METHOD AND MEANS FOR CONTROLLING FLOW IN A VERTICAL SHAFT KILN

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ABSTRACT OF THE DISCLOSURE

Vertical shaft kiln for burning fluent material passing downwardly by gravity having upright shell with upper combustion zone adjoining cooling zone and valved lower outlet, circumferential baffle with bottom opening providing restricted flow path to outlet, an elongated breaker and air distributor oscillating about vertical axis through said opening and impacting agglomerate descending through combustion zone to outlet. Air input for combustion through direct drive means to openings in baffle and distributor cools and prevents dust and grain penetration into drive means oscillating distributor. Retarder means for material passing restricted opening and seal means for preventing short circuiting of air input through bottom outlet.

This invention relates to improvements in vertical shaft kilns and more particularly to an improved method and apparatus for more efficiently controlling material flow and combustion in a vertical shaft kiln or similar material treatment equipment.

Vertical shaft kilns have hereuntofore been provided for burning various types of fluent material capable of disassociation under high temperatures such as lime, shale and the like. These treatments may include total production of cement clinker, limestone calcining beneficitation and sintering of iron, oil shale retorting, as well as other drying, sintering and briquetting operations. Such kilns are generally hollow and the material is directed therethrough by gravity flow, first passing through a combustion zone in which the material is preheated, then burned, and then passing through a cooling zone in which the material is cooled and from which it is discharged.

In the practice of the present invention, the material is confined in the treatment or combustion zone and a sufficient time for proper burning or other chemical or physical change and then is discharged in such a manner as to provide controlled air flow and distribution in conjunction with uniform bed movement. Agglomerate portions of the material may tend to form in or below the combustion zone causing erratic flow and uneven distribution of material in the bed. Also, to prevent erratic discharge it is necessary to reduce the agglomerated portions to smaller sizes in order to maintain a desired rate of discharge and permit passage of all material through a restricted outlet opening. Even when no agglomerate material is present, it is desirable to effect a controlled progressive movement of material through the treatment zone, particularly when gravitational movement is provided.

Various types of heating may be employed in a vertical kiln depending on the material being treated. In some instances, the material under treatment is combustible and does not require fuel addition. In other instances, additional material is added to support combustion or external furnaces may be utilized to generate hot gases which are then passed into the kiln.

For best results in such vertical kilns it is necessary to provide a controlled gravitational descent in which all sizes of the material and particularly agglomerate portions have substantially the same treatment time in the kiln. Directed movement of the material and breaking action applied to the agglomerated content is required to maintain an even movement of the bed. Where air or other oxygen-containing gas is supplied to support combustion in the kiln, it must be fed uniformly and delivered in relatively uniform increments throughout the combustion zone to produce optimum combustion effect.

Accordingly, it is an object of this invention to provide a simple, economical and efficient method and apparatus for the control of gravitational flow maintaining an improved action in a vertical kiln characterized by even movement of the bed of material under treatment with a controlled or uniform rate of discharge.

Another object of this invention is to provide a simple, durable and efficient means for introduction and passage of air or other gas into and through the combustion zone of a vertical kiln.

A further object of this invention is to provide a simple, durable and efficient structural assembly for exerting a breaking action against agglomerate formations in various types of materials treated in a vertical kiln.

Still another object of my invention is to provide a simple, reliable and efficient vertical kiln which is capable of treating a variety of materials throughout a range of sizes and which employs an agglomerate reducing mechanism as an air input distributor to provide controlled distribution of air in the bed and uniform bed movement throughout the kiln and also utilizes such air distributions to prevent excess heating of the mechanism.

Other objects, advantages and capabilities of the invention will become apparent from the following description taken in conjunction with the accompanying drawings showing a preferred embodiment of the invention.

In the drawings:

FIG. 1 is a vertical section through a vertical shaft kiln embodying novel features of this invention;

FIG. 2 is a partial top plan view of the combined breaker and air distributor member and pusher plate assembly of the kiln shown in FIG. 1 and drawn to an enlarged scale;

FIG. 3 is a side elevational view partially in section and essentially a developed section view taken along lines 3—3 of FIG. 2 showing flow paths of air or gas movement through the breaker and air distributor member;

FIG. 4 is a top plan view of the baffle member shown in FIG. 1 drawn to an enlarged scale;

FIG. 5 is a vertical section through the baffle member shown in FIG. 4; and

FIG. 6 is a sectional view taken along line 6—6 of FIG. 1 showing the relationship of the retarder plate, pusher plate and side walls of the shell and drawn to an enlarged scale.

Referring now to FIG. 1, the vertical shaft kiln illustrated therein in general comprises a hollow shell 1 supported in an upright position by suitable support structure 2. The upper portion of the shell is generally cylindrical and defines an upper combustion zone 3 and the lower portion of the shell is generally cylindrical at the top and inclines inwardly toward the bottom and defines a lower cooling zone 4 above a final discharge outlet 8.

The top of the shell is closed with a cover member 5 which supports a feed assembly 6 for introducing a charge of material through fed inlets 7 into the combustion zone in a uniform distribution. The bottom of the shell terminates in a discharge outlet 8 which has a valve 9 coupled thereto for preventing short circuiting of air delivered to the kiln.

A baffle member 12 inclusive of a restricted bottom opening 13 extends inwardly and downwardly from the
inner walls of the shell intermediate its top and bottom. A pusher plate 15 and breaker and air distributor member 16 are mounted as an integral functional assembly for conjoint oscillatory movement about a generally vertical axis extending through the cylindrical portion of the shell with the breaker and air distributor member having its lower end disposed within the bottom opening 13 and its upper end extending upwardly a substantial distance toward the combustion zone 3. A retar- der plate 14 is held in a stationary position beneath pusher plate 15 and below bottom opening 13 and functions as a deck to retard descent of material which is directed laterally across its surface by pusher plate 15. Baffle member 12 with the breaker and air distributor member 16 define a restricted annular passage or flow path 11 at the bottom of cooling zone.

Below the kiln there is supported a drive assembly inclusive of a vertically mounted drive motor 17 and a shaft 18 connected between the motor and the assembly of the pusher plate 15 and breaker and air distributor member 16. In the preferred practice, shaft 18 will be driven by a hydraulic motor which has the capacity to drive the shaft under full load conditions at low operating costs. In addition, the drive assembly provides a low-cost installation eliminating costly gears and gear reduc- ters and which would operate efficiently under capacity load only at substantially higher initial and operating costs.

A conduit 19 connected with a suitable source of supply (not shown) discharges into branches 19a and 19b which extend through the shell to introduce air or gases into the combustion zone through the breaker and air dis- tributor member 16 or the baffle member 12 or into both as shown. While the air so delivered into the interior of the kiln is provided primarily to support com- bustion therein, it also functions as a heat exchange medium to prevent excessive heating of the breaker and distributor or baffle member 12.

More specifically, the shell 1 includes a suitable refrac- tory liner 23 which extends from the top of its side wall to the top of the baffle member 12 for heat insulat- ing the shell from the intense heat generated in the combustion zone varied gas- type configuration 3. Cover member 5 includes apertures 24 and an exhaust duct 24a for exhausting combustion gases, usually by induced flow, and a feed duct 25 extending throughout its circumference for introducing the charge of material from the feed assembly 6 through the feed chute 7 at a uniform rate provides a substan- tially uniform distribution throughout the cross section of the combustion zone 3.

A hollow support member 27 extends upwardly through a lower side wall 1a of the shell and surrounds the shaft 18 in spaced relation. Support member 27 has a closed lower end and is in sealed connection at its upper end with the bottom of the retar- der plate 14 providing a passageway from branch 19a into the hollow interior of the breaker and air distributor member 16. By suitable valving of conduit 19 (not shown) air or gas may be introduced into the kiln through either branch 19a or 19b or both.

Valve 9 coupled to the discharge outlet 8 may be any one of various known valves which operate to seal the outlet 8 from the cooling zone to prevent short circuiting of the introduced air to support combustion in the combus- tion zone of the kiln.

Motor 17 is constructed so as to oscillate about a vertical axis and preferably through an arc of about 90 degrees, but which may be as much as 180 or 270 so as to drive the breaker surfaces against the material in the kiln and direct broken material downwardly through the annular flow path 11. The extent of oscillatory move- ment varies throughout a range of 300 degrees or more but I have found that best results are obtained with the rotation of about 90 degrees and gas distribution is efficient in such rotation when air or other gas is discharged through the breaker and air distributor member.

Referring now to FIGS. 2 and 3 the breaker and air distributor member 16 has an upper portion in the form of a hollow cage-like configuration 31 and a lower portion in the form of a hollow closed cylinder 32 with upright walls. The upper portion comprises a plurality of hollow flat ring portions in- clusive of a top ring portion 34a, plural intermediate ring portions 34b and a bottom ring portion 34c of increasing diameter from top to bottom. These ring portions are held in vertically spaced relationship by the rear portion of a plurality of radially spaced vertical supports 35 disposed between each of the spaced ring portions and at intervals at about 30 degrees which form circumferentially extending apertures 40 in the configuration 31.

Each of the top and intermediate ring portions 34a and 34b are provided with a depending flange member 35a which is attached to its forward undersurface and which extends throughout the circumferential extent of the cage-like configuration 31. Flange members 35a are positioned inwardly and in abutting relationship with the rear end portion of respective vertical supports 36 and extend therefrom with a lesser extent than the respective vertical supports 36.

Each of the intermediate and bottom ring portions 34b and 34c is provided with an upstanding flange member 35b which is attached to its rearward upper surface and which extends throughout the circumferential extent of cage-like configuration 31. Flange members 35b are positioned inwardly and in spaced relation to respective flange member 35a and extend vertically a lesser extent than respective vertical supports 36 so that adjoining flange members 35a and 35b provide a sinuous path (indicated by flow arrows) for gas flowing upwardly through the air distributor and out apertures 40. This arrangement of flanges 35a and 35b shields the hollow interior of the breaker and air dis- tributor assembly from clogging by downflowing mate- rial being treated.

A pair of oppositely disposed breaker members 37 and oppositely disposed breaker members 38 having pointed and sharpened upper edges extend upwardly from the top of said configuration 31. Vertical spaced supports 36 are provided with breaker member surfaces 39 extending outwardly a substantial distance from respective ring por- tions and have pointed and sharpened outer edges. Each of the vertical spaced supports 36 may be provided with breaker surfaces 39 or alternate ones may be so provided to allow the descending material to more readily collect between the configuration 31 and baffle member 12 during the oscillatory movement. A plurality of pointed and sharpened breaker members 41 extends outwardly at spaced vertical intervals on the outer periphery of the walls of cylinder 32.

The interior framework of cylinder 32 includes an intermediate support 52 extending horizontally between its interior walls and immediately of its top and bottom. Support 52 is provided with a series of circumferentially spaced apertures 52a for passage of air or gases upwardly through the interior of the cylinder as shown by arrows. A lower support 53 extends horizontally between the interior walls of cylinder 32 adjoining its bottom. Support 53 is provided with a series of circumferentially spaced apertures 53a which line with apertures 52a. Retarder plate 14 extends across the bottom of cylin- der 32 as a closure therefor and is disposed below sup- port 53. Plate 14 includes a plurality of circumferentially spaced apertures 14a which line with apertures 52a and 53a. Shaft 18 extends upwardly through the center of retarder plate 14 and lower support 53 and terminates in abutting relationship to the support 52. A vertical sleeve 54 is disposed between plate 14 and supports 52 and 53 and fits on the upper end of shaft 18, preferably
in keyed connection therewith. This arrangement permits the entire air distributor and breaker assembly 16 to seat on the upper end of shaft 15 in driven connection therewith. Retarder plate 14 is provided with an annular flange 55 outwardly of aperture 14a over which the lower end of a cylindrical portion 52 fits to provide a partial seal against air leakage and prevent penetration of solid material into the interior of portion 32.

Baffle member 12 is further illustrated in FIGS. 4 and 5 which show the upper surface thereof to be generally that of an inverted cone open at top and bottom and includes spaced apertures 42 which are covered by ridge-like retarder plate 14 during oscillatory movement of plate 15. A substantial gap 48 is provided between the periphery of retarder plate 14 and the shell 1a for discharge of the material after its flow is interrupted by retarder plate 14.

The method of controlling the material flow through the kiln will now be described with reference to FIGS. 1-6, inclusive, as heretofore described. Material to be treated in a suitable size range is introduced at a substantially uniform rate by feed assembly 6 into feed trough 25 which is maintained substantially full and then descends through feed inlets 7 to distribute the material substantially uniformly throughout the cross-sectional area at the top of the combustion zone 3. Air or gas is introduced in controlled quantities into the cooling zone 4 either through branch conduit 19a and apertures 49 of cage-like configuration 31 or through branch conduit 19b and the openings 42 in baffle 12, or both. This air or gas is directed in an induced flow countercurrent to the descending material generally uniformly through the bed and centrally disposed apertures 23 and conduit 24a remove the combustion gases rising from the combustion zone. As the material descends downwardly through the kiln, burned and agglomerate portions may form in the combustion zone and may cause bridging, blockage or other erratic flow conditions. The agglomerate portions are impacted and kept in movement by the breaker members 37, 38, 39 and 41 during their oscillatory movement to break lumps and assist downward movement so to maintain a substantially uniform rate of gravitational flow throughout the cross-sectional area of the kiln. As the material descends through the kiln the upright cylinder wall portion 32 and baffle member 12 crowd the material toward and into restricted passage 11. The material is then passed through openings 13 and onto pusher plate 15 and retarder plate 14 which interrupt its gravitational movement and impart a lateral movement thereto, thereby regulating the rate of gravitational flow through the combustion zone and out of the cooling zone. The material forced across the periphery of retarder plate 14 resumes gravitational movement in free fall until it passes through and out the discharge outlet 8 under guidance of valve 9, and the latter seals the outlet from short circuiting air through the bottom of the kiln.

In the art of vertical shaft kilns where the inner wall of the kiln is usually a linear surface and the material treated is of varying size and irregular shape, there will be spaces and voids formed along the inner walls in the spaces between discrete particles of the material under treatment. These spaces or voids tend to channel air or gases upwardly along the walls resulting in unbalanced air distribution throughout the bed. This effect is sometimes known as the "wall effect." In the arrangement of the present invention the gas or air is introduced centrally into the treatment chamber at the lower end but above the point of final discharge therefrom and discharge outlets are centrally disposed at the top of the chamber which causes a substantial part of the air input to ascend centrally of the kiln thereby distributing the air or gas in a more uniform pattern throughout the bed.

In most vertical shaft kilns attrition of the material occurs due to the weight and movement of the material which produces particles in a dust state. When the point of introduction of air or gas is below the material discharge from the kiln these dust particles are held in a suspended state or may be entrained in the rising gas stream until gas can no longer penetrate and the rising gas exerts an elevating force impeding gravitational descent, thus creating an effect known as an "air lock." This "air lock" effect substantially impairs the uniformity of solid movements through the bed. In the practice of the present invention the air input is substantially above the outlet from the cooling zone so that there is little, if any, tendency to "air lock" even under extreme conditions of dust formation.  

The same general structural arrangement may be utilized for a variety of treatments, such as total production of cement clinker, limestone calcining, beneficiation and sintering of iron, oil shale retorting and other drying, storage, sintering and briquetting operations. In some of the foregoing treatments, no agglomerate formation will be present in the material, in which case breaker surfaces such as 39 and 41 may be omitted, and the member 16 will function as a bed impelling member and also may be a gas distributor, if gas input is required. The action of distributor member 16 directing transverse movement to the uniform distribution in conjunction with the retarded or bottom of the treatment zone insures a relative uniform and progressive flow of material through the treatment zone to the point of free fall from the periphery of retarder plate 14.

Relative to the arrangement of openings 42 as shown in FIGS. 4 and 5, this is a preferred arrangement for effective gas distribution through baffle 12 when combustion is provided in the kiln. However, other arrangements may be utilized, increasing or decreasing the number of such openings and also the distribution pattern of same and the arrangement shown and described is intended only as one satisfactory arrangement for effecting air distribution. The provision of the ridged members shielding the openings 42 is particularly effective where agglomerate material tends to form in the charge passing to discharge. Where no agglomerate is formed, the cover portion of the openings might be differently shaped.

Other changes and modifications may be availed of within the spirit and scope of the invention as set forth in the hereunto appended claims.

I claim:
1. A vertical shaft kiln adapted for burning a charge of material passing by continuous gravity flow therethrough, comprising a hollow shell supported in an upright position inclusive of an upper combustion zone and
an adjoining lower cooling zone terminating at the bottom in a discharge outlet member, a circumferential baffle member of generally conical shape supported from an inner wall of the shell and having a bottom opening providing a restricted flow path for material moving from the cooling zone to the discharge outlet, an elongated breaker and air distributor member supported for oscillatory movement about a generally vertical axis within said bottom opening and in spaced adjacency thereto and defining with said baffle member a restricted annular flow path for discharging material under treatment in a vertical shaft kiln, which comprises introducing material to be treated into the top of the kiln for gravitational flow through an upper combustion zone and a lower adjoining cooling zone to a final point of discharge in the kiln, introducing air in countercurrent flow at a plurality of spaced points into the flow of descending material adjacent the bottom of the cooling zone, said points of introduction being shielded against intake of kiln material countercurrent to said air flow, impacting agglomerate portions of the descending material centrally of the cooling zone for mainlining a substantially uniform gravitational flow throughout the cross-sectional area of the kiln, crowding treated material passing from the cooling zone through a restricted opening and into a central passage to the final point of discharge, interrupting gravitational movement of material through the central passage by imparting lateral movement to the crowded material passing through the restricted passage from the cooling zone, thereby regulating the rate of gravitational flow through the combustion and cooling zones, directing the interrupted flow of material in lateral movement and into a resumption of gravitational movement through and out of the kiln, air being supplied sealing circulating air from short circuiting through the bottom of the kiln with the resumed gravitational flow.

A method as defined in claim 5 in which the circumferentially spaced points of countercurrent air introduction are at different elevations above the bottom of the cooling zone to substantially uniformly throughout the cross-sectional area of the combustion zone.

Apparatus as defined in claim 7, in which said breaker and air distributor member in said oscillatory movement.

A vertical shaft kiln as set forth in claim 1 wherein said breaker and air distributor is oscillated about said vertical axis through an angle of about 90°.

A vertical shaft kiln as set forth in claim 1 wherein said internal passages are provided by conduits extending upwardly adjacent said vertical axis of rotation into said breaker and air distributor member at one end and outwardly through a wall of said shell at the opposite end.

A vertical shaft kiln adapted for burning a charge of material passing by continuous gravity flow there-through, comprising a hollow shell supported in an upright position inclusive of an upper combustion zone and an adjoining lower cooling zone terminating at the bottom in a discharge outlet member, a generally conical baffle member supported from an inner wall of the shell and having a bottom opening providing a restricted flow path for material moving from the cooling zone to the discharge outlet, said baffle member having ridged breaker surfaces on its inner face having overlapping portions shielding air discharge openings and having associated conduit means for air distribution through said openings for supporting combustion in the upper portion of the kiln, and elongated breaker member supported for oscillatory movement about a generally vertical axis within said bottom opening and in spaced adjacency thereto and defining with said baffle member a restricted annular flow path for discharging material under treatment in the kiln, said breaker member having outwardly projecting breaker surfaces for impacting descending agglomerate portions of material under treatment in the kiln, a retarder plate disposed below said bottom opening to intercept the discharging material passing through the bottom opening, means associated with said retarder plate for imparting outward movement to material deposited thereon so as to discharge said material across the periphery of the retarder plate for delivery to the outlet member, means including a valve as the outlet member providing a seal to prevent short circuiting of air from the kiln, and direct drive means for moving said breaker and air distributor member in said oscillatory movement.

A method of controlling the continuous flow of material under treatment in a vertical shaft kiln, which comprises introducing material to be treated into the top of the kiln for gravitational flow through an upper combustion zone and a lower adjoining cooling zone to a final point of discharge in the kiln, introducing air in countercurrent flow at a plurality of spaced points into the flow of descending material adjacent the bottom of the cooling zone, said points of introduction being shielded against intake of kiln material countercurrent to said air flow, impacting agglomerate portions of the descending material centrally of the cooling zone for mainlining a substantially uniform gravitational flow throughout the cross-sectional area of the kiln, crowding treated material passing from the cooling zone through a restricted opening and into a central passage to the final point of discharge, interrupting gravitational movement of material through the central passage by imparting lateral movement to the crowded material passing through the restricted passage from the cooling zone, thereby regulating the rate of gravitational flow through the combustion and cooling zones, directing the interrupted flow of material in lateral movement and into a resumption of gravitational movement through and out of the kiln, air being supplied sealing circulating air from short circuiting through the bottom of the kiln with the resumed gravitational flow.

Apparatus as defined in claim 7, in which the gas discharge openings of the breaker and air distributor member are circuitous outlet passages preventing penetration of material under treatment in the apparatus.

Apparatus as defined in claim 7, in which the baffles member includes ridged surfaces open at their lower ends disposed over its gas distributing openings.
breaker and air distributor member is oscillated about said vertical axis through an angle of about 90°.

11. Apparatus as defined in claim 7, in which said associated means extends upwardly adjacent said vertical axis of rotation into said breaker and air distributor member at one end and outwardly through a wall of said shell at the opposite end in covering relation to said drive means.

12. Apparatus as defined in claim 7, in which the retarder plate is stationary and the breaker and air distributor member is mounted for oscillation relative to the retarder plate.

13. Apparatus as defined in claim 7, in which said baffle member includes a plurality of rows of circumferentially spaced ridges with the ridges of one row in radial offset relation to the ridges of an adjoining row.

14. Apparatus as defined in claim 7, in which the gas delivery means includes a conduit enclosing the shaft and associated couplings so as to maintain the shaft in dust-free condition.

15. A vertical shaft kiln as set forth in claim 7 wherein said cage-like configuration includes surfaces to prevent clogging of the openings by downflowing material.

16. A vertical shaft kiln as set forth in claim 7 wherein said cage-like configuration includes a plurality of hollow ring portions of increasing diameter from top to bottom held in spaced relation by radially spaced supports to form said openings, said ring portions including surfaces to prevent clogging of the openings by downflowing material.

17. Apparatus for treating a granular material in continuous gravitational flow with a gas directed in countercurrent flow, comprising a hollow shell supported in an upright position and defining an enclosed treatment zone, said housing having a top inlet for granular material, a top outlet for exhaust gas separate from said inlet and having a valve-controlled bottom outlet for treated granular material, a circumferential baffle member of generally conical shape supported from an inner wall of the shell and having a bottom opening providing a restricted flow path for material moving from the treatment zone to the bottom outlet, said baffle member having a plurality of gas distributing openings in circumferentially spaced arrangement and associated conduit means for discharging gas through the openings, an elongated hollow member supported for oscillatory movement about a generally vertical axis within said bottom opening and in spaced adjacency thereto and defining with said baffle member a restricted annular flow path for discharging material at the bottom of the treatment zone, said elongated member having external material impelling surfaces at spaced points throughout its lengthwise extent for impounding material descending through the restricted opening, a retarder plate disposed below said restricted opening to intercept the material discharging therethrough, means associated with said retarder plate for imparting outward movement to material deposited on the retarder plate so as to discharge said material across its periphery for free fall to the bottom outlet, drive means for moving said elongated member and the associated means in said oscillatory movement, a valve associated with the bottom outlet for discharging granular matter from the shell and confining gas within the shell, and means for delivering gas into the conduit means and the elongated hollow member so as to direct a countercurrent flow of gas into the gravitating material approaching the restricted annular flow path.

18. Apparatus for treating a granular material in continuous gravitational flow with a gas directed in countercurrent flow, comprising a hollow shell supported in an upright position and defining an enclosed treatment zone, said housing having a top inlet for granular material, a top outlet for exhaust gas separate from said inlet and having a valve-controlled bottom outlet for treated granular material, a circumferential baffle member supported from an inner wall of the shell and having material-crowding surfaces and a bottom opening providing a restricted flow path for material moving from the treatment zone to the bottom outlet, said baffle member having a plurality of gas distributing openings in circumferentially spaced arrangement and associated conduit means for discharging gas through the openings, an elongated member supported for oscillatory movement about a generally vertical axis within said bottom opening and in spaced adjacency thereto and defining with said baffle member a restricted annular flow path for discharging material at the bottom of the treatment zone, said elongated member having external material impelling surfaces at spaced points throughout its lengthwise extent for impounding material descending through the restricted opening, a retarder plate disposed below said restricted opening to intercept the material discharging therethrough, means associated with said retarder plate for imparting outward movement to material deposited on the retarder plate so as to discharge said material across its periphery for free fall to the bottom outlet, drive means for moving said elongated member and the associated means in said oscillatory movement, a valve associated with the bottom outlet for discharging granular matter from the shell and confining gas within the shell, and means for delivering gas into the conduit means and the elongated hollow member so as to direct a countercurrent flow of gas into the gravitating material approaching the restricted annular flow path.

References Cited

UNITED STATES PATENTS

3,101,935 8/1963 Zeltner ............... 263—29

FOREIGN PATENTS

543,085 2/1932 Germany.

JOHN J. CAMBY, Acting Primary Examiner.