

Aug. 31, 1943.

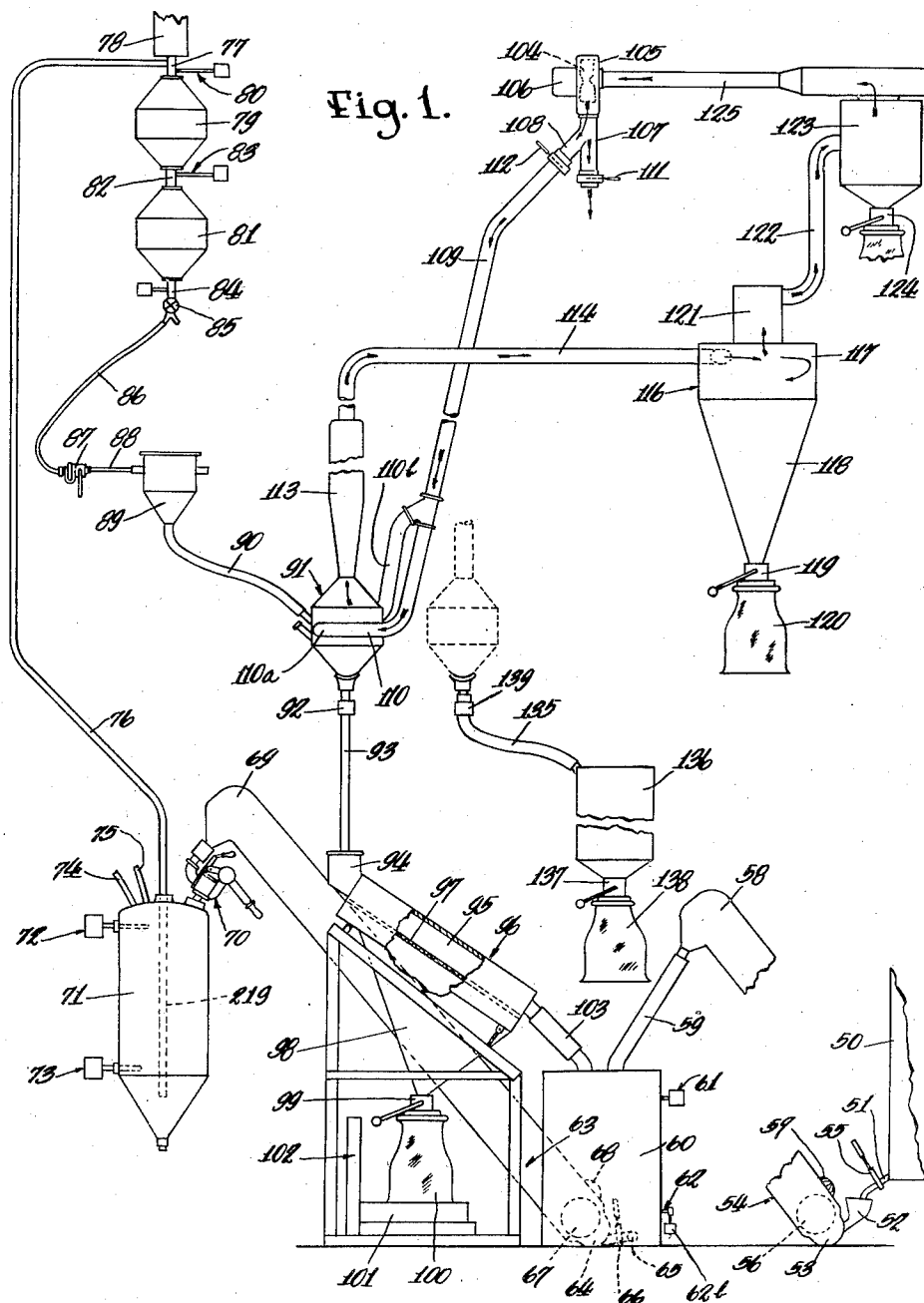
E. L. WIEGAND

2,328,240

PROCESSING OF MATERIALS

Original Filed Dec. 7, 1939

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

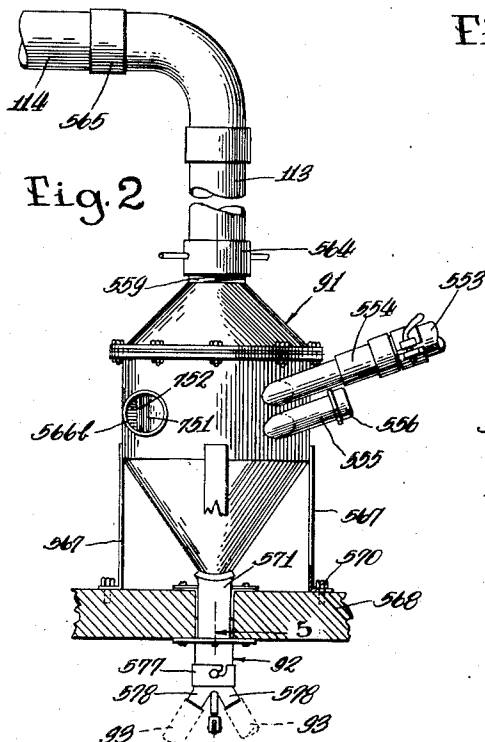


Fig. 2

Fig. 3.

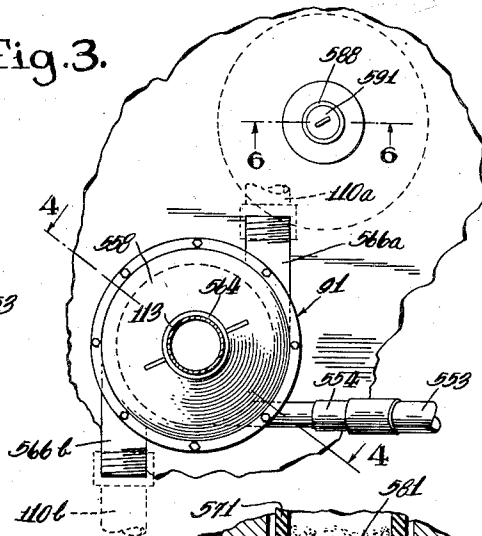


Fig. 5.

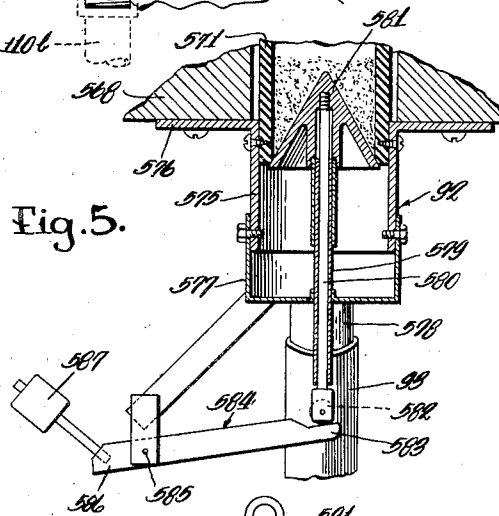


Fig. 6.

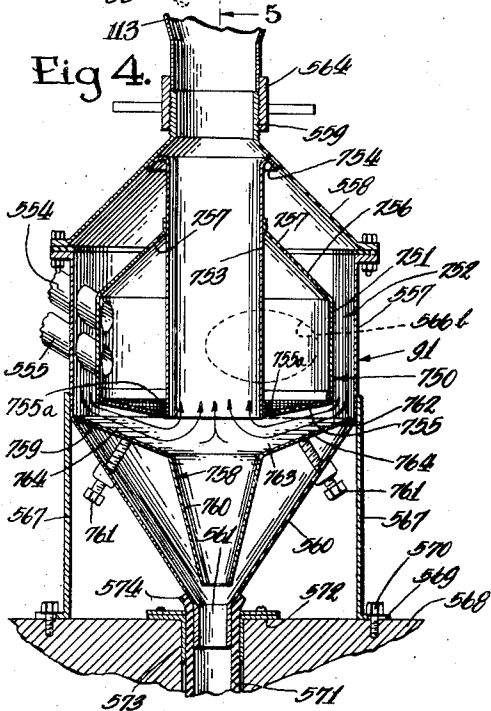
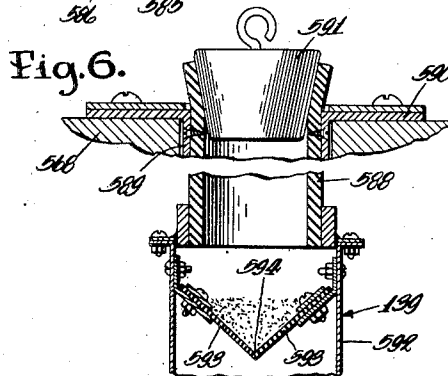


Fig. 4.

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UNITED STATES PATENT OFFICE

2,328,240

PROCESSING OF MATERIALS

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Original application December 7, 1939, Serial No.
308,002. Divided and this application Novem-
ber 2, 1940, Serial No. 364,072

4 Claims. (Cl. 83—93)

My invention relates to the processing of materials, and more particularly, the separation of co-mingled material particles. The invention is particularly applicable in connection with a system for grinding materials in which the grinding involves the projection of a stream of fluid and material particles moving at high velocity against an anvil or against a counter-stream of particles but is not limited to that purpose. The principal objects of the invention are the improvement of such processing of materials. This application is a division of my application Serial Number 308,002, filed December 7, 1939.

In the drawings accompanying this specification and forming a part of this application, there are shown, for purposes of illustration, several embodiments of apparatus embodying the invention, and in these drawings:

Figure 1 is a more or less diagrammatic view of the relation between material conveying means, grinding means, and separating means, as these means may be utilized in one embodiment of my invention.

Figure 2 is an elevational detail view of a separating device which may be used in an embodiment of my invention.

Figure 3 is a plan view of the separating device of Figure 2, showing in dotted lines the separating device moved to another position.

Figure 4 is an enlarged longitudinal sectional view through the separating device of Figure 2, corresponding generally to the line 4—4 of Figure 3.

Figure 5 is an enlarged detail sectional view corresponding generally to the line 5—5 of Figure 2, and,

Figure 6 is an enlarged broken sectional view corresponding generally to the line 6—6 of Figure 3.

The term "material" is used herein to include any substance of a divided nature, as distinguished from relatively large blocks of substances. The term "grinding" is used herein in its broader aspects as meaning reduction in size, in any way, of the material being treated, and in its more specific aspects, such "grinding" as occurs when material is subjected to impact. Examples of material which may be ground by an apparatus embodying my invention are such materials as zircon, rutile, quartz, feldspar, fluor spar, marble, glass, enameling frit, hard metals, artificial or other abrasives, industrial diamonds, and many others either of similar or different characteristics. The invention of the present application is shown as it may be used

in connection with the reduction of, particularly, hard, tough, and abrasive materials, including ores having these characteristics. The illustrated embodiment is particularly adapted to grind material to ultra-fine sizes, such as for example —200 mesh to micron sizes, and in this embodiment the material to be ground preferably should not be larger than 16 to 18 mesh size, although it is possible to accommodate larger sizes. In general the size to be commenced with in this embodiment may be any desirable size which cannot be better or more economically crushed otherwise, but since in this embodiment the material is projected through a gun the size of the material to be ground is related to gun size, and therefore also to the capacity of the apparatus.

Referring to the schematic arrangement shown in Figure 1, the embodiment of the invention there illustrated comprises a container 50 adapted to contain material to be ground, and hereinafter referred to as the new-materials container. The new-materials container 50 may be formed with an outlet spout 51 discharging into a funnel 52 carried by the receiving end 53 of an elevating device 54, such as the bucket elevator here shown. A suitable slide valve 55 is interposed in the outlet spout 51 to regulate the flow of material from the new-materials container 50 to the receiving end 53 of the elevator 54. The elevator 54 may be driven by means of an electric motor 56, and may also have a signal device, such as the electric light 57, to indicate when the elevator 54 is operating. The discharge end 58 of the elevator 54 discharges into a conduit 59 leading to a blending and metering hopper 60, having high and low limit controls 61 and 62, so as to control operation of the motor 56 of the elevator 54, the connections being such that the motor 56 of the elevator 54 is automatically started when the level of the material falls enough to actuate the low level device 62, and the motor 56 is automatically stopped when the material rises enough to actuate the high level device 61. The details of the blending hopper 60 and the controls therefor are described in my aforesaid application and, as far as the subject matter of the present application is concerned, these details need not be set forth herein.

Positioned alongside of the receptacle 60 is a second elevator 63, having its inlet end 64 receiving material from the lower end of the hopper 60, as by means of a conduit 65, a suitable slide valve 66 being so interposed as to control the amount of material flowing from the hopper

60. The elevator 63 is driven by an electric motor 67, and may have a signaling device, such as the electric light 68, to indicate when the motor 67 is running. The discharge end 69 of the elevator 63 leads to the inlet of a solids valve 70 the outlet of which communicates with the interior of a charge metering and hoist tank 71. The hoist tank 71 has high and low level devices 72 and 73 respectively, so related to other parts (as described in my aforesaid application) as to permit the motor 67 to operate when the material is below the low level device 73, and to interrupt the circuit of the motor 67 when the material reaches the high level device 72.

A fluid under pressure, in the present instance, air, may be admitted to the hoist tank 71 through a conduit 74, and such air may be released from the hoist tank 71 through either the conduit 74 or a blow-off conduit 75. With material in the hoist tank 71, and air under pressure supplied to the hoist tank 71 through the air conduit 74, the material in the hoist tank 71 is forced to move into the lower end of a tube 219 suitably connected at its upper end to and in communication with the conduit 76, the material continuing through the tube 219, through the conduit 76 to a connection conduit 77 between an air strainer tank 78 and an upper material feed tank 79, a valve 80 being interposed in the connection conduit 77 to permit admission of material to the upper tank 79 and to enable the tank to be placed under fluid pressure. Assuming the valve 80 to be in open position, the material which passes through the conduit 76 is delivered to the connection conduit 77, the air used for hoisting purposes being strained by and vented from the strainer tank 78, and the material dropping into the upper feed tank 79. The conduit 76 is preferably of rubber or rubber lined, and if desired the conduit 76, or the rubber lining thereof, may be continuous with a rubber lining in the tube 219.

The upper feed tank 79 is connected to a lower feed tank 81 by means of a connection conduit 82, a valve 83 being interposed in the connection conduit 82 to permit transfer of material from the upper tank 79 to the lower tank 81, and to enable the lower tank to be maintained under pressure. The lower tank 81 has an outlet conduit 84, a valve 85 being interposed in the outlet conduit 84 for permitting or interrupting the outflow of material from the lower tank 81. Means (not shown herein) is provided for admitting air under pressure to the upper and lower tanks 79 and 81.

Assuming that the valve 83 is closed and the valve 85 is open, and assuming also that material is in the lower tank 81, and that this tank is under air pressure, the material from the tank 81 will be forced through the outlet conduit 84, and through a hose conduit 86 to the breach 87 of a gun 88, and through this gun 88 to the grinder case 89, the material being projected from the muzzle of the gun in the grinder case and subjected to impact in any desired way. The ground material passes through a conduit 90 to a first separating device 91 of the cyclone type. The heavier material in the first separating device 91 may gravitate through a tube 571 against a check valve 82, this valve being so constructed and arranged that a predetermined "head" of material is built up and maintained at the discharge end of the separating device 91, material being permitted to gravitate past the check valve, into the conduit 93, as further material

accumulates in the discharge end of the separating device, as will more fully appear. The material then continues through the conduit 93 to a funnel 94, and from the funnel 94 to a screen chamber 95 of a screening device 96.

The screening device 96 may be of the vibrating type, having a screen 97 over which the material is shucked, the screen having a certain predetermined mesh size, as for example 200 mesh.

The material which passes through the screen 97 falls into a hopper 98, the outlet of the hopper 98 having a bagging device 99, to which a bag 100 is attached, the bag 100 receiving such material for shipment if desired. For convenience, the bag 100 may be disposed on a platform 101 of a scale 102, so that the amount of material delivered to the bag 100 may be weighed as it is delivered to the bag. That material which does not pass through the screen 97 is discharged from the screen chamber 95 through a conduit 103, and back to the mixing hopper 60. Additional materials, from the new-materials container 50, may be added to the hopper 60 by means of the elevator 54, the high level device 61 limiting the amount of new material delivered to the hopper 60. In this manner the material removed from the system is automatically replaced with new material from the new-materials container 50. The slide valve 55 may be adjusted to a particular flow rate, such rate being determined by the rate at which finished material is removed from the system.

Additional separating means is provided for additionally separating that material which does not gravitate from the first separating device 91, and this means comprises, among other parts, a pump, in this instance a blower fan 104, disposed within a fan chamber 105 and driven by an electric motor 106. The outlet of the fan chamber 105 is branched, one branch 107 leading to the atmosphere, and the other branch 108 being connected to one end of a conduit 109, the opposite end 110 of the conduit 109 leading tangentially into the first separating device 91, if desired in two diametrically disposed tangential branches 110a and 110b (see also Figure 3). Slide valves 111 and 112 are respectively interposed in the branch conduits 107 and 108, these valves being independently adjustable so as to regulate the amount of air discharged by the blowers through the respective branch, for a purpose to appear.

The upper discharge outlet of the separating device 91 is connected to the inlet of the blower chamber 105, and in this instance certain devices are interposed in this connection. Extending from the upper discharge outlet of the first separating device 91 is a separating column, 113, of any suitable cross-sectional form, area, and length, which extends vertically and is connected to a conduit 114 which is tangentially connected to the upper end of a second air separating device 116. Desirably the separating column 113 is enlarged with respect to the conduit 114, and may taper toward its lower end to cause hindered settling. The device 116 may be of the cyclone type, comprising a chamber having an upper cylindrical portion 117 and a downwardly tapering conical portion 118. A bagging device 119 is connected to the lower end of the conical portion 118, and has attached thereto a bag 120 for receiving material gravitating downwardly of the conical portion 118. The upper end of the second separating device 116 is formed with a

housing 121 communicating with the interior of the device 116. The housing 121 communicates by means of a conduit 122 with a dust collector or separator 123, which may be of any suitable type. The lower end of the dust separator 123 has attached thereto a bagging device 124, and the air outlet of the dust separator 123 is connected by a conduit 125 to the inlet of the fan chamber 105.

Assuming that the motor 106 is operating, and that the valve 111 is at least partially open, and that ground material, along with air used in grinding it, is being delivered through the conduit 90 to the first separating device 91, the material which under the air conditions prevailing in the separating system is not heavy enough to gravitate at once from the separating device 91, will be picked up by the stream of air in the column 113. Some of this material will continue to be carried by that stream to the top of the column 113 and through the conduit 114 to the upper end of the second separating device 116, and will be caused to swirl in this upper end because of the tangential connection of the conduit 114. The heavier materials in the second separating device 116 will gravitate downwardly through the conical portion 118, and will be delivered to the bag 120 through the bagging device 119. The lighter material will be carried upwardly by the air stream through the housing 121 and the conduit 122, to the dust collector 123, where the dust will be separated from the air, the dust particles being discharged from the bottom of the dust separator 123 and to the bagging device 124, and the air passing to the conduit 125 and back to the inlet of the blower chamber 105. Some of the material which enters the separating column 113 from the separating device 91 does not continue with the upwardly moving stream of air into the conduit 114, but gravitates back through the stream into the separating device 91 and finally reaches the lower or discharge end of the separating device 91, and thus the separating action of the system is improved.

Depending upon the setting of the slide valves 111 and 112, either an under-pressure or an over-pressure condition (with respect to atmospheric pressure) can be made to exist in the first separating device 91. Usually the valve 112 is partially or completely closed, and the valve 111 partially or completely open, so that an under-pressure or partial vacuum exists within the first separating device 91 and in the column 113, whereby material readily passes from the grinder case 89 to the first separating device 91, and no back pressure is created in the conduit 90 leading from the grinder case 89. Also, usually the valves 111 and 112 are adjusted to effect substantially zero (atmospheric) pressure in the grinder case 89, thereby to avoid back pressure in the grinder case 89 that might interfere with the operation of the grinder gun. However, it will be apparent that the pressure conditions in the grinder case and in the separating system can be regulated by adjustment of the slide valves 111 and 112 to obtain any desired pressure conditions. Furthermore, the velocity of the upwardly moving stream of air in the separating column 113 may be adjusted to a most suitable velocity so that the separating function of the column 113 will be optimum.

The first separating device 91 may be moved from the position shown in full lines in Figure 1 to the position shown in dotted lines, wherein its lower end no longer communicates with the

conduit 93, but instead communicates with a conduit 135 leading to a tank 136, hereinafter referred to as a by-pass tank. The lower end of the tank 136 carries a bagging device 137, to which a bag 138 may be attached, and a check valve 139 is interposed in the conduit 135. In this position of the device 91 the ground material, excepting only a controllable amount and size of very fine material, instead of going to the screen chamber 95, passes directly to the by-pass tank 136. The conduit 113 in this position may still be connected to the conduit 114. The by-pass tank connection is particularly useful when it is desired to make an unscreened ground aggregate, with only a minimum of extreme fines removed.

The valve 85 is closed when initially charging the apparatus, and may also be closed for interrupting the process temporarily without relieved pressure on the lower feed tank 81, or at the end of a run prior to a subsequent initial charging or beginning of operations. In other words, it is closed before initially charging, or at the end of a day's run, or for temporary interruption, and it is opened when beginning operations, as at the beginning of a day, or after an interruption as for inspection or adjustment of other equipment.

While the material in the lower feed tank 81 is being ground, the hoist tank 71 will have again been filled, with either new material or with a mixture of new and partly ground material from overage from the screen 96, and this charge will have been hoisted, and all is in readiness to "dump" the same into the tank 81 when a low level responsive device (not shown) in the lower tank 81 indicates sufficient evacuation to receive the next charge from the upper feed tank 79.

From the foregoing description of the apparatus and the operation thereof, it will be apparent that operation of the apparatus and process are enabled to be continuous, but interruptable when desired.

The material ground in the grinder case 89 gravitates down its inclined sides to its reduced outlet and thence through the conduit connection 90 to the first separating device 91, this connection including a flexible hose 553 one end of which is suitably attached to the outlet of the grinder case and the opposite end of which is attached to an inlet pipe 554 of the first separating device 91. As shown in Figure 2, the first separating device 91 has another inlet pipe 555 directly below the inlet pipe 554, but the inlet pipe 555 in this instance is closed by a cap 556. If desired, the inlet pipe 555 may lead to another grinder case, the tank 91 in such instance serving both grinder casings, or the pipe 555 may be used as an inspection opening.

Referring particularly to Figure 4, the tank 91 comprises a cylindrical portion 557, a conical upward extending portion 558 tapering to a reduced outlet 559, and a conical downward extending portion 560 tapering to a reduced outlet 561. The separating column 113 extending upwardly from the tank 91 has a quick-detachable connection 564 with the outlet 559, and also a quick-detachable connection 565 for engagement with the conduit 114. The cylindrical portion 557 has conduits 566a and 566b extending tangentially therefrom in opposite directions, as best seen in Figure 3, these conduits being connected respectively to the branches 110a and 110b of the conduit 109 leading to the blower casing 105.

Disposed within the wall portion 557 is a gen-

erally annular chamber 750 comprising a cylindrical outer wall 751 spaced from the cylindrical portion 557 to leave an annular space 752 into which the conduits 566a and 566b are adapted to discharge. The chamber 750 further comprises an inner cylindrical wall 753 which is coaxial with the outlet 559 and extends upwardly to the wall portion 558 where it is sealed off at 754. The lower end of the annular chamber 750 is covered by a screen 755, and since the inner wall 753 extends downwardly somewhat further than the outer wall 751, the surface of the screen 755 tapers downwardly slightly. The chamber 750 further comprises a top wall 756 which closes the chamber 750 at the top, the wall 756 being made conical to prevent material lodging thereon. A desired number of vents 757 may be provided in the wall 756. The pipes 554 and 555 extend inwardly across the annular space 752 into the outer wall 751 of the annular chamber 750, so that these pipes are adapted to discharge ground material tangentially into the chamber 750, the direction of rotation in the chamber 750 being the same as the direction of rotation caused in the annular space 752 by the conduits 566a and 566b.

Desirably, an adjustable false work 758 is provided for creating favorable air flow conditions, as will appear. This false work 758 comprises an annular conical portion 759 the outer margin of which so fits within the cylindrical wall 557 as to be movable up and down, and to the inner margin of which is joined a conical discharge portion 760. The false work 758 may be adjusted by any suitable means, such as three or four screws 761 extending suitably through the wall 560 and bearing at their upper ends against the under side of the portions 759. The construction, arrangement, and adjustment, preferably are such that the cross-sectional area of the passage 764 formed underneath the screen 755 by the conical portion 759 is about the same at the place 762 as it is at the place 763, and that said cross-sectional area is about the same as the cross-sectional area of conduit formed by the inside of the cylindrical wall 753. By this construction the passage underneath the screen 755 may be adjusted for suitable relationship in sectional area with respect to the sectional area of the separating column 113, the sectional area of said passage being slightly smaller than the sectional area of the column 113 but adjustable depending on the type and size of material being separated.

The screen 755 is of a mesh large enough to pass substantially all of the material discharged into the annular chamber from the pipe 554 (or 555), but an annular series of openings 755a may be provided near the inner edge of the screen for passing particles of greater size than will be passed by the screen. The particles, as they drop through the screen 755, have little or no whirling motion, but are then acted upon by the air which has come from the conduits 566a and 566b. This air, as it comes out of conduits 566a and 566b, first tends to whirl about in the annular space 752, then passes as indicated by the arrows, in the passage 764 underneath and across the lower face of the screen 755, into the conduit formed by the inside of the wall 753, and up into the separating column 113, carrying with it most of the lighter particles, as determined by the air velocity adjustment.

The surfaces in the device 91 which might be subject to abrasive wear may be suitably lined with rubber. The tank 91 is supported by means of legs 567, the legs being readily disconnectable

from a support 568, as for instance by having slots 569 in angular foot portions, the slots 569 receiving the shanks of bolts 570. The support 568 is formed with an aperture, and extending through the aperture is a rubber hose 571, reinforced by a tube 573 having a flange 572 secured to the support 568. The lower outlet 561 fits within the upper end of the tube 571, the inclined sides of the lower portion 560 somewhat distending the upper end of the tube 571, as shown at 574, to provide a sealing joint.

Referring particularly to Figure 5, the lower end of the rubber tube 571 is provided with a check valve 92. The lower end of the tube 571 is secured within a cylindrical flange 575 formed integral with a disk 576 attached to the lower surface of the support 568. The flange 575 extends some distance beyond the lower end of the rubber tube 571 and has a bayonet joint connection with a cap 577 having a pair of spout outlets 578 each receiving a conduit 93, so that material flowing to the hopper 94 of the screen apparatus 96 is spread out over the screen 97.

However, the cap 577 rigidly holds an elongated bearing 579 through which an elongated plunger 580 is reciprocable. The upper end of the plunger 580 carries a cone-shaped valve 581, the sloping surface of the cone 581 being engageable with the margins defining the lower end of the rubber tube 571 to prevent flow of material through the tube 571. The lower end of the plunger 580 carries a wheel 582 which has contact with one end 583 of a lever 584, the lever being pivoted intermediate its ends as at 585, and the opposite end 586 of the lever 584 carrying a weight 587 which is adjustable along a rod carried by the lever end 586. From the construction just described it will be obvious that the valve 581 will block passage through the tube 571 until sufficient material is trapped within the tube 571 to overbalance the weight 587, at which time a certain amount of material will drop from the tube 571, through the spouts 578 and the conduits 93 to the screen chamber 95. Thus it will be obvious that a certain "head" of material is built up and maintained within the tube 571, material being permitted to gravitate past the check valve as further material accumulates in the discharge end of the separating device 91, thereby preventing air communication between the conduits 93 and the interior of the first separating device 91. Thus the pressure condition within the device 91, either greater or less than atmospheric pressure, as may be desired, will not be changed, since the check valve 92, either open or closed, substantially prevents flow of air through the tube 571.

The support 568 is provided with another opening through which extends a rubber tube 588 which is reinforced by an encircling flange 589 integrally connected with a disk 590 overlying and connected to the upper surface of the support 568. The upper end of the tube 588, as shown in Figures 3 and 6, is closed by a plug 591. The lower end of the tube 588 carries the check valve 139, here shown as comprising a casing 592, preferably rectangular in cross-section, carrying on opposite walls a pair of downwardly inclined rubber flaps 593 being formed of relatively stiff rubber and meeting at a central point 594, so that a certain "head" of material will be built up within the chamber 592 before the flaps will yield to permit passage of material through the conduit 135 to the by-pass tank 136 (see Figure 1).

The tank 91 may be moved from the full line

position shown in Figure 3 to the dotted line position shown in that figure, merely by loosening the bolts 570, sliding the slotted feet from engagement with the bolts, and bodily shifting the tank 91 to the position shown in dotted lines, the plug 591 being removed from the tube 588, and the lower outlet 561 being inserted within the upper end of the upper tube 588, the plug 591 then being used to close the rubber tube 571.

From the foregoing it will be apparent to those skilled in the art that each of the illustrated embodiments of my invention provides a new and improved apparatus for carrying out the processing of materials, and each accomplishes a principal object of my invention. On the other hand, it also will be obvious to those skilled in the art that the illustrated embodiments of my invention may be variously changed and modified, and features thereof, singly or collectively, embodied in combinations other than those illustrated, without departing from the spirit of my invention or sacrificing the advantages thereof, and accordingly, that the disclosure herein is illustrative only, and that my invention is not limited thereto.

I claim:

1. Separating means of the fluid flow type, comprising: means providing a substantially vertical passage of approximately uniform cross-section; means providing a substantially vertical separating column connected at its lower end to the upper end of said passage, the lower portion of said separating column increasing in cross-section upwardly to a cross-section substantially larger than the cross-section of said passage; means for causing a stream of fluid to progress in a generally radially inward direction to the lower end of said passage and enter the lower end of said passage and move upwardly in said passage and said separating column; and means causing particles to be separated to fall into said radially inwardly progressing portion of said stream of fluid before said stream enters the lower end of said passage.

2. Separating means of the fluid flow type, comprising: means providing a substantially vertical passage of approximately uniform cross-section; means providing a substantially vertical separating column connected at its lower end to the upper end of said passage, the lower portion of said separating column increasing in cross-section upwardly to a cross-section substantially larger than the cross-section of said passage; means for causing a stream of fluid to progress in a generally radially inward direction to the lower end of said passage and enter the lower end of said passage and move upwardly with desired velocities in said passage and said separating column; means causing particles to be separated to fall into said radially inwardly progressing portion of said stream of fluid before said stream enters the lower end of said passage; means providing a downward passage in substantial alignment with said substantially vertical passage, the upper end of said downward passage being spaced from the lower end of said substantially vertical passage and extending down-

wardly to an outlet portion; automatic valve means biased to closed position and controlling said outlet portion; and said outlet portion and said automatic valve means being so constructed and arranged that a certain accumulation of said heavier material is required to move said valve means away from closed position to permit discharge of material while at the same time said automatic valve means so controls the discharge of material that fluid communication through said valve means between atmosphere and the inside of said separating means is substantially prevented.

3. Separating means, for separating commingled particles, comprising: outer casing means having an outlet for the heavier particles and an outlet for lighter particles; annular inner casing means within said outer casing means, said inner casing means having a discharge outlet; means for introducing particles to be separated into said inner casing means; and separate means, including inlet means through said outer casing means directly into the space therewithin and outside of the outer periphery of said inner casing means, constructed and arranged to provide for flow of a stream of fluid which at least in part flows across said discharge outlet of said inner casing means and into the space defined by the inner periphery of said annular inner casing means to said outlet for lighter particles.

4. In combination: separating means, of the fluid flow type, constructed and arranged to separate co-mingled material; said separating means having an inlet for material to be separated, and having a separate inlet for operating fluid, and having an outlet for a lighter fraction of material and having an outlet for a heavier fraction of material; automatic valve means responsive to the weight on an accumulation of said heavier material for controlling the discharge of said material from said outlet for said heavier fraction; grinding means comprising a source of fluid under pressure and means for entraining in a stream of fluid supplied by said source the material to be ground and subjecting the stream to impact, said grinding means including a housing in which said stream is discharged and subjected to impact; conduit means for conveying the ground material from said housing to said inlet of said separating means for material to be separated; a fluid pump having an inlet and discharge; first connection means, from said discharge to said inlet for operating fluid; means for controlling the flow of fluid in said first connection means; second connection means, from said discharge to atmosphere; means for controlling the flow of fluid out of said second connection means; and third connection means connecting said outlet for said lighter fraction to said inlet of said fluid pump, said third connection means providing a substantially vertical separating column connected at its lower end to said outlet for said lighter fraction, the lower portion of said separating column increasing upwardly in cross-section to a cross-section substantially larger than the cross-section of said outlet for said lighter fraction.

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