

March 28, 1967

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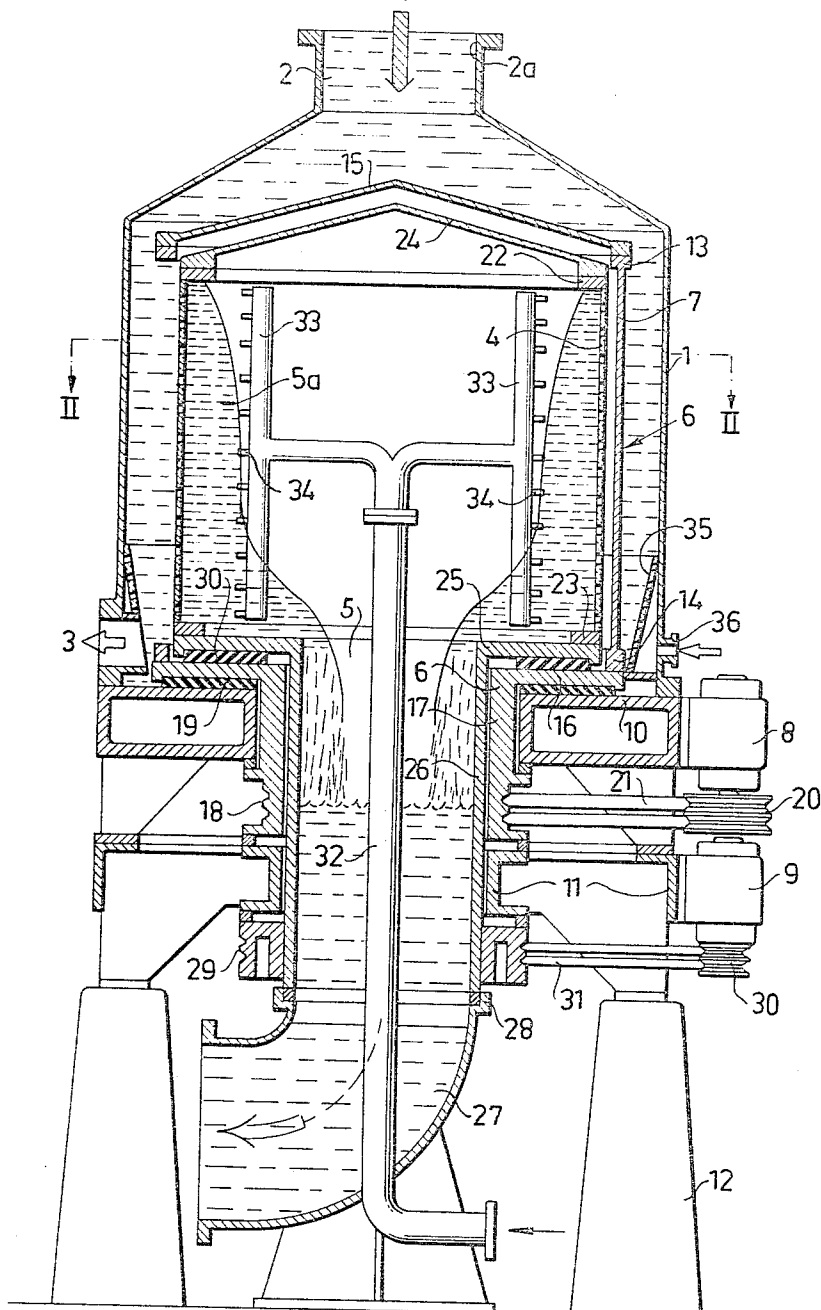
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MECHANICAL STRAINERS

Filed Aug. 23, 1966

3 Sheets-Sheet 1

Fig.1



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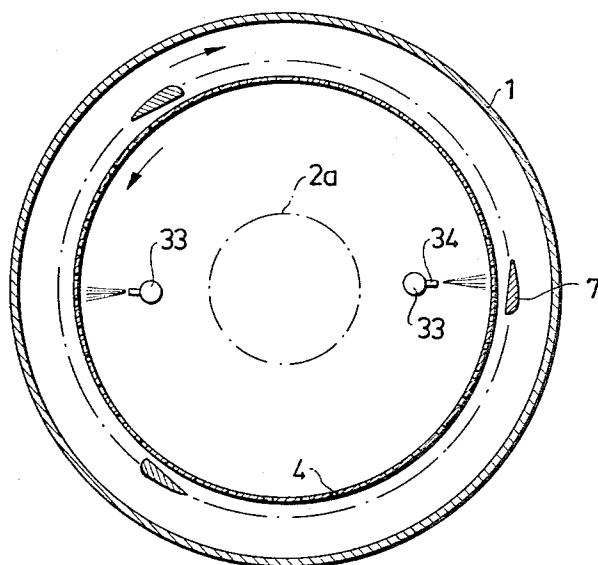
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3 Sheets-Sheet 2

Fig.2



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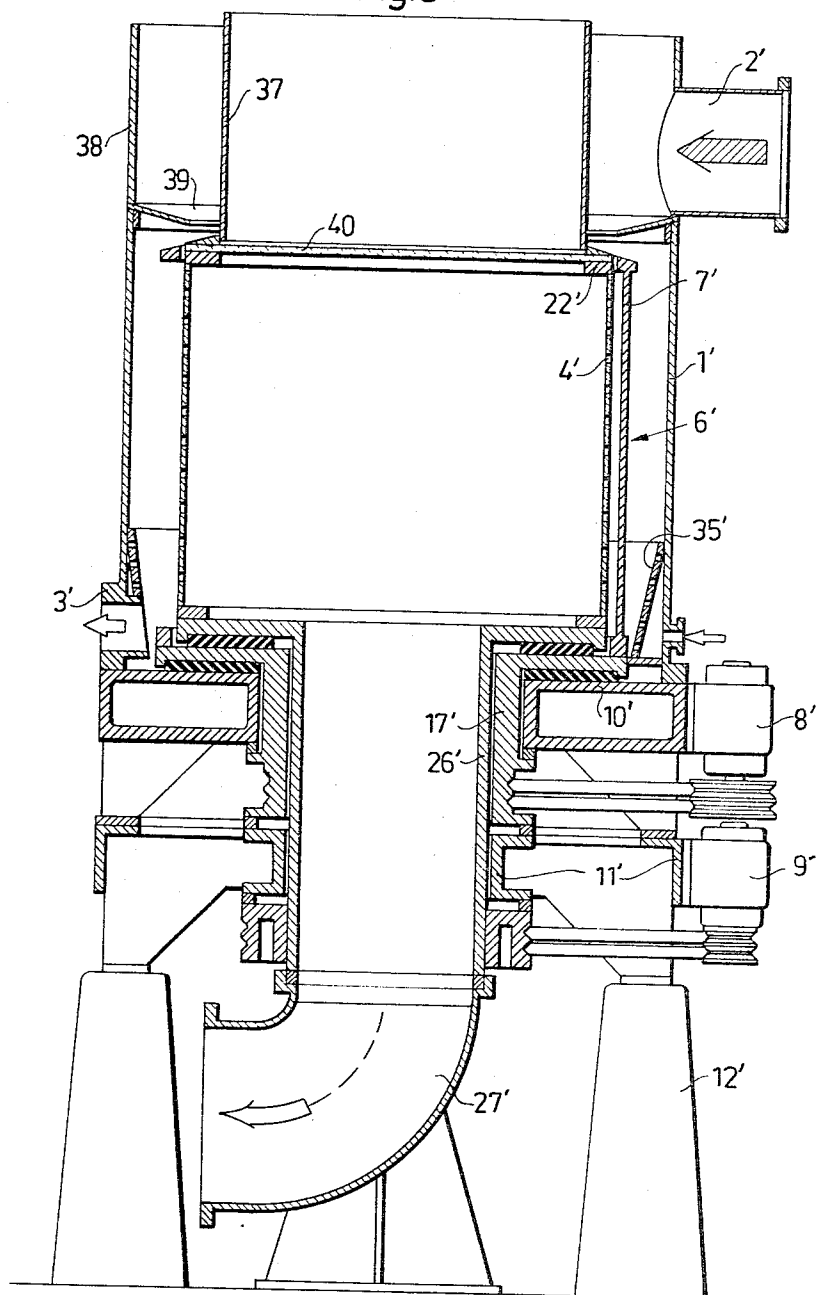
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Fig. 3



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3,311,235

MECHANICAL STRAINERS

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7,928/62

8 Claims. (Cl. 209—270)

This is a continuation-in-part of our application Ser. No. 294,393, filed July 11, 1963, and now abandoned.

This invention relates to mechanical strainers or screens as used for treating watery suspensions of fibres, such as paper pulp or other suspensions of solid material in screening, classifying, dewatering, resin removal or similar processes.

Of the above mentioned various treatments that may be carried out by means of generally similar apparatus the treatment generally called screening of fibre suspensions, such as paper pulp or other types of pulps, generally called pulp in the following, is described below.

More particularly the invention relates to strainers or pulp screens having the strainer or screen element shaped as a screen drum through the screen surface of which the main portion of the supplied pulp passes while the pulp is flowing along said screen surface.

The pulp to be treated is supplied at one end of the screen drum at one side thereof called infeed side and the residual or waste usually called tailings or rejects and including an increased proportion of undesirable solids is removed at the other end of the screen drum at the infeed side of the screen drum. The portion of the pulp passing through the screen element, called usable portion, is removed from its opposite or outlet side.

The main parts of a strainer are the screen element usually consisting of sheet material provided with perforations, slits or similar apertures, means for urging the pulp through the screen element and means for maintaining the suspension, that is to keep the fibres and other particles freely suspended in the fluid, especially on the infeed side of the screen element, and a casing for the described parts.

Fine perforations or slits offers greater resistance against fibres than against the water in which the fibres are suspended. When the pulp is forced through such a screen element a mat of fibres forms very rapidly on the screen surface, obstructing the passage of fibres and finally preventing further passage of the pulp through said perforations or slits. Therefore some kind of pulsating action, so-called pulsations, must be introduced to break up and counteract the formation of said fibre mat and make it possible for the water to fulfill its single function as carrier for the fibres and other solid particles. This mat forming tendency always decreases the capacity of the strainer but may be permitted if the mat can be maintained at a suitable thickness and density since said mat at acceptable decrease of the capacity in an essential degree improves the selectivity of the screening action.

In the types of strainers to which this invention refers one usually seeks to create frequent rapid pressure and suction impulses in the pulp supplied, by means of vanes or the like rapidly rotating adjacent to the stationary drum shaped screen element.

In a given apparatus with a certain number of vanes and a certain velocity of rotation the intensity and frequency depends on the relative velocity between vanes and pulp and the screening element respectively. In known apparatus the vanes have a tendency to drag the pulp with them along the screen surface. The more pronounced said tendency is the lower is the relative velocity between vanes and pulp and the intensity of the pulsa-

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tion is consequently decreased. One tries to prevent this phenomenon in certain known apparatus by besides the movable vanes introducing some sort of stationary braking baffles which besides the strong whirling action created thereby have no effective braking action on the pulp in the very straining zone adjacent to the screen element. Such vanes have thus no braking action in the intended sense that may justify the resulting large power consumption. Improved types of pulsating vanes similar to airfoils have been developed having a small drag on the pulp and an increased pulsating effect. In spite thereof the vanes must be given such a high velocity relative to the stationary screen element that the centrifugal effect in connection therewith in many cases exceeds a desired value and at the same time the power consumption will be very high.

In this connection it should be noticed that each pulp contains brittle or fragile impurities, which will easily be broken to small pieces of dimension difficult or impossible to separate at all from the pulp.

A main object of the invention is, therefore, to provide an improved mechanical strainer or pulp screen in which the screening process is carried out in a soft but effective manner, while at the same time making it possible to individually and independently adjust the factors and effects, which in various manners have an important influence on the screening process and that the latter can be carried out with as little power consumption as possible.

For the above purpose a strainer according to the invention consists of a combination of a preferably vertical screen drum having a screen surface in the shape of a rotary surface and being adapted to be rotated individually with respect to direction of rotation and velocity, means for supplying the suspensions to be treated to the outer side, infeed side, of the screen drum at one end thereof and for removal of suspension remaining on said outer side at the opposite end of said screen drum and for removal of screen suspension from the inner side of the screen drum, and vanes or the like extending substantially axially along the outer or infeed side of the screen drum and being adapted to be rotated in a predetermined direction individually with respect to the velocity of the same.

According to the characteristic features for the invention the screen drum is adapted to rotate about its shaft in desired directions relative to the direction of rotation of the vanes and additionally the relative velocity between the vanes and the pulp in the very straining zone and the screen drum respectively can be adjusted at will.

The rotation of the screen drum results in a pumping action the magnitude of which depends on the rotational velocity and the shape of the screen element. The screen drum acts as a modified centrifugal pump working against maximum pressure and already at a relative low velocity of rotation a liquid ring is formed on the inner side of the screen drum.

At the rapid rotation of the vanes relative to the drum the pulp supplied, infeed, is subjected to a downwardly directed helical and successively accelerated rotational movement and thereby elongated impurities, such as slivers, splinters, bast-fibres of fibre-bundles are stably oriented along the whole length of the screen drum resulting in an extremely effective removal of said impurities. The centrifugal force created by the rotational movement assists in moving heavy undesirable particles outwardly from the very screening zone and are carried away with the tailings or rejects.

The vanes are shaped and arranged in such a manner relative to the screen element that they, when rotating, give a suitable pulsating effect.

By the combination of and suitable adjustment of the

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rotation of the drum and the vanes respectively important effects for the screening process are obtained in the pulp layer between the vanes and the outer screen surface, in the apertures (perforations or slits) of the screen element and on the inner side of said screen element.

In order to obtain optimal and undisturbed utilization of said effects the screen element should be manufactured entirely smooth on the inner side as well as on the outer side thereof.

In the case the screen drum has a direction of rotation in the pulp layer therebetween a boundary layer is formed evenly distributed over the whole inject surface of the screen element, said boundary layer having a favorable influence on the flow conditions of the pulp through the screen element and at the same time it increases the pulsating effect. Said mutually opposite rotation results also in the fact that a stable liquid ring is maintained within wide boundaries of flow capacity through the screen element, that means widely varying volume per time unit through said screen element. In practical operation a satisfactory cleaning effect is maintained at low loads as well as at fully capacity of the apparatus.

It should further be observed that several types of fibre pulps having essentially different screening ability are to be treated in practice. One pulp is easy to screen and another pulp is much more difficult to treat. Moreover, in any pulp different fractions of fibres and different impurities act differently during the screening process. Thus, the fraction of short fibres passes almost totally through the screen element during the first part of a normal continuous screening process. Heavy particles are subjected to a substantial action of gravity and centrifugal force, while fibre-bundles react in different manner than free fibres to the action and velocity of flow. These conditions are of special importance in the very screening zone closely adjacent to the infeed or inject surface of the screen element and notice should be taken of the fact that the pulp in said zone changes during the screening process with respect to its constituents as well as to its ability of screening.

It is thus easily understood that not only the size and shape of the apertures of the screen element (perforations or slits) determine the capacity, efficiency and selectivity of the screening process but in a well adapted screening process several other factors or effects have a considerable influence on the screening results.

From the above description it is apparent that in apparatus according to the present invention it is possible for each type of pulp to adjust and regulate the factors or effects having importance for the screening process and this independent of each other and therefore it is also possible due to the special effects in the very screening zone on the infeed side (obtained by a suitably adjusted relative rotation between the screen element and the vanes and their mutual velocities) to obtain in each special case an optimal screening result.

In the following the invention will be described in details with reference to the accompanying drawings showing two embodiments of the invention. On the drawings:

FIG. 1 is a vertical sectional view showing an apparatus embodying the invention.

FIG. 2 is a fragmentary section taken along the II—II of FIG. 1.

FIG. 3 is a vertical sectional view similar to that shown in FIG. 1 of a modified apparatus embodying the invention.

Referring now to FIGS. 1 and 2 the apparatus shown therein comprises a stationary, cylindrical and vertical casing 1 having an inlet opening 2 at its top for supply of pulp to be treated, inject, shown by an arrow with dash lines, and at its lower end an outlet 3 for removal of reject shown by a filled arrow. A rotatable screen element 4 is concentrically provided in the casing 1 and has

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at its lower end an outlet 5 through which screened pulp shown by an open arrow is discharged from the apparatus. An individually rotatable vane construction 6 is concentrically provided between the stationary casing 1 and the rotatable screen element 4 with its substantially vertical vanes with suitable cross-section extending along the whole height of the screen element 4 and at a suitable distance from the screen surface.

Motors 8 and 9 rotate the vane construction 6 and the screen element 4 with predetermined or adjustable velocities and in elective directions of rotation.

The stationary casing 1 is supported by an upper and a lower ring-shaped base-element 10 and 11 respectively said latter base-element being supported by foundation posts 12.

The three vanes of said rotary construction 6 are at their upper and lower ends connected with flanges 13 and 14 respectively and form a basket-like construction. To the upper flange a conical roof 15 is secured. The "basket" 6 is with its lower flange 14 screwed to a ring-shaped plate 16 running at its inner periphery into a downwardly directed cylindrical part 17 being rotatably mounted in the upper base-element 10 in a suitable manner and has its lower portion shaped as a pulley 18. A suitably arranged thrust bearing 19 supports the vane construction or rotor 6.

The vane construction is driven by its motor 8 through a belt-drive including a pulley 20 and V-ropes 21 in a direction determined by the cross-section of the vanes. The cross-section of the vanes can be such that the rotor 6 can be driven in any direction.

The screen element 4 is at its upper and lower ends provided with flanges 22 and 23. On the upper flange 22 an impervious and conically shaped roof 24 is provided while the screen element or drum 4 is by its lower flange 23 screwed to a ring-shaped plate 25 running at its inner periphery into a cylindrical downwardly directed part 26 having an outlet 5 for screened pulp. Said cylindrical part 26 is in a suitable manner rotatably mounted in the cylindrical part 17 of said rotor 6 as well as in the lower base-element 11 and is at its lower portion rotatably sealed against a stationary outlet tube 27 by means of sealing means 28. The cylindrical part 26 is additionally provided with a pulley 29 at its lower portion. Said whole screen drum unit is supported by a thrust bearing 30 arranged in a suitable manner and is rotated by its motor 9 through a belt-drive including a pulley 30 and V-ropes 31.

Although it is found that in normal operation the inside of the screen drum is practically entirely free from deposits of solid ingredients in the suspension it may be suitable to provide a stationary vertical tube 32 within said outlet tube 26, said vertical tube 32 within the drum 4 ramifying into two spray tubes 33 provided with nozzles 34. At a cleaning stop of the apparatus the screen drum 4 may be rotated slowly during spraying from said stationary spray tubes 33, 34 so that a cleaning of the whole screen surface is obtained.

For dilution and washing out of fibres in the remaining centrifugal action, outwardly directed forces on the lower end of the casing 1 is provided with a mantle 35 which is provided with suitable openings for supply of pressure water through a tube fitting 36. The pulp remaining in the space between the lower part of the mantle 35 and the screen drum 4, the tailings or rejects, is discharged from the apparatus through outlet means connected to an outlet 3, said outlet means being provided for automatic or manual regulation of the volume of reject.

The aforesaid rotating fluid ring is shown in FIG. 1 and designated 5a. The rotating fluid ring exerts, due to centrifugal action, outwardly directed forces on the inside of the drum surface. The centrifugal forces are normally overcome by the higher pressure in the suspension on the outside of the drum, so that suspension

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is pressed through the apertures of the drum to the interior of the latter. In the longitudinal zones of the drum where for the moment suction forces are set up by the vanes of the pulsating member, the centrifugal pressure in the fluid ring assists the suction forces in creating a back-flow through the apertures, thus improving the cleaning action of the vanes. In addition, the fluid ring prevents the rotating vanes from sucking air through the screen apertures into the suspension being treated. In this respect the fluid ring is equally effective as if the interior of the drum were filled entirely with screened suspension. Because of the comparatively small radial thickness of the ring the mass forces to be overcome when changing the direction of flow through the vanes are reduced, a circumstance which also improves the effectiveness of the vanes. A necessary condition for the formation of a fluid ring on the inside of the rotating screen drum is the presence of a central outlet opening at the lower end of the drum and, of course, the provision of outlet means capable of taking care of the maximum amount of suspension passing per unit of time through the screen surface. Preferably the drum is adapted to be driven at a variable speed in either direction. The speed of rotation of the fluid ring depends on the speed of rotation and on the direction of rotation of the drum so that by changing the speed of rotation of the drum a fluid ring having the characteristics best suited to each particular case can be secured.

FIG. 2 shows in section how the vanes 7 are arranged in relation to the screen element 4 and the casing 1. As is apparent from the figure the vanes 7 can have a cross-section similar to an air-foil at a rapid rotation of the vanes adapted to create a subpressure on the side thereof facing the infeed surface of the screen drum 4. In connection herewith it is to be noticed, that the vanes 7 should also create a flow in the pulp remaining in the annular space between the screen drum and the casing 1, said flow being substantially peripheral with a downwardly helical direction having a very small pitch and the peripheral velocity of the pulp increases during the downward flow for a purpose described in the following. A dash and dotted circle 2a shows in FIG. 2 the inner circumference of the inlet 2 for pulp in the casing 1.

In FIG. 3 a modified embodiment of the invention is shown and main parts of the apparatus are designed with the same numbers as in FIG. 1 with a prime sign added.

Thus, a screen drum 4' and a surrounding vane construction 6' are in the manner previously shown individually rotatable in a casing 1' and provided with tube-shaped parts 17' and 26' coaxially mounted in a built up base 10'-12'. The screen drum 4' and the vane construction 6' are driven by their motors 8' and 9' in the manner previously described. The inner tube-shaped element 26' is connected to an outlet 27' for screen pulp.

The upper part of the apparatus differs from the previously shown embodiment in such a manner that the screen drum 4' is at its upper side provided with an upwardly open tube-shaped mantle 37 with great inner diameter. Also the casing 1' is provided with an upwardly extended mantle 38 for instance with the same diameter as the casing 1' so that an open ring-shaped inlet chamber for pulp to be treated is formed between the mantles 37 and 38. The pulp is supplied through an inlet 2' in the outer mantle 38.

A ring-shaped, preferably removable shield 39 is arranged such that it extends radially inwardly from the outer mantle 38, 1' nearly up to the inner mantle 37 immediately above the screen drum.

In operation the process in the inner of the screen drum 4' can be directly inspected and most favorably operation conditions can be rapidly and easily adjusted and corrected respectively independent of changes of, for instance, feed and pulp quality.

Moreover, the screen drum 4' as well as the vane construction 6' are easily accessible for inspection, cleaning

and possible replacement without the need of dismounting the apparatus.

Without reducing the inspection possibilities in the case one desires to work with the inner of the screen drum 4' closed upwardly a transparent plate 40 of glass, transparent plastic material or the like can be provided at the top of the screen drum 4' and retained between a flange 22' of the screen drum 4' and said tube-shaped extension 37.

Even if the invention is considered to be used for the previously described different treatments the embodiment shown will be described firstly in connection with screening of paper pulp in which treatment impurities, such as shivers and splinters, small knots, pieces of bark and other undesirable solid particles should be separated from the pulp.

The pulp is supplied to the casing 1, 1' through the upper inlet 2, 2' with a suitable pressure difference between the outer and inner side of the screen element for obtaining a desired flow through the screen element. The rotor 6, 6' with its vanes 7, 7' is rotated by the motor 8, 8' in a determined direction of rotation sufficient for giving the pulp in the space on the infeed side of the screen drum 4, 4' a rapid rotation with a suitable velocity.

When the pulp reaches the space between the screen drum 4, 4' and the casing 1, 1' and into the zone actuated by the vanes 7, 7' the pulp is successively accelerated by said vanes and starts owing to the pressure difference prevailing between the outer and inner side of the screen drum 4, 4' to flow inwardly and through the screen drum while the pulp remaining on the infeed side of the screen drum 4, 4' flows helically downwardly with a successively accelerated rotary velocity.

At said rotary movement of the vanes 7, 7' and the supplied pulp respectively the screen drum 4, 4' is brought to rotate in a direction relative to the vanes determined by the character of the present treatment (screening, classifying etc.), for instance, in opposite direction to the velocity of the vanes 7, 7' for creating a pulsating effect with sufficient frequency and intensity. The velocity of the vanes is determined on other grounds. As by view of example can be noticed that in practice necessary frequency of the pulsation is between 5 to 40 per second.

It has proved in practice that the development of a liquid ring within the screen drum 4, 4' to a great degree is supported in the case the screen drum 4, 4' rotates in a direction opposite to that of the vanes 7, 7'. In this case the velocity component of the liquid is directed in the direction of rotation of the screen drum 4, 4'. Thus, the liquid ring will in this case rotate in the same direction as the screen drum but with an essentially greater velocity of rotation. Thus, favorable conditions in this respect can be obtained already at low speeds of the screen drum 4, 4'.

During the above described process large and heavy impurities are moved outwardly from the screen drum 4, 4' by the successively increased centrifugal force and proceed their movement helically along the inner side of the casing 1, 1' at the same time as elongated ingredients, such as splinters, bast-fibres or fibre-bundles are oriented in peripheral direction resulting in an effective removal of the same.

The peripheral velocity of the remaining pulp on the infeed side is many times over the radial and axial velocities. The pulp remaining in the lower part of the infeed side meets at the mantle 35, 35' a suitably adjusted counter stream or spray of pressure water and is then discharged through the outlet 3.

In this connection should be noticed that even if the screen drum 4, 4' has a low rotary velocity and is suitably shaped for the rest, said rotation results in a certain pump action that must be overcome by the pressure difference between the outer and inner side of the screen drum 4, 4'.

In the closed embodiment shown in FIG. 1 the inlet 2

coaxial with the screen drum 4 has an opening with preferably smaller diameter than the vane construction 6, so that at rotation of the inject, a desired screen pressure can be obtained by dynamical forces. It can also be suitable to provide the roof 15 of the vane construction 6 accelerating the incoming pulp to a suitable rotary velocity with ridges or carriers not shown.

The above described embodiments of the invention can advantageously be used, for example, for removal of the resin (fractionating) of sulphite pulp. In this treatment one considers to separate low-grade and especially resin-rich noil fibres from a usually previously screened pulp. Contrary to screening the main part of fibres shall not pass through the screen element which in this case suitably consists of relatively fine wire-screen supported on a suitable backing but only the noil fibres together with a sufficient volume of water shall pass through the screen element. This treatment can be carried out with essentially smaller pulsating and centrifugal effects than what is needed for screening. In this case the mat formation on the screen element should be continuously prevented and the pulp should be effectively mixed on the infeed side of the screen element and this with lowest possible need of power. The especially characteristic feature of forming a boundary layer on the outer or infeed side of the screen element preferably rotating in opposite direction to the vanes and the pump effect of the screen drum is of great importance for the efficiency and selectivity of the treatment. In order to increase the mixing and turbulence on the infeed side of the screen drum the trailing edges of the vanes 7, 7' can be squared.

Normal long fibrous sulphite pulp contains about 15 percent noil fibres and it is usually necessary to separate about 30 percent thereof in this treatment. The main part of the fibres is thus discharged from the infeed side therefore the outlet 3, 3' must be dimensioned with respect thereto. How the apparatus, according to the invention, for the rest should be adjusted for the present treatment is apparent to each man skilled in the art.

It is apparent from the above description that the invention results in new and effective combinations of elements and effects so that any desired treatment of any special pulp or other suspension can be carried out and adjusted to give the highest possible selectivity and capacity at the lowest possible need of power.

We claim:

1. An apparatus for screening, classifying, dewatering or the like of suspensions of solid particles, such as fibres, comprising in combination a casing, a screen drum having a smooth outer and inner mantle surface mounted in said casing with its axis in a vertical position for rotation about said vertical axis, said screen drum having a central

opening at its lower end, inlet means formed by said casing and being operable for supplying suspension to be treated to the outer side of the screen drum at one end thereof, first outlet means formed by said casing and being operable for removing rejected suspension at the opposite end of the screen drum on the same side thereof, second outlet means comprised by said casing and being operative for removing screened suspension from the interior of the screen drum through said central opening, a pulsating member mounted for rotation in said casing coaxially with the screen drum, said pulsating member comprising a plurality of vanes extending substantially axially along the outer side of the drum, first drive means operable for rotating said screen drum at a speed sufficient to create a rotating ring of screened suspension on the inside of the drum, and second drive means operative for rotating said pulsating member with respect to said casing and to said screen drum, setting up periodically in the suspension adjacent the outer surface of the drum suction forces at consecutive longitudinal zones of the screen surface, thereby to generate a periodic back-flow of suspension through the screen.

2. In an apparatus as claimed in claim 1, the further feature that said screen drum and said pulsating member are adapted to rotate in mutually opposite directions.

3. In an apparatus as claimed in claim 1, the further feature that said screen drum and said pulsating member are adapted to rotate in the same direction.

4. In an apparatus as claimed in claim 1, the further feature that the first drive means rotate said screen drum at an adjustably variable speed.

5. In an apparatus as claimed in claim 1, the further feature that the second drive means rotate said pulsating member at adjustably variable speed.

6. In an apparatus as claimed in claim 1, the further feature that a transparent window is provided at the top of the screen drum and adapted to upwardly seal the interior of the screen drum.

7. In an apparatus as claimed in claim 1, said casing having a mantle surface, said screen drum having an upright extension, the further feature that an annular shield is provided between the mantle surface of said casing and the upright extension of said screen drum.

8. In an apparatus, as claimed in claim 1, said central opening having a diameter smaller than the maximum internal diameter of said screen drum.

No references cited.

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