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CENTRIFUGAL SEPARATOR

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Fig. 1

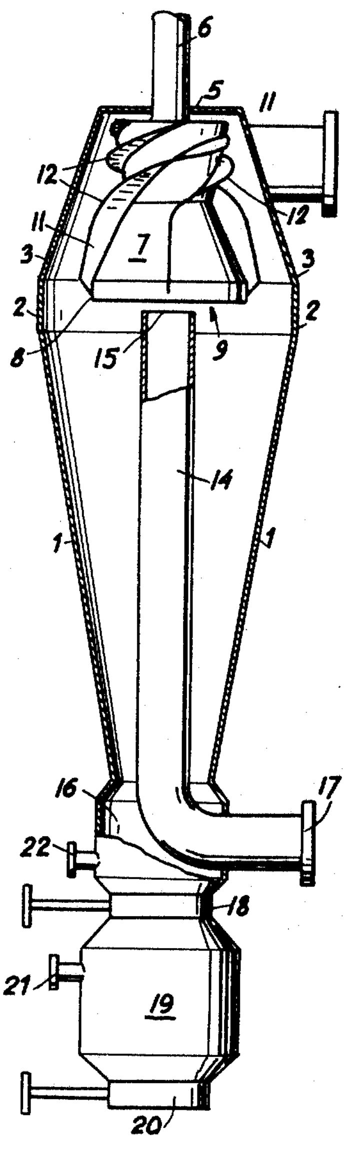
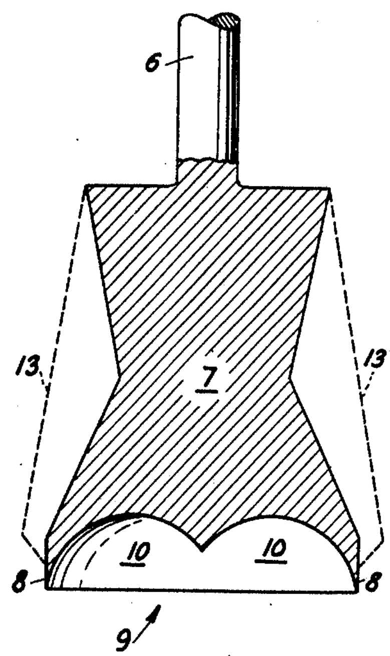


Fig. 2



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CENTRIFUGAL SEPARATOR
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U.S. Cl. 209—211 9 Claims

ABSTRACT OF THE DISCLOSURE

A centrifugal separator for paper stock has a normally vertically elongated casing conically tapering in both axial directions from a central portion, a tangential feed conduit to the top portion, a coaxial rotor in the top portion carrying vanes which are helical at the top, almost axial at the lower end of the rotor, and a toroidally curved recess in the bottom face of the rotor which guides rising purified stock into the closely adjacent upwardly directed, axially centered orifice of a discharge conduit. Heavy impurities are collected at the casing bottom.

BACKGROUND OF THE DISCLOSURE

This invention relates to papermaking equipment, and particularly to a centrifugal separator for purifying paper stock.

When paper stock is prepared from rags or waste paper, it usually contains iron particles such as clips and staples and other particulate contaminants heavier than the suspended fibers. It is common practice to install a centrifugal separator between the regulating box and the screens on the paper machine. The centrifugal force may be created by an external pump which forces the stock against suitably arranged deflecting surfaces in the separator casing. When stock of high consistency, three percent or more, is to be handled, separators equipped with a driven rotor in the casing are more effective.

While the known separators with driven rotors constitute an important advance in the purification of high consistency stock, they are sensitive to changes in process variables. If the pressure or the velocity of the feed varies relatively slightly from the values for which the known separator is designed, its effectiveness decreases and heavy contaminants reach the screens. The known separators are particularly sensitive to temporary increases in stock flow rate, and to pressure changes which cause expansion and contraction of the air bubbles unavoidably present in the stock.

The object of the invention is the provision of a centrifugal separator for purification of paper stock which is less sensitive to relatively small variations in operating conditions than the known devices, and delivers paper stock of uniformly high purity.

SUMMARY OF THE INVENTION

The invention is based on the known separator type in which the cavity of the separator casing is of circular cross section about practically the entire length of the normally vertical casing axis. A feed conduit admits paper stock to the upper end portion of the cavity through an orifice which is directed tangentially relative to the casing axis. A rotor is arranged in the upper end portion and a collector chamber gathers the heavy impurities at the bottom of the casing. A discharge conduit for purified paper has its orifice upwardly spaced from the collector chamber. The orifice intersects the casing axis and is axially directed against the bottom face of the rotor.

It has now been found that the performance of such a

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separator can be improved significantly by providing the bottom face of the rotor with a recess whose wall is a surface of revolution about the rotor axis, that is, the recess wall is of circular cross section about the axis. In its preferred form, the recess is of toroidal curvature, but recesses bounded by other surfaces of revolution are also effective at least to some extent.

The efficiency of the separator is further improved by shaping the rotor body and the rotor vanes according to one or more of the following features. The axial outer wall of the body, which extends upwardly from the recessed bottom face, should be of circular cross section about the separator axis, the two axially terminal portions of the wall flaring radially in a direction away from an axially central portion, and the lowermost part of the wall being substantially cylindrical and very narrow in an axial direction. Separation between the impurities and the fiber suspension is facilitated if the lowermost wall part and the recess in the bottom face define therebetween an annular edge portion of the latter even narrower than the cylindrical lowermost part of the axial wall.

The vanes are circumferentially disturbed on the rotor body in the usual manner. The upper portion of each vane extends in a helix of approximately uniform pitch and is at least partly coextensive in an axial direction with the orifice of the inlet conduit and the upper terminal portion of the axial wall on the rotor body. The lower portion of each vane is more nearly parallel to the rotor axis than the helix, and may be actually flat in an axial plane.

The radially outer edges of the vanes jointly define an upwardly tapering conical surface during operation of the rotor, and the upper portion of the separator cavity is bounded by an upwardly tapering conical wall. The apex angle of the conical surface defined by the rotating vane edges is smaller than the apex angle of the cone defined by the last mentioned wall.

Other features, additional objects, and many of the attendant advantages of this invention will readily be appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the appended drawing.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing:

FIG. 1 shows a centrifugal separator of the invention in elevation, and partly in section on its vertical axis; and

FIG. 2 shows the rotor body of the separator and associated elements in axial, elevational section on a larger scale.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, and initially to FIG. 1, there is seen a centrifugal separator whose sheet metal casing has a long, frustoconical, upwardly flaring bottom portion **1** connected by a short, cylindrical section to an upwardly tapering, frustoconical upper portion **3** of intermediate axial length. An inlet conduit **4** communicates with the cavity in the upper casing portion by an orifice, obscured in the drawing by other elements, and directed tangentially into the cavity relative to the separator axis, as is well known in itself.

The radial top wall **5** of the casing provides a bearing, not shown in detail, for a vertical, coaxial drive shaft **6** from which the body portion **7** of a rotor is suspended in the upper end portion **3**. The shaft **6** is driven by a non-illustrated motor in a conventional manner during operation of the separator.

As is better seen in FIG. 2, the rotor body **7** has the shape of an hourglass, and flares frustoconically from a central, narrow waist toward the two axial ends. The lowermost part of the body **7** is cylindrical, but the axial ɩidth of the cylindrical wall 8 is less than one quarter of s radius. Whereas the two conical portions of the outer, xial body wall are axially coextensive with the conical ɩall in the casing portion 3, the cylindrical wall portion is coextensive in an axial direction with a part of the ɜntral casing portion 2.

The radial bottom face 9 has a recess 10 whose wall is surface of rotation similar to a portion of a torus. The ɩtter wall and the cylindrical lowermost portion 8 of the uter axial wall of the rotor body 7 meet at a small acute ngle to define an annular knife edge portion of the bot- ɔm face 9. The wall of the recess forms a downwardly irected, pointed projection in the center of the recess 10, nd extends in a circular arc of almost 180° in each plane ɪrough the rotor axis from the aforementioned knife dge to the point of central projection.

As is shown in FIG. 1 only, the rotor body 7 carries ɔur sheet metal vanes 11 which are equiangularly offset n the axial wall of the rotor body 7. An upper part of ach vane 11 extends in approximately one turn of a helix f approximately uniform pitch about the separator axis nd is axially coextensive with the non-illustrated orifice f the inlet conduit 4 as is obvious from the location of ɪe conduit, as seen in FIG. 1. The pitch of each helix ɪcreases sharply in a downward direction after one turn ɔ that the lowermost portion of the vane is parallel or early parallel to the rotor axis.

As is indicated in FIG. 2, the radially outer edges 12 of ɪe rotor vanes 11 define a frustoconical surface 13 dur- ɪg rotation of the rotor body 7. The apex angle of the onical surface 13 is smaller than the corresponding angle f the casing portion 3.

A discharge conduit 14 is partly coaxial with the rotor asing. Its upwardly directed circular orifice 15 thus inter- ɜcts the casing axis and is coaxially aligned with the entral projection in the recess 10. The diameter of the ɾifice 15 is approximately one third of the diameter f the recess 10, and the orifice is closely adjacent to the ottom face 9 in a downward direction, the axial spacing f the orifice from the bottom face 9 being but a small raction of the diameter of either. The conduit 14 down- ɩardly extends into a collector chamber 16 at the bottom f the separator casing and radially outward from the hamber. Its terminal flange 17 is normally connected to ɪe papermaking machine.

A gate valve 18 may separate the chamber 16 from subjacent lock 19 which is usually closed in a down- ɩard direction by another gate valve 20. Washout fittings ı1, 22 permit rinsing water to be introduced into the ɔck 19 or the chamber 16, the control valves in the water upply having been omitted for the sake of clarity.

The separator described above is operated as follows: With the valves 18, 20 closed, the casing is filled with ɩater from the fitting 22, and the non-illustrated drive notor for the shaft 6 is started. Contaminated paper tock is fed from a regulator box or other source through he inlet conduit 4 into the upper casing portion 3. The tock is driven mainly in an axially downward direction ɩy the helical portions of the vanes 11, and is imparted predominantly circumferential and radially outward novement by the lower axial vane portions and by the entrifugal forces generated thereby. An outer vortex of ncoming stock develops along the casing walls and the pirals downward. The heavier contaminant particles are lriven toward the casing wall and move downward along he same toward the chamber 16 while the lighter fibers ravel with the carrier liquid downward, and then upward n an inner or central vortex about the conduit 14.

The preferred shapes of the rotor body 7, of the casing ɩortion 3, and of the vanes 11 enhance the formation of he descending vortex and its separating effect. The an- ɩular gap between the body portion 7 and the casing wall ı increases in a downward direction over the axial dimen- ion of the orifice in the inlet conduit 4, thereby minimiz- ng turbulence at the stock inlet, and favoring axially downward flow under the action of the helical vane portions. As the lower portion of the body 7 flares downward, it assists the vanes 11 in driving the stock radially outward, and the axial flow velocity is decreased by the widening of the annular gap between the vane edges 12 and the less steeply inclined casing wall 3. Separation of the outer vortex from the axial wall of the body 7 without excessive energy losses due to turbulence is made possible by the narrow cylindrical wall portion 8 at the lowermost part of the body 7, thereby also preventing excessive mixing of the descending outer vortex with the ascending inner vortex.

Enough water is admitted during separator operation through the fitting 22 to rinse most adhering fibers from the falling impurities and to return the fibers to the ascending central vortex. The upward flow of the inner vortex is reversed, and the purified stock is directed downward and toward the axis into the orifice 15 by the approximately toroidal wall of the recess 10. The edge of the bottom face 9 is beneficial in separating the two vortexes which do not mix over a wide range of varying operating conditions, particularly variations in the flow rate and pressure of the incoming stock.

The collected impurities may be removed from the separator casing through the lock 19 without interrupting the operation of the apparatus by sequentially opening and closing the valves 18, 20 at the two ends of the lock 19 in an obvious manner. Residual fibers may be washed from the impurities in the lock 19 by means of water admitted through the fitting 21 and returned to the inner vortex through the open valve 18.

We claim:

1. In a centrifugal separator for removing heavy impurities from paper stock, the separator having a casing substantially enclosing a cavity of substantially circular cross section about a normally vertically extending axis and being axially elongated; a feed conduit for admitting paper stock to upper end portion of said cavity and having an orifice in said end portion directed tangentially relative to said axis; a rotor mounted in said end portion for rotation about said axis; a collector chamber for said impurities at the bottom of said cavity; and a discharge conduit for purified paper stock having an orifice upwardly spaced from said chamber, said rotor having a bottom face, and said orifice intersecting said axis and axially directed toward said bottom face, the improvement in the rotor which comprises:

(a) said rotor having a body portion carrying said bottom face and having an axial outer wall extending upwardly from said bottom face; and

(b) said bottom face being formed with a recess having a wall of circular cross section about said axis.

2. In a separator as set forth in claim 1 said wall being of circular cross section about said axis and having an axially central portion and two axially terminal portions radially flaring in a direction away from said central portion.

3. In a separator as set forth in claim 2, the lowermost part of said axial wall being substantially cylindrical and of an axial width substantially smaller than the radius thereof.

4. In a separator as set forth in claim 3, said lowermost part and said recess defining therebetween an annular edge portion of said bottom face, the radial width of said edge portion being substantially smaller than said axial width of said lowermost part.

5. In a separator as set forth in claim 2, a plurality of vanes circumferentially distributed on said axial wall, each vane having an upper portion extending about said axis in a helix of approximately uniform pitch and a lower portion more nearly parallel to said axis than said helix.

6. In a separator as set forth in claim 5, said helix being at least partly axially coextensive with the upper

axially terminal portion of said axial wall and with said orifice of said inlet conduit.

7. In a separator as set forth in claim 6, said vanes having respective radially outer edges jointly defining an upwardly tapering conical surface about said axis during rotation of said rotor, said upper portion of said cavity being bounded by an upwardly tapering wall of said casing of conical shape about said axis, the apex angle of the conical surface defined by said edges being smaller than the apex angle of the cone defined by said upwardly tapering wall.

8. In a separator as set forth in claim 1, said recess being of substantially toroidal curvature.

9. In a separator as set forth in claim 8, the axial distance between said bottom face and said orifice of the discharge conduit being substantially smaller than the greatest dimension of said orifice perpendicular to said axis.

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FRANK W. LUTTER, Primary Examiner

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