

March 4, 1941.

F. C. SCHRAMM
SEPARATING APPARATUS

Filed Feb. 8, 1936

2,233,432

3 Sheets-Sheet 1

FIG. 1.

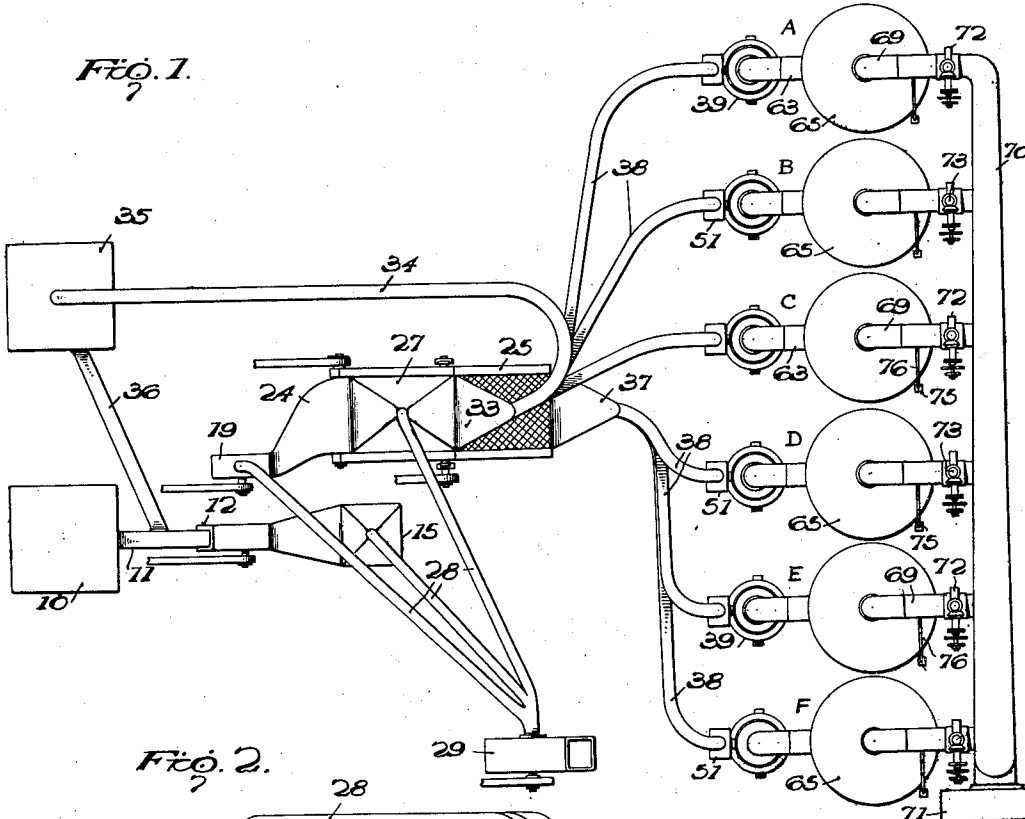
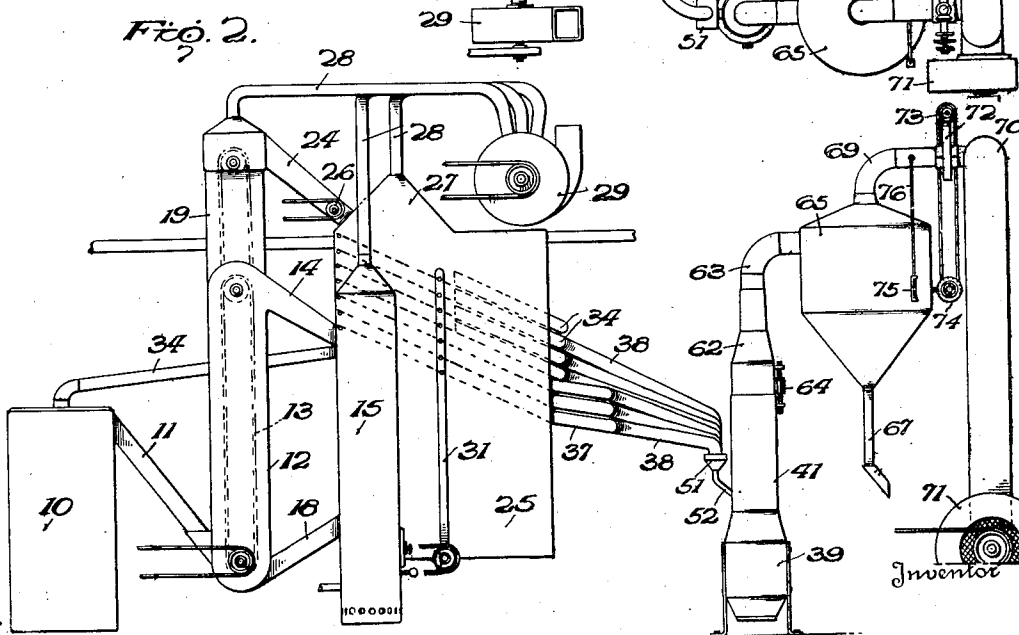


FIG. 2.



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By

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March 4, 1941.

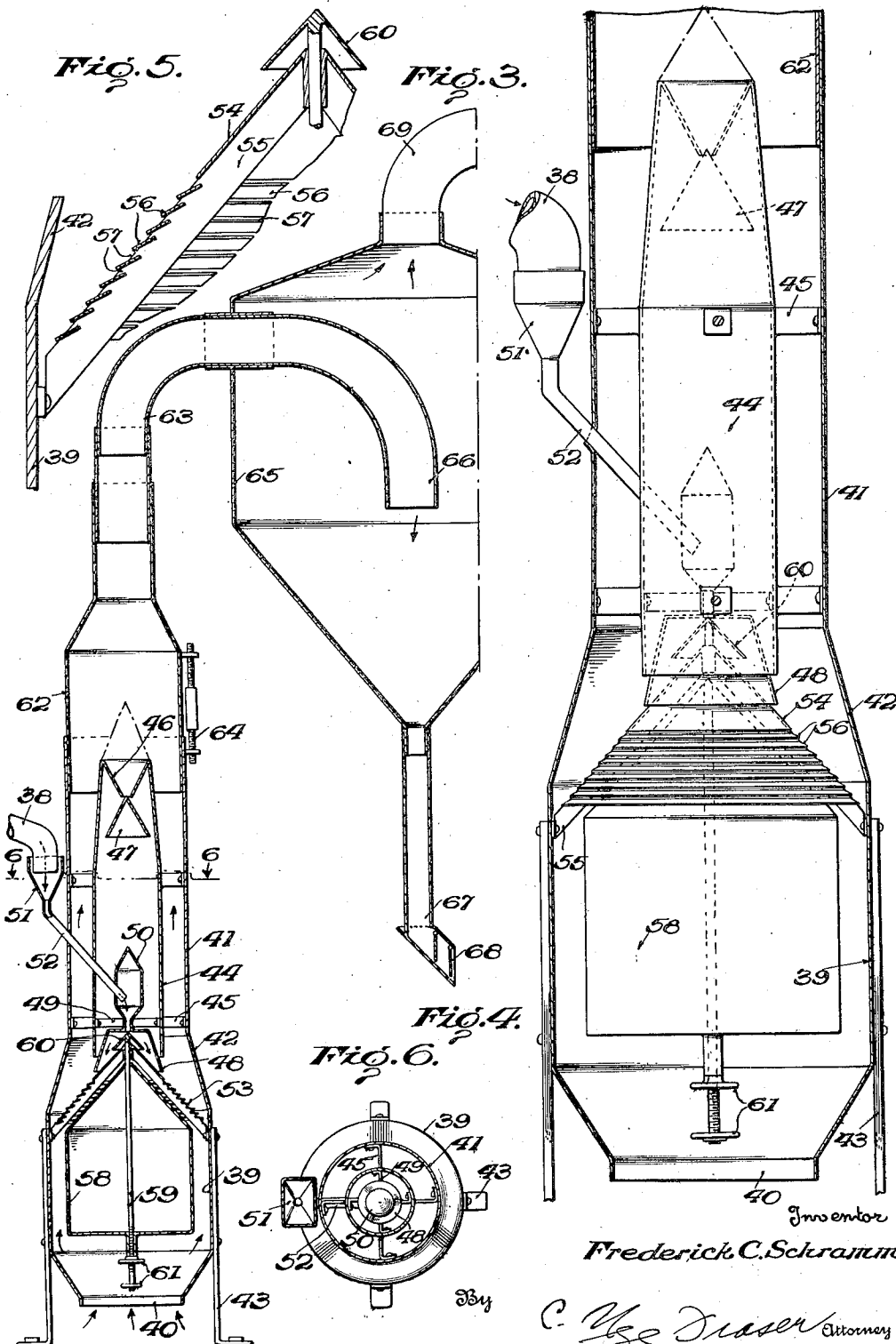
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March 4, 1941.

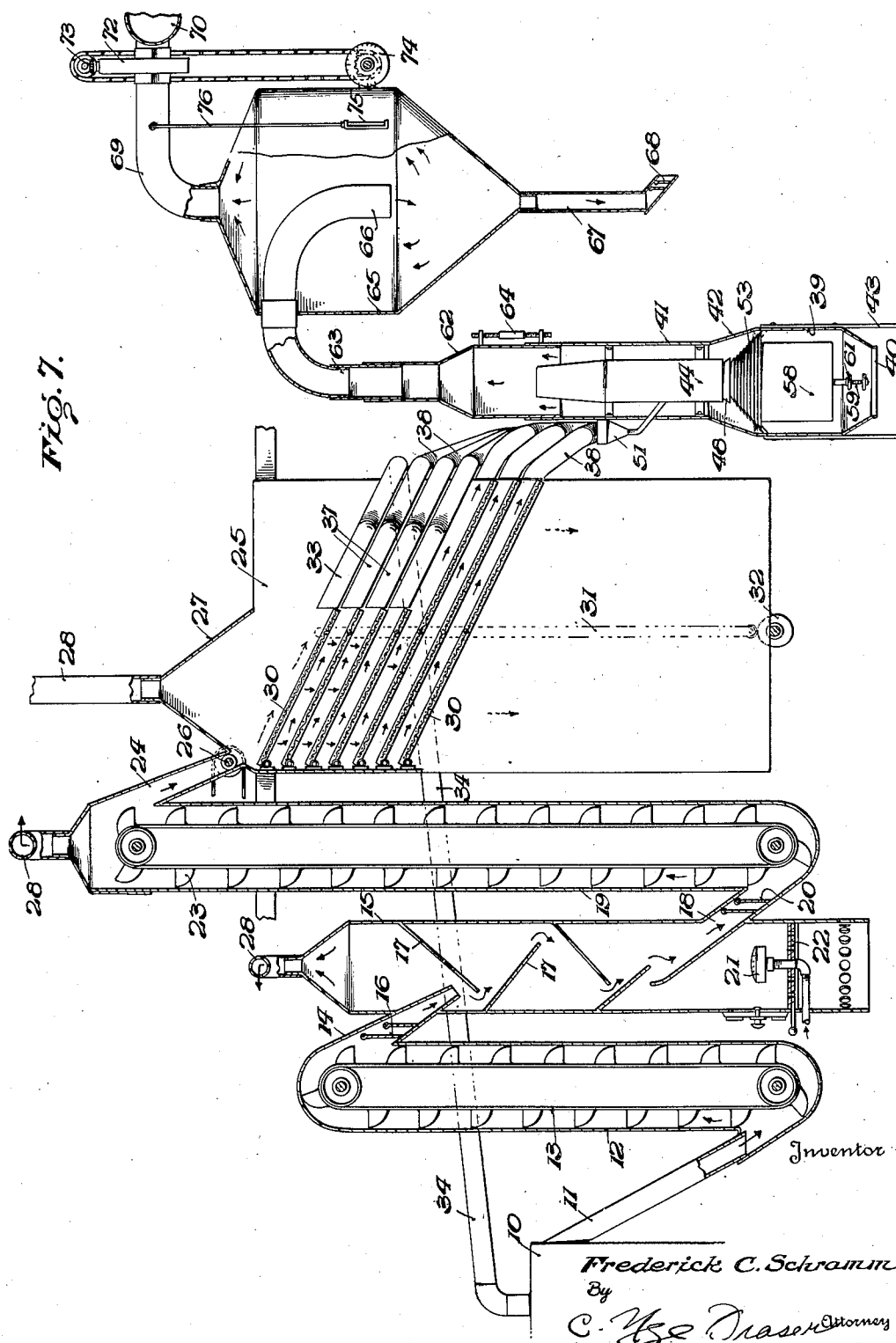
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SEPARATING APPARATUS

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UNITED STATES PATENT OFFICE

2,233,432

SEPARATING APPARATUS

Frederick C. Schramm, New Orleans, La., assignor of sixty-six two-hundred-and-fifty-seconds to Koch Co. Inc., thirty-one two-hundred-and-fifty-seconds to Anthony J. Marciante, thirty-one two-hundred-and-fifty-seconds to Peter Ciaccio, thirty-one two-hundred-and-fifty-seconds to Vito Manale, thirty-one two-hundred-and-fifty-seconds to Dominick Ciaccio, thirty-one two-hundred-and-fifty-seconds to J. C. Hare and thirty-one two-hundred-and-fifty-seconds to Peter J. Ciaccio

Application February 8, 1936, Serial No. 63,005

21 Claims. (Cl. 209—139)

My invention relates to an apparatus and a method for separating or classifying materials having different densities or specific gravities and/or of different sizes.

The present invention is adapted to be used in the treatment of materials in which there are particles of different sizes and/or densities, such as various ores, sands, grains, pulverulent or granular materials. For the purpose of illustration, the invention will be described in connection with the treatment of metalliferous ores, although this use represents merely one possible application of the invention.

While many devices have been designed to separate materials by the dry process in which the separation has been accomplished by suitable currents of air, the separation has not been so fine as to effect a complete or substantially complete separation, and consequently these devices have not been widely adopted in the treatment of materials requiring a complete separation, such for example as the treatment of ores or the like containing precious or valuable metals or other materials, or materials mixed with a foreign material which interferes with their use or value, or materials the densities of which are so nearly the same as to render their separation a difficult operation. Because of this lack of a fine or complete separation, the dry or pneumatic separators have not replaced the more expensive methods of separating such materials, particularly in the treatment of ores having valuable constituents, or having several valuable constituents which have varying densities but no great difference in density.

An object of the present invention is the provision of a method and an apparatus for separating materials in which the separation is fine and complete, so as to be effective in the treatment of ores having a valuable metallic constituent, or of materials in which a fine or complete separation is necessary or desirable.

Another object of this invention is the provision of an apparatus of the above mentioned character in which the factors affecting the separation are under independent and accurate control.

A further object of this invention is to provide an apparatus and method of this character in which a fine separation of particles with no great difference in density is possible.

Still another object of the invention is the provision of an apparatus and method by means of which precious and valuable metals or other materials may be substantially completely separated

from their ores or from other materials by the dry process in a minimum of time and in a single operation.

A still further object of the invention is the provision of an apparatus of this character which is of simple construction, inexpensive to install and operate, and which, when properly set, is automatic in its operation.

Other objects and advantages of this invention will be apparent during the course of the following description.

In the accompanying drawings, which form a part of this specification and in which like characters of reference denote like parts throughout,

Figure 1 is a plan view of the complete apparatus in which, for the purpose of illustration, six pneumatic separating units are shown,

Figure 2 is a side elevation thereof,

Figure 3 is a vertical sectional view through one of the separating units and its gangue chamber,

Figure 4 is a vertical sectional view through the casing of one of the separating units showing the interior parts of the unit in elevation, and on a somewhat larger scale than Figure 3,

Figure 5 is a detail fragmentary sectional view of the slotted cone and the adjustable feed cone,

Figure 6 is a horizontal sectional view taken on the line 6—6 of Figure 3 and looking in the direction of the arrows, and,

Figure 7 is a sectional view of the entire system showing the apparatus arranged in the order of the passage of the material therethrough.

In the drawings, wherein for the purpose of illustration is shown a preferred embodiment of the invention the numeral 10 designates a primary pulverizer for crushing the ore or other material, which may be of any suitable construction and having a discharge conduit 11 extending downwardly from the pulverizer 10 to the lower end of a vertical conveyor casing 12 in which a suitable conveyor 13 is arranged, which may be of the chain and bucket type. The upper end of conveyor casing 12 is provided with a downwardly inclined discharge chute 14 extending into the upper portion of a drier or heater 15 and having a pair of spaced, pivoted gate valves 16 therein to permit passage of pulverized material therethrough while preventing passage of heated air from heater 15.

Heater or drier 15 may be of any suitable type such for example, as the heater shown in Figure 7 in which the interior is provided with a plurality of downwardly inclined baffles 17 alternately extending from opposite sides of the

heater to pass the material from side to side of the heater and deposit it in the chute 18 arranged adjacent the bottom of the heater and connecting the heater to the lower end of a second conveyor casing 19. Suitable spaced gate valves 20 are arranged in chute 18 to permit passage of material but to prevent passage of hot air from the heater. A suitable burner or other heating member 21 is arranged in the lower portion of the heater 15 and a draft control device 22 may be located below the burner.

Conveyor casing 19 is also vertically arranged and is provided with a suitable conveyor 23 to raise the material from heater chute 18 to a chute 24 at the upper end of the casing 19 which extends downwardly and discharges into a screen compartment or casing 25. A rotating spreader roll 26 is preferably disposed at the discharge end of chute 24 and may be of any suitable construction. A hood 27 is disposed at the top of compartment 25 over the screens therein, and this hood, together with heater 15 and conveyor casing 19 is connected by conduits 28 to the intake of a blower or exhaust fan 29 which may be of the axial intake and peripheral exhaust type for removing dust from the pulverized material.

The apparatus thus far described may be of any suitable or well known construction, the construction shown being merely illustrative. Where the material to be treated is in a granular condition it need not pass through the pulverizers and associated apparatus but may be discharged directly into the screen compartment 25. It is desirable however to assure the absence of all moisture or a uniform moisture content before passing the material to the screens, and for this reason the material to be treated should be passed through the heater or drier 15 before being screened and passed to the separating units.

A plurality of inclined superposed screens 30 are arranged within the compartment 25 and are pivoted at one end and vibrated by means of a pitman 31 which may be reciprocated by a rotating cam 32. The screens are shown as seven in number, arranged one above the other, although any desired number or arrangement of screens may be employed. The top screen has the largest mesh while each successive screen therebelow has progressively finer mesh. A flat hopper 33 is arranged to receive material which will not pass through the top screen and a conduit 34 conducts such material to a secondary crusher 35 where it is again crushed and passed through conduit 36 to conduit 11 where it joins the material from primary crusher 10 and again passes through the system to the screens. Other hoppers 37 are arranged to receive the material which will not pass through each screen and such material passes through conduits 38 to the pneumatic separators A, B, C, D, E, F. Each separator will therefore receive material ground to a predetermined mesh, the material of the largest mesh going to unit A while that of the finest mesh goes to unit F.

Each of the units A to F are of the same construction although adjusted to accommodate material of different mesh or fineness. The interior construction of these units is shown in Figures 3 to 7. Each of the separating units consists of a vertical column formed by a metallic casing which has an enlarged lower portion 39 with a reduced discharge opening 40 at its lower end, and a longer reduced column 41 connected at its lower end to the enlarged portion 39 by means of a frusto-conical intermediate section 42. The portions 39 and 41 are circular in cross section, as

indicated in Figure 6, and are supported by suitable legs or supports 43. An elongated core 44 is arranged concentrically within the column 41 and supported by suitable spiders 45 the arms of which are flat and arranged with their flat sides parallel to the axis of the column 41 to assist in guiding the currents of air vertically through the column. The core 44 is tapered at its upper end to provide a progressively increasing space in the column 41 approaching the top of the core. The core 44 is cylindrical in cross section and is hollow, having an inverted frusto-conical lip or skirt 46 at its upper end extending down into its interior and having a relatively small opening at its lower end. A cone 47 is supported concentrically within core 44 directly below skirt 46 and the apex of the cone extends into the opening in the bottom thereof. The greatest diameter of cone 47 is substantially less than the internal diameter of the core 44 adjacent the cone.

An outwardly and downwardly flared apron 48 is supported concentrically within the open lower end of core 44 by means of a spider 49 and extends below the lower end of core 44, there being a circumferential opening between the apron 48 and the lower end of the core 44 as indicated in Figure 3. A small core 50 arranged above the apron 48 is pointed at its upper end and tapers at its lower end, terminating in a small passage which discharges into apron 48, the top of the apron being closed except for the passage from the small core 50. A hopper 51 is arranged exteriorly of the column 41 and has a discharge pipe 52 extending downwardly through column 41 and core 44 into the small core 50 into which it discharges. Pipe 38 discharges material into hopper 51 and the material passes through pipe 52 into small feed core 50 and down into the apron 48.

A slotted spreader cone 53 is secured to the casing 39 adjacent the top thereof and extends into the section 42 and up into the apron 48, there being a relatively small annular space between the bottom of apron 48 and the spreader cone 53. Spreader cone 53 comprises an upper imperforate portion 54 secured to vanes 55 which in turn are riveted, bolted, or otherwise secured at their lower ends to casing 39. The vanes 55 are provided with a series of spaced inclined slots arranged between the portion 54 of the cone and the lower ends of the vanes, and these slots receive relatively narrow overlapping cone sections 56 arranged in spaced relation with spaces or slots 57 therebetween as shown in detail in Figure 5. The angle of the cone sections 56 and slots 57 is such as to cause air currents passing through slots 57 from within the spreader cone to take a substantially horizontal path. The lower cone section is spaced from the side of the casing 39 to permit material to pass downwardly into the bottom of the casing 39.

A lower cone member 58 is concentrically arranged within the casing 39 and has a conical upper portion which extends up into the spreader cone in spaced relation therewith, as seen in Figure 3. The cross-sectional area of the annular space between lower cone member 58 and casing 39 is substantially equal to the cross-sectional area of the space between the cylindrical lower portion of core 44 and column 41. In practice it is preferable to have a slightly greater area about upper core 44 so that the air current therein will be slightly weaker and will permit heavier material to drop into the casing 39. A difference in area of about 1½% is sufficient for this purpose. The combined cross-sectional area of the slots 57 75

between the spreader cone sections is also substantially equal to the cross-sectional area of the space between the lower core 58 and casing 39. A shaft 59 is journaled centrally of the lower core 58 and extends through the apex of the spreader cone. A small feed control cone 60 is carried by the upper end of the shaft 59 and above the top of the spreader cone. The lower end of shaft 59 is screw-threaded, and suitable adjusting hand wheels 61 are provided to raise and lower the feed control cone 61, and the proximity of the cone 60 to the opening in the top of apron 48 controls the amount of material fed onto spreader cone 53 from hopper 51.

It will be noted that the opening between the bottom of lip 46 and cone 47 is very small as compared to the annular opening between the bottom of core 44 and the apron 48. As a consequence when a rising column of air is induced in column 41 by means of an exhaust or suction fan connected to its upper end, or by other means, air will be drawn out of the bottom of core 44 at a faster rate than out of its top, thereby tending to produce a vacuum or partial vacuum in the core 44 or at least resulting in a substantially quiescent or stationary condition of the air in the core 44. This results in a downward movement of any air or at least a stationary condition of the air in the core 44, a condition which is enhanced by the tendency of material falling into lip 46 to partially or wholly close up the opening in the top of the core 44, the core 44 thereby becoming a chamber through which particles of material will drop very rapidly, due to the absence of a lifting force therein.

The upper portion of column 41 telescopically receives an adjustable extension 62 which is reduced at its upper end to form a connection to telescopically receive a conduit 63. A suitable adjusting rod, or the like, 64 connects the extension 62 to column 41 and may be operated to raise and lower extension 62 with respect to column 41, thereby increasing or decreasing the length of the column above the vacuum core 44. Conduit 63 extends radially through the side wall adjacent the top of a gangue or detritus chamber or tank 65 and terminates in a downwardly turned vertical portion 66 arranged concentrically with the axis of tank 65. The bottom of the tank 65 is of inverted cone-shaped formation terminating in a discharge chute 67 provided with a pair of spaced outwardly swinging gate valves 68 arranged to permit passage of material while preventing ingress of air.

A conduit 69 opens into the top of tank 65 centrally thereof, and connects the tank to a manifold 70 which is connected to the axial intake of an exhaust fan, blower or the like 71 which is preferably of the axial intake and peripheral exhaust type.

For convenience of illustration, six separator units are shown arranged in alignment as seen in Figure 1. Any suitable number of units may be employed, and one screen is provided for each unit with an additional screen for returning large particles to the secondary crusher. In Figure 1 unit A is shown as farthest from fan 71 while unit F is shown as closest to the fan 71. Manifold 70 gradually increases in size from unit A to unit F so that an equal current of air will normally be obtained in each unit.

As material of different mesh is treated in each unit it is necessary to provide an independent control of the air currents in each unit, and this is accomplished by means of a suitable valve 72

arranged in each conduit 69 between the units and the manifold. This valve may be of the sliding gate type, or of any other suitable construction permitting complete or partial shutting off of the conduit 69, and may be controlled by any suitable means, as by the bevel gear mechanism indicated at 73 and controlled by means of a hand wheel or the like 74 provided with a suitable scale. A manometer 75 is preferably arranged adjacent control wheel 74 and is connected to the conduit 69 by means of a tube 76 extending into the conduit 69 between the valve 72 and tank 65. By means of manometer 75 the strength of the air current within the unit may be determined and the desired adjustment made through valve control wheel 74.

By this means, the air current within each unit may be easily and accurately adjusted or shut off completely independently of the other units. The relatively large tank 65 serves as a vacuum tank to equalize pressure within the units and thus prevent surging or variation of air current due to momentary changes in the speed of blower 71, or to other factors. Suitable graduated scales are used with control wheel 74, adjusting rod 64 and adjusting rod 59. In place of an exhaust blower, a blast of air may be blown through the units from the opposite ends thereof, but the exhaust fan is preferred as it produces more uniform conditions in the units and results in a finer separation.

In operation, the material, if not in a suitable granular condition, is fed into the pulverizer 10 where it is pulverized and carried by conveyor 13 to the top of heater or drier 15 where moisture is removed. The pulverized and dried material is then conveyed to the top of screen chamber 25 where it is spread out by roller 26 and deposited upon the vibrating screens 30. All of the material which is too large to pass through the top screen goes into hopper 33 and through conduit 34 to secondary pulverizer 35 to be again pulverized and passed through the system. Material fine enough to pass through the first screen but too large to pass through the second screen goes through the upper hopper 37 and conduit 38 to unit A, while material rejected by the third screen goes to unit B, and so on. All the material treated in a single unit is of a given, predetermined mesh, and has a uniform moisture content, so that the separation of the heavier particles from the lighter particles may be accurately and completely effected in the separating units.

The screened, granular material is delivered by conduits 38 into hoppers 51 and passes through pipe 52 into the small feed core 50 where it feeds through the apron 48 onto the surface of the slotted spreader cone 53. Accurate control of the rate of feed may be effected by means of the adjusting wheels 61 operating to move the feed cone 60 toward or away from the opening in the top of apron 48. A uniform current of air rises up through casing 39 and column 41 induced by the exhaust fan 71, and this current of air is kept uniform by the large gangue tank or chamber 65. An important feature of this invention is the use of the cores 44 and 58 to maintain a uniform flow of air through the separating column. When a current of air is drawn or blown through a column, a wide variation of pressure is found in different portions of the column, particularly in the center where the pressure is much less than adjacent the side walls. There is also found to be a swirling and gyration of air in such a column.

Where such a variation occurs, it is impossible to make a fine separation according to density or weight because of the difference in strength of the currents of air at different points in the column. With the arrangement of cylindrical cores concentrically arranged in the cylindrical column, indicated in Figures 3, 4, 6 and 7 however, the greatest portion of the central portion of the column cross-sectional area is taken up by the cores, and the annular space around these cores will produce a ring-like column of air having a uniform pressure so that a fine separation can be obtained.

An annular current of air passes around core 58 and around the spreader cone 53 into the column 41. Other currents of air pass under the slotted spreader cone, being guided by the conical upper portion of the core 58 and by the vanes 55, and pass out through the annular slots 57 between cone sections 56 in a substantially horizontal path to impinge against the stronger vertical current of air passing around the spreader cone and interfere therewith to cause a disturbance of the air currents adjacent the surface of the spreader cone. This disturbance of the air, and the currents of air passing through slots 57 serves to disperse and separate the material passing down the cone 53 so that the rising column of air can take effect thereon. The very heavy or dense material will pass through these air currents without being picked up thereby, and will drop down the casing 39 adjacent the periphery thereof, dropping through opening 40. The other material will rise through column 41, and the heavier particles will drop back through the column to the opening 40. Many particles will be carried up the column although of a density or weight such as is desired to drop into opening 40. These particles tend to be released by the weakening air current adjacent the top of the core 44 because of the gradually increased area of the column formed by the tapered upper end of the core 44. The area of the column suddenly increases at the top of core 44 and forms a breakdown or expansion chamber where the final separation is made. There will tend to be a vacuum or partial vacuum formed at the top of core 44 or at least a stationary or quiescent condition of the air therein, as indicated by the dotted lines in Figures 3 and 4, due to the small opening in the top of core 44, and heavy particles will fall into this space and down into lip 46 where they are carried by cone 47 to the periphery of core 44 and dropped onto apron 48 and down into casing 39 and out through opening 40.

An important feature of this invention is the use of the core 44. Particles which approach the line of division between the light and heavy particles, if dropped into a rising column of air will tend to be picked up by the column of air, remaining in the column, being first raised and then dropped. Under such conditions a fine division is impossible. In the core 44, however, due to the small opening at the top of the core and the tendency of this opening to clog, there will be no lift in the core, or a stationary column of air which will permit a very rapid drop of the particles onto the apron 48. As a consequence, these particles will gain momentum and will glance off the surface of apron 48 to pass through the currents of air over material on cone 53 and out through opening 40. The very heavy particles will not reach the top of core 44 while those particles that do reach this point require the

momentum attained in core 44 to pass through the air currents without being again picked up by the air.

For treating finely divided material, or material the particles of which do not vary greatly in weight or density, it is desirable to increase the length of the breakdown or expansion chamber above core 44 and this may be accomplished by adjusting shaft 64 to raise section 62 and thus increase the length of column 41. The gangue or light particles are carried through pipe or conduit 63 and through the downturned end 66 into the gangue chamber 65. The material is released by the reduction in the strength of the air current due to the size of tank 65, and by the sudden reversal of direction of the air current, and passes down chute 67 and out through valves 68. The air current passes out through the top of tank 65 through conduit 69 and manifold 70.

The strength of the air current in the unit is determined by manometer 75 and the proper adjustment is made by means of control wheel 74 and valve 72. When setting the units for treating any material the proper adjustment of valve 72, feed cone 60 and column section 62 are made. These adjustments depend on the mesh, weight and comparative densities of the material being treated. For example, material of fine mesh would require a relatively weak air current and a long breakdown or expansion chamber, whereas material of coarser mesh would require a stronger air current while not requiring a large breakdown or expansion chamber. Adjustment of feed cone 60 depends on the capacity or size of the unit, the character of material being treated, and the strength of the air current being used. Gyration of the current of air is prevented by the presence of the cores 44 and 58 and by the arms of the spiders 45 and vanes 55 which may be of any suitable width to guide the air current in a vertical path and prevent any tendency to swirl or gyrate. Inspection of the gangue issuing from chute 67 or of the concentrates falling through opening 40 indicates whether proper adjustment has been made.

As an example, when treating material of 24 mesh, a vacuum of about $2\frac{1}{2}$ inches would be used; for material of 30 mesh a vacuum of about 2 inches would suffice; and for material of 70 mesh a vacuum of about $\frac{3}{4}$ of an inch would be sufficient, the adjustment being made by valve 72 with reference to manometer 75. These figures are approximate, and will vary somewhat with different materials, being given as illustrations only. Corresponding adjustments of the column section 62 and feed cone 60 would also be made.

In practice this apparatus has separated various materials with a recovery ranging from 98½% to 100%. For example, two sands were mixed, one being black and having a specific gravity of 4.55 while the other was white with a specific gravity of 2.66. Although the difference in specific gravity was only 1.89 a recovery of 100% was effected. Comparable results were obtained with other materials.

Where several metals are present in the same ore, the apparatus may be adjusted to separate the metals from the gangue in one operation, and then adjusted to separate the metals from one another, or the heavier metal may be first removed from the material, then the next heavy metal and so on.

While this invention has been described with particular reference to the treatment of ores, it

is to be understood that it can be used for the treatment of any materials having particles of different sizes or weights. In practice this invention has operated effectively in the treatment of several grades of sand which were intermixed, in the treatment of various kinds of ore and in the treatment of ground coffee. To adapt the apparatus to various materials, or to materials having different grades of fineness, it is only necessary to adjust the air current control valves, column sections and feed cones. Screens of different mesh may be substituted for those in use, to suit varying conditions or different materials. When the apparatus has been properly set, its operation is entirely automatic.

While I have shown and described the preferred embodiment of my invention it is to be understood that various changes in the size, shape and arrangement of parts, and in the various steps of the process, may be resorted to without departing from the spirit of my invention or the scope of the subjoined claims.

Having thus described my invention, what I claim and desire to protect by Letters Patent is:

1. In a separating apparatus, a column, means to induce a current of air in said column, means to feed material to be separated into said column, an axially extending cylindrical core arranged in the column and spaced from the walls and top thereof to provide an annular space in the column for the passage of a uniform current of air, and means to adjust the length of said column above the core.

2. In a separating apparatus, a column, means to induce a current of air in said column, means to feed material to be separated into said column, an axially extending cylindrical core arranged in the column and spaced from the walls and top thereof to provide an annular space in the column for the passage of a uniform current of air, means to adjust the length of said column above the core, means to regulate the feed of material into said column, and means to regulate the strength of the air current in the column.

3. In a separating apparatus, a column, a hollow core arranged in said column in spaced relation to the walls of the column, said core having an opening at its lower end and a substantially smaller opening at its upper end, means to induce a rising current of air in the column from a point below said core to a point above the top thereof, and means to feed granular material into the column below said core, whereby the material may be lifted by the annular column of air and some of the material dropped into the upper end of said core.

4. In a separating apparatus, a column, a core arranged within the column in spaced relation to the walls of the column and terminating below the top of the column, a spreader cone located in said column below the hollow core, means to induce a rising current of air in the column, means to feed granular material onto said spreader cone, and means to vary the length of the portion of the column above the top of the hollow core.

5. In a separating apparatus, a column, a hollow core arranged within the column in spaced relation to the walls of the column and terminating below the top of the column, a spreader cone located in said column below the hollow core, means to induce a rising current of air in the column, and means to feed granular material onto said spreader cone to be spread thereby for exposure to the rising column of air, said spreader

cone having slots therein to permit the passage of air through the cone, there being an annular space between the spreader cone and column walls for the passage of material and for the passage of an annular rising column of air.

6. In a separating apparatus, a column, a hollow core arranged within the column in spaced relation to the walls of the column and terminating below the top of the column, a spreader cone located in said column below the hollow core, means to induce a rising current of air in the column, means to feed granular material onto said spreader cone to be spread thereby for exposure to the rising column of air, said spreader cone having slots therein to permit the passage of air through the cone, there being an annular space between the spreader cone and column walls for the passage of material and for the passage of an annular rising column of air, means to regulate the feeding of material onto the spreader cone, and means to control the length and strength of the rising current of air in the column.

7. In a separating apparatus, a column, a core arranged in the lower portion of the column, a spreader cone secured in the column and spaced above the core, said spreader cone having openings therein to permit the passage of air, there being an annular space between the walls of the column and the core and spreader cone for the passage of material and for the passage of an annular rising column of air, means to feed granular material onto said spreader cone, and means to induce a rising current of air in said column exteriorly of said core.

8. In a separating apparatus, a column, an imperforate core arranged in the lower portion of the column, a spreader cone secured in the column and spaced above the core, said spreader cone having openings therein to permit the passage of air therethrough, there being an annular space between the walls of the column and the core and spreader cone for the passage of material and for the passage of an annular rising column of air, means to feed granular material onto said spreader cone, means to induce a rising current of air in said column, means to regulate the feed of material onto the spreader cone, and means to control the strength of the current of air in the column.

9. In a separating apparatus, a column, an imperforate core arranged in the lower portion of the column, a spreader cone secured in the column and spaced above the core, said spreader cone having openings therein to permit the passage of air therethrough, there being an annular space between the walls of the column and the core and spreader cone for the passage of material and for the passage of an annular rising column of air, means to feed granular material onto said spreader cone, means to induce a rising current of air in said column, and a second core arranged in the column above the spreader cone and spaced from the walls of the column, whereby an annular space is provided for the passage of the annular rising column of air.

10. In a separating apparatus, a column, an imperforate core arranged in the lower portion of the column, a spreader cone secured in the column and spaced above the core, said spreader cone having openings therein to permit the passage of air, there being an annular space between the walls of the column and the spreader cone for passage of material and for the passage of an annular rising column of air, means to feed

granular material onto said spreader cone, means to induce a rising current of air in said column, a second core arranged in the column above the spreader cone and spaced from the walls of the column, whereby an annular space is provided for the passage of the rising column of air, and means to vary the length of the column.

11. In a separating apparatus, a column, a spreader cone secured in the column and comprising a series of overlapping annular sections with circumferential slots therebetween, there being an annular space between the walls of the column and the spreader cone for the passage of material and for the passage of a rising annular column of air, means to feed granular material onto the spreader cone, and means to induce a rising current of air in said column around and through said spreader cone.

12. In a separating apparatus, a column, a spreader cone secured in the column and comprising a series of overlapping annular sections with circumferential slots therebetween, there being an annular space between the walls of the column and the spreader cone for the passage of material and for the passage of a rising annular column of air, means to feed granular material onto the spreader cone, means to induce a rising current of air in said column around and through said spreader cone, means to regulate the feed of material onto the spreader cone, and means to control the strength of the current of air in the column.

13. In a separating apparatus, a column, a spreader cone secured in the column and comprising a series of overlapping annular sections with circumferential slots therebetween, there being an annular space between the walls of the column and the spreader cone for the passage of material and for the passage of a rising annular column of air, means to feed granular material onto the spreader cone, means to induce a rising current of air in said column around and through said spreader cone, and a core arranged in the column and spaced from the walls thereof said core being imperforate and arranged in spaced relation below the spreader cone to form an annular space in the column for the passage of an annular column of air.

14. In a separating apparatus, a column, an imperforate core arranged concentrically in the column and spaced from the walls thereof, a spreader cone spaced above the core, a second core concentrically arranged in the column above the spreader cone and spaced from the walls of the column said second core terminating short of the top of the column to form a break-down chamber above the core, a gangue tank connected to the upper end of the column, an air current inducing mechanism connected to the gangue tank to induce a current of air in the column and tank, and means to feed granular material onto the spreader cone.

15. In a separating apparatus, a column having an enlarged lower portion connected to its upper portion by a tapered connecting section, an imperforate core arranged concentrically within the enlarged lower portion of the column and spaced from the walls thereof, a spreader cone arranged in the column and extending into the tapered connecting portion thereof, a second core concentrically arranged in the column above the spreader cone and spaced from the walls of the column, said second core terminating below the top of the column to form a break-down cham-

ber in the top of the column, means to feed material onto the spreader cone, and means to induce a rising current of air in said column.

16. In a separating apparatus, a column having an enlarged lower portion connected to its upper portion by a tapered connecting section, an imperforate core arranged concentrically within the enlarged lower portion of the column and spaced from the walls thereof, a spreader cone arranged in the column and extending into the tapered connecting portion thereof, a second core concentrically arranged in the column above the spreader cone and spaced from the walls of the column, said second core terminating below the top of the column, means to feed material onto the spreader cone, means to induce a rising current of air in said column, and means to vary the length of the column above the second core.

17. In a separating apparatus, a column having an enlarged lower portion connected to its upper portion by a tapered connecting section, a core arranged concentrically within the enlarged lower portion of the column and spaced from the walls thereof, a spreader cone arranged in the column and extending into the tapered connecting portion thereof, a second core concentrically arranged in the column above the spreader cone and spaced from the walls of the column, said second core terminating below the top of the column, means to feed material onto the spreader cone, and means to induce a rising current of air in said column, the space between the lower core and the walls of the column having substantially the same cross sectional area as the space between the upper core and the walls of the column.

18. In a separating apparatus, a column, a hollow elongated core supported in said column and spaced from the top and the walls thereof, said core having a relatively small opening in its upper end, an annular deflector arranged in the lower end of the core and spaced from the walls thereof, the space between the deflector and the walls of the core being of substantially greater area than the opening in the top of the core, means to induce a rising current of air in the column, and means to feed material into the column adjacent the lower end of the core whereby material dropped through the opening in the top of the core will drop through the core free of the lifting influence of the rising current of air and strike said deflector.

19. In a separating apparatus, a column, a hollow core supported in said column and spaced from the top and the walls thereof, said core having a relatively small opening in its upper end, an annular deflector arranged in the lower end of the core and spaced from the walls thereof, the space between the deflector and the walls of the core being of substantially greater area than the opening in the top of the core, means to induce a rising current of air in the column, means to feed material into the column adjacent the lower end of the core whereby material dropped through the opening in the top of the core will fall through the core free of the lifting influence of the rising current of air, and means to vary the length of the column above the core.

20. In a separating apparatus, a column, a hollow core supported in said column and spaced from the top and walls thereof, said core having a relatively small opening in its upper end, a spreader arranged below said opening interiorly of the core, a deflecting apron arranged in the open lower end of the core and spaced from the

walls thereof, a spreader cone supported in the column below the core and apron, means to feed material through said apron onto the spreader cone, and means to induce a rising current of air in the column whereby material dropped into the opening in the top of the core will drop through the core and strike said deflecting apron.

21. In a separating apparatus, a column, a hollow core supported in said column and spaced from the top and walls thereof, said core having a relatively small opening in its upper end, a spreader arranged below said opening interiorly of the core, a deflecting apron arranged in the open lower end of the core and spaced from the walls thereof, the space between the apron and

the walls of the core having an area substantially greater than the area of the opening in the top of the core, a spreader cone supported in the column below the core and apron, means to feed material through said apron onto the spreader cone, means to induce a rising current of air in the column whereby material will be raised by the column of air and dropped into the opening in the top of the core to fall through the core onto the deflecting apron free from the lifting influence of the rising column of air, and a second core supported below the spreader cone and spaced from the walls of the column.

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