May 15, 1945. H. E. B. SCOTT 2,375,826

VORTEX SEPARATOR APPARATUS FOR TREATING PAPER PULP

Filed July 22, 1940 2 Sheets-Sheet 1

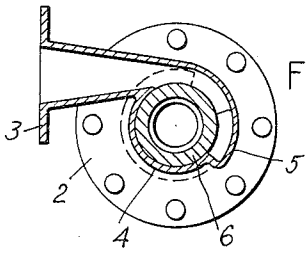


FIG. 2.

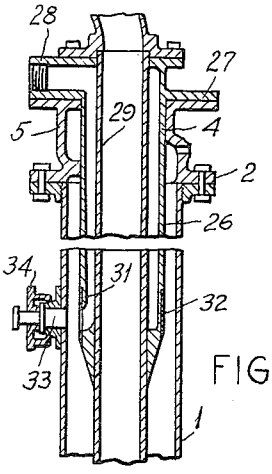


FIG. 3.

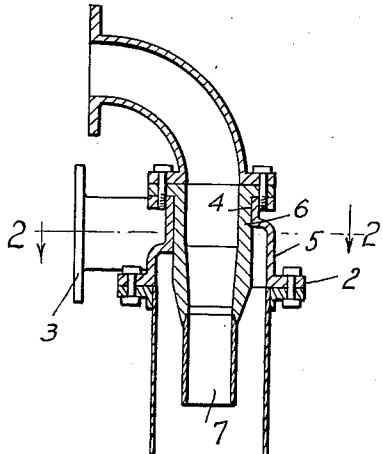


FIG. 1.

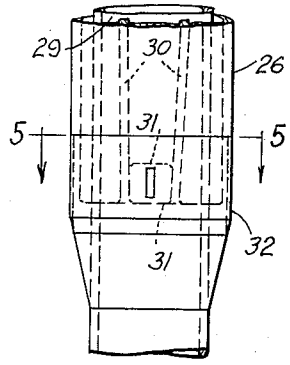


FIG. 4.

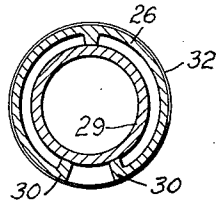
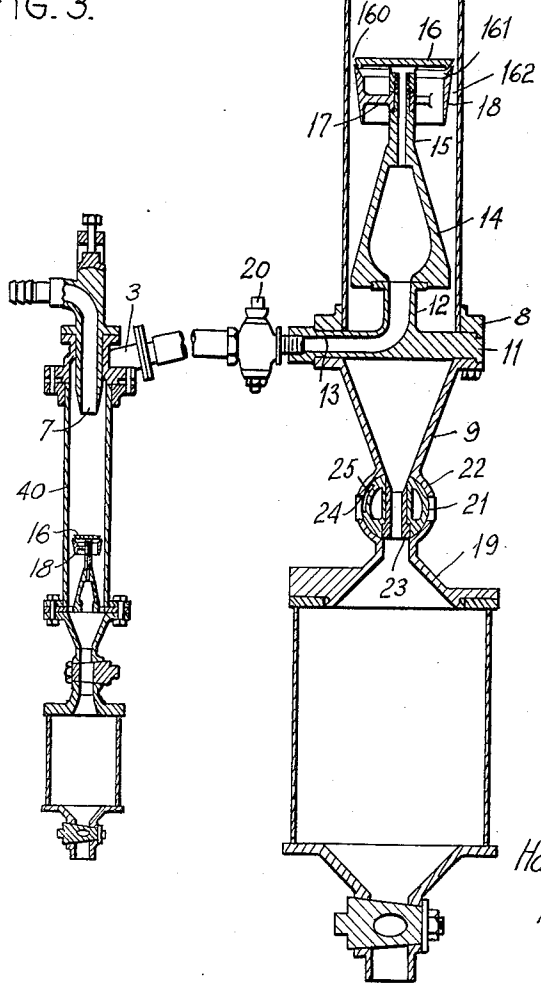


FIG. 5.



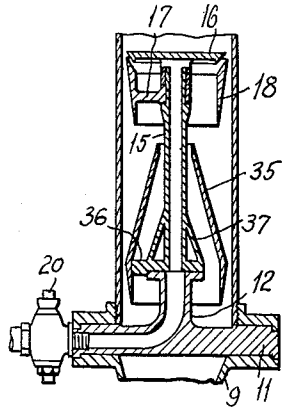


FIG. 6.

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VORTEX SEPARATOR APPARATUS FOR TREATING PAPER PULP

Filed July 22, 1940 2 Sheets-Sheet 2

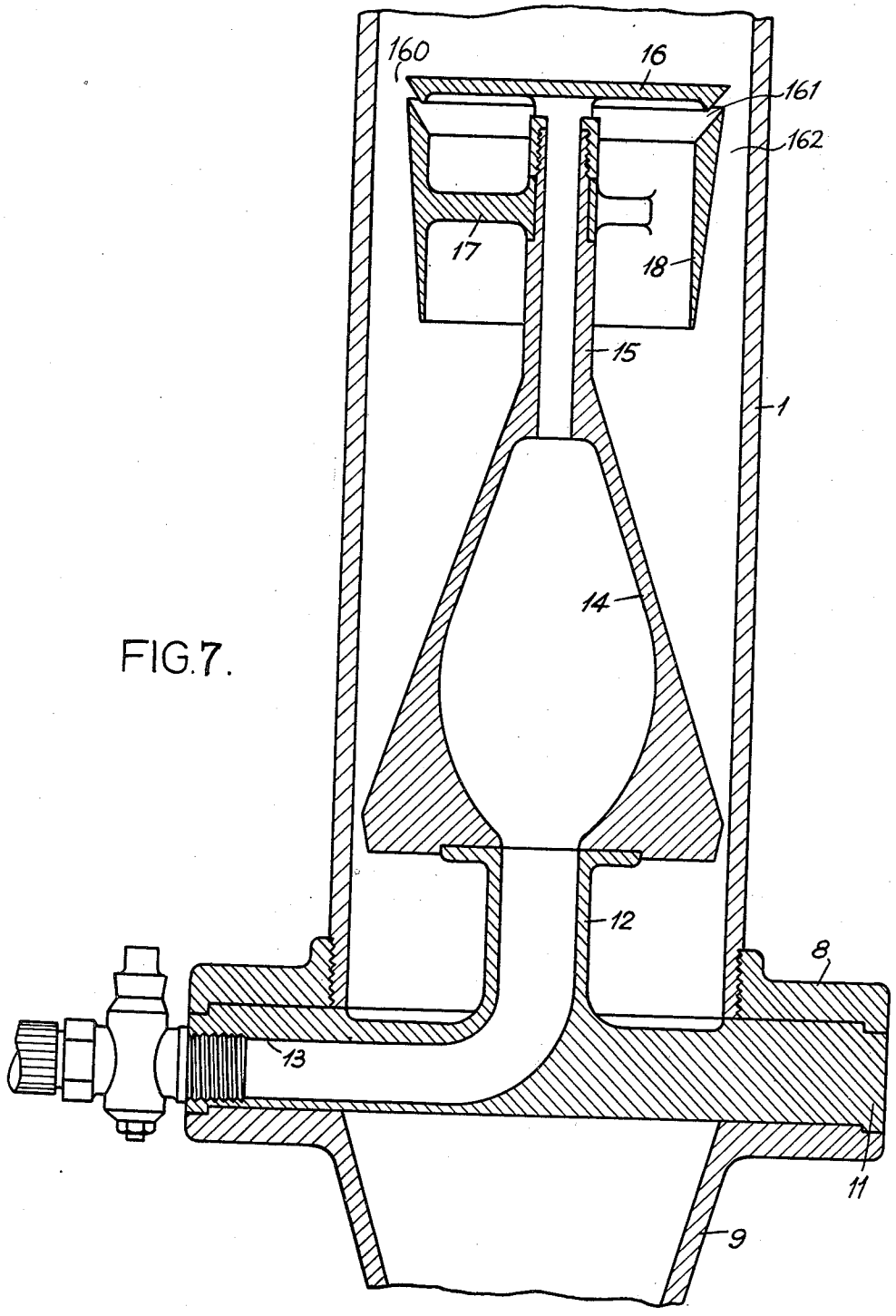

FIG. 7.

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2,375,826

UNITED STATES PATENT OFFICE

2,375,826

VORTEX SEPARATOR APPARATUS FOR TREATING PAPER PULP

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Application July 22, 1940, Serial No. 346,781
In Great Britain July 26, 1939

10 Claims. (Cl. 92—28)

This invention relates to separators of the vortex type in which the fluid to be treated is injected at high speed tangentially into a cylindrical vessel, and is particularly concerned with vortex separators for the treatment of paper pulp.

Apparatus of this type for treating paper pulp has already been described in which the heavy impurities separated by the centrifugal action of the whirl set up in the upper part or vortex chamber of the cylindrical vortex vessel are caused to pass by a constricted passage into a settling chamber beneath the vortex chamber, such constricted passage being most conveniently an annular passage between a baffle nearly filling the cross-section of the vortex chamber and the wall of the chamber.

The principal objects of this invention are to adapt separators of this type to operate under different conditions; to perfect the separation of impurities and achieve the maximum economy of useful pulp in circumstances which justify additional expense to those ends; and to simplify the construction of the separator.

In the new separator the baffle which divides the sheltered settling chamber from the vortex chamber is supported at the top of a pipe which opens laterally beneath it, and which can serve to carry a stream of impurity-laden liquid out of the sheltered chamber. As heretofore the baffle has a skirt which adds to the length of the constricted annular passage by which separated impurities pass from the vortex chamber to the settling chamber; but for the purpose of this invention the skirt is divided from the baffle proper which lies across the separator so that it is possible for pulp to pass from within the skirt around the edge of the baffle.

The advantage of withdrawing a stream of pulp from the settling chamber and thereby facilitating and encouraging the flow of heavy impurities into that chamber is already known; the above described construction enables pulp to be so withdrawn and also enables the apparatus to operate when the pipe beneath its baffle is closed. Improved separation is obtained when a stream of pulp is issuing from this pipe, and a further part of the invention provides for the recovery of good pulp from this issuing stream. To this end the stream is delivered into another substantially similar separator, which may, however, be of smaller size and somewhat simpler construction, and a sufficient pressure is maintained in the principal separator to impart the requisite speed of rotation to the pulp entering the auxiliary separator, so that one pump serves both separators.

Provision has been made in separators of this kind for the removal of light impurities separated at the inner part of the vortex. But it is not possible to provide an outflow for light impurities which will be satisfactory under all circumstances. For paper pulp varies widely in its nature and composition according to the particular paper product that is to be manufactured. The present invention makes provision for varying the aperture, located in the interior of the vortex, through which light impurities are allowed to escape.

A corresponding provision needs to be made in respect of the fall of heavy impurities from the settling chamber into the collecting chamber beneath it. This passage should preferably be of no greater cross-section than is necessary to allow the slowly gathering heavy impurities to pass into the collecting chamber and the fluid displaced by them to rise into the settling chamber. But in a coarse pulp there may be such large pieces of extraneous matter as necessitates an area of passage far greater than is desirable for a better class pulp. To enable the separator to deal efficiently with a wide range of the materials included under the term paper pulp provision is made for easily and quickly adjusting, according to the purpose immediately in view, and without interrupting the working, the area of the passage through the isolating valve by which the collecting chamber is separated from the settling chamber.

Figure 1 is a central vertical sectional view of a paper pulp treating apparatus including main and auxiliary separators each of the vortex type.

Figure 2 is a sectional view on line 2—2 of Figure 1.

Figure 3 is a fragmentary vertical sectional view of the upper portion of a separator showing a modified construction suitable for the removal of light impurities.

Figure 4 is a fragmentary elevation projected at right angles to Figure 3.

Figure 5 is a sectional view on line 5—5 of Figure 4.

Figure 6 is a sectional view similar to a portion of Figure 1, but showing a modification within the settling chamber.

Figure 7 is a view similar to a portion of Figure 1, but to a larger scale.

The body of the separator consists, as usual, of an elongated vertical cylindrical vessel 1 in which a vortex of pulp is established. To its

flanged top is fastened an inlet head-piece 2, which has a flange or like means 3 for connection to a pipe, and a vertical cylindrical body of two diameters 4, 5, the line of junction between them being helical. An inlet passage running from the pipe connection 3 merges into the part 5 of larger diameter which by the fitting of a tube or sleeve 6 into the part of smaller diameter becomes a helical inlet channel. The inlet passage varies in cross-section from a circular form at the pipe flange 3 to a substantially rectangular form of greater depth than width where it merges into the body of the inlet head-piece, the depth preferably expanding and the width contracting.

As already indicated, paper pulp, under which term is here included all fibre suspensions that are treated by paper-making methods and apparatus for the production not only of paper, but also of such products as mill-board, roofing felt and the like, varies greatly in its nature and composition. In general it may contain impurities both of large and small size, any of which may be specifically heavier or lighter than the fibre of which the pulp is, and must remain, a substantially uniform suspension. In some pulps there may be an appreciable proportion of light impurities which tend to separate upon the inner boundary wall of the vortex of pulp, and for certain purposes it will be desirable to remove these. In other cases the impurities so appearing may be negligible. If no specific provision is made for the removal of light impurities so separating, the sleeve 6 fitting the inlet head-piece and completing the helical inlet passage may form the outlet for purified pulp. It is continued by a tube 7 to such a depth below the inlet that its mouth lies in the middle of a vortex of purified pulp from which all the heavy impurities have been driven by centrifugal action into the outer layers of the vortex.

To the flanged lower end 8 of the principal vortex vessel 1 is attached a flanged collecting cone 9, with a stout metal ring 11 intervening between them. This ring is the rim of a spider having a draw-off tube 12 for impure pulp projecting upward from its centre, the bore of which is continuous with a passage 13 through one arm of the spider and the ring 11. The tube 12 supports, and communicates with the interior of, a hollow upright cone 14, the base of which is only a little less in diameter than the inner wall of the vessel. At its top the cone is continued as a tube 15 which, as shown, opens by a lateral aperture beneath a horizontal baffle plate 16 attached to the top of the tube 15 of slightly less diameter than the base of the cone 14 and forming with the vessel wall a restricted annular passage 160. Beneath the bevelled edge of the baffle plate 16 and spaced slightly from it to form a second annular passage 161 upwardly and outwardly inclined and leading into the passage 160 is an annular wall or skirt 18 which tapers downward both in thickness and in external diameter and forms with the vessel wall a prolongation 162 of the passage 160. The skirt may be integral with the baffle plate 16; it is preferable to support it independently from the draw-off tube by a spider 17 as shown, on order that there may be an uninterrupted gap between it and the baffle plate.

At the apex of the inverted collecting cone 9 is an isolating valve leading to a sump or collecting chamber 19 having in its lower end a discharge cock.

The isolating valve is of the nature of a cylindrical (or slightly tapered) cock 21 turning in a corresponding ported seat 22, its axis being horizontal. A transverse bore through the body of the cock 21 makes communication between the collecting cone 9 of the settling chamber and the sump 19 when the cock is turned to set the bore vertical. The bore is threaded to receive a sleeve 23, and the effective bore may be varied as desired by removing this sleeve altogether or substituting for it a thicker or thinner sleeve. To permit of such changes lateral openings 24 are made in the seating 22 of the isolating valve, so that when the cock is turned at right angles to its open position the sleeve 23 in its bore is accessible for removal or for cleaning. A groove 25 may be made over part of the circumference of the cock, so that in an intermediate position of the cock there is an air vent passage around it from the sump 19 to one of the lateral openings 24 of the seating.

The pipe 13 is shown as provided with a cock 20 by which it may be closed. The separator thus far described then works as a self-contained unit. Pulp is supplied by a pump to the inlet 3 at such a pressure that the pulp enters at high speed. It is directed by the inlet in a tangential and downwardly inclined path so setting up a vortex of pulp within the vessel 1. Since the outlet 7 is central and directed upward, the pulp after a certain downward travel must move inward and reverse its vertical component of movement, all the time rotating at a high angular velocity determined by the inlet speed and the outlet path. As a consequence of the centrifugal forces set up by this rotation most of the impurities contained in the pulp find their way to the outer layers of the vortex. They tend, also, under gravity, to continue their initial downward movement. They are therefore concentrated towards the annular gap 160 between the baffle 16 and the wall of the vessel 1 and fall through that gap and its prolongation 162 into the sheltered space or settling chamber below, which is shielded by the baffle from the violence of the whirl above and especially from the uprush of pulp towards the outlet 7. The settling chamber remains full of pulp and while shielded from the violent whirl above the baffle, whirling of the fluid column occurs therein above the major diameter portion of the cone 14 so that centrifugal stratification occurs, the stock of lowest consistency, that is, of the maximum dilution of water, and the fine impurities being displaced toward the vertical axis of the whirl. This portion of the settling chamber may be termed the active portion. Below the major diameter portion of the cone 14, and particularly below the ring 11, the centrifugal action is substantially spent. The entry of the impurities into the settling chamber necessarily involves a corresponding displacement of fluid from that chamber, and this can take place by a creeping of pulp from within the skirt 18 through the inclined channel 161 formed between the bevelled edges of the baffle 16 and the skirt 18. Thereafter the heavy impurities settle under gravity, finding little lodgment on the steep cone 14, into the collecting cone 9 and through the cock 21 into the collecting chamber. It is preferable that the opening through the cock 21 should be no greater than is necessary for the passage of the largest agglomerations of impurities encountered; but as that varies with the class of pulp under treatment provision is made by openings 24 and the threading of the bore for readily placing and

holding in the bore a sleeve 23 of such thickness as circumstances admit, or of the removal of any such sleeve when the maximum bore is required. The turning of the cock at right angles to the position shown in Figure 1 does not interrupt the operation of the separator, but only hinders for the few moments occupied in removing, replacing, or exchanging the sleeve, the passage of separated impurities into the collecting chamber. The cock can also be so turned for the purpose of cleaning its bore should it become clogged.

The movement of heavy impurities into the settling chamber is greatly facilitated and encouraged by setting up a slight current of pulp through the annular gap between the baffle 16 and the vessel 1 beyond that afforded by the upward flow between the baffle 16 and the skirt 18. This is done by constantly permitting a stream of material to be forced out from the settling chamber through the pipe 15, the cone 14 and the pipe 13. Since the pipe 13 opens directly and unobstructedly at the most nearly axial point of the whirling column within the entire length of the active portion of the settling chamber, the stream of material passed through is drawn from stock of the lowest consistency, being much diluted, and contains the maximum amount of the small heavy impurities. Where thorough purification is desirable, therefore, the pulp treating plant thus far described is supplemented by extending the pipe 13 directly to the inlet 3 of an auxiliary separator 40. This auxiliary separator may be of similar construction to that of the main separator. It can be of smaller size since the pulp it has to deal with is but a small fraction of the input into the principal separator; and it does not require a pipe 13 the aiding of the flow of heavy impurities into the settling chamber being then done wholly by the spacing between the baffle 16 and the skirt 18 which facilitates upward displacement of material from the settling chamber around the periphery of the baffle. No alteration to the plant so far described is involved in making this addition, save the opening of the cock on pipe 13, for the same pump which supplied the pulp to the principal separator can be made adequate for propelling through the auxiliary separator the fraction of the pulp abstracted through the pipe 13. It is important, however, that the pipe 13 extend directly to the inlet of the auxiliary separator so that force for impelling the pulp therethrough be derived from the pump which forces the pulp through the main separator rather than employing a second pump for this auxiliary separator. The pulp treated by the auxiliary separator, being drawn from the inner portion of the vortex in the main separator, contains a relatively large proportion of small size impurities, and the action of a pump on such impure stock would have the effect of so working the impurities into the fibers as to make later removal of the impurities almost if not quite impossible. By reason of the condition of the pulp delivered to the auxiliary separator very little good fiber is lost in its collecting chamber.

As already indicated in some pulps there may be light impurities which tend to accumulate towards the interior boundary of the vortex of pulp. Removal of these may be provided for by the construction of inlet head shown in Figure 3 which may be substituted for that shown in Figure 1. The helical inlet passage to which the inlet 3 leads is here completed, not by the outlet pipe, but by a depending cylindrical wall 26, having a flange 27 and a lateral outlet 28. The internal diameter of the wall 26 is reduced at its lower end, and the outlet pipe 29 for good pulp fits this reduced part and also an opening in the flange 27. A portion of the annular space enclosed between the wall 26 and pipe 29 is partitioned off by longitudinal ribs 30 seen in dotted lines in Fig. 4, which is an elevation of the lower part of the inlet head projected at right angles to Fig. 3, and in section in Fig. 5. In this portion an opening or port 31 is made through the wall 26 at its lower end. At this part the wall 26 is surrounded by an apertured ring 32, which is rotatable upon the tube, and serves to close the opening 31 save insofar as the aperture in the ring overlaps it. An opening is made in the wall of the vessel 1 opposite the ring 32, and is normally closed by a plug 33 and cap 34. By removal of these access can be had to the ring 32 to turn it so as to close the entrance to the outlet channel 28 as much as desired.

By this means the proportion of pulp allowed to escape from the innermost layers of the vortex can be controlled so as just to carry away such light impurities as are to be found in the particular pulp under treatment.

An alternative construction of parts within the settling chamber is shown in Figure 6 which may be substituted for that shown in Figure 1. Here the pipe 15 connects directly with the pipe 12, and it is surrounded by a hollow cone 35 which is not in communication with it, and which is spaced a little from it at its upper end. The cone is carried from the pipe 15 by a spider 36 and is integral with a cone 37 covering the flange of pipe 12. This construction permits of pulp displaced by the falling heavy impurities rising from the lower part of the settling chamber through the interior of the cone 35, and thence as before through the skirt 18 to the gap 161 between it and the baffle 16.

I claim:

1. In a paper pulp separator, the combination with a vortex vessel having a pulp inlet tangential to said vessel at the upper end thereof, and a central pulp outlet pipe extending through the upper end of said vessel to a distance below said inlet, of a baffle dividing the vortex vessel below said outlet pipe into a vortex chamber above said baffle and a settling chamber below said baffle communicating only through a restricted annular passage between the periphery of said baffle and the wall of the vessel, and a skirt supported within said vessel beneath said baffle prolonging said annular passage, there being a second passage providing for upward flow from within said skirt outwardly into said restricted passage around said baffle, and means for collecting material which settles in said settling chamber.

2. In a paper pulp separator, the combination with a vortex vessel having a pulp inlet tangential to said vessel at the upper end thereof, and a central pulp outlet pipe extending through the upper end of said vessel to a distance below said inlet, of a baffle dividing the vortex vessel below said outlet pipe into a vortex chamber above said baffle and a settling chamber below said baffle communicating only through a restricted annular passage between the periphery of said baffle and the wall of the vessel, and a skirt supported within said vessel beneath and spaced from said baffle prolonging said annular passage, the periphery of said baffle being downwardly and inwardly beveled and the upper edge of said skirt

similarly beveled to define between them an upwardly and outwardly inclined passage providing for upward and outward flow from within said skirt into said annular passage, and means for collecting material which settles in said settling chamber.

3. Apparatus for treating paper pulp comprising a cylindrical vortex vessel having a tangential inlet at its top and a central pulp outlet pipe extending through the upper end of said vessel to a distance below said inlet, a baffle extending transversely across said vessel below said pipe, said baffle having a periphery spaced from the vessel wall to provide a narrow annular passage therebetween, said baffle dividing said vessel into an upper vortex chamber and a lower settling chamber communicating with each other only by said annular passage, and a second pipe extending into said settling chamber and opening directly into said settling chamber beneath the center of said baffle in position to receive therein material reaching the most nearly axial position within said settling chamber and for discharge of such material from said vessel.

4. Apparatus for treating pulp, comprising a pair of elongated cylindrical vortex vessels each having a tangential inlet at the top thereof and a central outlet pipe extending through the top thereof and downwardly below said inlet, a baffle within and extending transversely across each vessel beneath said outlet pipe and dividing the vessel into a vortex chamber above and a settling chamber below said baffle communicating with each other through a restricted passage between the periphery of said baffle and the vessel wall, a skirt within each vessel spaced below said baffle and forming with said vessel wall a continuation of said restricted passage, said space forming a second annular passage providing for upward flow from within said skirt around the periphery of said baffle, and a pipe extending into the settling chamber of the first and principal separator and opening unobstructedly beneath said baffle in position to receive therein all material reaching the most nearly axial position within said settling chamber, said pipe leading directly to the inlet of the other vortex vessel, said other vortex vessel being substantially smaller than said first vessel.

5. Apparatus for treating pulp, comprising a pair of elongated cylindrical vortex vessels each having a tangential inlet at the top thereof and a central outlet pipe extending through the top thereof and downwardly below said inlet, a baffle within and extending transversely across each vessel beneath its outlet pipe and dividing the vessel into a vortex chamber above and a settling chamber below said baffle communicating with each other through a restricted passage between the periphery of said baffle and the vessel wall, a skirt within each vessel spaced below said baffle and forming with said vessel wall a continuation of said restricted passage, the periphery of said baffle being downwardly and inwardly beveled and the upper edge of said skirt similarly beveled to define between them an upwardly and outwardly inclined passage providing for an upward and outward flow from within said skirt into said annular passage, and a pipe extending upwardly through the settling chamber of the first and principal vessel and opening directly into said settling chamber centrally beneath the baffle of said first vessel and in position to receive therein fluid from the most nearly axial position within the active length of said settling chamber, said second pipe leading directly to the inlet of the other vortex vessel, said other vortex vessel being substantially smaller than said first vessel.

6. In a paper pulp separator the combination with a vortex vessel having a pulp inlet tangential to said vessel at the upper end thereof and a central pulp outlet extending through the upper end of said vessel to a distance below said inlet, of a pipe mounted centrally in the lower part of said vessel and communicating with a channel extending to and through the wall of said vessel, a baffle supported above said pipe, said pipe opening beneath the baffle in position to receive fluid therein from the most nearly axial position between said baffle and channel, said baffle dividing the vortex vessel into a vortex chamber and settling chamber communicating only by a restricted annular passage between the periphery of said baffle and the wall of the vessel, a skirt supported beneath and spaced from the periphery of said baffle prolonging said annular passage, said space forming a second annular passage providing for upward flow from within said skirt around said baffle through said first-mentioned annular passage, and means for collecting material which settles in said settling chamber.

7. In a paper pulp separator, the combination with a vortex vessel having a pulp inlet tangential to said vessel at the upper end thereof and a central pulp outlet pipe extending through the upper end of said vessel to a distance below said inlet, of a baffle dividing the vortex vessel into a vortex chamber and a settling chamber communicating with each other only by a restricted annular passage between the periphery of said baffle and the wall of the vessel, a skirt supported beneath and spaced from the periphery of said baffle prolonging said annular passage, the space between said skirt and baffle forming a channel providing for upward flow of pulp from within said skirt around said baffle, means for collecting material which settles into said settling chamber, and a pipe extending centrally within said skirt and open at its upper end beneath said baffle to receive material from the nearest to the axial center within the length of said skirt and leading outside of said vessel below said skirt.

8. In a paper pulp separator, the combination with a vortex vessel having a pulp inlet tangential to said vessel at the upper end thereof and a central pulp outlet pipe extending through the upper end of said vessel to a distance below said inlet, of a baffle dividing the vortex vessel into a vortex chamber and a settling chamber communicating with each other only by a restricted annular passage between the periphery of said baffle and the wall of the vessel, the outer edge of said baffle being inwardly and downwardly beveled, a skirt positioned beneath said outer edge and defining therewith a narrow downwardly and inwardly inclined annular passage through which pulp may pass upward from within said skirt around said baffle, said skirt forming between its outer face and the vessel wall a continuation of said restricted annular passage between said baffle and vessel wall, and a pipe having a lateral aperture centrally of and beneath said baffle in position to receive material from within said settling chamber nearest to the central axis thereof, said pipe leading outwardly from said settling chamber and through which pulp may be forced out from said vessel.

9. Apparatus for treating paper pulp comprising a cylindrical vortex vessel having a tangential inlet at its top and a central outlet pipe extending downward from its top to a depth at which the desired separation is substantially effected, means for shielding the lower part of said vessel from the vortex action, said means being so spaced from the walls of said vortex vessel as to provide a restricted narrow annular space for the passage of heavy impurities into the shielded space, a pipe surrounding said first-mentioned pipe and defining therewith a light impurities outlet channel extending downward from the top of the vessel to a depth at which the desired separation is substantially effected, the outer face of said last-mentioned pipe forming the inner boundary of the vortex of pulp and having an inlet port therein, and means for adjusting the area of said inlet port, said central outlet pipe being extended below said port.

10. In an apparatus for treating paper pulp the combination with a cylindrical vortex vessel having a tangential inlet at its upper end, of a cylindrical wall coaxial with said vessel depending from its upper end therein to a depth at which the desired separation is substantially effected, a second cylindrical wall coaxial with said first-mentioned wall and spaced therefrom to provide a channel formed between said walls closed at its lower end and extending out of the separator and having an opening through the outer wall near its lower end, an apertured ring rotatably mounted upon the lower end of said last-mentioned wall and closing said opening except so far as the aperture overlaps said opening, and a removable cap closing an opening in the wall of said vortex vessel beside said ring for giving access to said ring for adjusting and cleaning it.

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