Sept. 13, 1955 C. C. MARTIN 2,717,695

CYCLONIC SEPARATOR FOR WET OPERATION

Filed Nov. 29, 1949

FIG. 1.

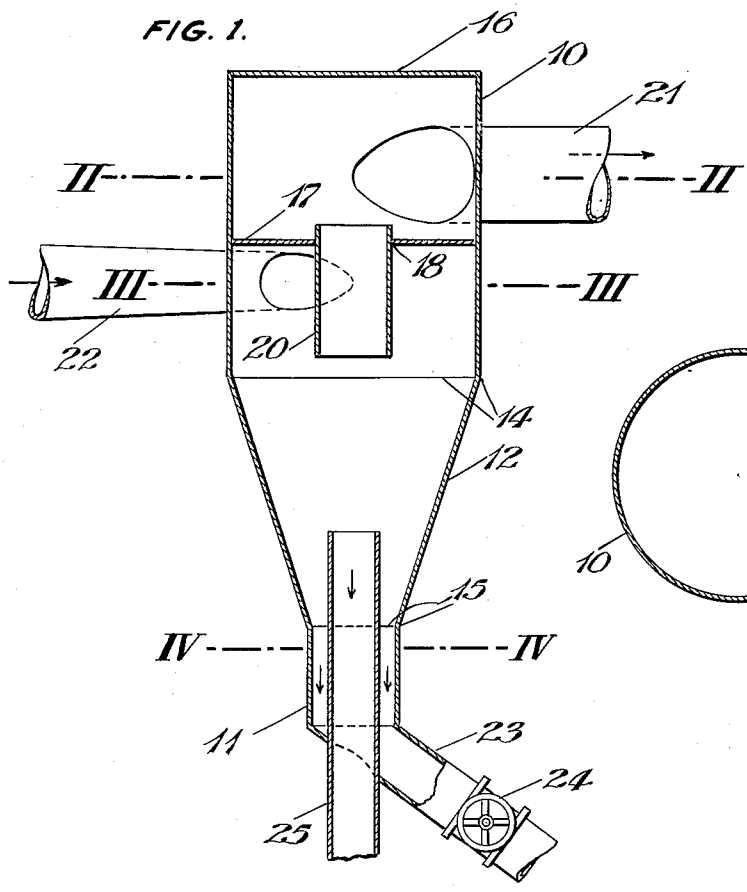


FIG. 2.

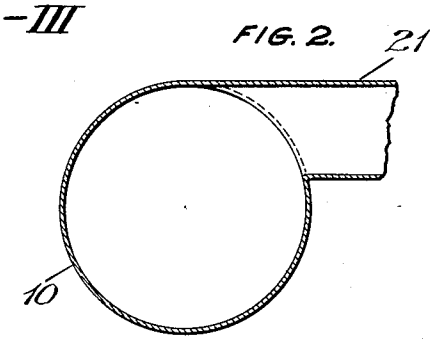


FIG. 3.

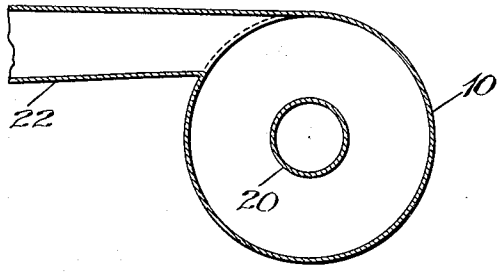
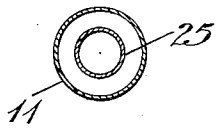


FIG. 4.



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United States Patent Office 2,717,695 Patented Sept. 13, 1955

2,717,695

CYCLONIC SEPARATOR FOR WET OPERATION

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Application November 29, 1949, Serial No. 129,911

4 Claims. (Cl. 209—211)

This invention relates to cyclonic separators and particularly to such equipment wherein three separations may be accomplished simultaneously and wherein adjustable means provide greater control over each of the separations.

The devices which are presently known and which are used as concentrators and classifiers, make no provision for obtaining a third or intermediate separation and do not provide for a readily discernible split between the separations. Accordingly it is a purpose of this invention to provide equipment which will enable rapid, continuous operation with three separations rather than the usual two, while at the same time accomplishing a wider split between the tailings and the concentrate than was heretofore possible.

In general, the embodiment of the present invention employs the two cylinders of different diameters united by a truncated cone to form a hopper-like chamber, the bases of which are respectively equal to the bases of the two cylinders which are joined. The larger cylinder is separated into two chambers by a transverse baffle, with the one which is joined to the truncated cone becoming the cyclonic delivery chamber. The two chambers are in open communication having an axially adjustable tubular member as the passage therebetween. Concentrically within the smaller cylinder is a spaced inner tubular member of smaller diameter which is adjustable axially with respect to the small end of the truncated cone.

The essential features of the invention are defined with particularity in the appended claims, but further objects are to provide a construction of maximum simplicity, economy and ease of manufacture, and also such further objects, advantages and capabilities as will fully appear and as are inherently possessed by the device and the invention described herein.

In addition the invention further resides not only in the process but in the combination, construction and arrangement of parts illustrated in the accompanying drawings and while there is shown therein a preferred embodiment thereof, it is to be understood that the same is merely illustrative of the invention and that the invention is capable of modification and change and comprehends other details of construction without departing from the spirit thereof or the scope of the appended claims.

Referring to the drawings:

Figure 1 is a diagrammatic representation of the cyclonic separator of the present invention, in elevation.

Figure 2 is a transverse section taken on the line II—II of Figure 1.

Figure 3 is a transverse section taken on the line III—III of Figure 1.

Figure 4 is a transverse section taken on the line IV—IV of Figure 1.

Referring now more particularly to the drawings, in which like reference numerals indicate like parts in the several views, and with particular reference to Figure 1,

the general appearance of the device of the present invention is apparent.

This equipment is composed of a large cylinder **10** and a small cylinder **11** joined in axial alignment and relationship by a truncated cone **12**, the larger base of which is equal in diameter to that of the cylinder **10** and thus joined at **14**. The smaller base of the truncated cone **12** is equal in diameter to the diameter of the smaller cylinder **11** and is joined therewith as at **15**. The large cylinder **10** is closed at the opposite end from the juncture **14** with the truncated cone **12**, by the end wall **16**. The large cylinder **10** is also divided into two separate chambers by the dividing partition or baffle **17** which is provided with a concentric central opening **18**. Communication between the two chambers of the large cylinder **10** is established by a cylindrical tube **20** which is in axial alignment with the completely assembled apparatus and movable axially so that the length of its projection into one chamber or the other can be adjusted as desired. The communicating tube **20** is here termed a vortex finder. The chamber between the end wall **16** and the baffle wall **17** is provided with a tangential outlet **21**, and the chamber on the inner side of the baffle wall **17** is provided with a tangential inlet nozzle **22**. Although the outlet **21** is shown as tangential it is to be understood that any suitable form of outlet may be employed.

The smaller cylinder **11** is connected directly to the discharge passage **23** which is controlled by valve **24**. Concentric with the small cylinder **11**, in axial alignment therewith and spaced therefrom within it, is a movable cylindrical tube, **25**. The cylindrical tubular member **25** may be moved axially with respect to the complete device and particularly with respect to the tangential nozzle inlet to adjust the length which projects into the cyclonic chamber of the device.

Operation

A liquid pulp, consisting of solid particles in a liquid, is introduced through the inlet nozzle **22** into the cyclonic chamber of the device and since the tangential nozzle **22** transforms pressure head into velocity head, the pulp acquires a centrifugal or whirling cyclonic motion within the chamber. The differential separation which takes place as the result of this action follows the well-known principles of difference in specific gravity and size. The differentiation is not only effective between the liquid and the solid particles, but also separates the solid particles according to specific gravity.

It is apparent that part of the liquid and part of the solid particles of the pulp with smallest sizes and lowest specific gravity, will flow to the center, pass through the vortex finder tube **20**, and be discharged through the discharge outlet **21**. The remainder of the material within the device will continue to be subjected to centrifugal motion and travel in a spiral-like path downwardly towards the smaller base of the truncated cone **12**. Part of the liquid and part of the solid particles, with the smaller sizes and the lower density will be discharged through the middlings tube **25** and the remainder of the liquid and the remainder of the particles with greater sizes and for higher specific gravities will collect in the annular space between the outer wall of tube **25** and the inner wall of tube or cylinder **11** and be delivered through the discharge outlet **23**. Accordingly, it is apparent that three different separations are made simultaneously by using this equipment.

The principal means of effecting control of the process while the equipment is in operation, are as follows:

a. Control may be effected by increasing or decreasing the pressure head with which the liquid pulp is introduced through the nozzle **22**.

b. Control may also be effected by adjusting the vortex finder tube **20** axially and in respect to the amount of projection thereof within the chamber.

c. Control may also be effected by adjusting the position of the middlings tube **25** with respect to the amount of projection thereof within the chamber.

d. Control may also be effected by closing or opening the discharge outlet valve **24**.

An important feature of the present invention is that regardless of the extent of the opening or the position of the valve **24**, there is always a column of air being delivered to the cyclonic chamber. The tube **25** being open, air is free to pass therethrough into the chamber within the truncated cone member **12**.

It is also apparent that by varying the diameter of the middlings tube **25**, the percentage of take-off between the middlings and concentrate being discharged through outlet **23** can be varied. Obviously the varying of the diameter of the middlings tube **25** will not only control the percentage of takeoff, but will also control the degree of split between the concentrates and the tailings. It is further apparent that the use of the present device provides a wider split between the tailings which are discharged through outlet **21** and the concentrate discharged through outlet **23**.

The device of this present invention is capable of multiple uses as it can be used as a concentrator as well as a thickener or classifier by merely making a pulp with water or other suitable liquid. When the device is so used most of the liquid will be concentrated in the low density pulp. This equipment finds particular use in the concentration of metallic and non-metallic minerals and in the cleaning of coal and provides a means for recirculating only the discharge from the middlings tube **25** without the necessity of also recirculating the discharge from the tailings outlet **21**. In this manner, the equipment may be used much more efficiently and advantageously than any other known equipment since the volume required to pass through is materially reduced.

It will be observed that by adjusting the vortex finder **20** with respect to the inlet opening, the nature and characteristics of the tailings can be controlled. For example, the lower the tube is moved into the chamber and below the nozzle inlet, the lower will be the average density of the low density particles contained in the tailings. These adjustments are made, however, only to obtain desired optimum operating conditions. Likewise, the higher the middlings tube **25** is projected in the cyclonic chamber, the less will be the average specific gravity of the solid particles in the middlings discharged from tube **25**, and this adjustment is made to obtain optimum operating conditions as desired.

It is apparent to those skilled in this art that several units substantially like that shown in Figure 1, may be operated in series, or that the discharge from the middlings tube **25** may be recirculated through the nozzle **22**. The versatility of the equipment is one of its chief advantages as well as the elimination of great volume.

While the terms concentrate, middlings and tailings have been used herein, it is understood that these terms are generally used only in mineral separation processes. This equipment and the method disclosed herein is not confined or limited to the usual mineral separations but refers generally to obtaining three separations simultaneously according to the density of the materials involved. The term liquid pulp as used herein is intended in its usual meaning to cover a suspension or mixture of solid particles in a liquid, usually water.

I claim:

1. In a cyclonic type separator for wet operation, in combination a truncated cone delivery chamber with the larger base at the top, a tangential inlet adjacent the top of said delivery chamber, a separated chamber above said delivery chamber having an outlet therefrom, axial communicating means between said chambers, an outlet cylinder connected to the smaller base of the said delivery chamber, and an outlet tube within and separate from but concentric with said last mentioned outlet cylinder, also communicating with the said delivery chamber.

2. In a cyclonic type separator for wet operation, in combination a truncated cone delivery chamber with the larger base at the top, a tangential inlet for the delivery of liquid pulp to be separated adjacent the top of said delivery chamber, a separated chamber above said delivery chamber having an outlet therefrom, axially aligned tubular communicating means between said chambers, a tubular outlet cylinder connected to the smaller base of the said delivery chamber, and another tubular outlet within and separate from but concentric with said last mentioned tubular outlet cylinder, also communicating with the said delivery chamber, all of said tubular members being in axial alignment.

3. In a cyclonic type separator for wet operation, in combination a truncated cone delivery chamber with the larger base at the top, a tangential inlet for the delivery of liquid pulp to be separated adjacent the top of said delivery chamber, a separated chamber above said delivery chamber having an outlet therefrom, axially aligned tubular communicating means adjustable axially with respect to penetration into the delivery chamber between said chambers, a tubular outlet cylinder connected to the smaller base of the said delivery chamber, and another tubular outlet within and separate from but concentric with said last mentioned tubular outlet cylinder, also communicating with the said delivery chamber, and adjustable axially with respect to the amount of projection into the delivery chamber, all of said tubular members being in axial alignment.

4. In a cyclonic type separator for wet operation, in combination a truncated cone delivery chamber with the larger base at the top, a tangential inlet for the delivery of liquid pulp to be separated adjacent the top of said delivery chamber, a separated chamber above said delivery chamber having an outlet therefrom, axially aligned tubular communicating means adjustable axially with respect to penetration into the delivery chamber between said chambers, a tubular outlet passage connected to the smaller base of the said delivery chamber, valve means for controlling the flow through said outlet passage, and another tubular outlet passage separate from but concentric with said last mentioned outlet passage and adjustable axially with respect to the amount of projection into the delivery chamber all of said tubular members being in axial alignment.

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