

Nov. 13, 1934.

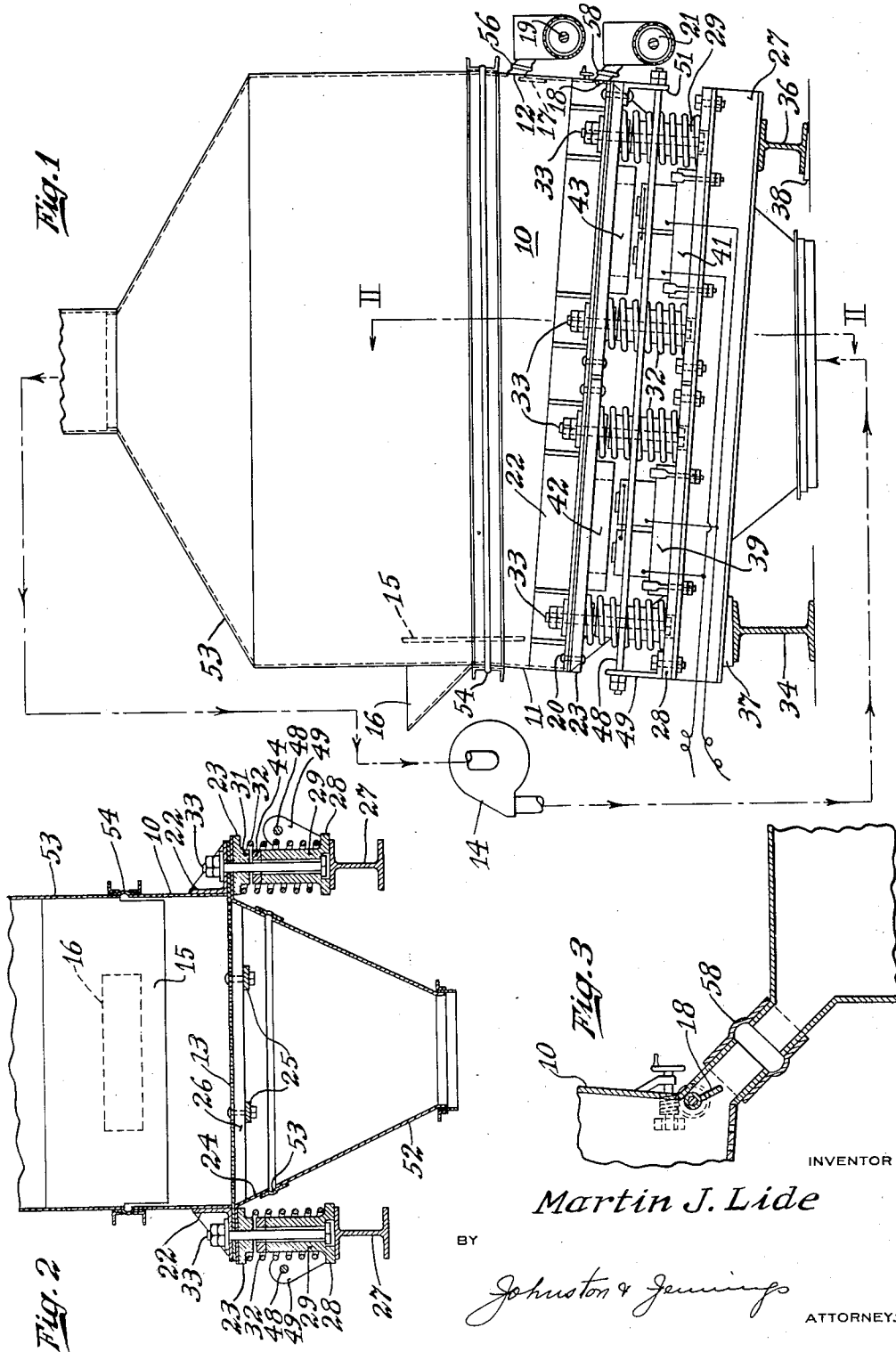
M. J. LIDE

1,980,490

CONCENTRATOR

Filed Nov. 4, 1929

2 Sheets-Sheet 1



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Fig. 4

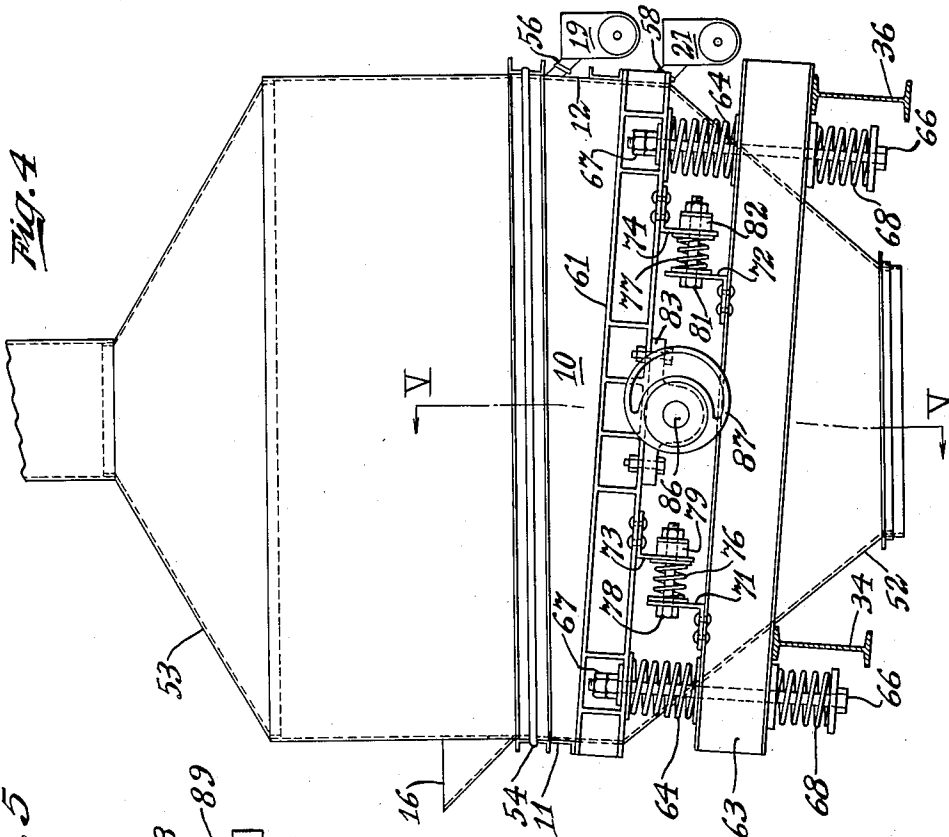


Fig. 5

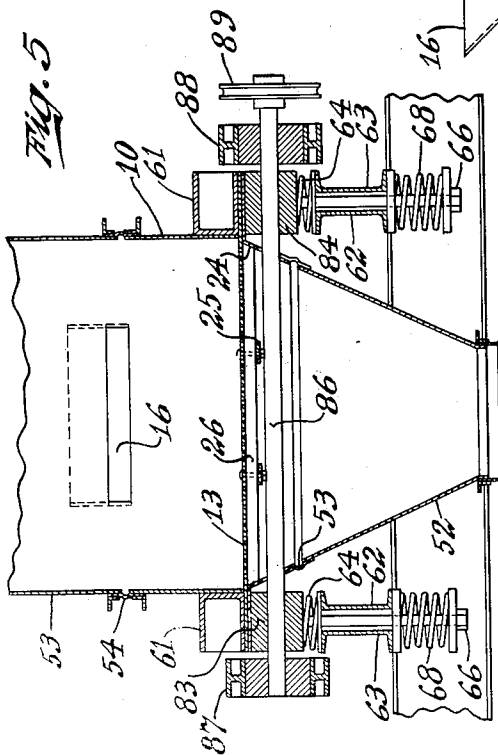
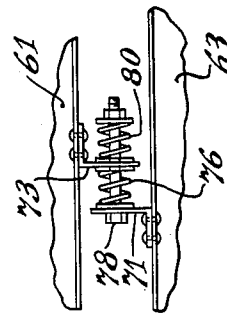


Fig. 6



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1,980,490

CONCENTRATOR

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5 Claims. (Cl. 209—326)

My invention relates to separators or concentrators of materials having different specific gravities and has for its object the provision of apparatus of the character designated which shall be simple and sturdy of design, reliable in operation and which shall have a relatively large capacity.

A further object of my invention is to provide a concentrator embodying a means for treating a relatively deep bed of material and employing air as a flotation medium, together with simple effective means for vibrating the concentrator.

A still further object of my invention is to provide a concentrator for coal and like materials, employing air as the flotation medium, and embodying means for treating a relatively deep bed of material, together with simple, sturdy supporting structure for the concentrator and means for imparting relatively high frequency short vibrations to the concentrator in a manner for moving the materials thereover.

Apparatus for separating coal from slate and other impurities, as heretofore known to me, may be divided into two general classes. The first of these, and the one more widely used, employs water as the flotation medium and usually embodies a screen on which is treated a relatively deep bed of material and means for supplying pulsations of water upwardly through the screen to effect stratification of the material. In such apparatus the current of water overflowing the material bed is employed to carry off the lighter materials while the heavier materials are allowed to pass out through suitably arranged slate gates.

The necessity of drying coal which has been treated in the manner just described has led to the adoption of concentrating tables employing air as the flotation medium for separating coal from its heavier constituents. Air concentrators, as heretofore constructed, have usually comprised inclined riffled perforated tables, with means to force a current of air upwardly through the table to stratify the material. Horizontal oscillations are imparted to the table so that the heavier material is usually delivered at one side of the table by the inclined riffles and the lighter material flows by gravity over the riffles to a separate discharge.

The great difficulty heretofore in the dry concentration of fine coal, has been to obtain efficiency in cleaning. Not only is the ratio of sizes very great in fine coal, but when the sizes approach dust, the effect of viscosity preponderates so greatly over that of gravity that processes

based on gravity alone become ineffective. In this invention it is hoped to increase the efficiency of concentrating fine dry coal, in three ways, as follows:

(1) The particles will be catapulted upward with such an acceleration as to leave the screen surface. The upward flow of air will increase the rise of the particles and resist their fall, and due to both causes, will cause them to stratify according to their gravity ratio.

(2) By means of high frequency vibration the catapulting cycles per minute will be greatly increased over slow speed oscillatory apparatus.

(3) By means of a deep bed, the well known principle of hindered settling in jigging practice will apply to increase the size ratio through which the material can be concentrated.

In carrying out my invention, I provide a pan, resembling the well known jig bed, which may be deeper at one end than the other and which is provided with a perforated bottom which may be inclined. Material to be separated is fed into the shallower end of the pan and moves toward the deeper end of the pan while being subjected to vibration in a manner to effect vertical propulsion to the particles as well as movement of the material from the feed to the discharge end of the pan, and to a current of air flowing upwardly through the material bed. By the time the material has reached the deeper end of the pan, it is thoroughly stratified and the lighter material passes over a suitable overflow discharge while the heavier material passes under a slate gate to a suitable discharge.

Apparatus embodying features of my invention is illustrated in the accompanying drawings, forming a part of this application, in which

Fig. 1 is a side elevational view of a concentrator made in accordance with my invention;

Fig. 2 is a sectional view taken on the line II—II of Fig. 1;

Fig. 3 is a detail sectional view of the discharge end of the apparatus;

Figs. 4 and 5 are views similar to Figs. 1 and 2 showing a modified means for imparting relatively high frequency vibrations to the concentrator, and

Fig. 6 is a detail of a modified spring construction.

Referring now to the drawings for a better understanding of my invention, I show a pan 10 having a feed end 11 and a deeper discharge end 12. The pan is provided with an inclined perforated bottom 13 through which air is forced by means of a suitable blower 14. The perforations

of the bottom 13 may be arranged in any suitable manner to supply the required volume of air through the different areas of the pan. Material to be separated is fed into the pan at 16, entering under a baffle wall 15, forming an air seal, and after traveling to the deeper end of the pan, the lighter material passes over a gate 17 while the heavier material passes out through an adjustable slate gate 18. A screw conveyor 19 carries the lighter material away and a screw conveyor 21 carries the heavier material away from the apparatus.

The pan 10 is provided with a frame comprising structural steel angles 22 secured to the sides of the pan and extending parallel to the bottom 13. The bottom 13 extends outwardly under the bottom flanges of the angles 22 and is secured between the lower flange of the angle 22 and steel castings 23 by means of rivets 20. Also joined to the bottom flange of the angles 22 is a steel hopper bottom 24. Extending across the hopper bottom 24 and secured thereto by welding, in a position to support the bottom 13, are suitable cross supports 26. Extending longitudinally of the pan 10 and bolted to the bottom 13 underneath the cross supports 26 are longitudinal bars 25.

Extending parallel to the angles 22 is a sub frame comprising longitudinally extending parallel I-beams 27. Mounted on the I-beams 27 are steel castings 28 having formed integrally thereon cylindrical guide members 29 which extend upwardly from the castings 28. The castings 23 also have formed thereon integral cylindrical guide members 31 which are similar to the guide members 29 and which extend downwardly from the castings 23 opposite the guide members 29.

Surrounding the guide members 29 and 31 are coil springs 32 of sufficient strength to support the pan 11 with the material to be treated and to project it upwards upon being compressed. The guide members 29 and 31 are held in their proper relative positions by means of bolts 33 which extend downwardly through the castings 23, the guide members 31 and 29 and the castings 28. The sub frame members 27 are mounted on suitable foundation beams 34 and 36 so that the bottom 13 of the pan 11 is inclined. This inclination may be varied by any suitable means, shown conventionally as by means of wedges 37 and 38.

Mounted on the castings 28 and secured to each of the beams 27, are electro-magnets 39 and 41, those on one side only being shown and it being understood that the opposite side of the frame is similarly equipped. These magnets are preferably of the alternating current type and are synchronously energized so as to act simultaneously. Secured to the castings 23 are armatures 42 and 43 for the electromagnets 39 and 41 respectively. It will be seen that when the electromagnets 39 and 41 are energized, the armatures 42 and 43 are drawn downwardly with the pan 10 and, upon deenergization, the springs 32 force the pan up to its original position, limited by the adjustment of the bolts 33. Anvils 44, conforming in shape to the cylindrical guides 29 and 31, are interposed between the guides 29 and 31 and against which the guides 31 strike upon downward motion of the pan.

It will be noted that inasmuch as the pan frame and sub frame are both inclined to the horizontal, that the pan would tend to move to the right as seen in the drawings, with respect to the frame members 27, when being vibrated. This tendency

is increased by reason of the fact that the springs 32 are also inclined to the vertical. This tendency is overcome by means of links 48 which extend from end to end of the apparatus and are secured at the upper end to upwardly extending brackets 49 carried by the beams 27, and at the lower end to downwardly extending brackets 51 carried by the beams 23.

The hopper 24 at the bottom of the pan 10, is connected to an air delivery conduit 52, which is stationary relative to the conduit 24, by means of a suitable flexible connecting means 53, making a flexible joint which extends entirely around the hopper. The upper sides of the pan 10 are likewise flexibly connected to a delivery hood 53 by means of a flexible connection 54. The overflow for lighter material is connected to the screw conveyor 19 by means of a flexible connection 56 and the discharge for heavier material is connected to the screw conveyor 21 by means of a flexible connection 58. The flexible connections just described permit vibration of the pan 10 without vibration of the hood 53, air delivery conduit 52, or the conveyors 19 and 21. Preferably the air employed in stratifying the material is returned to the blower 14 from the hood 53 as indicated diagrammatically and is again forced through the perforated bottom 13, all of which is more particularly described in my prior Patent No. 1,701,624, issued February 12, 1929.

From the foregoing description the operation of my improved concentrator will be readily apparent. Material to be separated is fed into the pan 10 through the hopper 16 under the baffle wall 15 and moves toward the discharge end of the pan over the inclined perforated bottom 13. A current of air from the blower 14 is passed upwardly through the bottom 13 while the material in the bottom of the pan is subjected to high frequency vibrations from the synchronously driven electromagnets 39 and 41. The inclination of the springs 32 to the vertical and the action of the electromagnets in a direction inclined to the vertical aids in urging the material toward the discharge end of the pan 10. By the time the material has reached the discharge end, it is thoroughly stratified and the lighter constituents of the material pass out over the discharge gate 17 while the heavier constituents pass out underneath the slate gate 18.

Referring now to Figs. 4 and 5, of the drawings, I show a modified means for imparting high frequency vibrations to the concentrator. The concentrator generally is constructed in a manner similar to that already described and a description of such parts of the construction will not be repeated. In accordance with the modified form, I provide the pan with heavy side frame beams 61. The sub frame for this construction comprises parallel channel beams 62 and 63 on each side of the pan and extending longitudinally thereof and resting on the foundation beams 34 and 36. Interposed between the side frame beams 61 and the sub frames 62 and 63 are springs 64 of sufficient strength to support the concentrator with its load of material. Extending through the springs 64 and between the beams 62 and 63 are bolts 66 secured to the side frame members 61 by means of nuts 67. On the lower end of the bolts 66 beneath the sub frame members 62 and 63 are coil springs 68 of substantial strength for limiting the upward movement of the pan 10 away from sub frame.

In order to limit horizontal movement of the pan 10 with respect to the sub frame I provide on

the sub frame members 62 and 63 upwardly extending brackets 71 and 72 and on the side casting members 61 downwardly extending brackets 73 and 74. Between the brackets 71 and 73 I interpose a spring 76 and between the brackets 72 and 74 I interpose a spring 77. Passing through the brackets 71 and 73 is a bolt 78 provided with a thick stop washer 79 on the lower end thereof, which washer may be made of leather or material of similar qualities. Connecting the brackets 72 and 74 is a bolt 81 and on the lower end of the bolt 81 is a thick washer 82 similar to the washer 79. The bolts 78 and 81 permit a small amount of vertical motion of the pan 10 relative to the sub frame and the springs 76 and 77 permit a slight movement of the pan toward the upper end thereof which, upon return movement of the pan, is suddenly arrested by means of the washers 79 and 82 in a manner to be described later.

Instead of employing a washer such as 79 and 82 on the lower ends of the bolts 78 and 81, I may connect the brackets between the pan and sub frames such as 71 and 73 with a longer bolt 78, as shown in Fig. 6, and employ a spring 80 above the bracket 73 and a spring 85 below the bracket 73. The springs 80 and 85 may be of differing resiliency characteristics in order that the table may have a greater acceleration backward than forward and thereby accelerate the movement of the material forwardly.

Secured to the underside of the side frame members 61 are bearings 83 and 84 in which is mounted a shaft 86 carrying unbalanced weights 87 and 88. The shaft 86 is driven by means of a pulley 89 from any suitable source of power not shown. When the shaft 86 is rotated, which is preferably done at a relatively high velocity, the unbalanced weights 87 and 88 bring about vertical vibrations of the concentrator with respect to the sub frame which vibrations are limited by the strength of the springs 64 and by the adjustment of the bolts 66.

It will be noted that with this form of vibratory means, as the weights 87 and 88 revolve there is also a tendency to impart horizontal vibrations to the pan 10 which tendency, toward the upper end of the pan, is resisted by the springs 76 and 77. As the weights move round in a direction to tend to move the pan toward the lower end, the pan's movement in that direction is accelerated by the springs 76 and 77 and is brought to a sudden stop by brackets 73 and 74 engaging the washers 79 and 82. This slight motion and abrupt stop accelerates the movement of the material being concentrated toward the discharge end of the apparatus. Otherwise the operation of the apparatus is the same as that already described in connection with Figs. 1, 2 and 3.

From the foregoing it will be apparent that I have devised an improved concentrator which is extremely sturdy of design, reliable in operation, and one which affords, in apparatus employing air as the flotation medium, all of the advantages attainable by apparatus employing water.

While I have shown my invention in but two forms, it will be obvious to those skilled in the art that it is not so limited but is susceptible to various other changes and modifications, without departing from the spirit thereof, and I desire therefore that only such limitations shall be placed thereupon as are imposed by the prior art, or as are specifically set forth in the appended claims.

What I claim is:

1. In a separator, a separating pan having a perforated bottom, a frame for the pan extending parallel to the bottom, a sub frame extending parallel to the pan frame, supporting springs between the two frames, springs adapted to yieldably resist upward movement of the pan, bolts joining the frames to adjust the compression of all of said springs, springs adapted to yieldably resist horizontal movement of the pan frame towards both ends of the sub frame, and an unbalanced actuating pulley mounted on the pan to impart a gyratory motion thereto in a vertical plane.

2. In a separator, a separating pan having an inclined perforated bottom, a frame for the pan extending parallel to the bottom, a sub frame extending parallel to the pan frame, supporting springs between the two frames, springs adapted to limit the upward movement of the pan, bolts joining the frames to adjust the compression of all of said springs, springs adapted to resist horizontal movement of the pan towards the upper end of the sub frame, and rigid means adapted to stop horizontal movement of the pan towards the lower end of the sub frame.

3. In an air separator, a separating pan having an intake end and an opposed discharge end, sides and ends for the pan of sufficient height to permit vertical stratification thereon, unbalanced pulleys ridably mounted with said pan, a plurality of spring means supporting and yieldably resisting up and down movement of the pan, other spring means adapted to yieldably resist horizontal movement of the pan towards the intake end of the separator, and bumper means adapted to oppose horizontal movement of the pan toward the discharge end of the separator.

4. A pan separator comprising a perforate bottom, vertical sides surrounding the bottom of sufficient height to permit vertical stratification of the material in the pan, air ducts flexibly connected to the top and the bottom of the pan, means for imparting vertical vibrations to the pan, bumper means effecting horizontal movement of the material in the pan toward the discharge end thereof, means for introducing unstratified material at one end of the pan, weir means for removing the lighter stratified material from the upper level of the pan opposite to the intake end, and adjustable gate means for removing the stratified heavier material from the bottom of the pan and disposed under the weir means.

5. A pan separator comprising a perforate bottom, vertical sides surrounding the bottom of sufficient height to permit vertical stratification of the material in the pan, air ducts flexibly connected to the top and the bottom of the pan, means for imparting vertical vibrations to the pan, bumper means effecting horizontal movement of the material in the pan toward the discharge end thereof, means for introducing unstratified material at one end of the pan, weir means for removing the lighter stratified material from the upper level of the pan opposite to the intake end, adjustable gate means for removing the stratified heavier material from the bottom of the pan and disposed under the weir means, conveyer means for removing the stratified materials, and flexible connections between the pan and the conveyer means.

MARTIN J. LIDE.