

Sept. 10, 1968

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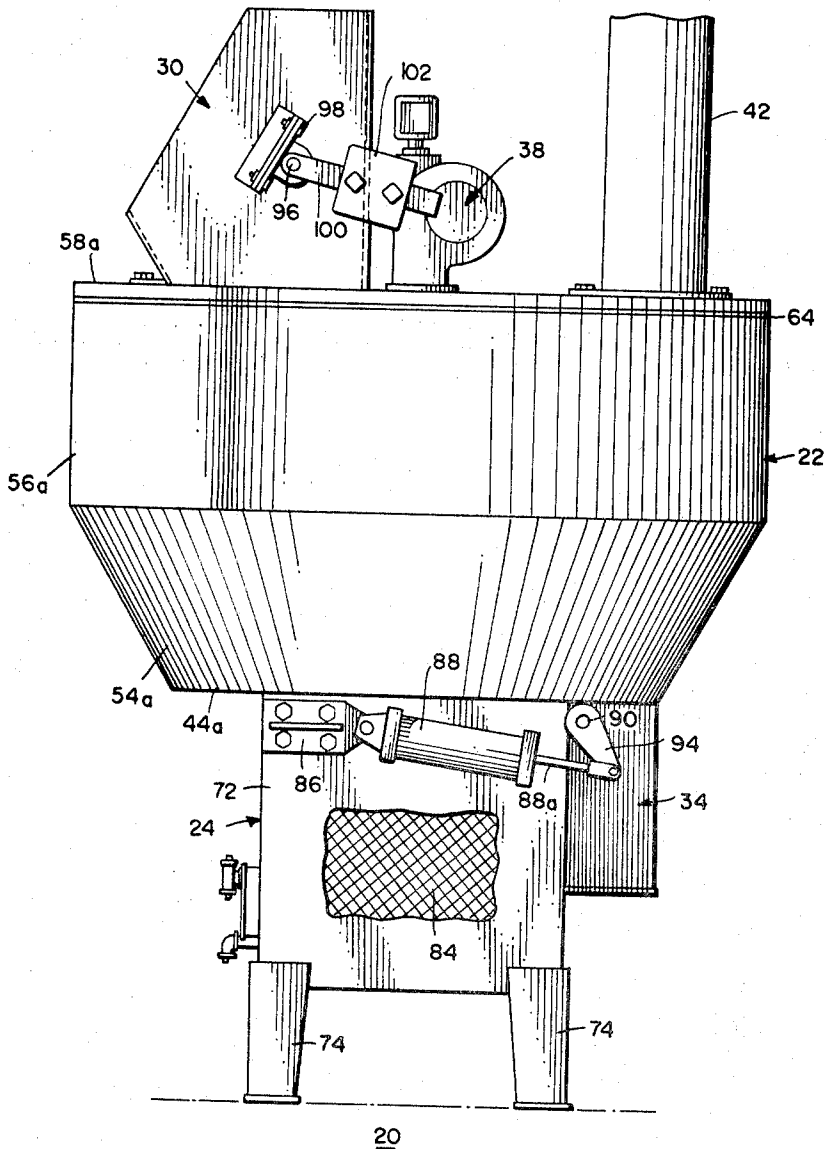
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METHOD AND APPARATUS FOR CONDITIONING PARTICULATE MATERIALS

Filed May 4, 1966

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FIG. 1



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FIG. 11

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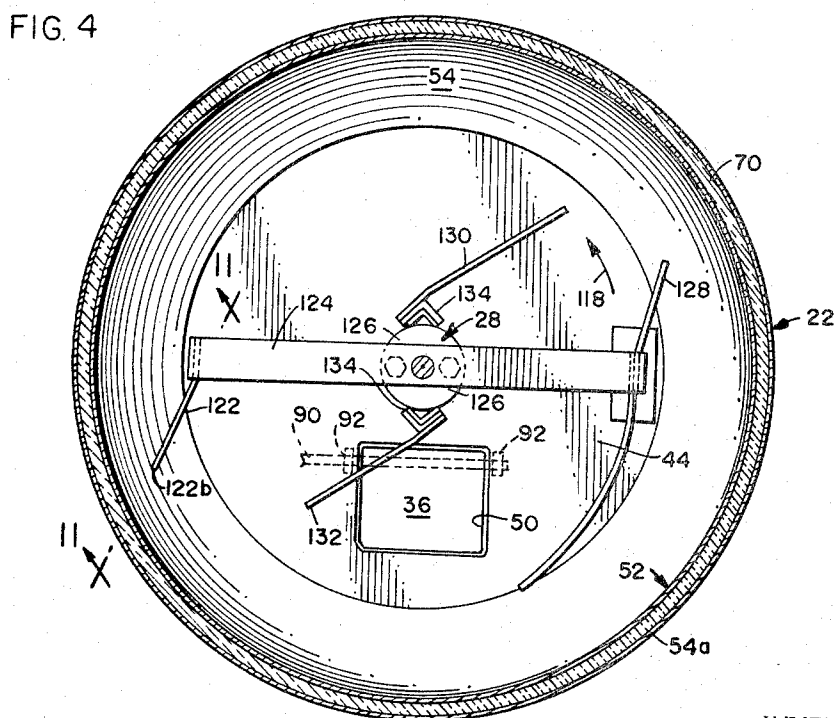
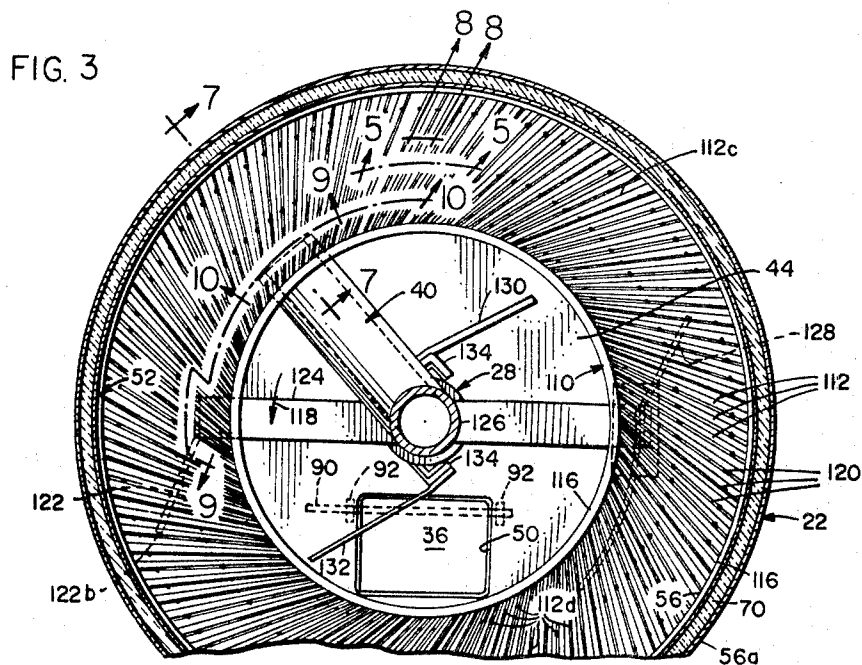
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METHOD AND APPARATUS FOR CONDITIONING PARTICULATE MATERIALS

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METHOD AND APPARATUS FOR CONDITIONING PARTICULATE MATERIALS

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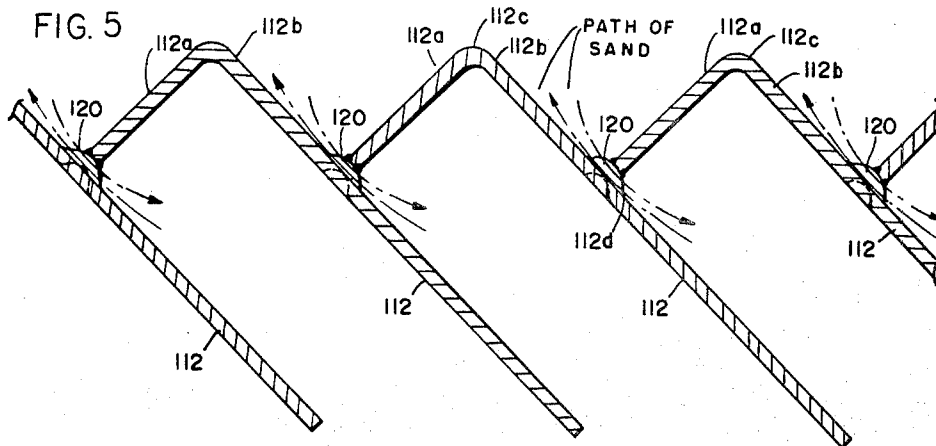


FIG. 6

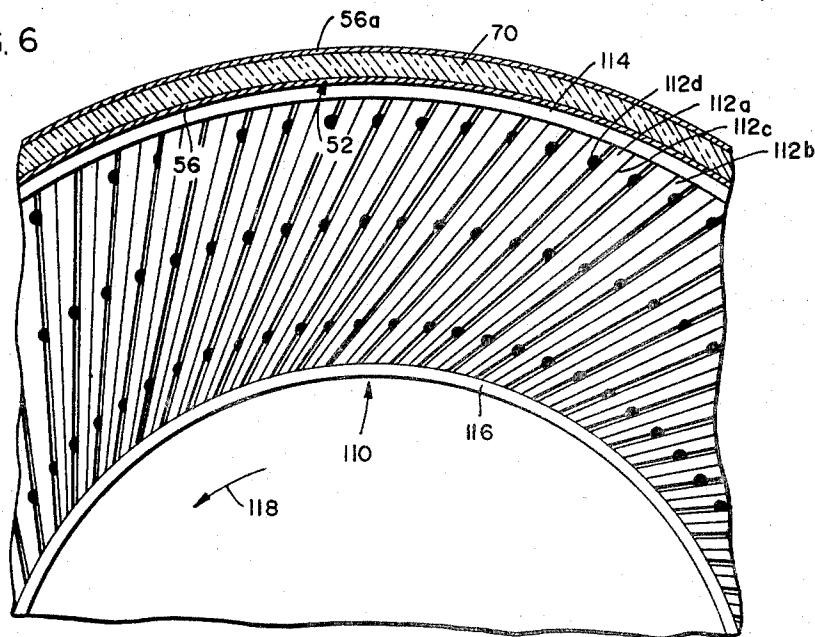


FIG. 7

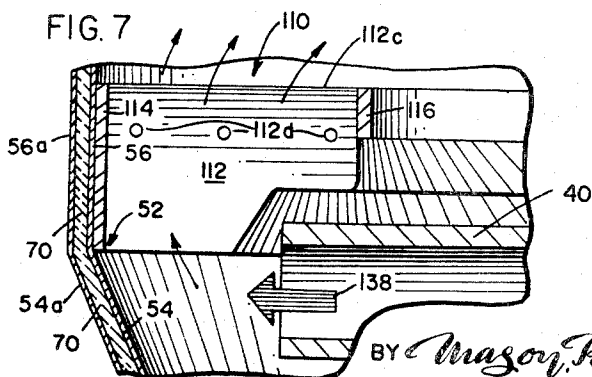
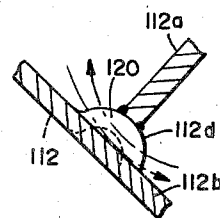


FIG. 8



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METHOD AND APPARATUS FOR CONDITIONING PARTICULATE MATERIALS

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FIG. 10

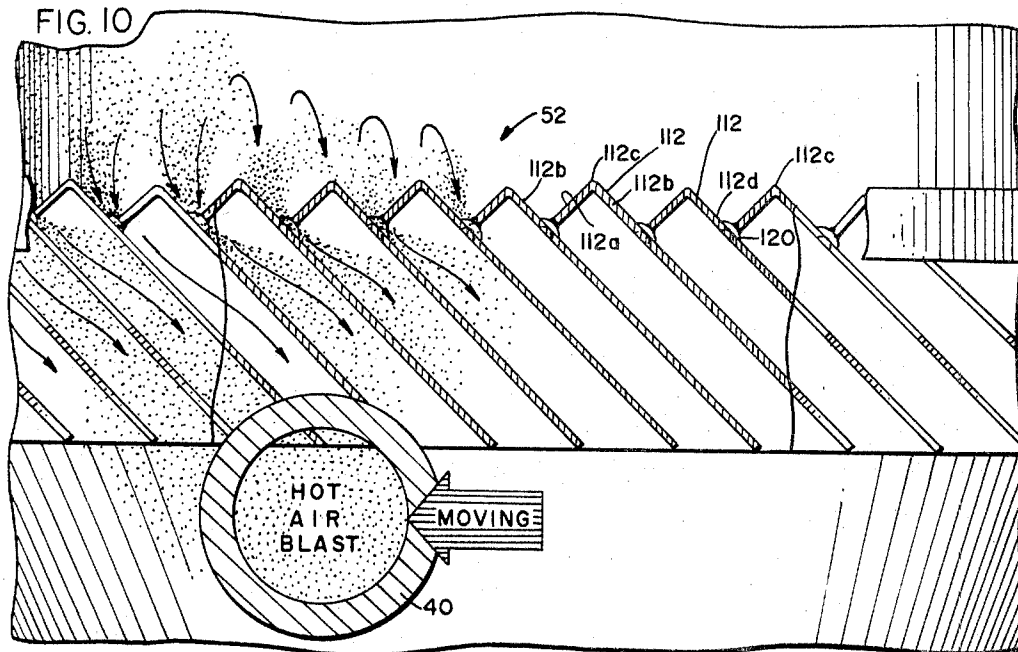
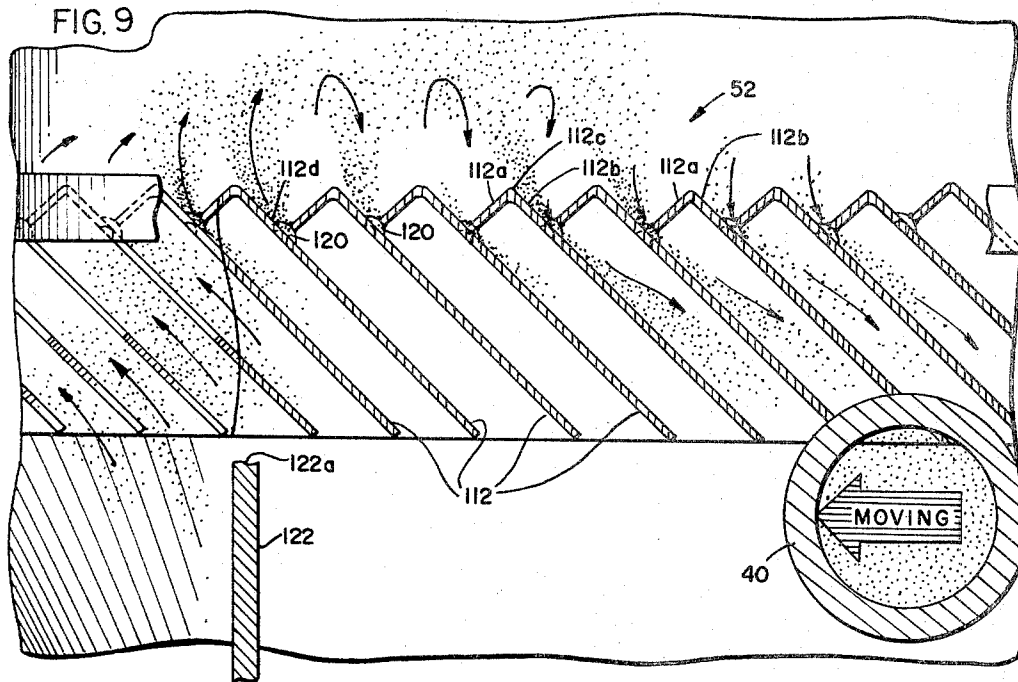


FIG. 9



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3,400,916

METHOD AND APPARATUS FOR CONDITIONING PARTICULATE MATERIALS

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The present invention relates to a new and improved method and apparatus for conditioning particulate materials, such as foundry sand, granular materials, powdered materials, and the like.

A problem often encountered in foundry operations is that of rapidly and efficiently heating and mixing batches of foundry sand to elevated temperatures of approximately 300° F. so that bonding materials can then be easily blended into the batch to coat the sand granules.

It is an object of the present invention to provide a new and improved method and apparatus for conditioning particulate materials, such as sand, granular and powdered materials and the like.

More specifically, it is an object of the present invention to provide a new and improved method of rapidly and efficiently heating particulate materials, such as foundry sand, granular and powdered materials, and the like.

It is another object of the invention to provide a new and improved method of heating particulate materials which insures a thorough and intimate mixing of the materials providing a substantially uniform temperature throughout.

Another object of the invention is the provision of a new and improved method of mixing particulate materials.

Still another object of the invention is the provision of a new and improved method of rapidly, thoroughly, and intimately mixing particulate materials with a minimum amount of mechanical energy expended.

Still another object of the invention is the provision of a new and improved method of conditioning particulate materials which employs primary direct heating of a fractional portion of the materials while the particles are in an individually separated condition, and thereafter employs surface contact between the heated particles to produce a secondary heat transfer and insure uniformity of temperature throughout material being conditioned.

Yet another object of the invention is the provision of a new and improved method of conditioning particulate materials employing the principle of relative movement between a source of heat and a fractional portion of the material, wherein the particles are separated from each other during heating and then are returned over stationary heating surfaces to a gravity compacted condition to effect heat transfer to the remaining portion of material.

Yet another object of the present invention is the provision of a new and improved method of treating particulate materials which is capable of rapidly elevating the temperature of the materials to the desired level.

Another object of the invention is the provision of a new and improved apparatus for rapidly and efficiently heating particulate materials, such as foundry sand, various granulated and powdered materials, and the like.

Yet another object of the present invention is the provision of a new and improved apparatus for rapidly and efficiently heating particulate materials while thoroughly and intimately mixing the same to insure uniformity of temperature and consistency throughout.

Another object of the present invention is to provide a new and improved apparatus for thoroughly and intimately mixing particulate materials with a minimum of

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energy expended and a minimum of wear resulting on the apparatus.

Yet another object of the invention is the provision of a new and improved apparatus for heating and mixing particulate materials capable of rapidly and efficiently heating and mixing even the most finely divided materials, including those having relatively low heat absorption characteristics.

Still another object of the invention is the provision of a new and improved apparatus for conditioning and treating particulate materials including means for rapidly moving the material around a chamber while lifting and maintaining a fractional portion of the material in a condition wherein the individual particles are separated from one another, and means for directing heated gases into the fractional portion of material so separated before the particles are returned to a gravity compacted condition with the remaining material.

Yet another object of the invention is the provision of a new and improved apparatus for intimately and thoroughly mixing particulate materials as described above, including means for dividing the separated particles of material into a plurality of streams and then reuniting the material with a common mass.

Still another object of the invention is the provision of a new and improved apparatus for treating particulate materials capable of rapidly elevating the temperature of the materials to the desired level.

A further object of the invention is to provide a new and improved apparatus for treating particulate materials of the type described which is low in cost, relatively simple in construction, reliable in operation and economical to operate.

These and other objects and advantages of the present invention are achieved by the provision of a new and improved method of treating material comprising the mixing of a mass of particulate material by circular spiraling movement around a confined area and continually lifting or elevating a fractional portion of the material above the level of a remaining portion. The individual material particles of the elevated fractional portion of material are separated from one another to expose maximum surface areas thereof to the surrounding atmosphere and, while in such separated or exposed condition, are subjected to a direct blast of heated gases to effect a rapid and efficient heating thereof. The particles are returned to the remaining mass of material in various diverse and reuniting streams and reach a gravity compacted condition in the particles and remaining material wherein conductive heat transfer takes place between the particles to effect a uniform temperature throughout the material being treated.

Briefly, the apparatus of the present invention comprises a circular mixing chamber having a bottom and a sidewall and annular baffle means are mounted in the chamber spaced above the bottom and extending inwardly toward a central upstanding axis of the chamber. The baffle means includes a plurality of individual, spaced apart baffle members having surfaces inclined relative to the bottom of the mixing chamber. A mixing head is mounted in the chamber for rotation about the central axis and the head includes plow means radially outward of the central axis and movable around the chamber below the annular baffle means for lifting and elevating a fractional portion of the material upwardly through the openings between the individual baffle members. As the material is elevated, the baffle members help to separate the particles of material from one another so that above the baffle means the material particles are in an exposed or widely separated condition. The lifted material particles drop downwardly by gravity toward

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the baffle means and are separated into various diverse streams and reunited as the particles flow downwardly toward the bottom of the mixing chamber. Burner means are provided for supplying heat to the material in the mixing chamber and the burner means includes a movable nozzle structure having an outlet end positioned to move around the chamber adjacent the level of the baffle means. The nozzle structure is mounted for rotation with the mixing head and the outlet thereof is positioned to produce a high velocity flow of heated gases for direct contact with the material flowing down through and below the baffle means. Accordingly, the individual particles returning toward the bottom of the mixing chamber are enveloped in high temperature gases from the nozzle outlet and absorb large quantities of heat. These heated particles eventually reach the material in the lower portion of the mixing chamber below the baffle means in a gravity compacted condition, and heat transfers from the hotter particles of material to the cooler ones by direct conduction as these particles are thoroughly and intimately mixed traveling around the chamber.

For a better understanding of the present invention, reference should be had to the following detailed description taken in conjunction with the drawings, in which:

FIG. 1 is a side elevational view of a new and improved apparatus for treating particulate materials constructed in accordance with the features of the present invention;

FIG. 2 is a vertical cross-sectional view taken through the central portion of the apparatus of FIG. 1;

FIG. 3 is a transverse cross-sectional view taken substantially along line 3-3 of FIG. 2;

FIG. 4 is a transverse cross-sectional view taken substantially along line 4-4 of FIG. 2;

FIG. 5 is an enlarged, fragmentary, sectional view taken substantially along line 5-5 of FIG. 3 and illustrating in detail the construction of baffle members of the present invention;

FIG. 6 is an enlarged, fragmentary, sectional view similar to FIG. 3 illustrating a portion of the baffle means of the present invention, in plan view;

FIG. 7 is an enlarged, fragmentary, sectional view similar to FIG. 2 taken substantially along line 7-7 of FIG. 3.

FIG. 8 is an enlarged, detailed, fragmentary, cross-sectional view taken substantially along line 8-8 of FIG. 3;

FIG. 9 is an enlarged, fragmentary, cross-sectional view taken substantially along line 9-9 of FIG. 3 and illustrating somewhat schematically the lifting and heating action of the apparatus;

FIG. 10 is an enlarged, fragmentary, cross-sectional view, similar to FIG. 9, taken substantially along line 10-10 of FIG. 3; and

FIG. 11 is an enlarged, fragmentary, sectional view taken substantially along line 11-11 of FIG. 4.

Referring now, more particularly, to the drawings, therein is illustrated a new and improved apparatus for treating particulate material constructed in accordance with the present invention and indicated generally by the reference numeral 20. The apparatus 20 includes a large, insulated, enclosed mixing chamber 22 which is supported from the floor or other structure by a leg structure 24 which houses and supports a power driving assembly 26 (FIG. 2) for driving a mixing head assembly 28 mounted for rotation in the mixing chamber. Particulate material to be treated is introduced into the mixing chamber 22 through an inlet chute 30 having a movable inlet door or gate 32 to control the flow of material through an inlet opening in the top of the mixing chamber. After treatment in the mixing chamber 22, the material is discharged through an outlet chute 34 supported by the leg structure 24 and having a movable discharge

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door or gate 36 for controlling outflow of material through an opening in the bottom of the mixing chamber. In order to supply heat to the material in the mixing chamber, a gas or oil burner 38 is mounted on the top wall of the chamber to direct heated gases downwardly into the chamber for distribution by the mixing head assembly 28 through a curved nozzle structure 40 mounted thereon. Exhaust gases, water and other products of combustion are removed from the enclosed mixing chamber 22 through an exhaust stack or vent pipe 42 which extends upwardly from the chamber and may be connected with suitable dust collector equipment (not shown) for removing any fine particulate materials carried by the exhaust gases.

Describing the mixing chamber 22 in greater detail, the chamber includes a circular bottom wall or inner wear plate 44 having a centrally located aperture 46 therein to accommodate an upstanding drive axle or shaft 48 of the mixing head assembly 28. The bottom wall 44 is formed with a generally rectangular discharge opening 50 adjacent the perimeter thereof to accommodate the movable discharge door 36 which, when in a closed position (solid lines, FIG. 2), is level with the upper surface of the bottom wall and forms a portion of the bottom wall of the mixing chamber 22. The mixing chamber includes an upstanding sidewall 52 comprising a lower frustoconical section 54 joined to the outer perimeter of the circular bottom wall 44 and sloped to extend upwardly and outwardly thereof, and an upper cylindrical section 56 joined to the upper end of the lower section 54. The slope of the lower section 54 is approximately 60 degrees to the bottom 44 in order to help direct the material inwardly toward the central portion of the mixing chamber and the junction between the upper and lower sections of the sidewall 52 is approximately midway between the upper and lower ends of the mixing chamber. Normally, the mixing chamber 22 is filled with particulate material to a level somewhat below the junction between the upper and lower sections 56 and 54, leaving the upper portion of the chamber open to accommodate a relatively large volume of hot gases introduced into the chamber by the burner assembly 38. The upper end of the mixing chamber 22 is closed by a removable top wall 58 having a central opening 60 therein to accommodate the downward discharge from the burner assembly 38. The top wall is held in place by a number of cap screws 62 which extend downwardly into an angular rim 64 at the upper end of the upper sidewall section 56, and after removal of these screws the top wall can be lifted off to open the interior of the chamber for inspection or maintenance if necessary. In addition to the central burner opening 60, the top wall includes a rectangular opening 66 in communication with the inlet chute 30 for receiving material therefrom, and a circular vent or exhaust opening 68 is provided to communicate with the lower end of the exhaust stack 42.

Because large quantities of heat are introduced into the mixing chamber 22, the outer surfaces thereof are insulated by a layer 70 of suitable insulating material, such as fiber glass or the like, and the insulating material is protected against damage by sheet metal coverings 44a, 54a, 56a, and 58a corresponding generally in shape to the adjacent mixing chamber wall surfaces 44, 54, 56 and 58. Because of the excellent insulation provided, heat losses to the atmosphere from the mixing chamber 22 are reduced and minimized; however, if not heating is to take place in the chamber, the insulation and sheet metal protective coverings can be dispensed with.

The leg structure 24 includes a rectangular boxlike housing 72 having short supporting legs 74 extending downwardly from the corners thereof, and the housing encloses a power driving assembly connected to drive the drive shaft 48 of the mixing head assembly 28. To this end, the lower end of the drive shaft is supported in a tubular sleeve 76 having a flanged upper end 76a bolted to

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the underside of the mixing chamber bottom wall. The lower end of the drive axle 48 extends below the lower end of the sleeve 76 and is directly coupled to the output shaft of a speed reducer 78 (FIG. 2) which, in turn, is driven by an electric motor 80 through belt drive system 82. The motor 80, belt drive system 82, and speed reducer are enclosed within the housing 72 and opposite sidewalls thereof are formed with grilled openings 84 (FIG. 1) to permit a ventilating airflow to cool the motor and speed reducer. The discharge chute 34 is supported by one of the sidewalls of the leg structure housing 72, and an adjacent sidewall thereof provides support for a bracket 86 which pivotally supports one end of an air cylinder 88 for controlling the discharge gate 36. The discharge gate is supported on an axle 90 mounted on a pair of brackets 92 depending from the underside of the mixing chamber 22, and the axle 90 protrudes outwardly from one side of the discharge chute 34 for connection with the movable piston rod 88a of the door cylinder through a lever 94. Pressurized fluid flow into the cylinder 88 is controlled by a conveniently located control system (not shown) so that the discharge gate 36 can be opened and closed as desired.

Referring to the inlet chute 30 and inlet gate 32, the gate is supported on an axle 96 mounted in bearing assemblies 98 on the sidewalls of the chute. The axle 96 protrudes outwardly through the chute sidewalls and a pair of lever arms 100 (FIG. 1) are connected to the outer ends thereof for supporting movable weights 102 which bias the gate to a closed position. The upper edge of the inlet gate 32 is sealingly connected to a baffle plate 104 in the inlet chute by a flexible seal 106 of heat resistant material, such as asbestos or the like. The arms 100 and weights 102 normally bias the inlet gate to a closed position (solid lines, FIG. 2); however, when a batch of particulate material is dumped into the inlet chute, the weight of the material causes the gate to move to the open position (dotted lines, FIG. 2) and the material flows into the mixing chamber 22 through the inlet opening 66. After the material has entered the chamber, the inlet gate 32 then moves back to the closed position and seals off the inlet opening 66 to prevent the escape of heated gases in the mixing chamber. To this end, suitable stationary seals or stops 106 are provided around the inner surfaces of the inlet chute 30, as shown in FIG. 2, to seal against the edges of the inlet gate 32 when in a closed position.

Turning to the structure interiorly of the mixing chamber 22, there is provided in accordance with the present invention, an annular ring 110 of inwardly extending baffle members or vanes 112 positioned adjacent the level of the junction between the lower frustoconical section 54 and upper section 56 of the mixing chamber sidewall 52. The baffle members 112 are supported by a relatively deep outer band or ring 114 and a narrower inner ring or band 116 which are concentric with the central axis of the chamber and mixing head drive shaft 48. The bands or rings 114 and 116 may be segmented, if desired, to facilitate assembly and disassembly, and the lower end of the outer ring 114 rests against the inwardly sloping section wall 54 for support of the baffle assembly.

The outer ends of the individual baffle members 112 are fastened to the outer ring 114 and the inner ends of the baffle members are secured to the smaller inner ring 116. The upper edges of the baffle members extend generally horizontally inwardly of the outer sidewall 56 of the mixer toward the central portion thereof, and are arranged in plan view, as best shown in FIG. 3, with their inner ends positioned in advance or ahead of their outer ends in the direction of rotation of the mixing head assembly 28, as indicated by an arrow 118; thus the vanes could be described as being askew in relation to radii extending outwardly from the central axis of rotation of the mixing head.

Preferably, the baffles 112 are formed of heat-conducting metal, such as stainless steel, aluminum, or the like and are cut and bent to shape in a stamping operation.

As best shown in FIGS. 5, 9, and 10, each baffle 112 is formed into an angular cross section with a pair of oppositely and downwardly extending surfaces 112a and 112b integrally joined together at their upper edges to form an apex 112c along the upper edge of the baffle member as a whole. The inclined surfaces 112b of the baffles are considerably larger in area than the surfaces 112a and the lower edges of the smaller surfaces are adapted to lie in spaced facing relation to the larger surfaces 112b along a line positioned downwardly of the apex 112c. Spacing between the lower edges of the smaller baffle surface portions 112a and the larger surface portions 112b of adjacent baffle members is obtained by means of a plurality of upwardly extending spaced apart projections or bosses 112d (FIG. 8), and adjacent baffle members are welded together at the projections to form the annular baffle structure. Because of the spacing, a plurality of narrow slots or openings 120 are formed between adjacent baffle members 112 to permit material to flow upwardly and downwardly through the baffle assembly, as best shown in FIGS. 9 and 10. The slots 120 are narrow enough in width to retard the downward flow of material therethrough but are wide enough so that individual grains or granules of the material will pass. Accordingly, several baffle assemblies 110 may be provided for insertion in the mixing chamber, having different openings 120 between baffles 112 to accommodate the types of material being treated.

Energy for forcing the material beneath the baffle assembly in the lower section of the mixing chamber upwardly through the slots 120 is furnished by the mixing head assembly 28 as it rotates around the chamber. To this end, the mixing head assembly includes an upper and outer plow or scraper 122 having an upper edge 122a positioned to move in close proximity to the lower edges of the baffle surface members 112b, as best shown in FIGS. 9 and 11. The plow 122 includes an outer edge 122b which is sloped to be parallel with and move in close proximity to the frustoconical wall section 54 of the mixing chamber. The plow 122 is supported on a downturned portion at one end of a cross arm 124 which is carried by a turret head 126 on the upper end of the drive shaft 48 of the mixing head assembly. The opposite end of the cross arm 124 provides support for an elongated, curved upper flow 128 positioned midway between the underside of the baffle structure 110 and the mixer bottom wall 44. As illustrated in FIGS. 3 and 4, the plow 122 is in angular relation with the radial axis of the cross arm 124, and the outer edge 122b of the plow is advanced from the cross arm in the direction of rotation of the mixing head.

The turret head 126 of the mixing head assembly also provides support for a pair of lower plow members 130 and 132 which move along the circular bottom wall 44 to continually mix the material in the center of the mixing chamber. The inner plows 130 and 132 are supported on a pair of downwardly extending angle brackets 134 bolted to the turret head 126 by cap screws 136 (FIG. 2), and the plows extend outwardly toward the periphery of the mixing chamber to move the material outwardly as the mixing head 28 rotates.

The turret head 126 also provides support for the movable nozzle structure 40 which directs the downwardly moving high velocity hot gases from the burner 38 outwardly toward the sidewall 52 of the mixing chamber 22. The nozzle structure 40 comprises a tubular elbow of heat resistant material having a pair of mounting feet 40a (FIG. 1) which rest upon the top of the turret head 126 and are secured thereto by a pair of removable cap screws 136. The discharge end of the nozzle structure 40 extends horizontally outwardly from the central axis of the mixing chamber (FIG. 2), and the nozzle includes an upstanding inlet portion in concentric alignment with the downward discharge axis of the burner 38. Because of relative rotation between the burner 38 and the rotating nozzle structure 40, the upper

end of the nozzle structure is open to accommodate a downwardly protruding portion 38a of the burner. The opening 60 is somewhat larger than the outer diameter of the burner discharge nozzle 38a to permit outside air to be drawn into the nozzle structure 40 by venturi action when the burner is in operation. The heated gases from the burner 38 flow downwardly in the upstanding inlet portion of the nozzle structure 40 and are directed radially outward in the direction of the arrow 138 in FIG. 2. These hot gases are directed at high velocity against the material moving through the baffle structure 110 and against the lower portion of baffle members 112b which are cut out, as shown in FIGS. 2, 7 and 11, in order that the outlet end of the nozzle structure 40 may move in close proximity thereto, as best shown in FIG. 7. The nozzle structure 40 is positioned on the mixing head 28 so that the outwardly extending outlet portion is angularly displaced with respect to the cross arm 124 and outer plow 122 in a direction generally opposite to the direction of mixing head rotation (arrow 118) as best shown in FIG. 3.

In operation, the mixing chamber 22 is filled with a quantity or batch of particulate material, such as sand or the like, which is to be treated to a level somewhat below the underside of the annular baffle structure 110. After filling, the inlet gate 32 moves to a closed position sealing off the upper end of the mixing chamber. As the mixing head assembly 28 is rotated, the lower inner plows 130 and 132 rapidly mix and agitate the material adjacent the circular bottom wall 44 and move the material outwardly toward the sloping frustoconical wall section 54. The upper, inner plow 128 pulls the material back inwardly toward the central portion of the mixing chamber and provides a feeding type action to resupply the lower plows 130 and 132 so that the material, while being moved in a generally circular pattern around the mixing chamber is also rolled inwardly and pushed outwardly as the mixing head rotates.

The outer plow 122 moves at a velocity somewhat greater than the other plows because of its greater distance from the central axis of the chamber, and as it moves in close proximity to the frustoconical sidewall section 54 and underside of the annular baffle structure 110, a fractional portion of the material is forced or lifted upwardly through the narrow slots 120 between the adjacent baffle members 112. The lifting action causes the individual particles or granules of the material to be separated from one another in an aerating type action, and the particles are divided into various diverse streams by the sloping surface members 112b of the baffles, as shown in FIG. 9. Some of the particles strike the oppositely sloping baffle surface members 112a and are directed downwardly into the upwardly moving streams in a reuniting action and the streams pass upwardly through the narrow slots 120 in the annular baffle structure 110.

The mixing head assembly is driven at speeds ranging from 50 to 60 r.p.m. producing velocities of around 1000 to 1200 f.p.m. for the outer plow 122 in a mixing chamber having a diameter of approximately six feet. In viewing the apparatus in operation it appears as if a fractional quantity of the material in the chamber is literally being exploded upwardly through the annular baffle assembly 110 in the vicinity of the outer plow 122. And as the plow moves around the baffle assembly it appears that an explosive wave of material is moving around the chamber when viewed from above. The material exploded upwardly through the slots 120 by the plow 122 comprises a fractional portion of the total quantity of material in the mixing chamber being treated, and the material begins to fall back downwardly toward the annular baffle assembly 110 after the plow 122 has passed underneath. The material falling downwardly strikes the apexes 112c of the baffle members 112 and is divided into oppositely flowing streams by the surfaces

112a and 112b, and these streams collect in the troughs between adjacent baffle members and the particles flow downwardly through the narrow slots behind the moving plow 122, as shown in FIG. 10.

The lifting and aeration of the material traveling upwardly through the narrow slots and the dividing, reuniting, and dividing action of the baffle members 112 on the upwardly and downwardly traveling material, provides for excellent mixing action to insure uniform consistency of the material when the apparatus is used in dry blending operation. The continual mixing action of the material below the baffle assembly 110 by the plows 128, 130 and 132 insures that the fractional portion of the material lifted by the upper plow 122 is thoroughly and intimately blended with the mass of material in the bed or lower section of the mixing chamber. The sloping wall section 54 also aids greatly in the mixing process in returning the material falling through the slots of the baffle ring back toward the control portion of the mixing chamber.

The outlet end of the nozzle structure 40 is positioned to direct a high velocity flow of heated gases directly into the material that has been elevated and lifted by the plow 122 and is passing back through the slots 120 and downwardly into the material beneath the baffle assembly 110 in the bed of the mixing chamber. Because the baffle members 112 are constructed of material having good heat conductivity characteristics and because the nozzle structure outlet is positioned to direct a portion of its discharge directly against the lower portions of the baffle member surfaces 112b, as best shown in FIG. 7, the baffle members 112 become heated as the nozzle structure rotates around the chamber. Accordingly, as the particles or granules of material pass upwardly and downwardly through the heated baffle assembly 110 in contact with the baffle surfaces 112a and 112b, direct heat transfer by conduction takes place and the particles of material are elevated in temperature. Greater heat transfer is effected because the particles are separated into thin streams passing over the baffle surfaces and are retarded somewhat on their downward travel through the slots 120 by the collecting action on the upper troughs formed by baffle surfaces 112a and 112b of adjacent baffle members.

The heated gases from the nozzle structure outlet also flow upwardly through the narrow slots 120 in the annular baffle structure 110 and subject the separated individual particles and granules passing therethrough to intense heat. Because of the separating or aerating action during lifting and falling of the particles of material through the baffle structure and the direct and enveloping contact between the particles so moving and the high velocity hot gases from the nozzle structure 40, a rapid heat exchange process is effected between the materials and the gases, causing the temperature of the material to be rapidly elevated. Even materials such as foundry sand having relatively low heat conductivity can be rapidly heated in this manner.

The heated material falling downwardly from the baffle structure 110 returns to the material remaining in the bed of the mixing chamber and is thoroughly and intimately intermixed therewith by the plows 128, 130 and 132, and during this process heat is transferred from the hotter particles to the colder ones by direct conduction. Because the material in the bed of the mixing chamber is in a gravity compacted condition, good contact is obtained between the individual hotter and colder particles, and the thorough and intimate continuous mixing achieves a uniform temperature throughout the entire mass.

It is believed that the highly efficient heat transfer is effected in two stages comprising the primary direct application of the hot gases to lifted and separated ever changing fractional portions of the material lifted by the plow and passing through the heated baffle structure in various diverse thin streams. A secondary heat transfer

is effected as the heated streams of particles return to the gravity compacted mass in the mixing chamber below the baffle structure and are thoroughly and intimately mixed with the colder particles.

In an apparatus constructed in accordance with the present invention for handling 500-pound batches of foundry sand and using a burner capable of supplying 1,000,000 B.t.u.'s per hour, it was found that the sand batch could be heated from an ambient temperature of 80-90° F. to approximately 300-350° F. within a time period of less than three minutes. Also, it was found that extremely high heat transfer efficiencies (in the range of 70 to 80%) were attained with the apparatus.

The apparatus 20 of the present invention is extremely useful in blending dry materials together into a mixture having a uniform consistency throughout and, more importantly, is useful for rapid and efficient heating of material having low heat absorption characteristics. Specifically, the invention is useful in foundry operations for rapidly heating batches of used foundry sand in order to carbonize the coating materials thereon. The apparatus is extremely reliable in operation and very little mechanical wear occurs, greatly reducing the maintenance required. In previous types of batch heaters for sand and other abrasive material, mechanical wear comprises a major problem, necessitating frequent maintenance and repair. In the present invention wear occurs mainly on the outer plow 122, which is easily replaceable, and because there is no direct engagement between moving parts, such as chains and sprockets, etc., commonly used in other types of heaters for moving the material, the present invention offers many operating advantages in addition to the extremely high heat transfer efficiencies obtainable.

While there has been illustrated and described a single embodiment of the present invention, it will be appreciated that numerous changes and modifications will occur to those skilled in the art, and it is intended in the appended claims to cover all those changes and modifications which fall within the true spirit and scope of the present invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. Apparatus for conditioning particulate material comprising a mixing chamber having a bottom and a sidewall, annular baffle means in said chamber spaced upwardly from said bottom and extending inwardly of said sidewall toward an upstanding central axis in said chamber, said baffle means including a plurality of spaced apart baffle members having surfaces inclined relative to said bottom, and a mixing head in said chamber mounted for rotation about said central axis and including plow means radially outward of said axis and movable around said chamber below said baffle means for lifting a portion of said material in said chamber upwardly through said baffle means upon rotation of said mixing head in one direction.

2. The apparatus of claim 1 wherein said inclined surfaces include first surfaces sloped upwardly away from said bottom in a direction generally the same as the direction of movement of said plow means around said chamber.

3. The apparatus of claim 2 wherein said inclined surfaces include second surfaces sloped in a direction opposite to that of said first surfaces.

4. The apparatus of claim 3 wherein said baffle members are integrally formed of angular cross section including longitudinal upper apexes formed along the junction of said first and said second inclined surfaces and extending inwardly of said sidewall.

5. The apparatus of claim 4 wherein said second surfaces of said baffle members are smaller in dimension between a said apex and a lower edge thereof than said first surfaces, and said lower edges are fixed in narrow spaced relation away from the first surfaces on adjacent

baffle members along a position intermediate said apex and the lower edges of said first surfaces.

6. The apparatus of claim 5 wherein said first surfaces include integrally formed spaced apart projections thereon engaging the lower edges of said second surface on adjacent baffle means.

7. The apparatus of claim 4 wherein the upper apexes of said baffle members are angularly disposed in relation to radial planes extending outwardly from said central axis.

8. The apparatus of claim 7 wherein the inner ends of said baffle members are forward of the outer ends thereof in respect to the general direction of movement of said plow means.

9. The apparatus of claim 8 wherein said plow means includes an advancing face angularly disposed in relation to the apexes of said baffle members with the outer edge of said plow means forward of the inner portions of said baffle members in respect to the general direction of movement thereof.

10. The apparatus of claim 1 wherein said baffle means includes inner and outer concentric support rings for supporting the inner and outer ends of said baffle members.

11. The apparatus of claim 1 wherein said mixing chamber sidewall includes a lower frustoconical section sloping upwardly and outwardly of said bottom and an upper section angularly joined with the upper end of said lower frustoconical section.

12. The apparatus of claim 11 wherein said baffle means is positioned adjacent the junction of said upper and lower sections of said sidewall and extends inwardly thereof toward the central portion of said mixing chamber.

13. The apparatus of claim 12 wherein said plow means includes an upper edge moving in close proximity to the underside of said baffle means and a sloping outer edge moving in close proximity to said lower frustoconical wall section.

14. The apparatus of claim 11 including lower plow means positioned to move material adjacent the bottom of said mixing chamber outwardly toward said lower section of said sidewall.

15. Apparatus for treating particulate material comprising a mixing chamber having a bottom and a sidewall, annular baffle means in said chamber spaced upwardly from said bottom and extending inwardly of said sidewall toward an upstanding central axis of said chamber, said baffle means including a plurality of spaced apart baffle members having surfaces inclined relative to said bottom, a mixing head in said chamber mounted for rotation about said central axis and including plow means radially outward of said axis and movable around said chamber below said baffle means for lifting a portion of the material in said chamber upwardly through said baffle means upon rotation of said mixing head in one direction, and burner means for supplying heat to the material in said chamber including nozzle means extending outwardly toward said sidewall adjacent the level of said baffle means and rotatable with said mixing head round said chamber for directing heated gases into the material moving through said baffle means.

16. The apparatus of claim 15 wherein said nozzle means includes an outlet for discharging heated gases positioned behind said plow means in respect to the direction of movement thereof around said chambers.

17. The apparatus of claim 16 wherein the inclined surfaces of said baffle members include second surfaces sloped in a direction opposite to that of said first surfaces.

18. The apparatus of claim 17 wherein said baffle members are integrally formed of angular cross section including longitudinal upper apexes formed along the junction of said first and second inclined surfaces and extending inwardly of said sidewall.

19. The apparatus of claim 18 wherein said second sur-

faces are smaller in dimension between said apex and a lower edge thereof than said first surfaces, and said lower edges are fixed in narrow spaced relation away from the first surfaces on adjacent baffle members along a position intermediate said apex and the lower edges of said first surfaces.

20. The apparatus of claim 16 wherein said nozzle outlet is positioned to move under and in close proximity to inner portions of said baffle members.

21. The apparatus of claim 16 wherein said mixing chamber includes a top wall and said burner means includes a fixed portion centrally positioned on said top wall to discharge hot gases downwardly into said nozzle for direction outwardly thereby toward said sidewall.

22. The apparatus of claim 21 wherein said nozzle means is fixedly mounted on said mixing head and includes an upstanding leg axially aligned with the discharge of said fixed portion of said burner means.

23. The apparatus of claim 22 including means for introducing ambient air into said nozzle means between said upstanding leg and said fixed portion of said nozzle means.

24. The apparatus of claim 15 wherein the inclined surfaces of said baffle members include first surfaces sloped upwardly away from said bottom in a direction generally the same as the direction of movement of said plow means around said chamber.

25. The apparatus of claim 15 wherein said mixing chamber sidewall includes a lower frustoconical section sloping upwardly and outwardly of said bottom and an upper section angularly joined with the upper end of said lower section.

26. The apparatus of claim 25 wherein said annular baffle means is positioned adjacent the junction of said lower and upper sidewall sections and extends inwardly thereof toward the central portion of said chamber.

27. The apparatus of claim 25 wherein said flow means includes an upper edge moving in close proximity to the underside of said baffle means and a slopping outer edge moving in close proximity to said lower frustoconical sidewall section.

28. A method of treating particulate material comprising mixing a mass of said material by circular movement around a confined area, lifting a fractional portion of said mass upwardly above the remaining portion, dropping said lifted fractional portion of material to return back to said remaining portions, dividing said drop-

ping fractional portion of material into plural streams, and retarding the downward velocity of said diverse streams above said remaining portion of said material mass.

29. The method of treating particulate material of claim 28 wherein said plural streams of material are directed in diverse directions.

30. The method of treating particulate material of claim 28 wherein said lifting separates individual particles of said material from one another.

31. The method of treating particulate material of claim 28 including the step of directly applying heated gases to said fractional portion of material lifted above said remaining portion of said mass.

32. The method of treating particulate material of claim 31 wherein said heated gases are directed into said material falling in plural streams back to said mass.

33. A method of heating a quantity of particulate material comprising the steps of confining a first portion of said material in a gravity compacted condition in a heat insulated area, separating the particles of a fractional portion of said material from one another and from the gravity compacted portion, subjecting said separated fractional portion of material to directly applied heated gases raising the temperature of said particles, and returning said heated particles to a gravity compacted condition with direct contact between said particles and with said first portion of material.

34. The method of heating particulate material of claim 33 including the step of dividing and reuniting said separated particles during the application of heated gases thereto.

35. The method of heating particulate material of claim 34 wherein said separated particles are subjected to direct heated gases during their return to said gravity compacted condition.

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