April 12, 1960 G. M. CROFT ET AL 2,932,458

IMPACT MILL

Filed Aug. 25, 1954 3 Sheets-Sheet 1

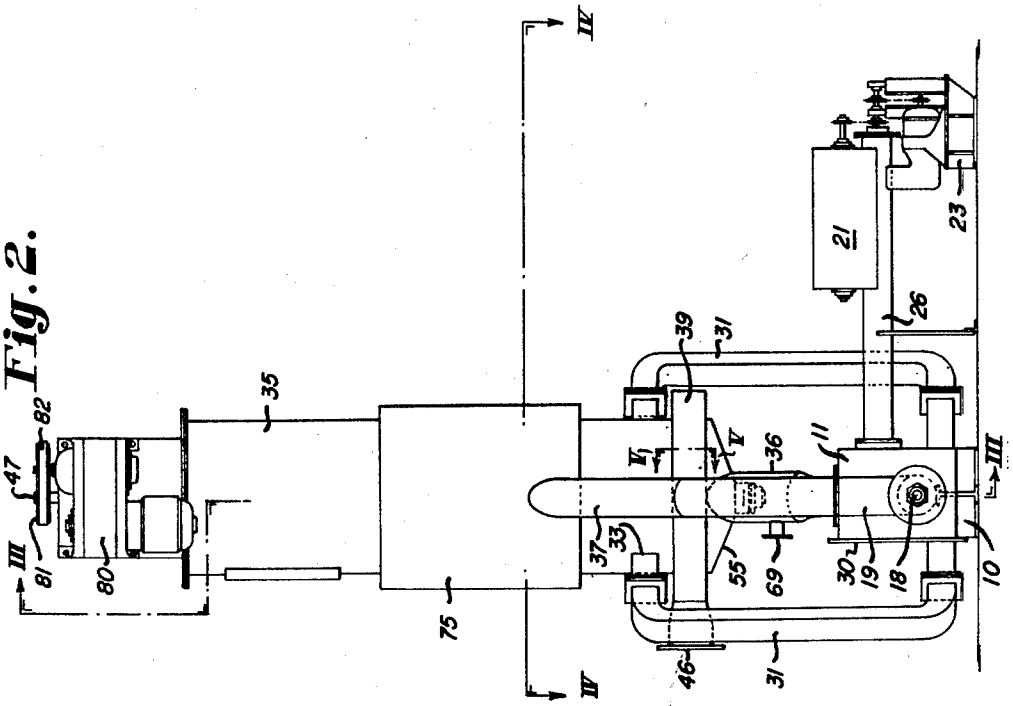


Fig. 2.

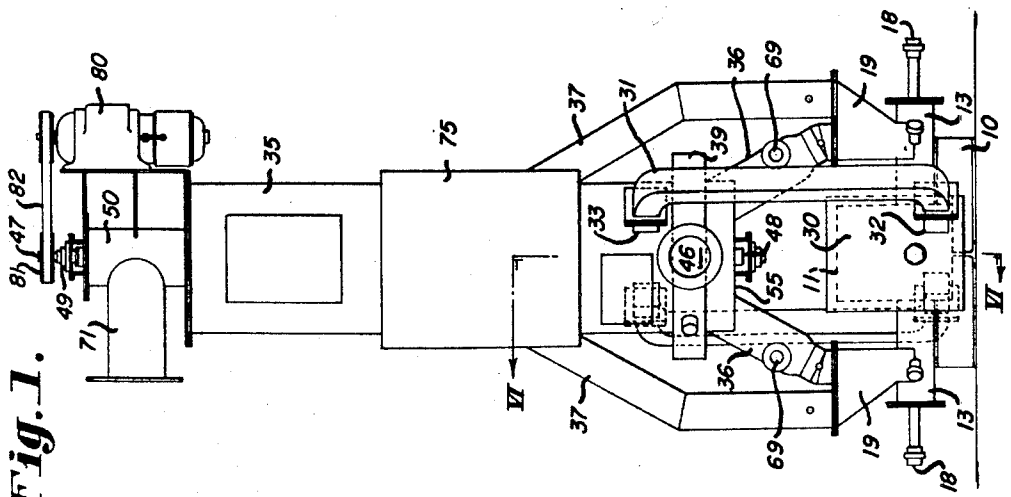


Fig. 1.

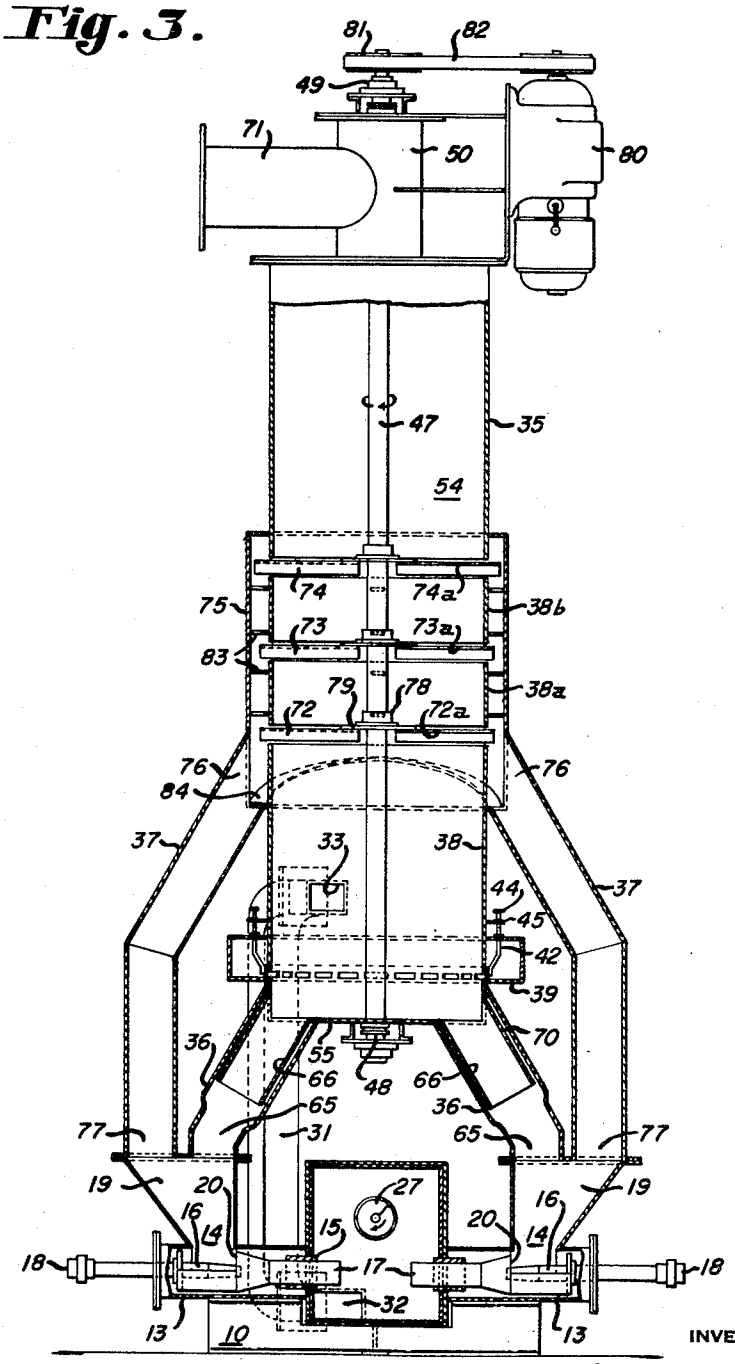
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Fig. 3.



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Fig. 4.

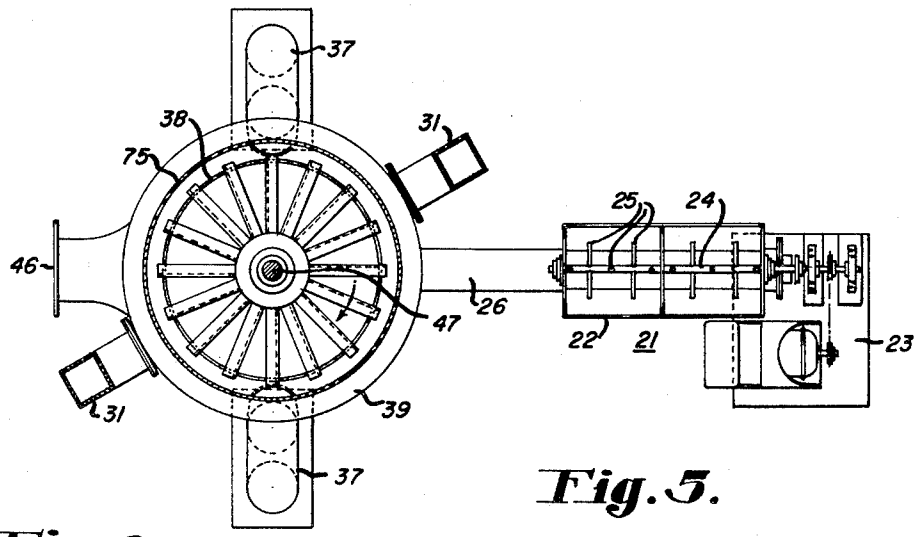


Fig. 5.

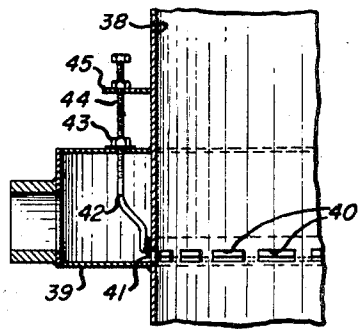


Fig. 6.

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IMPACT MILL

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Application August 25, 1954, Serial No. 452,116

7 Claims. (Cl. 241—39)

This invention relates to an impact mill for grinding and classifying solid particles. More particularly, this invention pertains to a jet impact grinder and power classifier for processing solid substances which is of great flexibility in respect of materials which can be treated and of control over the end product.

In the present invention, new means are provided for grinding and classifying a wide variety of substances including, for example, coal, graphite, talc and mica. Our new mill operates as a closed system wherein all of the material charged to the mill is reduced in size to predetermined final product specification. That reduction in size which is termed "grinding" herein comprehends pulverizing as well as other forms of reduction such as exfoliation in the case of a substance like mica. The new mill is also useful in shredding or parting certain fibrous materials that may be charged thereto. Particles of various substances charged to the new mill are ground and classified and such particles which do not meet specification are returned for regrinding until the specification is met. In the operation of the new mill, substantial economies are possible with exceptional control for producing specification end product. Furthermore, the new mill is flexible in respect of readily being shiftable to the grinding and classifying of other substances that a user may desire to charge.

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 our new mill;

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 detail view in section taken along line V—V of Figure 2; and

Figure 6 is a partial view in section taken along line VI—VI of Figure 1.

Referring to the drawings, a new mill made in accordance with our 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 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 helical screw 27 rotates to feed such 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 feed 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 preliminary to classification by a classifier 54. Classifier 54 is in a tower 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 tower 35 is surrounded by a ring chamber 39 adjacent the lower end thereof, entrance to the interior of classifier 54 from chamber 39 being provided through the ring of openings 40. As shown in Figure 5, 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 classifier 54 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 classifier tower 35 and is suitably journaled in a journal 48 at the bottom 55 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.

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. The upper end of an internal coaxially positioned and spaced cylindrical liner 66 is flush with portion 68 of bottom 55 and with wall 38. 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, since space 70 is closed off at the upper end thereof, and thence upwardly into the bottom of tower 35 and classifier 54. 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. Such coarser particles from return pipe 36 are propelled through the respective jets 14 and further reduced by impact against one another in the discharges from the respective jets 14 in impact chamber 11. The particles undergoing grinding and classification, when sufficiently reduced, are carried out of the new mill in a gaseous stream through outlet pipe 50 and its branch 71. The remainder of the particles not sufficiently reduced is circulated and recirculated to jets 14 via return pipes 36 and downcomer pipes 37 with the aid of cooperating elements in classifier 54 until all of the material fed to the mill is ground to specification and passes off upwardly through tower 35.

Generally, coarser particles will return through return pipes 36 as a consequence of rejection by the portions of spinner blades 72, 73 and 74 nearer shaft 47. Finer particles which still are unsuitable 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 classifier 54, the particles rising therein in a gaseous carrier medium such as air encounter 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, the spinner blade tiers 72 to 74, inclusive, will also rotate and perform their respective classifying functions. Preferably, the radial arms or blades 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, particles, somewhat less coarse than that which would be returned directly through pipes 36, encounter the inner portions of the respective blades in the respective tiers and may be returned within tower 35 and the return pipes 36.

Finer portions of the particles 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 38 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.

Between the respective tiers of spinner 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 rejected particles 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 particles through the remaining height of tower 35 above the tiers in classifier section 54 tends to afford a further opportunity for classification 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 our new mill we have provided a new means which will reduce end product particles to generally any condition of fineness desired. Throughout the operation of our new system, the circulating streams and flows of materials and gases are continuous. Adjustments are readily made for a change in kind of feed charged to our new system as well as for desired variations in the end product to meet market or other circumstances. At the same time, overreduction in size is avoided in operation in our new mill.

Reference is made to application Serial No. 434,947, filed June 7, 1954, for United States patent for Particle Mill System.

Various changes in details may be made without departing from the spirit of our invention or the scope of the appended claims.

We claim:

1. In an impact mill, in combination, an impact grinding chamber, a pair of jets in aligned arrangement to discharge in opposite directions into said chamber, said jets having an entry chamber for solid particles to be ground, said jets further having a gas nozzle for a jetting gaseous medium under pressure, means for feeding solid material to be ground and classified into said impact grinding chamber, means adjacent the lower end of said chamber to receive the contents of said chamber, a classifier tower connected in superjacent relation to said last-mentioned means adjacent the lower end of said classifier tower, return pipes connecting the lower end of said classifier tower with said entry chambers respectively, said return pipes having a liner in spaced relation to the interior thereof, means for introducing sweep air into the space between said return pipe and liner, said space being blanked off at its upper end to cause said sweep air to pass around the lower end of each said liner and upwardly into said classifier tower while too coarse particles pass downwardly, a ring chamber positioned above said return pipes but below the place of connection of said second-mentioned means to said classifier tower, means for varying the amount of air entering said classifier tower from said ring chamber around the periphery of said classifier tower, a plurality of spinner blade tiers in said classifier tower, the spinner blades in said tiers having their outer ends projecting through the wall of said classifier tower, a bustle chamber enclosing the outer ends of said spinner blades, downcomer pipes connected to the lower end of said bustle chamber and to said entry chambers for said jets, an undulating collector to form troughs for the inlets to said downcomer pipes in said bustle chamber, means for turning said spinner blades, and an outlet for fully classified solid particles above said spinner blade tiers.

2. In an impact mill, in combination, an impact grinding chamber, jets in aligned arrangement to discharge in opposite directions into said chamber, said jets having inlets thereto for solid particles to be ground, said jets further having a gas nozzle for a jetting gaseous medium under pressure, means for feeding solid material to be ground and classified into said mill, a classifier connected in superjacent relation to said impact chamber to receive the contents of said chamber, return pipes connecting the lower end of said classifier with said inlets, said return pipes having a liner in spaced relation to the interior of said return pipe, means for introducing countercurrent sweep air in the space between said return pipe and liner, means for introducing strip air into said classifier around the periphery thereof substantially across the path of material discharged from said impact chamber into said classifier, a plurality of rotatable blade tiers in said classifier tower, said tiers having their outer ends projecting through the wall of said classifier tower, a bustle chamber enclosing the outer ends of said tiers, down-

comer pipes connected to the lower end of said bustle chamber and to said inlets, an undulating collector means for said downcomer pipes, and an outlet for fully classified solid particles above said tiers.

3. In an impact mill, in combination, an impact grinding chamber, jets in aligned arrangement to discharge in opposite directions into said chamber, said jets having inlets thereto for solid particles to be ground, means for feeding solid material to said mill, a classifier tower above said impact chamber and connected thereto to receive the contents of said chamber, return pipe means connecting the lower end of said classifier tower to said inlets, a ring chamber for strip air positioned above said return pipe means but below the connection between said classifier tower and said impact chamber, a plurality of spinner blade tiers in said classifier tower, the spinner blades in said tiers having their outer ends projecting through the wall of said classifier tower, a bustle chamber enclosing the outer ends of said spinner blades, downcomer pipe means connected to the lower end of said bustle chamber and to said inlets for said jets, means for turning said spinner blades, and an outlet for fully classified solid particles.

4. In an impact mill, in combination, an impact chamber, opposed jets discharging into said chamber, means for feeding solid particles into said impact chamber, a classifier above said chamber, a riser pipe connecting said chamber with said classifier, means for admitting strip air to said classifier adjacent the connection between said riser pipe and said chamber, a return pipe connected to said classifier adjacent said connection between said riser pipe and said classifier, said return pipe connecting said classifier with said jets, a plurality of radially extending blades in said classifier, a rotatable shaft for said blades, the ends of said blades projecting through the wall of said classifier, a bustle chamber surrounding said classifier and the outer ends of said blades, a downcomer pipe connected between said bustle chamber and said jets, and an outlet for sufficiently fine particles positioned generally above said blades.

5. In an impact mill, in combination, an impact chamber, jet means discharging into said chamber, means for feeding solid material to said mill, a classifier above said chamber, a riser pipe connecting said chamber with said classifier, a return pipe connecting the lower end of said classifier with said jet means, a plurality of radially extending blades in said classifier, means for rotating said blades, the ends of said blades projecting through the wall of said classifier, a bustle chamber surrounding said classifier and the outer ends of said blades, a downcomer pipe connected between said bustle chamber and said jet means, and an outlet for fully classified material positioned adjacent the upper end of said classifier.

6. In an impact mill, in combination, an impact chamber, means for initially feeding particles into said chamber, opposed jet means discharging into said chamber, a classifier above said chamber and connected to it, pipe means for returning coarser particles from a position adjacent the lower end of said classifier to the inlets of said jet means, spinning means having radially extending arm portions within said classifier above said last-mentioned means to reject less coarse particles and return them to said jets through said first-mentioned pipe means, said spinning means extending to a position adjacent the outside of said classifier, a chamber enclosing the outer ends of said spinning means, further pipe means independently connecting the lower end of said last-mentioned chamber with the inlets to said jets to return still less coarse particles, means for turning said spinning means, and means for removing sufficiently fine particles from said mill above said spinning means.

7. In an impact 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 primary classifier portion, a rotating shaft positioned axially in said primary classifier portion, 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 tiers of radially extending spinner means in said secondary classifier portion mounted on said last-named shaft, 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 prime mover to regulate flow through said classifier vessel.

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