June 20, 1944. R. C. NEWHOUSE 2,351,870

COMBINED BALL MILL AND DRIER

Filed Dec. 26, 1940 2 Sheets-Sheet 1

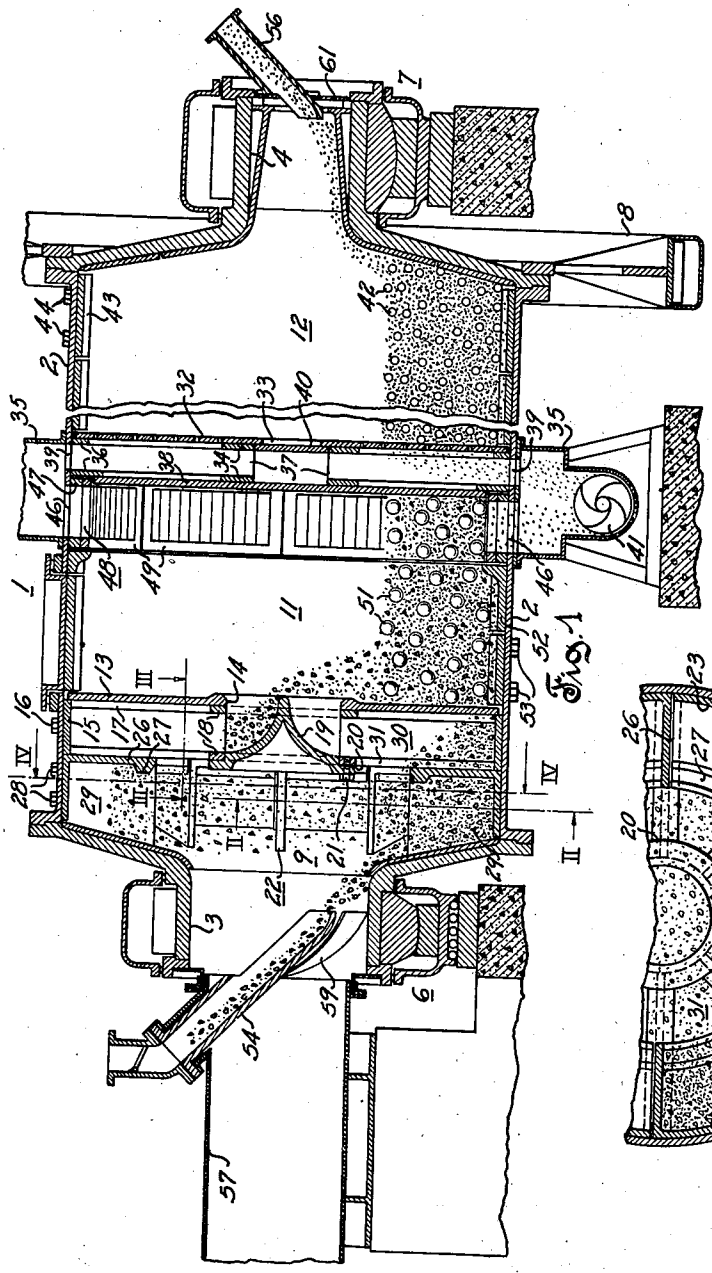

Fig. 1

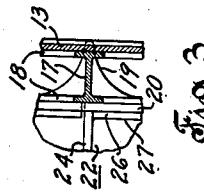

Fig. 3

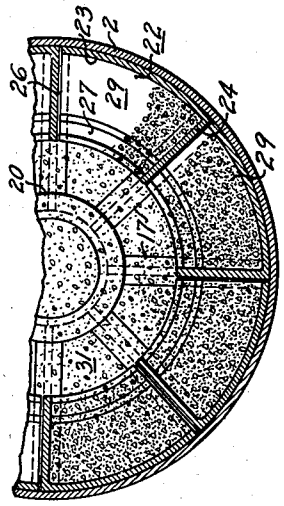

Fig. 2

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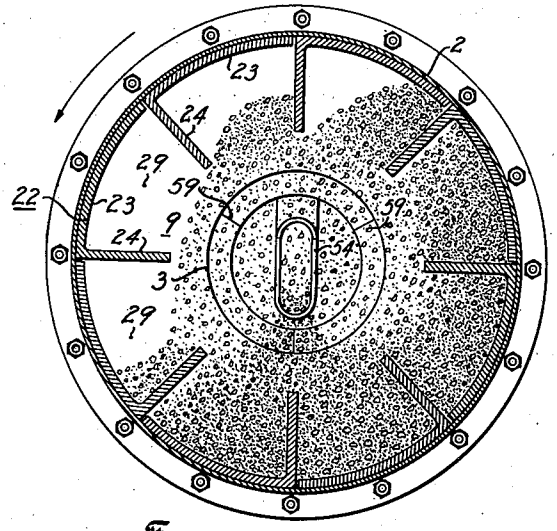

Fig. 4

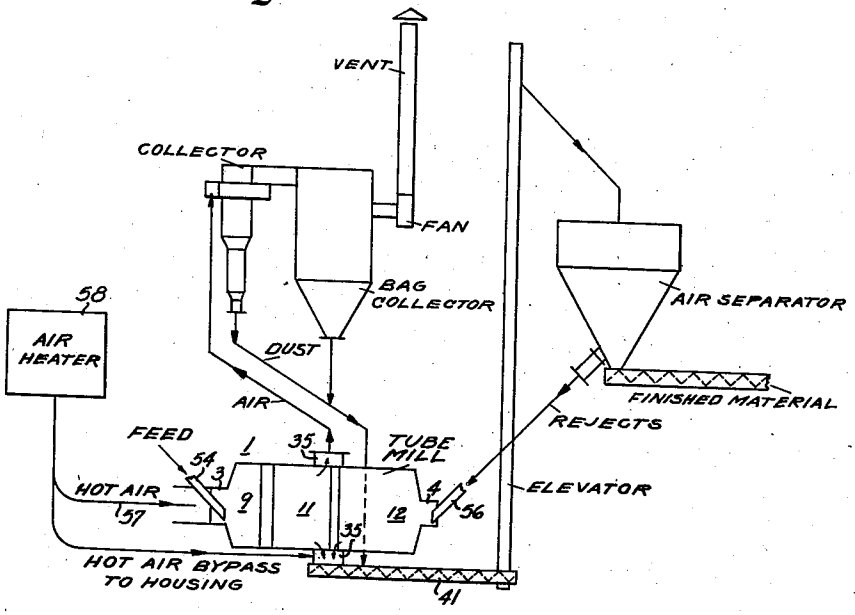

Fig. 5

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COMBINED BALL MILL AND DRIER

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7 Claims. (Cl. 83—9)

This invention relates generally to the drying of moist materials and more particularly to a manner of and means for pre-drying the moist material prior to the first or preliminary grinding thereof.

The nature and the moisture content of the material to be ground may be such that the ground material agglomerates and/or adheres to the grinding media employed thereby materially reducing the capacity of the mill and materially increasing its power consumption. The agglomeration and the adhesion of the ground material to the grinding media and to the other parts of a mill presents series operating difficulties, particularly with respect to tube mills, which in some instances has necessitated complete and frequent shutdowns. The known types of tube mills designed to overcome these difficulties, such, for example, as that illustrated by United States Patent to Hidoux No. 1,614,364, issued January 11, 1927, Combined drying and grinding machine for clay and other plastic materials, employ a relatively long predrying chamber through which is passed a heated gas and through which the moist material is conveyed by the inclination of the tube and by the inclined or helical vanes or ribs disposed therein. However, the known types of tube mills are objectionable in that (1) the initial cost is excessive, (2) a large space is required for installation and operation which materially increases plant costs, (3) the power consumption is excessive which materially increases operating costs, and (4) the manner of predrying employed is inefficient which also increases operating costs and materially reduces the overall efficiency of the mill.

In accordance with this invention, the moist material is dried or partially dried by showering the material through a stream of heated gas transversely with respect to the direction of gas flow and mixing the showered and partially dried material with additional moist material before subjecting the additional moist material to the showering action. Some of the material which has been mixed and then showered through the heated gas stream is then withdrawn and ground and the remainder is retained and mixed with the incoming moist material to effect a preliminary dry ng action which precedes the further drying action effected by showering the mixture through the stream of heated gas. In other words, once this procedure has been initiated, the incoming moist material is sequentially subjected to two drying actions, namely, (1) a preliminary drying action effected by direct contact between the moist particles and the previously showered and partially dried particles during the mixing operation, and (2) a further drying action effected by then passing the mixture of moist and partially dried particles through the stream of heated gas.

An important object of this invention is to provide an improved method of drying moist material which, when the dried material is to be ground, may be carried out in a tube or other type of mill without materially increasing the initial and operating costs thereof.

Another important object of this invention is to provide an improved mill compactly incorporating a novel combination of features operative to efficiently predry moist material in accordance with the method herein disclosed.

Still another object of this invention is to provide an improved tube mill embodying apparatus for practicing this invention compactly arranged in a non-grinding preliminary drying chamber of relatively small axial length.

A further object of this invention is to provide an improved tube mill embodying apparatus for practicing this invention compactly arranged in a non-grinding preliminary drying compartment of relatively small axial length intermediate the material inlet and discharge openings therein so as to interpose a curtain of showering material between said openings and thereby prevent incoming moist material from passing directly through said compartment without being subjected to the mixing and showering operations performed therein.

The invention accordingly consists of the various methods and of the various features of construction, combinations of elements and arrangements of parts as more particularly pointed out in the appended claims and in the detailed description, in which:

Fig. 1 is a longitudinal vertical section through a tube mill embodying the invention;

Fig. 2 is a partial transverse vertical section through the mill taken on line II—II of Fig. 1;

Fig. 3 is a section illustrating the cone discharge member taken on line III—III of Fig. 1;

Fig. 4 is another transverse vertical section through the mill taken on lines IV—IV of Fig. 1; and

Fig. 5 is a diagrammatic illustration of the preferred manner in which the tube mill shown in Fig. 1 is embodied in a drying, grinding and separating system.

Referring to the drawings and particularly Figs. 1 to 4, inclusive, it is seen that the tube mill 1 comprises a generally cylindrical shell 2

having opposite ends of reduced diameter providing axially extending inlet end portions 3 and 4. The shell is mounted for rotation about its longitudinal axis on axially spaced end bearing structures 6 and 7 which coact with and support the axially extending end portions 3 and 4, respectively. The shell is rotated in said bearings by means of the ring gear 8 which is attached thereto and which in turn is adapted to be driven by any suitable means such as a gear connected driving motor (not shown).

The interior of the shell 2 is provided with axially spaced means which coact and divide the interior of the shell into a preliminary drying compartment 9, a preliminary grinding compartment 11, and a final grinding compartment 12. The means separating the drying compartment 9 from the preliminary grinding compartment 11 comprises an annular plate 13 having a central opening 14; a lifting vane assembly consisting of a cylindrical ring 15, which is preferably removably secured to the inner periphery of the shell 2 by any suitable means such as bolts 16 and to the inner periphery of which is secured a series of circumferentially spaced inwardly extending radial vanes 17 which are generally I-shaped in cross-section, as best shown in Fig. 3, and a pair of annular rings 18 which are secured in any suitable manner, such as by welding or brazing to the opposite inner side portions of the vanes 17, as best seen in Figs. 1 and 2; a hollow cone member 19 having a flanged base portion 20 which is preferably removably secured to a ring 18 by any suitable means such as cap screws 21; and an annular series of lifting members 22, each of which has an arcuate bottom wall 23, an inwardly extending radial end wall 24, and an inwardly extending arcuate side wall 26. The inner edge of the side wall 26 is enlarged to provide an arcuate material deflecting portion 27. The lifting members 22 which are preferably removably secured to the inner periphery of the shell 2 by any suitable means such as the bolts 28, coact with each other and with the adjacent end wall portion of the shell 2 and define an annular series of lifting compartments 29.

Stated differently, the means defining and separating the drying compartment from the grinding compartment comprises a hollow partition structure including in axially spaced proximate relation a grinding compartment wall 13 having a central opening 14 therethrough and a drying compartment having an annular coaxial opening 31 therethrough formed by a central portion (cone member 19) positioned opposite and in air deflecting relation to the inlet opening in the reduced end portion 3 of the drum and in opposite shielding relation to the central opening 14 and by an outer annular material retaining portion (the abutting side walls 26 of lifting members 22) spacedly surrounding the central portion, that is the base of cone member 19. In this connection, it should be particularly noted that the inner diameter of the annular wall 13 is considerably less than the inner diameter of the outer annular material retaining wall portion formed by the abutting side walls 26 of lifting members 22, that the central opening 14 is of nearly the same diameter as the base of cone member 19, and that the annular coaxial opening 31 is in effect defined by radially spaced inner and outer wall portions (the base of cone member 19 and the side walls 26 of members 22) which extend nearly equal distances from the longitudinal axis and from the periphery of the drum, respectively.

The lifting vane assembly is disposed between the annular plate 13 and the side walls 26 of the lifting members 22 and the vanes 17 coact with said annular plate and side walls to define an annular series of lifting compartments 30. The cone member 19 is axially alined with the central opening 14 in the annular plate 13 and the apex of the cone extends into said opening and defines with the plate 13 an annular discharge opening placing the interior of the preliminary grinding compartment 11 in communication with the space between the lifting members 22 and the annular plate 13. The annular opening 31 defined between the inner edges of the side walls 26 of the lifting members 22 and the base portion 20 of the cone member 19 places the interior of the drying compartment 9 in communication with the space between said side walls 26 and the annular plate 13. When the shell 2 is rotating, material entering the space between said side walls and the said annular plate is elevated in the lifting compartments 30 and then gravitates onto the cone member 19 which directs the gravitating material through the opening 14 in the plate 13 and into the preliminary grinding compartment 11. Consequently, the cone member 19 and the lifting vane assembly disposed between the annular plate 13 and the lifting members 22 provide in effect a material conveying means which is operative when the shell is rotating to conduct the material passing through the annular opening 31 into the preliminary grinding compartment 11.

The means separating the preliminary grinding compartment 11 from the final grinding compartment 12 comprises an annular perforated plate 32 having a central opening 33 therein, a lifting vane assembly consisting of inner and outer pairs of axially spaced annular rings 34 and 36, respectively, between which are secured an annular series of circumferentially spaced radially extending spacing blades 37, and a circular plate 38 which, if desired, may be removably secured to the side surfaces of the adjacent inner and outer rings 34 and 36, respectively, in any suitable manner such as by bolts or screws (not shown). The annular perforated plate 32 may also be removably secured to the side surfaces of the adjacent inner and outer rings 34 and 36, respectively, in a similar manner. The shell is provided with an annular series of circumferentially spaced openings or slots 39 which places the interior of a collector housing 35 in communication with the space between the plates 32 and 38. The collector housing 35 is provided with a suitable material conveying means such as the helical screw 41. The interior of the final grinding compartment 12 is provided with any suitable grinding media such as the steel balls 42 and with ribbed or corrugated liner plates 43 which are preferably made in arcuate sections (not shown) removably secured to the inner periphery of the shell in any suitable manner, such as by the bolts 44. A circular plate 40, which closes the opening 33 in the plate 32 to prevent the coarse material and the grinding balls 42 from entering the space between the plates 32 and 38, is removably secured to the adjacent annular ring 34 by any suitable means (not shown).

The shell is also provided with a second annular series of circumferentially spaced openings or slots 46 disposed immediately adjacent the circular plate 38 to permit the passage of the

ground material from the preliminary grinding compartment 9 into the collector housing 35. Disposed in overlying relation with respect to that portion of the shell containing the annular series of openings 46 is a grating structure comprising a slotted filler ring 47 and a superimposed grate ring 48. The rings 47 and 48 are preferably made in arcuate sections 49 which are removably secured to the inner periphery of the shell 2 by any suitable means such as bolts (not shown). The purpose of employing two rings in superimposed relation is to reduce costs as the outer ring 47 may be made of a material which is less expensive than that of the inner ring 48 which must possess excellent wearing properties. The interior of the preliminary grinding compartment 11 is also provided with any suitable grinding media, such as the steel balls 51 and with ribbed or corrugated liner plates 52 which are preferably made in arcuate sections (not shown) removably secured to the inner periphery of the shell 2 by any suitable means such as bolts 53.

The reduced inlet end portions 3 and 4 of the shell 2 are provided with any suitable material introducing means such as the spouts 54 and 56, respectively. The inlet end portion 3 is also connected with a conduit 57 for conducting a heated gas, such as air, from the heater 58 shown in Fig. 5, into the drying compartment 9. The interior of the reduced inlet portion 3 is provided with one or more helical vanes 59 which operate when the shell is rotating to prevent the incoming moist material discharged from the spout 54 from backing up into the heated gas conduit 57. The reduced end portion 4 is provided with a cover plate 61 having a central opening through which the spout 56 extends.

Referring particularly to Fig. 5, it is seen that the collector housing 35 is also directly connected with the source of heated air and with a Sirocco type collector (any other suitable type of collector may be used) which in turn is connected with the suction fan and vent conduit or stack through a bag collector. The conveyer 41 which extends into the housing 35 is operatively connected with an elevator which in turn discharges the material received from the conveyer 41 into an air separator from which the fine ground or finished material is removed by a suitable conveyer preferably of the helical screw type as diagrammatically indicated. The rejects or coarse material present in the air separator is conducted to the spout 56 through which it passes into the final grinding compartment 12. The dust separated from the air in the Sirocco collector and in the bag collector is delivered to the conveyer 41 from which it passes into the air separator as previously described.

In the operation of the mill, heated gas flows into the rotating mill through the conduit 57 and the reduced inlet end portion 3 and then passes through the drying compartment 9, out through the annular discharge opening 31 and into the space including the lifting vanes 17, through the central opening in the circular plate 13 and into the preliminary grinding compartment from which it passes into the collector housing 35 through the grating comprising the rings 47 and 48. Moist material to be ground is delivered, preferably in a continuing stream, from a suitable source (not shown), through the feed spout 54 and into the drying compartment 9. The lifting members 22 operate to shower the material within the drying compartment through the stream of heated gas passing therethrough and to mix the showered partially dried and heated material with the incoming moist material. In this connection, it should be particularly noted that the base of hollow cone member 19 is disposed directly opposite to the inlet opening to the chamber 9, that the diameter of the base of said cone member is nearly equal to the diameter of said inlet opening, and that therefore the major portion of the heated gas passing directly through the curtain of showering material impinges against the open base end of cone member 19 and is directed thereby outward toward the peripheral portion of predrying chamber 9. In addition, it should also be noted that said inlet opening and the discharge opening 31 are in fact restricted relative to the diameter of the shell or drum 2, thereby providing the predrying chamber 9 with a pair of axially spaced restricted inlet and outlet openings. Consequently, the portion of the entering stream of heated gas directed outward by the open base end of cone member 19 impinges against that portion of said stream tending to pass directly into the annular discharge opening 31 and forms therewith a resultant stream of which at least a part enters the peripheral portion of chamber 9. In other words, the predrying compartment 9 is provided with means including said openings operative to cause heated gas to enter said compartment through one of said openings and at least a portion of said gas to flow outward and into contact with the peripheral portion of the substantially continuous curtain of showering material produced therein before leaving said compartment through the other opening, thereby quickly and efficiently drying a predetermined quantity of moist material to a selected degree in a predrying space or chamber of short axial length. This action continues until the lower portion of the drying compartment 9 becomes filled with material to a depth equal to the radial width of the side walls 26 of the lifting members 22 whereupon the introduction of additional moist material causes a commensurate quantity of the showered and partially dried material to pass through the annular opening 31 and into the space containing the lifting vanes 17. The additional moist material mixes with the showered and partially dried material remaining within the compartment 9 and the mixture is then showered through the stream of heated gas, as previously stated. Consequently, the moist material is subjected to two drying actions within the compartment 9, comprising (1) a preliminary drying action effected by mixing the moist material with the showered and partially dried and heated material, and (2) a further drying action effected by showering the mixture through the stream of heated gas.

The deflecting portions 27 on the side walls 26 of the lifting members 22 operate to direct the showering material away from the annular discharge opening 31, and since the lifting members 22 also operate to interpose a curtain of showering material between the incoming moist material and the said annular discharge opening, moist material is prevented from passing directly through the drying compartment without first being subjected to the mixing and showering actions previously pointed out. Stated differently, the introduction of additional moist material through the feed spout 54 causes some of the previously mixed and showered material to overflow into the space containing the lifting vanes

17 which operate to again shower the dried or partially dried material through the stream of heated gas which passes through said space and into the preliminary grinding compartment 11. Some of the material which is reduced to dust in the preliminary grinding compartment 11 is carried by the gas stream into the sirocco and bag collectors, as previously indicated in connection with the description of Fig. 5. The mixture of the coarser particles and dust is conducted by the conveyer 41 at the elevator shown in Fig. 5 for further separation and grinding as previously described.

Referring again to Figs. 1, 2 and 4, it should be particularly noted that the side walls 29 of the lifting members 22 provide an annular wall which is arranged in opposed and axially spaced relation with respect to the adjacent end wall of the shell tube; that the predrying compartment 9 is thereby defined by a pair of opposed wall portions spaced apart a relatively short distance with respect to the diametrically opposed inner wall portions of the shell 2; that the heated gas flows through the predrying compartment in an axial direction; i. e., in a direction approximately parallel to the aforementioned remaining opposed wall portions; that the lifting members coact with said end wall and with said annular wall and form therewith an annular series of lifting compartments surrounding a generally cylindrical showering space having a distance therethrough in an axial direction which is relatively short with respect to its diameter (compare Figs. 1 and 4); that when the shell 2 is rotating the lifting compartments shower material through said space in a direction approximately at right angles to the direction of gas flow and so as to form a substantially continuous and relatively thin curtain of showering material having relatively large oppositely facing side areas disposed approximately normal with respect to said direction of flow; that the curtain of showering material has a distance therethrough measured in the direction of gas flow which is relatively short with respect to the major dimension of said side areas; that the moist material is introduced into the predrying compartment on one side of the curtain of showering material and is moved substantially directly into contact and mixed with the showered material forming one side of said curtain; and that some of the showered material which forms the other side area of the curtain is removed from adjacent the bottom of the said other side of the curtain. In view of the foregoing it should be obvious that the disclosed and claimed procedure and apparatus permit a maximum degree of drying in a minimum space with a minimum quantity of heated gas.

The drying of moist material by (1) mixing moist material with dried and/or partially dried and heated material, (2) showering the mixture through a stream of heated gas, (3) withdrawing some of the showered mixture, and (4) mixing the remainder of the showered mixture with additional moist material preparatory to the showering thereof is of particular importance, as it can be readily accomplished without effecting an appreciable movement of the material in the direction of gas flow during the mixing and showering operations. Consequently, this procedure can be readily carried out in a relatively small compartment; i. e., a compartment having a distance therethrough in one direction which is relatively short with respect to the distance therethrough in a direction approximately at right angles to said one direction, simply by passing a stream of heated gas through said compartment in a manner effective to substantially fill said compartment with heated gas and effecting the previously stated mixing, showering, and withdrawing operations either manually or mechanically. The mixing operation can be readily carried out either within or outside of the drying compartment and the latter is preferred when the material is manually mixed.

The mechanism disclosed for inherently performing the mixing, showering, and withdrawing operations within a generally cylindrical drying compartment of relatively small axial length with respect to its diameter is also of importance, as it can be readily incorporated in a tube or other type of mill, thereby materially increasing its capacity without materially increasing the initial and operating costs. In this connection, an important feature of the mechanism is the provision of means, such as the lifting members 22, which coact with the adjacent structure to effect the mixing, the showering, and the withdrawing operations without effecting an appreciable movement of the material toward the grinding compartment thereby rendering the relatively deep lifting compartments formed within the predrying chamber 9 effective to act on the predetermined quantity of material retained therein and pass at least a portion of same between the inlet and outlet openings a plurality of times in a relatively thin and substantially continuous curtain of showering material having relatively large side surface areas opposing said openings. Moreover, the overflow action operating to cause material to pass from the drying compartment into the conducting means for conveying the material into the preliminary grinding compartment eliminates mounting the mill in an inclined position to effect a conveying action, thereby materially reducing bearing costs and maintenance.

The drying of moist material in the manner herein disclosed can be carried out by apparatus other than that shown and described for purposes of illustration, and it should be understood that it is not desired to limit the invention to the exact procedure and to the exact structure herein shown and described, as various modifications within the scope of the appended claims may occur to persons skilled in the art.

It is claimed and desired to secure by Letters Patent:

1. In a drying and grinding apparatus, the improvement comprising a drum having a coaxial inlet opening in an end wall thereof, means rotatably supporting said drum, a hollow partition structure disposed within said drum and defining in coaxial relation a grinding compartment and a drying compartment longitudinally spaced from each other, said partition structure including in axially spaced proximate relation a grinding compartment wall having a central opening therethrough and a dyring compartment wall having an annular coaxial opening therethrough, said drying compartment wall embodying a central portion positioned in opposite air deflecting relation to said inlet opening and in opposite effective shielding relation to said central opening and an outer annular material retaining portion spacedly surrounding said central portion, means between and including said walls operative when said drum is rotating to act on material entering the space between said walls and discharge same through said central opening, material showering elements positioned within said drying com-

partment, and means for introducing material to be dried and ground and a gaseous drying medium into said drying compartment through said inlet opening.

2. In a drying and grinding apparatus, the improvement comprising a drum having a coaxial inlet opening in an end wall thereof, means rotatably supporting said drum, a hollow partition structure disposed within said drum adjacent said end wall thereof and defining in coaxial longitudinally spaced relation a grinding compartment and a drying compartment having an axial length which is short relative to the diameter of the drum and relative to the axial length of the grinding compartment, said partition structure including in axially spaced proximate relation a grinding compartment wall having a central opening therethrough and a drying compartment wall having an annular coaxial opening therethrough, said drying compartment wall embodying a central portion positioned in opposite air deflecting relation to said inlet opening in opposite effective shielding relation to said central opening and an outer annular material retaining portion spacedly surrounding said central portion, means between and including said walls operative when said drum is rotating to act on material entering the space between said walls and discharge same through said central opening, material showering elements positioned within said drying compartment, and means for introducing material to be dried and ground and a gaseous drying medium into said drying compartment through said inlet opening.

3. In a drying and grinding apparatus, the improvement comprising a drum having a coaxial inlet opening in an end wall thereof, means rotatably supporting said drum, a hollow partition structure disposed within said drum adjacent said end wall thereof and defining in coaxial longitudinally spaced relation a grinding compartment and a drying compartment having an axial length which is short relative to the diameter of the drum and relative to the axial length of the grinding compartment, said partition structure including in axially spaced proximate relation an annular grinding compartment wall and a drying compartment wall comprising in radially spaced relation an outer annular material retaining portion having an inner diameter considerably greater than the inner diameter of said grinding compartment wall and an inner central portion positioned in opposite air deflecting relation to said inlet opening and in opposite effective shielding relation to the central opening defined by said grinding compartment wall, means between and including said walls operative when said drum is rotating to act on material entering the space between said walls through said annular opening and discharge same through said central opening, material showering elements positioned within said drying compartment, and means for introducing material to be dried and ground and a gaseous drying medium into said drying compartment through said inlet opening.

4. In a drying and grinding apparatus, the improvement comprising a drum having an axial inlet opening in an end wall thereof, means rotatably supporting said drum, a hollow partition structure disposed within said drum adjacent said end wall thereof and defining in coaxial longitudinally spaced relation a grinding compartment and a drying compartment having an axial length which is short relative to the diameter of the drum and relative to the axial length of the grinding compartment, said partition structure including in axially spaced proximate relation a drying compartment wall embodying a central portion of nearly the same diameter as said inlet opening and positioned in opposite air deflecting relation to said inlet opening and an outer annular material retaining portion spacedly surrounding and forming with said central portion an annular coaxial opening and an annular grinding compartment wall having an inner diameter considerably less than the inner diameter of said annular material retaining portion and defining a central opening disposed opposite and effectively shielded by said central portion, means between and including said walls operative when said drum is rotating to act on material entering the space between said walls through said annular opening and discharge same through said central opening, material lifting and showering elements positioned within said drying compartment, and means for introducing material to be dried and ground and a gaseous drying medium into said drying compartment through said inlet opening.

5. In a drying and grinding apparatus, the improvement comprising a drum having an axial inlet opening in an end wall thereof, means rotatably supporting said drum, a hollow partition structure disposed within said drum adjacent said end wall thereof and defining in coaxial longitudinally spaced relation a grinding compartment and a drying compartment having an axial length which is short relative to the diameter of the drum and relative to the axial length of the grinding compartment, said partition structure including in axially spaced proximate relation a drying compartment wall and a grinding compartment wall, said drying compartment wall embodying radially spaced inner and outer wall portions which extend nearly equal distances outward and inward from the longitudinal axis and from the periphery of said drum, respectively, and said grinding compartment wall having a central opening therethrough of nearly the same size as said inner wall portion and disposed opposite same, means between and including said walls operative when said drum is rotating to act on material entering the space between said walls through said annular opening and discharge same through said central opening, material lifting and showering means positioned within said drying compartment, and means for introducing material to be dried and ground and a gaseous drying medium into said drying compartment through said inlet opening.

6. In a drying and grinding apparatus, the improvement comprising a drum having end portions of reduced diameter rotatably supported on axially spaced bearings, one of said end portions having an inlet opening extending axially therethrough, a hollow partition structure disposed within said drum adjacent said one end portion and defining in coaxial longitudinally spaced relation a grinding compartment and a drying compartment having an axial length which is short relative to the diameter of the drum and relative to the axial length of the grinding compartment, said partition structure including in axially spaced proximate relation a drying compartment wall embodying a central portion of nearly the same diameter as said inlet opening and disposed opposite same and an outer annular material retaining portion spacedly surrounding and forming with said central portion

an annular coaxial opening and a grinding compartment wall spaced from said drying compartment wall and having a central opening therethrough of nearly the same diameter as said central portion and disposed opposite same, means between and including said walls operative when said drum is rotating to act on material passing from said drying compartment through said annular opening and into the space between said walls and discharge same through said central opening into the grinding compartment, circumferentially spaced radially extending lifting and showering elements uniting the outer annular portion of said drying compartment wall with the opposed end portion of said drum, and means for introducing material to be dried and ground and a gaseous drying medium into said drying compartment through said inlet opening.

7. In a drying and grinding apparatus, the improvement comprising a drum having end portions of reduced diameter rotatably supported on axially spaced bearings, one of said end portions having an inlet opening extending axially therethrough, a hollow partition structure disposed within said drum adjacent said one end portion and defining in coaxial longitudinally spaced relation a grinding compartment and a drying compartment having an axial length which is short relative to the diameter of the drum and relative to the axial length of the grinding compartment, said partition including a drying compartment wall embodying a coaxially disposed hollow cone-like member having a base of nearly the same diameter as said inlet opening and disposed opposite same and an outer annular material retaining portion spacedly surrounding and forming with the base of said cone member an annular coaxial opening and a grinding compartment wall having a central opening therethrough of nearly the same diameter as the base of said cone member and toward which extends the apex thereof, spaced, radially extending lifting elements uniting the outer opposed wall portions of said partition structure, spaced radially extending lifting and showering elements uniting the annular portion of said drying compartment wall with the opposed end portion of said drum, and means for introducing material to be dried and ground and a gaseous drying medium into said drying compartment through said inlet opening.

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