MATERIAL DISINTEGRATING-AND-BLOWING APPARATUS

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ABSTRACT
Apparatus for disintegrating-and-blowing material such as pulp, comprising a housing containing a plurality of rotatable vanes and having a discharge volute axially spaced from the vanes whereby the latter are external to the volute. The vanes are rotatably driven relative to the material disintegrating means; and the latter is located spaced outwardly from the vane outer ends and in the path of material discharged from between said outer ends, whereby such discharged material is disintegrated by impact with the disintegrating means and moved inwardly towards the vane outer ends to a location wherein the lighter disintegrated material can readily be gas blown through the discharge volute. Dam means, disclosed as being an inclined ramp and a dam wall, are interposed intermediate the disintegrating means and the discharge volute for restraining heavier undisintegrated, or only partially disintegrated, material from passing to the volute.

21 Claims, 6 Drawing Figures
MATERIAL DISINTEGRATING-AND-BLOWING APPARATUS

The present invention relates to apparatus for disintegrating-and-blowing material such as pulp and more specifically to apparatus of this type particularly suitable whereby, for example, pulp may be disintegrated external to a gaseous reaction vessel and then gas blown to the vessel.

An object of the present invention is to provide new and improved apparatus particularly adapted for disintegrating-and-blowing material such as pulp.

Another object of the invention is to provide new and improved apparatus of the type set forth particularly adapted whereby material such as pulp may be disintegrated outside of a gaseous reaction vessel and then gas blown to the vessel.

Another object is to provide new and improved apparatus of the type set forth particularly adapted to provide more efficient disintegration of the material than attained with conventional apparatus for its purpose.

Another object is to provide new and improved apparatus of the type set forth particularly adapted to substantially eliminate formation of undesirable pockets of pulp in the apparatus.

Another object is to provide new and improved apparatus of the type set forth particularly adapted whereby the disintegrating means includes a volute axially spaced from the rotatably driven vanes of the apparatus.

Other objects and advantages of the invention will become apparent from the following description taken in connection with the accompanying drawings wherein, as will be understood, the preferred embodiments of the invention have been given by way of illustration only.

In accordance with the invention, material disintegrating-and-blowing apparatus may comprise housing means, rotatably driven vane means in the housing means having inner end means and outer end means, the housing means having material inlet means for supplying material between such inner end means of the vane means whereby, during driven rotation of the vane means, such material passes outwardly between the vane means and is discharged from between such outer end means of the vane means, the housing means having blowing gas inlet means for supplying blowing gas into the housing means separately from the supplied material, material disintegrating means in the housing means spaced outwardly from such outer end means of the vane means and in the path of the material discharged from between such outer end means, the housing means having material outlet means for discharging material from the space between such outer end means and the material disintegrating means, the vane means being rotatable relative to the material disintegrating means, and means for causing blowing gas supplied by the blowing gas inlet means to flow through the space between such outer end means and the material disintegrating means for blowing the disintegrated material through the material outlet means.

Referring to the drawings:

FIG. 1 is an elevational side view, partially broken away and in section, schematically illustrating one embodiment of the apparatus of the invention;

FIG. 2 is an elevational end view, partially broken away and in section, of the embodiment of the apparatus shown in FIG. 1;

FIG. 3 is a substantially enlarged, fragmentary sectional view illustrating the material disintegrating means and associated structure of such apparatus;

FIG. 4 is another substantially enlarged fragmentary view showing such material disintegrating means; and

FIGS. 5 and 6 are fragmentary view illustrating other forms of material disintegrating means suitable for alternative employment in the apparatus shown in FIG. 1.

Referring more particularly to the drawings wherein similar reference characters designate corresponding parts throughout the several views, the illustrated embodiments of the invention are particularly well suited for employment with a gaseous reaction vessel, for example, of the type described in U.S. patent application Ser. No. 288,031, filed Sept. 11, 1972, and assigned to the assignee of the present invention now U.S. Pat. No. 3,814,664, issued June 4, 1974. However, the use of said embodiments is, of course, not limited either to use with such a gaseous reaction vessel and/or use in the gaseous reaction processes practiced thereby; and the disclosed embodiments of the invention are alternatively capable of employment with other apparatus and in other processes.

As shown in FIGS. 1 through 4, the apparatus comprises a housing or casing 10 containing an imperforate, disc-like, rotatable divider or barrier wall 12 which is hereinafter termed a rotor. The rotor 12 divides the housing 10 into a blowing gas chamber 14 on one side of the rotor 12 and a material chamber 16 on the opposite side of the latter; and the rotor 12 is peripherally spaced from the adjacent parts of the apparatus to provide an annular space 18 communicating the chambers 14, 16 around its periphery. The rotor 12 is fixedly mounted on a hub assembly designated generally as 20 which is, in turn, axially connected to a drive shaft 22 to be rotatably driven by the latter, the shaft 22 being rotatably supported by bearings contained within a bearing housing 24 and adapted to be rotatably driven by a conventional drive motor (not shown) connected to its other end 26.

The blowing gas chamber 14 communicates through an axial opening 28 in a casing wall 30 with a blowing gas inlet chamber 32 also contained within the housing 10; and the housing 10 is provided with a blowing gas inlet 34 communicating the inlet chamber 32 with a source (not shown) of the blowing gas for continuously supplying gas from such source to the inlet chamber 32. The source of the blowing gas may be, for example, the gaseous reaction vessel of the aforementioned U.S. patent application Ser. No. 288,031. The rotor 12 rigidly carries fan means in the blowing gas chamber 14, this fan means being illustrated as comprising a plurality of arcuately spaced apart, radially extending, fan vanes or blades 36. The fan blades 36 are affixed at their inner ends to the hub assembly 20 and during their rotation with the rotor 12 cause the gas supplied to the blowing gas chamber 14 to flow through the annular space 18 peripherally of the rotor 12.

The housing 10 is also provided with a material inlet or inlet conduit 38 open to the chamber 16 centrally, and as illustrated co-axially, of the rotor 12, the material inlet 38 serving during operation of the apparatus for continuously supplying the pulp or other material to
the chamber 16. The material inlet 38 is connected through a material supply conduit 40 to a source (not shown) of the pulp or other material; the conduit 40 including a portion narrowing or tapering in cross section towards the material inlet 38. A rotatably driven shaft 42 is coaxially disposed in such tapering portion of the conduit 40 and therein carries a feed-and-compacting screw 44 which is continuously rotatably driven throughout the operation of the apparatus. Hence, throughout such operation, the screw 44 continuously compacts the material in the tapering portion of the conduit 40 to form a plug of compacted material in the conduit 40 upstream of the material inlet 38 and thereby prevent both gas loss from the housing 10 through the conduit 40 and introduction of undesirable gases into the housing 10 through such conduit 40; and the screw 44 simultaneously feeds this plug of material through the material inlet 38 into the material chamber 16.

Immediately adjacent the material inlet 38 and in the material chamber 16 centrally of the rotor 12, the hub assembly fixedly carries a plurality of radially extending, knife-like elements or blades 46 serving to break-up or shred the compacted material supplied through the material inlet 38. The rotor 12 rigidly carries a plurality of generally radially extending vanes 48 in the material chamber 16 at locations spaced around the blades 46. The vanes 48 therebetween define generally radially extending pockets or passages 50, the inner ends 52 of the vanes 48 being arcuate spaced apart generally centrally of the rotor 12 to permit feed of the broken-up or shreded material into the inner ends of such pockets 50. The outer ends 54 of the vanes 48 are arcuate spaced apart around the periphery of the rotor 12 whereby such broken-up material is, during the driven rotation of the vanes 48, outwardly discharged from the pockets 50 adjacent such outer ends 54 at the velocity dictated by the speed of the driven rotation of the latter. The sides of the pockets 50 adjacent to the rotor 12 are throughout their lengths closed by the rotor 12 from direct connection to the blowing gas chamber 14; however, the opposite sides of such pockets 50 are open for purposes to be hereinafter described.

The housing 10 is provided with a material discharge outlet, designated generally as 56, which communicates with the material chamber 16 for discharging disintegrated material from the housing 10. The material discharge outlet 56 comprises a discharge volute 58 located axially spaced from the material chamber 16 and its contained vanes 48, whereby such vanes 48 are completely external to the volute 58; and the annular casing wall 60 surrounding the vanes 48 is throughout its arcuate extent a constant, uniform distance from the vane outer ends 54. The volute 58 is open along its inner periphery 62 to the material chamber 16 and the open sides of the pockets 50 between the vanes 46.

The material disintegrating means of the apparatus is designated generally as 64 and disposed in the material chamber 16 spaced radially outwardly from the vane outer ends 54 in the path of the material outwardly discharged from the pockets 50 between such outer ends 54. The vanes 48 are rotatable relative to the material disintegrating means 64, and the means 64 is particularly adapted to disintegrate the material by impact of the material thereon, while simultaneously causing the material to move inwardly towards the vane outer ends 54. In addition, dam means, designated generally as 66, is interposed intermediate the material disintegrating means 64 and the material discharge means of the apparatus for restraining heavier undisintegrated, or only partially disintegrated material, from passing to the material discharge means.

More particularly, as shown in FIGS. 1 through 4, the material disintegrating means 64 comprises an annular, undulating or waved, disintegrating ring 68, throughout its length including alternate inwardly projecting peaks 70 and outwardly disposed valleys 72, which is rigidly affixed on the annular casing wall 60 to extend around the vanes 48 spaced from their outer ends 54 by an annular space 74. The space 74, as will be understood, communicates at opposite sides with the space 78 around the periphery of the rotor 12 and the discharge volute 58, whereby blowing gas from the space 18 flows transversely through the space 74 to the discharge volute 58 for blowing lighter, disintegrated material to the latter. The waved or undulating configuration of the disintegrating ring 68, as will be seen, causes the material discharged from the pockets 50 to be disintegrated by its impact with the ring 68 while simultaneously causing inward movement of the material from the ring 68 towards the vane outer ends 54 whereby the lighter disintegrated material is moved inwardly to a location whereby it is readily blown over the hereinafter described dam means 66 to the volute 58.

The dam means 646 comprises an annular ramp 76, affixed on the casing wall 60, which is interposed intermediate the disintegrating ring 68 and the volute 58 immediately following the disintegrating ring 68. The ramp 76 is upwardly angled or inclined from the ring 68 towards the volute 58 whereby material adjacent the inner circumference of the ring 68 must climb the ramp 76 to enter the discharge volute 58; and hence the ramp 76 restrains or retards the heavier material from passing to the volute 58 and causes such heavier material to be retained at the ring 68 for disintegration into its component lighter material. The ramp 76, moreover, as will be seen, prevents the formation of the material pockets which would otherwise inherently occur at its location, which material pockets would be highly undesirable particularly as the material contained in the pockets would degrade and subsequently separate from the pockets in clumps.

The dam means 66 further comprises an inwardly projecting, annular dam wall 78 located intermediate the ramp 76 and the volute 58, the dam wall 76 defining the open side 62 of the volute 58 and projecting further inwardly than the innermost end of the ramp 76 to restrain the passage of the heavier material from the upper end of the ramp 76 to the volute 58. As shown in FIGS. 1 through 4 and beforedescribed, the disintegrating ring 68 and ramp 76 may be both components affixed to the casing wall 60. Alternatively, however, as shown in FIG. 5, wherein parts similar to those beforedescribed are designated by the corresponding reference numerals followed by the suffix a, the ramp 76a may be formed integrally with the casing wall 60a. Also, as shown in FIG. 6, wherein parts similar to those beforedescribed are designated by the corresponding reference numerals followed by the suffix b, the disintegrating ring 80 could be replaced by an annular array of generally diamond-shaped elements 78 affixed on the casing wall 60b around the vanes 48 in a manner similar to that beforedescribed for the ring 68. In this
event, of course, the before-described dam means 66 and the remainder of the apparatus, could be as before-described.

During the operation of the apparatus of FIGS. 1 through 4 in the disintegrating-and-blowing of pulp for the manufacture of paper, the shaft 22 is continuously rotatably driven to provide continuous driven rotation of the rotor 12, vanes 48, knife-like elements 46 and fan blades 36. Blowing gas is continuously supplied into the gas inlet chamber 32 and thence passes into the gas chamber 14 where the rotating fan blades 36 direct said gas at relatively high velocity through the annular spaces 18, 74 for blowing disintegrated pulp to the discharge volute 58 and from the housing 10. Pulp to be processed is continuously supplied through the conduit 40 and the compacting screw 44 is continuously rotatably driven to compact the pulp into non-porous plug upstream of the material inlet 38 while simultaneously continuously feeding the compacted pulp plug into the material chamber 16 through the inlet 38. The knife-like elements 46 break-up or shred such supplied pulp and the broken-up pulp passes outwardly between the inner ends 52 of the vanes 48 into the there-between passages or pockets 50. The rotation of the vanes 48 accelerates the pulp to relatively high velocity as the pulp passes radially outwardly through the pockets 50; and the pulp is outwardly discharged from the passages 50 between the vane outer ends 54 at the relatively high velocity dictated by the rotational speed of such outer ends 54. (The direction of this discharge of the pulp from between the vane outer ends 54 is schematically depicted by the broken arrow shown in FIG. 4 wherein the rotary direction of the rotation of the vanes 48 is schematically shown by the solid arrow.) The discharged pulp is resultantly impacted at its relatively high discharge velocity onto the disintegrating ring 68. Such impacting of the pulp on the ring 68 causes the discharged pulp to be broken-up into smaller, lighter fibers, and in some cases even individual fibers, which are thrown inwardly back towards the vane outer ends 54 to a location wherein they are rapidly gas blown over the dam means 66 and out through the discharge volute 58. The heavier bundles of pulp, however, are not gas blown over the dam means 66 and being unable to climb the ramp 76 and pass over the dam wall 78, are repetitively re-impacted with the disintegrating ring 68 until finally broken-up into lighter fiber groups or fibers which can be blown into the discharge volute in the described manner.

As the sides of the pockets 50 adjacent to the volute 58 are open to the latter, recirculation of a portion of the blowing gas back through the pockets 50 is obtained; and thereby disintegrated material conveying is enhanced. Also, as will be seen, as the volute 58 is axially displaced from the vanes 48 whereby the latter are external to the volute 58, the space 74 is of constant cross-section, excepting only as its cross-section is varied by the undulating configuration of the disintegrating ring 68, and resolutely uniform treatment of the pulp in the material chamber 16 is attained. The pockets of pulp which would otherwise occur at the location of the ramp 76 are prevented by the provision of the latter; and extremely rapid separation of the lighter, disintegrated pulp from the heavier undisintegrated, or only partially disintegrated, pulp is attained due to the great speed at which such lighter pulp is blown from the space 74 to the volute 58. The operation of the embodiments of FIGS. 5 and 6 is believed to be apparent from the foregoing description of the operation of the apparatus of FIGS. 1 through 4.

From the preceding description, it will be seen that the invention provides new and improved means for attaining all of the beforestated objects and advantages. It will be understood, however, that, although only several embodiments of the invention have been illustrated and hereinbefore specifically described, the invention is not limited merely to these several embodiments, but rather contemplates other embodiments and variations within the scope of the following claims.

Having thus described my invention, I claim:

1. Material disintegrating-and-blowing apparatus comprising housing means, dividing means dividing said housing means into a material chamber on one side of said dividing means and a gas chamber on the other side thereof, rotatably driven vane means in said material chamber having inner end means and outer end means, said housing means having material inlet means for supplying material to said material chamber between said inner end means of said vane means whereby, driven by driven rotation of said vane means, such material passes outwardly between said vane means and is discharged from between said outer end means of said vane means, means in said housing means intermediate said inner end means and said material inlet means for breaking-up compacted material supplied through said material inlet means prior to the supply of such material to said inner end means, said housing means having blowing gas inlet means for supplying blowing gas into said gas chamber separately from the material supplied to said material chamber, material disintegrating means in said material chamber spaced outwardly from said outer end means of said vane means and in the path of material discharged from between said outer end means, said vane means being rotatable relative to said material disintegrating means, said housing having material outlet means communicating with said material chamber for discharging material from the space between said outer end means and said material disintegrating means, means including passage means peripherally of said dividing means for causing blowing gas supplied by said blowing gas inlet means to flow from said gas chamber through the space between said outer end means and said material disintegrating means for blowing the disintegrated material through said material outlet means, and ramp means intermediate said material disintegrating means and said material outlet means for restraining heavier material from passing to said material outlet means.

2. Material disintegrating-and-blowing apparatus according to claim 1, wherein said vane means comprises a plurality of vanes extending generally radially of said dividing means and at locations spaced around said material breaking-up means, and said material breaking-up means and said dividing means are connected for rotation with said vane means.

3. Material disintegrating-and-blowing apparatus according to claim 2, wherein said material outlet means comprises a discharge volute axially spaced from said vane means.

4. Material disintegrating-and-blowing apparatus according to claim 2, further comprising dam wall means projecting inwardly intermediate said ramp means and said material outlet means for restraining heavier mate-
Material from passing to said material outlet means, said material disintegrating means being non-rotatable during operation of the apparatus, and said material disintegrating means comprising means arranged around said vane means for disintegrating the material by impact and also for causing material to move inwardly towards said vane outlet means whereby the lighter disintegrated material may be readily blown to said material outlet means.

5. Material disintegrating-and-blowing apparatus according to claim 4, wherein said material disintegrating means comprises an annular undulating disintegrating ring extending around said vane means.

6. Material disintegrating-and-blowing apparatus comprising a housing, a rotatable drive shaft associated with said housing, a rotor in said housing connected to said drive shaft to be rotatably driven thereby, said housing containing a material chamber along one side of said rotor and a gas chamber along the opposite side of said rotor, there being a space peripherally around said rotor communicating said chambers, said housing having a material inlet connected to said material chamber centrally of said rotor for supplying material to said material chamber and also a gas inlet connected to said gas chamber for supplying blowing gas thereto, said housing having material discharge means communicating with said material chamber peripherally of said rotor for discharging blown disintegrated material from such chamber, material shredding means connected to said drive shaft to be rotatably driven thereby and adjacent said material inlet for shredding compacted material supplied therethrough, a plurality of vanes in said material chamber having inner ends generally centrally of said rotor and spaced apart outer ends adjacent the periphery of said rotor, said vanes being connected to said drive shaft to be rotatably driven thereby, material disintegrating means in said material chamber spaced outwardly from said outer ends of said vanes and in the path of material discharged from between said outer ends, said material disintegrating means being arranged around said outer ends of said vanes and adapted for disintegrating the material by impact and also for causing the material to move inwardly towards said outer ends, and means intermediate said material disintegrating means and said material discharge means for restraining movement of heavier material from adjacent said material disintegrating means towards said material discharge means, said restraining means comprising ramp means inclined upwardly towards said material discharge means, and said vanes being rotatable relative to said material disintegrating means and said ramp means.

7. Material disintegrating-and-blowing apparatus according to claim 6, wherein said material discharge means comprises a discharge volute axially spaced from said vane means.

8. Material disintegrating-and-blowing apparatus according to claim 6, further comprising dam wall means intermediate said ramp means and said material discharge means.

9. Material disintegrating-and-blowing apparatus according to claim 8, wherein the sides of the passages between said vanes most adjacent to said material discharge means are open thereto.

10. Material disintegrating-and-blowing apparatus according to claim 9, wherein said material disintegrating means, ramp means and dam wall means are carried by said housing.

11. Material disintegrating-and-blowing apparatus according to claim 10, wherein said material disintegrating means comprises undulating element means.

12. Material disintegrating-and-blowing apparatus according to claim 10, wherein said material disintegrating means comprises a plurality of disintegrating elements at locations spaced around said vanes.

13. Material disintegrating-and-blowing apparatus comprising housing means, means in said housing means dividing said housing means into a material chamber on one side of said dividing means and a gas chamber on the other side thereof, there being a space peripherally around said dividing means communicating said chambers, said housing means having material inlet means connected to said material chamber centrally of said dividing means for supplying material to said material chamber and also gas inlet means connected to said gas chamber for supplying blowing gas thereto, said housing means having material means communicating with said material chamber peripherally of said dividing means for discharging blown disintegrated material from such chamber, material shredding means in said material chamber adjacent said material inlet means for shredding compacted material supplied therethrough, material disintegrating means in said material chamber intermediate said material shredding means and said material discharge means for disintegrating the material, and said material discharge means comprising a discharge volute axially offset spaced from said vane means.

14. Material disintegrating-and-blowing apparatus according to claim 13, further comprising vane means in said material chamber intermediate said material shredding means and said material disintegrating means, said discharge volute being axially spaced from said vane means.

15. Disintegrating-and-blowing apparatus for material such as pulp, comprising a housing, a rotatable drive shaft associated with said housing, a rotor in said housing connected to said drive shaft to be rotatably driven thereby, said housing containing a material chamber along one side of said rotor and gas chamber along the opposite side of said rotor, a material inlet connected to said material chamber centrally of said rotor for supplying material to said material chamber, a gas inlet connected to said gas chamber for supplying blowing gas thereto, a plurality of vanes in said material chamber having inner ends generally centrally of said rotor and spaced apart outer ends adjacent the periphery of said rotor, said vanes being connected to said drive shaft to be rotatably driven thereby, material disintegrating means in said material chamber spaced outwardly from said outer ends of said vanes and in the path of material discharged from between said outer ends, said material disintegrating means being arranged around said outer ends of said vanes and adapted for disintegrating the material by impact and also for causing the material to move inwardly towards said outer ends, said material discharge means communicating with said material chamber adjacent said material disintegrating means for discharging disintegrated material, means including rotatable fan means in said gas chamber and passage means peripherally around said rotor for causing blowing gas to flow from said gas chamber to said material chamber whereby such blowing gas
blows the disintegrated material to said material discharge means, and means intermediate said material disintegrating means and said material discharge means for restraining movement of heavier material from adjacent said material disintegrating means towards said material discharge means, said restraining means comprising ramp means inclined towards said material discharge means, said restraining means further comprising dam wall means intermediate said ramp means and said material discharge means, and said vanes being rotatable relative to said material disintegrating means and said ramp means and dam wall means.

16. Material disintegrating-and-blowing apparatus according to claim 15, wherein said ramp means is disposed peripherally of said rotor and adjacent said material disintegrating means, said material discharge means comprises a discharge volute axially spaced from said vanes, and said dam wall means extends inwardly from said ramp means and defines a side of said discharge volute.

17. Disintegrating-and-blowing apparatus for material such as pulp, comprising a housing, a rotatable drive shaft associated with said housing, dividing means dividing said housing into a material chamber on one side of said dividing means and a gas chamber on the opposite side of said dividing means, material inlet means connected to said material chamber centrally of said dividing means for supplying material to said material chamber, gas inlet means connected to said gas chamber for supplying blowing gas thereto, a plurality of vanes in said material chamber having inner ends generally centrally of said dividing means and spaced apart outer ends adjacent the periphery of said dividing means, said vanes being connected to said drive shaft to be rotatably driven thereby, material disintegrating means spaced outwardly from said outer ends of said vanes and in the path of material discharged from between said outer ends, said material disintegrating means being arranged around said outer ends of said vanes and adapted for disintegrating the material by impact and also for causing the material to move inwardly towards said outer ends, material discharge means communicating with said material chamber adjacent said material disintegrating means for discharging disintegrated material, means including passage means peripherally of said dividing means for causing blowing gas to flow from said gas chamber to said material chamber whereby such blowing gas blows the disintegrated material to said material discharge means, and means intermediate said material disintegrating means and said material discharge means for restraining movement of heavier material from adjacent said material disintegrating means towards said material discharge means, said restraining means comprising ramp means inclined towards said material discharge means, and said restraining means further comprising dam wall means intermediate said ramp means and said material discharge means.

18. Material disintegrating-and-blowing apparatus according to claim 15, wherein said ramp means is adjacent said vane outer ends and relatively arranged with said material disintegrating means to cause the heavier material to be retained adjacent said material disintegrating means for disintegration into component lighter material, and said dam wall means is disposed adjacent said ramp means and relatively arranged therewith for restraining the heavier material from passing from said ramp means to said material discharge means.

19. Material disintegrating-and-blowing apparatus according to claim 18, wherein said ramp means comprises an annular ramp carried by said housing, and said dam wall means comprises an annular dam wall carried by said housing and extending further inwardly than the innermost side of said ramp.

20. Material disintegrating-and-blowing apparatus according to claim 18, wherein said material discharge means comprises a discharge volute axially spaced from said vanes, and further comprising material feed means operatively associated with said material inlet for feeding a compacted plug of material into said material chamber therethrough.

21. Material disintegrating-and-blowing apparatus according to claim 17, wherein said ramp means is disposed at least substantially immediately following said material disintegrating means to cause heavier material to be retained adjacent said material disintegrating means for disintegration into component lighter material, and said dam wall means is disposed adjacent said ramp means and relatively arranged therewith for restraining the heavier material from passing from said ramp means to said material discharge means.