This invention relates to the separation according to relative densities of intermixed, discrete materials of different densities, and has as an object to provide novel and improved means efficiently operable to effect many such separations.

A further object of the invention is to provide improved means for the separation according to relative densities of intermixed, discrete materials of different densities in reaction to pressure flow of the intermixed material as a water pulp therethrough.

A further object of the invention is to provide improved means for the concentration of relatively denser constituents from water pulp of natural sands and comminuted ores in direct reaction to pressure flow of such pulps therethrough.

A further object of the invention is to provide a separator and classifier for intermixed, discrete materials of different densities operable to disrupt and disintegrate lumps and agglomerations of the mixed material entrained in a pressure flow of the material as a water pulp therethrough.

A further object of the invention is to provide a separator and classifier for intermixed, discrete materials of different densities characterized by separate, concentric, discharge passage for the segregations therein effected and furnished with means for maintaining the lesser of said passages free from clogging and obstruction.

A further object of the invention is to provide a separator and classifier for intermixed, discrete materials of different densities that is simple and inexpensive of construction and operative installation, convenient of transportation to and use with a minimum of adjunctive apparatus in regions difficult of access, capable of high volume output in relation to power input, and efficient in attainment of the ends for which designed.

With the foregoing and other objects in view, my invention consists in the construction, arrangement, and combination of elements as hereinafter set forth, pointed out in my claims, and illustrated by the accompanying drawings, in which—

Figure 2 is a somewhat diagrammatic side elevation of typical apparatus operable to give effect to the principles of the invention, portions of the showing being broken away to conserve space.

Figure 3 is a cross section, on the same scale as Figure 2, taken substantially on the indicated line 3—3 of Figure 1.

Figure 4 is a section axially of the assembly shown centrally of Figure 1 taken substantially on the Indicated line 4—4 of Figure 2.

Figure 5 is a cross section taken substantially on the indicated line 5—5 of Figure 4.

Figure 6 is a fragmentary, detail section taken substantially on the indicated line 6—6 of Figure 5.

Figure 7 is a detail elevation, partially in section and on a relatively reduced scale, of an element of the apparatus fragmentarily shown in Figure 1.

Figure 8 is a fragmentary, detail cross section, on a relatively enlarged scale, taken substantially on the indicated line 8—8 of Figure 7 to illustrate a modification of the latter showing within the contemplation of the invention.

In many operations associated with the recovery and treatment of natural materials it is expedient to classify and separate intermixed material constituents or components of different densities for the recovery of one or the other of the so-separated fractions or for the conditioning of one or both said fractions for subsequent use, and the instant invention is hence directed to the provision of novel and improved means operable to classify and separate such intermixtures when in granular or comminuted form and combined with water as a pulp suitable to be pumped.

A significant feature of my improvement is a separator or classifying barrel B accommodative of pulp flow therethrough and effective to separate and segregate the pulp components of distinctly different densities as an incident of such flow. In a variety of particular sizes, proportions, and specific structural organizations adapted to the variations and requirements of function and installation to which applicable, the barrel B is constituted as a straight, rigid, cylindrical tube 10 having a length several times its bore diameter and end flanges 11 and 12, or the equivalent, whereby it may be connected in and with other elements of the apparatus in a usual manner. Conditioning the tube 10 to accomplish its pulp separating and classifying functions, the otherwise smooth interior wall of the tube bore is interrupted by a circumferential series, in this instance three, of like, similarly-spiraled vanes or flutes 13 fixed in a uniform angular spacing to said bore wall to traverse the full length of the tube and to intrude radially of the tube bore. The number, spiral pitch, and typically inward projection of the vanes 13 associated with a given tube 10 may be varied at the time of barrel production to meet the various conditions of particular barrel installation and use, but, in general, the vanes of each such barrel will be few in number, pitched to complete at least one full revolution internally of the associated tube within the limits of the tube length, and of a width, or radially-inward projection relative to the tube, not exceeding one-half the tube bore radius, thus to leave unobstructed a flow passage of relatively considerable size centrally and longitudinally of the barrel. When a pulp containing materials of different densities is pumped, or otherwise pressure-fed, through the barrel B furnished with the interior vanes 13 as shown and described, said vanes develop in the pulp flow a rotary component generative of a centrifugal force factor which acts to segregate the pulp materials of greater density in the flow stream radially outward from and about the pulp materials of lesser density and which as a cylindrical flow stream layer adjacent and moving spirally along the bore wall of the tube 10; the rotary component and centrifugal force factor so induced, and the density classification of pulp materials resulting therefrom, being functions of the vane spiral pitch and the velocity of pulp flow, as is well understood in the art of centrifugal separation. When the material to be separated is characterized by lumps or is of a nature requiring agitation to effect the desired separation, the tube 10 may be readily adapted to function as an agitator and lump breaker, as well as a separator, through the addition thereto of pins 14 intruded radially of the tube bore in any appropriate number, spacing, and pattern; it being convenient and expedient to constitute such pins as the inner ends of studs 14' threaded engaged through and radially of the tube wall for removal, replacement,
and adjustment of their projection inwardly of the tube, as represented in Figure 8.

The intake end of the barrel B is connected by means of its flange 11 with the barrel 16 and to constitute a coaxial extension of the delivery end of a flow line 15 therethrough the material to be classified and separated is supplied as a free-flowing pulp, as through a pump or from an elevated reservoir, under pressure productive of adequate velocity of pulp flow through and in filling relation with the barrel. As the pulp travels through the barrel B an annular space 13, the centrifugal force factor introduced by the latter acts as above pointed out to concentrate the greater density components of the pulp outwardly from and about the lesser density component flow moving centrally of the barrel, so that the so-conditioned pulp flow is presented at the output end of the barrel B as an annular layer or zone of greater density material adjacent the tube bore wall surrounding a core of lesser density material in an arrangement facilitating separation of the so-classified material fractions.

Separation of the material fractions of different component density developed as a consequence of pulp flow through the barrel B is expediently accomplished as an incident of pulp flow at the output end of said barrel by means of a cylindrical selector tube 16 coaxially registered at one end with and to intersect the plane of the barrel output end in a maximum, or exterior, diameter sufficient that of the annular passage between the periphery of the tube 16 and the circumferentially-adjacent end of said bore through which may pass the pulp material layer or zone concentrated against the tube bore wall while the core or central portion of the pulp flow enters and passes along the selector tube 16. To facilitate a sharp separation of the pulp material fractions and to minimize eddies and flow obstruction at the zone of such separation, the end of the tube 16 opposed to the output end of the barrel B is preferably interiorly chamfered, or beveled, as at 47. Manifestly, the diametrical proportion of the tube 16 intake end to the tube 10 bore determines the effective area of the passage therebetween and consequently the proportion of the pulp material flow diverted therethrough, hence adaptation of the apparatus to effect variously-proportioned fractional separations of the pulp flow is readily had through operative association of a selector tube 16 of appropriate size with and to divide the outflow from the delivery end of the barrel B. Facilitative of the proper coaxial, operative registration of the selector tube 16 end with the output end of the barrel B, notches 18 engageable by tube 16 end with different sizes may be formed in the ends of the vanes 13 to define circles of appropriate size concentric with the tube 10.

Various practical arrangements within the contemplation of the invention may be devised to mount the tube 16 in proper cooperating relation with the barrel B and to collect and direct the pulp flow fraction diverted both and exteriorly of the selector tube, the mounting for said tube illustrated and hereinabove described being of especial advantage in that it conveniently mounts and accommodates operation of appurtenant features frequently important to successful functioning of the primary apparatus. As shown, a generally tubular housing 19 is formed to an interior diameter considerably exceeding that of the tube 10 bore and to a length exceeding its diameter and is secured by means of a flange 20 at an open end thereof to the flange 12 at the end of the barrel B to extend in coaxial relation with and beyond said end remote from the tube 16. The housing 19 is formed with an internally-threaded, annular hub 21 defining an aperture coaxial with the housing and barrel in a size to slidably accommodate the selector tube 16 and an annular shoulder 22 exteriorly and circumferentially thereof, so that a threaded collar 23 on and rotatable about the said tube 16 in end-bearing engagement with the shoulder 22 functions in threaded engagement with the opening of the hub 21 to clamp said tube endwise against the opposed ends of the vanes 13 and to support said tube in appropriate cooperating relation with the barrel B. In view of the diameter between its ends the housing 19 is enlarged to provide a basin 24 opening to one side of the assembly, which basin serves in an obvious manner to collect the pulp material fraction diverted from the flow stream of the barrel B by and exteriorly of the selector tube 16 and to direct such material and extension of the selector tube opening to such disposition or further processing as may be desired. The material fraction received within the selector tube 16 retains much of its original flow velocity whereunder it may be directed through conduit extensions 25 of the selector tube to waste, storage, or further processing.

In certain operations, and particularly when the separation sought requires a small diversion passage at and exteriorly about the intake end of the selector tube 16, there may be a tendency of the diversion passage to become plugged or obstructed with undesirable effect upon the separatory functioning of the apparatus, hence it is significant to the successful operation of many installations that means be provided to maintain the diversion passage open and to free the same of incept obstructions, one practical arrangement of such means being illustrated as carried by and operatively associated with the housing 19. As shown, tubular guides 26 fixed in and opening through the closed end of the housing 19 in angularly-spaced relation about the hub 21 slidably accommodate stems 27 therein supported for axial reciprocation in spaced parallelism with and exteriorly of the selector tube 16. Corresponding ends of the stems 27 exterior to the housing 19 are formed as radially-enlarged, domed heads 28 and at its other end, interiorly of the housing 19, each of said stems carries an arcuate spider 29 adapted to conformably overlie and slidably embrace an exterior circumferential arc of the tube 16. Surrounding the portion of each stem 27 exposed interiorly of the housing 19 and in end-bearing engagement between the associated spider 29 and adjacent end of the guide 26, an expansive coil spring 30 functions to yieldably urge the stem and spider assembly inwardly of the housing and tube 16, to the output end of the barrel B, and about the portion of each stem 27 exposed exteriorly of said housing and in end-bearing engagement between the stem head 28 and adjacent end of the guide 26 an expansive coil spring 31 functions to yieldably urge the stem and spider assembly inwardly of the housing and tube 16, to the output end of the barrel B, and about the portion of said barrel, the said springs 30 and 31 of each stem 27 thus serving in an appropriate balance of their expansive forces to normally and yieldably position the stems with their domed heads 28 in a common plane perpendicular to the axis of the tube 16 and with their spiders 29 in a uniform spacing away from the output end of the barrel B. Each spider 29 mounts a plurality of spacedly-parallel tines 32 closely adjacent and parallel to the exterior wall of the tube 16 in such extension from the spider as serves to dispose the preferably tapered and laterally expanded free ends of the tines in outwardly adjacent position outwardly of the exterior surface of said tube in the manner shown and to engage the adjacent end of the tube 16 and hence in position for reciprocation through the corresponding arc of said passage when the associated stem 27 is displaced axially and inwardly of its guide 26 against the pressure of its spring 31. Successive and repetitive actuation of the stems 27 for barrel B endwise engagement with the selector tube through and to clear the diversion passage of the apparatus is the function of a pulley 33 rotatable on a Shouldered bearing sleeve 34 telescoped over and secured to the closed end of the housing 19, said pulley being retained in operative position axially of said sleeve by means of a ring 35 and being engaged for continuous rotation, as by a belt 36, with any appropriate power.
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source. Rotation of the pulley 33 is reflected as successive, individual actuation of the stems 27 through the agency of an arm 37 fixed to and extending in spaced parallelism with the pulley axis of rotation from one side of said pulley for travel in an orbit exteriorly about the headed end portions of said stems, which arm carries at its end remote from the pulley a fixedly and perpendicularly related finger 38 directed radially of and inwardly toward the tube 16 to travel in the general plane of the normally-positioned stem heads 28 for engagement of a cam block 39 inwardly terminating said finger successively with the domed areas of said heads in a manner to shift the stems 27 inwardly of the housing 19 against the pressure of their springs 31. Thus, as the pulley 33 is rotated in the appropriate direction, the cam block 39 acts successively upon and through the stems 27 to project the tines 32 shiftable with said stems inwardly of the barrel B through the diversion passage at the output end of said barrel, thus effectively maintaining said passage clear of obstructions and impactions.

Since changes, variations, and modifications in the form, construction, and arrangement of the elements shown and described may be had without departing from the spirit of my invention, I wish to be understood as being limited solely by the scope of the appended claims, rather than by any details of the illustrative showing and foregoing description.

I claim as my invention:
1. In combination, an elongated tubular barrel adapted to transmit a flow of pulp, like vanes spaced angularly about and correspondingly spiraled in fixed relation along the barrel interior wall to project radially and inwardly therefrom, a selector tube of less diameter than said barrel coaxially end-registered with the delivery end of the barrel to define an annular diversion passage between the interior wall of the barrel at its delivery end and the spacedly adjacent exterior wall of the selector tube, and means actuable exteriorly and longitudinally of said selector tube through said passage to clear the latter of obstructions.

2. In combination, an elongated tubular barrel adapted to transmit a flow of pulp, like vanes spaced angularly about and correspondingly spiraled in fixed relation along the barrel interior wall to project radially and inwardly therefrom, pins fixed in spaced relation to and intruding radially from the barrel interior wall between convolutions of said vanes, a selector tube of less diameter than said barrel coaxially end-registered with the delivery end of the barrel to define an annular diversion passage between the interior wall of the barrel at its delivery end and the spacedly adjacent exterior wall of the selector tube, and means actuable exteriorly and longitudinally of said selector tube through said passage to clear the latter of obstructions.

3. In combination, an elongated tubular barrel adapted to transmit a flow of pulp, like vanes spaced angularly about and correspondingly spiraled in fixed relation along the barrel interior wall to project radially and inwardly therefrom, a housing including a collecting basin carried by the delivery end of said barrel, a selector tube of less diameter than said barrel mounted in and adventurously traversing said housing in coaxial end-registration with the delivery end of the barrel to define an annular diversion passage opening to said collecting basin between the interior wall of the barrel at its delivery end and the spacedly adjacent exterior wall of the selector tube, and means actuable exteriorly and longitudinally of said selector tube through said passage to clear the latter of obstructions.

4. In combination, an elongated tubular barrel adapted to transmit a flow of pulp, like vanes spaced angularly about and correspondingly spiraled in fixed relation along the barrel interior wall to project radially and inwardly therefrom, pins fixed in spaced relation to and intruding radially from the barrel interior wall between convolutions of said vanes, a housing including a collecting basin carried by the delivery end of said barrel, a selector tube of less diameter than said barrel coaxially end-registered with said housing with the delivery end of the barrel to define an annular diversion passage opening to said collecting basin between the interior wall of the barrel at its delivery end and the spacedly adjacent exterior wall of the selector tube, and means actuable exteriorly and longitudinally of said selector tube through said passage to clear the latter of obstructions.

References Cited in the file of this patent

UNITED STATES PATENTS

216,958 Hudson July 1, 1879
429,347 Haskell June 3, 1889
1,701,942 Andrews Feb. 12, 1929
2,027,015 Bell Jan. 7, 1936
2,346,005 Bryson Apr. 4, 1944
2,407,851 Shannon Sept. 17, 1946
2,512,253 Lipcomb June 20, 1950

FOREIGN PATENTS

52,537 Denmark Jan. 4, 1937