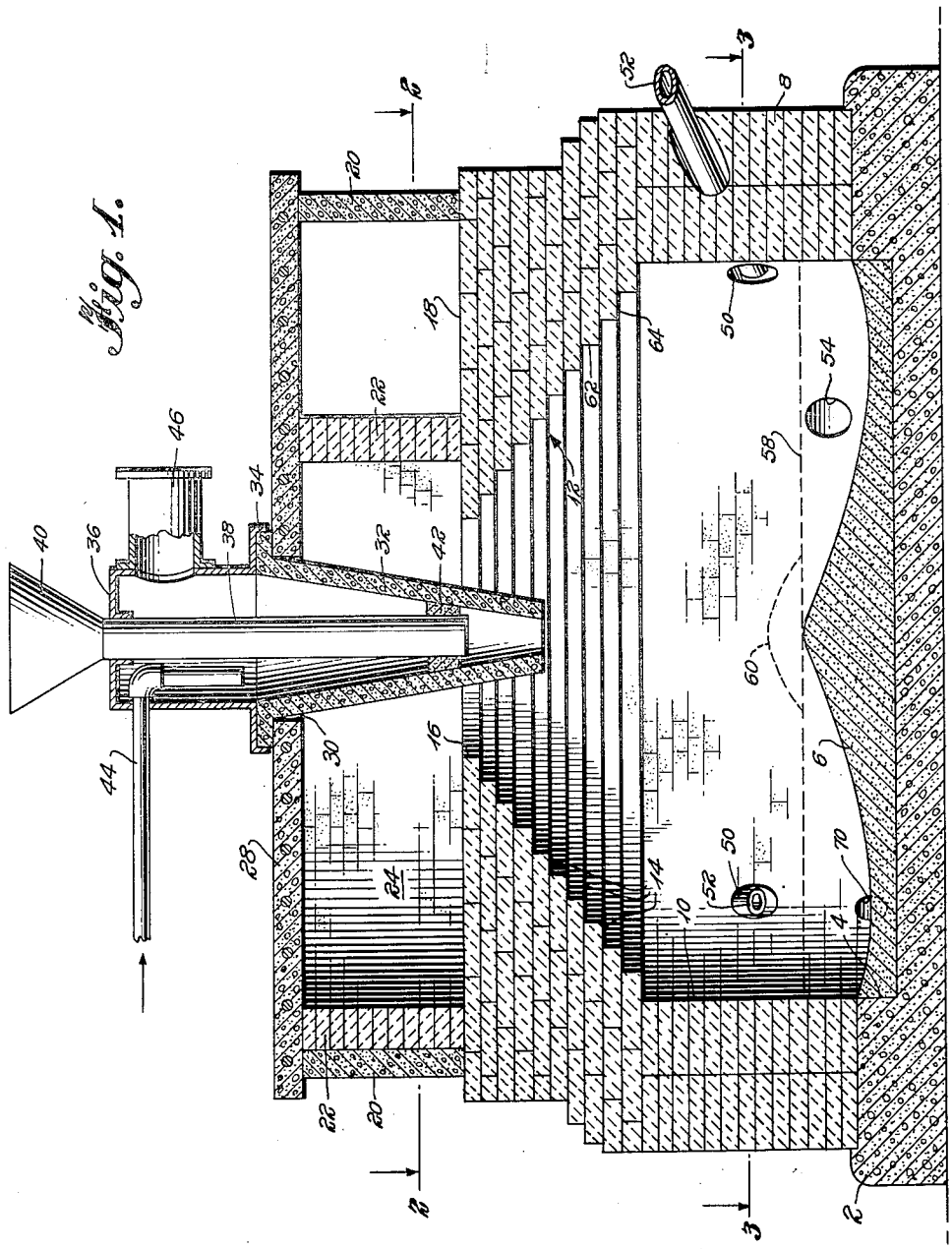
March 3, 1953 F. C. RAMSING 2,630,309

CENTRIFUGAL REVERBERATORY FURNACE

Filed July 25, 1950 2 SHEETS—SHEET 1

Fig. 1.



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Fig. 2.

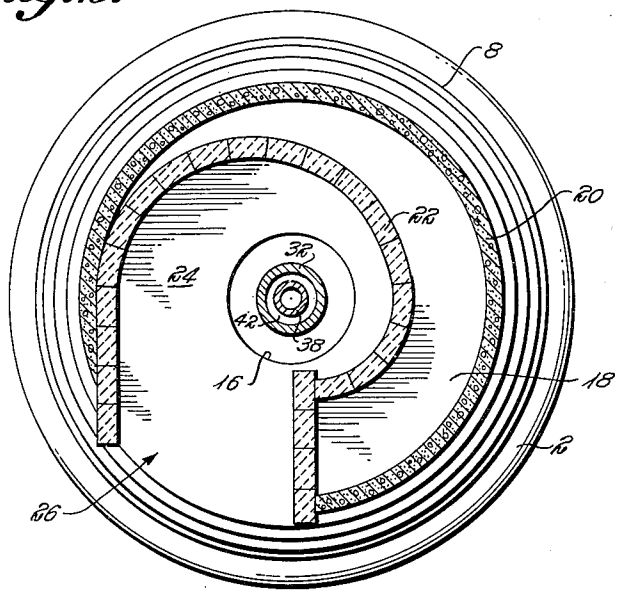
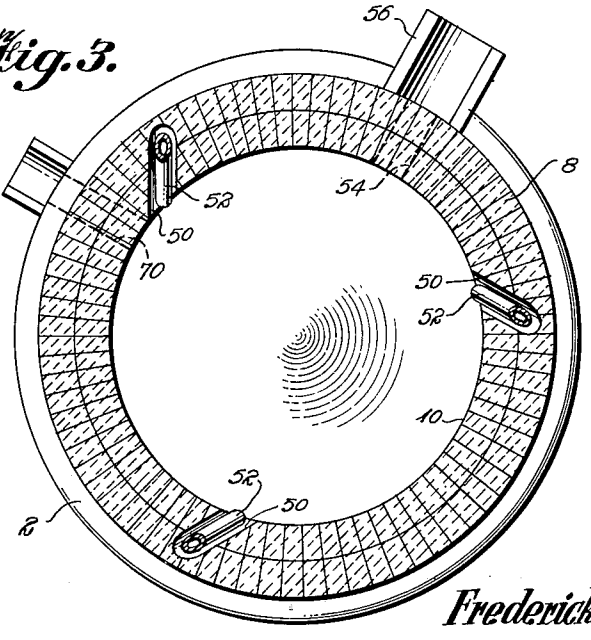


Fig. 3.



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CENTRIFUGAL REVERBERATORY FURNACE

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4 Claims. (Cl. 263—21)

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The present invention relates to a process and furnace for fusing finely divided material. The apparatus and process may be employed in the smelting or reduction of ores or in fusing slag-forming materials for the production of rock wool.

In general, the furnace provides for combining the advantages of a large reverberatory furnace with those of a small, flame-vortex type of apparatus. The furnace comprises generally a cylindrical chamber having a frusto-conical ceiling portion overlying a substantial part of the hearth. Flame jets are directed inwardly and downwardly of the chamber toward the hearth in a direction to impinge on the surface of a bath of molten material and are directed chordally of the chamber to impart a whirling or centrifugal motion to the hot gases. The gases are then caused to spiral upwardly in contact with the frustro-conical ceiling toward a flue opening at the apex of the chamber where they are led off through a horizontally volute flue chamber and may be employed to operate an auxiliary boiler or the like.

Finely divided material to be fused or otherwise treated in the furnace is fed downwardly in a continuous stream through the central portion of the flue opening and the center of the furnace chamber to the molten bath on the hearth.

The construction of the chamber is such that the heated walls and ceiling act to reflect their heat downwardly onto the bath and to melt or fuse the fine dust-like particles that may be thrown thereagainst as a result of the whirling action of hot gases in the chamber. This reflection of radiated heat back onto the bath of molten material constitutes the reverberatory feature of the present furnace.

The whirling action of the gases insures that no particles of finely divided material will be carried outwardly through the flue since the centrifugal force acting on those particles causes them to move outwardly into contact with the refractory walls of the furnace chamber to be fused thereon by the hot walls and heat radiated from the bath. Such fused particles form a liquid film on the walls of the chamber and run downwardly, under the influence of gravity, to the bath. Appropriate means are provided for maintaining the material-feeding means at a suitable, safe temperature.

It is therefore an object of this invention to combine, in a relatively small furnace, the advantages of a large, reverberatory furnace with the advantages of a small, continuously-fed, flame-vortex furnace.

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It is a further object of this invention to provide a furnace adapted to the fusing of finely divided material in a continuous process.

It is a still further object of this invention to provide a furnace of the character described that is simple in construction, yet highly efficient in operation and of small over-all dimensions.

It is a still further object of this invention to provide a furnace and process for the fusing of finely divided material wherein the dust-like particles are handled by centrifugal action to insure their being retained in the furnace chamber.

It is a still further object of this invention to provide means for feeding finely divided material into a furnace in a rapid and efficient manner.

Further objects and advantages will become apparent to those skilled in the art as the description proceeds in connection with the accompanying drawings wherein:

Fig. 1 is a vertical, sectional view through a preferred embodiment of the invention.

Fig. 2 is a horizontal section, on a reduced scale, taken substantially along the plane of the line 2—2 of Fig. 1, and

Fig. 3 is a horizontal, sectional view taken substantially on the plane of the line 3—3 of Fig. 1.

Referring to the drawings in more detail, numeral 2 indicates a suitable base slab or structure having a recess 4 therein defining a hearth for the furnace. In the preferred mode of operation, a layer or blanket of silica sand 6 is positioned to cover the bottom and sides of the recess 4 for a purpose well known to those skilled in the art. Supported on base 2 is a generally cylindrical wall structure 8 comprised of suitable refractory bricks or the like to define a relatively low, vertical cylinder having an inner wall surface 10. The refractory brick work is continued upwardly from the cylindrical portion 10 to define an inwardly tapered, generally frustro-conical ceiling 12 for the chamber. As shown in the embodiment illustrated, the ceiling portion 12 consists of a series of concentric steps 14 to be referred to later.

The ceiling 12 terminates in a flue opening 16 of generally circular configuration and of considerably less diameter than the cylindrical portion 8 of the furnace. It is to be noted that the interior chamber defined by the wall 10 and ceiling 12 is of relatively low height in relation to its horizontal diameter and the ceiling portion 12 converges inwardly at a relatively small angle from the horizontal.

The brick work defining the portions 8 and 12

of the furnace is so arranged as to define a generally flat upper surface 18. An outer cylindrical wall 20 which may be of concrete or other suitable material is arranged concentric to the opening 16 and extends upwardly from the surface 18 adjacent the outer periphery of that surface. Within the generally cylindrical wall 20 is a generally spiral wall 22 of suitable refractory material, such as firebrick, defining a volute chamber located eccentrically with respect to the flue opening 16 and constituting a horizontally volute flue chamber 24 (see Fig. 2). The flue chamber 24 is provided with an exit passageway 26 extending generally tangentially of and through the wall 20.

A cover or upper wall for the flue chamber is provided by a reinforced slab 28 of any suitable refractory cementitious material. Clearly, the slab 28 may be constructed of any suitable material offering the requisite mechanical strength and resistance to heat necessary for exposure to the hot gases in the flue chamber.

The cover or upper wall 28 of the flue chamber 24 is provided with a central opening 30 concentric with and directly above the flue opening 16. A tubular or tube-like member 32 of suitable refractory material and provided with an upper outwardly extending flange 34 is positioned in the opening 30 as shown in Fig. 1 of the drawings with the flange 34 overlying the margin of the opening 30. The member 32 is thus supported by the cover or upper wall 28 of the flue chamber and the hollow member 32 extends downwardly through the flue chamber 24 and opening 16 into the upper part of the furnace chamber. As shown, the member 32 is cone-shaped, tapering downwardly, but may readily be constructed as a cylindrical tube. The cone shape is preferred, however, since the outer surface of the member then tends to radiate its heat into the furnace chamber and reflects downwardly some heat that would otherwise be lost. Suitable means such as the housing 36 may be provided to support a material feed pipe 38 within the tubular member 32 to extend downwardly therethrough to a position adjacent the lowermost end of the member 32. The feed pipe 38 is sufficiently small to be spaced from the inner surface of the member 32 while extending centrally therethrough. If desired, a suitable funnel, hopper or the like 40 may be attached to the feed pipe 38 to receive finely divided material to be fed into the furnace. The pipe 38 may be supported by any other suitable bracket construction.

Adjacent the lowermost end of the pipe 38 a refractory sealing material 42, which may be clay or the like, is interposed between the member 32 and the pipe 38 to provide a seal to prevent the escape of hot furnace gases through the member 32. A suitable conduit or pipe 44 extends into the housing 36 and downwardly therein with its end directed into the interior of the member 32. The housing 36 is also provided with a suitable exhaust conduit 46. It is contemplated that cool air saturated with water vapor will be pumped through the conduit 44 and projected downwardly into the space between the pipe 38 and the member 32 to provide a cooling medium for the pipe 38 which is preferably of metal. As the cooling air and water vapor are heated and expanded they pass to the exhaust duct 46 and are carried away therefrom by any suitable means or may be exhausted to the atmosphere. If the pipe 38 is supported by other bracket means, as previously suggested, the housing 36 need not be provided and the air from conduit 44 may be discharged directly into the surrounding air from the member 32.

Referring now to Fig. 3 along with Fig. 1, it will be seen that the cylindrical portion 8 of the furnace is provided with a plurality of openings 50 through the wall thereof with the openings 50 extending inwardly and downwardly in a plane parallel to a tangent to the inner wall 10. In other words, the openings 50 are directed downwardly and chordally of the circular hearth of the furnace. Through each opening 50 extends a suitable nozzle or pipe 52 for the purpose of conducting a combustible material into the furnace. In operation, the combustible material is ignited within the furnace chamber and a blast or jet of flame is thereby directed downwardly onto the molten bath on the hearth and chordally of the circular bath. A suitable opening 54, below the normal bath level, is provided for the withdrawal of molten material as required or desired. The opening 54 may discharge into a suitable spout 56 on the exterior of the furnace.

In utilizing the above-described furnace to practice the process of the present invention, finely divided material may be fed downwardly through the pipe 58 in a continuous stream while the furnace is in operation. Assuming that the furnace has been put into operation and a bath of molten material has been established, having an upper surface as indicated at 58 in Fig. 1, finely divided material is fed thereto through the pipe 38 at such a rate that a small quantity of heated but unfused material collects on the hearth as shown at 60 in Fig. 1. The high temperatures in the furnace, coupled with the intimate contact between the material at 60 and the molten bath and heat being reflected or radiated from the ceiling 12 and wall 10 will be effective to rapidly fuse the solid material 60 into the molten bath. The heat for the operation is provided, of course, by the flame jets issuing from the nozzles 52 and since those nozzles are directed downwardly, the bath is maintained at the required high temperature to insure its being kept continually in the molten state and at a sufficiently high temperature to melt the material at 60. Since the flame jets are directed not only downwardly but chordally of the circular bath, a whirling or rotary motion will be imparted to the bath, thus tending to distribute solid material from 60 throughout the bath to further insure its rapid fusion.

The flame and hot gases from the nozzles 52 will assume a swirling motion within the cylindrical portion of the furnace chamber and travel upwardly in a vortex of flame and hot gases to the opening 16 and therethrough to the flue chamber 24. It will be noted that the direction of whirling motion imparted to the gases by the nozzles 52 is such that the gases will pass through the flue opening 16 without losing their rotary motion and will enter the flue chamber 24 while whirling in such direction as to cause them to pass freely and easily through the horizontal passage 26 leading from the flue chamber without substantial turbulence.

The finely divided material being fed through the pipe 38 will necessarily include some extremely small particles tending to float in the gases within the chamber and which will not readily settle onto the bath 58. These fine particles will be entrained in the vortex of upwardly rising hot gases and will be whirled within the chamber. Centrifugal force acting on the whirling particles

will cause them to be thrown outwardly against the walls of the chamber or the ceiling 12 and it has been found that no dust particles are carried by the gases into the flue chamber 24. It is to be noted that the angular velocity of the vortex increases as the gases approach the opening 16 thus increasing the centrifugal force acting on the entrained particles. During operation of the furnace the wall 10 and the ceiling 12 will attain a temperature above the fusion temperature of the material being treated and the fine particles thrown thereagainst by centrifugal action, having been preheated by the hot gases, will immediately liquefy and form a film of liquid material over the entire inner surface of the furnace chamber. Additional dust particles are thrown into that liquid film and trapped thereby, immediately becoming fused or molten and as the film of liquid on the furnace wall collects, it will travel under the influence of gravity down the furnace walls, into the molten bath 58.

As shown in Fig. 1, the frustro-conical ceiling 12 consists of a plurality of concentric steps having vertical surfaces 62 and downwardly facing horizontal surfaces 64. This is the preferred construction since the step formation assists in reflecting heat from the bath back down to the molten material on the hearth. It will be apparent that heat radiated from the bath to the ceiling cannot be reflected into the flue chamber but must necessarily be reflected back down into the chamber. Furthermore, the temperature of the furnace walls being quite high, there will be considerable radiation therefrom which also will be directed in such direction that it will eventually be radiated or reflected down onto the molten bath. The stepped construction of the ceiling 12, however, is not a vital part of the present invention and need not necessarily be provided. The essential aspects of the invention would be present in a furnace having a ceiling 12 defined by a smooth, conical surface.

When the above-described furnace is being employed for smelting or reducing ores to the metallic state, a matte tap 70 is provided. The opening 70 extends through the wall of the furnace at a point below the lowermost level of the floor defined by sand 6 and a suitable furrow may be formed in the sand to lead the collected matte to the tap 70.

While the drawings herein show the nozzles 52 as plain tubular members extending completely through the furnace wall, it will be understood that other suitable types of burner may be employed to satisfactorily handle the particular fuel chosen. A furnace of this type has been operated employing natural gas as the fuel and the burner employed was of the pre-mix, zero valve type. Clearly, burners of the "tunnel" type may be employed where the actual burner nozzle is adjacent the outer surface of the furnace and the burning jet is directed inwardly through the openings 50, which would then be provided with suitable liners. The furnace may be operated with oil or powdered fuel, which would dictate the use of a different type of burner than that shown. It may also be used with newly developed commercial oxygen burners.

It has been found that a furnace constructed in accordance with the present invention results in increased capacity and since the conical construction is self-supporting, thus reducing materially the installation costs, the cost per unit volume of material processed has attained an unusually low value.

Since the bath of this furnace takes on a slow, circular motion, due to the impinging of the flames thereon, gravitational settling of the heavier matte, magnetite, etc. from the lighter slag is facilitated when the furnace is employed for smelting or reducing operations.

While a specific embodiment of the invention has been shown and described herein, it is to be understood that the invention is not limited thereto but includes all modifications falling fairly within the scope of the appended claims.

I claim:

1. Apparatus for fusing finely divided fusible material, comprising, a furnace having an interior wall of refractory material providing a substantially cylindrical furnace chamber having a vertical axis, the diameter of said chamber being substantially greater than its height, an inwardly and upwardly converging wall above said cylindrical chamber terminating in a centrally located flue opening, means for directing and dropping finely divided fusible material axially downwardly into said chamber, said means comprising a nozzle extending through but spaced inwardly from the sides of said flue opening and terminating below said flue opening but adjacent the apex of said upwardly converging wall, and a burner nozzle projecting into the said chamber and arranged to direct a stream of combustible mixture downwardly and chordally of said chamber.

2. Apparatus for fusing finely divided fusible material, comprising, a furnace having an interior wall of refractory material providing a substantially cylindrical furnace chamber having a vertical axis, the diameter of said chamber being substantially greater than its height, an inwardly and upwardly converging wall above said cylindrical chamber terminating in a centrally located flue opening, a flue chamber over said flue opening, an open-ended hollow member of refractory material extending downwardly through said flue chamber and substantially centrally through but spaced inwardly from the sides of said flue opening and into said furnace chamber, said member terminating closely adjacent said opening and well above the bottom of said chamber, a material feeding pipe extending downwardly within and spaced from said hollow member, and a burner nozzle projecting into the said chamber and arranged to direct a stream of combustible mixture downwardly and chordally of said chamber.

3. An apparatus as set forth in claim 2, including packing means between said pipe and member adjacent the lower ends thereof, and means for circulating a fluid coolant between said pipe and said member.

4. The process of fusing finely divided fusible material comprising, establishing a generally circular bath of molten fused material, directing a jet of flame downwardly on the surface of said bath and chordally thereof to maintain a high temperature therein and impart rotary movement to said bath, directing the hot gases helically upwardly and inwardly to establish a generally conical vortex above said bath, reflecting heat from the outer surface of said vortex downwardly to said bath, feeding finely divided material to be fused through the apex of said vortex while keeping said material out of contact with said hot gases, cooling said material during said feeding, and continuously dropping and dis-

persing said finely divided material within but adjacent the apex of said vortex and into said hot gases substantially above the surface of said bath.

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