

May 7, 1940.

T. A. BRYSON

2,199,848

CENTRIFUGAL MECHANISM

Filed Jan. 24, 1933

3 Sheets-Sheet 1

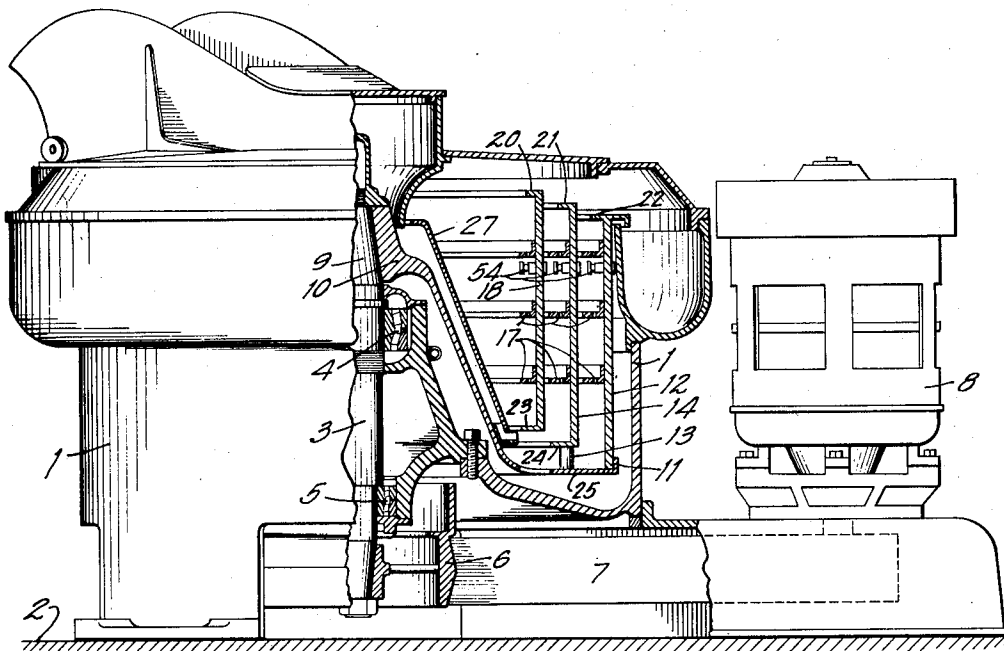


FIG. 1

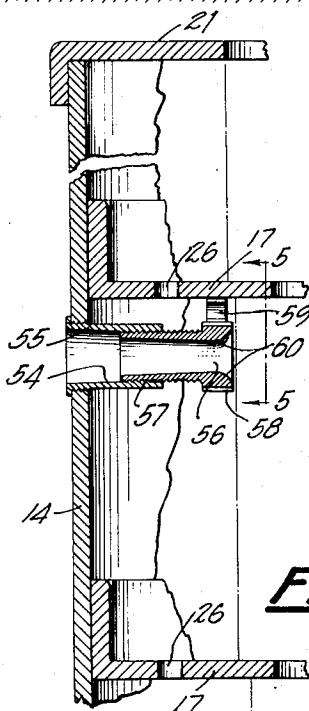


FIG. 2

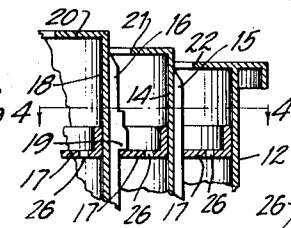


FIG. 3

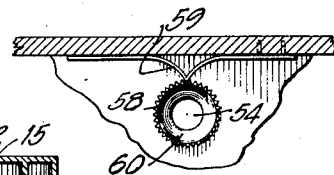
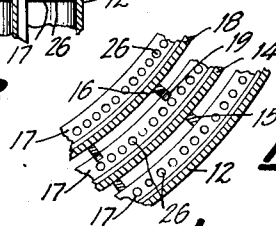


FIG. 4



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3 Sheets-Sheet 2

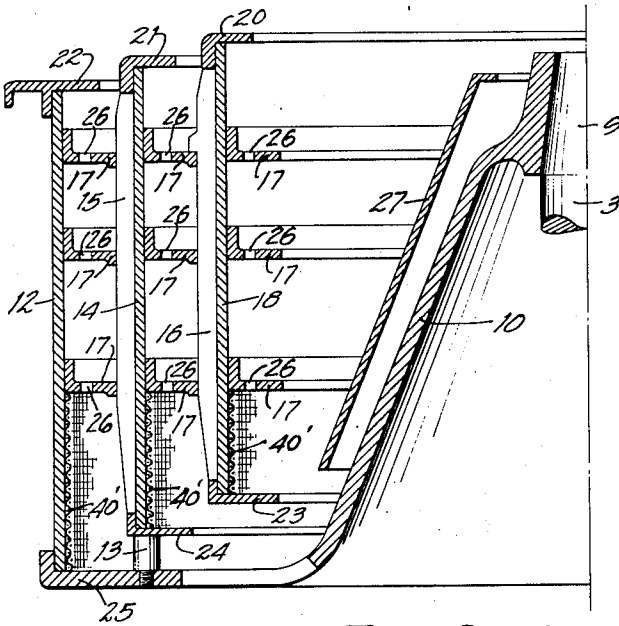


Fig. 6

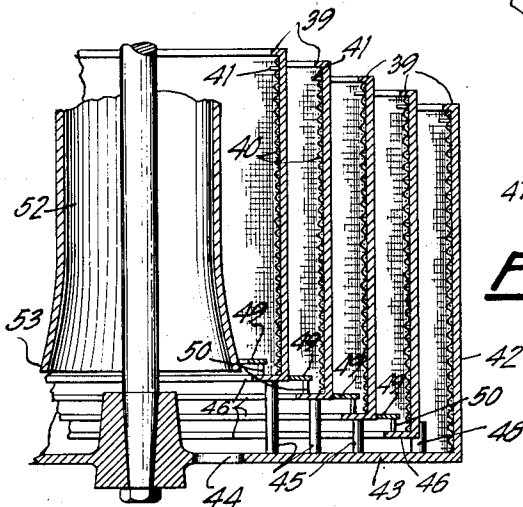


Fig. 7

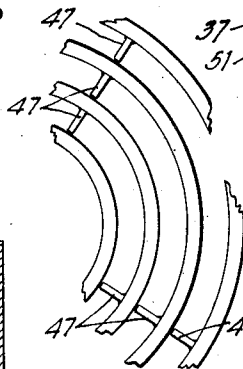


Fig. 7a

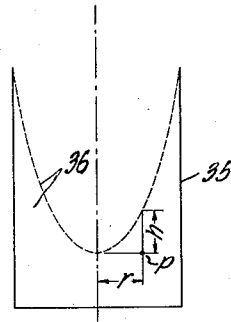


Fig. 8

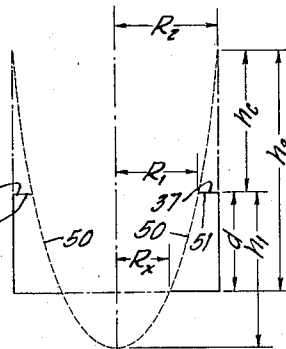


Fig. 9

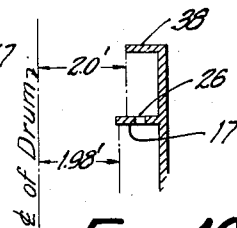


Fig. 10

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3 Sheets-Sheet 3

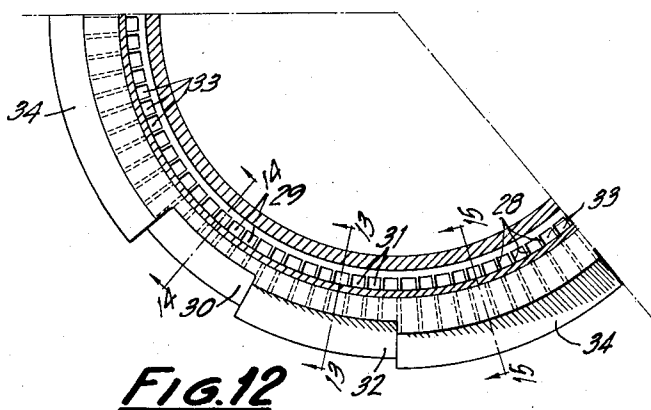


FIG. 12

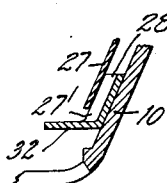


FIG. 13

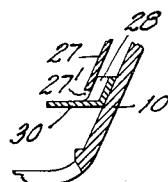


FIG. 14

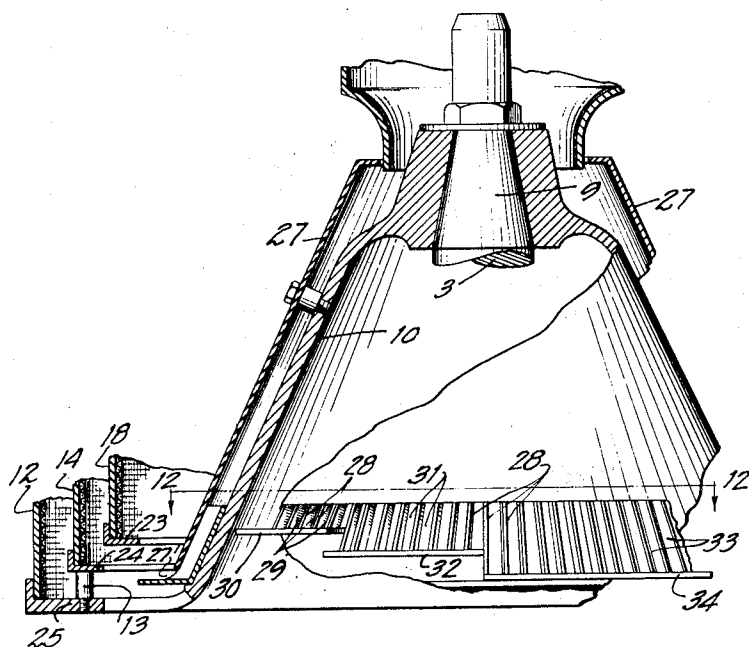


FIG. 11

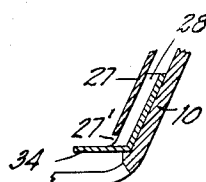


FIG. 15

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CENTRIFUGAL MECHANISM

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Application January 24, 1933, Serial No. 653,271
In Great Britain August 14, 1931

9 Claims. (Cl. 233—17)

My invention relates to centrifugal machines of the sedimentation type which are employed for the treatment or purification of liquid material. More particularly it relates to machines of this general character comprising a plurality of co-axially arranged drums nested, one within the other, and into each of which material to be treated is simultaneously fed in parallel, and from each of which fully treated material is simultaneously withdrawn.

This application is a continuation in part of my application, Ser. No. 477,965, filed August 26, 1930, and, while it is to be distinctly understood that my machine is not limited thereto, it is particularly applicable to the treatment of paper pulp or other fibrous material.

In my said copending application I have described and broadly claimed a centrifugal machine of the multiple nested drum type to which the material is fed and from which it is discharged in the manner described above. In a machine of this type, in which each drum functions as a purifier independently of each other drum, it is practically necessary that the material in passing through any drum be purified substantially to the same degree as the material passing through every other drum, and to provide such a machine is one of the objects of this invention.

It is well known to those skilled in the art that the effect upon efficiency of separation of variations of a few percent (say up to 5%) in centrifugal force cannot be observed except in very rare instances. If the variation in centrifugal effect between one drum and another of a two drum unit is to be maintained within limits which ordinarily are not observable, that is in the neighborhood of 5% from the average, then, since the drums are both running at the same rotative speed and develop centrifugal force in proportion to their respective diameters, it follows that the diameters of the two drums cannot differ more than about 10%.

In the actual manufacture of multiple drum machines of the type in which both "heavies" and "lights" are removed, practical considerations demand that the radial space between the inside of one drum and the outside of the next inner drum be in the order of three inches or more; that is, two adjacent drums must differ in diameter by at least six inches. Considering the effect of these two limitations, it is apparent that the minimum size of drum which can be employed has a diameter equal to 6 divided by 0.1 or 60". In many cases, however, machines con-

structed with drums of 60" diameter and larger require more than the floor space which can be economically spared.

In the practical manufacture and operation of three-drum machines of the type mentioned, it was soon discovered that where the diameter of the drums employed was substantially under 60" in diameter, the machine could be operated under conditions which would make any one of the drums effective but it was not possible to make all the drums equally effective without modification in design. When the outer drum was operated effectively the inner drums tended to become clogged with fiber regardless of the amount of stock which was fed to them. Increasing the feed to the smaller drums, the usual procedure to prevent clogging in a single drum machine, did not correct the trouble, because the inner drums would not accept all the material fed at the increased rate. The excess flowed under the flange rings of the inner drums until it reached the outer drum where, having no other place to go, it overflowed the baffles in this drum, and destroyed the proper proportion of feed thereto.

The primary object of my present invention, therefore, is to provide a multiple drum machine of the character described which is so designed that each drum unit thereof will operate at its maximum efficiency; and in which the material in passing through any drum will be subjected to a purifying treatment to substantially the same degree as the material passing through each other drum, or in other words, subjected to substantially the same force-time effect.

Another object is to provide a machine of this type having a novel and improved means for positively and properly fractionating the feed of material between the separate drums.

Another object is to provide a machine of this type in which a common feed is employed but in which each of the inner drums is so designed that it will accept only its proper proportion of the total volume of material offered and will reject the excess passing it along to the next outer drum.

Another object of my invention is to provide a means for continuously withdrawing the lighter impurities in the material being treated as they are segregated in the drums and, in connection therewith, to provide an adjustable means of this character whereby the gravity of the lighter materials so withdrawn may be varied.

Another object is to provide a machine of this type having a novel means for anchoring heavy dirt therein and eliminating or reducing

tangential swirl particularly in drums which are not provided with intermediate baffles such as described in my United States Patent No. 1,828,096 or which may be applied to machines of the type described in that patent for the purpose of anchoring heavy dirt and preventing swirl in the lower compartment.

A further object of my invention is to provide a multiple drum machine of the general character described but which will have an unusually large capacity for the removal of heavy dirt only and which is particularly adapted for removing grind stone grit from paper stock consisting wholly or in part of ground wood. A still further object is to provide a multiple drum machine of such design that each inner drum may be readily withdrawn from the next outer drum to facilitate cleaning.

With these objects in view, my invention includes the novel elements and the combinations and arrangements thereof described below and illustrated in the accompanying drawings in which—

Fig. 1 is an elevation view, partially in section and with some details omitted, of a multiple drum machine embodying some of the features of my invention;

Fig. 2 is an enlarged fragmentary vertical section of the upper portion of one of my drums;

Fig. 3 is a fragmentary vertical section of a portion of a three drum assembly taken near the top thereof and illustrating how the innermost drum is supported on the next larger drum;

Fig. 4 is a section of Fig. 3 in the plane 4—4;

Fig. 5 is a fragmentary sectional view of Fig. 2 in the plane 5—5;

Fig. 6 is a fragmentary vertical section of a three drum assembly embodying a novel feature of my invention;

Fig. 7 is a fragmentary vertical section of a five drum machine for the removal of heavy dirt only and which is provided with the novel means of my invention for anchoring heavy dirt and for restricting the acceptance of each of the drums to its separating capacity;

Fig. 7a is a fragmentary plan view of a drum assembly;

Figs. 8 and 9 are diagrams illustrating the action of a liquid subjected to centrifugal force;

Fig. 10 is a fragmentary vertical section near the top of one of my drums showing, in a more or less diagrammatic way, the centrifugal head upon the orifices of the upper intermediate baffles;

Fig. 11 is a fragmentary elevation view, partially in section, of a centrifugal machine embodying my novel feeding means for positively fractionating the supply of material to each of the drums in accordance with its capacity;

Fig. 12 is a section of Fig. 11 in the plane 12—12;

Fig. 13 is a fragmentary section of Fig. 12 in the plane 13—13;

Fig. 14 is a fragmentary section of Fig. 12 in the plane 14—14; and

Fig. 15 is a fragmentary section of Fig. 12 in the plane 15—15.

Referring to the drawings and particularly to Figs. 1, 3, 4, 11, 12, 13, 14 and 15 thereof, my invention includes a stationary casing, 1, which is mounted upon a suitable foundation 2 and contains the multiple drum assembly. The rotating unit comprises a vertical spindle 3, mounted in anti-friction bearings 4 and 5, and provided at its bottom with a pulley 6 having a rope or belt

drive 7 from the motor 8. The upper portion of the spindle 3 is tapered as shown at 9 and seated thereover and secured thereto is a conical element 10. The element 10 extends downwardly and outwardly, and at its lower outer extremity is provided with a peripheral flange 11 within which the larger and outermost drum 12 is supported. The element 10 is provided with a plurality of upwardly projecting studs 13 upon which the next inner drum 14 is supported. Each of the inner drums is provided on its exterior with a plurality of vertically extending staves, 15 and 16, (see Fig. 3) which coact with the intermediate rings or baffles 17, of the next larger drum to center the inner drums therein. The innermost drum 18 is supported upon the top intermediate baffle 17 of the drum 14 by means of projections 19 on staves 16 which rest thereon as shown in Fig. 3. The drums are provided at their upper ends with inwardly projecting peripheral lips 20, 21 and 22, respectively, and the lower ends are provided with like lips or flanges 23, 24 and 25, respectively, which serve to retain the layers of material in each drum while it is being centrifuged. Intermediate the upper and the lower lips or flanges of the drums and secured to the drum walls are spaced intermediate baffles 17, having perforations or openings 26 therein (see Figs. 3 and 4) forming submerged orifices. The orifices in any intermediate baffle lie upon a circle concentric with the drum axis and the radial width of the orifices is limited to the radial depth or thickness of the zone of material of desired gravity. Otherwise these intermediate baffles are imperforate and they perform the same functions as described in my United States Patent No. 1,828,096. The submerged orifices and the upper and lower peripheral lips having inside diameters proportioned as hereinafter described cooperate to control the rate at which material is accepted and flows through each individual drum so that the material passing through all of the drums is subjected to substantially the same force-time effect.

Surrounding the conical element 10 and slightly spaced therefrom, is a second conical element 27. The space between the elements 10 and 27 forms a duct through which all of the material is fed to the respective drums. In Figs. 6 and 7 all of the material is fed directly to the inner drum and this drum is so designed, as will be explained, that it will accept only its proper proportion of the total volume. The excess which is rejected by the inner drum flows under the lower lip of flange 23 and is initially delivered into the next larger drum. The next larger drum is also designed to accept only its proper proportion of the excess material rejected by the inner drum and will pass what it does not accept to the next outer drum. Where more than two inner drums are employed, such as in the type of machine shown in Fig. 7, each is designed to accept its proper proportion only and to reject the excess, which is passed along from drum to drum.

In Figs. 1, 11, 12, 13 and 14, I have shown a pump or impeller arrangement in connection with the conical elements 10 and 27 which will positively fractionate the total feed between the several drums in accordance with their separating capacities. The details of this fractionating will best be understood by a consideration of Figs. 11 to 15 inclusive. Instead of leaving a clear unobstructed opening at the bottom of the duct formed by the elements 10 and 27, this opening, 75

as shown in Figs. 11 and 12, is sub-divided into a multiplicity of separate passages or openings by means of blades 28. These blades are of different vertical extent, as shown in Figs. 11 to 15 inclusive, and the total number of openings so formed is divided into a plurality of groups, one group feeding each of the drums. For example, the inner drum is fed from groups of openings 29 between blades, each of which terminates in an arcuate flange 30, the upper surface of which is slightly above the upper surface of the lower lip or flange 23 of the inner drum. The intermediate drum is fed from groups of openings 31 between blades, each of which terminates in a peripheral flange 32, the upper surface of which is horizontal and slightly above the upper surface of the lower peripheral lip or flange 24 of the intermediate drum. The outer drum is fed from groups of openings 33 between blades, each of which terminates in an arcuate flange 34, the upper surface of which is disposed at a somewhat higher elevation than the upper surface of the lower peripheral lip or flange 25 of the outer drum. The various groups of blades are, of course, symmetrically arranged about the axis of the machine to avoid any unbalancing effects and the total number of openings or passages between the blades in those groups which feed the inner drum, for example, bears the same proportion to the total number of openings in those groups which feed the outer drum as the separating capacity of the inner drum bears to the separating capacity of the outer drum. The element 27 is appropriately notched or cut away at the bottom so that openings of uniform height are provided between each group of blades, as shown at 27'.

In order that a clear understanding may be had of the principles controlling the design of a multiple drum machine of the type contemplated, it may be well to compare the operation of a centrifugal machine with that of a gravity riffler.

A gravity riffler is essentially a shallow trough or flume through which paper stock to be purified is flowed. In the bottom of the trough are shallow submerged dams placed transversely to the direction of flow. These dams provide a quiet area into which the heavy impurities may settle and into which, incidentally, flows a small portion of the fiber.

A vertical baffle or inverted weir may also be placed across the trough for the skimming off and retention of impurities which being lighter than the other constituents of the stock may rise to the surface.

Since the cellulosic fiber is of a somewhat greater specific gravity than water and it is desired that impurities be removed from the mixture, it is apparent that the fiber must not be allowed to settle in accordance with its natural tendency. This is accomplished by maintaining a rate of flow of stock through the device such that it remains therein long enough to dispose of its impurities by sedimentation and flotation, and sufficient current must be maintained to wash the fiber along before it is precipitated. The principle of operation is that of elutriation whereby material, such as clay for example, may be washed along in a current of water in such a manner that the quick-settling particles are deposited in the early stages of its course of flow and the slowest-settling particles are collected near the end of its path of treatment.

It happens that the impurities ordinarily found

in paper stock are such that they are more rapidly moved by precipitation or flotation forces and are less affected by the current than are the relatively large-surface, low-weight, fiber particles. In other words, fiber may be classed as a slow-settling particle to the extent that it follows more stubbornly the course of the liquid than does a compact, more or less spherical body, in which latter form most of the impurities occur.

In the paper stock riffler, elutriation is not carried on until all particles are precipitated, but the process is stopped before the fiber has time to settle out of the path of flow. In other words the rate of flow and the length of path are so proportioned to the intensity of the separating force, which in this case is gravity, that only the impurities are removed and the fiber is withdrawn with the water.

In a centrifugal machine the separating force is centrifugally generated and is usually far greater than the force of gravity. It is, therefore, necessary to proportion the rate of flow and the length of path to this new force intensity in order to accomplish the desired results. Obviously, a single drum centrifugal machine requires no particular provisions to meet these described conditions of separation for it is only necessary so to regulate the feed as to create a flow balanced to the length of path and to the centrifugal force acting. Whatever stock is fed to the drum must pass through it.

In the multiple drum machine, in which each drum develops a different value of centrifugal force and has a different area of riffing surface, the problem of meeting the above described conditions for separation of impurities while discharging fiber requires novel variations in construction.

In a centrifugal machine, the radial depth of head must be sufficient to generate a centrifugal head great enough to force the desired amount of material therethrough. In the single drum machine this requirement may be easily met and without special provision since the whole space in the drum inside of the wall of material being treated is available wherein this head may be built up. In the multiple drum machine, where the above described limitation in increment of drum diameter must be met, the space devoted to centrifugal head must be carefully conserved. However, by proper provision of centrifugal head, it is possible to make effective a range of drum sizes which produce much more than a 10% range in centrifugal effect.

In a centrifugal machine the flow requirement of the different drums is further complicated by the fact that different drums produce different centrifugal force which must be balanced by flow rate; whereas in the riffler the force is the constant one of gravity. Consequently, in a multiple drum machine a centrifugal head must be provided in harmony with this condition.

As stated above, while it is not necessary, I nevertheless prefer to provide my drums intermediate the top and bottom with a plurality of perforated baffles of such design as will enhance the separation of impurities. These baffles offer some restriction to stock flow and, in order to hold the flow to the proper balance for centrifugal effect, it is necessary to provide additional centrifugal head to overcome this restriction. The restriction of the baffles does not necessarily vary in the different drums in accordance with the variance of separation or desired flow capaci-

ty. Therefore, it is necessary to provide appropriate variations in centrifugal head in the different drums to meet this requirement.

Referring to Fig. 8, I have here shown a container 35 partially filled with liquid 36 and subjected to rotation about a vertical axis. Any point p in the body of the liquid has a velocity due to rotation, v equals $2\pi rn$, in which v is velocity in feet per second, r is the distance of point p from the axis in feet, and n is the number of revolutions per second. While this liquid is not necessarily flowing within the container but has velocity merely by rotation of the vessel, the same relation between velocity and velocity head attains as if the liquid were actually flowing at this velocity. This relation between velocity and head is expressed by the formula V^2 equals $2gh$ in which g is the acceleration due to gravity and h is the head.

Hydraulic pressure is exerted equally in all directions. Since the rotation of the vessel generates only centrifugal force and that in a radial direction this velocity head must be balanced in an axial direction only by gravity head. That is, since equilibrium exists at the point p , there must be a gravity head over that point of an amount h equal to

$$\frac{V^2}{2g}$$

By laying off this distance h above the point p a point in the surface of the liquid, when subjected to the assumed conditions, is determined. Other points may be found in the same way and the whole surface thus determined.

If, in the formula

$$h = v^2/2g$$

we substitute $2\pi rn$ for v , we then have

$$h = \frac{2\pi^2 r^2 n^2}{g}$$

This indicates that the surface of the liquid is a paraboloid of revolution.

In the above case it was assumed that no pressure head, other than that necessary to balance velocity, was acting at the point, p . Hence, the origin of the paraboloid of revolution represented by the surface of the liquid, is in the horizontal plane passing through the point p .

Referring now to Fig. 9, let it be assumed that the liquid is contained in a revolving drum, such as shown by the solid lines, which has an in-turned upper lip 37 and the dimensions indicated in the figure. The origin of the paraboloid may be located in accordance with the formula.

$$h_1 = 2\pi^2 R_1^2 n^2 / g$$

The maximum intensity of pressure on the top ring, that is at radius R_2 is obviously

$$h_c = h_2 - h_1 = \frac{2\pi^2 n^2}{g} (R_2^2 - R_1^2)$$

The intensity of pressure on the top ring varies from zero at its inner lip to the above value as the maximum at its outer periphery.

If the depth of the drum is d , it is possible to find the value of R_x as follows:

$$h_1 - (h_1 - d) = \frac{2\pi^2 n^2}{g} (R_1^2 - R_x^2)$$

or

$$R_x = \sqrt{R_1^2 - \frac{dg}{2\pi^2 n^2}}$$

Referring now to Fig. 10 which indicates a

fragmentary section of one drum of a centrifugal machine, provided with an upper lip 38 and an intermediate baffle 17 provided with perforations 26, let it be assumed that a static head of roughly 5 feet, is necessary to force the material through the perforations 26 at the desired velocity. Then, by means of the formulae above indicated, and assuming that the radius of the inner edge of the upper lip is 2 feet, the radius of the inner edge of the flange 17 can be determined as approximately 1.98 feet if the revolutions per minute of the machine are about 600. In other words, at this velocity a difference of about .02 of a foot in radius in the surface above and below the baffle corresponds to a differential pressure head about equivalent to a five foot gravity head. This result is not absolutely correct since the thickness of the baffle has not been taken into consideration nor has any correction been made for the normal slope of the paraboloid in the vertical extent of the baffle.

Obviously, from the foregoing it will be apparent that in any given drum, rotated at a given number of revolutions per minute, and fed at a given rate, the amount of material which will actually pass therethrough depends upon the centrifugal head created. In other words, the amount of material which will be accepted by a drum (beyond certain limits) is entirely independent of the rate at which the material is fed to the drum. Therefore, if the rate of feed exceeds the acceptance capacity the excess material will flow under the lower flange of the drum and will not pass upwardly through the drum.

With these principles in mind, it is possible so to proportion the upper and lower flanges of each drum of a multiple drum machine that each drum will not accept material at a rate in excess of its purifying capacity.

Referring now to Fig. 6, if the differential in centrifugal head on the orifices 26 in the lowest baffle in each drum be so adjusted, by properly proportioning the upper and lower flanges of each drum, that the material will be forced therethrough at the desired rate, then, if all of the material to be purified be first delivered into the lower part of the innermost drum, the innermost drum will accept only such part of the entire delivery as can pass therethrough at the desired rate. The excess material will flow under the lower flange 23 and be initially delivered into the intermediate drum which in turn will accept only its proper proportion thereof and deliver the balance to the outer drum. By this design, all necessity of positively fractionating the material delivered to the drums is eliminated and, where it is desirable to remove from the material only the "heavies," machines of very great capacity occupying very little floor space can be provided. In the manufacture of newsprint there is a great demand for such a machine. Newsprint contains a very large proportion of ground wood, and the pulp, as it is delivered to the paper making machine, contains considerable grind stone grit which is carried on to the wire and which accumulates about the suction boxes. The wire, running over this accumulation of grit is rapidly abraded and the ordinary life of a wire, costing \$1000 or more, is only about a week.

In Fig. 7, I have shown in fragmentary vertical section an assembly of five drums to be used for removing "heavies" from liquid material. Due to the fact that no space is necessary between the drums for the collection of "lights," the drums can be placed much closer together than is the

case with machines in which both "lights" and "heavies" are removed.

The upper peripheral flanges 39 may be of relatively small radial extent, and where the interior surfaces of the drums are roughened or where a lining, such as screen, is employed, so that the heavy impurities are entrapped thereby, they may be omitted altogether. I prefer to provide each of the drums with an inner removable lining of screen 40. This screen, where no upper peripheral flanges are employed, may be a closed cylinder but where upper flanges are used it is more convenient simply to lay a strip of screening around the interior surface of the drum so that it may be readily contracted and removed through the opening at the top of the drum. These screens will be held quite securely in place against the inner surface of the drums by centrifugal force although pins 41 may be employed if desired. The outer drum 42 is provided with the usual inturned flange or bottom 43 provided with openings 44 for drainage purposes. The inner drums are preferably supported on projecting elements 45 extending upwardly from the flange or bottom 43. These supports are of different heights so that each inner drum is disposed at a somewhat higher elevation than the next adjacent outer drum. The inner drums are provided with lower inturned flanges 46 which rest upon the supports 45 and the drums may be held in nested coaxial relation at the top by means of the radial lugs 47, as shown in Fig. 7a, or by other suitable means. The whole assembly of inner drums may conveniently be centered within the outer drum by supports 48 at the bottom which engage the lower periphery of the first inner drum. In each of the inner drums I prefer to provide a ring or baffle 49 which is supported upon and spaced somewhat above the lower inturned flange 46 of each drum by means of vertically extending pins 50. These annular baffles 49 are radially spaced from the interior of the drum in which they are located to provide a passage or submerged orifice for the upward flow of material through the drum. The inside of these annular baffles is preferably of such diameter as to engage the outer surface of the next inner drum and thus provide a centering means at the bottom for the removable inner drums. Where these annular baffles are employed the inner edge thereof should extend somewhat further towards the axis of the assembly than the inner edge of the inturned lip on which it is supported.

As is the case in all multiple drum machines of this type the force which tends to separate the heavier impurities varies in each drum. That is, since the drums are arranged as shown in the drawings of this application, and all of the drums are of substantially the same vertical depth, it follows that if the material passing through each drum is to be purified to substantially the same degree it will be necessary to maintain the material for progressively longer periods of time in each drum from the outer to the inner drum. Therefore, the relative size of the openings in the top and bottom of the drum must be so proportioned that the material will flow through each drum at the proper rate in order that all of the material in all of the drums may be subjected to substantially the same force-time effect. Where, as might be the case in the machine shown in Fig. 7, the upper flanges are omitted, then the lower flange must be so designed according to the principles above outlined as to permit the proper flow of materials over the upper edges of

the drums. Where both upper and lower flanges are employed the proper proportioning may be affected by varying the inner diameters of either the lower inturned flanges or the upper inturned flanges. As pointed out above in respect to the upper and lower peripheral lips and the orifices in the baffles 49, the submerged orifices formed between the baffles 49 and the inside of the drums, and the openings in the top and bottom of each drum, proportioned as above described, cooperate to control the rate at which material is accepted and flows through each individual drum so that the material passing through all of the drums is subjected substantially to the same force-time effect.

For example, if reference be had to Fig. 9, it will be apparent that with any given diameter and any given number of revolutions the paraboloid of revolution defining the surface of the water within the drum will be constant. Under the conditions assumed above in respect of Fig. 9, it will be apparent that if a drum of the dimensions shown in the solid lines in that figure is revolved, the surface of the water within the vertical confines of the drum will be defined by the dotted line 50 and if the upper and lower lips of the drum be of the internal radii, R_i and R_x , respectively, the material will not flow upwardly over the upper lip of the drum. However, if the upper lip of the drum be milled out slightly, say to the point 51, then, if material be supplied to the bottom of the drum, a flow will be created over the upper inturned lip, and by properly varying the internal diameter of the upper lip the rate at which the material flows through the drum can be varied.

For most efficient operation the paraboloidal curve for the assumed number of revolutions and the assumed upper diameter should be computed and the lower lip of the drum be carried in a distance sufficient to approximately intersect the paraboloidal surface, the inner diameter of the upper lip may then be calculated to permit the desired flow thereover and hence through the drum itself. Thus all of the drum lips may be proportioned so that the material in each drum will be subject to the same force-time effect.

It might be pointed out in respect of Fig. 9 that if the upper and lower flanges are as shown by the solid lines and the water surface is as indicated by the dotted line 50, the water is in stable equilibrium and, hence, speaking in a centrifugal sense, its surface is level. Therefore, if additional liquid material is supplied to the bottom of the drum, it is just as apt to flow upwardly as it is to flow downwardly because of the fact that the surface 50 is a centrifugally level surface. Bearing this in mind, the baffles 49 (see Fig. 7) which extend inwardly somewhat further than the inner edges of the lower flanges function as dams to prevent the upward flow of water supplied to the drums and hence it must flow downwardly.

The material is fed to the device shown in Fig. 7 through a central duct 52, the lower end 53 of which is preferably splayed and terminates somewhat above the upper surface of the lower inturned flange of the innermost drum. Due to the rotation of the duct, the liquid material fed downwardly therethrough tends to cling to the inner surface thereof until it reaches the bottom where it is thrown outwardly into the innermost drum. The upper and lower flanges of this drum being so proportioned that under the centrifugal head generated material can pass therethrough

only at a predetermined rate, the excess volume delivered through the duct 52 will flow under the lower flange of the innermost drum and be discharged into the next outer drum. This drum being designed, as are all the other inner drums, to accept material only at a certain rate, the excess delivered thereto will flow under the lower flange of the drum and into the next outer drum, and so on until the outermost drum is reached.

10 The baffles 49 serve to prevent any tendency of the material to flow upwardly through the drums.

Since, in any multiple drum machine of this type the drums are spaced as closely as possible, it will be obvious that unless the design is such that each drum can be readily withdrawn from the next outer drum it will be very difficult, if not impossible to clean out the impurities collected therein. This is particularly true where intermediate baffles are employed, because it is absolutely impossible to hose out the dirt from the top. In any case the impurities are very tightly caked in the drums and it is quite impossible to clean them thoroughly when assembled. Therefore, I prefer so to design the assembly that each inner drum may be readily lifted out of the next larger drum. In other words, the drums are telescopically slidable one within the other so that when it becomes necessary to clean the machine each drum may be lifted out so that the interior surface of the next larger drum is freely accessible for cleaning. In defining this important feature in my claims, I, of course, do not mean to exclude from the scope of my invention drum assemblies of this type which may be secured together by easily removable clamps and like devices, but the time required to clean a machine is such an important factor that the drums should be readily withdrawable without any substantial delay entailed in the removal of other parts which project thereover.

In connection with Figs. 1, 2 and 5 I have illustrated a device whereby the impurities of low specific gravity which accumulate at the radially inner surface of the liquid in the drums may be removed. This device comprises a tubular element 54 preferably consisting of two parts 55 and 56, the part 55 preferably being screwed into a threaded opening in the drum at some point in the upper portion thereof, and where intermediate baffles 17 are employed, just below the uppermost baffle. The part 55, at its inner end, is interiorly threaded, as shown at 57, and the part 56 is threaded therein. The part 56 is provided with a milled or toothed head 58 and a light spring pawl 59 cooperates therewith. By turning the milled head 58 the length of the tubular element may be varied by moving the part 56 in or out of the part 55. Thus the inner end may be moved radially so that the opening will lie precisely in the zone to which particles of a predetermined gravity are removed. The inner end of the part 56 is splayed, as shown at 60, and the inner diameter of the tubular element increases radially outward to prevent clogging. Depending upon the percentage of "lights" to be removed, two or more of these tubes may be circumferentially spaced about each of the drums. It will be observed from an examination of Fig. 1 that the tubular elements 54 may be placed in radial alignment from the inner drum to the outer drum so that material removed from the inner drum will discharge directly into the tube in the next outer drum and from there directly into the tube of the outermost drum where it will be discharged into the casing around the outermost drum. Al-

though my device is not necessarily limited to its use in connection with a multiple drum machine or a machine in which intermediate baffles are employed, it will be found to function best in drums so provided because of the tendency of the intermediate baffles to prevent swirling of the material in the drum. In any centrifugal machine, and particularly in those of the type illustrated in Fig. 6 in which all of the material is initially delivered into the lower part of the innermost drum, a heavy dirt anchoring means, such as a screen 40', placed at least in the lower portion of the drum will serve to hold the "mat" in the drums and will permit material to be fed to the drums at greatly increased rates without swirl or scour. While I prefer to use a removable strip of screen as shown at 40 and 40' in Figs. 7 and 6, respectively, it is to be understood that other means, such as roughening the interior of the drums or providing the interior thereof with corrugations, projections, depressions or both, will serve to anchor the heavy dirt. The term "rugose surface," as used in the claims, is therefore to be understood as including in its meaning all surfaces having such characteristics.

From the foregoing it will be apparent that I have provided a multiple drum machine of the parallel feed and parallel discharge type in which the material in passing through each of the drums is subjected substantially to the same force-time effect and, therefore, is purified substantially to the same degree. The advantages of having all of the material purified to an equal degree are perfectly obvious. By utilizing the principles of my invention it is not only possible, with the minimum practical drum spacing to build comparatively small machines of very great capacity but also to build machines in which the outer drum is of very large diameter as compared with the inner drum thus permitting many more drums to be utilized in a single unit.

While I have described my invention in its preferred embodiment it is to be understood that the words which I have used are words of description rather than of limitation and that changes within the purview of the appended claims may be made without departing from the true scope and spirit of my invention in its broader aspects.

What I claim is:

1. In a multiple nested drum centrifugal machine of the parallel-feed-parallel-discharge type for treating a liquid mixture, a single duct for feeding said machine, said duct initially delivering all of said mixture to the innermost drum, and means independent of said feeding means in each of the inner drums for accepting only such a part of said mixture and deflecting the balance thereof to the next outer drum as will subject the material accepted by any drum to substantially the same force-time effect as the material accepted by the other drums.

2. In a multiple nested drum centrifugal machine of the parallel-feed-parallel-discharge type for treating a liquid mixture, a single duct for feeding said machine, said duct initially delivering all of said mixture to the innermost drum, and flow-restricting means in each inner drum independent of said feeding means for establishing such an acceptance rate of said drum and deflecting the feed in excess of said rate to the next outer drum as will subject the material accepted by each of the drums to substantially the same force-time effect.

3. In a multiple nested drum centrifugal machine of the parallel-feed-parallel-discharge type

for treating a liquid mixture, a single duct for feeding said machine, said duct initially delivering all of said mixture to the innermost drum, each of the inner drums being provided with top and bottom openings of suitable relative extent to establish such an acceptance rate of said drum and to deflect the feed in excess of said rate to the next outer drum as will subject the material accepted by each drum to substantially the same force-time effect.

4. In a centrifugal machine of the sedimentation type for the treatment of liquid material, the combination with an outer drum, of an inner drum of smaller size nested therein, means for initially feeding all the material to said inner drum, means associated with said inner drum for limiting the rate at which it will accept material from the feeding means to that at which said material in passing through said inner drum will be subjected to substantially the same force-time effect as the material passing through the outer drum, and means associated with the outer drum for receiving directly from the inner drum the excess of material fed to and rejected by said inner drum.

5. In a centrifugal machine of the sedimentation type for the treatment of liquid material, the combination with an outer drum, of a plurality of inner drums nested therein, one within the other, means for feeding all material to the innermost drum and means associated with each of said inner drums for limiting the rate at which each said inner drum will accept material to that at which the accepted material in passing through each of said drums will be subjected to substantially the same force-time effect, said limiting means associated with each of said inner drums, other than the innermost, including means for receiving directly some of the excess material fed to and rejected by the next inner drum.

6. In a centrifugal machine of the sedimentation type for the removal of heavy impurities from a liquid mixture comprising a plurality of rotatable, imperforate drums coaxially arranged in nested relation one within the other and provided with rough interior surfaces adapted to prevent substantial relative circumferential movement of heavy particles relative to said surfaces in respect to said drums, means for first offering all of the raw material to the innermost drum, and means associated with each inner drum for limiting the amount of material which it will accept and rejecting the excess to be offered to the next larger drum.

7. In a centrifugal machine of the sedimentation type for the removal of heavy impurities

from a liquid mixture comprising the combination with a plurality of rotatable, imperforate drums of different size and separating capacity coaxially arranged in nested relation one within the other and provided with rough interior surfaces adapted to prevent substantial relative circumferential movement of heavy particles relative to said surfaces, means for feeding material in parallel but in sequence to each of said drums, means for receiving the discharge therefrom in parallel, means for simply supporting each inner drum within the next outer drum and centering means on each outer drum cooperating with the next inner drum for maintaining said drums in assembled, coaxial relation; whereby each inner drum may be readily withdrawn from the next outer drum to facilitate cleaning the interior of said outer drum.

8. A centrifugal machine comprising inner and outer, substantially cylindrical, imperforate drums open at the top and assembled in nested, spaced, coaxial relation, one within the other, means at the bottom of each drum for retaining therein a layer of material undergoing treatment, means for feeding material to be treated to said drums at the bottom thereof, means for receiving the discharge of treated material from said drums in parallel, means projecting from the interior of the outer drum, and means projecting from the exterior of the inner drum and resting upon and coacting with said means projecting from the outer drum to maintain said inner drum in simply supported, coaxial relation to said outer drum; whereby said inner drum may be readily withdrawn telescopically as a unit from said outer drum to facilitate cleaning the interior of the outer drum.

9. A centrifugal machine comprising inner and outer, substantially cylindrical, imperforate drums open at the top and assembled in spaced, nested, coaxial relation, one within the other, means at the bottom of each drum for retaining therein a layer of material undergoing treatment, means for feeding material to said drums at the bottoms thereof, means for receiving the discharge of treated material from said drums in parallel, an annular baffle in the outer drum intermediate the top and bottom thereof, and a plurality of projections on the exterior of the inner drum resting upon and coacting with said baffle to maintain said inner drum in suspended, coaxial relation to said outer drum; whereby said inner drum is readily, telescopically withdrawable as a unit from said inner drum to facilitate cleaning the interior of the outer drum.

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