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Zemanek

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[54] **HYDROCYCLONE PULP CLEANER**

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[52] **U.S. Cl.** **209/211,** 210/512

[51] **Int. Cl.** **B04c 5/16**

[58] **Field of Search** 209/144, 211; 210/512

[56] **References Cited**

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[57] **ABSTRACT**

This invention is a hydrocyclone pulp cleaner having a single conical shell divided into two separation chambers by an improved baffle construction which materially increases the efficiency of separation thus increasing the percentage of acceptable material and reducing the percentage of bottom reject material. The dividing baffle is constructed to provide an inlet for the material entering upper portion of the bottom chamber in a substantially tangential direction at the upper portion of the side wall of the lower chamber and in the form disclosed the size of the inlet opening is adjustable. The baffle is also designed to retard the flow of pulp from the top to the bottom chamber and is provided with a central discharge to remove the acceptable material from the bottom separation chamber upwardly through the baffle.

9 Claims, 3 Drawing Figures

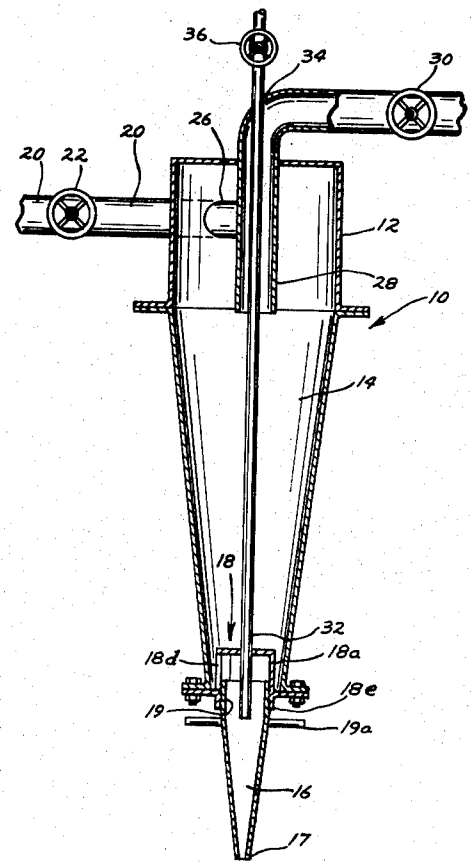

FIG. 1

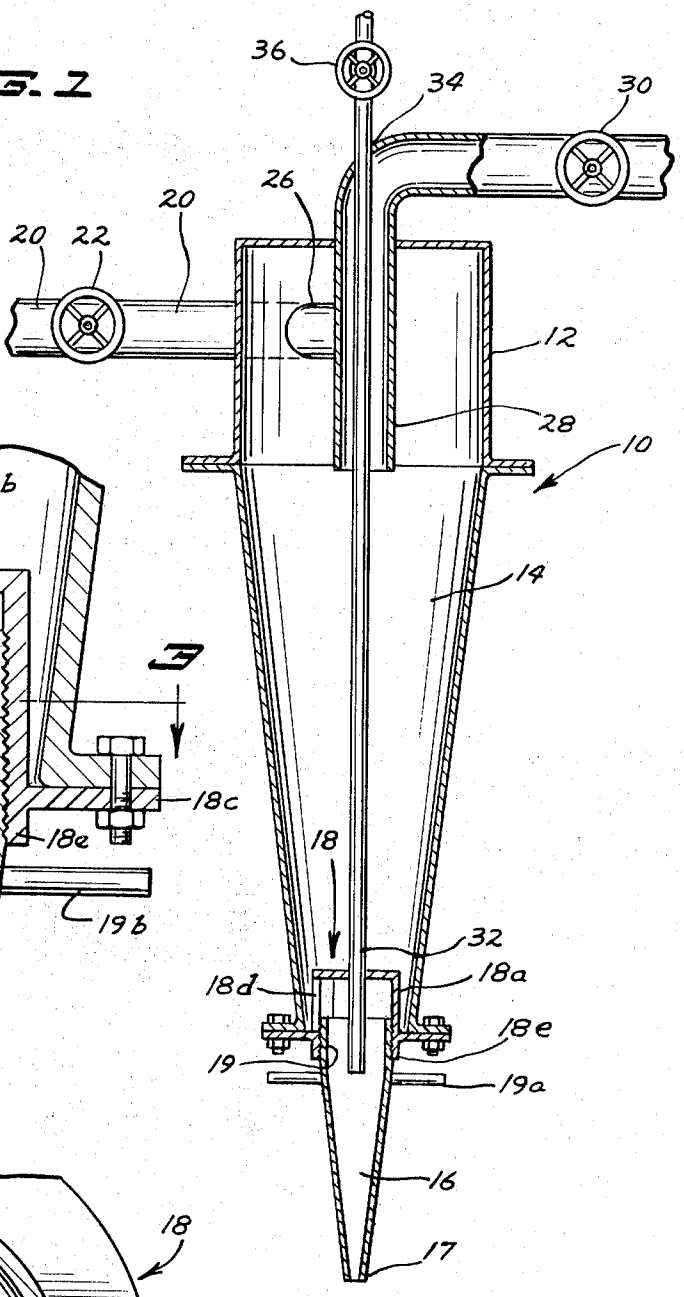

FIG. 2

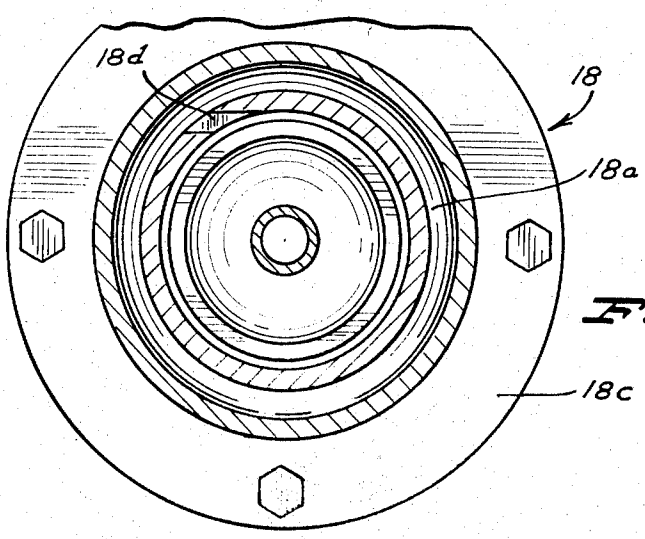

FIG. 3

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HYDROCYCLONE PULP CLEANER

This invention is particularly adapted to produce efficient separation with high capacity pulp flow and although the cleaner herein disclosed is related to the prior art cleaner disclosed and claimed in U. S. Letters Patent No. 3,425,545 of which the present inventor was a co-inventor, the present cleaner has proved considerably more efficient for use with high volume flow than was the cleaner disclosed in said prior art patent.

Pulp used in the paper making process must be highly refined in order to produce finished paper of acceptable strength and appearance. Impurities which must be removed from the paper pulp during the refining process may be classified generally in two categories. One type of impurity is material of a heavier density than the density of the acceptable final pulp product and consists of coarse material such as bark and dirt, and is generally referred to by the term "specks." The heavier specks are removed at the bottom of hydrocyclone cleaners. In present pulp cleaning procedures it is normal to process the paper pulp through a stage of cleaning in which a plurality of high capacity pulp cleaners clean the pulp and pass an acceptable fraction on for further proccessing and paper making. However, in the prior art the acceptable fraction of pulp which is rejected with the impurities classified as "specks" is so large that a second stage of cleaning process is used on the rejected "speck" material from the first stage of the hydrocyclone cleaning system.

The present invention eliminates the necessity for a two stage cleaning process by improving the efficiency of the cleaning operation and "speck" removal in a single stage operation.

This invention is a two-chamber single stage hydrocyclone pulp cleaner with a baffle disposed between and connecting the two chambers and in which the rejected pulp does not contain acceptable fibers which must be reclaimed. The first chamber is a large conical chamber having a main feed pulp inlet in the side thereof and a discharge outlet at the top thereof for the acceptable pulp. The first chamber tapers downwardly to the baffle which serves to connect the first chamber with the second smaller conical chamber. The pulp travels helically downwardly in the first chamber with the heavy impure particles tending to accumulate along the peripheral edges of the fluid flow near the side wall of the chamber. The acceptable pulp is circulated towards the central area of the chamber by the centrifugal effect of concentrating impurities at the outer wall and as the chamber is tapered downwardly the volume of fluid flow is restricted so that the acceptable pulp material in the central region is forced upwardly along the central vertical axis of the chamber and out the centrally located discharge outlet at the top thereof. The heavier unacceptable fibers concentrated at the outer edges of the fluid flow are permitted to travel through the baffle whereas the acceptable pulp materials in the center of the fluid flow are not allowed to travel through the baffle.

The second conical hydrocyclone chamber receives only the pulp containing the heavier impure particles and will further refine and separate these heavier impurities from the pulp. The baffle separating the first chamber from the second chamber is designed to allow only the peripheral rotating fluid in the first chamber to pass spirally downwardly into the second chamber and which will cause the refined acceptable material in

the first chamber to be directed upwardly towards the acceptable pulp discharge outlet therein. In the embodiment of my invention illustrated herein the baffle consists of a cylindrical side wall closed at the upper end and open at the lower end which is mounted on an annular attachment flange with the axis of the cylinder coinciding with the vertical central axis of the conical chambers. A tangentially directed slot is cut through the wall of the cylinder parallel to the axis thereof. The slot is cut in the direction of fluid flow so that the rotating heavier pulp passes into the lower chamber while maintaining its rotational movement. The size of the slot may be easily adjusted in the form of the baffle disclosed.

One of the results achieved by my invention is the reduction in the quantity of bottom reject material to a volume which may be effectively considered waste without the necessity or re-claiming acceptable fibers contained therein. This improvement in reducing the percentage of bottom rejects therefore eliminates the requirement of an entire second stage of hydrocyclone cleaning of the bottom rejected material.

It is accordingly an object of this invention to produce an improved single stage hydrocyclone pulp cleaning apparatus which will improve the overall efficiency of removing reject particles from a feed pulp material.

It is a further object of this invention to provide a pair of axially arranged conical separation chambers separated by an inverted cup-shaped baffle having a generally cylindrical side wall portion which is provided with an inlet opening to permit the heavier material circulating around the wall at the bottom of the upper chamber to pass into the lower chamber along the outside upper wall portion of said lower chamber, the acceptable material passing upwardly through the chambers and the reject material being discharged through an opening in the bottom of the lower chamber, said two chambers producing materially improved separation of the pulp material into the accepts and rejects.

These and other objects and advantages of this invention will be apparent from the following description made in connection with accompanying drawing wherein like reference characters refer to similar parts throughout the the several views, and in which:

FIG. 1 is a semi-diagrammatic cross-sectional view of a hydrocyclone cleaning apparatus according to my invention;

FIG. 2 is a fragmentary central vertical sectional view of the separation baffle portion hydrocyclone apparatus shown in FIG. 1; and,

FIG. 3 is a cross-sectional view thereof taken substantially along lines 3—3 of FIG. 2.

In the embodiment of my invention shown in the figures reference number **10** generally designates the entirety of a hydrocyclone cleaning apparatus. The apparatus consists of an inlet chamber **12**, a large first conical hydrocyclone chamber **14**, and a second smaller hydrocyclone chamber **16** connected to the first at the bottom end thereof. Chamber **16** has a bottom reject orifice **17**. The taper of the second conical chamber need not necessarily be of the same proportion as that of the first chamber, as is shown in this embodiment of my invention. Fluid flowing from the first hydrocyclone chamber to the second must pass through a baffle element **18** which will be more fully explained later. A pipe **20** is connected to a feed pulp supply for the hy-

drocyclone pulp cleaning system. A valve **22** in pipe **20** is used to regulate the pressure and rate of flow of fluid pulp into the hydrocyclone cleaner. An inlet pipe **24** extends from the valve **22** so that paper pulp enters the inlet chamber **12** through a tangential inlet opening **26** which will cause the incoming pulp to rotate in the cleaning apparatus **10.** A discharge outlet **28** is provided for acceptable fiber separated from impurities in the first larger conical separation chamber **14.** This outlet **28** may extend, as in this embodiment of my invention, through the inlet chamber **12** and out the top thereof. A valve **30** is provided in the acceptable fiber outlet **28** in order to control the back pressure of fluid in the first hydrocyclone chamber. As will be explained further, it is necessary to regulate the fluid pressures within the hydrocyclone chambers to establish the proper fluid flow characteristics for the most acceptable pulp cleaning efficiency.

An outlet pipe **32** is provided, extending through the baffle **18,** to discharge acceptable pulp from the second small conical hydrocyclone chamber **16.** As shown in this embodiment of my invention, the pipe **32** may extend centrally through the central vertical axis of the larger hydrocyclone chamber **14,** into the acceptable discharge pipe **28** and through the side thereof at a bend therein, as at **34.** A valve **36** is provided in the pipe **32** in order to control the fluid flow in the pipe and to establish the proper back pressure characteristics in the hydrocyclone cleaning chamber **16** for the most acceptable cleaning characteristics and operation within the chamber. The back pressure in chamber **16** would not be as easily controlled and adjusted if the pipe **32** and valve **36** were eliminated and the baffle **18** had a central opening directly into the larger chamber **14.**

The present embodiment of my invention includes a baffle member **18** separating the first and second conical hydrocyclone separation chambers. The baffle required to make this invention operative, as has been previously described, should be of a type allowing the fluid flowing tangentially near the peripheral side wall of the upper conical chamber **14** to flow into the lower chamber **16** and continue to circulate spirally downwardly in the second chamber as in the first. The embodiment of my invention, herein illustrated, employs an inverted cup-shaped baffle **18.** The side wall portion **18*a*** of the baffle **18** is generally cylindrical with a plate **18*b*** at the upper end thereof and has an opening therein for connection with pipe **32** to discharge acceptable pulp from the lower conical hydrocyclone separating chamber **16.** The lower end of the side wall **18*a*** is secured to an annular mounting plate **18*c*** which is suitably attached at the lower end of the upper chamber **14.** Through the wall **18*a*** there is a slot **18*d*** which in the form shown extends the longitudinal length of the cylinder and which, as shown in FIG. **3,** is tangentially directed so that the pulp portion circulating around the outer portion of chamber **14** in a generally downwardly extending direction will be directed through the slot **18*d*** tangentially into the upper portion of the lower chamber. The rate of fluid entry into the lower chamber is regulated by the size of the slot and pressure of the pulp in the lower portion of the upper chamber **14.** That is the fluid which enters the lower conical separating chamber **16** will be directed in a spiral motion and the volume of fluid entering said chamber is controlled by the dimensions of the slot **18*d***.

In the form shown, the size of the slot **18*d*** can be adjusted during the operation of the separator. This can be accomplished in a number of ways. The adjustment means illustrated consists in a longitudinally adjustable generally cylindrical sleeve portion **19** which is connected to the upper end of the tapered shell forming the lower chamber **16.** The cylindrical portion **19** is vertically adjustable within the cylindrical side wall portion **18*a*** of baffle **18** by means of a threaded connection therewith thereby varying the length of slot **18*d***. An internally threaded sleeve member fixed to the lower portion of mounting plate **18*c*** is provided to permit full length opening of slot **18*d*** while still providing support for the shell of the lower chamber **16.** Suitable handles **19*a*** may be provided for assisting in the rotational adjustment of said lower shell portion.

In operation, the fluid pulp material containing "speck" type impurities, flows through pipe **20,** valve **22,** into the upper end of upper inlet chamber **12** through the tangential opening **26** to produce the desired cyclonic rotation of the pulp within the upper separating chamber **14** of the hydrocyclone cleaning apparatus. The rotating fluid pulp flows downwardly as a result of the operation of gravitational force and the particles of heavier density accumulate near the side wall of the upper chamber **14** as a result of centrifugal force. As the chamber **14** is tapered in a conical shape in the downward direction, the volume of pulp accommodated at the top of the chamber **14** does not have sufficient room at the bottom of the chamber. Therefore, the fluid tends to rotation more rapidly as it travels downwardly and inwardly in the chamber and the fluid near the center of rotation is forced upwardly to the acceptable pulp outlet **48** throughout the length of the chamber. The heavy body impurities, however, are retained near the outer wall and travel the entire length of the upper chamber **14** in a downward spiral path and are admitted to the lower chamber **16** through the tangentially directed slot **18*d*** in the baffle **18** while maintaining the cyclonic rotational movement thereof.

Most of the acceptable pulp in the original feed pulp is carried away as a result of the separating action in the first chamber and as a result only pulp containing a relatively high concentration of impurities is introduced into the lower chamber **16.** It has been found that the appropriate rotational velocities and rate of passage of fluid through a conical separation chamber when impurities are relatively concentrated must be different from that when impurities are relatively less concentrated. In the first chamber **14,** of this embodiment of my invention, the inlet pulp feed rate is controlled by valve **22** and the pressure drop between the inlet **26** and the outlet **28** is controlled by valve **30,** the differential pressure between the inlet feed pulp and the outlet of acceptable feed pulp determining the rate of passage of fluid through the chamber. The operator of this hydrocyclone separator will adjust the fluid pressure and the rate of flow thereof through the first chamber so that conditions are optimum for efficient separation of accepts from rejects in the concentration of original feed pulp. The baffle **18** acts to control the rate of fluid flow from the first chamber **14** to the lower chamber **16.** The inlet slot **18*d*** controls the rotational velocity and volume of the pulp entering the chamber **16.** The rate of flow and pressure of fluid pulp in the chamber **16** is controlled by the dimensions of the inlet slot **18*d***, the reject discharge orifice **17** in the chamber **16** and the

valve **36** on the acceptable pulp outlet of the chamber **16.** Thus, in the operation of the unit illustrated, the size of the bottom orifice **17** and the slot **18***d* and the setting of the valves **22, 36** and **30,** can be used to regulate the fluid flow characteristics in the two chambers respectively to produce optimum separation characteristics in both chambers.

It will be appreciate that I have provided an improved single stage hydrocyclone pulp cleaner having two chambers. A substantial benefit of this invention is that the quantity of bottom reject material is reduced to the point where a further stage of cleaning of the pulp is not required and the reject material may be treated as waste. This substantially reduces the cost of pulp cleaning by eliminating the capital expense and cost of operating a second stage of cleaners and associated dumping machinery which is presently conventionally used for reclaiming acceptable pulp from a pulp material having an unacceptable content of rejects.

It will, of course, be understood that various changes may be made in the form, details, arrangement and proportion of the parts without departing from the scope of the invention, which generally stated, consists in the matter set forth in the accompanying claims.

What is claimed is:

1. A hydrocyclone pulp cleaner for separating impurities from wood pulp comprising, as a single stage cleaning unit,

a baffle member,

a casing portion defining with said baffle member a first conical chamber having a pulp inlet at the upper large diameter end thereof, said inlet disposed so that cyclonic rotational movement is produced in the pulp being supplied to said chamber, and having a centrally disposed discharge conduit at the large diameter upper end thereof for removing acceptable pulp therefrom,

a casing portion defining with said baffle member a second conical chamber connected to the lower end of the first chamber and having a final reject outlet opening at the bottom thereof,

said baffle member disposed between said first and second chambers having passage means at the outward portion thereof permitting pulp to flow from a position near the side wall of the bottom of the first chamber into the top of the second chamber in a manner to produce rotational cyclonic movement in the body of pulp discharged into said second chamber, and a central conduit section in the upper portion of said second chamber for removing the acceptable pulp therefrom, and

means for adjustably varying the differential pressure between the pulp inlet and at least certain of said pulp discharge outlets of the cleaning unit to regulate the pulp flow conditions in said unit.

2. Structure set forth in claim **1** and said baffle comprising an inverted cup-shaped member having a generally cylindrical side wall portion with a tangentially directed opening formed therein to tangentially discharge into the upper portion of the second chamber, the portion of the pulp circulating in close association to the lower inside wall surface of the first chamber.

3. Structure set forth in claim **2** and means for varying the size of the discharge opening in said baffle side wall.

4. Structure set forth in claim **3** and said means comprising an axially adjustable valve member mounted adjacent said opening and adjustably projectable longitudinally thereof for varying the length of said opening.

5. Structure set forth in claim **3** and valve means for varying the flow of pulp through said inlet and the discharge conduits from the two chambers.

6. Structure set forth in claim **4** and said valve member comprising the upper portion of the casing defining the second chamber, said casing having a threaded connection with the side wall of said baffle member whereby rotation of the casing projects the upper portion thereof upwardly and downwardly to vary the length of said opening.

7. Structure set forth in claim **1** and valve means for controlling the flow through said central discharge conduit connected to the first chamber to adjust the back pressure of the acceptable material flowing from said first chamber.

8. The structure set forth in claim **7** and valve means for controlling the flow of pulp through the pulp inlet at the upper end of the first chamber.

9. Structure set forth in claim **8** and valve means for controlling the flow of acceptable pulp through the central conduit section in the upper portion of said second chamber.

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