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[54] **APPARATUS FOR THE GASEOUS REACTION OF MATERIAL**

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[51] **Int. Cl.** **B02b 1/00**

[58] **Field of Search** ..... 241/34, 47, 57, 60, 241/161.2, 186 A, 186.2, 188 A, 247, 301

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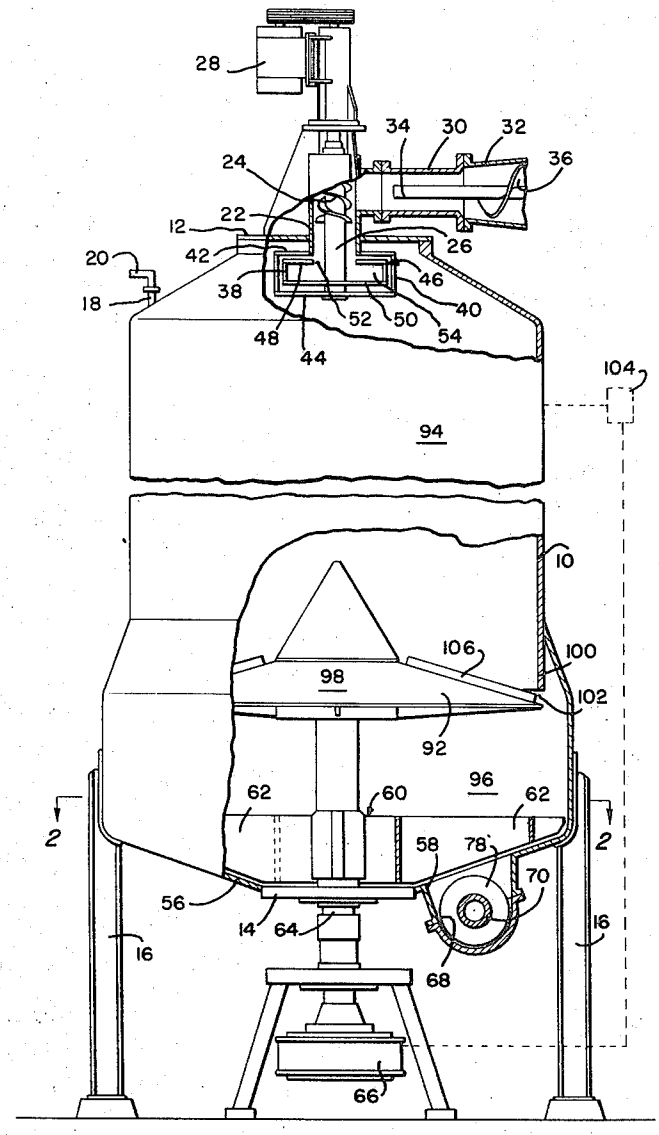
[57] **ABSTRACT**

Apparatus comprising a vessel, means for compacting material and supplying the compacted material to the vessel, means for breaking-up the compacted material and spreading the broken-up material in the vessel, means for supplying gas to the vessel, and discharge means for discharging material in compacted condition, such discharge means including a discharge opening and flap means causing material to be discharged therethrough in said compacted condition. A rotatably driven platform divides the vessel into communicating retention and discharge chambers and controls the passage of material from the retention chamber to the discharge chamber; and the retention chamber is connected to the material and gas supplying means and contains the material breaking-up and spreading means, while the discharge chamber is provided with a large, offset, discharge opening and contains a scraper movable thereover.

20 Claims, 3 Drawing Figures



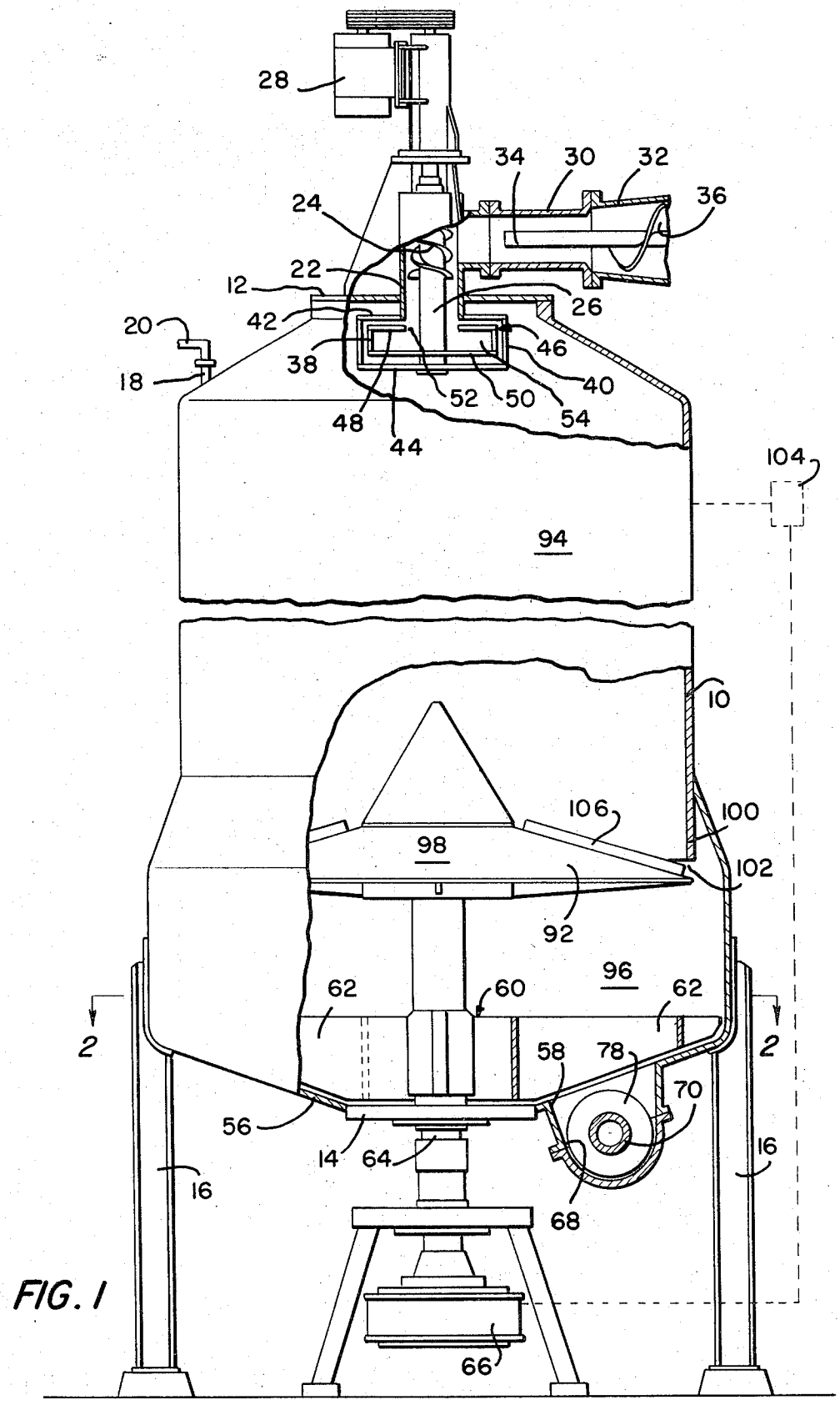

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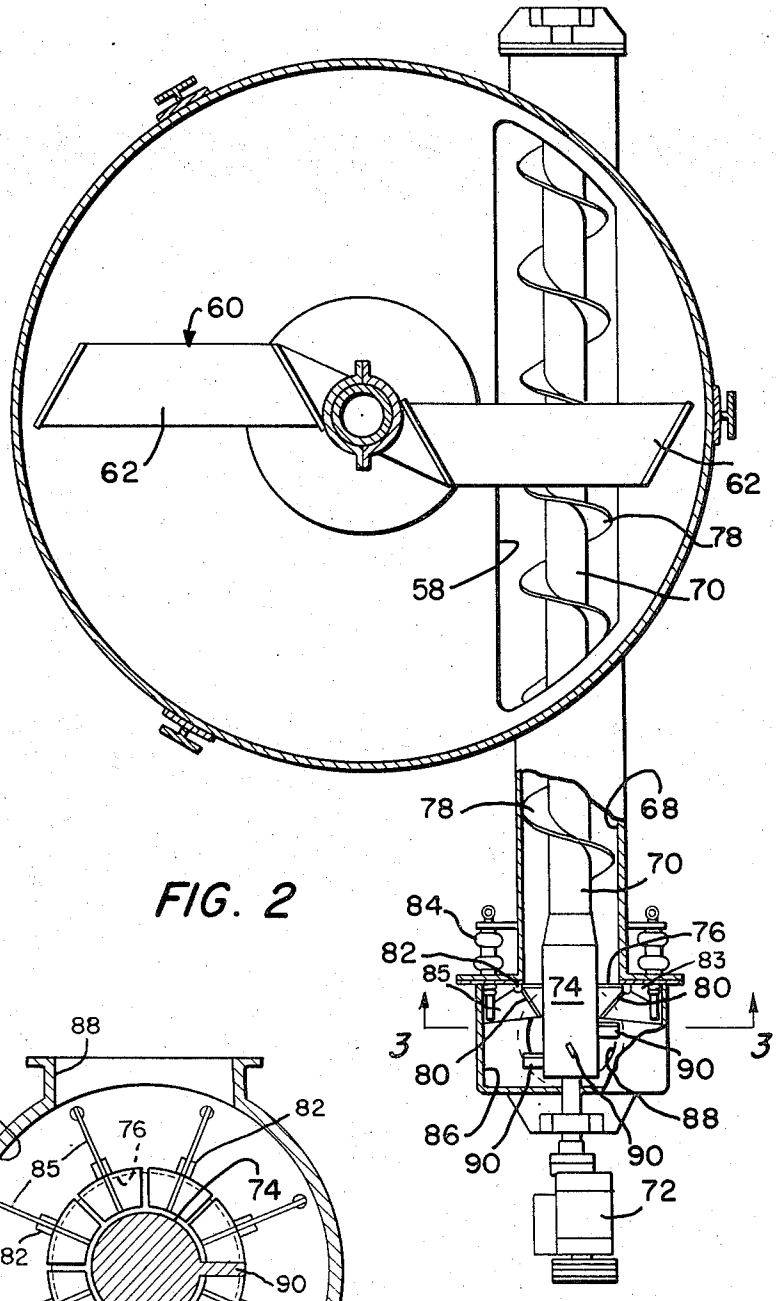
FIG. 1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72

FIG. 2

88
86
76
82
85
74
82
90
80
82

FIG. 3

APPARATUS FOR THE GASEOUS REACTION OF MATERIAL

The present invention relates to apparatus for the gaseous reaction of material such as a solid or solid-liquid mixture.

Conventional apparatus employed for continuous operation in the gaseous reaction of lignocellulosic material, such as the bleaching of pulp or the delignification of lignocellulosic material, is inherently subject to undesirable carry-over of the gaseous reagent in the discharged material. This carry-over not only results in undesirable loss of the gaseous reagent, but also causes problems in the handling of the discharged material and, or course, results in increased operating costs.

An object of the present invention is to provide new and improved apparatus for the gaseous reaction of material such as a solid or solid-liquid mixture, which apparatus is particularly constructed and arranged to substantially minimize the carry-over of the gaseous reagent with the discharged material.

Another object of the invention is to provide new and improved apparatus for the gaseous reaction of material such as a solid or solid-liquid mixture, which apparatus is particularly constructed and arranged to discharge material at high consistency.

Another object is to provide new and improved gaseous reaction apparatus particularly constructed and arranged to both receive and discharge material at high consistency.

Another object is to provide new and improved apparatus of the type set forth which, although particularly suited for employment in a pulp bleaching or delignification process, is alternatively capable of use in the gaseous reaction of other solid-liquid and solid material.

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

In accordance with the invention, an apparatus for the gaseous reaction of material, may comprise a vessel, means for supplying material to said vessel, said material supplying means including means for compacting material and supplying the material in compacted condition, means for breaking-up the compacted material and spreading the broken-up material in the vessel, means for supplying gas to the vessel, and discharge means for discharging material from the vessel, the discharge means including a discharge opening and flap means controlling the discharge of material through the discharge opening for causing the material to be discharged therethrough in compacted condition. Also, in accordance with the invention, the apparatus may comprise dividing means dividing the vessel into communicating retention and discharge chambers and controlling the passage of material from the retention chamber to the discharge chamber; and the retention chamber may be connected to the material and gas supplying means and contain the material breaking-up and spreading means, while the discharge chamber may be provided with a large, offset discharge opening and contain a scraper movable thereover.

Referring to the drawings:

FIG. 1 is an elevational view, partially broken away and in section, of an apparatus constructed in accordance with the present invention;

FIG. 2 is a sectional view taken on line 2—2 in FIG. 1, looking in the direction of the arrows; and

FIG. 3 is a sectional view taken on line 3—3 in FIG. 2, looking in the direction of the arrows.

Referring more particularly to the drawings wherein similar reference numerals designate corresponding parts throughout the several views, the illustrated apparatus comprises a generally vertical, annular vessel **10** which is closed at its upper and lower ends by end closure plates **12, 14,** respectively, and ground mounted by supporting pillars or piers **16.** The vessel **10,** as desired or required by the gaseous reaction process to be carried out by the apparatus, may be designed for operation at atmospheric pressure or at any other pressure above or below atmospheric pressure; however, in any event the vessel **10** is gas tight to prevent gas leakage into and out of the vessel **10.**

The vessel **10** is provided with a gas inlet or inlet conduit **18** which connects the upper end of the vessel interior to a gas supply pipe **20,** in turn, communicating with a source (not shown) of the gas or gaseous reagent to be employed during operation of the apparatus. The employed gaseous reagent will, of course, depend upon the gaseous reaction process to be performed; and, by way of specific example only, either chlorine gas or chlorine dioxide mixed with steam could be used as the gaseous reagent when the apparatus is employed for the bleaching of pulp. The vessel **10** is also provided with means adapted for compacting material to be reacted with the gas and feeding or supplying the compacted material to the vessel **10,** whereby the compacted material forms a plug upstream of the vessel **10** to prevent air and other undesirable gases from being introduced into the vessel **10** with the material.

More particularly, as illustrated, the vessel **10** is provided with a material inlet or inlet conduit **22** which is connected to the upper end of the vessel interior centrally of the vessel **10.** The inlet conduit **22** contains a feed screw **24,** mounted on a supporting shaft **26** rotatably driven by a driving motor **28,** which is adapted for downwardly feeding the material into the vessel interior. The inlet conduit **22** is connected through a supply conduit **30** to a source (not shown) of the material, the supply conduit **30** including a portion **32** tapering in cross-section in the direction of the passage of material to the vessel **10** therethrough. A rotatably driven shaft **34** is coaxially disposed in the supply conduit **30** and in the tapering portion **32** thereof carries a feed and compaction screw **36.** Hence, during operation of the apparatus, the driven rotation of the feed and compaction screw **36** in the tapering portion **32** of the supply conduit **30** causes compaction of the material in the supply conduit **30** to prevent the flow of undesirable gases therethrough, while the feed screws **24, 36** feed the material to the vessel upper end.

The upper end of the vessel **10** contains means particularly adapted for disintegrating or breaking-up the compacted material supplied through the inlet conduit **22** and spreading the disintegrated or broken-up material across the cross-section of the vessel **10.** As illustrated, this disintegrating and spreading means comprises an inner annulus or ring of arcuately spaced apart rotary pins **38** and a concentric, radially spaced, outer annulus or ring of arcuately spaced apart station-

ary pins **40**. The upper ends of the stationary pins **40** are rigidly mounted on an annular support **42** which is affixed around the wall of the inlet conduit **22**; the lower ends of the stationary pins **40** are affixed to a stationary support **44** which surrounds supports the lower end of the shaft **26**. The rotary pins **38** are carried by a frame **46** which is mounted on the shaft **26** for rotation therewith, the frame **46** including upper and lower plates **48,50**, respectively, rigidly connected to the corresponding ends of the rotary pins **38**. The upper frame plate **48**, as will be noted, is spaced from the shaft **26** by an at least generally annular space **52**, whereby the space **52** communicates the inlet conduit **22** with the chamber **54** within the annulus of rotary pins **38**. Hence, during the operation of this disintegrating and spreading means, the rotary pins **38** are continuously rotatably driven by rotation of the shaft **26** and the material supplied to the chamber **54** through the space **52**, being prevented from direct downward passage in the vessel **10** by the plate **50** and support **44**, is disintegrated by the pins and passes outwardly through the spaces between adjacent ones of the pins to be resultantly spread in disintegrated or broken-up condition across the cross-section of the vessel **10**. However, it will be understood that this illustrated material disintegrating and spreading means, and also the beforedescribed material compacting and supplying means, have been shown as being of described construction only for the purposes of illustration, and alternatively could be of other construction suitable to perform their intended functions.

The lower end of the vessel **10** is provided with discharge means particularly constructed and arranged to cause material to be discharged from the apparatus in compacted condition. As illustrated, the lower end portion of the vessel **10** is enlarged and the vessel bottom **56** is constructed of generally conical configuration. Offset from the center or vertical axis of the vessel **10**, the vessel bottom **56** is provided with an elongated discharge opening **58** which longitudinally extends substantially across the vessel **10** at its offset location. The lower end of the vessel **10** contains a coaxial, rotatable scraper **60** having a plurality of scraper arms or blades **62**, each of sufficient length to move or sweep over the discharge opening **58**; and the scraper **60** is mounted on a rotatable shaft **64** which is rotatably driven by a driving motor **66**.

An elongated, horizontal, discharge conduit or conduit means **68** longitudinally extends transversely or cross-wise of the vessel **10** at the offset location of the discharge opening **58** parallel to and beneath the latter, and projects outwardly from the vessel **10**. As shown in FIG. **2**, the discharge conduit **68** extends beneath the full length of the discharge opening **58**; and the discharge opening **58** is open throughout its length to the therebelow discharge conduit **68**. The discharge conduit **68** contains a coaxial, rotatable shaft or support **70**, which extends the full length of the discharge conduit **68** and is connected to a driving motor **72** to be rotatably driven thereby. The shaft **70** includes an enlarged portion **74** which cooperates with a thereadjacent portion of the wall of the discharge conduit **68** to bound a therebetween annular discharge opening **76** communicating through the discharge conduit **68** with the discharge opening **58**. The portion of the shaft **70** intermediate the discharge openings **58, 76** carries a screw flight **78** which, during the driven rotation of the shaft **70**, serves to convey material through the discharge conduit **68** from adjacent the discharge opening **58** towards the discharge opening **76**.

Annular flap means control the discharge of material through the discharge opening **76** to cause the material to be discharged therethrough in compacted condition, such flap means movably extending generally transversely of the discharge opening **76** and being caused to yieldably restrain discharge of material through the latter. More particularly, as illustrated the flap means comprises an annulus or ring formed from a plurality of imperforate, rigid flaps **80**, cooperative to encircle the enlarged shaft portion **74** and each extending generally transversely of the discharge opening **76**, which are pivotally mounted by individual pivotal mountings **82** on a support plate **83** carried by the wall of the discharge conduit **68** to be individually movable towards-and-away from the enlarged shaft portion **74** for yieldably restraining discharge of material through the discharge opening **76**. The flaps **80** are, as shown in FIGS. **2** and **3**, connected by individual links **85** to individual pressure fluid operated actuators **84**, per se of any suitable conventional construction, which during the operation of the apparatus are fluid caused to bias their respective flaps **80** towards the enlarged shaft portion **74** and against the discharge of material through the opening **76** to thereby cause the flaps **80** to yieldably restrain material passage through the opening **76**. As illustrated, the flaps **80** are eight in number, it being understood, however, that alternatively they could be of other desired number.

On the opposite side of the discharge opening **76** from the discharge opening **58**, the discharge conduit **68** includes an enlarged, outlet chamber **86** provided with an outlet or outlet conduit **88** which communicates with the discharge opening **76** through the chamber **86** and is adapted to discharge the material from the apparatus. The shaft **70** carries a plurality of breaker elements **90** in the chamber **86**, such breaker elements **90** serving during rotation of the shaft **70** to break-up compacted material discharged through the discharge opening **76** prior to the passage of the material through the outlet **88**.

As illustrated in FIG. **1**, an imperforate metering platform or dividing means **92** may be disposed transversely in the vessel **10** intermediate the upper and lower ends thereof to divide the interior of the vessel **10** into an upper or retention chamber **94** above the platform **92** and a lower or discharge chamber **96** below the platform **92**, the platform **92** being mounted on the shaft **64** for conjoined driven rotation with the scraper **60**. In this event, as will be noted, the inlets **18** and **22** will be connected to the retention chamber **94** and the latter will contain the beforedescribed, compacted material disintegrating and spreading means, while the discharge chamber **96** is provided with the discharge opening **58** and contains the rotating scraper **60**. Also, as illustrated, the upper side of the platform **92** may be provided with an annular wall **98** downwardly sloping towards its periphery and adjacent such periphery spaced from the lower end of a depending annular wall **100** by an annular space **102** communicating the lower end of the retention chamber **94** with the upper end of the discharge chamber **96**. This arrangement, as will be seen, causes the platform **92** to control the passage of material from the retention chamber **94** to the discharge chamber **96** and enables the rate of

such material passage to be readily and simply varied by adjustment of the speed of the driven rotation of the platform **92**. Hence, this arrangement is advantageously accompanied by control means controlling the speed of the driven rotation of the platform **92** responsive to the level of material in the retention chamber **94**, such control means being schematically depicted in FIG. **1** as including a conventional level sensing device **104** sensing the level of the material in the retention chamber **94** and connected to the motor **66** to cause the rotary speed at which the latter rotatably drives the platform **92** and the scraper **60** to be varied responsive thereto. Moreover, the wall **98** of the platform **92**, as illustrated, may be provided with spiral flights **106** adapted to facilitate passage of material from the retention chamber **94** to the discharge chamber **96** through the space **102**.

Throughout the operation of the beforedescribed apparatus, the driving motor **66** is continuously operated to provide continuous rotation of the shaft **64** and its carried scraper **60** and platform **92**; and the driving motor **72** is also continuously operated to rotate the shaft **70** and the carried screw flight **78** and breaker elements **90**. Similarly, the shaft **34** is continuously rotatably driven by its driving means (not shown) to cause continuous rotation of the feed and compacting screw **36**; and the driving motor **28** is continuously operated to rotate the feed screw **24** and rotary pins **38**. Pressurized fluid at constant, pre-determined pressure is maintained in the actuators **84** to cause the latter to exert pre-determined, equal forces yieldably biasing the flaps **80** against the discharge of material through the discharge opening **76**, whereby the flaps yieldably restrain passage of material through the opening **76**.

The gas or gaseous reagent (for example, chlorine gas or chlorine dioxide mixed with steam when the apparatus is employed for the bleaching of pulp) is continuously supplied to the vessel retention chamber **94** through the gas supply pipe **20** and gas inlet **18**. The solid or solid-liquid material, such as lignocellulosic material, is continuously supplied through the supply conduit **30** to the rotatably driven feed and compacting screw **36** which compacts the material in the tapering portion **32** of the supply conduit **30**, thereby forming a plug of the material upstream of the vessel **10** to prevent the flow of undesirable gases to the vessel **10** through the supply conduit **30**. The screws **24,36** feed this compacted material through the inlet **22** into the vessel retention chamber **94** whereupon the beforedescribed disintegrating and spreading means including the pins **38,40** disintegrates or breaks-up the compacted material and spreads the broken-up material across the cross-section of the retention chamber **94**. This spread, disintegrated material falls downwardly in the retention chamber **94** to form a pile of the material on the wall **98** of the platform **92**, the volume of which pile of material divided by the volumetric through-put of material through the apparatus determines the time the material is retained in the retention chamber **94** exposed to the gaseous reagent. The driven rotation of the platform **92** causes the latter to move material on the bottom of the pile outwardly to the periphery of the platform **92** where the material is discharged through the annular opening **102** to the discharge chamber **96**, the speed of the driven rotation of the platform **92** being controlled responsive to the level **108** of the upper end of the pile of material. The material, thus discharged to the discharge chamber **96**, falls downwardly therein by gravity.

The material at the bottom of the discharge chamber is raked along the bottom **56** of the vessel **10** towards the discharge opening **58** and discharged through the latter into the discharge conduit **68**. The rotatably driven screw flight **78** conveys this discharged material through the discharge conduit **68** towards the discharge opening **76**. The flaps **80**, as beforedescribed, yieldably restrain the discharge of the material through the discharge opening **76** to thereby form a plug of the material at the opening **76** and cause the material to be discharged through the latter in compacted condition. This plug or compacted condition of the material, as will be seen, prevents the material passing through the opening **76** from including gas-containing interstices and thereby substantially minimizes the carry-over of gas with the material discharged through the opening **76**. The chamber **86** receives the compacted material from the opening **76** and, after such material has been broken-up by the breaker elements **90**, discharges the material through the apparatus outlet **88**.

From the preceeding description, it will be seen that the material may be both supplied to the vessel **10** and discharged therefrom at consistences may be above 10 percent solid material. Also, the consistency of the discharged material may be, as desired or required, either higher or lower than, or the same as, that of the supplied material. Moreover, although the beforedescribed apparatus provides only for the supply of gas to the material in the vessel **10**, it will be understood that liquids, steam and/or the like could also be supplied to the material in the vessel.

From the preceeding 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 a single embodiment of the invention has been illustrated and hereinbefore described, the invention is not limited merely to this single embodiment, but rather contemplates other embodiments and variations within the scope of the following claims.

Having thus described our invention, we claim:

1. Apparatus for the gaseous reaction of material, comprising a vessel, means for supplying material to said vessel, said material supplying means including means for compacting material and supplying the material in compacted condition, means for breaking-up the compacted material and spreading the broken-up material in said vessel, means for supplying gas to said vessel, and discharge means for discharging material from said vessel, said discharge means including a discharge opening and flap means controlling the discharge of material through said discharge opening for causing the material to be discharged therethrough in compacted condition.

2. Apparatus according to claim **1**, wherein said flap means extends generally transversely of said discharge opening and is movable to yieldably restrain discharge of material therethrough, and further comprising means for causing said flap means to yieldably restrain discharge of material through said discharge opening.

3. Apparatus according to claim **2**, wherein said flap means is annular.

4. Apparatus according to claim **1**, wherein said vessel is generally vertical, said material supplying means and said gas supplying means are connected to the

upper end of said vessel, said compacted material breaking-up and spreading means is in the upper end of said vessel, and said discharge means is connected to the lower end of said vessel.

5. Apparatus according to claim **1,** wherein said flap means includes a plurality of flaps extending generally transversely of said discharge opening and movable to yieldably restrain discharge of material therethrough, and further comprising means for causing said flaps to yieldably restrain discharge of material through said discharge opening.

6. Apparatus according to claim **5,** wherein said flaps are pivotally mounted, and said yieldable restraining causing means comprises individual means for said flaps.

7. Apparatus according to claim **1,** wherein said discharge means further includes conduit means, a second discharge opening communicating said conduit means with said vessel and connected through said conduit means to said discharge opening, rotatably driven screw means in said conduit means for conveying material from said second discharge opening towards said discharge opening, said flap means extending generally transversely of said discharge opening and being movable for varying the open area of said discharge opening, and means for yieldably biasing said flap means against discharge of material through said discharge opening.

8. Apparatus according to claim **7,** wherein said flap means includes a plurality of flaps.

9. Apparatus according to claim **8,** wherein said flaps are pivotally mounted, and said biasing means includes individual biasing means for said flaps.

10. Apparatus according to claim **8,** wherein said screw means comprises support means and flight means on said support means, said conduit means includes an outlet opening on the opposite side of said discharge opening from said second discharge opening, said support means extends through said discharge opening, and further comprising means on said support means adjacent said outlet opening for breaking-up compacted material discharged through said discharge opening.

11. Apparatus according to claim **1,** wherein said vessel is generally vertical, said material supplying means and said gas supplying means are connected to the upper end of said vessel, the lower end of said vessel is generally conical and provided with a second discharge opening offset from the center of said vessel, and further comprising rotatable scraper means in the lower end of said vessel movable over said second discharge opening, and conduit means communicating said second discharge opening with said discharge opening.

12. Apparatus according to claim **11,** wherein said second discharge opening is elongated and longitudinally extends across substantially the width of said vessel at its offset location.

13. Apparatus according to claim **12,** further comprising rotatably driven screw means in said conduit means for conveying material from said second discharge opening towards said discharge opening through said conduit means, said screw means comprising rotary support means and flight means carried by said support means, said flap means including a plurality of flaps extending generally transversely of said discharge opening and individually movable for yieldably restraining the discharge of material therethrough, and means for yieldably biasing said flaps against discharge of material through said discharge opening.

14. Apparatus according to claim **1,** further comprising means in said vessel dividing said vessel into a retention chamber on one side of said dividing means and a communicating discharge chamber on the other side thereof, said dividing means controlling the passage of material from said retention chamber to said discharge chamber, said material supplying means and said gas supplying means being connected to said retention chamber, said discharge chamber being provided with a second discharge opening for discharging material therefrom, said compacted material breaking-up and spreading means being in said retention chamber, conduit means communicating said second discharge opening with said discharge opening, and scraper means in said discharge chamber.

15. Apparatus according to claim **14,** wherein said vessel is generally vertical, and said retention and discharge chambers are, respectively, adjacent the upper and lower ends thereof.

16. Apparatus according to claim **15,** wherein said dividing means is rotatably driven.

17. Apparatus according to claim **16,** further comprising said second discharge opening being offset from the center of said vessel.

18. Apparatus according to claim **17,** further comprising rotatably driven screw means in said conduit means for conveying material through said conduit means from said second discharge opening towards said discharge opening, said flap means comprising a plurality of flaps extending generally transversely of said discharge opening and movable for yieldably restraining discharge of material therethrough, and means for yieldably biasing said flaps against discharge of material through said discharge opening.

19. Apparatus according to claim **18,** wherein said screw means includes rotary support means and flight means carried by said support means, said conduit means includes an outlet opening on the opposite side of said discharge opening from said second discharge opening, said support means extends through said discharge opening, and further comprising means carried by said support means adjacent said outlet opening for breaking-up the compacted material discharged through said discharge opening.

20. Apparatus according to claim **18,** further comprising means for controlling the driven rotation of said dividing means responsive to the level of material in said retention chamber.

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