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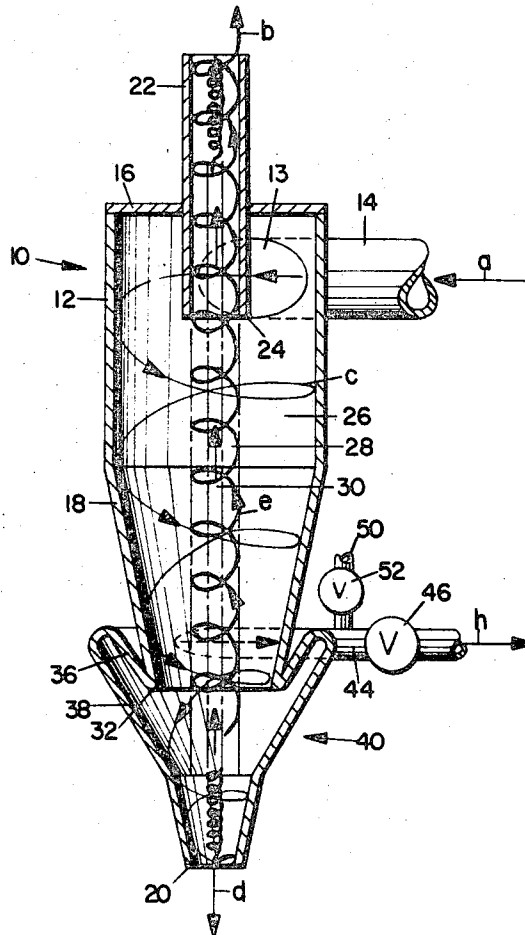
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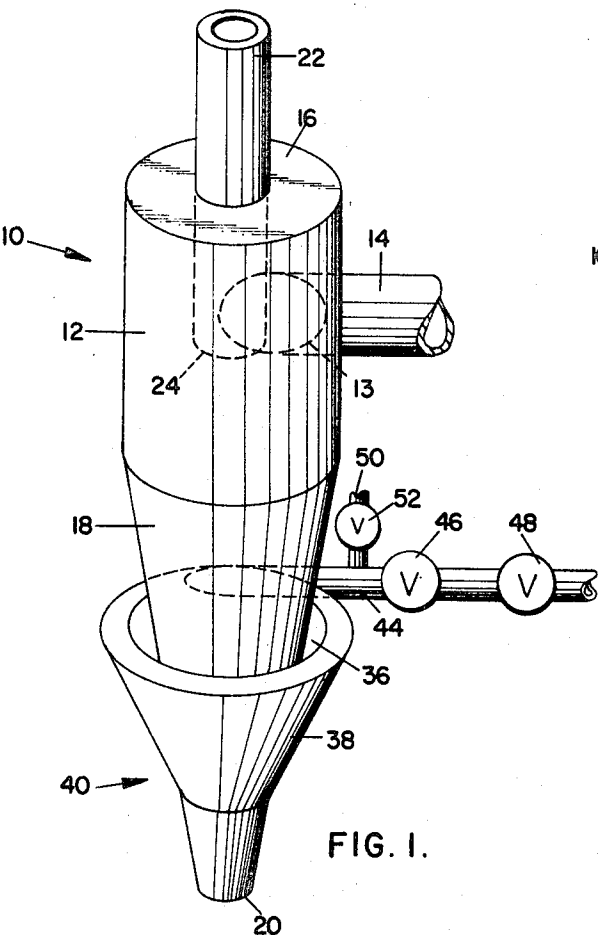
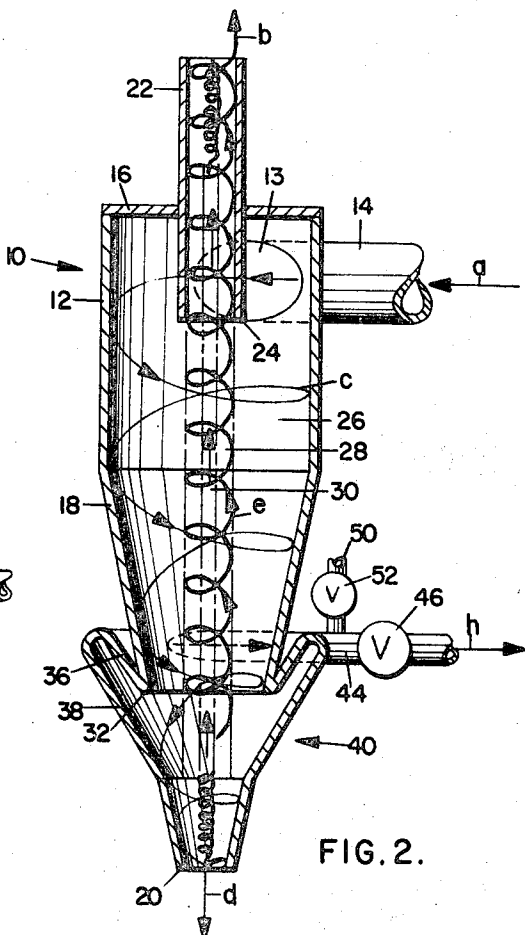
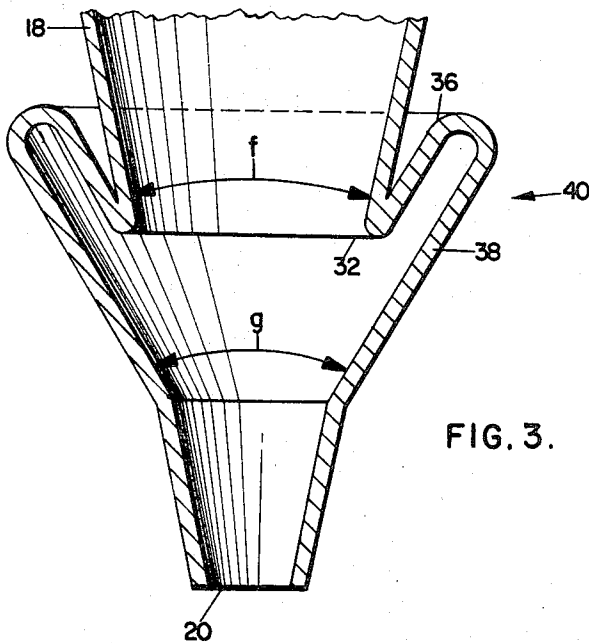
[54] **HYDROCYCLONE**
6 Claims, 4 Drawing Figs.

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209/211, 210/512
[51] Int. Cl. B04c 5/18
[50] Field of Search 210/84,
304, 512; 209/144, 211

[56] **References Cited**
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ABSTRACT: A means and method for controlling the separation of particles or contaminants from liquid mixtures, within a hydrocyclone, by locating, within an area above the area of transition from free to forced vortex and whereat the removable particles are in close proximity to the cone wall, an impurities collector embodying a pair of walls each contiguous with the cone wall and having an increased included angle with respect to the included angle of the cone for allowing the travel of some of the particles of the reject fraction outwardly into the collector and through a communicating tangentially-arranged secondary reject outlet.





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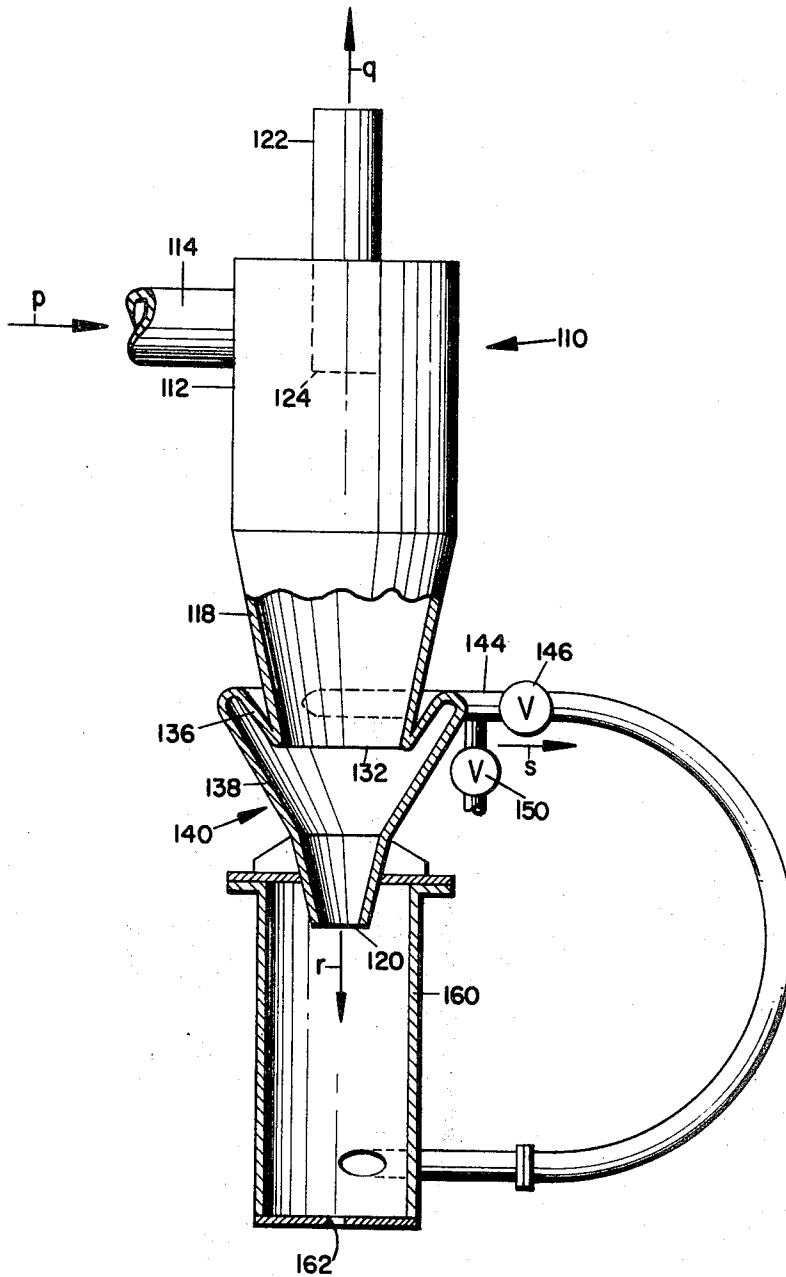


FIG. 4.

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HYDROCYCLONE

BACKGROUND OF THE INVENTION

1. Field of the Invention

Centrifugal separators or cyclones are known for separating heavier components, such as solids, from liquids and gases. That is, they are generally used in the purifying of a liquid or gas by the removal of particles entrained therein. When used to separate heavier components from liquids, they are frequently termed hydrocyclones or hydroclones.

The invention relates particularly to hydroclones, but its principles are equally adaptable to the separation of heavier components from gases, the term "fluid" as contemplated herein including both liquids and gases, and the term "heavier components" including any components solid or liquid or gas, dispersed in a base medium having a lower specific gravity than the heavier component.

An important field of use for centrifugal separators is in the purifying of paper stock wherein wood pulp fibers are suspended in the water solution. It will be understood that the principles of the present invention will find application in many fields but for convenience of disclosure of preferred embodiment thereof, reference will be made to the use of a centrifugal separator for purifying paper stock by the separating out of solid contaminants.

The invention has application with a full range of pulps, from short-fibered hardwood soda and semichemical pulp, through softwood, groundwood, sulphite and kraft.

2. Description of the Prior Art

The hydroclone envisions the tangential introduction of a liquid mixture containing suspended solid matter under high input pressure into a cylindrical head and thence into an inverted cone so that the liquid mixture is caused to flow circumferentially within the cone. The liquid mixture assumes a rotary path of travel and, so swirling, is moved downwardly into the cone or cyclone chamber. As the flow moves toward the cone apex, a vortex of conical shape is formed, the cone diameter decreases, and the angular velocity and centrifugal force increase. The centrifugal force serves as the means for separating the objectionable solids from the liquid.

The carrier fluid and the particles contained therein may be classified into categories as follows:

- a. The main fluid (gas or liquid)
- b. The acceptable fraction (in our case, wood pulp fiber)
- c. The reject fraction, which can be further grouped into:
 1. Particles of specific weight close to the acceptable fraction and similar in material but of different geometric configuration and, therefore, of apparent greater density (in our case, bark, shives, nodules, etc.)
 2. Particles of other origin than the acceptable fraction but approaching in specific weight and size
 3. Particles of other origin than the acceptable fraction and of substantially different specific weight or apparent density.

The bulk of the flow entering the tangential inlet is immediately subjected to a centrifugal component, among other forces acting on the entering stream. This component is a function of the tangential velocity and the radius of the particular point and its action will immediately separate the portion of the reject fraction referred to above as comprising particles of different specific weight or apparent density. Such portion of the reject fraction remains, during the period of its presence within the cone, in a helical path close to the wall, ultimately being discharged outwardly through the cone apex.

The other force acting on the flow is the entrainment of the liquid created by the presence of the central discharge orifice. As the liquid tries to exit through this opening, it is immediately subjected to an increasingly larger centrifugal field. The intensity of this field depends on the size of this orifice, and it increases with decreasing of the orifice.

Assume for the moment that separation has occurred and particles 1 and 2 will be rejected as part of the reject fraction and, therefore, directed toward the periphery. In their path,

they will encounter other particles, collide and lose part of the energy they have been initially imparted. This energy loss is coupled with a concentrating effect of the entrained particle 3 present in the suspension between the core of the vortex and the periphery.

In the operation of cyclone cleaners heretofore used, the concentration at the wall increases rapidly until it reaches a maximum at the apex.

The centrifugal force exerted by the circumferential flow within the hydroclone is such that solid matters are propelled exteriorly of the stream flow whereas the outlet from the hydroclone is taken from the interior.

Water, fiber and dirt particles react differently to the somewhat complex pattern of forces prevailing, which forces include:

1. a pressure differential from the periphery of the cylindrical head towards the central, liquid-free axis and towards the bottom of the cone,
2. the centrifugal force caused by the rotating liquid, and
3. the angular velocity gradient from the cone periphery to the liquid free axis.

The swirling liquid mixture adjacent the center of the vortex travels at a greater angular velocity than the liquid mixture adjacent the outer area of the vortex.

Fiber and dirt, in passing through the created fields of successively-increasing centrifugal force, tend to slow down in relation to their inward radial travel. A dirt particle, reaching a centrifugal field which counterbalances the radial flow is carried downwardly in this field by the downward component of liquid flow toward the cone apex. The fiber, having a high length-to-diameter ratio, tends to overlap into zones of faster tangential velocity.

The liquid and fibers are carried toward the center of the whirlpool and finally upwardly, and because of the shear, without serious entrainment of dirt, so that the lighter liquid mixture and desirable particles suspended therein are drawn off as the accepted fraction through a suitable exiting means, called the accept outlet. The remainder or heavier portion or dirt of the liquid mixture, together with some fibers, which to a minor extent concentrate at the cone wall, recirculates in the vortex and carries downwardly toward the cone apex where it is finally separated out as the rejected fraction through the exiting means, called the reject outlet.

Pulp fibers are accepted by the hydroclone because the hydraulic drag creates radial flows which move the fibers against the centrifugal force and when the hydraulic drag is greater than the centrifugal force, the particles are eventually accepted.

If the contaminate is say, disc shaped, its chances of responding to the hydraulic drag are greater than if it is spherical, where the ratio of surface to mass is low. Thus, sand is readily rejected by a cleaner while some larger particles may be either rejected or accepted depending on their shape.

Particles which move to the wall of the cone are forced, due to the increasing physical restrictions imposed by the decreasing cone diameter, to the higher angular velocity and centrifugal force zones whereat the particles may be held in a semistationary orbiting field, there to be forced, by succeeding particles, with either toward the path to the accept outlet or toward the path to the reject outlet.

With very large "dirt", such as knots, the downward liquid components of flow may not be sufficient to overcome the component of centrifugal force acting upward in the cone so that an orbit is established with these particles held in equilibrium. Such orbit is characteristic for the particle, the unit and the method of operation. A single knot may stay in this orbit until worn down by attrition. However, if several such knots enter with the stock, the orbits will overlap and, depending on their location, with reference to the rejected and accepted stock outlets, will appear eventually either in the accepted stock or in the rejected stock.

Prior art hydrocyclones employed for the cleaning of cellulose suspensions and similar liquid-solid slurries have been

relatively ineffective in removing foreign particles from mixtures above 1.0 percent fiber consistency (*i.e.* one part fiber per 100 parts liquid by weight).

Small diameter separators (*i.e.* below fifteen inches as measured at the larger section of the hollow truncated cone) have offered special difficulties in removing large particles having high length-to-width ratios, such as, shives, knots, and like objectionable contaminants. This has been for the reason that, as a result of the shear force, such particles are pulled into the higher angular velocity zones of the vortex and then eventually into the normal accept or cleared zone and out through the accept outlet, an obviously disadvantageous feature.

Large diameter separators have presented corresponding problems in removing foreign contaminants, but for a different reason. In such, if a high angular velocity is maintained, in order to achieve a resultant high centrifugal force, the particles are forced to the cone wall, and the shear force, which would normally tend to pull these particles through the high centrifugal force field, is overcome by the mass of the particles themselves and the centrifugal force acting thereupon. The result is that these particles are substantially held in a stationary orbiting field, with a low probability of going either to the vortex finder area, as a part of the accept fraction, or to the cone apex area, as a part of the reject fraction.

Various techniques have been attempted to overcome the inherent problems. For example, lower angular velocities have been used to prevent the particles from being held at the cone wall, but these lower angular velocities, and the resulting lower centrifugal forces, are objectionable in that they serve to decrease effective removal of the particles as rejects at the cone apex.

One avenue of solution has been to increase cone diameter, say to as much as 35 inches. So to increase diameter means to lower angular velocity and hence the centrifugal force acting upon the particles, but it does serve to minimize the difficulties inherent in stationary orbiting. However, due to ineffective elimination of the finer foreign particles, because of the lower centrifugal force, the cyclone has a narrowed particle size separation range.

Often, even with lower centrifugal force, particles having lengths in excess of 2 inches remain in a stationary orbiting field or are pulled by shear force into the vortex finder field to the exclusion of being rejected at the cone apex.

Cone included angles have been experimented with, although, conventionally, they have been held to a minimum. In cyclones of from 3 to 6 inches in diameter, the included angles have been normally held between 3° and 8° so as to minimize other dimensional inefficiencies. Only in the larger sizes has the cone included angle been extended to as much as 15°.

SUMMARY OF THE INVENTION

The invention relates to hydrocyclone or centrifugal vortex separators, which are effectively operable on mixtures of liquid and solid particles suspended therein, such as paper-making stock slurries of varying consistencies, for the separating out of the undesirable solid impurities from the liquid mixture.

It teaches a significant departure from and refinement in the prior art in the means and method for separating out and removing undesirable particles having varying degrees of shape and specific gravity, accomplishing such with a strikingly new degree of efficiency.

The structure comprehends a hollow truncated cone, the top of which is joined to a cylindrical head, which head is provided near its top with a stock inlet tangential thereto and an accepted stock outlet. A primary rejected stock outlet is located at the truncated apex of the cone. The continuous surface of the cone defines a relatively sharp included angle, and that surface is interrupted by an angular opening intermediate its opposite extremities. This annular opening is connected at its upper and lower edges to the top and bottom walls respec-

tively of a generally cone-shaped reject collector which circumscribes the cone, the bottom wall of the collector defining an included angle which is greater than the cone included angle. A secondary rejected stock outlet is located tangential to the collector and communicates therewith at the top thereof.

The heart of the invention is in the correlation of the included angles of both cone and its cooperant collector, allowing an increased efficiency of particle separation at greater consistency levels.

The continuous removal of particles of objectionable shape or specific gravity utilizes the free vortex principle but exploits the movement of some of those particles along a nonrestricted path resultant from the collector included angle which is greater than the cone included angle and thus into a collector from which they are discharged as rejects.

In accordance with the invention, separation of the particles is more effectively controlled by the use of this second discharge means which is located in close proximity to the cone wall above the transition area and is in the form of a cone shaped collector communicating with the conical portion of the vortex chamber and having an included angle greater than the included angle of the conical portion of the vortex chamber to allow further collecting and discharging of undesirable impurities separated from the liquid mixture.

Thereby some of the particles of the reject fraction are entrained toward the second discharge means where they will again have a chance to be accepted or rejected, the number of chances the particles have to be selected being increased since the flow continuously entrains also the dubious particles contained in fractions close to the periphery toward the first discharge means.

It is accordingly an object of the present invention to provide an improved cyclone separator which operates in a more effective manner accomplishing better separation and which is particularly well suited for use for cleaning wood pulp stock.

Yet another object of the invention is the reduction of the concentration of fiber at the wall of a conical separator and thereby providing a separator capable of efficiently handling suspensions having high or low consistencies.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an isometric view of the structure exploiting the hydrocyclone principle and including a collector having an included angle greater than that of the cone for allowing the outward travel of reject particles to and through a secondary reject discharge;

FIG. 2 is a vertical sectional view through the hydrocyclone of the invention for showing typical particle trajectories;

FIG. 3 is an enlarged detail view of the section of the cone incorporating the collector showing the relationship of the included angles of the cone and collector; and

FIG. 4 is a side elevational view, partly in section, showing a modified form of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A hydrocyclone or centrifugal separator, generally indicated by numeral 10, includes, as the basic elements thereof, a vertically-disposed elongate body or housing 12 of a hollow cylindrical configuration and tangentially intersected at 13 by a stock inlet 14, which inlet may be of either circular or rectangular or square cross section, for supplying the water suspension and solid impurities to the hydrocyclone in the direction of arrow *a* from a line (not shown) used for transporting the mixture from one operation to another in a processing program.

The top of body 12 is enclosed by a cap or cover 16.

Descending from and communicating with body 12 is an elongate truncated cone or vortex chamber 18 extending downwardly at a continuously-reduced internal diameter to a point of truncation or apex opening 20, the point of minimum internal diameter of the cone.

Body 12 defines the base of cone 18, the interior configuration of the cone converging axially in one direction toward the point of truncation forming apex opening 20 and diverging axially in the opposite direction toward body 12.

The outlet diameter of body 12 (the base of the cone) is the same as the inlet diameter of cone 18 to present no restriction to the downward flow of incoming liquid mixture into the vortex chamber, to the end that turbulence is minimized.

Extending outwardly and axially and centrally of body 12 is an outlet or vortex finder or accept line 22 for removing the accepted fraction for the separator in the direction of arrow *b* and delivering same to a line (not shown) for transporting the separated liquid mixture to the next subsequent processing operation. The vortex finder has a lower extremity 24 extending interiorly of the body and communicating with the separator interior.

The stock suspension, a liquid mixture, containing desirable or accept fibers and non-desirable or reject particles, is charged under pressure, say 40 to 50 p.s.i., through tangential inlet 14 and into cylindrical body 12 where it immediately develops a circuitous motion or vortical whirl. Input flow may be controlled, if desired, by a valve (not shown) in inlet 14.

The suspension spirals downwardly and follows a rotary path of travel, as indicated by *c*. The rotating liquid mixture is forced downwardly, by the subsequently-incoming liquid mixture, into cone or vortex chamber 18, and is forced inwardly toward the axis thereof, thereby causing the angular velocity of the liquid mixture to increase, with an increasing centrifugal force being imparted to the fluid and its heavier components.

During this downward movement, the heaviest particles are forced outwardly toward the cone wall by the centrifugal force, while the lighter particles are urged inwardly toward the vortex axis. This downward flow is in what is termed a free vortex path in the area delineated by numeral 26. The heavier particles are entrained and move downwardly in the outer portion of this free vortex path and the lighter particles are entrained and move downwardly in the inner portion thereof.

Dirt and like reject particles which can more easily pass through the high centrifugal force field continue downwardly to the through apex opening 20 in the direction of arrow *d*.

The liquid mixture, on the other hand, continues its downward swirling movement through the free vortex path, only to be turned back upon itself, and then to move upwardly, while continuing its rotary path of travel, as indicated by *e*, in what is termed the forced vortex path in the area delineated by numeral 28, circumscribing a central air column in the area delineated by numeral 30.

As known, the transition zone or point between the free and forced vortex paths has heretofore varied in its location within the hydroclone in accordance with various combinations of factors such as the diameters of the inlet and outlets, the cone diameter, and the like. The transition zone or point defines the area of highest centrifugal force and shear force.

The continuous interior surface or cone or vortex chamber 18 is interrupted intermediate its opposite extremities by an annular opening 32, which opening is connected at its upper and lower edges to the respective top and bottom walls 36 and 38 respectively of a cone-shaped reject collector, generally indicated by 40, circumscribing the cone.

At the area of the conventional cone where the particles concentrate, due to the barrier of high centrifugal force and shear between free and forced vortex flow, collector 40 of the invention is disposed, and by its means, objectionable large particles are allowed to move upwardly along a non-restricted path provided by the included angle of the collector bottom wall which exceeds the included angle of the cone along which the particles have travelling been travelling.

By way of exemplification, the included angle of cone 18 is represented by *f* as may be 12° and the included angle of collector 40 is represented by *g* and may be 16°.

The change of the included angle from twelve degrees to sixteen degrees allows a new direction of flow of particles

travelling downwardly along the wall area at the point where the transition zone comes in close proximity to the conical wall in the lower cone section. The particles, by the high centrifugal forces acting upon them, are forced outwardly and thence upwardly along the new path. At a distance suitable for the reject particles to follow the new path, the fibrous solution returns to the previous main cone angle of 12°, thus allowing the fine dirt to travel toward the cone apex, all the while with a minimum of disturbance to the hydraulic flow patterns.

Increasing the included angle in excess of 3° permits the particles to be moved by centrifugal force along the new path, without being obstructed by the confined cone area of the previous included angle, and into the collector which collects the particles for separation from the hydrocyclone.

The dimensions of a typical installation are given by way of exemplification:

Maximum diameter of cone 10' = *D*.
Stock inlet diameter = .3 x *D*.
Accepted stock outlet diameter = .35 x *D*.
Main cone included angle = 12°.
Transition radius = 2.2 inches.

Various combinations of cyclone diameter and inlet and outlet diameters may be successfully used so long as the main included angle is changed to an increase of a minimum of three degrees slightly above or at the transition area of highest centrifugal force.

An increase of included angle by as much as 3° or more allows the large particles to be moved by centrifugal force along a new path free of the obstruction presented by the confined area of the cone with its lesser included angle. These particles move upwardly into collector 40 and are eventually directed into a tangentially-arranged reject outlet 44 which may be valved as at 46 and 48 for intermittent reject removal in the direction of arrow *h*.

The large particles, travelling the new orbiting path, due to the difference in included angles, are removed through outlet 44 in such manner as to permit desirable fibrous materials to be forced from the collector and back into the main stream by water or other elutriant forced under pressure into the collector through a line 50 including valve means 52.

Lower specific gravity reject particles may require a greater included angle at the collector upwards from 10° to permit the change in orbiting paths to the reject collection point.

It is adjacent the transition zone between the forced and free vortex paths, extending vertically from the cone top to the cone bottom, that the action of the invention takes place.

By locating the collector above the transition area of highest centrifugal force and angle velocity, at which point it reaches close proximity, greater included angles may be used in the main cone body. The transition area will remain fixed once the physical dimensions are kept in a static condition, independent of pressure drop and flow through the cyclone.

It may be desirable to locate more than one such collector within a cyclone to give finer selections of reject material heretofore not possible within hydrocyclones. The location of side ports would be at higher points within the free vortex zone of the unit for higher specific gravity material which would move to the wall section early in the centrifugal separation process before reaching the high centrifugal force and angular velocity between the free and forced vortex area.

To improve the efficiency of the hydroclone in separating very minute particles, an additional novel reflux system is provided and is shown in FIG. 4.

Therein, the hydrocyclone or centrifugal separator is generally indicated by numeral 110 and includes a vertically disposed elongate body or housing 112 of a hollow cylindrical configuration and tangentially intersected by a stock inlet 114 for supplying the water suspension and solid impurities to the hydrocyclone in the direction of arrow *p* from a line transporting the mixture from one operation to another in a processing program.

Descending from and communicating with body 112 is an elongate truncated cone or vortex chamber 118 extending downwardly at a continuously-reduced internal diameter to a point of truncation or apex opening 120.

Extending outwardly and axially and centrally of body 12 is an outlet or vortex finder or accept line 122 for removing the accepted fraction from the separator in the direction of arrow *q* and delivering same to a line (not shown) for transporting the separated liquid mixture to the next subsequent processing operation. The vortex finder has a lower extremity 124 extending interiorly of the body and communicating with the separator interior.

The stock suspension is charged under pressure through tangential inlet 114 and into cylindrical body 112 where it immediately develops a circuitous motion or vortical whirl. Input flow may be controlled, if desired, by a valve (not shown) in inlet 114.

The suspension spirals downwardly and follows a rotary path of travel. The rotating liquid mixture is forced downwardly, by the subsequently-incoming liquid mixture, into cone or vortex chamber 118, and is forced inwardly toward the axis thereof, thereby causing the angular velocity of the liquid mixture to increase, with an increasing centrifugal force being imparted to the fluid and its heavier components.

During this downward movement in the free vortex path, the heavier particles are forced outwardly toward the cone wall by the centrifugal force, while the lighter particles are urged inwardly toward the vortex axis.

Dirt and like reject particles which can more easily pass through the high centrifugal force field continue downwardly to and through apex opening 120 in the direction of arrow *r*.

The liquid mixture, on the other hand, continues its downward swirling movement through the free vortex path, only to be turned back upon itself, and then to move upwardly, while continuing its rotary path of travel in the forced vortex path circumscribing the central air column.

The continuous interior surface of cone or vortex chamber 118 is interrupted intermediate its opposite extremities by an annular opening 132, which opening is connected at its upper and lower edges to the respective top and bottom walls 136 and 138 respectively of a cone-shaped reject collector, generally indicated by 140, circumscribing the cone.

Collector 140 is disposed at the area of the conventional cone where the particles concentrate, due to the barrier of high centrifugal force and shear between free and forced vortex flow. By its means, objectionable large particles are allowed to move upwardly along a nonrestricted path provided by the included angle of the collector bottom wall which exceeds the included angle of the cone along which the particles have been travelling.

By way of exemplification, the included angle of cone 118 may be 12° and the included angle of collector 140 may be 16°.

The change of the included angle from 12° to 16° allows a new direction of flow of particles travelling downwardly along the wall area at the point where the transition zone comes in close proximity to the conical wall in the lower cone section. The particles, by the high centrifugal forces acting upon them, are forced outwardly and thence upwardly along the new path. At a distance suitable for the reject particles to follow the new path, the fibrous solution returns to the previous main cone angle of 12°, thus allowing the fine dirt to travel toward the cone apex, all the while with a minimum of disturbance to the hydraulic flow patterns.

Increasing the included angle in excess of 3° permits the particles to be moved by centrifugal force along the new path, without being obstructed by the confined cone area of the previous included angle, and into the collector which collects the particles for separation from the hydrocyclone.

An increase of included angle by as much as 3° or more allows the large particles to be moved by centrifugal force along a new path free of the obstruction presented by the confined

area of the cone with its lesser included angle. These particles move upwardly into collector 140 and are eventually directed into a tangentially-arranged reject outlet tube 144 which may be valved as at 146 for intermittent reject removal in the direction of arrow *s*.

The large particles, travelling the new orbiting path, due to the difference in included angles, are removed through outlet tube 144 in such manner as to permit desirable fibrous materials to be forced from the collector and back into the main stream by water or other elutriant forced under pressure into the collector through a line including valve means 150.

Secured to the lower portion of the hydroclone is an underflow pot 160 so as to receive the reject fraction from outlet 120.

The opposite extremity of reject outlet tube 144 communicates with underflow pot 160.

A portion of the reject fraction entering underflow pot 160 from reject outlet tube 144 is thereby allowed to ultimately reenter the hydroclone for retreatment. In this manner, the fluids most likely to contain ejected solids are recirculated to insure a higher cleaning efficiency.

Underflow pot is additionally provided with an opening 162 through which the finally rejected particles may be removed from the apparatus.

I claim:

1. A centrifugal separator for separating foreign particles from a liquid mixture comprising:

- a. an inlet chamber adapted to receive the liquid mixture therein;
- b. an elongate vortex chamber communicating with the inlet chamber for receipt of the liquid mixture therefrom and having a cylindrical portion immediately adjacent the inlet chamber and a conical portion disposed below the cylindrical portion and communicating therewith;
- c. means in the vortex chamber for angularly accelerating the incoming liquid mixture to sufficient angular velocity for creating a vortex of the liquid mixture flowing downwardly and then into a transition area and then upwardly in the vortex chamber;
- d. a first discharge means connected to the lower end of the vortex chamber for collecting and discharging a first fraction of undesirable impurities separated from the liquid mixture;
- e. accept outlet means communicating with the vortex chamber for siphoning off the accepted fraction of lighter portions of liquid mixture from the vortex chamber; and
- f. a second discharge means located in close proximity to the wall of the conical portion of the vortex chamber in the form of a cone-shaped collector communicating with the conical portion and having an included angle greater than the included angle of the conical portion for collecting and discharging a second fraction of undesirable impurities separated from the liquid mixture.

2. The centrifugal separator as defined in claim 1, with the included angle of the collector being at least 3° greater than the included angle of the conical portion.

3. The centrifugal separator as defined in claim 1 with a pair of the second discharge means being spaced as to each other at above the transition zone.

4. In the separator of claim 1, with the angle of the collector being greater than the angle of the conical portion by at least 3°.

5. In the separator of claim 1, the vortex chamber having from a 5 to 45 inch maximum diameter at its larger end and a main cone included angle between 6° and 30° and inlet and outlet greater than 1 inch, and a section having a minimum of 3° included angle greater than the main cone section with a tangential reject section located thereon and an apex opening greater than ¼ inch diameter.

6. In the centrifugal separator as set forth in claim 1, and including an underflow pot communicating with the first and second discharge means for allowing retreatment of portions of the secondary reject fraction.