopper or funnel 34 extends through the top of the chamber 10^h to a point above the uppermost shelf 10^i, the latter being provided with a central aperture 10^k through which material can be discharged upon the next lower shelf 10^i, the latter being provided with discharge openings 10^m at its outer periphery, the next lower shelf 10^i having the central aperture similar to that of the uppermost shelf, the lowermost shelf 10^i having discharge openings 10^o, which communicate with spouts 31. These spouts extend to the hoppers 16 into which they are intended to discharge, as will be more fully explained in the description of my apparatus. Carried by the rabble shaft 22 are the radial arms 22^b, each of said arms being provided with blades 22^c, the blades of each horizontal set of arms being properly inclined to move the material supported on the shelves or hearths to discharge openings of said shelves. In short, the blades of the uppermost rabble arms 22^b are so inclined that, when the rabble shaft 22 is rotated in the proper direction, the material upon the uppermost hearth or shelf 10^i will be advanced to and thereafter through the discharge opening 10^k upon the next lowermost hearth. The blades of the rabble arm coacting with this hearth will be reversed in inclination with respect to those of the uppermost arms and will move the material outwardly upon the second shelf or hearth and so on. The feed tubes 35 are provided for each of the retorts 11, such tubes extending through the hollow shafts 18 and terminating at the upper ends of the retorts 11, these tubes being provided to discharge reducing material, such as powdered coal, coke, hydrocarbon oil, or other reducing agent.

The bottoms of the retorts 11 are provided with collection receptacles 40 preferably constructed of cast iron or some other material possessing rapid conductivity. These receptacles are in communication with horizontal discharge tubes 41 in which are provided screw conveyors 42 having the central hollow shaft 42^a through which a cooling fluid, such as water, is circulated, being supplied at one end by the pipe or tube 43 and discharged at the other through the pipe 44. The discharge pipes 41 are provided with the discharge outlets 41^a located above the magnetic separator units 45. The collection receptacles 40 and a proportion of the discharge pipes 41 are located in the chamber B, which is open to the outside atmosphere and which is in effect a cooling chamber, the temperature thereof being considerably less than that in the casing 10^a, as will be obvious. A neutral or reducing atmosphere obtains in the receptacles 40, however.

The magnetic separator unit comprises the conveyor belt 45^a driven by the pulley 45^b and extending partially around the magnetic drum or cobber 45^c within which are located the magnets 45^d excited by current passing through suitable feed wires 45^e from the source of current 45^f. The action of this separating unit is well known and needs no further amplification herein save to state that iron particles passing therethrough will be subjected to the influence of the magnets 45^d and drawn into the collection space 46, while the non-iron particles will be projected outwardly into the space 47.

The chimney 10^b is provided with the ports 10^t and 10^u at the bottom and top thereof respectively, a rotatable damper 50 being provided in the flue between such ports and a similar damper 51 being provided in the flue 10^b just above the port or by-pass 10^g. With the dampers in the position shown in Fig. 1, the heating gases will circulate around the retorts and flow upwardly through the chimney flue 10^b through the port 10^t into the space above the lowermost hearth 10^i through the successive upper spaces provided by the upper hearths and finally flow into the chimney flue through the port 10^u. With this circulation of heating gas the hearths will be heated to a temperature sufficient to calcine material thereon, if so desired, or to preheat such material, if desirable. If it is not desired to preheat or calcine the material, the damper 50 may be opened to permit direct upward flow of the heating gases after leaving the retort spaces. During the reduction of the ore, gases are evolved which are capable of use either in the carrying out of my process or for heating such as carbon monoxide and I find it advisable to collect such gas as a by-product and for that purpose I have provided collection pipes 55 in communication with the interior of collection receptacles 40 to provide an outlet for the discharge and subsequent collection of such gas from the retorts.

In the utilization of the apparatus shown and described where it is desired to treat a sulphide of metal, such as iron pyrites, for example, precalcining of the ore is advisable and necessary to obtain an oxide which can thereafter be reduced to obtain pure sponge iron. Accordingly, I introduce the ground ore through the hopper or funnel 34 onto the uppermost hearth 10^i from which it is advanced to the lowermost hearth by the action of the rabble arms and plates described

above. From the lowermost hearth it is delivered through the spouts 31 to the hoppers 16. The proper regulation of the chimney damper insures the calcining of the ore in its passage through this preheating chamber to drive off the sulphur, for example, and thereby an oxide of the ore, such as Fe_2O_3. As this resultant oxide passes through the hoppers 16, the rotating distributors 17 permit and assist the flow of the same, restricting such flow, into the retorts 11, to sufficient quantity to obtain a shower or unimpeded dropping of the material through the retort. At the same time a proper proportion of reducing agent, such as powdered coal, coke, hydrocarbon oil, or the like, is fed, preferably under pressure, through the tubes 35 into the retorts dropping with the oxide particles and coacting therewith under the heat of the retort to reduce such oxides to obtain pure metal, such as sponge iron, in the example under consideration. After passage through the heating zone of the retorts, particles in their reduced state drop through the receptacles 40, which are at a perceptibly lower temperature due to their contact with the outside atmosphere in the cooling chamber and as a consequence the metal particles are cooled below the point of agglomeration in the case of iron and during their subsequent collection and passage through the discharge tube 40 they will be further cooled by the water cooled screw conveyor, as well as the conduction of the heat through the iron tube to a point below that at which oxidation readily takes place.

The screw conveyor 42 discharges the reduced metal and other substances from the discharge tube upon the conveyor 45^a of the magnetic separating unit and the latter, conveying this deposit to the magnetic drum, will result in the subsequent separation of the iron particles in the collection space 46 while the non-iron particles are deposited in the space 47.

In the reduction of the oxides, gas is evolved, which is capable of use for heating or other purposes, the same being largely carbon monoxide, and I find it desirable to collect such gas through the collection pipes 55, which, as described, are in communication with the interior of collection receptacles 40.

By constructing these retorts with a lining of carbon, such as graphite, adhesion of the impinging metal particles, when at their greatest temperature, is prevented since I have found that at the temperature of reduction these particles, while they are capable of agglomeration with each other, will not adhere to carbon. Consequently, I am enabled to obviate clogging or reduction of the available ore of the retorts. Also the carborundum refractory possesses relatively great strength and high heat conductivity which make for economy and rapidity of operation.

Where ores such as hematite or magnetite, are used, these being oxides of iron, it will not be necessary to calcine the same, but I find it advisable to preheat the same in order to reduce the time of reduction of the oxide thereby also enabling me to reduce the distance through which said particles must fall. I may obtain this preheating by proper use and regulation of the calcining or preheating apparatus described and thereby avail myself of the heating gases used to heat the retorts prior to their discharge through the chimney.

It will be obvious that my apparatus is susceptible of numerous modifications and improvements and I do not wish to be restricted to the form shown and described except as defined in the appended claims.

What I claim is:—

1. In apparatus of the class described, a heating furnace, a retort mounted therein, means to shower metalliferous particles through said retort, and means to supply a reducing agent to said retort adjacent the point of supply of said metalliferous particles.

2. In apparatus of the class described, a heating furnace, a retort mounted therein, means to shower metalliferous particles through said retort, means to supply a reducing agent to said retort adjacent the point of supply of said metalliferous particles, and a collection receptacle in communication with said retort.

3. In apparatus of the class described, a heating furnace, a retort mounted therein, means to shower metalliferous particles through said retort, means to supply a reducing agent to said retort adjacent the point of supply of said metalliferous particles, a collection receptacle in communication with said retort, and a discharge tube in communication with said receptacle.

4. In apparatus of the class described, a retort, a charging hopper at one end thereof, a rotatable distributor coacting with said hopper to restrict flow therethrough, means to rotate said distributor, said means comprising suitable gearing, a reducing agent supply tube extending through said hopper and the distributor at one end of said retort.

5. In apparatus of the class described, a furnace comprising a source of heating gas, a retort located in said furnace, a chimney leading from said furnace, a calcining chamber, and means to direct said heating gas through said calcining chamber.

6. In apparatus of the class described, a furnace comprising a source of heating gas, a retort located in said furnace, a chimney leading from said furnace, a calcining chamber, means to direct said heating gas through said calcining chamber, said means com-

prising ducts leading from said chimney to and from said calcining chamber, and a damper to regulate the flow through said ducts and chimney.

7. In apparatus of the class described, a retort, a calcining chamber comprising a plurality of hearths, rotating arms mounted to sweep over said hearths, said arms being provided with inclined blades to convey material on said hearth from the periphery thereof toward the center and vice versa, and means to convey said material from one of said hearths to said retort.

8. In apparatus of the class described, a retort constructed of silicon-carbon material having a lining of carbon.

9. In apparatus of the class described, a retort constructed of silicon-carbon material having a lining of graphite.

In testimony whereof, I have subscribed my name.

EDWIN B. THORNHILL.