Oct. 20, 1959 G. M. CROFT 2,909,331

PARTICLE MILL SYSTEM

Filed June 7, 1954 4 Sheets-Sheet 1

Fig. 2.

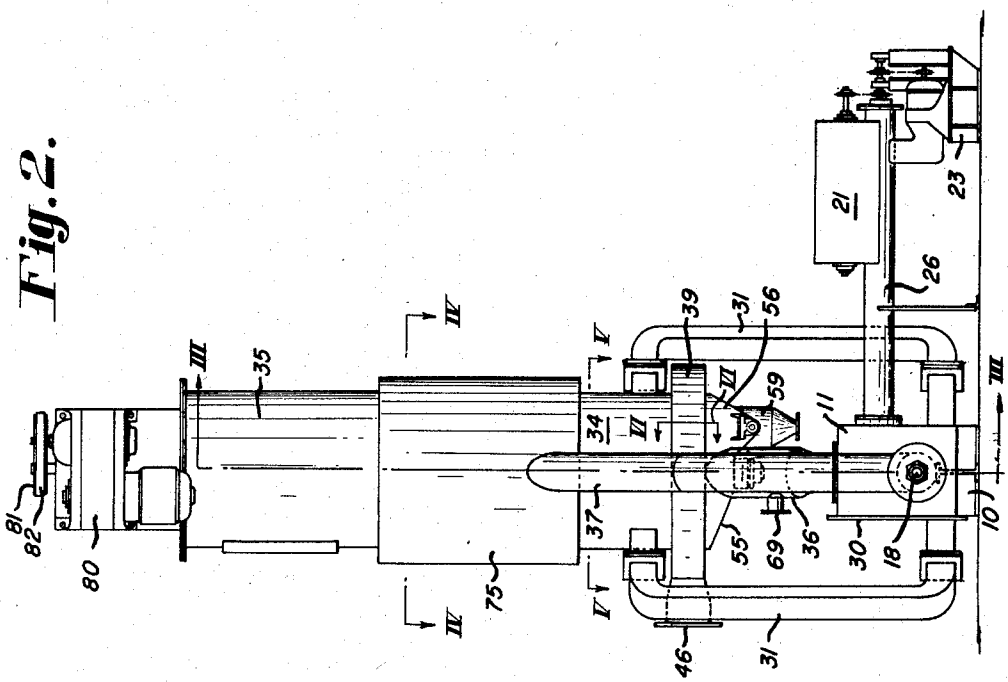
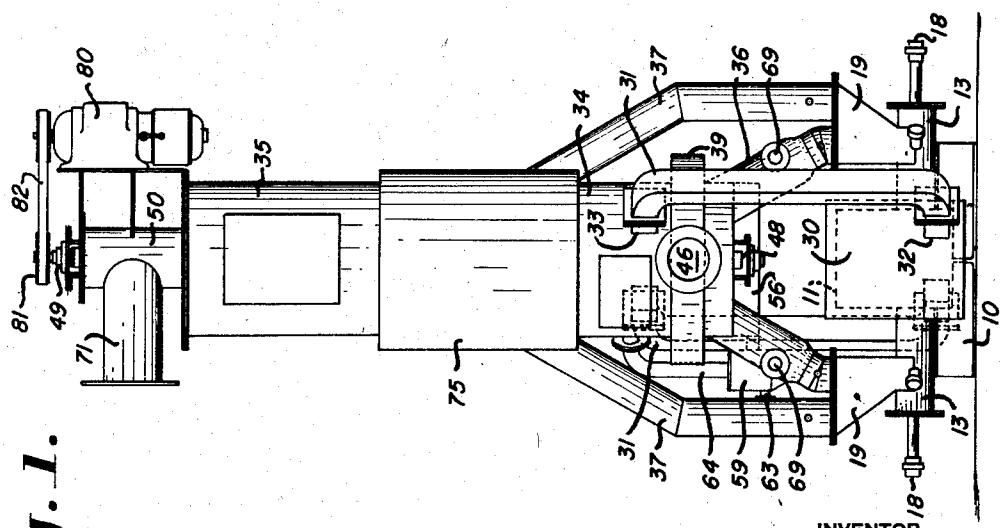


Fig. 1.



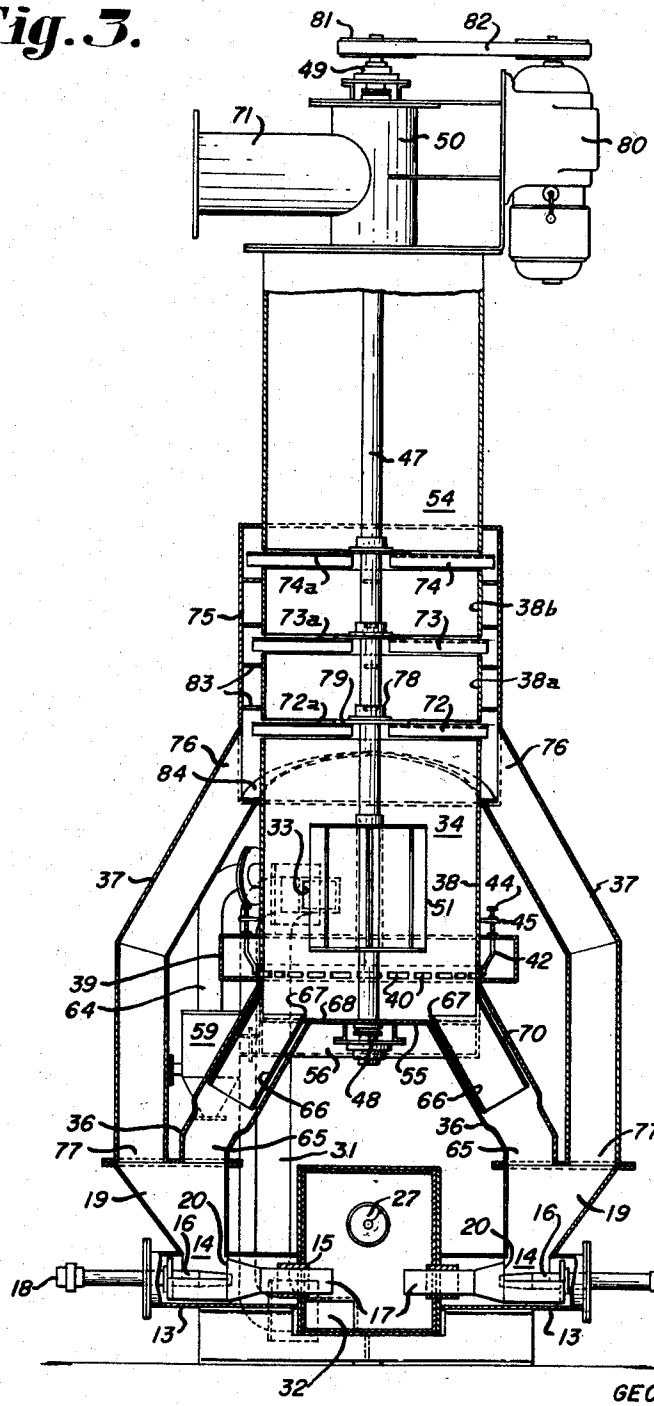
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Oct. 20, 1959 G. M. CROFT 2,909,331

PARTICLE MILL SYSTEM

Filed June 7, 1954 4 Sheets-Sheet 2

Fig. 3.



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Oct. 20, 1959 G. M. CROFT 2,909,331

PARTICLE MILL SYSTEM

Filed June 7, 1954 4 Sheets-Sheet 3

Fig. 4.

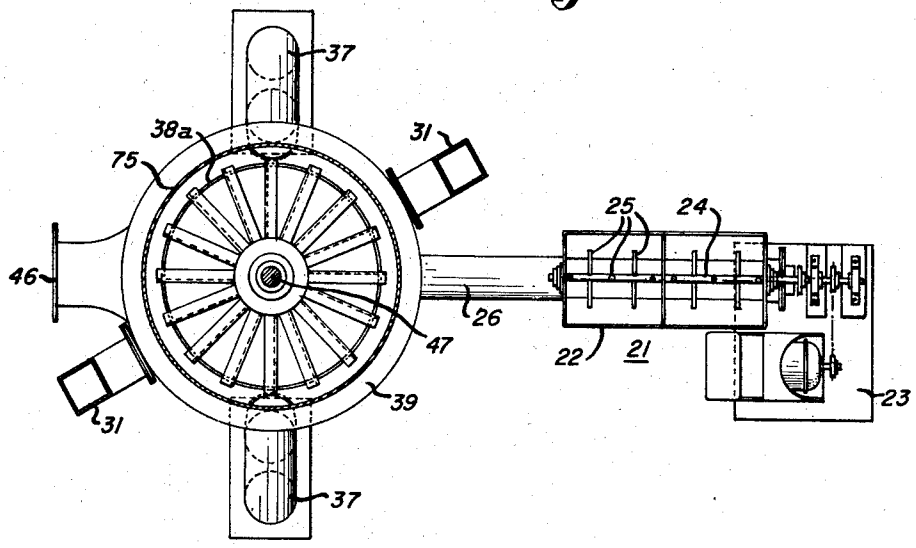
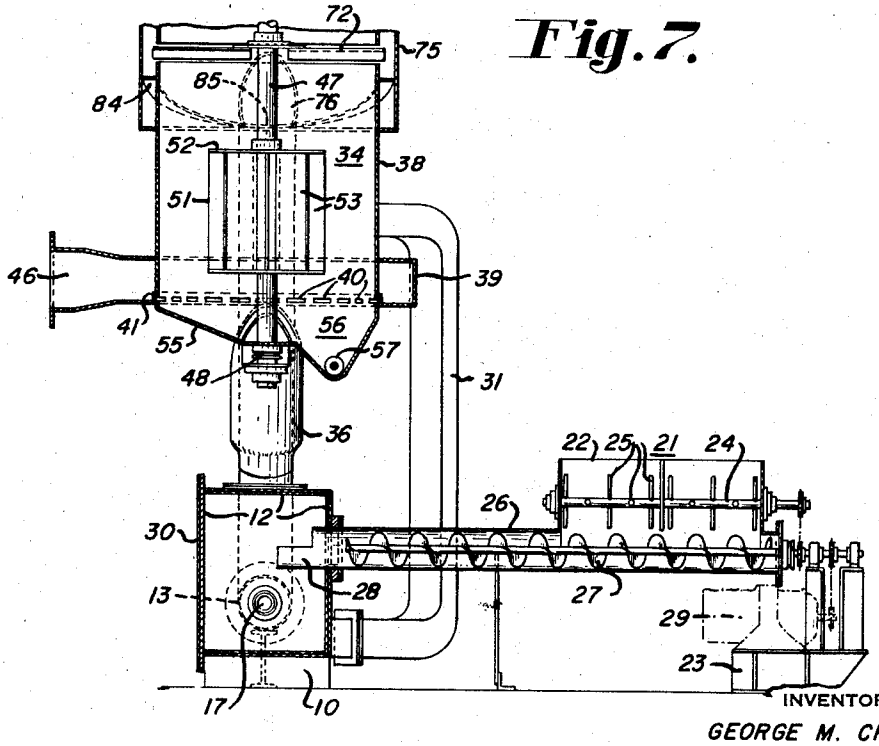


Fig. 7.



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Oct. 20, 1959 G. M. CROFT 2,909,331

PARTICLE MILL SYSTEM

Filed June 7, 1954 4 Sheets-Sheet 4

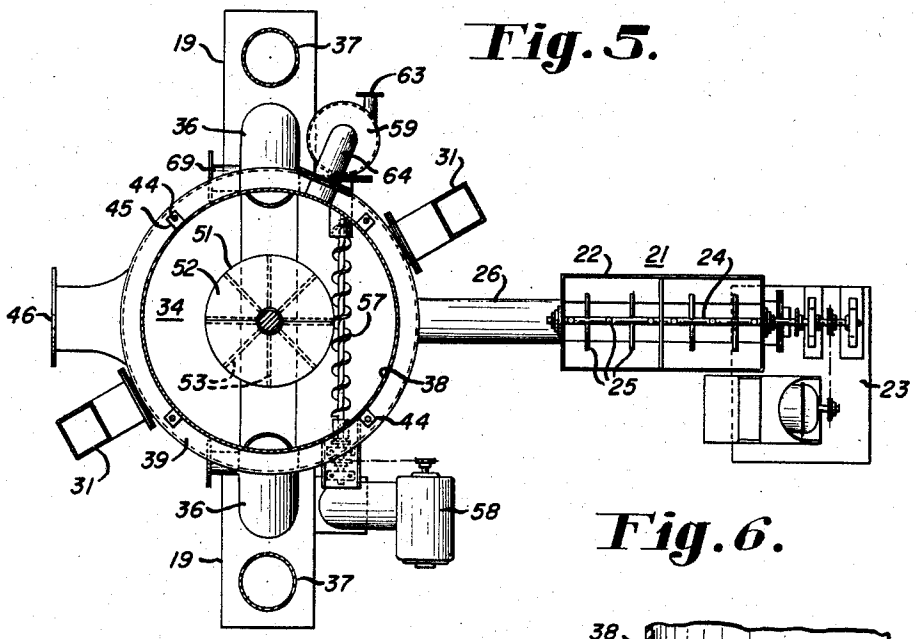
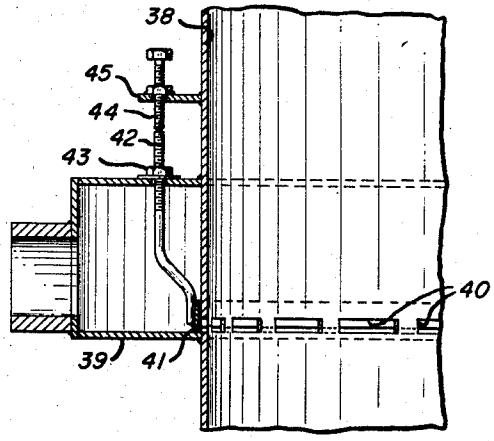


Fig. 5.

Fig. 6.



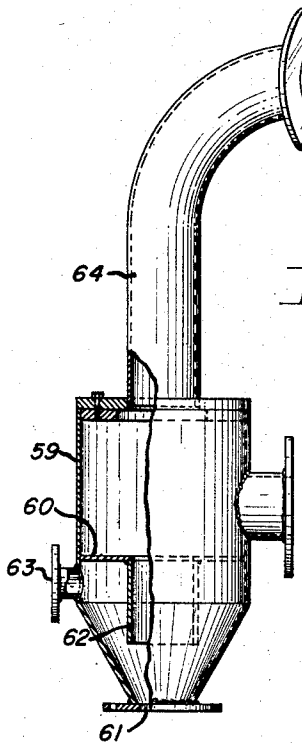


Fig. 8.

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United States Patent Office 2,909,331 Patented Oct. 20, 1959

2,909,331

PARTICLE MILL SYSTEM

George M. Croft, Fox Chapel Borough, Pa., assignor to Majac, Inc., Sharpsburg, Pa., a corporation of Pennsylvania.

Application June 7, 1954, Serial No. 434,947

11 Claims. (Cl. 241—39)

This invention relates to a particle mill system for parting and classifying solid particles utilizing jet circulating means. More particularly, this invention pertains to impact reduction in combination with classification of desired material and removal of undesired material from the new system.

In the exfoliation and/or grinding of mica, for example, prior pulverizing mills of the impact jet pulverizer kind utilizing a gaseous circulating medium, such as air or steam, have been considered unsuitable as a practical matter. Moreover, the entire feed to such prior mills was operated upon until pulverized to an extent which satisfied the classification operation accompanying such prior mills.

On the other hand, in the instant invention, a new particle system is provided in which a raw material like mica is readily separated from its matrix material which may be schist and is reduced in size and the cleavage of mica particles from one another is achieved to the desired extent in terms of capacity and of quality. In addition, foreign material such as the heavy rock matrix itself is collected and removed entirely from my new system. At the same time, uniformity of operation and continuity of classification is carried on in a new way to achieve an end product with circulation and recirculation of the desired material until it conforms to the predetermined specification.

Other objects and advantages will be apparent from the following description and the accompanying drawings, which are illustrative only, in which

Figure 1 is a side view in elevation of one embodiment of my new device;

Figure 2 is an end view in elevation of the embodiment shown in Figure 1;

Figure 3 is a side view partly in section taken along line III—III of Figure 2;

Figure 4 is a view in section taken along line IV—IV of Figure 2;

Figure 5 is a view in section taken along line V—V of Figure 2;

Figure 6 is a detailed view in section taken along line VI—VI of Figure 2;

Figure 7 is a partial view in section taken along line VII—VII of Figure 1; and

Figure 8 is a detailed view partly in section of a discharge box assembly for a heavy material removal device.

Referring to the drawings, a new particle mill made in accordance with my invention may comprise a base **10** on which various parts of the new device are supported. Thus, a wholly enclosed cubical impact chamber **11** is provided and lined with wear plates **12**. A pair of housings **13** for jets **14** are connected to chamber **11** and surround openings **15** through the side walls of chamber **11** in directly opposed relation. Each jet **14** may comprise a nozzle **16** and an axially spaced barrel **17**. The discharge ends of the respective barrels **17** extend through the openings **15** and are properly supported therein for adjustable axial movement, as desired, to

provide the selected distance between the inner discharge ends of the respective barrels **17**. A gaseous fluid like compressed air enters the outer end **18** of each nozzle **16** and supplies a circulating medium for the new mill in operation. Entry chambers **19** in the form of funnels deposit material passing thereinto from above in position to be aspirated into the inlet end **20** of the barrel **17** by virtue of the force of gravity, the circulating gaseous medium and the force of the discharge from each nozzle **16**. The entire mill is properly bushed and gasketed and may be suitably lagged where such is desired so that the operation is wholly enclosed.

A raw material feed device **21** is provided with a hopper **22** and a foundation member **23**. Hopper **22** may be provided with a rotating shaft **24** having beater spokes **25** thereon to keep raw material deposited in the top of hopper **22** from unduly lumping. The bottom of hopper **22** is open and empties into the interior of a conveyor tube **26** in which an endless screw **27** rotates to feed such raw material through the wall of chamber **11** and out of discharge end **28** of tube **26**. Shaft **24** and the shaft of screw **27** are provided with sprockets adjacent a variable drive motor **29** which is used in the illustrated embodiment to rotate such sprockets and turn such shafts. One side of chamber **11** may be made in the form of a removable door **30**.

In operation, the impact of solids within chamber **11** occasioned by the oppositely directed discharge from the jets **14** and the forces present carry all material, gaseous and solid including raw material discharged from end **28** of tube **26**, into two riser pipes **31** which take the total contents of impact chamber **11** out of openings **32** and discharge such contents through openings **33** into a primary classifier **34**. Primary classifier **34** is the lower section of a tower structure **35** superimposed above impact chamber **11** and capable of being supported in that superposed relation by riser pipes **31**, by return pipes **36** and by downcomer pipes **37**. Wall **38** of primary classifier **34** is surrounded by a ring chamber **39** adjacent the lower end thereof, entrance to the interior of classifier **34** from chamber **39** being provided through the ring of openings **40**. As shown in Figure 6, openings **40** may be fully or partially closed by a sliding door **41** in the form of a ring. The vertical adjustment height of door **41** is controlled around the periphery of chamber **39** by a series of rods **42** extending through the top of chamber **39** and having an adjustment nut **43** in engagement with the upper threaded end of the rods **42**. A jamming stud **44** is provided on a bracket **45** so that in whatever position each rod **42** is adjusted by nut **43**, stud **44** which is in threaded engagement with bracket **45** can be jammed against the end of rod **42** to lock it in the adjusted position of ring **41**, between full open and full closed position relative to the openings **40**, as desired. Strip air at suitable pressure is admitted to chamber **39** and thence to primary classifier **34** whenever openings **40** are partially or fully opened, such strip air being supplied to inlet **46** of the ring **39**. Preferably, the openings **40** are below the discharge openings **33** from the risers **31**.

A shaft **47** extends throughout the height of tower **35** and is suitably journaled in a journal **48** at the bottom of tower **35** and in a thrust bearing journal **49** at the top of tower **35** and through an outlet pipe **50** for fully classified material. Shaft **47** in turn is keyed to a vane distributor **51** generally opposite the openings **33** from riser pipes **31**. As shown, vane distributor **51** comprises a top plate **52** and a series of fixed radial vanes **53**. Plate **52** closes the sectors between the vanes **53** at the top thereof but there is no such closure of the sectors defined by the bottommost edges of adjoining vanes **53**. As material issues from the riser pipes **31**, heavier portions particular-

ly tend to move more forcefully toward distributor **51** and may also be thrown more forcefully by distributor **51**. Further, the distributor enables strip air entering through the openings **40** to be highly effective and efficient in carrying suitable end product particles away into a secondary classifier **54** in tower **35** above primary classifier **34**.

In exfoliating and/or grinding a material like mica, in my new system, rock and grit material may be in the raw material fed into hopper **22** and will be separated from mica particles for removal from the system. Further, such removal of rock and grit is without deleterious effect on either the continuity of the new operation or the cleavage of mica particle from mica particle or the grinding of mica particles to the size desired. Thus, it will be noted that in my illustrated embodiment, bottom **55** of tower **35** and hence of primary classifier **34** slopes to a low trough or sump **56** in which a helical removal conveyor **57** is positioned. The ends of helical conveyor **57** are suitably journaled outside the walls **38** of tower **35** and one end is fastened to a sprocket which is rotated by a variable speed motor drive set **58** as shown in Figure 5.

Heavy reject material directed into sump **56** is carried out of the new mill by conveyor **57** into a discharge box **59** having an annular partition **60**, the opening in which is confined for a distance extending toward the bottom opening **61** of box **59** by a cylindrical flange **62**. Air is admitted into a fitting **63** between the inside of box **59** and the outside of flange **62** to create a whirling rising sweep air current which, while heavy reject material like rock and grit of relatively higher bulk density falls through the inside of flange **62** and passes out of bottom opening **61**, enables lower bulk density end product material to be picked up by such sweep air and carried off and upwardly through an uptake pipe **64** which discharges into primary classifier **34**. In that way, assurance against loss of desired material from the new system is obtained while at the same time the new system rids itself continuously of waste or foreign matter such as schist which occurs with mica deposits.

As more particularly shown in Figure 3, the lower end **65** of each return pipe **36** discharges into entry chamber **19**. The upper end of each return pipe **36** terminates at the outside of the lower end of tower **35**. An internal coaxially positioned and spaced cylindrical liner **66** projects into the bottom of primary classifier **34** in such a manner that the upper projecting edge **67** of liner **66** forms a dam above portion **68** of bottom surface **55**. A sweep air inlet pipe **69** admits air into the space **70** between the outside of liner **66** and the inside of pipe **36** thereby tending to give the sweep air a whirling or tangential motion as it moves around the lower end of lining **66** and then upwardly into the bottom of primary classifier **34**. Thereby, finer particles are removed from the coarser reject particles moving downwardly through lining **66** and thereby through return pipe **36** into the respective entry chambers **19**. At the same time, the dam **67** permits heavy reject material to move along bottom **55** towards sump **56** without interfering with the flow of coarser particles through return pipe **36**. Such coarser particles from return pipe **36** are propelled through the respective jets **14** and further reduced and/or separated by impact against one another in the discharges from the respective jets **14** in impact chamber **11**. The upper end of space **70** is blanked off by the wall and bottom of tower **35** as hereinabove described.

Conveyor **57** will remove as a part of the new removal device, from my new particle mill system, the rock or other foreign matter or material of heavier gravity than the desired particles undergoing separation and/or reduction and classification. The desired material, that is, the part of the raw material which is to undergo reduction and/or separation and classification passes out of the system, when sufficiently reduced and/or separated, in a gaseous stream through outlet pipe **50** and its branch **71**. The remainder of the desired portion of the raw material not sufficiently reduced in size and/or separated is circulated or recirculated to jets **14** via return pipes **36** and downcomer pipes **37** with the aid of the cooperating elements in primary classifier **34** and in secondary classifier **54**. Generally, coarser end particles will return through return pipes **36** as a consequence of rejection by vane distributor **51** and by the portions of spinner blades **72**, **73** and **74** nearer shaft **47**. Finer end product material still not yet suitably reduced in size and/or separated for movement through outlets **50** and **71** will be returned by spinner blade tiers **72**, **73** and **74** to a bustle chamber **75** communicating with the upper ends **76** of downcomer pipes **37**. The lower ends **77** of downcomer pipes **37** also discharge into the respective entry chambers **19**.

In secondary classifier **54**, the desired end portion material rising therein in a gaseous carrier medium such as air encounters one or more of the spinner blade tiers **72**, **73** and **74**. Each tier is fastened to shaft **47** by a collar **78** and a plate **79** to which the radially extending blades **72**, **73** and **74** in each of the tiers are respectively immovably affixed. Hence, as shaft **47** rotates in the direction of the arrow, vane distributor **51** and the spinner blade tiers **72** to **74**, inclusive, will also rotate and perform their respective classifying functions. Preferably, the radial arms or blades **74** in tier **74** are somewhat longer than the blades in tier **72**. Similarly, if desired, the blades in tier **73** may be made of a length intermediate the respective lengths of the blades **72** and **74**, respectively. A variable speed drive motor set **80** mounted on the top of tower **35** drives pulley **81** through a belt **82**, the pulley **81** being keyed to the top of shaft **47**.

Preferably, the blades **72**, **73** and **74** in the tiers of like number are in angle form in cross section with the horizontally placed sides respectively designated **72***a*, **73***a* and **74***a*, leading. Thereby, end product material somewhat less coarse than that which would be rejected by vane distributor **51** is encountered by inner portions of the respective blades in the respective tiers and some at least of those less coarse portions of the desired end product may be returned within tower **35** and passed downwardly through classifier **34** into the open upper ends of the lining **66** in return pipes **36**.

Finer portions of the desired end product material which nevertheless are not suitable for further ascent in tower **35** tend to move outwardly along the respective blades in the respective tiers beneath the horizontal angle sides until discharged outside of the wall **138** and within bustle chamber **75**. Solid particles entering chamber **75** pass into upper ends **76** of downcomer pipes **37** and thence pass into the jets **14** for recirculation and further reduction in size and/or separation in the nature of exfoliation in the case of mica being the end product or of fiber separation in the case of mica being the end product or of fiber separation in the case of asbestos being the desired end product.

Between the respective tiers of spiner blades, wall **38** comprises two ring sections designated **38***a* and **38***b* respectively affixed to the wall of chamber **75** by spacer lugs **83**. A collector ring **84** having an endless undulating character closes the space between wall **38** and the vertical wall of chamber **75** below tier **72**. The lowermost portions of collector ring **84** form respective troughs **85** which coincide with the bottom of the opening into upper ends **76** of downcomers **37**. Hence, finer reject desired end product material passing downwardly through chamber **75** may encounter the top of ring **84** and thence be conducted by ring **84** toward the discharge trough portions where the finer rejected material passes into the downcomer pipes **37**.

The ascent of desired end product particles through the remaining height of tower **35** above secondary classifier **54** tends to afford a further opportunity for classi-

fication as the end product material and carrier gas spiral toward the outlet pipe **50**. That outlet pipe **50** may, if desired, provide a still further classification in having the lower end thereof project downwardly a predetermined distance within tower **35**. It will be noted that in my new particle mill system, I have provided means for ridding desired end product material of unwanted heavier specific gravity components such, for example, as rock and grit. In addition, I have provided a new particle mill system which will reduce end product particles in size to generally any condition of fineness desired. In addition, as in the case of mica and asbestos, as illustrations, I also provide means whereby mica particles are exfoliated and in the case of asbestos where asbestos fibers are separated. Throughout the operation of my new system, the circulating streams and flows of materials and gases are continuous. Adjustments are readily made for a change in kind of raw material charged to my new system as well as for desired variations in the end product to meet market or other circumstances. In the case of coal contaminated with iron pyrites, my new particle mill system will not only pulverize such coal to the desired degree of fineness but will also enable the iron pyrite contaminants to be continuously removed. At the same time, overreduction in size is avoided in operation in my new system. Of course, the raw material charged to my new particle system may, if desired, be composed wholly of desired end product material without contaminants or foreign material such as rock and grit, in which event, the heavy reject removal device including conveyor **57**, will not be operated.

Reference is made to application Serial No. 452,116, filed August 25, 1954, for United States patent for Impact Mill.

Various changes in details of construction and in arrangements and in raw materials and in desired end products may be made without departing from the spirit of my invention or the scope of the appended claims.

I claim:

1. In a particle mill, in combination, an impact chamber, opposed jet circulating means discharging into said chamber, a raw material feed device discharging into said chamber, a riser pipe connecting said chamber with a primary classifier, adjustable means for admitting strip air to said primary classifier adjacent the lower end thereof, a rotating shaft in said primary classifier, a vane distributor mounted on said shaft, a return pipe connecting the lower end of said primary classifier with said jet circulating means, a heavy reject removal device positioned in the bottom of said primary classifier, means for introducing countercurrent sweep air into said return pipe, an uptake pipe connected to said removal device and discharging into said primary classifier, a secondary classifier in superposed relation to said primary classifier, a rotating shaft in said secondary classifier, a plurality of radially extending blades in said secondary classifier, said blades having an angle with a generally horizontal flange of said angle leading, the ends of said blades further projecting through the wall of said secondary classifier, a bustle chamber surrounding said secondary classifier and the outer ends of said blades, a downcomer pipe connected between said bustle chamber and said jet circulating means, and an outlet for fully classified end product material positioned generally above said secondary classifier.

2. In a particle mill, in combination, an impact chamber, opposed jets discharging into said chamber, means for supplying end product material to said jets for impact reduction, a primary classifier connected to said impact chamber to receive the contents thereof, normally rotating distributing means positioned centrally in said primary classifier opposite the entry position of said contents into said primary classifier, a conveyor in said primary classifier, means below said distributing means for collecting heavy material other than end product material within reach of said conveyor to enable said heavy material to be removed from said mill, means for returning oversize end product material from said primary classifier to said jets, a secondary classifier connected to said primary classifier to receive gas-borne end product material from said primary classifier, spinning means in said secondary classifier to reject coarser and heavier end product material, means for returning said coarser and heavier end product material from said secondary classifier to said jets, means for feeding raw material to said mill, and an outlet for gas-borne end product material not rejected in said secondary classifier.

3. In a particle mill, in combination, an impact chamber, opposed jets having discharge ends directed into said chamber, a feed device for raw material including desired lighter material and undesired heavier material, means for discharging the contents of said chamber into a primary classifier through the side thereof, means for admitting strip air to said classifier adjacent said first-mentioned means, vertically extending horizontally rotatable vanes positioned centrally in said classifier and opposite to said first-mentioned means, means above and below said vanes for returning overweight lighter particles from said classifier to said jets, a removal device for said heavier material positioned adjacent the bottom of said classifier, and an outlet in said classifier for lighter material meeting classification requirements.

4. In a particle mill, in combination, an impact chamber, jet circulating means discharging into said chamber, a classifier connected by external pipe means to said jet circulating means, means for admitting strip air to said classifier, a horizontally rotating shaft in said classifier, a vertically extending vane distributor mounted on said shaft, said pipe means communicating with the interior of said classifier through the side thereof adjacent to said vane distributor, fluid-borne passage means above and below said distributor for returning heavier particles from said classifier to said jet circulating means, a heavier material removal device positioned in the lower portion of said classifier, an outlet for fully classified lighter particles in said classifier, and means for feeding solid material to said mill.

5. In a particle mill, in combination, an impact chamber, opposed grinding jets discharging into said chamber, means for supplying a gaseous medium under pressure to said jets as a carrier for particles in said mill, a riser pipe for the discharge of material and gas from said chamber, a classifier connected to said riser pipe, a horizontally rotatable vertically extending vane distributor mounted in said classifier adjacent the connection between said classifier and the riser pipe, a return pipe connected with the lower portion of said classifier and the inlet end of said jets to recirculate particles rejected in said classifier, a removal conveyor positioned in the lower portion of said classifier to remove heavier material from said mill, and a dam connected to said return pipe and projecting into said classifier to shield said return pipe against receipt of said heavier material.

6. In a particle mill, in combination, an impact chamber, opposed jet means discharging into said chamber, means for supplying a gaseous medium under pressure to said jet means as a carrier for particles in said mill, a riser pipe for the discharge of the contents from said chamber, a classifier connected at its side to said riser pipe, a rotatable distributor mounted in said classifier opposite to the connection between said classifier and riser pipe, said distributor having vertically extending radial vanes and a plate closing the sectors between said vanes adjacent the upper end of said distributor, a return pipe connecting the lower portion of said classifier with the inlet end of said jet means to recirculate particles rejected in said classifier, and means for introducing sweep air into said return pipe in a generally tangential and counterflow direction to the flow of gas and rejected

particles passing through said return pipe to said jet means.

7. In a particle mill, in combination, an impact chamber, jet circulating means discharging into said chamber, a classifier, a riser pipe connecting said chamber to a classifier, means in said classifier for separating heavier end product particles from lighter end product particles, means for returning said heavier end product particles to said jet circulating means, a bottom in said classifier sloping to a sump portion thereof, a removal conveyor extending along said sump portion to remove material heavier than said end product particles, a discharge box into which said removal conveyor discharges such heavy material, and means for circulating countercurrent sweep air through said heavy material outside of said classifier to return to said mill whatever end product particles may be in said heavy material.

8. In a particle mill system, in combination, the steps comprising, jetting material into collision impact in an impact zone, feeding raw material directly into said impact zone, delivering the contents of said zone including said raw material into a classifier in a fluid stream, dispersing at least heavier components of said first-named stream in said classifier by striking such heavier components, withdrawing relatively lighter end product particles from said classifier in a fluid stream, returning respectively heavier end product particles to said jetting step in a fluid stream, and mechanically removing from said system said heavier components.

9. In a particle mill system, the steps comprising, in combination, forcing material to collide in an impact zone, discharging the contents of said zone into a classifier zone through the side thereof, mechanically striking at least the heavier portions of said contents in said classifier zone, introducing stripping fluid into said classifier zone below the level of entry of said contents into said classifier zone, removing heavier portions of said contents from the bottom of said classifier zone, subjecting said heavier portions to a countercurrent flow of fluid adjacent said classifier zone to provide additional separation, intersecting material rising in said classifier zone and spinning heavier portions of said rising material to the outside of said classifier zone, removing said heavier portions of said rising material, and removing still rising material from said classifier zone.

10. In a particle mill, in combination, an impact chamber, opposed jet circulating means discharging into said chamber, a raw material feed device discharging into said chamber, a riser pipe connecting said chamber with the side wall of a primary classifier, adjustable means for admitting strip air to said primary classifier adjacent the lower end thereof, a rotating shaft in said primary classifier, a vane distributor mounted on said shaft opposite to said riser pipe connection, a return pipe connecting the lower end of said primary classifier with said jet circulating means, a secondary classifier in superposed relation to said primary classifier, a rotating shaft in said secondary classifier, a plurality of radially extending blades in said secondary classifier, the ends of said blades further projecting through a wall member in said secondary classifier, a surrounding chamber in said secondary classifier into which the outer ends of said blades extend, a downcomer pipe connected between said last-named chamber and said jet circulating means, and an outlet for fully classified end product material positioned generally above said secondary classifier.

11. In a particle mill classifier, apparatus comprising, in combination, a classifier vessel, a primary classifier portion adjacent the lower end thereof, means for introducing material to be classified through the side of said classifier, a rotating shaft positioned axially in said primary classifier portion, a vertically extending distributor with radially extending vanes mounted on said shaft adjacent said first-named means, an outlet means connected to the lower end of said primary classifier portion to remove heavier portions of said material from said primary classifier portion, means for introducing strip air around the lower end of said primary classifier portion adjacent and above said outlet means, a secondary classifier portion in the upper portion of said classifier vessel, a rotating vertical shaft positioned axially in said secondary classifier portion, a plurality of superposed sets of spinner blades in said secondary classifier portion mounted on said last-named shaft and extending radially outwardly therefrom, the ends of said spinner means projecting through a wall portion of said secondary classifier portion, a chamber surrounding said last-named wall portion, an outlet means connected to said last-named chamber to remove heavier portions of material in said secondary classifier portion, an outlet for relatively lighter classified material positioned generally above said spinning means, and means including a variable speed prime mover to regulate fluid stream flows through respective portions of said classifier vessel.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,909,331 October 20, 1959

George M. Croft

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 49, for "138" read -- 38 --; lines 55 and 56, strike out "in the case of mica being the end product or of fiber separation".

Signed and sealed this 22nd day of March 1960.

(SEAL)

Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents