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METHOD AND APPARATUS FOR COMMINUTING MATERIALS

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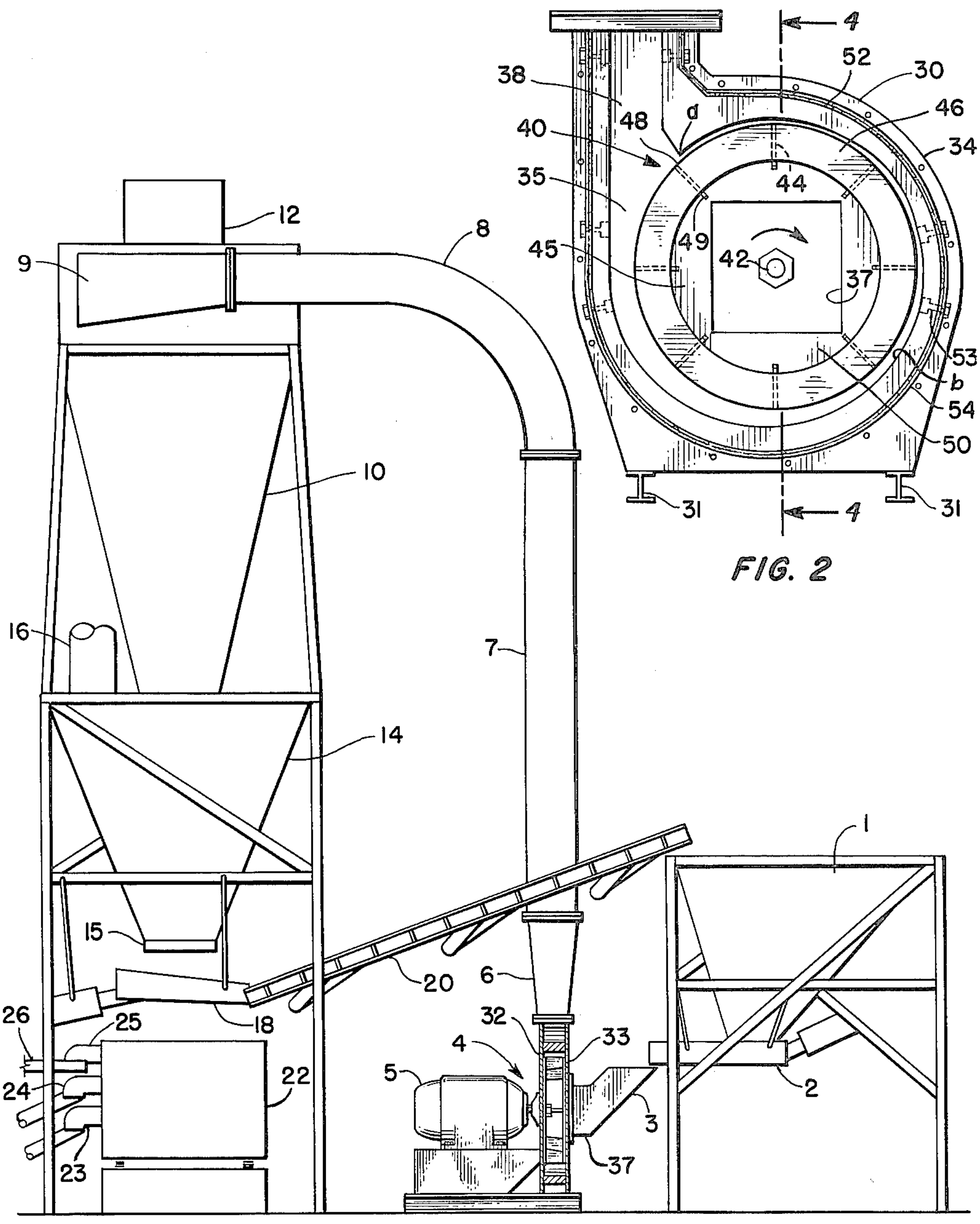

FIG. 2

FIG. 1

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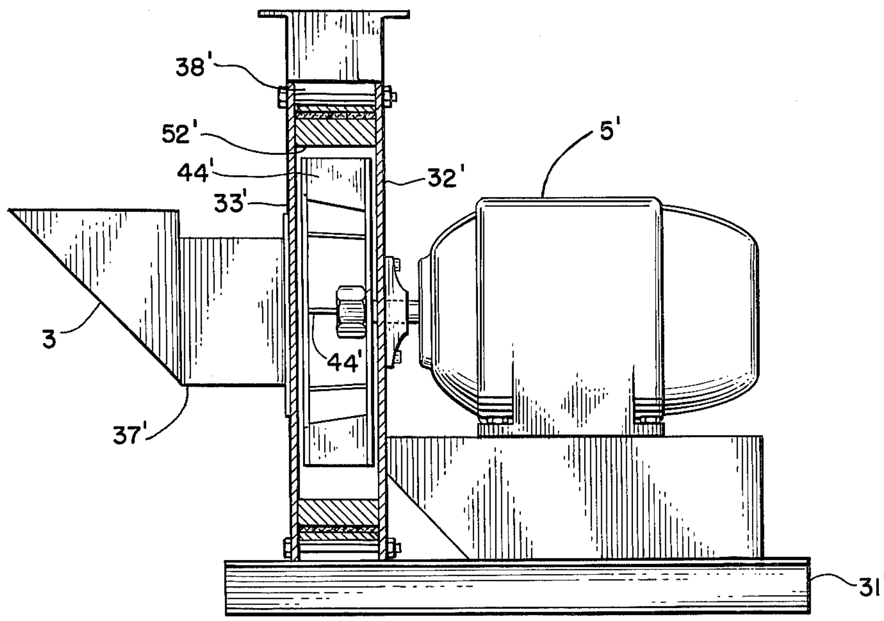

FIG. 4

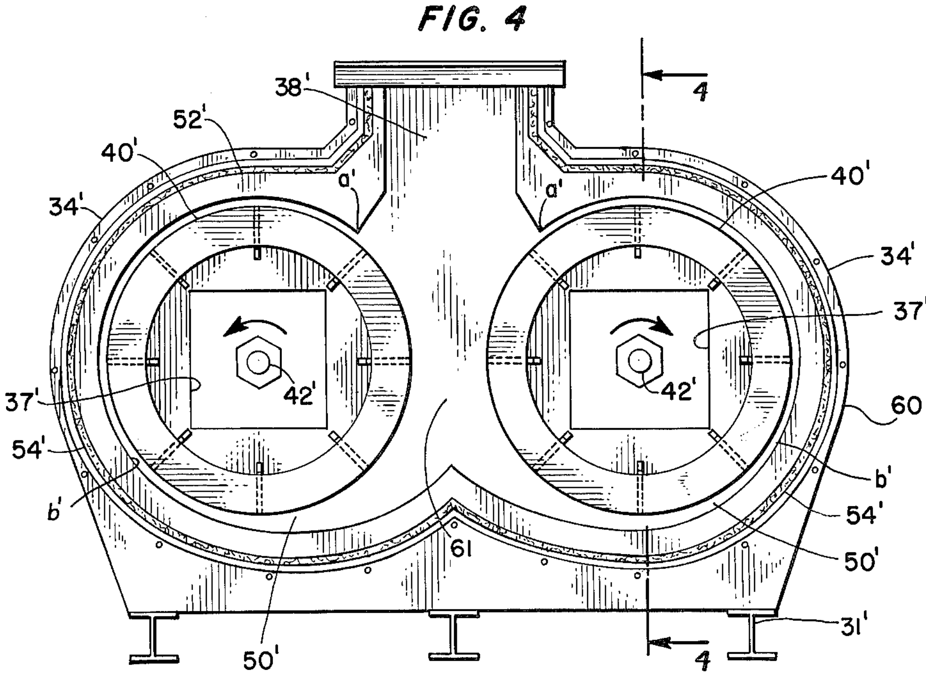

FIG. 3

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METHOD AND APPARATUS FOR COMMINUTING MATERIALS

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20 Claims. (Cl. 241—5)

This invention relates to a novel and improved method and apparatus for comminuting solid materials into particles of very fine mesh size; and, more particularly relates to a method and apparatus for preferentially grinding solid materials, such as, rocks or granular materials in such a way as to bring about virtually complete division or separation of each of the material constituents into particles of a common, very fine mesh size to enable accurate classification thereof, and to do so in an extremely rapid manner with negligible wear on moving parts.

Various methods and means have been devised heretofore for grinding or pulverizing solid materials. Nevertheless, in the use of conventional methods and means now available, it is still difficult to grind many materials to a state whereby the more valuable constituents contained therein are reduced to a common size so as to be susceptible of accurate classification and recovery in an efficient manner. For example, grinding the material through a multiplicity of stages or cycles, especially in centrifugal apparatus, has in the past been found to be time consuming and inefficient insofar as successful recovery of a high percentage of the desired constituents is concerned. Also, conventional apparatus employed for this purpose is quite often subjected to an unduly high amount of wear and results in the production of a considerable amount of dust and superfine mesh material.

It is therefore proposed, as a primary feature of the present invention, to create the necessary conditions under which dry solid materials, particularly rock and granular material of varying degrees of toughness and hardness may be preferentially ground; that is, the particles of any one predominant material contained in the matrix will grind upon themselves and in doing so reduce themselves and the more valuable constituents to be recovered to extremely fine, distinctive mesh sizes permitting highly accurate classification and screening. It is more specifically proposed to accomplish the above in a single cycle of operation so as to prevent overgrinding of the material, undue wear and to considerably reduce the time element involved.

Accordingly, it is a principal and foremost object of the present invention to provide for an improved method and apparatus for comminuting solid materials into particles of very fine mesh sizes and characterized by the fact that the individual material constituents can be easily and separately classified for extremely high percentage recovery.

It is another object of the present invention to make provision for a novel method and means of grinding and pulverizing dry solid materials in a single cycle or stage of operation and in such a way as to substantially eliminate wear on the moving parts of the apparatus and avoid overgrinding, thus to prevent production of dust or overly fine particles, and while permitting the high efficient recovery of desired material constituents.

It is a further object of the present invention to make provision for a method and centrifugal grinding apparatus for comminuting rocks and granular materials of varying degrees of hardness and toughness into particles of extremely fine mesh size into the minus range, and specifically in such a way as to bring about preferential grinding of such materials whereby the materials will grind upon themselves rather than upon the moving parts of the apparatus for most effective recovery of the desired constituents; moreover, where the method is continuous and carried out in a minimum number of steps.

It is an additional object to provide for a continuous and automatic method of grinding dry solid materials into particles of the desired mesh size and where the entire process can be accurately controlled in accordance with the size and characteristics of the material for maximum recovery of the desired constituents; and more specifically, whereby the materials are continuously and automatically handled through a rapid succession of steps including those of crushing, preferential grinding, classification and screening.

It is still an other object of the present invention to make provision for apparatus enabling maximum recovery of ore from rock particles in which the particles are entrained in an air stream for controlled, preferential grinding in a single cycle of rotation for complete disintegration thereof into particles of the desired mesh size and in such a way as to enable substantially complete separation and recovery of the more valuable ore materials therefrom.

The method and apparatus of this invention have been successfully employed in the continuous and automatic separation and recovery of valuable constituents from either dry or wet solid materials, and has been most effectively utilized in the reduction of mine ore, such as, pegmatite ore, asbestos, aluminum dross, bentonite and many others. Essentially, in accordance with the present invention, the raw materials is first crushed to a sufficiently reduced size to be easily picked up by a moving high velocity air stream induced to flow into a high speed rotor unit of unique design and in which sufficiently high speeds of rotation are developed in the rotor in relation to the velocity of the air stream so as to form eddy currents within the rotor between the rotor blades and whereby these eddy currents are restricted to remain between the blades by creating a high pressure peripheral zone along at least part of the cycle of rotation; and, this zone is progressively reduced in pressure toward the end of the cycle for expulsion of the materials from the rotor into an outlet for subsequent classification and screening. The particles entrained in the eddy currents undergo preferential grinding as described, most likely through a rapid series of violent collisions with one another with sufficient impact to disintegrate into particles of fine mesh size. The degree or extent of disintegration can be closely regulated by the air flow velocity and pressure differential established between the outlet and inlet, as well as pressure conditions within the rotor housing.

The above and other objects, advantages and features of the present invention will become more readily understood and appreciated from a consideration of the following detailed description of preferred and alternate forms of the present invention, taken together with the accompanying drawings, in which:

FIGURE 1 is a view in elevation showing a typical form of installation for carrying out the method of the present invention;

FIGURE 2 is a front view with the cover removed of one form of centrifugal grinding apparatus employed with the method shown in FIGURE 1 and constructed and arranged in accordance with the present invention;

FIGURE 3 is a front view, again with the cover removed, of another preferred form of grinding apparatus utilized in the installation shown in FIGURE 1, and also constructed and arranged in accordance with the present invention; and

FIGURE 4 is a view taken on line 4—4 of FIGURE 3 and showing also the drive means for the apparatus.

Referring in more detail to the drawings, there is shown by way of illustrative example of the method of the present invention in FIGURE 1 a material grinding and classifying installation wherein a raw material feed bin 1 converges into a vibratory feeder unit 2 which in turn conveys the material from the feed bin into a chute 3 for a centrifugal grinding apparatus 4, the latter in construction and operation constituting a principal feature of the present invention. A pair of variable speed drive motors are represented at 5, and a transition 6 leads upwardly from the outlet side of the grinding apparatus 4 through a vertical duct 7 and elbow-shaped duct 8 into a receiver 9 located at the upper end of a cyclone 10. Stack 12 serves as a discharge from the cyclone to the atmosphere, and the cyclone in turn converges into a sealed bin 14 having a weight-controlled gate 15 and an exhaust stack 16 to relieve air pressure in the bin and away from the gate 15. Suspended in spaced relation directly beneath the gate 15 is a screening feeder 18 which slopes into a vibrating conveyor 20 in order to feed back oversize material to the feed bin 1. Located beneath the feeder 18 is a triple-deck vibrating screen unit 22 to receive material passing through the oversize feeder 18, each screen, not shown, including a spout with a series of three spouts 23, 24 and 25 being illustrated to convey material away from each screen. A vacuum source may be utilized to draw the materials off of the screens of the unit 22 and of course, the vacuum head will vary depending upon the mesh feed size of each screen.

To better illustrate the particular mode of operation of the installation described in relation to the preferential grinding or comminuting of a specific material, the operation will be described in connection with the grinding and recovery of mica and beryl constituents from a pegmatite ore. Initially, the ore material is first crushed and rolled to a small particle size, for example, on the order of a —½" size and deposited in the feed bin 1. A high-speed rotor, to be described, in the grinding apparatus will create a high capacity, high velocity air stream flowing through the chute 3, grinding apparatus 4 and duct systems 6–8 into the cyclone. The particles delivered into the chute 3 are picked up by this air stream and sucked with the air stream through the grinding apparatus 4, wherein a high-speed rotor is specially designed to cause the particles to undergo preferential grinding as described in order to bring about reduction to very fine particle sizes for discharge through the duct systems 6–8 into the cyclone 10. The fine particles delivered into the bin 14 are selectively released through gate 15 for screening. As an example, the +20 mesh screen size may be returned for regrind along the conveyor 20 and since the mica is completely foliated at this stage, any minor amounts thereof drawn off onto the conveyor 20 may be removed by a suitable vacuum operation, not shown. By far the major quantities of mica will continue through oversize screen 18 for collection in the unit 22. The three decks referred to for the purpose of illustration in the unit 22 may have screens for collecting various size ranges, such (1) from 20 to 35 mesh material, (2) from 35 to 60 mesh material, and (3) from 60 to 80 mesh material. Mica contained in the material collected on the first screen can then be vacuumed off as described and any beryl chips collected on the second screen may pass by gravity through the spout 24 for separate collection. The lower screen material may separately be discharged and conveyed through spout 23 to a waste pile since generally in this finer mesh size there will be very little in the way of any recoverable beryl values or mica.

Of course, classification in the manner described is achieved as a result of the particular character and nature of preferential grinding in the centrifugal grinding apparatus 4 whereby the individual ore constituents are reduced to common size ranges for separate collection. By way of particular reference to FIGURE 2 in conjunction with FIGURE 1, it will be seen that one form of grinding apparatus is defined by a generally circular housing 30 mounted on floor supports 31 having opposite, vertical back and front end walls 32 and 33, respectively, interconnected by an outer peripheral wall portion 34 so as to form a circular chamber area 35 of limited width. Arranged coaxially in relation to the chamber is a horizontal feed inlet 37 extending from the chute 3, and a tangential, upwardly directed outlet 38 forms a vertical extension from one side of the peripheral wall portion 34 for connection into the transition duct 6. It will be noted from FIG. 4 that the sloping chute 3 terminates in a horizontal section of substantial length which connects it with the inlet entrance. In cross section, both the inlet 37 and outlet 38 are generally rectangular or square and it will be noted that the inlet 37 is centered in relation to the chamber area 35. A rotor 40 is mounted for rotation within the chamber area 35 having a central drive shaft 42 extending horizontally through the housing from the drive motor 5. A series of radial impellers or blade elements 44 are mounted at spaced circumferential intervals about the central drive shaft 42 and also in spaced relation thereto between a pair of opposed closure discs, there being a back circular closure disc or plate 45 and a front annular disc or plate 46. The back plate 45 is keyed for rotation on the central drive shaft 42 and preferably serves as the sole means of interconnection between the drive shaft and impeller blades 44, the latter being mounted with outer edge portions 48 aligned with the outer peripheral edge of the back plate 45. Similarly, the front plate 46 has its outer edge aligned with the outer peripheral edges 48 of the impellers and the outer peripheral edge of the back plate so as to form a central open area or cavity 50 within the rotor. Inner inclined edges 49 of the impeller terminate preferably just outside the inlet, in forming the cavity 50, so that the materials flowing into the chamber will not be contacted by the impeller blades, and specifically to enable a flow stream pattern to be established within the rotor before the particles are carried between the blades toward the outlet area.

Of particular importance is the outer peripheral zone formed between the chamber wall 34 and the outer peripheral surface of the rotor 40. As noted, an insert or lining 52 is affixed to the inner surface of the wall 34 by means of suitable connecting bolts 53, which lining may be composed of a high strength alloy material, such as steel, and a felt or other resilient composition pad 54 is interposed between the insert and the chamber wall. The insert in cooperation with the chamber wall defines a peripheral clearance zone to establish a high pressure or limited clearance area beginning at the point *a* at which the impellers have completed their movement through the outlet over to point *b*, or for substantially one-half the cycle of rotation; then, the zone forms or continues into a divergent clearance area from the point *b* into the outlet so as to effectively form a progressively reduced pressure zone for the remainder of the cycle of rotation into the outlet. The relative pressure established between the outer peripheral zone and the inlet will of course influence the movement of particles in the air stream particularly to regulate the rate of movement from the central cavity of the rotor outwardly into the clearance area for discharge through the outlet, bearing in mind that the centrifugal force of the rotor will tend to induce the outward movement of the particles with the air stream through the outlet.

Now considering in more detail the relationship between the flow of air through the grinding apparatus to the pressure conditions established therein, the air stream itself is developed by the high speed of rotation of the rotor and is controllable in capacity or volume to be sufficiently high to pick up and actually entrain the particles at the materials inlet; thus, the particular manner of flow of particles through the apparatus will be completely controlled by the flow pattern of the air stream. In turn, the pressure conditions in the grinding apparatus will influence the pattern of flow of the air stream as also will the relative size, or pressure differential, between the outlet and inlet. For this reason, the inlet area is made larger in relation to the outlet area so as to establish a greater pressure at the inlet along with a relatively low pressure, high velocity area at the approach to the outlet. The speed of rotation of the rotor will affect the turbulence and other flow characteristics of the air stream entering the rotor and under high speeds of rotation it is believed that as the air stream is forced to undergo an abrupt change in direction, before actually reaching the outer impeller zone, eddy currents will be formed within the rotor causing violent collision between the particles. These eddy currents will advance progressively outwardly between the impeller blades, due mainly to the centrifugal force of the rotor, but will be limited in outward movement by the high pressure zone formed at the periphery of the rotor, since this zone effectively forms a cushion of air preventing the outward movement of particles beyond the impeller area. This is premised on the fact that the inner surface of the insert or lining exhibits negligible wear with practically no evidence of impact between the particles and inner surface. In this connection, the impeller surfaces are notably free of wear or impact, also. However, as the impellers advance toward the divergent clearance area, the particles in turn will be free to move outwardly toward this clearance zone but will nevertheless remain in the air stream and flow with the air stream through the outlet and into the cyclone **10** after one complete cycle of rotation.

A preferred form of preferential grinding apparatus is shown in FIGURES 3 and 4 where a pair of rotors **40'** are mounted in spaced side-by-side relation on parallel, horizontal drive shafts **42'**. Here, the rotors **40'** are constructed and arranged identical to the rotor arrangement **40** of the form shown in FIGURE 2 and accordingly, like parts are correspondingly enumerated; however, the rotors are mounted within a single housing **60** which effectively forms a pair of juxtaposed chamber areas **50'** communicating through a common discharge area **61** with an outlet **38'**. Separate inlets **37'** are arranged in coaxial relation with each of the respective chamber portions **50'** as in the form of FIGURE 2. To establish the desired clearance area between the chamber wall **34'** and each respective rotor **40'**, a common insert **52'** as before establishes a limited clearance area throughout substantially one-half the circumferential extent of the rotors from points *a'* to *b'* then diverges gradually away from the outer periphery of the adjacent rotor into a comon area leading to the outlet **38'**. It will be noted, as indicated, that the directions of rotation of the rotors are opposite to one another so that the rotors will convey the air stream from the inlet in opposite directions away from one another then in opposite directions toward one another as the impeller blades approach the outlet; and again, the entrained particles will become violently intermixed and collide with one another as they pass through the rotor into the outlet.

It has been found that the particular relationship established between the rotors within the chamber area provides a most effective means of grinding and permits volume handling of materials at optimum efficiency substantially greater than merely double that afforded by the single unit. For this reason, the double rotor arrangement is greatly preferred and results in considerably less wear due to the fact that negligible amounts of oversize material are left at the end of each complete cycle of rotation while more than doubling the feed capacity of the system. To establish the desired flow and pressure conditions in the preferred form of apparatus, again the inlet sizes together are of greater crosssectional area than the common outlet and the clearance area established between the chamber wall and the outer peripheral surfaces of the rotor is such as to completely contain the particles for movement within eddy currents created within the rotor and specifically between the impeller blades. As stated before, the material particles will gradually move outwardly under reduced pressure in the divergent clearance area for eventual discharge through the outlet at the end of each cycle. For the purpose of illustration, in the practice of the present invention, a rotor 18" in diameter rotating at a speed of 3,600 r.p.m. will have a capacity on the order of 4–6 tons of material per hour. At the same speed, a rotor 24" in diameter will have an increased capacity of 15–17 tons per hour. Of course, the speed and capacity will vary somewhat depending upon the nature and properties of the material being ground.

In either form, the cooperative disposition and arrangement between the rotor and housing, as well as the relation between inlet and outlet has been found to create the necessary pressure and flow conditions for preferential grinding. More specifically, the outer spaced disposition of the impellers to the feed inlet is thought to permit the air stream to establish its own pattern of flow within the rotor before movement between the impellers; the high pressure zone contains the air stream within the blade area where the grinding action takes place, for the most part; and the divergent area in cooperation with the pressure differential between inlet and outlet induces the air stream to move through the discharge zone into the outlet at the end of the cycle, rather than to reenter the rotor area and otherwise disrupt the flow cycle, causing wear on the elements and overgrinding of the materials.

The method and apparatus of the present invention have been found to have particularly good application in the grinding of clays, rocks, grains and hays, either in the wet or dry state. Materials such as pegmatite ore for the recovery of mica and beryl, perlite, coal, gypsum, gold, graphite and innumerable others have been effectively ground to a finely divided state.

Preferential grinding as mentioned is therefore accomplished due to the preponderance of the percentage of any one material in the head feed. For example, if quartz and feldspar in a pegmatite ore are combined and represent 80 percent of the head sample, they will grind upon themselves and the desired material in the ore. In this example, mica is foliated, but remains in size, and is scalped away at the screening stage. Another example is in the separation and grinding of serecite mica. The preponderant percentage of this ore is mica. The quartz and kyanite crystals present in the ore are of a small percentage of the head sample, amounting to 10 to 20 percent. The mica is ground and the tramp rock, having nothing to grind against due to difference in hardness and the specific gravity of the material, remains in size and thus the rock is scalped away and the serecite mica is screened through a 20 mesh screen and is rock free and a merchantable product.

It will be apparent that the grinding apparatus can be used in various installations other than the particular arrangement shown in FIGURE 1. Also, an additional source of vacuum at the outlet can be provided to supplement that created by the rotor, if desired. Various other modifications and changes can be incorporated into the method and apparatus of the present invention without departing from the scope thereof as defined by the appended claims.

What is claimed is:

1. In a grinding apparatus, a housing forming a chamber including an outer peripheral wall portion, a materials feed inlet communicating with the central area of the chamber and an outlet leading upwardly from said chamber at one side thereof, a rotor mounted for rotation within said chamber, said rotor being defined by a series of radial impellers arranged at spaced circumferential intervals about a central drive shaft and including means mounting said impellers in outer spaced relation to the drive shaft outside the central area, rotor drive means for driving said rotor, and said peripheral wall portion forming in relation to the outer periphery of said rotor a limited clearance area extending substantially one-half the circumference of said rotor and gradually diverging into said outlet thereby with sufficient rotational speed of said rotor to contain said materials between said impellers along the limited clearance area and to permit their gradual outward movement near the end of each cycle for discharge upwardly through the outlet.

2. Apparatus for comminuting solid materials into particles of small size, comprising a housing providing a pair of opposed chambers arranged on spaced parallel axes and including a common discharge zone therebetween, a horizontal feed inlet communicating with the central area of each chamber and a common outlet extending vertically upwardly from the discharge zone; a rotor being mounted for rotation on a horizontal axis within each chamber, each rotor including a series of circumferentially spaced, radial impellers and support means mounting said impellers for rotation in outer spaced relation to the axis of rotation so as to form a central cavity in communicaiton with said feed inlet, rotor drive means for driving said rotors in opposite directions toward said outlet as selected speeds of rotation sufficient to draw air and entrained materials from the inlet into the central cavity and to discharge same through said outlet; and said housing forming in relation to the outer peripheries of said rotors limited clearance areas along the outer peripheries of said rotors extending a distance substantially one-half the circumference of said rotors and diverging into the discharge zone thereby to contain said materials between said impellers along the limited clearance area and to permit their gradual outward movement into the discharge zone for removal upwardly through said outlet.

3. Apparatus according to claim **2**, said support means for each rotor being defined by a circular disc closing one side of said rotor opposite said feed inlet and an annular disc secured to the radial sides of said impellers adjacent to said feed inlet.

4. Apparatus for comminuting solid materials into particles of small size, comprising a housing providing a pair of opposed chambers arranged on spaced parallel axes and including a common discharge zone therebetween, a horizontal feed inlet communicating with the central area of each chamber and a common outlet extending upwardly at the discharge zone from near sides of said chambers, said inlets together being greater in cross-sectional area than said outlet; a rotor being mounted for rotation on a horizontal axis within each chamber, said rotor including a central cavity aligned with said feed inlet, a series of radial impellers mounted for rotation at spaced circumferential intervals around the cavity and rotor drive means for driving said rotors in opposite directions toward said outlet at selected speeds of rotation sufficient to draw air and entrained materials from the inlet into the central cavity and at a pressure differential between the inlet and outlet in relation to the direction and speed of rotation of said rotors whereby the materials are caused to undergo substantially a complete cycle of rotation before discharge through said outlet; and said housing forming in relation to the outer peripheries of said rotors a high pressure air space along the outer peripheries of said rotors extending a distance of substantially one-half the circumference of said rotors and diverging gradually into the discharge zone thereby to contain said materials between said impellers along the air space and to permit their gradual outward movement into the discharge zone for removal through said outlet.

5. In apparatus for comminuting solid materials into particles of small size having a housing providing a pair of opposed chambers arranged on spaced parallel axes and including a common discharge zone therebetween, a feed inlet communicating with the central area of each chamber and an outlet extending vertically upwardly from the discharge zone, the combination therewith of a rotor being mounted for rotation on a central drive shaft within each chamber, each rotor including a series of radially extending blade elements traversing the substantial width of the chamber, a circular disc mounting said elements for rotation in outer spaced relation to the drive shaft with a central cavity formed between the drive shaft and said blade elements in communication with said feed inlet and an annular disc secured to the radial sides of said blade elements on the side adjacent said feed inlet, rotor drive means for driving said rotors in opposite directions toward said outlet at selected speeds of rotation sufficient to draw air and entrained materials from the inlet through the central cavity and at a pressure differential between the inlet and outlet in relation to the direction and speed of rotation of said rotors whereby the materials are caused to undergo a substantial reduction in size before discharge through said outlet; and said housing forming in relation to the outer peripheries of said rotors limited clearance areas along the outer peripheries of said rotors extending a distance substantially one-half the circumference of said rotors and diverging into the discharge zone thereby to contain said materials between said impellers along the limited clearance area and to permit their gradual outward movement into the discharge zone for removal through said outlet.

6. In apparatus according to claim **5**, each of said blade elements being generally rectangular in shape and having a lower edge inclining downwardly and in a direction away from said feed inlet.

7. Grinding apparatus comprising: an arcuate shaped casing means having a substantially horizontal feed inlet and a substantially vertical outlet; a rotor mounted for rotation in said chamber with its outer periphery adjacent the inner arcuate periphery of said casing means to form a circumferential clearance area between said peripheries, the width of said clearance area being substantially constant from said outlet to a distance substantially one-half the circumference of the rotor and from that point gradually increasing to the area of the outlet; means for rotating said rotor; said rotor comprised of a flat back plate joined to an annular front plate by circumferentially spaced impeller blades; said inlet positioned opposite said back plate and to deliver material to be ground internally of said rotor and in a direction substantially parallel to the axis of said rotor; said outlet being positioned substantially perpendicular to said axis and tangential to the periphery of said rotor and upwardly thereof.

8. Apparatus of claim **7** in which said outlet is flared outwardly at its entrance in the area adjacent said rotor.

9. Apparatus of claim **7** in which the ends of said impeller blades are angled downwardly from the side adjacent said inlet.

10. Apparatus of claim **7** in combination with screen and conveyor means for returning material passing through said apparatus to said inlet for regrinding.

11. Grinding apparatus comprising: arcuate shaped housing means having inlet means and outlet means and defining at least two internal chambers; a rotor mounted in each of said chambers on substantially parallel shafts with the rotors in substantially radial alignment and with their peripheries adjacent the internal periphery of said housing means to form a channel between the periphery of each rotor and the housing means; impeller means on said rotors for retaining material to be ground as the rotors rotate; means for rotating said rotors in opposite directions with respect to each other with their adjacent peripheries traveling upwardly to create an outlet fluid stream between the rotors traveling upwardly in the direction of said outlet and comprised of the combined fluid streams created by said rotors rotating in opposite directions; said inlet means being positioned to deliver material to be ground internally of at least one of said rotors; said outlet means extending upwardly and being positioned above a line joining the centers of said rotors; the ratio of the combined cross-sectional area of said inlet means to the combined cross-sectional area of said outlet

means being such that a pressure differential is created at the entrance of the outlet means between said inlet means and said outlet means with the rotors rotating.

12. The apparatus of claim 11 in which the internal surface of said housing means is provided with a raised portion in the area between said rotors and said outlet is flared outwardly at its entrance area.

13. The apparatus of claim 11 in combination with screen and conveyor means for screening and returning oversize material to said inlet to be reground.

14. Grinding apparatus comprising: arcuate shaped housing means defining two chambers and having at least two inlets and a common outlet for said chambers; a rotor mounted in each of said chambers on substantially parallel shafts with the rotors in substantially axial alignment and with their peripheries adjacent the internal periphery of said housing means to form a channel between the periphery of each rotor and the housing; the width of said channel being substantially constant from said outlet to a distance substantially one-half the circumference of the rotor and from that point gradually increasing to the end of the channel; said rotors comprised of a flat back plate joined to an annular front plate by circumferentially spaced impeller blades; means for rotating said rotors in opposite directions with respect to each other with their adjacent peripheries traveling upwardly to create an outlet fluid stream between the rotors traveling in the direction of said outlet and comprised of the combined fluid streams created by said rotors rotating in opposite directions; the inlet for each rotor being positioned to deliver material to be ground internally of said rotor; said outlet being positioned above a line joining the centers of said rotors; the ratio of the combined cross-sectional area of said inlets to the combined cross-sectional area of said outlet being such that a pressure differential is created at the entrance of the outlet between said inlet and said outlet with the rotors rotating.

15. Apparatus of claim 12 in which the internal surface of said housing means is provided with a raised portion in the area between said rotors, said outlet is flared outwardly at its entrance area, and said impeller blades are angled downwardly from the inlet side and protrude beyond the inner periphery of said annular front plate.

16. The method of fluid grinding of material which comprises entraining particles of the material in two separate high velocity air streams; drawing each air stream through a separate inlet into respective confined areas having a common outlet and each area surrounded by a series of rotating blade elements; continuously rotating the two series of blade elements in opposite directions to each other at a sufficiently high speed of rotation to induce the air streams and entrained particles to enter between the blade elements; confining within the area circumscribed by said rotating blade elements substantially all the material being ground for approximately one-half of each cycle of rotation thereof by creating a substantially constant high pressure peripheral zone bordering each series of blade elements along substantially one-half of each cycle of rotation thereof followed by gradually releasing, throughout the remaining one-half of each cycle, from within said circumscribed area by said rotating blade elements, the material which has been ground to a predetermined fineness by creating an outer peripheral zone of progressively reduced pressure throughout said approximate remaining one-half of each cycle; impinging said air streams against each other angularly and upwardly in the direction of and through said outlet; controlling said speed and the relative sizes of the combined cross-sectional areas of said inlets and the cross-sectional area of said outlet to maintain sufficient pressure differential therebetween to expel said particles through said outlet.

17. In a grinding apparatus, an arcuately shaped housing means having an inlet and an outlet and defining a pair of internal chambers, a rotor mounted in each of said chambers on substantially parallel shafts with the rotors in substantially radial alignment and a portion of their peripheries disposed adjacent respective portions of the internal periphery of said housing means to form a channel between the periphery portions of each rotor and the respective internal periphery portions of the housing means, impeller means on said rotor for containing material to be ground as the rotors rotate, means for rotating said rotors in opposite directions with respect to each other with their adjacent peripheries traveling upwardly to create an outlet fluid stream between the rotors, said fluid stream traveling upwardly through said outlet and comprising the combination of the fluid streams created by said rotors rotating in opposite directions, said inlet means being positioned to deliver material to be ground internally of at least one of said rotors, and said outlet means extending upwardly and being positioned above a line joining the center of said rotors.

18. Apparatus for comminuting solid particles comprising a pair of rotors mounted for rotation about parallel horizontal axes and each having a series of spaced radially extending impact-impeller blades surrounding an entrance chamber open axially in one direction, means for driving the rotors in opposite directions with their bottoms approaching one another, a housing for said rotors including inlet means for feeding an air stream and solid particles into each entry chamber and providing an outlet above the zone of proximity of the rotors whereby the particles moving downwardly into the path of the blades from the entrance chambers will be thrown by the blades in merging streams moving generally in the direction of the outlet, wall means having close clearance with the blades, for substantially reducing the flow of air therebetween, along a substantial arcuate portion of the path of the blades in the region upwardly of the entrance chamber for concentrating the flow of air somewhat in the downward direction in which gravity tends to move the particles; and peripheral walls beyond said wall means, in the directions of rotation, of convolute form providing passages of increasing cross section surrounding the rotors in the directions of rotation for conducting the air streams and any particles therein smoothly and at high velocity through the outlet.

19. Apparatus for communiting solid particles comprising a rotor mounted for rotation about a horizontal axis and having a series of spaced radially extending impact-impeller blades surrounding an entrance chamber opening axially in one direction, means for driving the rotor in a given direction, a housing for said rotor including inlet means for feeding an air stream and solid particles into the entry chamber and providing an outlet spaced in the direction of rotation from the lower portion of the rotor whereby the particles moving downwardly into the path of the blades from the entrance chamber will be thrown by the blades through the outlet, and wall means having close clearance with the blades, for substantially reducing the flow of air therebetween, along a substantial arcuate portion of the path of the blades in the region upwardly of the entrance chamber for concentrating the flow of air somewhat in the downward direction in which gravity tends to move the particles.

20. Apparatus for comminuting solid particles comprising a rotor mounted for rotation about a horizontal axis and having a series of spaced radially extending impact-impeller blades surrounding an entrance chamber opening axially in one direction, means for driving the rotor in a given direction, a housing for said rotor including inlet means for feeding an air stream and solid particles into the entry chamber and providing an outlet spaced in the direction of rotation from the lower portion of the rotor whereby the particles moving downwardly into the path of the blades from the entrance chamber will be thrown by the blades through the outlet, and wall means having close clearance with the blades for substantially reducing the flow of air therebetween, along a substantial arcuate portion of the path of the blades in the region up-

wardly of the entrance chamber for concentrating the flow of air somewhat in the downward direction in which gravity tends to move the particles; the peripheral wall beyond said wall means in the direction of rotation being of convolute form providing an increasing cross section surrounding the rotor in the direction of its rotation for conducting the air stream and any particles therein smoothly and at high velocity through the outlet.

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