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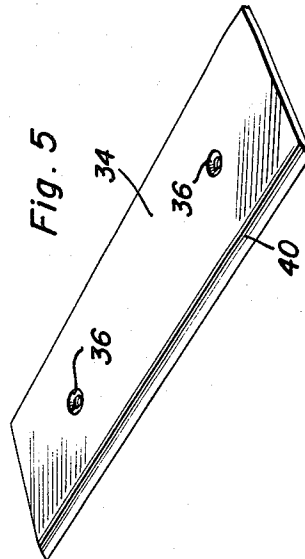
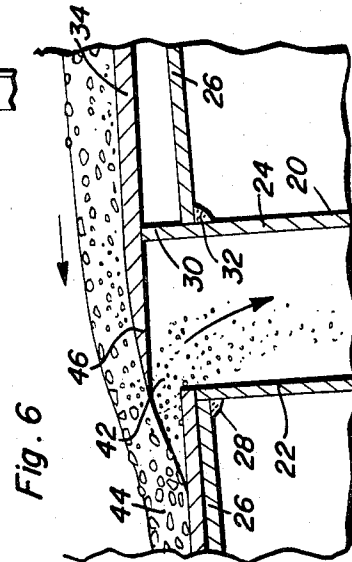
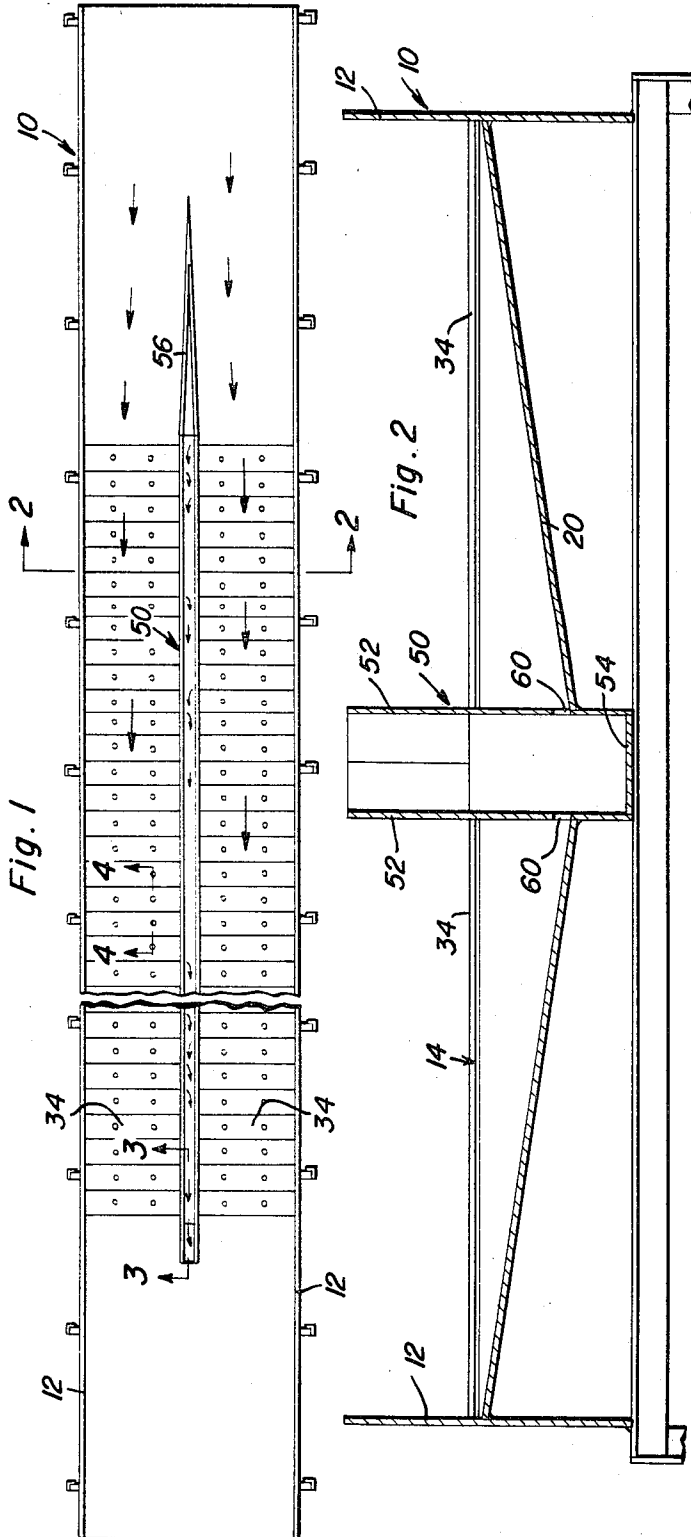
D. J. BAILEY

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METHOD AND APPARATUS FOR SEPARATING HEAVY MINERALS

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2 Sheets-Sheet 1



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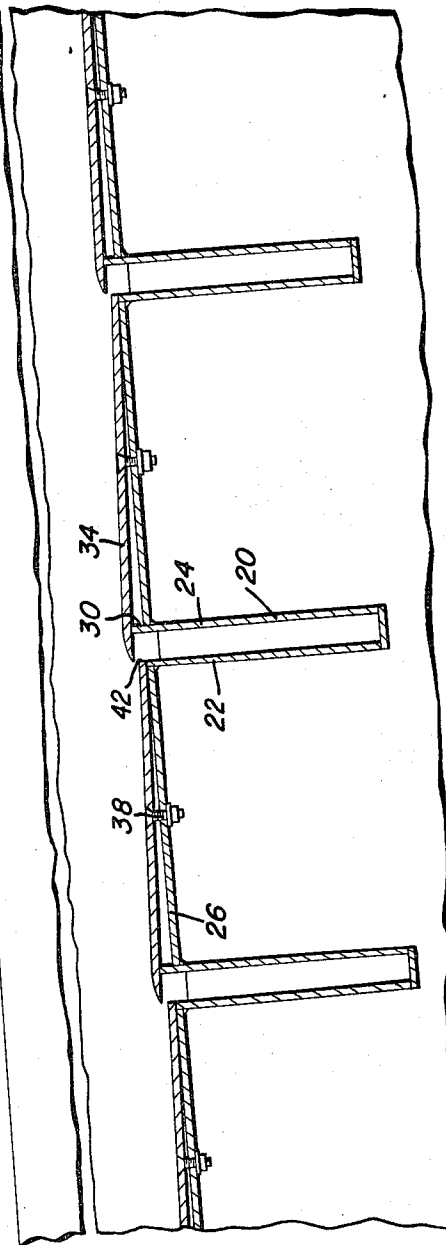
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**METHOD AND APPARATUS FOR SEPARATING
HEAVY MINERALS**

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ABSTRACT OF THE DISCLOSURE

A method for separating relatively heavy particles of small size from a slurry containing solid particles of varying size and weight by exposing the underside surface of the slurry to a partial vacuum as the slurry is subjected to intervals of free fall. The apparatus utilized in this method includes an inclined trough comprising a longitudinal row of plates disposed in side by side relation wherein adjacently positioned plates have their corresponding edges oriented vertically from one another thereby forming a slitted, sheltered opening. A receiver channel is located beneath each slitted opening so that the opening forms an inlet to the receiver channel which receives retrieved particles. The bottom portion of each channel includes a particle discharge aperture that is exposed to atmospheric pressure.

This invention comprises a novel and useful method and apparatus for separating heavy minerals and more particularly pertains to a system for separating solid particles of heavy minerals from a slurry containing various sizes of solid particles of different weights in a continuous operation.

It is the primary purpose of this invention to provide a system including both method and apparatus whereby solid particles lying within a predetermined range of size and weight may be efficiently and automatically removed from a slurry containing various sizes of solid particles and containing particles of different minerals therein.

A further object of the invention is to provide a system including both methods and apparatus which shall remove from a slurry solid particles of a predetermined size and weight accompanied by a minimum quantity of water.

A still further object of the invention is to provide an apparatus which shall consist of no moving parts and which shall be stationary during its operation and shall effectively and with a great efficiency of operation extract from a continuously moving slurry containing different sizes of solid particles of various weights therein separate and collect particles within a predetermined range as to size and weight.

A further object of the invention is to provide an apparatus in conformance with the preceding objects which shall be capable of being constructed of different sizes as to lengths and widths in order to obtain different volumetric capacities for handling a stream of slurry and for removing therefrom different quantities of a selected mineral.

Still another object of the invention is to provide an apparatus and a method which automatically and in a continuous process separate from a slurry and collect solid particles and which shall be substantially free from

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clogging of the restricted inlets into the collecting chambers.

More specifically, it is an object of this invention to provide a method which without requiring any movable parts shall effectively separate solid particles of a mineral of a predetermined size and weight of particles automatically from a stream of a continuously moving slurry containing various sizes of solid particles and which will enable the ready removal of the collected solid particles.

Still further it is an object of the invention to provide a system including apparatus and method which will effectively separate solid particles of a predetermined size and weight from a slurry containing a mixture of different sizes and weights of solid particles and which may be effective either as a first stage or a final stage separating device either when employed alone or in conjunction with other apparatuses and other processes for the separating of solids.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

FIGURE 1 is a view in top plan of one suitable form of apparatus in accordance with the principles of this invention;

FIGURE 2 is a detailed view in vertical transverse section taken upon an enlarged scale substantially upon the plane indicated by section line 2—2 of FIGURE 1;

FIGURE 3 is a further detail view in vertical longitudinal section taken upon an enlarged scale substantially upon the plane indicated by section line 3—3 of FIGURE 1;

FIGURE 4 is a further detail view in vertical longitudinal section upon an enlarged scale substantially upon a plane indicated by section line 4—4 of FIGURE 1;

FIGURE 5 is a perspective view of one of the blades forming a part of the bottom wall of the main trough of the apparatus; and

FIGURE 6 is an enlarged view of a portion of FIGURE 4 and showing in greater detail the arrangement of the receiver channel and the associated blade in accordance with the invention.

In the accompanying drawings, the numeral 10 designates generally one exemplary embodiment of apparatus comprising a separator in accordance with this invention. The separator consists of a main trough which is longitudinally extending and of any desired length and width, including upstanding marginal side walls 12 together with a bottom wall 14 extending therebetween.

By way of example, a satisfactory installation for the purposes of this invention may consist of a main trough about four feet and four inches in width, having an inclination from six to fifteen degrees depending on the volume of slurry and velocity of the slurry as it enters the trough together with marginal side walls approximately eighteen inches in height.

It is to be appreciated that the slurry containing solid particles of various sizes passes down the trough between the side walls 12 and during its passage solid particles of a predetermined size range and weight as by example heavy mineral particles of less than a size which would be retained upon a 20-mesh screen are automatically removed from the slurry, collected and recovered for further

treatment. The remaining portion of the slurry and solid particles then is discharged from the end of the trough for any subsequent purpose as for example to a waste station or possibly to other apparatuses for various types of treatment.

The particle extracting portion of the device comprises a plurality of transversely extending regions of reduced pressure having a sheltered inlet thereinto into which particles of selected size and weight are drawn and are collected. These regions are relatively closely spaced and any desired number of them may be provided.

In accordance with this invention, the regions preferably comprise receiver channels. The receiver channels are designated by the numeral 20 and extend transversely of the trough and preferably perpendicular to the side walls thereof. Referring to FIGURES 3, 4 and 6, it will be observed that each of the receiver channels 20 is U-shaped in cross-section having parallel vertical side walls 22 and 24, with the side wall 24 extending to a greater vertical height than does the side wall 22. The side walls are closely spaced, being in the order to one-half of an inch and being about four inches deep at their lowest end. As will be noted from FIGURE 2, the receiver channels 20 have a downwardly inclined bottom wall. In the arrangement shown, the upper portion of the bottom walls are disposed adjacent the side walls, with their lower portions being disposed adjacent the center of the trough where they are connected to and communicate with a collection trough to be hereinafter described. The inclination of the bottom walls of these receiver channels is such that the solid particles collected therein are conveyed by a slight accompanying flow of the liquid component of the slurry and descends by gravity transversely of the main chute and into the collection trough.

Referring now specifically to FIGURES 4 and 6 it will be observed that the bottom wall of the chute consists of a series of coplanar plates 26 which have transverse openings with which the open upper ends of the receiver channel 20 communicate. Thus, the wall 22 of each receiver channel is secured to the rim of the opening of the plates 26 as by welding 28. However, the wall 24 projects above the bottom plates 26 to provide an upstanding portion as at 30 which is on the upstream side of the bottom wall as compared to the other side wall 22. Welding as at 32 likewise secures the wall 24 to the bottom plates 26. It will thus be observed that each of the receiver channels comprises a transversely extending well or pocket which extends across the path of flow of the slurry moving down the chute, indicated by the arrows in FIGURE 1. That portion of the main chute bottom wall across which the receiver channels extend is provided with a plurality of deflector blades each indicated by the numeral 34. The deflector blade 34 as shown in FIGURE 5 consists of rectangular plates of any suitable material having openings 36 by which fasteners extending therethrough and flush with the top surface of the blades, these fasteners being shown at 38, detachably secure the blades in place upon the bottom plates 26 of the main chute bottom wall. The downstream or lower edges of the blades 34 are beveled as at 40 to provide a knife edge whose top surface is slightly convexed. The lower edge of the bevelled portion overlies the wall 22 as shown in FIGURE 6 and is spaced therefrom to provide an inlet opening in the form of a slit as indicated at 42 which is approximately $\frac{1}{8}$ of an inch in height and more than sufficient to accommodate the maximum size of the solid particles which are to be separated by the device from the slurry stream. Thus clogging of the inlet openings is prevented.

The contour of the top surface of the deflector blades 34 is such that as the slurry moves downwardly thereover, as shown at 44 in FIGURE 6, it will have flow characteristics such that the velocity of flow in conjunction with the restricted size of the inlet opening 42 will aid to produce the reduced pressure or partial vacuum within the interior of the receiver channels 20 as further explained hereinafter. The velocity of flow together with the size

of the inlet opening 42 are so selected that they will effectively cause the particles of sufficient weight and of a size sufficient to pass through a twenty mesh screen, to be drawn into the receiver channel 20, collected therein and with a slight accompanying in-flow of liquid from the slurry, will be caused to descend by gravity, see FIGURE 2, along the bottom wall of the receiver channel from whence they are discharged into the collection chute to be described hereinafter.

On the other hand, particles larger, and therefore heavier will be unaffected by the reduced pressure or suction at the inlet opening of the receiver channels and thus will pass down the main chute with the slurry. The recessed or sheltered location of the inlet openings effectively reduces the proportion of the water which enters the receiver channels 20.

In the apparatus illustrated, there is provided a medially disposed longitudinally extending collection trough indicated generally by the numeral 50. The collection trough 50 consists of parallel vertically extending side walls indicated by the numeral 52 together with a bottom wall 54 and having its top open to atmosphere as shown in FIGURES 1 and 2. At the upstream end of the collection trough 50, the side walls converge toward each other to provide a tapering wedge-shaped portion 56 which causes a stream of slurry entering the chute to be separated into two portions each passing along one side of the collection trough as indicated by the arrows in FIGURE 1. Each section portion passes over the series of receiver channels where the selected solid particle component is separated therefrom.

At its lowermost end, the collector chute or trough 50 is provided with a discharge opening 57, see FIGURE 3, from which the collected solid particles are discharged under atmospheric conditions for subsequent use or treatment.

Referring particularly to FIGURE 2 it will be seen that the discharge end of each of the receiver channels is abutted perpendicular against one of the side walls 52, and is securely united therewith as by welding or the like. At the lower end of the receiver channels the collected material and the accompanying liquid which conveys it are discharged into the collector trough 50 through restricted openings 60 which are of the order of one-half inch in height and one-half inch in width.

The restricted outlet 60 is continually exposed to externally applied atmospheric pressure during the separation process and is necessary in order that the partial vacuum or reduced pressure produced within the receiver channels 20 by the combined effect of the outlet and of velocity of flow of the slurry across the restricted inlet 42 may not be broken or destroyed. It is appreciated that variations in the dimension of the outlet 60, inlet 42 and flow velocity of the slurry will inherently vary the value of the reduced pressure consequently varying the suction effect on the various sized particles in the slurry.

Referring again to FIGURES 3 and 4, it will now be apparent that each of the deflector blades 34 is of a width sufficient that its upstream end may rest on the bottom plate 26 of the main trough with its lower end being supported upon the upstanding wall portion 30 of the corresponding receiving channel and with its bevel knife edge being disposed slightly above the adjacent upstream end of the next adjacent deflector blade.

It will be appreciated that any supporting framework may be provided for the device and further that the length and width of the device may be varied as desired.

It is evident that a critical relationship exists between the rate of flow of the slurry down the device and the size of the openings into the receiver channels. If too great a rate of flow exists, it is evident that all of the particles will be carried past the inlets of the individual receiver channels. On the other hand, if the rate of flow is too low, there will be insufficient velocity of the slurry to effect the suction at the inlet slit 42.

It will be appreciated that although the device has

been shown as including a centrally disposed collector trough thus providing two parallel paths of travel of the separating action of the device, this arrangement will be varied to provide a multiple number of parallel paths of travel or even a single path of travel with the collector trough or troughs being disposed on opposite sides of the main trough. It is merely necessary for the purposes of this invention that there be provided transversely extending receiver channels constituting regions or zones of reduced pressure depressed below the path of travel of the slurry in order that the suction effect produced by the velocity of the slurry may be utilized to draw into and collect into the receiver channels solid particles of a predetermined size and weight.

The apparatus has the advantage that it has no moving parts, and when its dimensions are properly proportioned, it will handle very high concentrations of solid particles in a slurry as for example a 40 to 60 percent concentration. Further, a relatively low quantity of the liquid component of the slurry is inducted into the receiver channels through the inlet slits 42. By way of example, when 2000 gallons per minute flow of slurry down the main trough, only 200 gallons per minute are collected by all of the receiver channels and delivered into and passed through the collector trough 50.

In conventional methods and apparatuses for separation, it should be noted, substantially the entire volume of 2000 gallons of water per minute will accompany the separated mineral particles as the latter pass through the usual 20 mesh separator screen. A subsequent de-watering operation is then necessary before the separated particles can be further processed.

With this invention, however, the separated particles are accompanied by only 200 gallons of water per minute, which enables elimination of a further de-watering step and allows the separated particles to be further processed.

The system of recovering solid mineral particles from the slurry in accordance with this invention involves both an apparatus, one example which has been disclosed in the accompanying drawings described hereinbefore and a method. The method itself consists in continuously supplying a stream of slurry containing a mixture of solid particles of varying sizes therein a certain class of which particles of a given size and weight are to be recovered. A stream of slurry is supplied continuously at a constant velocity of flow which is proportionate to and correlated to the structural dimensions of the apparatus. In accordance with this method, the velocity of flow is used by passing across the restricted opening to provide a suction effect which will produce a region or zone of reduced pressure into which particles of a selected size and weight are caused to enter and be collected by this reduced pressure. Thereafter, the collected particles are flushed by gravity and a conveying liquid also taken from the slurry into a common collecting means where they are recovered. The method thus performed is a continuous one, and its efficiency is not altered by the concentration of the solid particles in the slurry.

The method is capable of handling, in a suitable embodiment of apparatus, about 2000 gallons per minute of a slurry in which about 200 tons per hour of solid particles are entrained.

Further, the method is applicable to effect the efficient separation of the predetermined size and weight of particles from the slurry in a continuous operation and with an efficiency which may be employed as a final separation stage of particles from a slurry or a pre-treatment stage for preparing the slurry for further treatment by other apparatuses or methods.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and

equivalents may be resorted to, falling within the scope of the invention as claimed.

What is claimed as new is as follows:

1. A method for separating relatively heavy particles of small size from a slurry containing solid particles of varying size and weight by utilizing the effect of a pressure differential developed across a free falling segment of the slurry comprising the steps of subjecting said slurry to an incline whereby said slurry will develop a predetermined velocity during open channel flow, subjecting said slurry to free fall during traverse over a sheltered opening of preselected dimension, forming an enclosed region one end of said region being in communicating relation with said sheltered opening, continually subjecting a point in said region which is vertically removed from said opening to atmospheric pressure, subjecting the remainder of said region to a partial vacuum with respect to atmospheric pressure, subjecting said slurry to a pressure differential at said opening whereby particles of preselected size and weight will be deflected from said slurry into said region, and collecting those particles which are deflected into said region.

2. The method of claim 1 wherein said slurry velocity results from gravitational flow of said slurry.

3. The method of claim 1 wherein said collected particles are retained separately from the remaining slurry, said collected particles guided to a point remote from said region for said collection.

4. The method of claim 3 wherein said particles are of a size small enough to pass through a 20-mesh screen.

5. A separator for diverting solid particles contained within a slurry comprising means for channeling said slurry downwardly at a preselected velocity, means for subjecting said slurry to free fall at preselected longitudinal intervals along said channeling means and defining sheltered inlet means of preselected dimensions communicating with the downward surface of said free falling slurry, receiving channel means communicating with said inlet, said receiving channel means further characterized by aperture means vertically removed from said inlet and externally exposed to atmospheric pressure.

6. A separator for diverting solid particles contained within a slurry comprising a downwardly inclined trough having a bottom surface which is adapted to channel a slurry stream at a preselected velocity, said slurry containing a mixture of solid particles of varying sizes and weight, said trough comprising a plurality of transversely disposed rectangular plates orientated in a mutually parallel manner, the downstream edge of each said plate vertically aligned with the upward edge of a downwardly adjacent plate and in spaced relation thereto, whereby said downward and upward edges lying vertically aligned form a sheltered slitted opening of preselected dimensions, a plurality of receiver channels in said trough, each said channel underlying the downward edge portion of an associated plate and communicating with said slitted opening at the upper portion of said receiver channel, said receiver channel containing a partial vacuum for effectuating deflection of particles of preselected size and weight from said slurry into said channel, an aperture formed within the bottom portion of said receiving channel, a collection trough open to the atmosphere and disposed below said aperture for collecting said deflected particles.

7. The structure set forth in claim 6 wherein the underside of each said plate forms a top wall of said receiver channel.

8. The structure as set forth in claim 7 wherein the bottom of said receiver channel is downwardly inclined from the trough sides to a vertical height immediately beneath said aperture.

9. The structure as set forth in claim 8 wherein said trough is characterized by dual rows of said plates and a corresponding plurality of receiver channels, a collection trough medially disposed between said plate rows, said collection trough including wall segments shared with cor-

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respondingly positioned receiver channels, each of said shared walls including one said aperture.

10. The structure as set forth in claim 9 wherein the bottom wall of said collection trough includes an exit exposed to atmospheric pressure for providing a discharge from said collection trough.

11. The structure as set forth in claim 6 wherein said downstream edge of each said plate is characterized by a beveled contour for substantially eliminating turbulence in said slurry during traverse over said downstream edge.

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