

March 18, 1941.

B. M. BIRD

2,235,757

METHOD OF DESLIMING

Filed Dec. 30, 1938

3 Sheets-Sheet 1

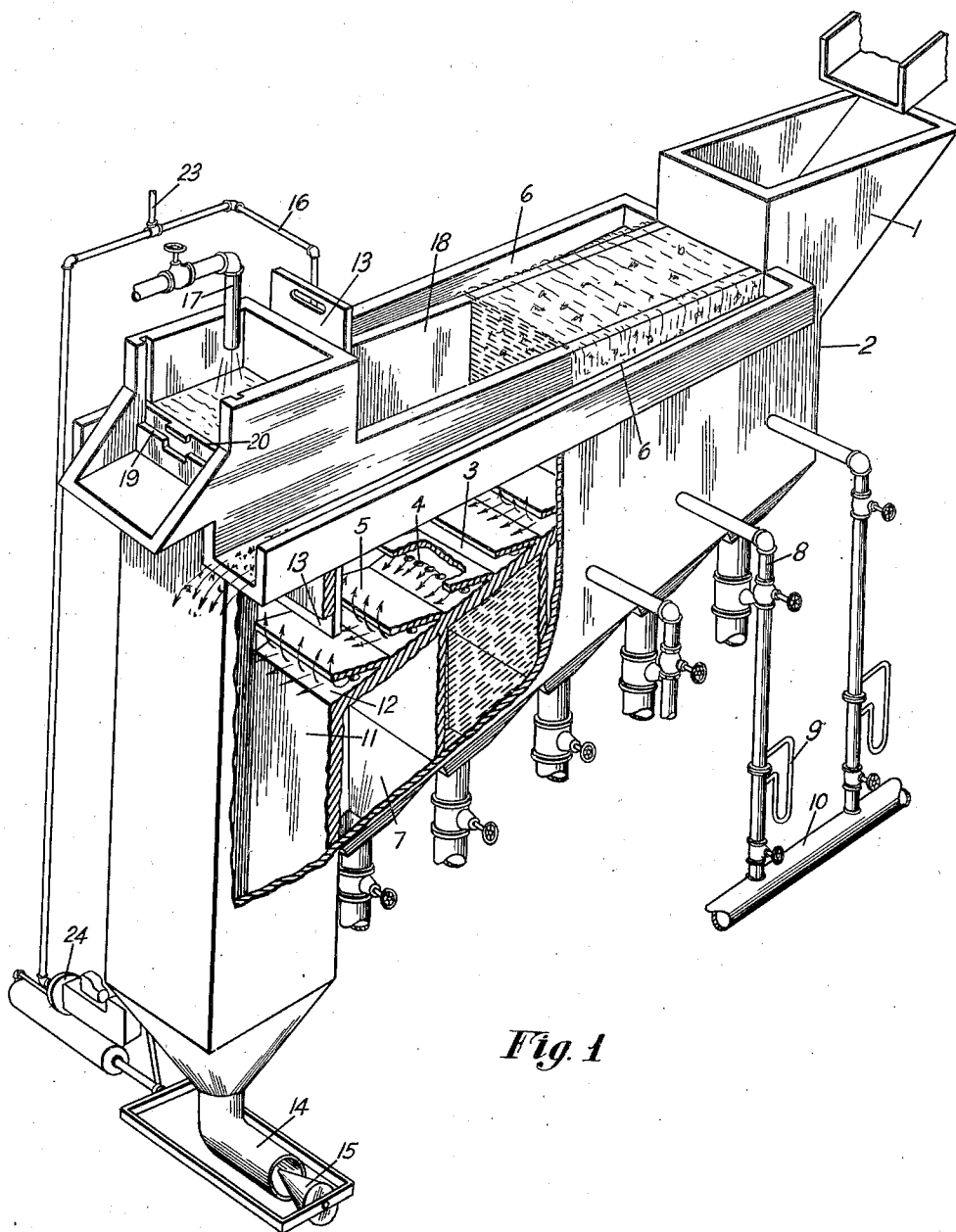


Fig. 1

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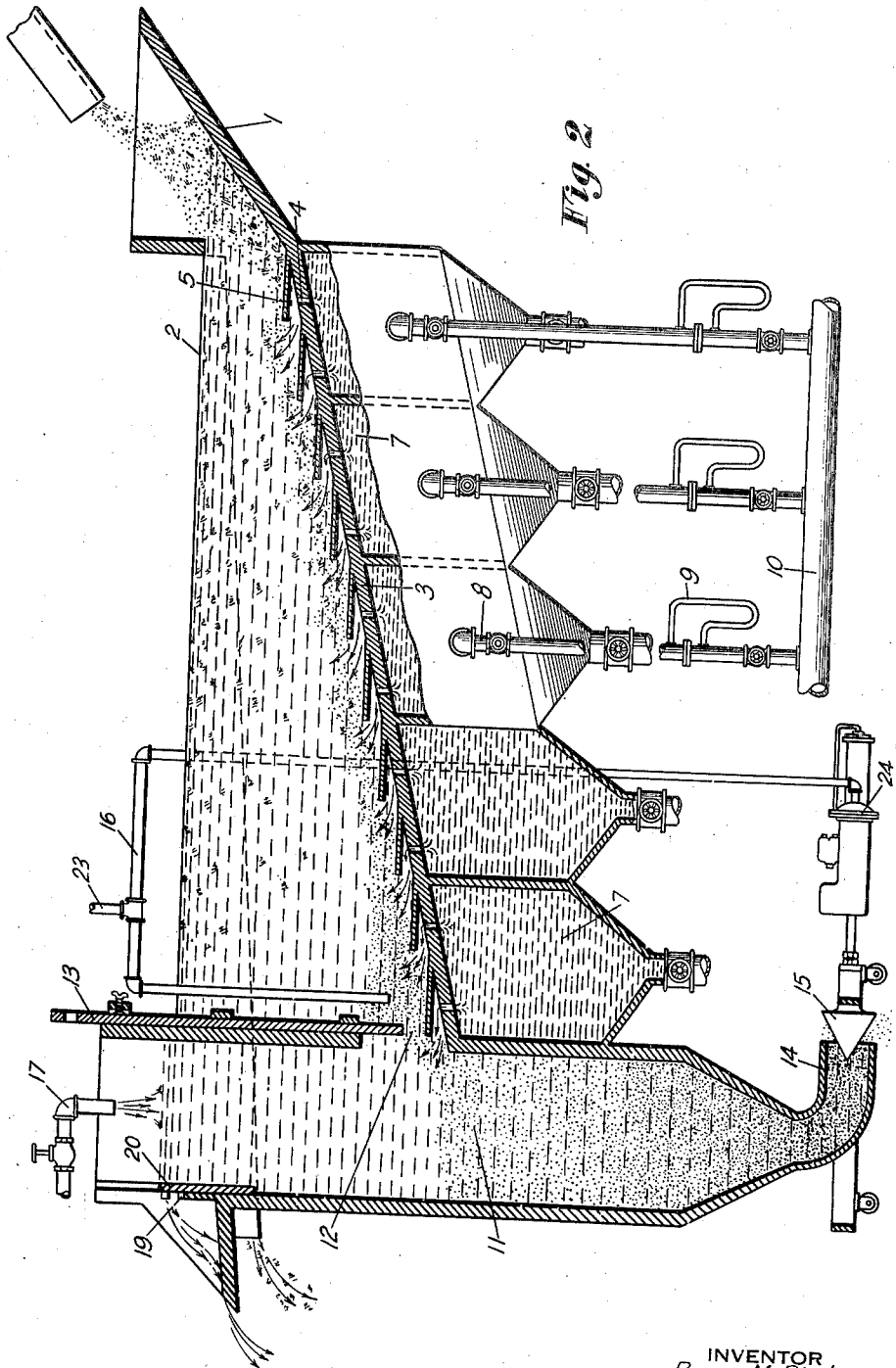
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

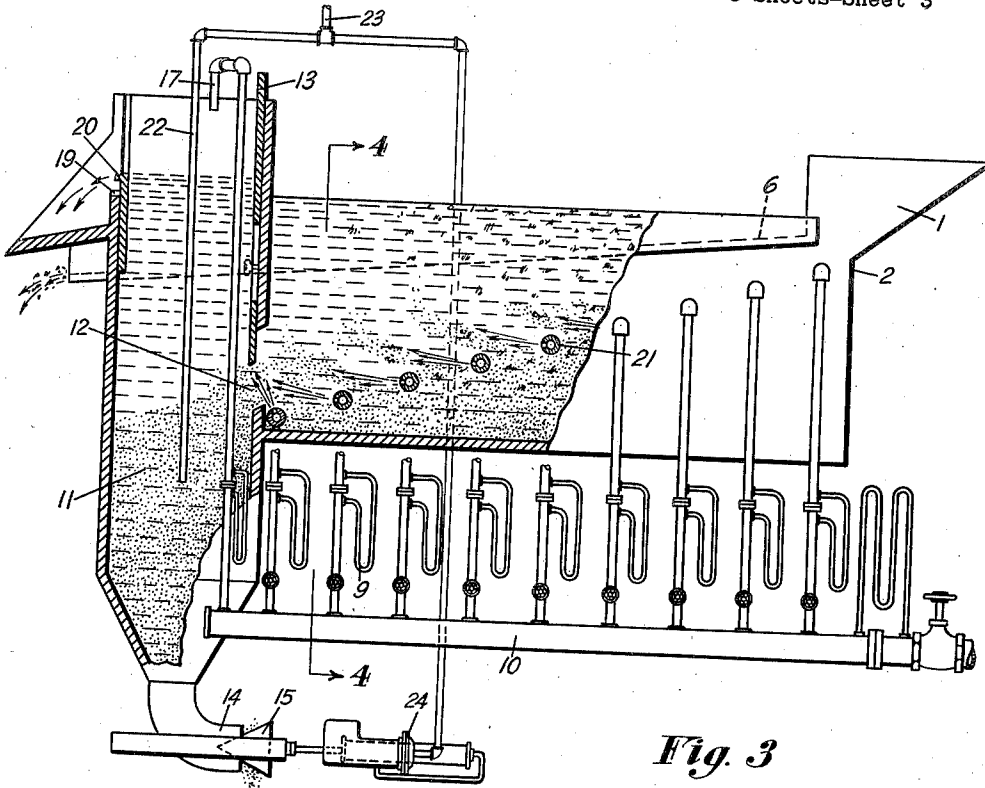


Fig. 3

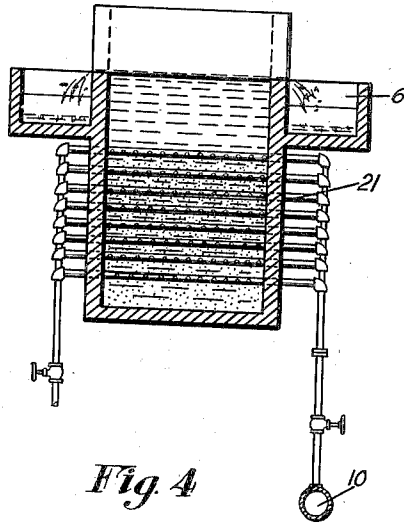


Fig. 4

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METHOD OF DESLIMING

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5 Claims. (Cl. 209—454)

My invention relates to a method of desliming. It has to do particularly with the removal of the sufficiently ground material from closed circuit ore grinding mill systems, although it is not necessarily limited thereto.

In the concentration of ores, one important problem is that of keeping overgrinding at a minimum, overgrinding being grinding finer than necessary to liberate the valuable from the gangue minerals. Requirements for power and supplies in grinding vary directly as the amount of surface produced, and the amount of surface mounts rapidly with each reduction in size of particle. For example, supposing the valuable mineral is liberated from the gangue mineral at 200-mesh (74 microns) and that the gangue is quartz. Quartz particles ground to 38 microns will have a surface of about 300 square centimeters per gram; those ground to 20 microns will have about 2100 square centimeters per gram; those ground to 7 microns will have about 5400 square centimeters per gram; and any ground to 1.5 microns will have 24,000 square centimeters per gram. These figures, indicating up to 300 times as high a cost for power and supplies as necessary, make clear the importance of this problem of reducing the amount of overgrinding in current concentration practice.

In ore dressing, grinding mills are usually run in closed circuit with a desliming device designed to remove the materials that are sufficiently ground and to return the balance to the mill for further grinding. In general, large circulating loads are used so that a minimum of overgrinding may result in the mill itself.

The most common desliming devices are mechanical classifiers. Basically, they work on the principle of removing slimes by dewatering the solids. When the water is removed, a high percentage of the ground solids is also removed mechanically and in suspension in the water. However, the percentage trapped between the coarser particles and so returned to the grinding mill is still a serious matter from a cost standpoint. The extent to which this occurs may be indicated by a typical case of excellent concentration practice with mechanical classifiers. In this the percentages of minerals that were already ground to the required fineness, but which were not removed by the desliming devices, were as follows: 40.2 per cent of the galena, 18.2 per cent of the sphalerite, 24.2 per cent of the pyrite, and 8.5 per cent of the gangue, a total of 21.0 per cent of all ground minerals. When it is considered that grinding is usually the single most

expensive item in ore concentration, the seriousness of this failure of present desliming devices to remove more of the ground materials will be apparent at once.

A more efficient method of desliming would be to pass currents of water upward through the ground materials as in a classifier of the hindered-settling type. In such a device it should be noted that the water would be supplied from outside the mass of solids. This point is important, for upward currents may also be developed in the mechanical types of classifiers. In that case, however, the upward currents are developed inside the mass of particles by the process of agitating them with water and then dewatering them. This latter method, as has been pointed out, has been allowing an undesirably large percentage of unground materials to be returned to the grinding mill and thus to be overground.

Although the efficiency of the hindered-settling classifier has been recognized in the art, no one has found a practicable means of using it without adding an excessive amount of water to the fine sizes. This fact has rendered the method uneconomical, for, in general, any water added beyond what can be handled advantageously in the subsequent concentration process must be removed by thickening the pulp after it is ground.

In the case of the prior art devices of the hindered-settling type, the required mobility is supplied by the upward current water; hence, in desliming a material passing 20-mesh, the upward currents must be swift enough to support the 20-mesh particles, or roughly 20 times as swift as those used in my classifier to give the minus 200-mesh particles an opportunity to escape from the interstices between the 20-mesh particles. As a result, the dilution of such prior art devices is excessive. Since the cost of thickening is a function of the dilution of the materials to be thickened, it follows that with such prior art devices it is not feasible to remove the excess water economically.

One of the objects of this invention is to effect desliming by the use of a minimum quantity of upward current water from without the mass of particles so that the water with the slimes will be a minimum. Other objects will appear as this description progresses.

One important feature of my invention lies in the fact that I utilize gravity travel of the ground material to impart mobility to the finer particles thereof so that they are brought into such a mobile condition that all particles are free to move with respect to the others. Another important

feature is that upward currents of water are applied to the materials from beneath while they are in the said state of mobility. The combined effect is that the fine materials of the desired size may be readily removed with much smaller amounts of water than is possible with classifiers of the hindered-settling type.

More specifically, my method involves the use of a launder in such a way that the ground materials are more or less in constant motion along a downwardly inclined surface while at the same time, they are being subjected to gently flowing vertical currents which are not adequate to maintain all of the material in a state of teeter as in the usual hindered-settling but which are adequate to suspend and remove the fine particles of the desired size.

As a matter of fact, I also utilize currents of water which are moving in a countercurrent direction to the direction of movement of the coarser particles of the material to assist in the separation of the finer particles from the said coarser particles. These last mentioned currents of water are not sufficiently strong to prevent the delivery of the coarser materials to their point of withdrawal but they are sufficiently strong to assist in the separation of the finer particles therefrom.

The apparatus which I preferably use is a launder with the bottom surface at such an angle to the horizontal that the solids to be deslimed roll or slide along the bottom. This bottom surface is provided with horizontal or vertical perforations through which currents of water may be admitted to the apparatus to effect the desliming. The top edge of the launder is approximately horizontal so that the general path of the water is vertical. At the high end of the launder is a suitable hopper for receiving the solids to be deslimed, and at the lower end is a mechanical device for withdrawing the deslimed solids without contaminating them with the fine solids that have been removed by the upward current water.

By reference to the drawings it will be seen that the bottom surface of the launder is disposed at a comparatively low angle to the horizontal. When solids move over a surface so disposed the bottom layers are greatly retarded. This brings about the said rolling and sliding of the solids with respect to each other. It will be understood that if the bottom surface of the launder were at too steep an angle, the solids would move as a mass downwardly thereover without the desired rolling or sliding of the particles with relation to each other.

In contrast to vertical current devices of the prior art, very little upward current water is necessary in my method of desliming. This is due to the fact that sliding and rolling of the particles down the inclined surface brings them into a mobile condition so that all particles are free to move with respect to the others. This leaves as the only function of the upward currents of water that of removing the fine materials of the desired size. In desliming minus 20-mesh material, for example, where it is desired to remove the minus 200-mesh sizes, it is only necessary to use an upward current sufficient to suspend the 200-mesh particles under conditions of hindered-settling. Thus, in the use of my desliming launder, with which roughly one-twentieth as much water added, the removal of the excess water is economically feasible if required by the subsequent concentration process.

The apparatus which I preferably use in the performance of my method is shown in the accompanying drawings wherein:

Figure 1 is a perspective view, partly broken away, of one form of apparatus which I may use in carrying out my method.

Figure 2 is a side elevation, partly broken away, of the apparatus shown in Figure 1.

Figure 3 is a side elevation, partially broken away, of a modified form of apparatus which I may use.

Figure 4 is a section taken on line 4-4 of Figure 3.

Referring more particularly to the form of apparatus shown in Figures 1 and 2, it will be seen that it comprises a receiving hopper 1 which is designed to deliver materials to a modified type of launder 2. This launder 2 is provided with an inclined bottom 3 having provided therein spaced rows of spray ports 4 which are disposed beneath overhanging substantially horizontal plates 5. The launder is further provided along the upper longitudinal edges thereof with overflow troughs 6 that are downwardly inclined toward their delivery ends as illustrated by the dotted line in Figure 2.

Beneath the bottom 3 of the launder are provided a series of compartments 7 which are fed with water for delivery to the spray ports by means of series of feed pipes 8, each of which has a standard orifice to a manometer 9. All of such feed pipes are connected to a manifold 10.

At the delivery end of the launder, there is provided a draw pocket or compartment 11 into which the deslimed or heavy classified product flows through an opening 12 which is under the control of an adjustable baffle member or gate 13. Adjustment of this baffle member or gate permits of variation of the size of the opening 12. The bottom of the compartment 11 is provided with a horizontally disposed conduit 14 for withdrawal of the solids from the compartment. The rate of withdrawal of such solids is regulated by any standard control which will open and close the valve 15 in response to fluctuations of the pressure within the compartment 11. In the method shown, a small amount of air is introduced at 23 into the pipe 16 that extends from the control and is projected downwardly into the launder adjacent the opening 12 between the launder and the compartment. In this way, the back pressure exerted by the bed is registered on diaphragm 24, which in turn regulates the withdrawal of solids through the conduit 14 by means of gate 15.

A spray 17 is inserted into the compartment 11 and the water washes the last traces of undersized material backward through the opening 14 as well as replacing the water removed with the solids through the conduit 14. The main overflow weir for this classifier is designated 18 and the overflow is collected in the troughs 6 which have been previously described. This overflow may be carried to a settling tank or direct to a concentration process, such as flotation.

The overflow weir for the draw compartment 11 is designated 19 and is at a slightly higher elevation than the main weir 18. An adjustable plate 20 is provided for regulating the height of this main weir.

In the form shown in Figures 3 and 4, the construction is substantially the same, with one or two exceptions. In this form, the water is introduced through a series of horizontally disposed spray pipes 21 which extend transversely

of the launder in spaced relation to each other. These spray pipes with the exception of the lowermost one are provided with series of horizontally disposed ports so that the water delivered therefrom will be initially delivered in substantially horizontal direction. The ports in the lowermost spray pipe are directed diagonally upward. No inclined bottom plate is used. However, it will be noted that the heights of the spray pipes are progressively lower as they approach the delivery end of the launder. It will also be noted that, in this form of apparatus, the control pipe 22 for the control system is projected downwardly into the draw compartment instead of being in the launder proper.

In the performance of my method with the apparatus shown in Figures 1 and 2, the material to be classified is introduced into the hopper 1 and slides and rolls down the inclined bottom of the launder, passing over the step-like plates 5 therein. This brings the particles into a mobile condition so that all particles are free to move with respect to each other. During this motion, the jets of water from the spray ports 4 are diverted by the plates 5 so that they are moving in a generally horizontal direction when they first contact the rolling and sliding particles. Because of this fact, the water has an opportunity to thoroughly diffuse before taking a vertical direction. This diffusion makes it possible to obtain the maximum utility of every gallon of water used. The water is preferably fed into the launder under a head of 2 inches to 12 inches of water to insure uniformity of distribution from the individual perforations.

In the performance of my method with the apparatus shown in Figures 3 and 4, the material to be classified is also introduced into the receiving hopper and thence into the launder proper. It is permitted to build up to the level of the spray pipes 21 and then is withdrawn at such a rate as to maintain a bed with an upper surface that substantially conforms to the inclined line of spray pipes. Thereafter, the material to be classified slides and rolls down the inclined upper surface of the bed of materials while, at the same time, being subjected to the substantially horizontal sprays of water. The movement of the particles along the inclined upper surface of the bed brings these particles into a mobile condition so that all particles are free to move with respect to each other. During this motion, the horizontally projected sprays of water thoroughly diffuse before taking a vertical direction. This diffusion makes it possible to obtain the maximum utility of every gallon of water used. With this form of apparatus, the water is likewise preferably fed into the launder under a head of two inches to twelve inches of water to insure uniformity of distribution from the individual perforations.

Another important feature of my method when it is practiced with the form of apparatus disclosed in all four figures of the drawings is the manner in which the coarser solids are withdrawn after they have been deslimed. For one thing, the seal gate 13 under which the coarser particles must pass penetrates downwardly into the mass of such coarse particles and holds back the slimes. Furthermore, the column of water in the draw compartment 11 is maintained at such a level that a backward current of water constantly flows in a direction counter to that of the coarser particles

automatic pressure controller to regulate the withdrawal of the coarser solids from the bottom of the water tower, while maintaining a uniform consistency, enables me to hold the level of the coarse solids in the classifying chamber about even with the opening under the seal gate and thus regulates the level of the solids in the launder proper so as to maintain it above the lower edge of the seal gate. This further assists in preventing any fine particles from entering the water tower in the draw compartment 11.

It will be understood that the water pipe delivering water to the water tower of the draw compartment may simply drop the water into the top or it may extend well down into the tower. As pointed out, the water tower or draw compartment has an adjustable overflow lip, namely, the plate 20 which is kept at such a level that the water in the tower is slightly above that in the launder proper. This insures a counterflow of the water from the tower to the launder under the seal gate.

It is within the scope of my method to utilize a launder chamber wherein one or more vertical partitions extend down part of the way to the screen, ample space being left to permit the solids to flow freely under such partitions. More than one partition may be used when two products are to be made, for example, a colloidal slime and an exceedingly fine sand, as -270 +325 mesh. In this case, two upward currents of different force would be used, the first very low and the second somewhat higher. A partition might be used to separate the two sections of the launder.

If desired, the top edge of the launder may be sloped rearwardly towards the receiving end thereof or downwardly towards the sand end. The rearward slope often facilitates a smooth desliming action, since it serves to get rid of the slimes further away from the delivery end of the launder and assists in preventing them from getting into the material in the draw compartment.

The number and spacing of the sprays as well as the angle they make with the horizontal depends upon the character of the separation required. The openings in the sprays are commonly directed so that they just clear the tops of the next spray in front. This arrangement gives the maximum diffusion of the water and aids in the forward movement of the heavier particles. Because of these conditions, it is possible to obtain vertical current classifications by using just enough current water to suspend the particles which it is desired to remove, which particles are substantially less in size than the maximum particles in the feed.

Many advantages of my method will appear from the above description. Others will appear from the appended claims.

Having thus described my invention, what I claim is:

1. A method of separating slime particles from granular material which consists in causing the granular material to flow by gravity in a thin layer downwardly along an inclined surface, the inclination of said surface being such as to insure that the particles of the layer will move with relation to each other, simultaneously applying to such mobile material horizontally directed currents of water of just enough velocity so that they will diffuse and turn upwardly after delivery, and thereafter suspending the slime particles without suspending the granular par-

In addition, my use of a standard type of auto-

ticles, withdrawing the slime particles and withdrawing the granular particles at a rate to insure that the said layer will be maintained at a substantially uniform and slight depth.

- 5 2. A method of separating slime particles from granular materials which consists in delivering the granular materials to the upper end of a surface which is inclined at such an angle that said granular materials flow by gravity downwardly along such surface and that the bottom layer of granular materials is retarded with the result that the particles above such bottom layer move with relation to such bottom layer and with relation to each other, simultaneously applying upward currents of water of just enough velocity to suspend the slime particles initially intermingled with the granular particles, withdrawing the slime particles which are thus separated from the granular particles and withdrawing the granular particles which remain after the slime is removed at a rate to insure that the slope required for causing the particles thereof to continuously move with relation to each other is maintained.
- 25 3. A method of separating slime particles from granular materials which consists in delivering the granular materials to the upper end of a surface which is inclined at such an angle that said granular materials flow by gravity downwardly along such surface and that the bottom layer of granular materials is retarded with the result that the particles above such bottom layer will roll with relation to such bottom layer and with relation to each other, simultaneously applying upward currents of water with just enough velocity to suspend the slime particles initially intermingled with the granular particles without suspending the granular particles, withdrawing the slime particles which are thus separated from the granular particles by overflow and withdrawing the granular particles downwardly at a rate to insure that the slope required for causing the particles thereof to continuously move with relation to each other is maintained.
- 45 4. A method of separating slime particles from granular materials which consists in delivering the granular materials to the upper end of a sur-

face which is inclined at such an angle that said granular materials flow by gravity downwardly along such surface and that the bottom layer of granular materials is retarded with the result that the particles above such bottom layer move with relation to such bottom layer and with relation to each other, simultaneously applying upward currents of water of just enough velocity to suspend the slime particles initially intermingled with the granular particles, withdrawing the slime particles which are thus separated from the granular particles, withdrawing the granular particles which remain after the slime is removed at a rate to insure that the slope required for causing the particles thereof to continuously move with relation to each other is maintained and simultaneously applying a current of water at the point of withdrawal of said granular particles in a direction opposite to their path of travel with said current of a velocity adequate to retard the withdrawal of the slime with said granular particles.

- 5 5. A method of separating slime particles from granular materials which consists in delivering the granular materials to the upper end of a surface which is inclined at such an angle that said granular materials flow by gravity downwardly along such surface and that the bottom layer of granular materials is retarded with the result that the particles above such bottom layer roll with relation to such bottom layer and with relation to each other, simultaneously applying upward currents of water to such mobile material at a series of points along the path of flow and at substantially equal distances below the upper surface of the flowing material with just enough velocity to suspend the slime particles initially intermingled with the granular particles without suspending the granular particles, withdrawing the slime particles which are thus separated from the granular particles by overflow and withdrawing downwardly the granular particles at a rate to insure that the slope required for causing the particles thereof to continuously move with relation to each other is maintained.

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