May 11, 1954 R. F. DORE 2,678,131

DRY CONCENTRATOR

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Fig. 1.

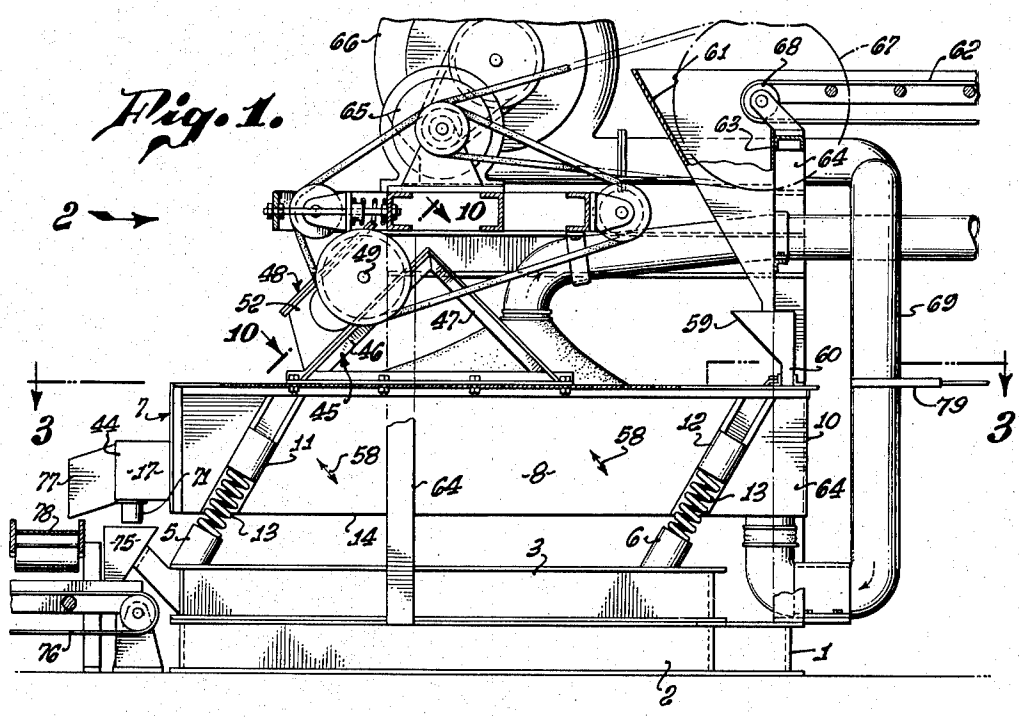


Fig. 2.

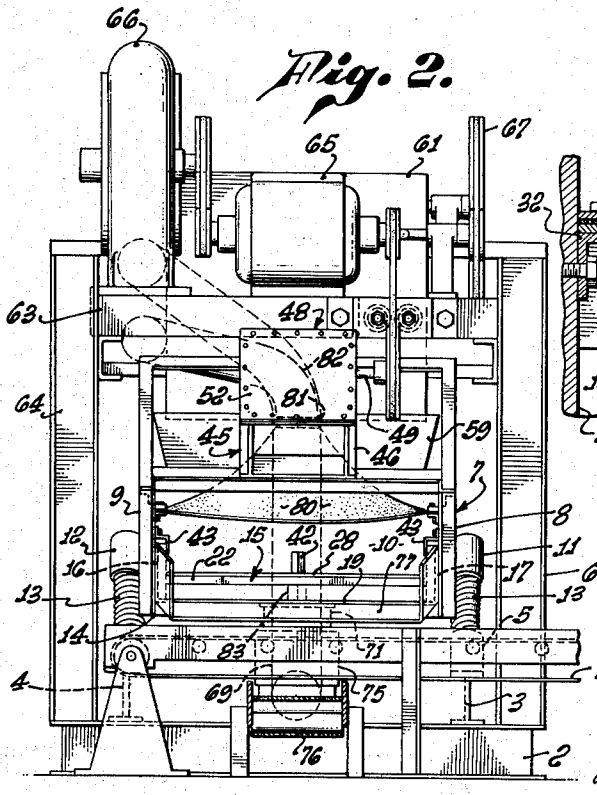
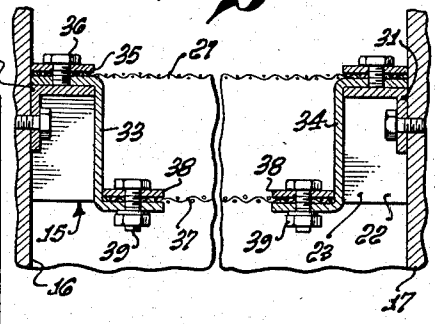


Fig. 6.



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Fig. 3.

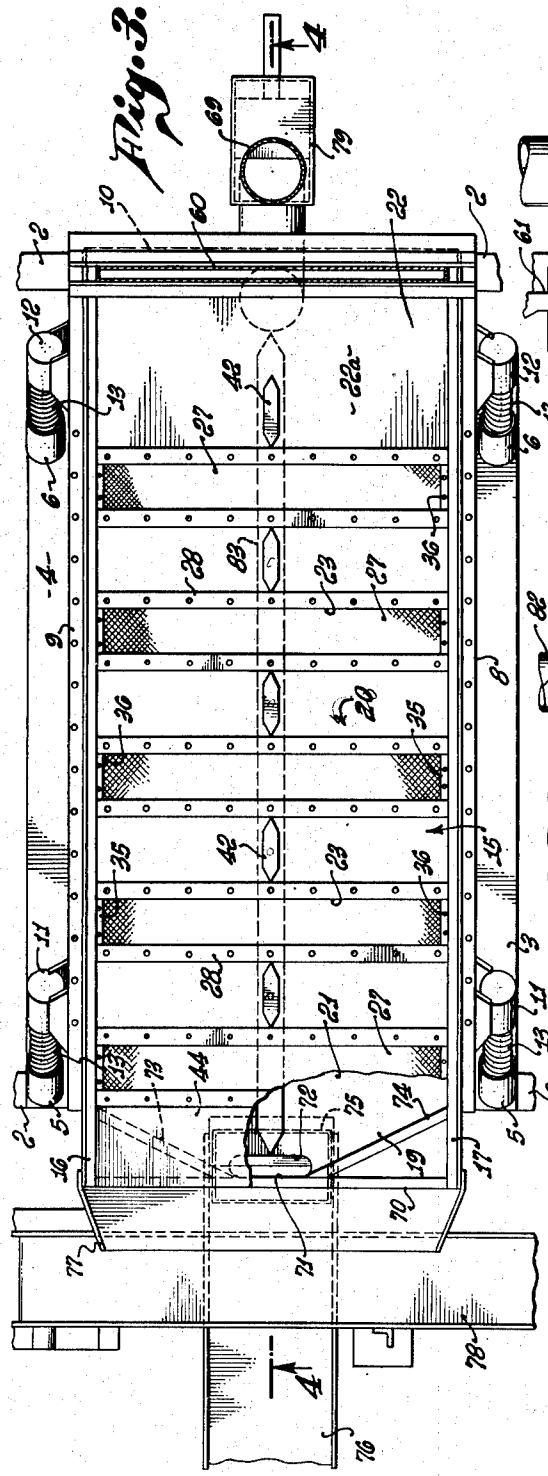
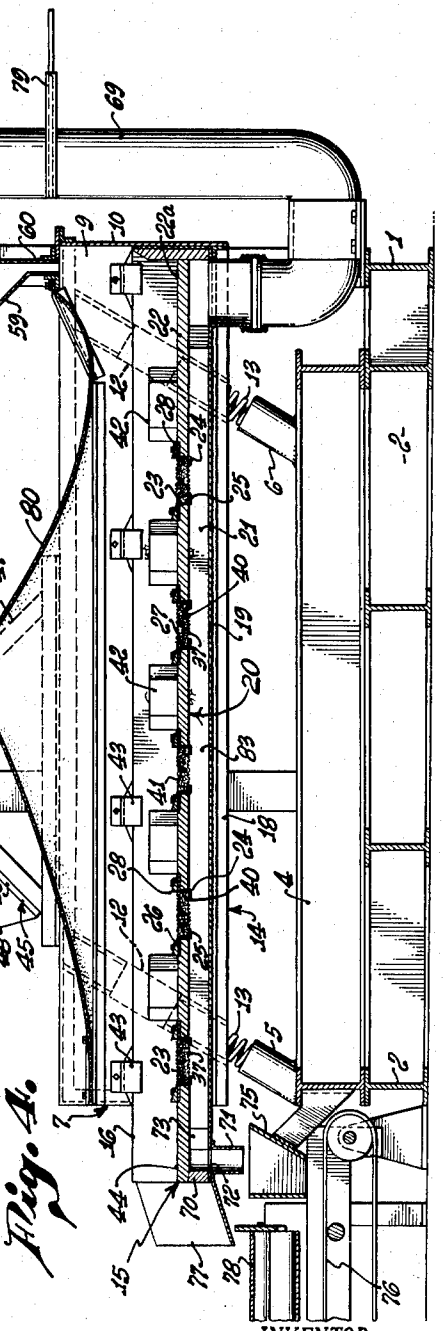


Fig. 4.



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Fig. 5.

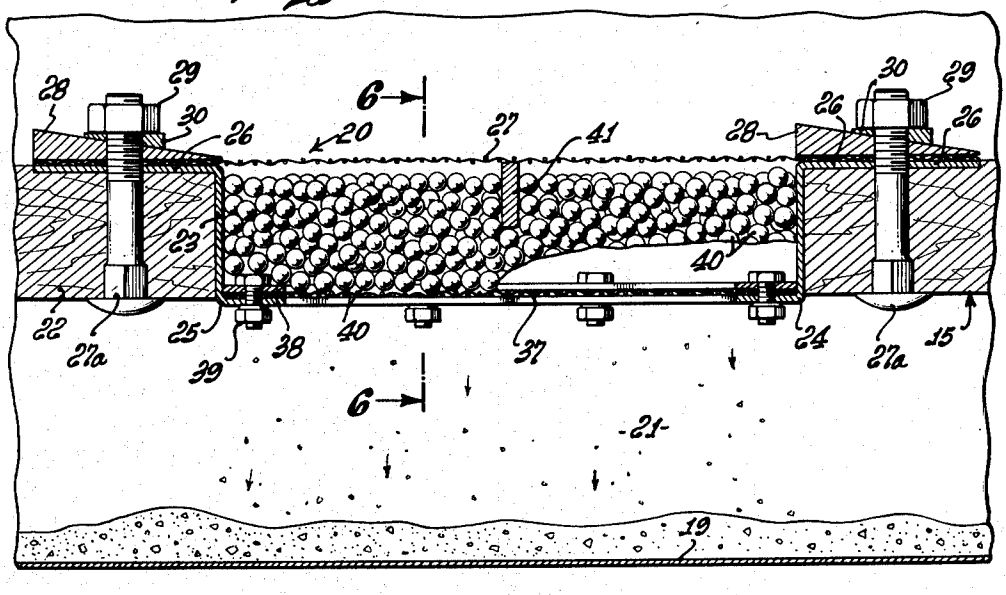


Fig. 7.

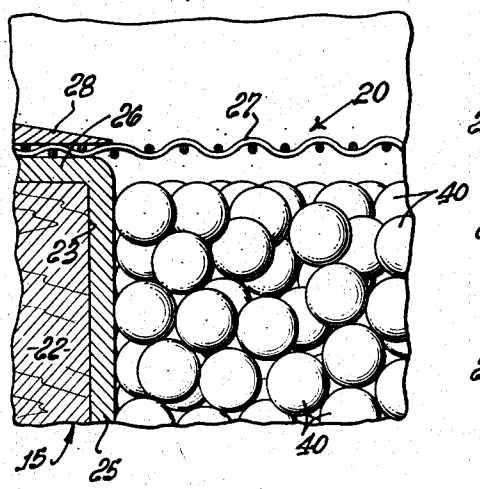


Fig. 8.

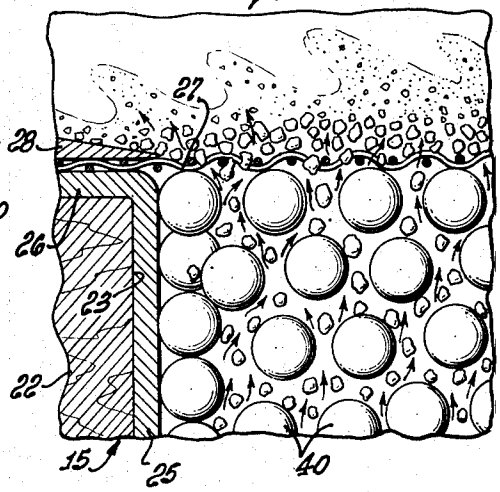
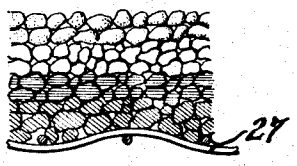


Fig. 9.



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Fig. 10.

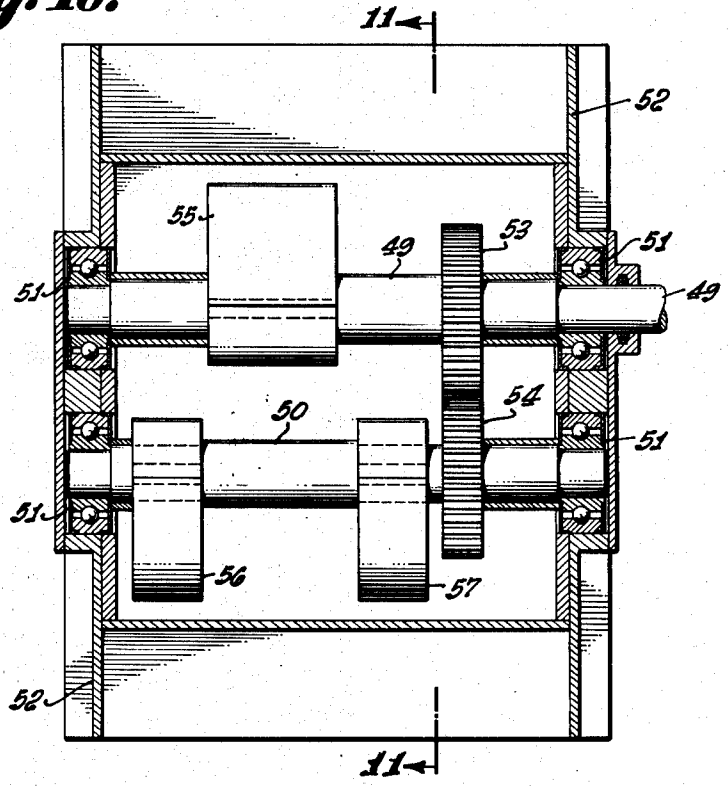
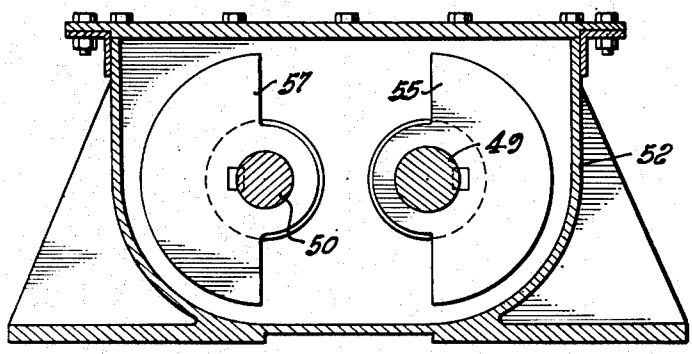


Fig. 11.



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UNITED STATES PATENT OFFICE

2,678,131

DRY CONCENTRATOR

Robert F. Dore, Los Angeles, Calif.

Application July 17, 1950, Serial No. 174,246

2 Claims. (Cl. 209—466)

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The present invention relates to ore concentrators and specifically to a pneumatic or air-float concentrator, applicable to the concentration of heavier valuable ore from lighter undesirable gangue material.

The present inventor was faced with the problem of developing a concentrator which would concentrate ores, without the use of water. The problem was to gather the mineral values into the form of a rough primary concentrate, which, in turn, could be conditioned and finished into marketable, high grade concentrates.

The concentrator of the present invention is capable of handling many types of ores, with a high recovery of the desired ore from the gangue material, resulting in a primary concentrate. This makes possible the practical operation of many deposits of natural resources in the form of critical and strategic minerals. Many such deposits in the arid regions are well known but are unworkable because of lack of water.

In test runs made with the present invention, using 500 pounds of properly ground tungsten ore, 32 pounds of concentrates were obtained assaying 7.02% WO_3. The recovery from the raw ore was sufficiently high to leave no further commercial values in the tailing. The tailings assayed .09% WO_3 and were ready for discard to the dump as waste material.

An object of the invention is the provision of a concentrator which is rugged in design, will continuously handle a uniformly ground ore feed, is constructed of standard parts, the replacements of which may be easily made, and which uses air instead of water as a suspensory medium.

With the above-mentioned and other objects in view, the invention consists in the novel and useful provision, formation, construction, association and relative arrangement of parts, members and features, all as shown in one embodiment in the accompanying drawings described generally and more particularly pointed out in the claims.

In the drawings:

Figure 1 is a fragmentary side elevation of the concentrator;

Figure 2 is an end elevation of the concentrator, looking in the direction of the arrow 2 in Figure 1;

Figure 3 is a fragmentary, longitudinal sectional view on the line 3—3 of Figure 1;

Figure 4 is a fragmentary, sectional view on the line 4—4 of Figure 3;

Figure 5 is an enlarged view, partly in section, of one of the pockets in the table of the concentrator;

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Figure 6 is a fragmentary sectional view, on an enlarged scale, taken on the line 6—6 of Figure 5;

Figure 7 is a fragmentary, partly sectional view of one of the pockets of the table;

Figure 8 is a view similar to that of Figure 7, illustrating action that occurs in the ore to be concentrated resultant upon certain operations of the concentrator table;

Figure 9 is a fragmenary, partly sectional view, illustrative of stratification of ore particles;

Figure 10 is a sectional view, on an enlarged scale, of the vibrating mechanism for the concentrator and taken on the line 10—10 of Figure 1; and

Figure 11 is a sectional view on the line 11—11 of Figure 10.

The concentrator of the present invention is capable of handling mixed sizes of feed over a wide range of mesh sizes to positively yield a primary concentrate. The continuously controlled constant volume of air is passed through pockets in the table within which pockets are balls of either uniform or graduated sizes. The table is vibrated at an angle and such vibration, together with air passage between the balls, produces eddy currents and a rapid change of position of the balls. Such action has been found to be very efficient in the practice of the invention in that the heavy concentrates pass by gravity downwardly through the upstream of air and between the balls while the lighter gangue material is lifted and conducted away from the concentrates.

Figures 1 and 2 show a sill 1 for the concentrator made up of I-beams 2. The said I-beams are arranged in any suitable manner and interconnected so as to provide a support and foundation for the concentrator considered as an entirety.

Resting on the I-beams 2 and supported thereby is a spaced pair of girders 3 and 4, see Figure 2. This is one possible arrangement. Each girder 3 and 4 carries front and rear sockets 5 and 6. The sockets are at an angle to the top flanges of said girders and incline toward the feed end of the concentrator. Immediately above the girders 3 and 4 is the feed table.

The feed table includes a framing 7 which has two substantially parallel sides 8 and 9, and an interconnecting end member 10, the said framing being of substantial depth. The said framing and associated parts, to be described, is pro-

vided with external sockets 11 and 12 on each side of the framing which are in axial alignment with the front and rear sockets 5 and 6. Coil springs, designated generally at 13, bridge the axially aligned pairs of sockets. The said coil springs resiliently support the feed table above the girders of the sill. The coil springs are held against displacement from the sockets in any approved manner although the weight of the framing and associated parts is usually great enough to prevent any displacement. Extending between the sides 8 and 9 and the end 10 of the feed table framing is a base member 14. This base member may, itself, constitute a skeleton framing, or it may be solid and said base member is adapted to support between the sides of said feed table framing the screen member designated as an entirety as 15. The screen member 15 includes a framing having two side rails 16 and 17 which are substantially parallel and adapted to lie closely adjacent the sides 8 and 9. The side rails are each provided, adjacent their bottom edges, with an angle iron 18, which acts to support a pan 19. Positioned above and spaced from the pan 19 is a screen 20. It will be seen from the description given that a duct is provided between the pan 19, the screen 20, and the side rails 16 and 17, this duct being designated generally as 21 and is used as a combination passageway for air and concentrates.

The screen construction forms one of the features of the present invention and constitutes a generally solid member which may be termed a wall 22 and which parallels the pan 19. This wall is secured in any approved manner between the side rails 16 and 17 and said wall is transversely provided with slots 23 at equidistantly spaced points, as shown in Figure 4. The longitudinal bounding edges for each slot 23 carry Z-shaped brackets 24 and 25, one leg of each bracket being supported on the top surface of the wall 22, while the bottom legs carry a screening which extends therebetween.

Reference is made to Figures 5 and 6 which are illustrative of the construction for each slot 23. As shown, the Z-shaped brackets or supports have both legs bored at a plurality of points, the upper leg 26 of each bracket arranged to have a screen 27 overlie said legs with bolts designated generally as 27*a* passed through bores in the wall 22, through the said screen and through risers 28 which overlie the screen in the zone of said legs 26. The assemblage is held by the usual nuts 29 carried by the bolts 27*a*. The risers 28 are wedge shaped and accordingly, complementary wedge shaped washers 30 are provided for each bolt. As shown in Figure 6 angle iron members 31 and 32 are secured to the side rails 16 and 17 and are interposed between both ends of members 26. One leg of each Z-shaped bracket 33 and 34 is carried by an angle iron member, 31 and 32, the screen 27 in turn being interposed between the uppermost legs of said Z-shaped brackets and a cap strip 35 and held by bolts 36. The bottom screen 37 engages the inner surface of the lower feet of the brackets 24, 25, 33 and 34, with overlying strips 38 positioned on top of the screen, there being a plurality of bolts 39 passed through the strips 38 and the lower feet of the said brackets for holding the screen in position. Included between the upper and lower screens 27 and 37 are steel balls or shot 40. Extending between the sides 16 and 17 and beneath the screen 27 is a baffle 41. In the present instance the baffle does not extend the entire distance between the screens 27 and 37.

While I have described the screen 27 as being one which extends between a pair of risers, yet it is evident that the said screen may overlie the entire deck or table top and be secured to the respective top legs 26 and under the risers, as just described. Either construction functions the same. The screen construction thus provides what may be termed a plurality of pockets, each pocket comprising upper and lower screens between which are placed hardened steel balls 40 which may be of the same size or of intermixed sizes. The number of pockets may vary as may likewise the spacing between the pockets. For instance in Figure 3, five pockets are provided. Secured to the solid portion of the wall 22 between pockets and intermediate the side rails 16 and 17 are blocks 42. The longest dimension of each block extends longitudinally of the wall 22 and the ends of each block are angular in form. These blocks act to divide the top and for purposes set forth in the statement of the operation.

The construction is such that screen member 15, considered as an entirety, may be withdrawn from between the sides 8 and 9. Ordinarily the side rails 16 and 17 are held to the sides 8 and 9 by Z-shaped clips 43, see Figures 2 and 4.

It will be noted upon reference to Figure 4 that the wall 22 has an extending solid portion at 22*a*. This is the portion that initially receives the grains of ore and is at what is termed the feed end of the screen, while the opposite end 44 provides for discharge of the tailings and of the concentrates. It is intended from the construction shown that the screen, considered as an entirety, should be vibrated and to accomplish this, a framing 45 transversely extends above and between the sides 8 and 9 of the feed table framing 7. The framing 45 has angularly related sides, as shown at 46 and 47, and on one of the said sides, in the present instance 46, a vibrator mechanism designated generally as 48, is mounted. This vibrator mechanism is illustrated in Figures 10 and 11, and includes a pair of shafts 49 and 50 suitably mounted in bearings designated generally as 51 carried by the sides of a housing designated generally as 52. Gears 53 and 54 are carried on the shafts 49 and 50, with the teeth of said gears in mesh, as shown. Shaft 49 carries an eccentric weight 55, while shaft 50 carries a pair of eccentric weights 56 and 57. The eccentric weights 56 and 57 are spaced apart to allow the weight 55 to pass therebetween during rotation of the shafts. Shaft 49 is the drive shaft, while shaft 50 is the driven shaft. It is evident that the unbalanced weights tend to balance each other when in the position shown in Figure 11 and give a maximum unbalanced effect when revolved 90° to a plane perpendicular to that shown in the figure. Such a device transmits vibration to the screen at an angle oblique to the screen surface which permits a horizontal setting of the screen, if desired. When the vibrator mechanism is mounted upon the inclined side 46 of the framing, vibration or movement of the screen is in the direction of the arrows 58 of Figure 1. Such a vibratory movement causes the grains of ore to move from the feed end of the screen to the discharge end, as more fully set forth in the statement of the operation. Secured between the sides 8 and 9 at the feed end of the concentrator is a hopper 59. The chute end 60 of said hopper 59 is elongated to length

as shown in section in Figure 3 and extends between the sides 8 and 9. This hopper acts in conjunction with the chute end of a superimposed hopper 61, which initially receives the crushed ore delivered into said hopper 61 from a belt conveyor 62. The hopper 61 and associated framing 63 is carried by posts 64, the lower ends of the posts being mounted upon the sill. Framing 63 is arranged to support a motor 65, a blower 66, and the pulley end 67 for the shaft of the roller 68 over which the belt conveyor passes. It will be noted that various pulleys are mounted on the blower, both ends of the motor shaft, and on the shaft 49 of the vibrating mechanism, with continuous belts passed between the pulleys for driving the same when the motor is energized. The blower is adapted to direct a constant volume of air through the duct 69, the outlet of the duct being between the pan 19 and the wall 22 immediately below the feed end 22*a*, see Figure 4. The discharge end of the feed table is provided with a transverse strip 70, and a small discharge spout 71 depends from the wall 22 adjacent the discharge end 44 of the concentrator table. This discharge spout communicates with an elongated slot 72 in the pan 19, see Figure 3. A pair of angular strips 73 and 74 extend between the pan 19 and wall 22 and the sides 16 and 17 for directing the concentrates to the slot 72. It is intended that the concentrates should be directed through the spout 71 into a hopper 75, which hopper discharges onto a continuous belt conveyor 76. The tailings are passed over the table top and are directed by a chute 77 onto a continuous belt type conveyor 78.

I have provided damper means 79 of the gate type as illustrated in Figures 3 and 4, for regulating the volume of air passed through the duct 69 and into the duct 21. I have also provided a canopy 80 positioned above the shaker table, as illustrated in Figure 4. The top of the canopy has an outlet 81 connected to a duct 82 for collecting dust which is normally raised when the shaker table is vibrated and ore is being passed thereover.

Other refinements in the construction include an elongated member 83 which is interposed between the pan 19 and the screen for bracing the screen and preventing distortion thereof during passage of ore thereover.

The operation, uses and advantages of the invention are as follows:

It is assumed that the ore desired to be concentrated has been suitably crushed to a size which will permit it to pass through the top screen 27 covering each pocket. Included between the top and bottom screens 27 and 37 are steel balls 40 of the same or graduated size. Upon actuation of the motor 65, the blower 66 will direct a continuous current of air through duct 69 and into duct 21. This air will pass upwardly through each pocket of the screen member 15. To assure such passage, the spout 71 and the hopper 75 are surrounded by a canvas bag to create a back pressure to air flow at the concentrate outlet end of the table. The motor also drives the vibrator 48 and as this vibrator is mounted at an angle and the shaker table is held by coiled springs 13 at substantially a 45° angle to the sill, vibration of the table occurs on an angle, the direction of movement of the table being in accordance with the arrows shown at 58 in Figure 1. This upward and downward movement of the table at a rapid rate causes travel of the ore from the intake or feed end of the table toward the outlet end thereof in a steady continuous flow. The properly graduated ore is fed by the belt conveyor 62 into hopper 61 and thence directed into hopper 59 positioned directly above the table at zone 22*a*, in Figure 4. Vibrating the table gives a panning action to the ore and the ore will stratify, the concentrates being on the bottom, the middlings at a middle zone, resting on the concentrates, with the tailings covering the middlings in the manner shown in Figure 9. Due to the vibratory action of the table and its particular motion, the concentrates, arranged in accordance with specific gravity, will move over the solid portion 22*a* of the table at the inlet end, will climb the first riser of the first pocket and onto the upper screen 27 of the first pocket. The concentrates will fall through the screen as may the middlings and perhaps some of the tailings, but as the table is vibrating rapidly, this vibration is communicated to the balls 40 in the pocket. These balls rapidly rotate in the manner indicated by the arrows in Figure 8 and change their positions as high as 1250 times per minute. During such vibratory movement, air is being directed through the pocket and around the balls at a continuous volume sufficient to lift the middlings and tailings through the uppermost screen 27 while permitting the concentrates to gradually move downwardly and pass through the lower screen 37 into the duct 21, being received on pan 19. However, air flow into duct 21, plus vibration, will cause the concentrates to move toward the discharge end of the table and pass through spout 71 into hopper 75 for deposit upon belt 76. In the meantime, the ore which includes the concentrates, middlings and tailings, will continue to move over the top screens of the several pockets until the concentrates have been removed from said ore. This is the reason for providing a plurality of pockets. In fact it is possible within the purview of the present invention to provide sequential concentrators to assure substantially complete removal of concentrates from the ore. The concentrates that are not captured or removed from the ore at the first pocket will continue to move on the table and will pass over the second riser of the first pocket which causes a tumbling action in the ore and aids in separting the concentrates from the middlings and tailings. In Figure 8, I have shown the general appearance of the ore and the waves produced therein during travel thereof over the vibratory table. Figure 8 also shows the eddying that occurs between the balls and the ore while separating the concentrates from the tailings. The eddying is of importance as constant agitation and movement of the balls functions to batter the ore received in the pocket while the air passed through the pocket carries the light gangue particles upwardly through the top screen. As stated, the action continues with the ore moving over the risers thence into the pockets to be acted upon by the balls and the air, while the table is being vibrated. After the last pocket has been passed over, the tailings and middlings or gangue will pass through chute 77 and be deposited upon the continuous belt 78, which will remove the same.

The device will operate without undue dust due to the presence of the dust collector positioned above the table. While the table may be placed at an angle to assure proper travel of the ore from the intake to the discharge end nevertheless, the angular mounting, both for the table and the vibrator, assures travel of the ore even

if the table is inclined upwardly toward the discharge end thereof.

I claim:

1. A concentrator including a foundation member, an elongated substantially rectangular solid table, provided with a series of equidistantly spaced apart transverse slots, screens covering the top and the bottoms of said slots, and triangular risers extending transversely of the table adjacent the edge of each slot and on the upper surface of said table, all of said risers extending in the same direction, balls within each transverse slot between the said screens, front and rear pairs of coil springs between the foundation member and the table, the axes of which springs are at an acute angle to the plane of the table and means for vibrating the table at an angle oblique to the plane of said table to pass particled ore over the table from one end thereof to the other, the said ore in each instance passing over the said risers and into each pocket, the mesh of the screen being such as to allow said particled ore to pass therethrough to have said balls batter the ore, and means for directing air through the screens and between said balls to lift the lighter particles of said ore upwardly for progressive movement to the next transverse slot,

the concentrates passing through the bottom screens.

2. The device as set forth in claim 1 characterized in that the means for directing air through the screens includes a blower and a duct beneath said table, the said duct adapted to receive concentrates passed through the bottom screens to be directed by vibratory movement toward the tail end of the concentrator.

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