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[54] MULTI-STAGE CALCINER

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[51] Int. Cl.F27b 1/10

[58] Field of Search263/30, 19 B, 21 A; 34/57 A

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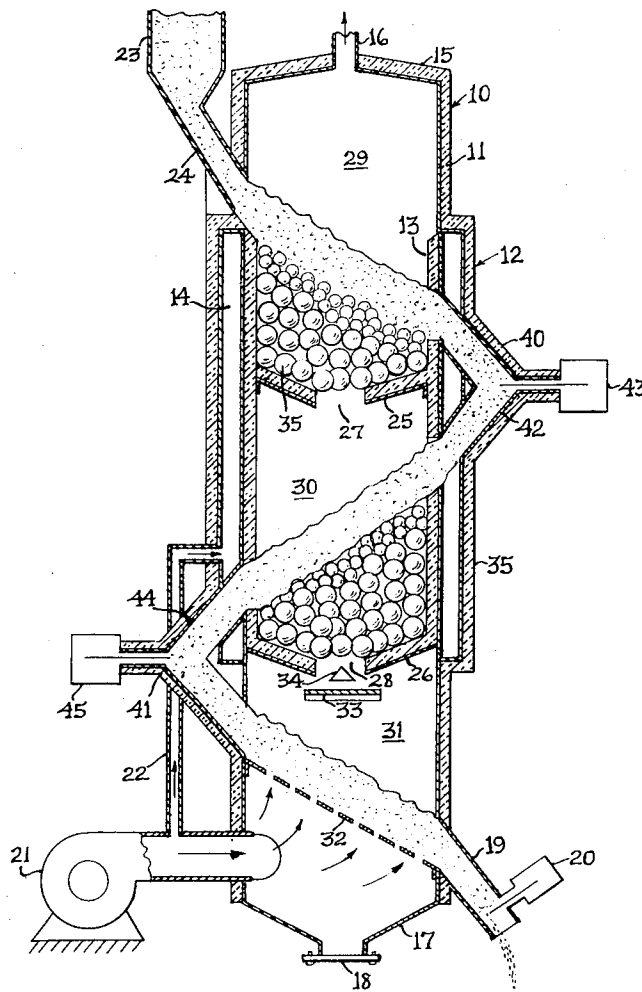
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[57] ABSTRACT

A multi-stage apparatus for drying and hardening ion ore pellets as they flow over a high-temperature sloping grid and pass through separated pre-heating and pre-cooling full flow areas. The apparatus provides a drying stage separated by a pre-heating area from the indurating stage that in turn is separated by a pre-cooling area from the cooling stage, with a single directional flow of air forced longitudinally through each stage to sequentially dry, heat and cool the green pellets as they flow through the apparatus.

8 Claims, 5 Drawing Figures



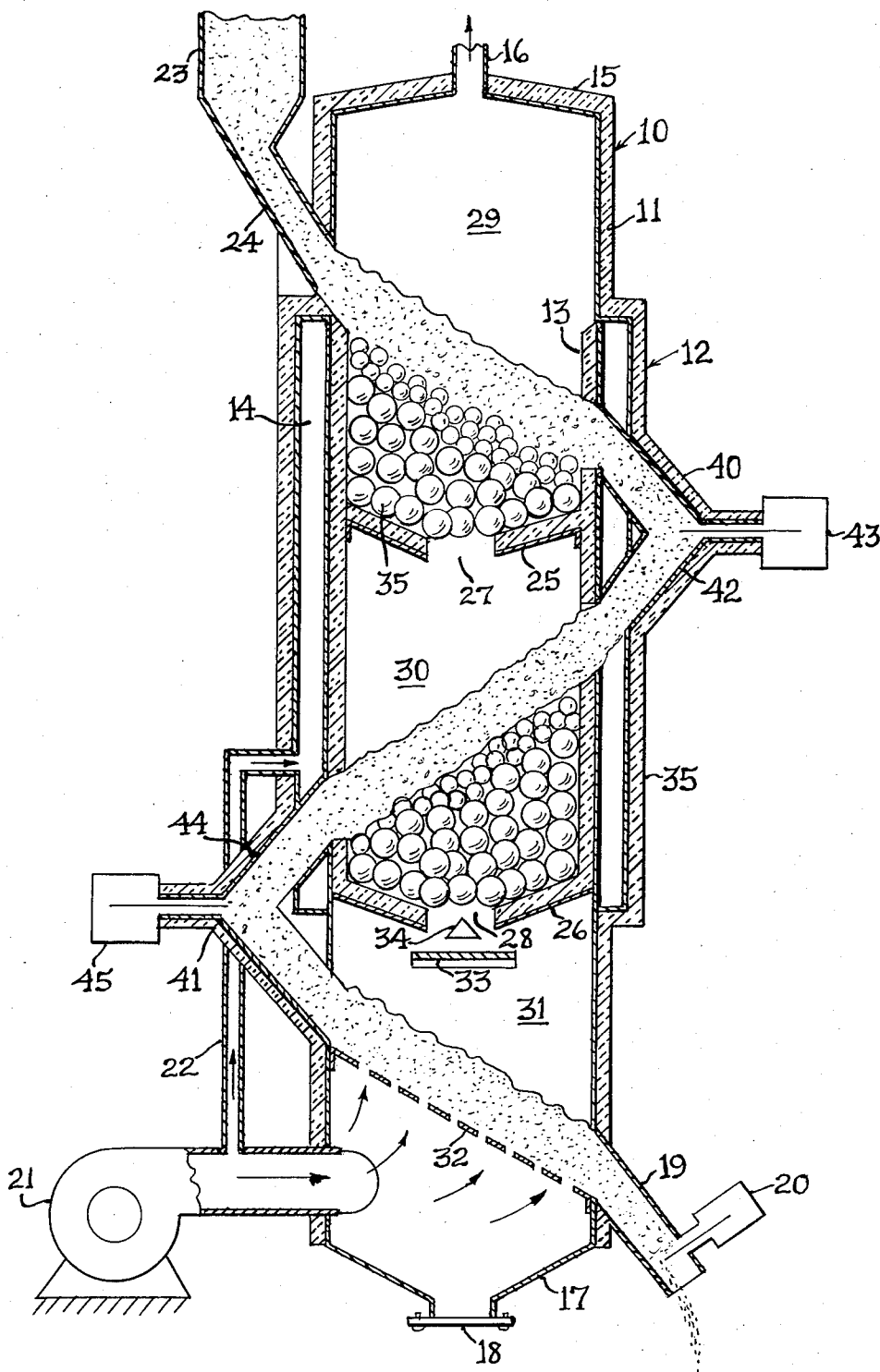
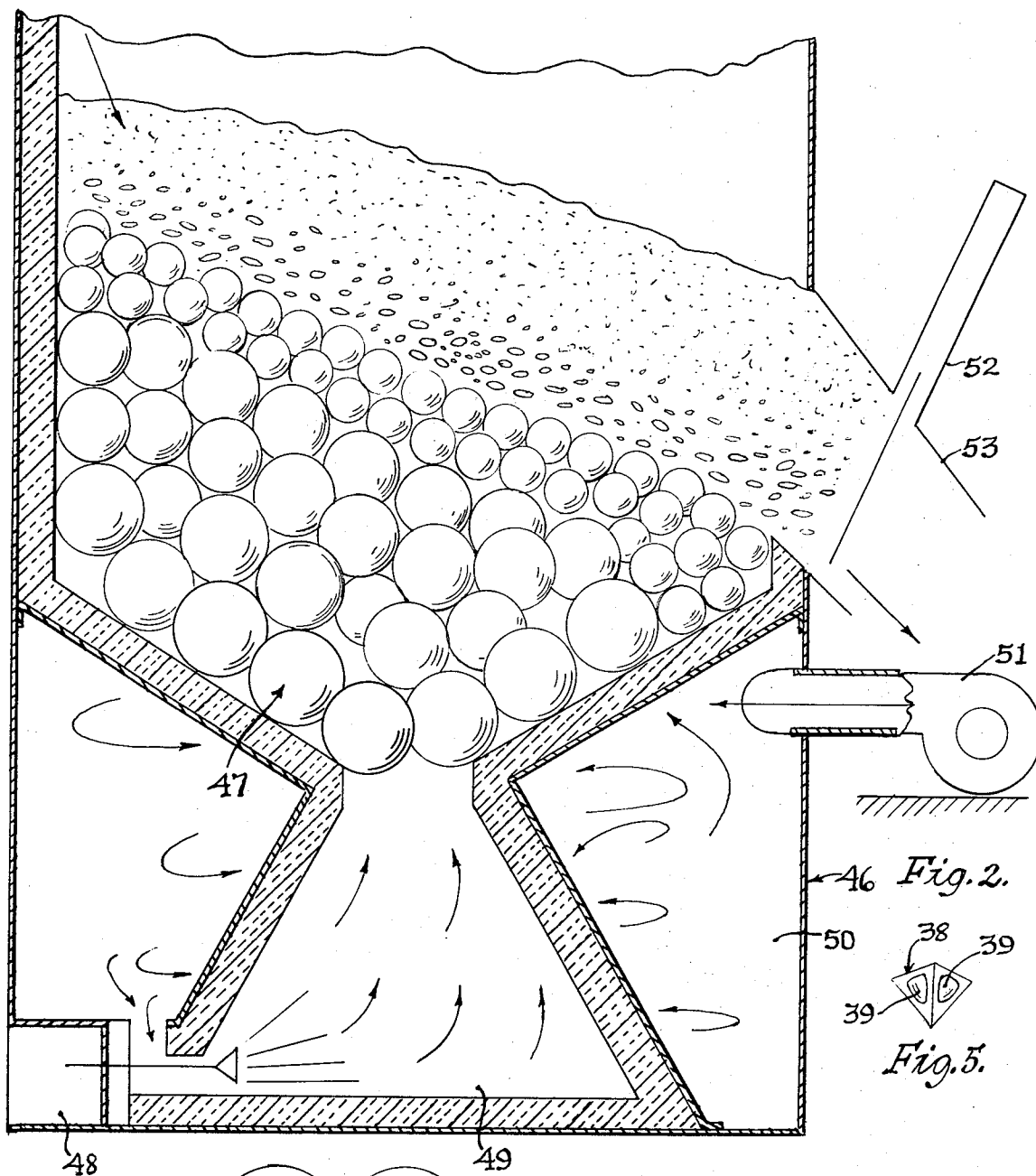
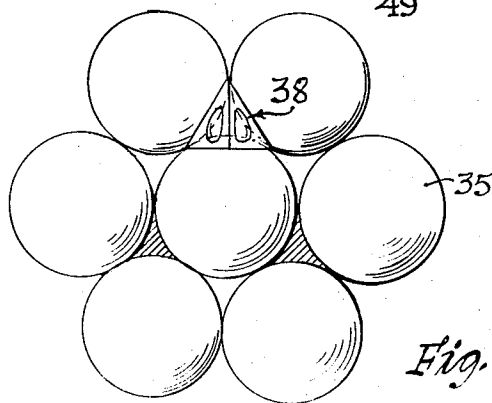
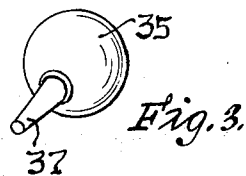
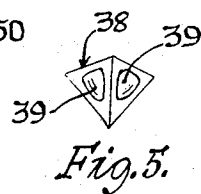


Fig. 1.

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MULTI-STAGE CALCINER

SUMMARY OF THE INVENTION

A multi-stage indurating unit which dries and hardens iron ore pellets, consisting of a vertical cylinder internally divided into drying, indurating, and cooling stages by sloping ceramic ball grids. A pair of full-flow moving bed areas external of the divided stages are utilized to pre-heat and pre-cool the material as it passes into and exits from the indurating stage. The unit is so constructed as to provide an annular pressurized chamber about the refractory-lined indurating stage to prevent deterioration of and leaking from the metallic wall thereof of the combustible hot gases utilized in such stage.

GENERAL DESCRIPTION

The invention as hereinafter described will be best understood by reference to the drawings which disclose the preferred embodiments of the invention, and in which:

FIG. 1 is a cross-sectional view of the multi-stage apparatus of the invention;

FIG. 2 is a fragmentary cross-sectional view of a high-temperature fluid bed unit; and

FIG. 3 is a perspective view of one of the lugged ceramic balls used to form the sloping grids utilized in the invention;

FIG. 4 is a schematic view showing the use of filler blocks utilized to control the amount of open area between the ceramic balls when formed into a sloping bed arrangement; and

FIG. 5 is a perspective view of the filler block.

As viewed in FIG. 1, the apparatus of this invention comprises a vertical cylinder 10 having an insulated outer metallic wall 11, the medial portion 12 of which is stepped radially from an inner refractory lining 13 so as to provide an annular chamber 14. The top wall 15 of the cylinder 10 is provided with an exhaust 16, while the bottom wall 17 has connected thereto a removable clean-out plate 18. Adjacent to the bottom wall 17 of the cylinder 10 is a discharge chute 19 having associated therewith a valve 20 for controlling the discharge of hard pellets from the apparatus. There is also provided adjacent the bottom wall 17 a fluidizing blower 21 having open communication with the interior of the cylinder 10 and a conduit 22 communicating with the annular chamber 14 for the purpose of pressurizing the same during the operation of the apparatus.

A surge bin 23 is provided having an inlet chute 24 which extends through the metallic insulated wall 11 and into the upper region of the cylinder 10. The cylinder 10 is provided with three stages by a pair of internal conical shelves 25 and 26, each of which provides a circular opening 27 and 28 at the apex of its conical shape. These shelves 25 and 26 divide the cylinder 10 into a drying stage 29, which occupies the area of the cylinder vertically above the shelf 25, an indurating stage 30 which occupies the area between the shelves 25 and 26, and a cooling stage 31 which occupies the area below the lowermost shelf 26.

In the cooling stage 31 there is provided a downwardly sloping perforated plate grid 32 over which the hardened pellets flow into the discharge chute 19. Also in the cooling stage 31 and immediately

beneath the center opening 28 formed in the shelf 26, there is a radiation shield 33 positioned immediately beneath a burner unit 34.

While the description of this invention is directed to pelletizing iron ore, it should be understood that it is adaptable for many materials which normally do not respond to fluidization over a heated sloping surface.

The method employed for adapting the apparatus to these other materials resides in the fact that on each of the shelves 25 and 26 there is provided a sloping grid constructed from a plurality of various sized ceramic balls 35. To form the ceramic balls into a sloping grid, each ball 35, as seen in FIG. 3, is provided with a horn or lug 37 which prevents each ball from rolling or sliding down the sloping grid as it is constructed. To regulate the amount of gases passing through the sloping grids provided by the balls 35, a triangularly shaped filler block 38, the faces of which are circularly recessed as at 39 as seen in FIG. 5, may be inserted between the balls 35 making up such grids.

Adapted to be positioned externally of the cylinder 10 are a pair of full flow leg sections 40 and 41, referring to the leg section 40, it is shown as comprising a V-shaped duct 42 which has associated therewith an air-heating unit 43. One leg of the V-shaped duct 42 has open communication with the lowermost side edge of the sloping grid positioned on the uppermost shelf 25. The other section of the duct has open communication with the indurating stage 30 at a point on the high side of the sloping grid supported on the shelf 26. The construction of the leg section 41 is identical to that of section 40, except that its V-shaped duct 44 carries an air-cooling unit 45, with one section of the duct communicating with the low side of the sloping grid constructed on shelf 26 and with its other portion discharging upon the perforated plate grid 32, all as shown.

In operation the fluidizing blower 21 forces a stream of gas into the cooling stage 31 through the perforated plate grid 32 around the radiation shield 33 and over the burner 34. At this stage, the burner will heat the gas so that it passes up through the sloping grid of ceramic balls 35 through the indurating stage 30 into the opening 27 formed in the shelf 25 around the sloping grid of ceramic balls 35 supported thereby and into the drying stage 29 and out the exhaust 16. Simultaneously a certain amount of the gases will be forced through the conduit 22 into and pressurizing the chamber 14 surrounding the indurating stage 30. At the same time, green pellets are fed from the surge bin 23 through its chute 24 into the sloping grid of ceramic balls 35, where such pellets are dried at a temperature of approximately 750° F.

As the material flows over the grid of ceramic balls 35, it will pass into the duct 42 of the pre-heating leg section 40. There the air-heating unit 43 introduces forced heated air in a direction opposite to the flow of material thereover, wherein the material is heated to approximately 2,000° F. Here it will pass into the indurating stage 30 and onto the sloping grid of ceramic balls 35 where it is subjected to temperatures ranging up to 2,400° F. From this stage it passes into the duct 44 of the pre-cooling section 41, wherein it is subjected to a flow of pre-cooled gases before it flows onto the perforated plate grid 32, where it is subjected to the full stream of cooling gases, and thence out the discharge chute 19.

In FIG. 2 there is fragmentarily shown a high temperature fluid bed unit 46 which utilizes the sloping grid of ceramic balls 47 of different diameters. Here the material may be processed on a batch or continuous basis. In this device the burner unit 48 heats the gases in a triangularly shaped chamber 49 which is surrounded by a pressurized chamber 50 into which the gases from a fluidizing blower 51 are introduced. The discharge of the material is controlled by a suitable discharge valve 52 located in a discharge chute 53.

The heretofore described apparatus permits the controlled heating and transporting of many materials by reason of the utilization of the sloping-surface, fluid grids novelly constructed from ceramic balls. The liberal use of balls of different diameters so as to build up a high or introduction side, tends to even out any pressure drop across the grid due to the increased depth of the piled balls to form the sloping grid. The employment of the pressurized annular chamber about the refractory lining in the indurating stage, prevents the metallic material from eroding, or the hot gases escaping through pin-hole leaks which would follow from erosion. The pressurized chamber also cools the exterior surface of the unit, notwithstanding the high temperatures employed therein.

While I have illustrated and described the preferred form of construction for carrying my invention into effect, this is capable of variation and modification without departing from the spirit of the invention. I, therefore, do not wish to be limited to the precise details of construction set forth, but desire to avail myself of such variations and modifications as come within the scope of the appended claims.

Having thus described my invention, what I claim as new and desire to protect by Letters Patent is:

1. A multi-stage calciner apparatus comprising a vertically disposed cylinder having an upper inlet and lower discharge chutes for the material to be indurated, wherein the improvement comprises

- a. means for dividing the cylinder into superimposed stages for the sequential indurating treatment of fluidized material passing therethrough,
- b. a plurality of spherical elements of different diameters supported upon said dividing means so as to provide heated sloping grids over which the material to be treated flows in a continuous path,
- c. means external of said cylinder between certain of said stages for receiving and pre-treating the material as it passes between successive stages provided by said apparatus during its continuous flow therethrough, and
- d. means for supplying a continuous flow of gas through said different stages of said apparatus for effecting different temperature treatment of the material flowing continuously therethrough.

2. A multi-stage calciner apparatus as defined by claim 1 wherein said means for dividing the cylinder into superimposed stages comprises a plurality of inverted conical shelves having a center opening providing open communication between each of the superimposed stages, with said spherical elements supported upon said shelves and covering said center openings provided therein so as to form a sloping grid thereon through which said continuous flow of gas is permitted

to pass and over which the fluidized material flows from one stage to the next.

3. A multi-stage calciner apparatus as defined by claim 1 wherein said spherical elements are provided with externally projecting means that cooperate with other of said elements to maintain said elements in their pre-arranged position after they are placed in a stacked relation on said dividing means to form the sloping grid over which the fluidized material will flow.

4. A multi-stage calciner apparatus as defined by claim 1 further defined by having means providing a pressurized jacket radially disposed about one of the superimposed stages formed in the cylinder with said jacket having open communication with said means for supplying a continuous flow of gas to said apparatus for pressurizing said jacket about said certain stage during the operation of the apparatus.

5. A multi-stage calciner apparatus as defined by claim 2 wherein said spherical elements are provided with externally projecting means that cooperate with other of said elements to maintain said elements in their pre-arranged position after they are placed in a stacked relation on said dividing means to form the sloping grid over which the fluidized material will flow.

6. A multi-stage calciner apparatus as defined by claim 2 wherein said spherical elements are each provided with a laterally extending lugs which cooperates with the lug on other elements to maintain said elements in their pre-arranged position upon said inverted conical shelves and over said center openings provided thereby after they are placed in a stacked relationship with respect to one another so as to provide a sloping grid over which the fluidized material will flow.

7. A multi-stage calciner apparatus as defined by claim 2 further defined by having means providing a pressurized jacket radially disposed about one of the superimposed stages formed in the cylinder with said jacket having open communication with said means for supplying a continuous flow of gas to said apparatus for pressurizing said jacket about said certain stage during the operation of the apparatus.

8. A calciner apparatus for heating and freely transporting materials to be treated, over a sloping surfaced fluid grid, wherein the improvement comprises

- a. a chamber formed within the apparatus by an inverted conically shaped wall providing an opening at the depending vertex thereof,
- b. a pressurized annular section about said inverted conically shaped wall,
- c. means for pressurizing said section,
- d. a combustion chamber within said pressurized section and having open communication therewith and with said opening provided at the depending vertex of said wall,
- e. means for heating the atmosphere of said combustion chamber,
- f. a grid of ceramic balls of different diameters on said wall arranged to provide a sloping surface for the material heated and transported thereover,
- g. and a discharge means associated with the lowermost edge of said sloping surface grid through which the treated material is passed from said apparatus.

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