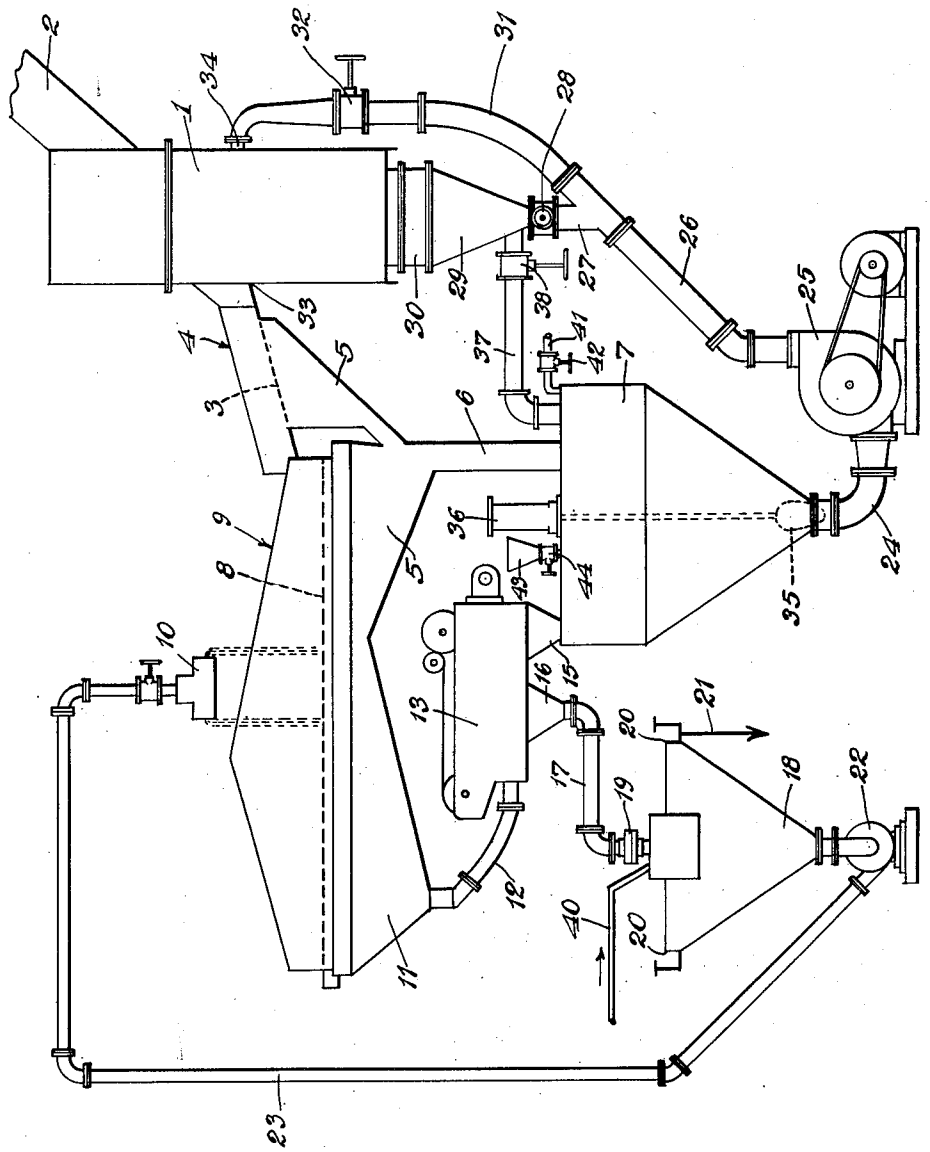
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APPARATUS AND METHOD FOR FLOAT AND SINK MATERIAL SEPARATION

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APPARATUS AND METHOD FOR FLOAT AND SINK MATERIAL SEPARATION

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My invention relates to improvements in apparatus and method for float and sink mineral separation. The broad objective is to provide new, simplified and improved apparatus for recovering the magnetic media which has been removed from the bath on the surface of the float and sink products of the separation and which must be rinsed from such products, and recovered magnetically in the form of a dense concentrate suitable for return to the bath circuit. As is the case with my previous inventions, these improvements are pertinent to the gaining of the float and sink separation of minerals of unlike specific gravity by means of a bath of dense medium consisting of water and finely divided magnetic solids such as magnetite.

In the use of heavy media mixed with a liquid to give a sink and float parting liquid, it is of the utmost importance to maintain the concentration of the media in the liquid constant, that is, the parting medium must as operation continues not vary in specific gravity or density.

The sink and float solids separated by the parting liquid and discharged from the system vary widely in size and shape and this variation means that definite quantities of the media are removed from the system. In the past it has been necessary to conduct constant, continuous tests to determine the amount of media being withdrawn because heretofore the media have been concentrated, settled out and treated over a substantial period of time before they were returned to the system. This required constant and frequent intermittent additions of solids and additions of water to the bath to maintain constant density.

I propose to so handle the medium discharged from the bath that it is rinsed from the solids and returned immediately without further treatment. The result is that addition to the bath of media to increase density or water to decrease density to compensate for change in the amount of media withdrawn is avoided.

Further objects of my invention are:

A. The return of the recovered magnetic concentrates to the bath within an exceedingly short time, a fraction of a minute, after they have been rinsed from the surface of the float and sink products.

B. The densifying of the recovered magnetic concentrates by means of magnetic forces rather than by gravitational sedimentation.

C. The desliming of the magnetic separator tailings slurries by means which will avoid an accumulative increase of non-magnetic solids in

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a semi-closed hydraulic circuit whereby the deslimed, before-mentioned tailings slurries can be directly returned to facilities regularly employed for rinsing the float and sink products. Heretofore magnetic separator tailings have been wasted or sent to large settling basins which permit the clarification of such slurries for reuse in the plant. My invention results in sending only a small fraction (the overflow slimes) to such water clarifying facilities with consequent savings in both the installed and operating costs.

A further object of my invention is to minimize the loss of magnetite, which result is accomplished because of the fact that deslimed magnetic separator slurries, which may contain some magnetite, are now to be returned for use as rinsing sprays and again be subjected encyclically to the influence of the magnetic separator.

Other objects of the invention will appear from time to time throughout the specification and claims.

My invention is illustrated more or less diagrammatically in the accompanying drawing which discloses the various elements and the arrangement required to carry out my invention.

Like parts are indicated by like characters throughout the specification and drawings.

1 is a processor or float and sink vessel. It may be of any suitable type. Raw coal is fed to the processor throughout the chute 2. Float and sink materials separated in the processor are discharged separately along the drainage screen 3, the sink and float being divided by the vertical wall 4. The drainage screen 3 is above a hopper 5, so that flotation medium drained from the float and sink material returns directly along the conduit 6 to a medium storage sump 7. The coal which is float in this case and the slate and other refuse which is sink, travels over the screen 3 to mechanically operated drainage and rinsing screens 8. The forward ends of the screens 8 also drain into the hopper 5 so that first flotation medium is drained by gravity from the solids and then mechanically removed from the solids by vibration, such fluid in both cases returning to the medium storage sump 7.

As the solids move further along the rinse and drainage screen they reach a point at which they are sprayed and washed by liquid discharged from the spray nozzle apparatus 10. This washes off adhering flotation media from the solids and the rinsing water with the flotation media where it is removed from the solids is caught in the hopper 11 discharged through a duct 12 to a magnetic separator 13. The magnetic material

separated out from the water is discharged by the magnetic separator as a concentrate through the hopper 15 back to the medium storage sump 7. The hopper 15 may, if desired, include a demagnetizer adapted to remove from the magnetic medium any magnetism imparted to it by the magnetic separator. In many instances this demagnetizer will be dispensed with.

Water from the magnetic separator with slimes removed from the solids as well as a certain small amount of magnetic media is discharged from the magnetic separator through the hopper 16, the duct 17 to the tailings sump 18. There may be a magnetizer 19 associated with the duct 17 so as to magnetize the relatively small amount of magnetic media which escaped the magnetic separator so as to flocculate these media and cause them to settle out in the tailings sump 18. This magnetizer may under some circumstances be omitted.

The slimes which are very light pass out across the weir 20 and are discharged along the path 21. The clarified water with some magnetic media will be discharged from the tailings sump 18 to the recirculating pump 22 and thence through the duct 23 to the spray head 10.

Medium in the storage sump 7 consisting of water and magnetite discharges through the duct 24 to the medium recirculating pump 25, thence through duct 26 which has two branches, one, the branch 27 which controlled by a valve 28 supplies medium to the hopper 29 thence upwardly through a diffuser 30 to the bottom of the processor. The other branch 31 of the duct 26 controlled by a valve 32 supplies medium to the processor at substantially the level of the weir 33 over which the float material passes. It supplies this material on the opposite side of the processor so as to cause a cross current to urge the float material toward the weir. The medium is fed to the processor through a diffuser 34.

35 is a plug valve at the bottom of the medium storage sump actuated by any suitable mechanism diagrammatically shown at 36. Such mechanism may be manually or mechanically controlled as the case may be.

The capacity of the medium storage sump 7 is such that when the processor is not in operation, the medium contained in the processor and in the system will flow by gravity back to the medium storage sump, the purpose of the sump merely to provide a reservoir so that the processor and the upper portion of the recirculating system may be drained. There is no storage of medium in the storage sump during operation and the amount of liquid medium in the system is just sufficient to maintain the system in closed continuous circulation.

37 is a duct controlled by valve 38 between the hopper 29 and the medium storage sump 7 so that when it is desired to stop operation and drain the processor, the plug valve may be closed and the valve 38 may be opened and the contents of the processor may drain back into the medium storage sump 7.

By the arrangement shown, I am able to provide a substantially closed circuit, the only exception to this being that make up water may enter the tailings sump along the path 40 to compensate for the water that leaves the tailings sump over the weir 20 to carry off the slimes resulting from degradation, clay on the coal and the like which must be continuously removed in order that the circulating system may not be clogged with these light slimes which having no flotation value could, if excess in quantity, interfere with the operation of the device.

There will be some loss of magnetite from the system. Some may go out with the float and sink solids because no rinsing operation can be one hundred percent effective. Some of it may go out with the water over the weir from the tailings sump, so suitable means will be provided to add additional magnetite. Moreover there will be some water left on the solids as they pass down the rinsing and drainage screen until they reach the rinsing point. That water may to some extent decrease the volume of water in the processor recirculation system.

41 illustrates a water make up pipe controlled by the valve 42 by which when needed additional water may be added to the sink and float system to compensate for any water carried out from the system adhering to the solids. 43 indicates a hopper controlled by valve 44 through which make up magnetic media may be added to the system to compensate for that relatively small amount of magnetic media which may escape from the system.

The important difference between my present solution of the problem and earlier solutions of the problem is that with respect to the closed circuit including the rinse and drainage hopper, the magnetic separator, the tailings sump, the tailings recirculating pump and the rinsing system, I withdraw from the system at the upper level of the tailing sump a continuous flow of liquid entraining the deleterious slimes and continuously recirculate across the rinse and drainage screen the water with whatever amount, and it will be quite small, of magnetic material may escape on the water discharge side of the magnetic separator. Thus no extensive settling means need to be provided. Any magnetic media circulating through the rinsing system can do no harm. It will be caught next time by the magnetic separator but the slimes which can do harm are continuously removed.

I have not illustrated the means by which the sink material is raised and discharged over the drainage screen 3 nor have I illustrated the details of that screen, the screen 8 or the means for subsequently removing the sink and float. Suffice it to say that the sink is raised above the level of the parting liquid by any suitable means well known in the art, discharged over the screen 3 separated from the float by the vertical wall 4 and the sink and float travel separately across the screen 8 being divided by the vertical wall 9 so that the screen 8 discharges sink and float separately into separate chutes for further treatment.

I have illustrated this invention as applied to the treatment of coal but it will be obvious that such a sink and float system is equally applicable to gravital separation of other solids. The proportions might have to be changed to compensate for different types of solids and to compensate for the relative quantities of sink and float because dealing with coal the bulk of the material is float. Dealing with ores, the bulk of the material might be sink but the mere change of proportion is sufficient to compensate for such change in the relative amounts of sink and float material.

The magnetic medium which is drained off the solids discharged from the vessel returns directly to the medium storage sump for immediate recirculation. The sump 7 has no storage function when the device is in operation. If we would be sure that the device never ceased operating, there

would be no need for the medium storage sump because the purpose of that sump is only to receive the liquid drained out of the vessel when the device is out of operation.

I have illustrated the magnetic separator with a demagnetizing means between the magnetic separator and the circulating system for the recovered magnetite. I have also illustrated a magnetizing device for the discharge of the rinse water from the magnetic separator. Either or both of these two latter devices may and frequently will be dispensed with. The essential thing is that the magnetic separator recover from the rinse water the magnetic media which may adhere to and not be drained from the solids and return that magnetic media directly and immediately for circulation with the float and sink system, thus protecting the specific gravity of the medium with appreciable diminution as a result of magnetic media escaping with the solids.

While my invention is illustrated as applied to a specific sink and float separating apparatus, the principles involved are equally applicable to any type of sink and float apparatus and method.

The use and operation of my invention are as follows:

As knowledge and experience was gained by commercial applications for achieving float and sink separations by means of parting liquids including density media, one of the principal problems encountered was the difficulty of maintaining uniformly constant density for the medium used as the parting liquid.

The source of this difficulty was found to be the constantly varying size of the feed material which entered the bath to be subsequently separated into float and sink products followed by drainage and rinsing operations used to recover the medium that was lifted from the bath on the surfaces of such products.

For example, it was found that a given weight of feed material consisting of larger than average size particles would remove on its surfaces only a small fraction of the amount of medium which the same weight of smaller than average weight particles would remove. This, of course, was due to the vastly different amount of surface area represented by the different average particle sizes of the feed material.

Consequently the amount of media removed by rinsing water and the amount of surface moisture removed by mechanical vibration through the rinse and drainage screens for the float and sink products varied to a great extent.

A magnetic separator can only operate at peak efficiency under reasonably uniform feed conditions. Hence experience at commercial plants revealed a waste of magnetite in the tailings slurries from the magnetic separators.

Even more importantly the conventional magnetite recovery such as described by Wade in his Reissue Patent No. 22,195 and by Rakowsky, Holt and Arms in their Patent No. 2,325,149 prevented the immediate return of the recovered magnetic concentrates to the bath circuit of the vessel in which the float and sink separation was gained.

From the above description it will be readily apparent that the removal of the medium in varying amounts from the vessel bath circuit made it extremely difficult to maintain uniform density conditions for that circuit. During periods of high magnetite removal rates, small amounts of magnetite had to be added by the man operating the system. Subsequently the removal rate diminished and excessive amounts of

magnetite were returned to the bath from the recovery circuit with the result that the density increased and dilute water had to be added at the discretion of the operator.

All of the above complications are solved if the magnetically recovered magnetite is returned to the vessel circuit bath instantly. My invention returns the magnetite in a fraction of a minute instead of more than one hour as is the case described under the two patents cited above.

This practically instantaneous return of all of the magnetite to the system results in maintaining a substantially constant concentration of the magnetite or other solid which is mixed with the liquid in the bath to form the heavy parting liquid and so no attention by the operator is required and no adjustments need to be made to compensate for variation in the amount of solids going through the separator or to compensate for change in the sizes of particles and so the surface areas upon which the magnetite or other media may be carried.

I claim:

1. The method of gravitally separating sink and float solids which consists in circulating a magnetically susceptible flotation medium continuously through a sink and float zone, supplying solids to be separated to such zone, separately discharging the sink and float solids and some of the flotation medium from the zone, draining the solids and returning the flotation medium without further treatment for immediate recirculation through the zone, rinsing the drained solids for the removal of adhering slime and magnetically susceptible media, magnetically separating the magnetically susceptible media from the rinse water and returning them without further treatment in concentrated form, for immediate recirculation through the zone, desliming the tailings slurries resulting from the magnetic separation and reusing them to rinse the drained solids.

2. The method of gravitally separating sink and float solids which consists in circulating a magnetically susceptible flotation medium continuously through a sink and float zone, supplying solids to be separated to such zone, separately discharging the sink and float solids and some of the flotation medium from the zone, draining the solids and returning the flotation medium without further treatment for immediate recirculation through the zone, rinsing the drained solids for the removal of adhering slime and magnetically susceptible media, magnetically separating the magnetically susceptible media from the rinse water and returning them without further treatment in concentrated form, for immediate recirculation through the zone, magnetizing and then desliming the tailings slurries resulting from the magnetic separation and reusing them to rinse the drained solids.

3. In a sink and float mineral separation system, a sink and float vessel, means for continuously circulating therethrough a magnetically susceptible flotation medium, means for supplying solids to be separated to the vessel, means for separately discharging sink and float solids and some of the flotation medium from the vessel, a drainage screen over which the solids are adapted to pass, means for returning the flotation medium drained from the solids without further treatment, for immediate recirculation through the vessel, means for rinsing the drained solids to remove adhering slime and magnetically susceptible media, a magnetic separator adapted to

separate the magnetically susceptible media from the rinse water, means for immediate recirculation of said media to the vessel without further treatment, means for desliming the tailings slurries discharged from the magnetic separator and for reusing them to rinse the drained solids.

4. In a sink and float mineral separation system, a sink and float vessel, means for continuously circulating therethrough a magnetically susceptible flotation medium, means for supplying solids to be separated to the vessel, means for separately discharging sink and float solids and some of the flotation medium from the vessel, a drainage screen over which the solids are adapted to pass, means for returning the flotation medium drained from the solids without further treatment, for immediate recirculation through the vessel, means for rinsing the drained solids to remove adhering slime and magnetically susceptible media, a magnetic separator adapted to separate the magnetically susceptible media from the rinse water, means for returning the separated magnetically susceptible media for immediate recirculation to the vessel without further treatment, means for magnetizing the tailings slurries discharged from the magnetic separator to coagulate them and means for desliming such tailings slurries and reusing them to rinse the drained solids.

5. The method of gravitally separating sink and float solids which consists in circulating a magnetically susceptible flotation medium continuously through a sink and float zone, supplying solids to be separated to such zone, separately discharging the sink and float solids and some of the flotation medium from the zone, draining the solids and returning the flotation medium without further treatment for immediate recirculation through the zone, rinsing the drained solids for the removal of adhering slime and magnetically susceptible media, magnetically separating the magnetically susceptible media from the rinse water, demagnetizing and returning them without further treatment, for immediate recirculation through the zone, desliming the tailings slurries resulting from the magnetic separation and reusing them to rinse the drained solids.

6. The method of gravitally separating sink and float solids which consists in circulating a magnetically susceptible flotation medium continuously through a sink and float zone, supplying solids to be separated to such zone, separately discharging the sink and float solids and some of the flotation medium from the zone, draining the solids and returning the flotation medium without further treatment for immediate recirculation through the zone, rinsing the drained solids for the removal of adhering slime and magnetically susceptible media, magnetically separating the magnetically susceptible media from the rinse water, demagnetizing and returning them without further treatment, for immediate recirculation through the zone, magnetizing and then desliming the tailings slurries resulting from the magnetic separation and reusing them to rinse the drained solids.

7. In a sink and float mineral separation system, a sink and float vessel, means for continuously circulating therethrough a magnetically susceptible flotation medium, means for supplying solids to be separated to the vessel, means for separately discharging sink and float solids and some of the flotation medium from the vessel, a drainage screen over which the solids are adapted to pass, means for returning the flotation medium drained from the solids without further treatment, for immediate recirculation through the vessel, means for rinsing the drained solids to remove adhering slime and magnetically susceptible media, a magnetic separator adapted to separate the magnetically susceptible media from the rinse water, means for demagnetizing and returning the separated magnetically susceptible media for immediate recirculation to the vessel without further treatment, means for desliming the tailings slurries discharged from the magnetic separator and for reusing them to rinse the drained solids.

8. In a sink and float mineral separation system, a sink and float vessel, means for continuously circulating therethrough a magnetically susceptible flotation medium, means for supplying solids to be separated to the vessel, means for separately discharging sink and float solids and some of the flotation medium from the vessel, a drainage screen over which the solids are adapted to pass, means for returning the flotation medium drained from the solids without further treatment, for immediate recirculation through the vessel, means for rinsing the drained solids to remove adhering slime and magnetically susceptible media, a magnetic separator adapted to separate the magnetically susceptible media from the rinse water, means for demagnetizing and returning the separated magnetically susceptible media for immediate recirculation to the vessel without further treatment, means for magnetizing the tailings slurries discharged from the magnetic separator to coagulate them and means for desliming such tailings slurries and reusing them to rinse the drained solids.

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