This invention relates to improvements in centrifugal separators by means of which a fluid can be separated from impurities of different specific gravity. While applicable to centrifugal separators in general, the invention relates more specifically to separators for removing foreign matter from aqueous suspensions of cellulosic material such as wood pulp, ground wood, cotton linters, bagasse, corn stalks, bamboo, or other fibers. Centrifugal separators of this type ordinarily consist of a cylindrical drum rotatable about its axis. The stock is fed in at one end and flows along the drum to the other end over one or more annular rings which extend inwardly from the drum. The stock flowing through the drum is held against the wall of the drum by the centrifugal force of rotation. The capacity of a separator of given diameter, that is, the rate at which pulp will be passed through the drum and properly purified, is limited. When the separator is first started up, the first pulp entering forms a soft mat or lining within the drum, over which flows the pulp stream. This mat combs the fibers in the stream and catches and holds the dirt particles which are found therein. The heavier dirt particles gradually work through the mat toward the drum wall while the mat itself tends to become gradually more compact. If an increase of capacity is attempted by increasing the speed of rotation above the optimum speed, the mat tends to pack rapidly and thus to diminish its capacity for catching and holding dirt particles from the pulp stream. Thus, capacity cannot be increased beyond a certain point by an increase of speed.

According to the invention, the capacity of a separator of given diameter may be nearly doubled by mounting a second drum within the first, sufficient clearance being provided between the walls of the two drums for a stream of pulp to flow along the wall of the outer drum. A second stream is introduced into the inner drum and flows along the drum to the discharge end where the streams from both drums may be discharged into a common receiving channel or into separate receivers. This increase in capacity involves no additional required floor space so that a separator embodying the invention is especially advantageous where available floor space is limited. As the diameters of the two drums preferably do not greatly differ, a speed of rotation which is just sufficient for the effective operation of the inner drum is suitable for satisfactory operation of the outer drum also. According to the invention, more than two concentric drums or shells may be provided, but there is a practical limit to such multiplication of drums owing to the fact that the drums must be spaced from one another, and if the difference between the diameter of the innermost drum and that of the outermost drum is too great, the difference between the centrifugal forces acting in these drums will be too great for satisfactory operation.

For a more complete understanding of the invention, reference may be had to the following description thereof and to the illustration thereof on the drawing, of which,—

Figure 1 is an elevation of an embodiment of the invention, a portion being broken away to show the working parts in section.

Figure 2 is a plan view of the mechanism shown in Figure 1, this figure being drawn to a smaller scale.

Figure 3 is a fragmentary sectional view of a portion of Figure 1, drawn to a larger scale, and showing the course of the streams of pulp passing therethrough.

The embodiment of the invention illustrated on the drawing comprises a rotatable drum 10 within which is mounted an inner drum 11, the drums being coaxial and radially spaced. These drums are mounted by suitable framework on a shaft 12 to which is coupled a suitable motor 13 or other equivalent source of power. On the drawing the shaft 12 is shown in a vertical position with the motor attached to the lower end. This arrangement is merely illustrative and the invention is not to be limited thereto. At the lower end of the drum 10 an inwardly extending flange 14 is provided, an open frame 15 being provided to connect this end of the drum rigidly with the corresponding end of the drum 11. The lower end of the drum 11 is secured to a conical supporting member 16 having a series of suitable openings 17 through which the interior of the drum may be washed when the mechanism is stopped. As shown, the supporting member 16 is mounted on the upper end of the shaft 12 approximately flush with the upper ends of the drums 10 and 11. The member 16 extends downwardly in conical shape and flares outwardly to reach the lower end of the drum 11 to which it is secured. This open structure provides space for the insertion of a feed pipe 18 thereby through which pulp stock or other liquid to be purified may be fed into the lower portion of the drum 11. The flange 14 of the drum 10 may extend lower than the end of the drum 11 to receive pulp stock through a feed pipe 18.

Within each of the drums 10 and 11 are one or
more rings 20 and 21. These rings extend inwardly from the shells of the respective drums and serve as barriers over which the pulp stock must flow in its upward course from the lower ends of the drums. At the upper end of the drum 10 an enlarged portion 22 may be provided having an inwardly extending lip 23. In like manner the drum 11 is provided with an enlarged portion 24 having an inwardly extending lip 25 at its upper extremity. A skimming ring 26 is provided for the drum 10, this ring being concentrically mounted on the exterior of the drum 11 and extending radially outward into the stream of pulp stock flowing along the shell of the drum 10. In like manner a skimming ring 27 is mounted within the drum 11 and projects radially toward the enlarged portion 24 of the drum 11, so that its outer edge is immersed in a stream of pulp stock in the enlarged portion 24 during the operation of the mechanism. The skimming rings 26 and 27 are preferably adjustable up and down so as to vary the clearances 28 and 29 respectively between the rings and the ends of the adjacent lips 23 and 25.

The drums are surrounded by a suitable housing 30, the upper portion of which is formed in the shape of a suitable channel 31 to receive pulp stock which flows over the lips 23 and 25. In order to avoid interference between the streams of pulp discharged into the channel 31, the lip 25 may be extended slightly above the lip 23, as shown in Figures 1 and 3. The pulp received in the channel 31 may be led off by any suitable discharge pipe 32.

When operating the mechanism, the motor 13 is started to rotate the drums 10 and 11 at a suitable speed, this speed depending on the average diameter of the drums. When the drums have been brought up to speed, pulp stock is admitted through the supply pipes 18 and 19, the rate of supply for each drum depending on the diameter thereof. The streams of incoming stock are forced against the respective drums by centrifugal force and form pools below the ring 20 until the depth of these pools is sufficient to enable the stock to flow between the respective rings into the compartments above. The pulp in the pools of stock below the rings 20 forms a soft mat which very gradually packs during the operation of the mechanism. Meanwhile the continued supply of pulp stock flows over the mats below the rings 20, the mats exerting a brushing action on the flowing stock which tends to straighten out the fibers and to catch particles of knots, sand, or other impurities which have substantially the same or greater density than that of the pulp itself. As the pulp flows over the rings 20 in thin streams, the edges of the rings tend to break up fiber bunches and thus tend to promote a more even distribution of the pulp through the aqueous vehicle.

The lips 25 and 26 are arranged respectively outward a short distance in comparison with their respective rings 20 so that while the lips act as dams to form pools above the rings 20, the surfaces of these pools are radially outward with respect to the surfaces of the pools below the rings 20. The skimming rings 26 and 27, which project outwardly toward the enlarged portions 22 and 24, project beneath the surface of the upper pools of stock so that impurities having a lower density than the stock are thus carried on the surface of the pools not caught by the skimming rings so that only the purified middle stratum of stock escapes around the skimming rings and through the clearances 28 and 29 between the skimming rings and the respective lips of the drums. The skimming rings are preferably adjustable to vary the clearances 28 and 29 so as to regulate the depth of the upper pools of stock. The depth of either pool can be increased by diminishing the clearance between its skimming ring and the adjacent lip. The sharp edges of the lips 23 and 25 have an additional combing effect on the pulp which further breaks up any fiber bunches present in the stock.

The clearance or spacing between the drums 10 and 11 is preferably as small as possible, consistent with the accommodation of the skimming rings in the outer drum 10 during the operation of the machine. This minimum clearance is desirable in order not to have too great a difference in the centrifugal forces acting in the respective drums.

Since the drums are of nearly the same size, the capacities of the two are approximately equal so that the capacity of the mechanism as a whole is substantially double that of a similar mechanism having but a single drum of the same diameter.

I claim:

1. Apparatus for purifying pulp stock, which comprises a rotatable vertical shaft, a conical support member secured at its upper end to said shaft to rotate therewith and diverging downwardly therefrom, an outwardly projecting flange at the lower end of said supporting member having apertures therein for the drainage of wash water, and a plurality of nested, radially spaced cylindrical drums supported by said flange, said drums having end flanges and intermediate annular ribs to retain series of pulp mats and overflowings of pulp stock therein during the rotation thereof and to determine the depth of said pools.

2. Apparatus for purifying pulp stock, comprising a vertical rotatable shaft, a conical support member secured at its upper end to said shaft for rotation therewith and extending downwardly and outwardly, a pair of nested cylindrical drums supported adjacent to their lower ends by said support member, said drums having end flanges and intermediate annular ribs to retain series of pulp mats and overlying pools of pulp stock therein during the rotation thereof and to determine the depth of said pools, means for feeding into the several drums at the same end separate streams of pulp to be purified, and means for collecting the purified pulp discharged from the opposite end of the drums.

3. Apparatus for purifying pulp stock, comprising a vertical rotatable shaft, a conical support member secured at its upper end to said shaft and diverging downwardly away from the shaft, a plurality of nested cylindrical drums supported by the lower end of said member, each said drum having an inwardly projecting flange at its upper end and a second flange at its lower end projecting inwardly further toward the axis, means for feeding separate streams of pulp into the several drums adjacent to the lower flanges thereof, and means for collecting the pulp discharged over the upper flanges thereof.

4. Apparatus for purifying pulp stock, comprising a vertical rotatable shaft, a conical support member secured small end uppermost to said shaft, a plurality of cylindrical drums supported adjacent to their lower ends by the lower end of said support member, each said drum having an inwardly projecting flange at its lower end and upper end and between said ends, the inner diameter of the uppermost flange in each drum being greater than that of the corresponding
lowermost flange, means for feeding separate streams of pulp into the lower ends of the several drums, and means for collecting the pulp discharged from the upper ends of said drums.

5. Apparatus for purifying paper-pulp stock, comprising a plurality of nested, substantially vertical radially spaced rotatable cylindrical drum, end members within the upper and lower ends of said drums adapted to retain pools of pulp-stock within said drums during rotation thereof, the upper end members being formed to provide for the free and unobstructed escape of purified pulp stock over the upper rims of the drums, the lower end members being formed to provide substantial openings for the escape of wash water and dirt-retaining fiber when the drums are stopped and washed, and to prevent downward escape of pulp stock from the drums during operation thereof, and means for supplying to the several drums separate streams of pulp stock to be purified.

6. Apparatus for purifying paper-pulp stock, comprising a plurality of nested, radially spaced cylindrical drums rotatable about a common vertical axis, end members within the upper and lower ends of said drums adapted to retain therein pools of stock during the operation thereof, said upper end members consisting of rings extending radially inward and terminating in edges forming complete circles concentric with the axis of rotation for the unobstructed discharge of excess pulp stock thereover, said lower end members having substantial openings therein for the escape of wash water and dirt-retaining fiber when the drums are stopped and washed, skimming members in said drums, and means for feeding into the several drums near the lower ends thereof separate streams of stock to be purified.

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