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D. B. BINNIX

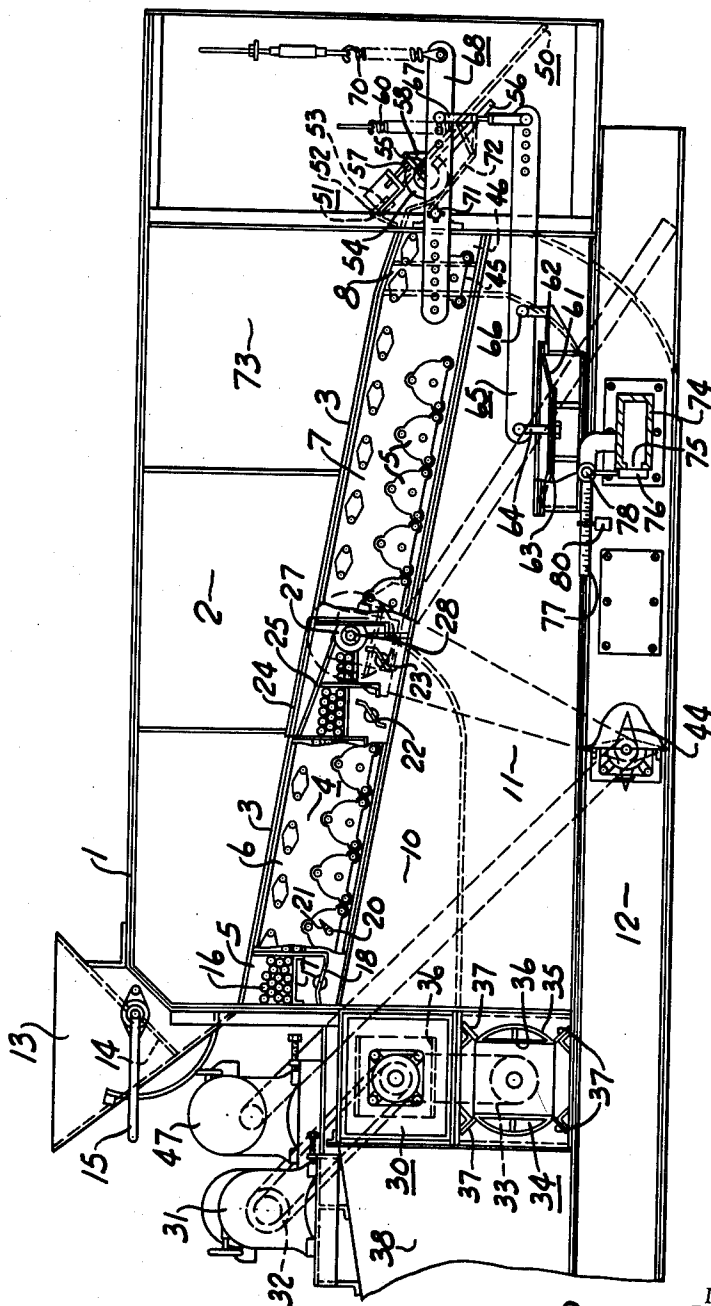
3,065,853

CONTROL FOR PNEUMATIC STRATIFICATION SEPARATOR

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3 Sheets-Sheet 1

Fig. 1



INVENTOR.
DONALD B. BINNIX
BY
William D. Carothers
HIS ATTORNEY

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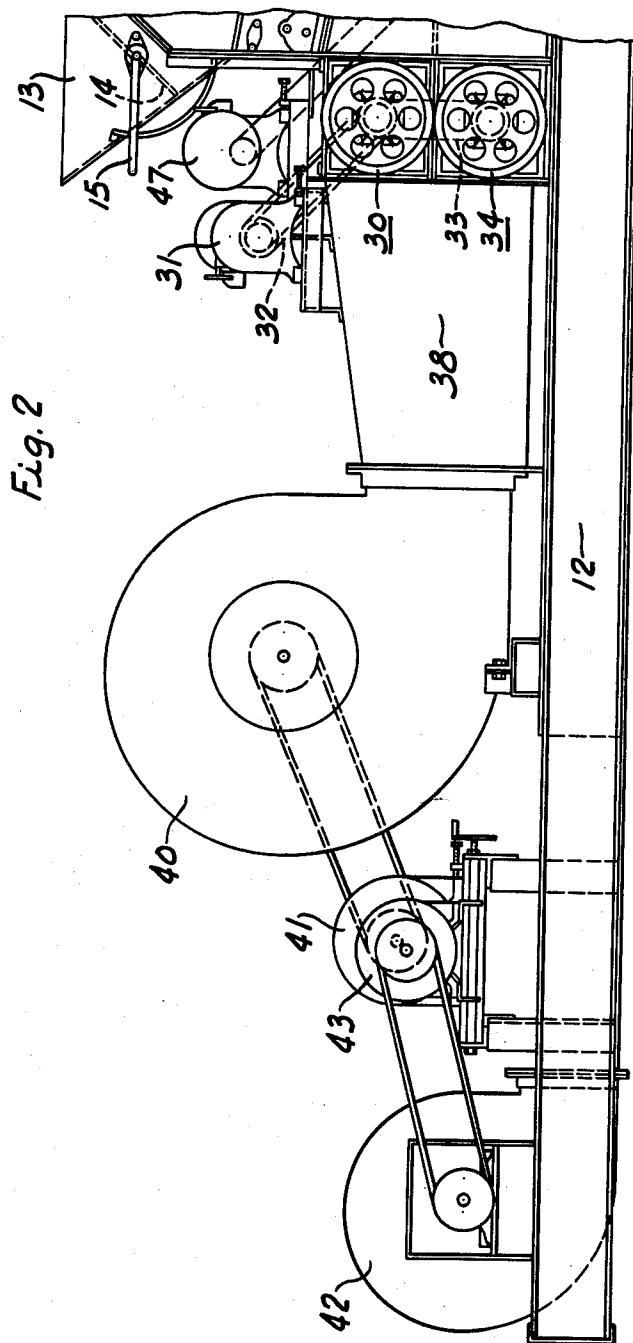
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INVENTOR.

DONALD B. BINNIX

BY

William D. Crother

HIS ATTORNEY

Nov. 27, 1962

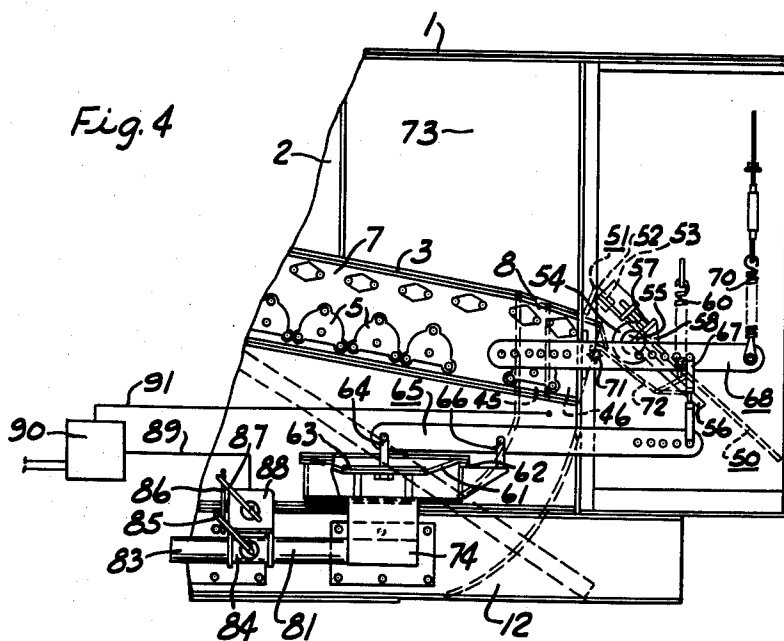
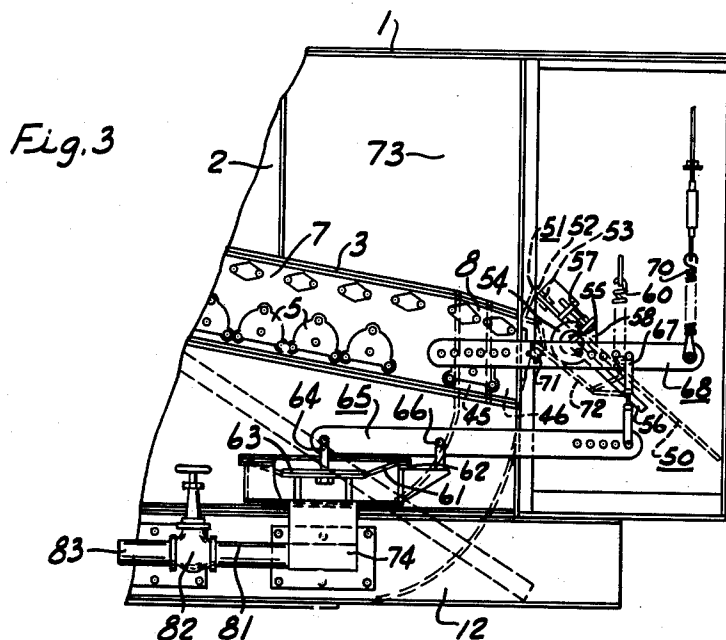
D. B. BINNIX

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CONTROL FOR PNEUMATIC STRATIFICATION SEPARATOR

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3 Sheets-Sheet 3



INVENTOR.
DONALD B. BINNIX
BY *William J. Crother*
HIS ATTORNEY

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CONTROL FOR PNEUMATIC STRATIFICATION SEPARATOR

Donald B. Binnix, % Ridge Equipment Co.,
Fallentimber, Pa.

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This invention relates generally to the separation of minerals by pneumatic stratification and more particularly to an improved method of control of a stratification separator.

Pneumatic stratification of minerals such as coal presents many problems in the smooth operation of the separator apparatus when subjected to continuous changing of the waste loads presenting a vast difference in the amount of slate and other impurities. The machine becomes adjusted to ore percentage of waste and the next load has a materially different amount of bone, slate and other waste. It takes a few minutes for the pneumatic pressure to become effective.

The principal object of this invention is the provision of an added control to aid the separator to more quickly respond to such rapid changes.

Another object is the provision of a sensitive pneumatic pressure control to operate the refuse gate opening in accordance with the resistance to flow of air through the last portion or sections of the pneumatically suspended bed by quickly bleeding off a portion of the air flowing to that section of the bed to decrease the pressure and prevent the control from overcarrying its operation in the amount it opens the refuse gate. The buildup of the heavier waste material adjacent the lower end of the pneumatically suspended bed causes the pressure to build up which actuates the waste discharge gate by a pneumatic servomotor such as a diaphragm type. The resistance to flow readily builds up in the air duct and operates the servomotor. This action can be too impulsive and to temper the same a portion of the air under pressure may be discharged continuously or intermittently during this period either manually or automatically.

Another object is the provision of a manual valve for exhausting a portion of the air supplied to the last two cells which pneumatically floats the material to be separated just prior to the dam that selects the denser strata to be discharged to enable manual manipulation of the pressure where the pneumatically floated bed is heaviest and less impenetrable requiring greater pneumatic pressures. By observing the movement of the pneumatically suspended bed through a transparent plastic side, such as glass or methamethacrylic, one can judge when the air should be bled a little to be more effective in continuously discharging the waste product.

Another object is the provision of an automatic valve for discharging a portion of the air under pressure that is suspending the last portion of a pneumatically suspended stratification bed just prior to discharge.

Other objects and advantages of this invention appear hereinafter in the following description and claims.

The accompanying drawings show for the purpose of exemplification without limiting this invention or the claims thereto, certain practical embodiments illustrating the principles of this invention; wherein

FIG. 1 is a view in side elevation with parts in section showing the pneumatic stratifier comprising this invention.

FIG. 2 is a view in side elevation illustrating the blowers attached to the left end of the machine shown in FIG. 1.

FIG. 3 is a detailed view in partial section showing a manually operated valve for controlling the partial discharge of the pneumatic pressure from the last portion of the suspended bed.

2

FIG. 4 is a detailed view in partial section showing an automatically operated valve for controlling the partial discharge of the pneumatic pressure from the last portion of the suspended bed.

Referring to FIG. 1 of the drawings the pneumatic stratifier comprises the enclosure 1 being separated in five different chambers, the material chamber 2 the bottom of which contains the sloping pneumatic screen 3, the second chamber 4 containing a series of cells 5 which separate the under side of the screen 3 in seven cells for the first section 6, for the second section 7 there are six cells 5 and in the third section 8 there are two cells. The third chamber is a pneumatic chamber 10 that supplies the air to the first section 6 of the cells 5. The fourth chamber 11 is a pneumatic chamber that supplies air to the second section 7 of the cells 5 and the fifth chamber 12 is a pneumatic chamber that supplies air to the last two cells in the section 8. Thus each of the five chambers within the enclosure 1 provides a function to increase the volume and pressure of the air downwardly along the pneumatic screen 3 to the discharge end.

Chamber 2 is supplied with a mineral such as run of the mine coal which is preferably sized from zero to three-quarter inch that is dumped in the hopper 13, the hopper gate 14 of which is adjustably positioned by the operating handle 15. The limitations of the movement of the gate 14 are shown in the drawing.

The coal proceeds down into the chamber 2 and along the screen 3 and each cell 5 under the screen is divided into two sections, the top section that contains a marble pack which consists of a pack of glass marbles 16 that diffuse the air flowing upwardly through the cell and through the screen 3 to suspend the coal and stratify the same. The marbles 16 are supported on a large screen mesh 17 and the marble pack or bed will vary in depth in the consecutive cells from the beginning of the screen to the discharge thereof. More marbles are provided in the initial cells than in the end cells because the marbles have the effect of not only diffusing the air but also diminishing the volume and pressure of the air to the screen 3 as the pack is increased in depth. Each cell also contains a manually operated vane or valve 18 pivoted on the shafts 20 and provided with an indicator such as shown at 21. The vanes or valves 18 are employed to also regulate the amount of air admitted to each cell. Thus the adjustment of the vanes or valves 18 together with the depth of the marble pack are determining factors in the amount of air that is admitted to that section of the screen 3 supplied by each particular cell 5 for determining the pneumatic suspension of the body of material such as coal.

When the run of mine coal enters this stratifier the particles of heavier specific gravity such as slate and rock and sulphur balls and the like are interspersed throughout the material but as the material is suspended by the air these heavier particles drop to the lower part of the screen; whereas the lighter coal particles stay at the top of the bed of pneumatically suspended coal. As the bed moves down the screen the heavier parts all collect at the underside of the bed close to the screen and become very dense which requires a greater volume of air and a higher pressure of air to suspend the bed which is compensated for by separating the chambers 10, 11 and 12.

As the bed reaches the cells 22 and 23, a special screen is provided as indicated at 24 over these cells and which permits the entry of $\frac{3}{16}$ " reject off the bottom of the suspended coal bed moving thereunder. These rejects are the heavy particles initially separated out from the bed and have not had a sufficient time to become too dense and therefore are more readily removed through the screen 24 from whence it drops on the lower screen 25 and is conveyed transversely through the opening 27

and is conveyed laterally by the screw 28. If these $\frac{3}{16}$ " rejects were permitted to be conveyed further along the pneumatically suspended bed of coal the increased air pressure from this point on would have the tendency of sending these ten mesh rejects higher in the pneumatically suspended coal bed and thus create a condition where it would be difficult to insure the removal of a high percentage of the $\frac{3}{16}$ " rejects at the end of the bed. The separation is therefore improved by this intermediate draw-off of the $\frac{3}{16}$ " rejects before the air volume and pressure becomes too high to cause these rejects to intermingle with the coal. It will be noted that the cells 22 and 23 are at the end of the air chamber 10 which is the first chamber of the system. The chamber 10 is supplied with air through the rotary valve 30 which is driven by the variable speed motor 31 and reducer mechanism through a chain 32. A second chain 33 drives the lower rotary valve 34. The rotary valves 30 and 34 are the same and have spherical plug members as indicated at 35 with a central passageway 36. The spherical portion of the plug 35 of the valve cooperate with the adjustable port members 37 of which there are four. It will be noted in the drawings that the same motor driving the two rotary valves 30 and 34 control the movement of air therethrough at 180° out of phase from each other as the part 36 of the upper valve plug is shown in a horizontal position while the port 36 of the lower valve plug is shown in vertical position. In other words, while the valve 30 has its passage 36 so as to let the maximum amount of air from the chamber 38 to the chamber 10 as shown, the valve 34 closes and prevents any passage of air from the chamber 38 to the chamber 11. Thus upon the rotation of both of the valves 30 and 34 the air supplied to the cells 5 is pulsated according to the revolutions per minute of the rotary valves and since these valves are operated simultaneously but at 180° out of phase with each other, the pulsation of air in pneumatically suspending the initial portion of the coal bed is also 180° out of phase than the second portion which is indicated by that portion of the pneumatically suspended coal over the cell 7 fed by the chamber 11. These pulsations not only aid in the suspension of the bed but provide a movement that allows the particles making up the coal bed to arrange themselves in stratification throughout the depth of the bed in accordance with the specific gravity of each of the particles. Thus not only the size and depth of the marbles in the marble pack 16 but also the adjustment of the valves or vanes 18 function to pneumatically suspend the coal bed but the number of air pulsations created by the rotary valves 30 and 34 likewise have an effect in the pneumatic suspension of the coal bed that permits the particles of different specific gravity to reach their own level within the bed. This too is further affected by the size and the number of cells pulsated by each of the valves. One thus has many variables which may be adjusted to provide an improved pneumatic suspension of the coal bed.

The chamber 38 as shown in FIG. 2 is supplied with air from the fan indicated at 40 which is in turn driven by a motor 41. The chamber 12 in turn is supplied with air from the fan 42 driven by the motor 43. The motors 41 and 43 are likewise variable in speed so as to permit a chamber in the volume of air produced over a given time which is a sixth factor in the control of the supply of air to pneumatically suspend the bed of coal which is thus caused to move down the sloping screen 3 due to gravity and because of this pneumatic pulsating suspension.

The chamber 12 is provided with the rotary valve member 44 which is a single bladed valve that imparts two pulsations per revolution from the chamber 12 to the end cells 45 and 46. The valve 44 is driven by means of the variable speed motor and reducer 47 and

this motor is also employed to drive the screw conveyor 23 as shown.

Thus not only each of the consecutive cells 5 all the way down the screen 3 provide for the passage of an increased volume of air progressively down the screen but the last two cells require a considerably greater amount of air than the cells in the chamber 7 because the bed of coal by this time is substantially all properly stratified with the heavy specific gravity rejects lying along the bottom portion of the bed being substantially uniform in depth and the air supplied through the cells 45 and 46 of the chamber 8 must be materially greater in volume to pulsate the bed at this position for which reason the chamber 8 is supplied with air from an independent source.

At the end of the chamber 2 a discharge chute 50 which is rather steep in its inclination has a lip or dam 51 at its upper end. This dam has upper and lower projections 52 and 53 that fit on the top and bottom of the chute 50 which permit the dam member 51 to be removable and changed for different types of run of the mine coal. It will be noted that the bottom edge of the dam is spaced from the screen 3 and this spacing permits the flow of the reject material from the under side of the stratified bed; whereas the coal will flow over the top of the dam 51 and pass down the chute 50 cleaned of all of its reject. The chute 50 rests on the cam 54 which is mounted on the shaft 55 rotated by the hand lever 56. Thus different positions of the lever 56 will cause the cam 54 to vary the height of the chute 50 and thus the opening between the bottom edge of the dam 51 and the screen. A stop 57 prevents the member 58 on the shaft 55 to limit the movement of the lever and the spring 60 is attached to the lever 56 to maintain the movable abutment 58 against the stop 57 and thus at all times maintain a constant opening between the bottom of the dam 51 and the screen 3. If for some reason a large chunk of material descends in the pneumatically suspended bed and tends to clog this opening under the dam one need only to depress the lever 56 and the cam 54 will raise the chute 50 and the dam to permit the large piece that is blocking the dam to pass therethrough to reject. The mere release of the handle 56 causes the spring 60 to move into its fixed position against the stop 57.

The air chamber has exposed thereto a servomotor of pneumatic type containing a flexible diaphragm 61 which is fastened between the annular rings 62 and the center of the diaphragm is provided with the plates 63 which permit it to be attached by the link 64 to the lever 65. The lever 65 is fulcrumed at 66 and its other end is provided with the link 67 that connects to the second lever 68 of the system. The link 67 may be adjusted along the levers 65 and 68 to provide for different weights of the reject material. The end of the lever 68 is supported by the spring 70 and its intermediate portion is fulcrumed as indicated at 71. This fulcrum can be changed in its position along the lever 68 by means of the many holes provided. Thus the lever 68 is adjustable relative to the lever 65 as well as the link 67.

The fulcrum 71 of the lever 68 carries the refuse gate 72 which receives all the refuse that flows under the dam 51. The refuse is held on the gate by reason of the lever system and is opened only when the air effective on the diaphragm 61 is of sufficient pressure which indicates that it is having a very difficult time pneumatically suspending the bed of coal just above the dam 51. As the reject strata in the coal bed on the screen 3 becomes very dense, the pressure in the chamber 12 increases. This dense material is of course a measurement of the weight of the reject and since the high density creates an increased pressure on the diaphragm 61 the lever 65 will be rotated clockwise and pull the lever 68 against the tension of the spring 70 and will open the gate 72 and

5

allow more or less reject to flow from the end of the screen 3.

The pulsating air pressure in the chamber 12 is effective to vibrate the lever system in the period of the pulsations of air which vibration makes the lever system sensitive to slight variations in pressure and the gate 72 is thereby maintained open to the proper amount for the exit of the reject at a speed correlated with the density of the reject in the last portion of the screen. In this manner a very high degree of accuracy is maintained in the separation of reject from the coal by this gaseous suspension stratifier.

The sides 73 of the chamber 2 may be made of a clear plastic when the stratifier is employed for the separation of rejects from coal. Such plastic side walls may be made of methyl methacrylate and will last a considerable length of time which is rather difficult to understand as one would think that such a material would become scratched by the coal and other particles traveling therethrough. However, the methyl methacrylate is found to stand up far better than that of glass which is much harder and it permits the operator to frequently view the stratification of the reject in the pneumatically suspended pulsating coal bed. It is believed that the plastic is lubricated by the coal and does not set up a charge that will hold the dust particles which permits the bed to be readily observed through plastic rather than through glass.

The lateral throat 74 connecting the chamber for the diaphragm 61 has the valve opening 75 on one side thereof which is closed by the valve 76 attached to the valve bell crank lever 77 having a fulcrum at 78 and carrying a poise 80. The poise is adjustable along the horizontally disposed arm of the bell crank 77 in the manner of that of a beam balance. The pressure that the poise exerts on the valve opposes the internal pneumatic pressure of the fifth chamber 12. Thus the area of the valve 76 that is exposed together with the weight of the bell crank and poise must be calibrated against the air pressures built up in the chamber 12 for different coal having varying amounts of bone, slate and other waste. This bell crank arm is also readily operable by hand.

It should be noted that the valve 76 is out of the way of the path of flow of air so that the actual movement of air is ineffective on the valve.

Referring to FIG. 3 the lateral chamber 74 has the pipe 81 connected thereto which is provided with a valve 82 having a discharge pipe 83. Thus an operator can watch the action of the suspended bed and operate the valve 82 to obtain the best percentage of waste floatation. The valve 82 may be set manually every so often. One could of course do the same by lifting the arm 77 of FIG. 1 but the same adjustment would prevail when the operator allowed the arm 77 to return.

Referring to FIG. 4 the valve 84 is of the butterfly type and this valve is actuated through the arm 85 and the link 86 and the arm 87 by the servomotor 88 which in turn is actuated by the pressure variations obtained through the pipe means 89, the pressure responsive means 90 which in turn is connected by the pipe means 91 with the chamber 12 closely adjacent the cell chambers 45 and 46. Through these instruments the valve 84 may be regulated by relative changes in the pulsating pneumatic pressures to properly proportion the discharge of the air from the chamber 12 to overcome too active or over regulating the operation of the valve 72. At the same time the full air supply and appropriate pressure remains available of use.

I claim:

1. The method of cleaning minerals which comprises the steps of suspending a downwardly sloping mineral bed by applying a pulsating pneumatic pressure upwardly therethrough for its full length of the mineral bed to move it downwardly, providing a gradation of increased pneumatic pressure along the downwardly sloping min-

6

eral bed to stratify and maintain the suspended particles stratified according to their specific gravity, separating the stratified layers at the end of the mineral bed as the sloping mineral bed continues to move, restraining the movement of the separated particles having heavier specific gravity to control the movement of the unseparated particles of heavier specific gravity, and discharging from the system to atmosphere a portion of the increased pneumatic pressure from adjacent the lower end of the mineral bed to prevent the control from over-carrying the operation in discharging the separated particles of heavier specific gravity.

2. The method of claim 1 characterized by manually controlling the discharge of the portion of the increased pneumatic pressure from adjacent the lower end of the bed.

3. The method of claim 1 characterized by automatically controlling the discharge of the portion of the increased pneumatic pressure from adjacent the lower end of the bed in accordance with the pressure developed to suspend the lower end of the bed.

4. The method of claim 3 characterized by balancing the pneumatic pressure against a predetermined load to proportion the control of the partial pneumatic discharge.

5. The method of claim 3 characterized by proportioning the control of the partial pneumatic discharge by relative changes in the pulsating pneumatic pressure.

6. A machine for pneumatically stratifying a mineral bed which comprises a downwardly sloping screen having a discharge at its lower end, a stratification separator means at said discharge, a plurality of divisible sections disposed in series along the underside of said screen, dividing means to independently isolate from each other a plurality of said divisible sections in different chambers, means for supplying different and independent pneumatic pressures in selected of said chambers, a rotary valve means in each of said chambers to create pulsations in the pneumatic fluid delivered under pressure thereto, and pneumatic pressure discharge valve means connecting at least one chamber supplying pulsating pneumatic pressure to the sections adjacent said mineral discharge to atmosphere.

7. The structure of claim 6 characterized in that said last mentioned valve means is manually operated.

8. The structure of claim 6 characterized in that said last mentioned valve means is pivotally supported and presents a predetermined area to said chamber, and poise to apply a predetermined weight to said last mentioned valve means.

9. The structure of claim 6 characterized in that said last mentioned valve means is actuated by a pressure responsive means controlled from the pressure developed in said chamber.

10. The method of cleaning minerals which comprises the steps of suspending a downwardly sloping mineral bed by applying independent pulsating pneumatic pressure upwardly through different portions of the mineral bed to move it downwardly to separate the stratified layers adjacent the lower end of the mineral bed as the bed continues to move, restraining the movement of the separated particles of heavier specific gravity at the lower end of the mineral bed, controlling the discharge of the separated particles having heavier specific gravity at the lower end of the bed in accordance with the independently isolated pneumatic pressure at the lower end of the bed, and independently exhausting to atmosphere a portion of the independently isolated pneumatic pressure from adjacent the lower end of the mineral bed to prevent the overrunning of the control in operating the discharge of the separated particles having heavier specific gravity.

11. The method of cleaning minerals which comprises the steps of suspending a downwardly sloping mineral bed by applying pulsating pneumatic pressure upwardly therethrough for the full length of the mineral bed to move it downwardly to separate the stratified layers adjacent

the lower end of the mineral bed as the bed continues to move, restraining the movement of the separated particles of heavier specific gravity at the lower end of the mineral bed, controlling the discharge of the separated particles having heavier specific gravity at the lower end of the bed in accordance with the pneumatic pressure suspending the mineral bed, and independently exhausting to atmosphere a portion of the pneumatic pressure to prevent the overrunning of the control in operating the discharge of the separated particles having heavier specific gravity.

12. A machine for pneumatically stratifying a mineral bed which comprises a downwardly sloping screen having a discharge at its lower end, means for supplying a gradation of increased pulsating pneumatic pressure along the downwardly sloping mineral bed to stratify and maintain the suspended particles stratified according to their specific gravity, stratification separator means at said discharge, pneumatically operated pressure control means to actuate said stratification separator means to restrain the movement of the separated particles having heavier specific gravity and control the stratification, and valve means connected to discharge a portion of the pulsating pneumatic pressure to atmosphere to prevent said pneumatic pressure control means actuating said stratification

separator means from overrunning the operation thereof in discharging the particles of heavier specific gravity.

13. The pneumatic stratifier of claim 12 characterized in that said last mentioned valve means is manually operated.

14. The pneumatic stratifier of claim 12 characterized in that said last mentioned valve means is pivotally supported and presents a predetermined area exposed to the pulsating pneumatic pressure, and a balance arm having a poise to apply a predetermined weight to said pivotally supported valve means.

15. The pneumatic stratifier of claim 12 characterized in that said last mentioned valve means includes a pressure responsive means controlled from the pulsating pneumatic pressure suspending the mineral bed to control the discharge of the pulsating pneumatic pressure.

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