

July 30, 1968

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3,394,809

PULP SCREENS

Filed Jan. 25, 1965

2 Sheets-Sheet 1

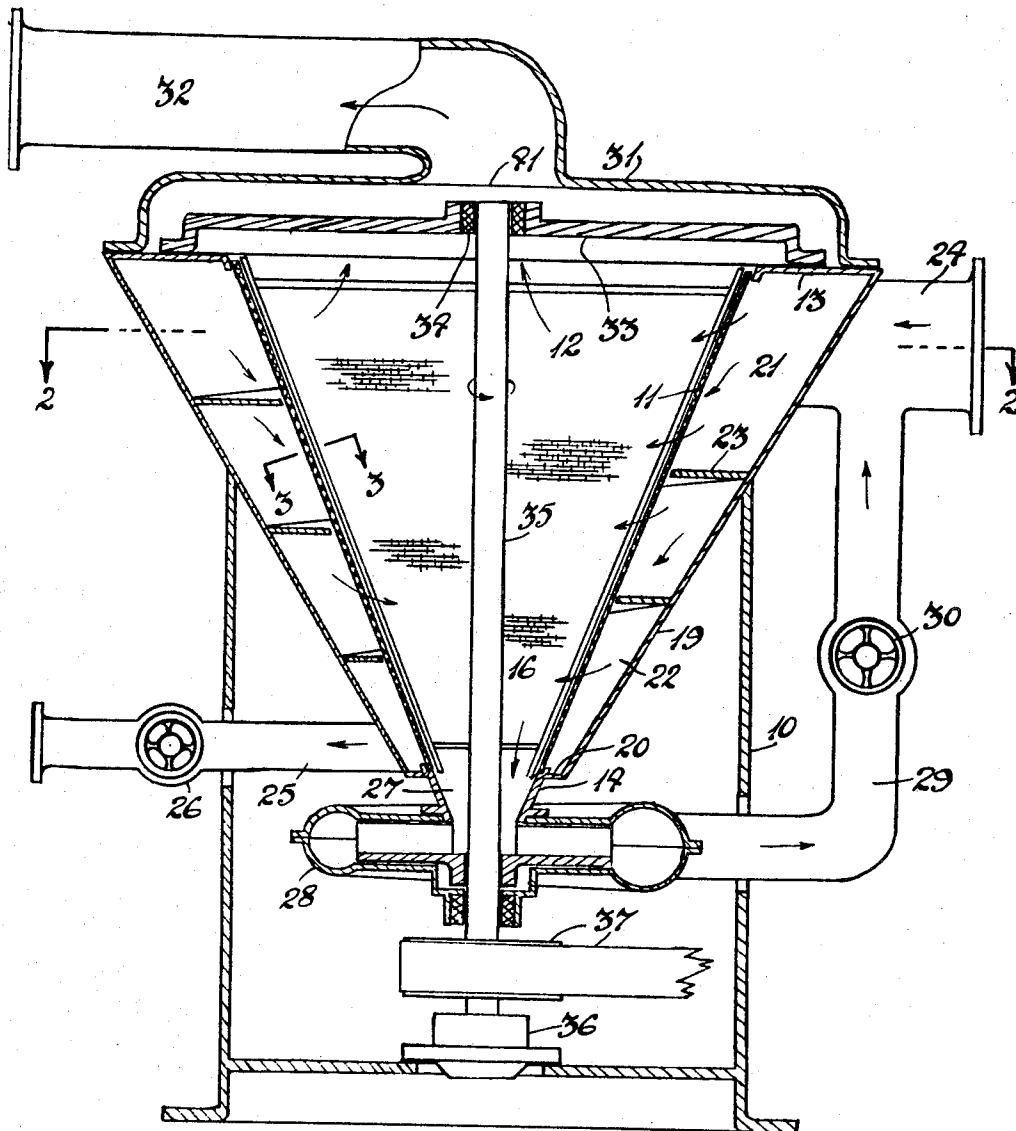


Fig. 1

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Att'y

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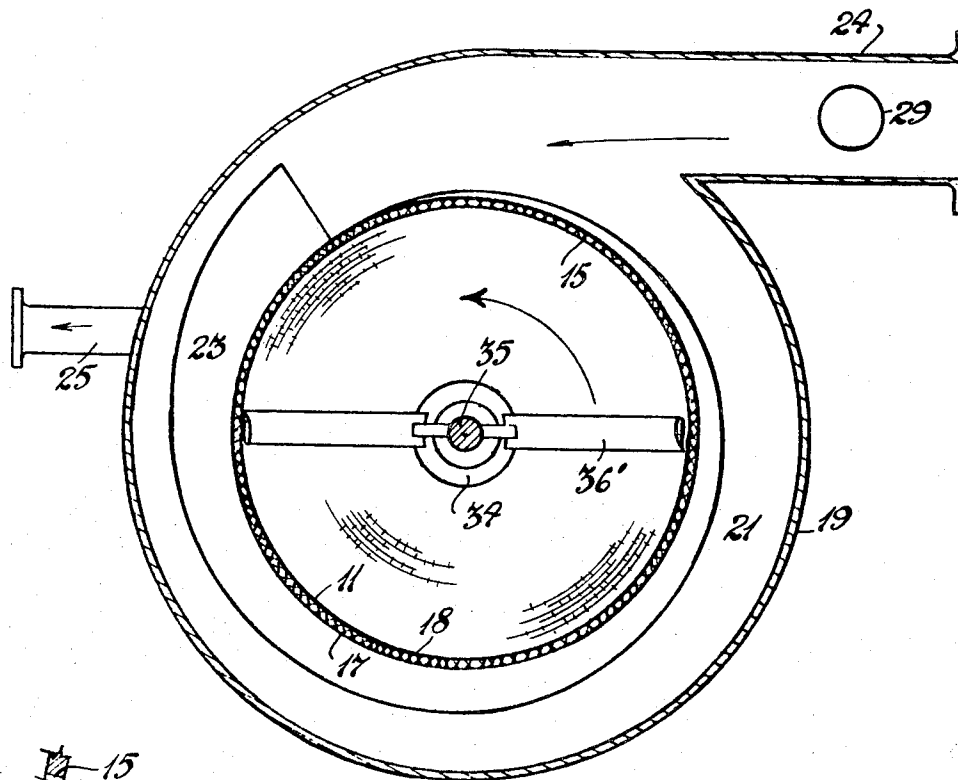


Fig. 2

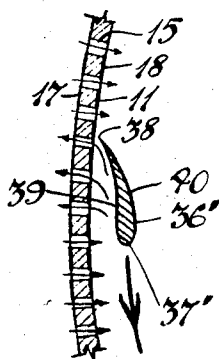


Fig. 3

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3,394,809

PULP SCREENS

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12 Claims. (Cl. 209—273)

ABSTRACT OF THE DISCLOSURE

A pulp screen embodying an outer jacket and an inner screen spaced therefrom and both inversely frusto-conical, provide a spiral passageway of downwardly diminishing cross-section due to differing slope of the jacket and screen, the velocity of pulp-flow between the upper end source and the lower end sink remaining substantially constant due to the passageway being defined by a spiral floor, and, in combination with the foregoing (a) vanes arranged to rotate adjacent the inner screen surface for momentarily and periodically interrupting the flow of a fraction of the pulp suspension which is in the immediate vicinity of the inner and outer screen-sides to prevent blinding and stapling of the screen on the outer flow-side, and (b) a pump at the restricted bottom end of the screen communicating with its accepts interior for re-cycling oversize accepts which have been forced through the screen, back to said source.

The present invention relates to improvements in the screening of solid particles in fluid, and particularly liquid suspension, and predominantly, though not necessarily, fibres in aqueous suspension, such as paper pulp and paper making stock.

In the paper making process, and in the preparation of pulp for paper making, it is frequently necessary, at various stages of the process, to screen the pulp fibres carried in suspension in water. Screening removes oversize fibres, removes foreign material, and also defloculates the stock by which is meant separating agglomerations of fibre which have clumped together in the liquid suspension.

Screening is accomplished by causing the suspension to flow through a screen element, which may be a metal plate having perforations or slots drilled, cut, or punched therein. Alternatively it may be a woven mesh of metal wire, or other material. Particles sufficiently small in size pass through the openings in the screen element. Oversize particles are retained by the screen element, and must be removed or rejected, either to waste, or to further processing.

It will readily be appreciated that some driving force is necessary to cause the liquid suspension to pass through the screen element. It will also be appreciated that means must be provided for removal of the oversize particles. It should be further understood that, due to the nature of paper making fibres, means must also be provided to prevent blocking of the openings in the screen element, since oversize fibres, or agglomerations of fibres, or fibres which have become "stapled" (by which is mean hooked in the screen largely due to their length) tend to block the holes, resulting in reduction of capacity of the screening device, and eventually seriously restricting, or completely blocking the flow. It should also be understood that these fibres are somewhat elastic, as well as subject to plastic deformation, and that the force applied to promote flow through the screen element, or the means provided to prevent blocking of the openings, may cause oversize particles to pass through the screen element, by elastic or plastic deformation.

As will readily be appreciated by those skilled in the art, the value or desirability of a screen device may be judged by three major criteria. These are: its effectiveness in removing the greatest possible proportion of oversize

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particles from the accepted screened stock; its effectiveness in reducing to a minimum the proportion of fibres of acceptably small size removed with the oversize fibres in the rejected stock which does not pass through the screen; and its capacity, or flow rate, for a given size of machine, or per unit area of screen element. To these, a fourth criterion may be added. This is that the device should consume the minimum amount of mechanical power per unit volume of pulp suspension screened, consistent with achieving acceptable levels of the major criteria.

Hitherto, three principal types of screening device have been in common use in paper and pulp manufacture. These are ordinarily known as flat screens, centrifugal screens, and pressure screens, respectively. Flat screens use gravity as the driving force to propel the suspension through the screen element, with mechanical vibration of the screen element to prevent blocking of the openings, and a shower, or spray of water to remove the oversize rejects. Despite the fact that flat screens, generally, permit very little oversize fibre to pass through the screen element, and reject very little fibre of acceptable size, and require relatively little mechanical power, their use has progressively declined, until they are now little used in the industry. The principal reason is that flat screens are relatively large and bulky for a given capacity, and have a relatively very low flow rate per unit area of screen element. Further, the necessity of operating under gravity flow conditions severely limits the flexibility of paper mill layout, and overall mill system design.

Centrifugal screens employ centrifugal force as the driving force, high velocity of the unscreened stock parallel to the screen element to prevent blocking of the openings, and a flow of dilution water, together with a fractional part of the incoming liquid suspension, to remove the oversize rejects through a tailings outlet. With centrifugal screens more oversize fibres are caused to pass through the screen element. They permit considerably more acceptable fibre to be rejected with the oversize tailings than do flat screens. They require much more mechanical power than do flat screens, for comparable flow rates. However, centrifugal screens have the advantage of smaller size and more compact shape, for a given capacity, and greater flow rate per unit area of screen element than do flat screens. In the present state of the paper making art, centrifugal screens are in common use in many applications. Since centrifugal screens are ordinarily supplied with incoming stock under atmospheric pressure only, and since both the accepts and the rejected tailings ordinarily leave the screen by gravity flow, their use involves limitations to the flexibility of mill layout, and mill system design.

Pressure screens operate with the incoming stock, or suspension of fibres in water, under pressure from an external pump. Both the accepted stock, and the rejects, or oversize tailings, leave the screen still under positive pressure above that of the atmosphere. It will be appreciated that this permits great flexibility of mill layout, and overall mill system design. A pressure screen is, in effect, a pump-through device which can be located at any convenient location in a pipe-line, without arbitrary limitations of vertical elevation, proximity to the source of the fibre suspension, or proximity to the point of use of the screened stock.

Pressure screens employ a pressure drop through the screen element as the driving force. The rejects, or oversize particles, are carried from the device by a flow of a fractional part of the incoming liquid suspension. As commonly used hitherto, pressure screens normally employ one or more moving vanes or foils, passing in close proximity to the screen element, to prevent blocking of the openings in the screen element. This is achieved through turbulence created by the moving foil, which is driven by an external source of mechanical power. The foil cre-

ates an area of increased pressure adjacent its leading edge, followed by an area of reduced pressure adjacent its trailing edge. It is important to note that foils as normally used up to the present time, move past the incoming side of the associated screen element.

Pressure screens, as used hitherto, are also smaller and more compact, for a given capacity, than either flat screens or centrifugal screens. They typically operate with much higher flow rates per unit area of screen element than do either of the other types. They have the further advantage of flexibility of location, and elevation, in the mill layout. They require less mechanical power for a given capacity than do centrifugal screens. For these reasons, their use in the industry has steadily increased.

However, pressure screens, as hitherto employed, have some disadvantages. As is well known to those familiar with the art, pressure screens permit an appreciable amount of oversize fibre to pass through the screen element by elastic or plastic deformation. It is believed that this is due, in part, to the effect of the moving foil, and in particular, to the effect of the area of increased pressure adjacent to the leading edge of the moving foil, which tends to force oversize particles through the openings in the screen element.

It has been found that this tendency to pass oversize fibre particles through the screen element can be controlled to some extent, and kept within reasonable limits, by increasing the reject rate. That is, an increase in the proportion of the incoming liquid suspension rejected leads to a reduction in the proportion of oversized particles in the accepted screened stock. Thus it is apparent that, in the case of pressure screens as hitherto employed, two of the major criteria of desirability of a screening device are, in a sense, mutually exclusive. To achieve an acceptable low proportion of oversize particles in the accepted stock, it is necessary to run the screen with a high reject rate. This means that the proportion of fibres of acceptably small size removed along with the oversize fibres in the rejected stock is greatly, and arbitrarily, increased.

It is also well known, among those skilled in the art, that the effectiveness of a pressure screen in reducing to an acceptable minimum the proportion of oversize fibres in the accepted stock is a function of the relative fraction of oversize fibres in the incoming unscreened stock. That is, with the reject rate, and other operating variables held constant, an increase in the relative proportion of oversize fibres in the incoming stock will lead to an increase in the relative proportion of oversize fibres in the accepted screened stock. The relationship is nearly in direct proportion.

In view of the above well known operating characteristics of pressure screens, as hitherto employed, it has been a well known practice to employ a multiple number of pressure screens, with the flow circuit arranged either in series or cascade, or both, to achieve an acceptable minimum of oversize fibre in the final accepted stock while at the same time reducing the proportion of acceptably small fibres removed with the rejects. By a flow circuit in series is meant passing the stock through two successive pressure screens, so that the accepted stock from the first screen is the inlet stock of the second screen. The first screen removes a portion of the oversize fibre, so that oversize fibre forms a reduced fraction of the incoming stock to the second screen. This requires increased pressure ahead of the first screen, since two successive pressure drops are involved, and thus requires more mechanical power to the pump than does a single screen.

By a flow circuit in cascade is meant passing the incoming stock through a primary screen operated at a relatively very high reject rate, then passing the rejected stock from the primary pressure screen through a secondary pressure screen. The accepted stock from the secondary screen is returned to the inlet of the primary screen. To effect this, it is of course necessary to raise the pressure of the secondary screen accepts to or above that of the inlet to the

primary screen, employing an external pump driven by a source of mechanical power, to compensate for the pressure drop passing through the two screens. By a flow circuit arranged in both series and cascade is meant using at least three separate pressure screens, which may be known respectively as: first stage primary; second stage primary; and secondary screens.

The final accepted stock from the three screen system must have passed through, and been accepted by, both the first stage primary screen and the second stage primary screen. The rejected stock from both the first stage primary and the second stage primary is combined and forms the inlet to the second screen. The secondary accepts from the secondary screen are returned, after having their pressure raised by an external pump, to the inlet of either the first stage primary or the second stage primary screen. The system rejects are the rejects from the secondary screen, which are sent to waste, or to further processing.

Having regard to the foregoing technical discussion of the environment in which the invention presently to be described operates, and the various conventional means by which pulp in suspension is presently screened, it may next be stated that a primary feature of the inventive concept embodied in the present disclosure resides in the provision of a re-cycling operation through a single pressure screening unit which may be summarized for convenient understanding by the statement next following.

A chamber of inverted frusto-conical configuration formed by and within a surrounding screen or perforated wall portion, is in turn surrounded by a jacket spaced from said wall portion. This jacket is also of inverted frusto-conical configuration but converges towards the said chamber toward the base thereof. It follows that an annular surrounding chamber of inverted frusto-conical configuration but diminishing volume toward the lower end thereof exists between the aforesaid wall portion and jacket. Within this annular chamber is a spiral wall. Communicating with the upper end of the annular chamber is a pressure source for the incoming suspension medium, such source taking the form of a tangentially disposed input conduit. At the lower end of the annular chamber is a reject conduit also preferably tangentially disposed.

Leading off from the upper part of the perforated wall enclosed chamber is an accepts discharge conduit. The lower end of such chamber is open to provide an oversize-accepts discharge port communicating with a horizontally disposed re-cycling impeller. The said impeller communicates via a return conduit with the noted input conduit. The suspension accordingly enters the annular chamber through the input conduit and is caused to spiral around and downwardly within the same in virtue of the spiral wall provided therein while the greater part of the volume of such suspension is passed through the aforesaid perforated wall portion.

As the suspension proceeds downwardly it diminishes in volume, but not in velocity due to the diminishing cross-section of the annular chamber and its diminishing circumference in virtue of which the centrifugal force of the volumetrically reduced fluid suspension is increased.

As will become apparent as this specification proceeds, some oversize fibres will be passed through the openings within the frusto-conical perforated wall portion particularly at the lower end thereof even though the said openings in this region may, if desired be of smaller area.

As a result the fluid suspension within the lower part of the screen chamber will contain a substantial percentage of oversize fibres, and these will be drawn by the impeller downwardly therethrough and returned to the input conduit via the aforesaid return conduit.

From the foregoing it accordingly appears that an important feature of the present invention resides in the novel concept of screening from the external side of a chamber (and particularly an inverted frusto-conical chamber) formed within a surrounding perforated screen-

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ing wall portion. Another important feature ancillary to what has just been stated is the provision of the aforesaid annular, inverted frusto-conical, and downwardly diminishing spiral circulating chamber.

Another object is the provision in the base of a screening chamber of means for returning and re-cycling a fraction of the suspension which has passed therein back through the same chamber.

Still another and also very important aspect of the present inventive concept is the provision of novel means for pulsing the layer of the suspension which is in circulation against the external surface of the aforesaid frusto-conical perforated screening wall portion by means of a vane or foil, or a plurality of same within the frusto-conical screen chamber. By virtue of this relationship between the source of pulsation and the locus of occurrence of such pulsation (opposite sides of the frusto-conical perforated wall portion) a particularly effective elimination of blinding or blocking of the said wall portion on the external or incoming side thereof is provided as will be explained in greater detail hereinafter.

It is additionally an object of the present invention to provide a screening device for screening solid particles in liquid suspension, such as paper pulp, which will have all the desirable characteristics of pressure screens, as hitherto known; including small size and compact shape for a given capacity; high flow rate per unit area of screen element; and operation under pressure, permitting wide options of location in the mill flow circuit; yet which will improve in performance beyond any device for this purpose hitherto known, in that it will provide simultaneously a very low proportion of oversize particles in the accepted stock, and a very small proportion of particles of acceptably small size rejected along with the oversize particles in the rejected stock.

A further object is to provide a screening device for paper pulp or paper making stock capable of operation under pressure which will provide, with a single device, separation of acceptably small fibres in the accepted stock from oversize fibres in the rejected stock, with an efficiency of separation hitherto possible only by the use of two, three, or more, pressure screening devices, combined in series, or cascade, or both.

A yet further object of this invention is to provide a screening device capable of operation under pressure which will provide effective separation of fibres of acceptable size from oversize fibres while requiring less total mechanical power, including pump power in consideration as well as power for the clearing foils, for a given throughput and a given level of efficiency, than any screening device capable of operation under pressure hitherto known, or any combination or arrangement of such devices hitherto known.

A still further object of this invention is to provide a device for screening solid particles in liquid suspension under pressure in which the desired operating characteristics of the device (including (i) minimum proportion of oversize particles in the accepted stock, (ii) minimum proportion of acceptably small fibres in the rejected stock, (iii) maximum throughput for a given size of device or per unit area of screen element, and (iv) minimum mechanical power per unit throughput) may be interrelated, with the inter-relations and relative levels of such operating characteristics adjustable throughout a wide range of operating conditions, merely by actuation of a minimum number of simple controls, specifically (as the invention is herein particularly exemplified) by two conventional control valves as will hereinafter appear.

With the foregoing features and objects in view, and such other important features and objects as may hereinafter become apparent, the present invention consists of the arrangement, construction of parts, and method steps as herein set forth, reference being had to the accompanying figures in which:

FIGURE 1 is an elevational cross-sectional representation of the present invention.

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FIGURE 2 is a section on the line 2—2 of FIGURE 1. FIGURE 3 is a cross-section on the line 3—3 of FIGURE 1.

In the drawings like characters of reference designate similar parts in the several figures.

The device of the present invention is supported in a rigid frame 10 of appropriate design. The liquid suspension of solid particles such as paper pulp is screened as it passes through the surrounding wall portion or suspension-passing screen 11 of the screen chamber 12, "such wall portion being in the particular embodiment of the invention as exemplified, in the form of a screen of circumferentially closed superficial configuration (sometimes referred to in the art as a "surface of revolution"), and more specifically, as illustrated herein, of inverted frusto-conical, perforated, configuration," it being understood that these expressions are not intended to describe a figure which necessarily excludes accepts and rejects discharge openings. The said perforated wall is suitably supported at its upper and lower ends by the ring 13 and base process 14 respectively.

The apertures 15 which are provided over the whole surface of wall portion 11 may desirably be of progressively diminishing diameter toward the base 16 of chamber 12. These apertures may also if desired be divergently tapered in the direction of flow of the liquid suspension. In other words their diameter upon the exterior surface 17 of wall 11 may be less than upon the interior surface 18.

Surrounding the wall portion 11 and spaced therefrom is an inverted, frusto-conical jacket 19 closed at the upper end by the aforesaid ring 13, and at the lower end by ring 20. The slope of the jacket 19 is greater than that of wall portion 11. Accordingly it will be observed that the annular unscreened suspension compartment or fluid suspension circulating passageway 21 enclosed between wall portion 11 and jacket 19 diminishes in cross-section toward the base 22 thereof.

Extending within passage 21 is a spiral floor 23. Admittance to the upper end of spiral passage 21 is by way of the source 24 in the form of an input conduit tangentially disposed with respect to jacket 19 as best observed by reference to the accompanying FIGURE 2. Discharge from the lower end 22 of passage 21 takes place through the rejects conduit 25 also preferably arranged in tangential relationship to the said lower end of passage 21, the said conduit being provided with adjusting control valve 26.

The lower end or part 16 of chamber 12 terminates in an oversize-accepts discharging port 27 communicating with the re-cycling impeller and impeller housing assembly collectively designated 28. This impeller is tangentially connected to return conduit 29 provided with control valve 30. Conduit 29 communicates with input conduit 24.

Enclosing the upper end of chamber 12 is a cover plate 31 from which extends accepts discharge conduit 32. Supported on ring 13 is a spider 33 provided with a central bearing 34 in which is journaled the upper end of rotating spindle 35 the lower end of which is supported in the thrust bearing 36.

The spindle 35 operates impeller 28 through the agency of such as the pulley and belt assembly collectively designated 37. Also suitably supported for rotation upon and with the spindle 35 are vanes or foils collectively designated 36'. In detail these vanes each comprise a rounded leading edge 37', a tapered trailing edge 38, a concave surface 39 facing the inner perforated wall surface 18, a convex opposite surface 40.

Having now essentially described the structure of the present invention, its operation will be explained as follows:

Stock consisting of solid fibres in water suspension (in the case of paper pulp or paper making stock) enters under pressure supplied by an external pump through input

conduit 24 to flow in a spiral downwardly through the elongated path of passageway 21. During this process some of the water suspension including fibres of sufficiently small sizes, passes through the perforated wall portion 11 into chamber 12. Most of the suspension medium then passes upwardly between the spider 33 out through the accepts discharge conduit 32. The pressure at the neck 41 of conduit 32 will of course be less than the pressure in conduit 24 due to the pressure drop in passing through the apertures 15 of perforated wall 11.

The oversize fibres are retained with the remainder of the stock in passage 21. The remaining stock flows spirally downward therethrough and, as it travels, progressively more of the water and acceptably small fibres passes through the perforated wall portion 11. The remaining unacceptable stock, progressively diminishing in volume retains however a linear velocity along the spiral passage 21. Such velocity nearly approximates that linear velocity with which it entered through input conduit 24. This is because the cross-sectional area of the spiral passage 21 progressively diminishes downward, and because of the progressively shorter radial distance between the lower portion of perforated wall portion 11, and the lower portion of jacket 19.

This maintained linear velocity across the external surface 17 of wall portion 11 helps to prevent blocking or blinding of the apertures 15. However, this is not the only, nor indeed the principal provision for preventing blinding which is effected primarily by the action of the vanes or foils 36'. It is, none the less an important effect, and a unique feature of the present invention constituting an important improvement on the art of pressure screening as hitherto employed.

It should also be noted in this context, that the suspension or stock moving spirally around and downward through annular passage 21 at appreciable linear velocity, exhibits a marked centrifugal effect. The fibres used in paper making stock have a specific gravity which does not differ greatly from that of water. Hence the fibres themselves will be little affected by such centrifugal effect. However, the most usual particles of foreign material found in pulp or paper stock, are particles of sand, metal fragments and the like. These have specific gravities considerably greater than water. Hence they are effectively flung outward from the wall 11 by the centrifugal action aforesaid.

Accordingly such particles of heavy foreign matter travel downwardly in a controlled-velocity spiral until they leave tangentially through rejects conduit 25. Since pressure screens as hitherto known were not very successful in removing minute particles of heavy foreign materials which tended to pass through the screen openings with the fibres, this capability of this feature of the present invention is a further important improvement in the art of screening. Furthermore, large pieces of foreign material, such as stones, nuts and bolts, pieces of glass and the like, which may accidentally become entrained in the incoming stock or suspension, will not damage the sometimes fairly fragile screen wall portion 11 since they will be carried downwardly against the inner surface of jacket 19 under the influence of centrifugal force as aforesaid to rejects channel 25. Since pressure screens hitherto have either had no provision for such objects, and were subject to damage to the screen element, or else employed elaborate junk-traps, or separate junk-reject outlets and the like, this too constitutes an improvement in the art of screening.

Blinding or blocking of the perforated wall portion 11 is also prevented by the action of means which are solely for the purpose of momentarily and periodically interrupting the flow of a fraction of the suspension which is adjacent the sides of the screen and in co-incidence with

the apertures thereof. Such means comprise the rotating vanes or foils 36' as best depicted in the accompanying FIGURE 3. Screening flow through the apertures 15 of wall portion 11 is maintained by the pressure differential radially inward across it. However, each time the moving foil of novel design exemplified in the accompanying FIGURE 3, passes an individual aperture 15 there is a momentary, local interruption or reversal of the aforesaid pressure differential. This is caused by the curved cross-sectional configuration between the leading and trailing edges 37' and 38 respectively which provides a concave surface facing the perforated screen surface and the resultant out-curved trailing edge 38 directing a small reversed flow or wake in the radially outward direction. In this connection it should be explained that no actual reverse flow of any appreciable amount of liquid back out through the apertures 15 is necessary to clear a blocking particle pressed against the outer surface 17 and held there by the pressure differential. It is sufficient for the wake from the foil to neutralize the pressure differential only momentarily across the individual opening for the tangential or spiral flow through annular passage 21 to carry away the blocking oversize fibre particle. This action constitutes an important feature of the present inventive concept-as-a-whole over pressure screening techniques as hitherto employed.

In pressure screening practise until the present, it has been customary to employ moving foils on the unscreened stock side of the screen element, which screen element is usually of some circular configuration enclosing a chamber from which the stock moves outwardly. Since such foils created a local area of increased pressure differential, followed by an area of reduced pressure differential, they frequently cleared a blocking particle by forcing it through the screen element, with the accepts, by elastic or plastic deformation. The feature of the present invention as described in this connection therefore minimizes oversize particles in the accepted stock more efficiently than hitherto possible with pressure screens. In addition, the present arrangement prevents "stapling" which frequently characterized the operation of pressure screens as hitherto employed. Thus a long fibre would often be found hooked, or with its two ends respectively, through two adjacent apertures in the screen element. When this occurred, a foil on the unscreened stock side had little chance to clear it, with the result that such fibres would accumulate until it was necessary to shut down the screening device and clean it manually. The present invention eliminates this problem.

Further in this connection, in the present invention it is to be noted that the upper ends of the vanes or foils 36' being radially further out from the spindle 35, travel at a greater linear speed than do the lower ends which are radially closer to the said spindle. This means that the wake created by the foil the cross-sectional configuration of which is illustrated in the accompanying FIGURE 3, and thus the reversal of pressure, and the tendency to reverse flow through the adjacent apertures 15, also illustrated, will be greatest at the upper end of the foil where it is furthest from the spindle. The foil may also be made wider, at the upper end, from leading edge 37' to trailing edge 38, and diminish progressively downward along the length of the foil being a minimum at the lower end thereof, to create a greater wake at the upper end than at the lower end.

Thus, in the upper parts of chambers 12 and 21 where the greatest flow rates per unit area of perforated wall 11 are desired, a vigorous pulsating clearing action will take place which is desirable for high flow rates, and feasible since the probability of oversize fibres being forced through the screen or perforated wall 11 in this region are least. However, the vigor of such pulsating action will progressively decrease toward the lower end of the wall portion 11 until, at the lower end thereof where the vane or vanes are narrow, and at a small radius from the spindle

the pulsation will be quite gentle. This will mean both that, at the lower end the tendency to induce oversize fibres to be forced through the screen by violent turbulence will be minimized, and also the tendency to force already screened stock back and radially outwards through the apertures 15 to mix with the rejects will be minimized.

It should also be appreciated here that the combination of foils or vanes on the accepts or inner side or surface 18 of the perforated wall 11, together with a tangential scouring on the outer side, or surface 17, permits increased capacity per unit area of perforated wall due to more efficient cleaning. It should also be noted that this combination permits the use of smaller, fewer foils or vanes, moving more slowly, which permits efficient pressure screening while using less mechanical power to drive the foils than has been necessary with pressure screens as hitherto known.

As the so far unscreened stock or suspension in passage 21 moves spirally downward, the concentration of oversize fibres per unit volume of liquid increases since more of the fibres of acceptable size have passed through the perforated wall 11. Accordingly the tendency of oversize particles to be forced through the openings increases toward the lower end of the perforated wall portion. This is partially compensated for by making the apertures 15 progressively smaller toward the lower end. This also is a unique improvement in the art of pressure screening. Its value is maximized by the use of the spiral wall or conveyor 23 since this element minimizes turbulence and mixing on the inlet (external) side of the perforated wall 11 and promotes an orderly flow from the input conduit 24 past sections of the perforated wall containing progressively smaller apertures, which minimize the passage of oversize fibres into the accepts, to the rejects conduit 25.

The re-cycling impeller in combination with the port 27 leading thereinto and the return conduit 29, as already indicated constitute an important unique feature of this invention. The increasing concentration of oversize fibres in the as yet unscreened stock in passage 21 as the flow of the same nears conduit 25, will almost inevitably mean that at least some oversize fibres will be passed through the apertures 15 in the perforated wall portion 11 despite the fact that, toward the lower part of the same these openings may be of progressively smaller size. Thus some oversize fibres will enter chamber 12, but these will tend to be most numerous in the lower region 16. The recycling impeller bleeds off a portion of the flow entering chamber 12 principally from this region 16 where the concentration of oversize fibres which have been forced through the perforated wall 11 is greatest. This flow, bled off by the impeller, is returned by it through return passage 29 to conduit 24 for re-screening along with the new incoming unscreened pulp suspension or stock. This is possible since the passage through the rotating impeller will, like a pump, increase the pressure of the re-cycled flow to compensate for the pressure drop in passing through the perforated wall 11 and will raise the pressure of the re-cycled flow to or above that of the incoming stock entering through conduit 24.

Hence it will now be apparent that the lower part 22 of spiral passage 21, the lower part of the perforated wall portion, and the region 16 of chamber 12 will behave in a manner analogous to the secondary screen in a pair of pressure screens arranged in cascade as hitherto employed. Thus this invention will accomplish, with a single screening unit, what has hitherto required, with pressure screens as hitherto known, at least two screening units plus an external pump.

It should finally be noted that this invention permits wide flexibility of operation with only two simple adjustments. The valve 30 permits the quantity of flow re-cycled to be varied at will. Increasing the re-cycled flow increases the effective portion of the unit which, in effect is doing secondary screening. This will result in less oversize fibre in the accepts leaving by conduit 32 at the expense of some reduction in total screening capacity only, and a slight

increase in mechanical power requirements. The valve 26 permits the quantity of flow rejected to waste or to re-processing to be varied at will. Increasing the reject flow will result in less oversize fibre in the accepts leaving by conduit 32, but at the expense of more acceptable fibre leaving with the rejects. Thus the inter-relationships between the operating characteristics of the present invention can readily be varied to achieve optimum operation under any given conditions. Furthermore, adjustments can readily be made to compensate for changed operating requirements without shutting down the unit.

Since various modifications can be made to the invention of which a particular embodiment only has herein been described, within the scope of the inventive concept which such embodiment discloses, it is not intended that protection of the said invention should be interpreted as restricted to the said embodiment particularly described and illustrated since this disclosure is intended to explain the construction and operation of the inventive concept, and is not for the purpose of limiting protection to any specific embodiment or details thereof.

What I claim as my invention is:

1. The separation of a class of particles from a fluid suspension of generally elongated particles, by a perforated screen immersed in said suspension, with the unseparated fraction of said suspension flowing generally parallel with the input side of said screen, which is characterized by the method steps of (a) solely, momentarily, and periodically interrupting the flow of a fraction of said suspension which is adjacent the sides of said screen, and in co-incidence with the perforations thereof to prevent blinding of the input side by particles which have become lodged in said perforations, said interruption causing said particles to be dislodged and permitting same to continue flowing past or through said perforations, the only significant attraction toward the input side of said screen being that caused by the decrease in pressure upon the screen-passing fraction of said suspension, and (b) causing the as yet unseparated portion of said fluid suspension to flow generally parallel with said screen in progressively restricted volume at a pre-determined and substantially constant velocity between a source and a sink.

2. The invention according to claim 1 in which said periodical interruption takes place while the as yet unseparated portion of said fluid suspension moves in an elongated non-planar spiral column of progressively restricted volume.

3. The invention according to claim 2 which includes the step of returning oversized particles which have been forced through said screen, back to said source.

4. A device for separating or screening a fluid suspension of particles comprising in combination an accepts chamber of circumferentially closed superficial configuration with a perforated surrounding wall portion, a jacket spaced from and surrounding said wall portion to provide an annular unscreened-suspension compartment, said wall portion and said jacket converging relatively toward the rejects end of said compartment, a non-planar, spiral floor spanning said wall portion and said jacket to provide an elongated and enclosed non-planar, spiral passageway of progressively diminishing cross-sectional area towards said rejects end, adapted to maintain said suspension at a substantially constant velocity for the length of said passageway, and a tangentially disposed input conduit for admitting said suspension to said passageway under pressure at the end thereof opposite to said rejects end.

5. The device according to claim 4 which includes suspension interrupting vanes in said accepts chamber rotatable in the same direction as the flow-path of said suspension through said passageway.

6. The device according to claim 4 in which both said accepts chamber and said jacket are inversely frusto-conical.

7. The device according to claim 4 which includes

means for returning the over-size accepts admitted to said accepts chamber to said unscreened suspension compartment.

8. A device for separating a fluid suspension of particles comprising in combination (i) an accepts chamber at least partially bounded by a suspension-passing screen, (ii) an accepts discharge conduit leading from said device, (iii) means for directing said suspension from a source to a sink against one side of said screen at a pre-determined and substantially constant velocity, said means being in the form of a jacket spaced from and surrounding said chamber, with said source communicating with the interior of said jacket in the vicinity of the upper end thereof, a rejects conduit communicating with said jacket in the vicinity of the lower end thereof, and a spiral floor within said jacket over which said suspension flows, said floor, screen and jacket defining an elongated path of such cross-sectional configuration as to cause such suspension to flow therethrough when under pressure from a source, at a substantially constant velocity, and (iv) means solely for momentarily and periodically interrupting the flow of a fraction of said suspension which is adjacent the sides of said screen and in co-incidence with the apertures thereof, to prevent blinding of the suspension input surface thereof by particles which have become lodged in said apertures, said last mentioned means constituting the only means for varying the flow-rate of said suspension through said screen.

9. A device for separating a liquid suspension of generally elongated particles of deformable cross-section comprising in combination (i) an accepts chamber of circumferentially closed superficial configuration having a surrounding wall in the form of a screen having internal and external sides, (ii) an accepts discharge conduit connected to said chamber, (iii) means extending substantially the whole effective length of said chamber for directing said suspension from a source against the external side of said screen to a sink at a pre-determined and substantially constant velocity, (iv) means solely for momentarily and periodically interrupting the flow of a fraction of said suspension which is adjacent to said surrounding screen and in co-incidence with the apertures thereof to prevent blinding of the said apertures by particles which have become lodged therein, said last mentioned means constituting the only means for varying the flow of suspension through said screen, (v) an oversize accepts discharge port in said accepts chamber, (vi) a re-cycling impeller communicating with said port, and (vii) a return conduit extending between said impeller and said source.

10. A device for separating a liquid suspension of generally elongated particles of deformable cross-section comprising in combination (i) an accepts chamber of inverted frusto-conical configuration having a surrounding wall in the form of a screen, (ii) an accepts discharge conduit connected to said chamber, (iii) means extending substantially the whole effective length of said chamber for directing said suspension from a source against the external side of said screen to a sink at a pre-determined, substantially constant velocity, said means including a jacket of frusto-conical configuration spaced from and surrounding said chamber, said source being in the form of an input conduit tangent with said jacket to impart a non-planar spiral path of travel to said suspension within said jacket, said sink being in the form of a rejects conduit communicating with said jacket remote from said input conduit, and (iv) means solely for momentarily and periodically interrupting the flow of a fraction of said suspension which is adjacent said surrounding screen, and in co-incidence with the apertures

thereof to prevent blinding of the said apertures by particles which have become lodged therein, said last-mentioned means constituting the only means for varying the flow of suspension to said screen.

11. The means according to claim 10 which includes a spiral floor within said jacket and spanning the space between said chamber and said jacket over which said suspension flows for directing through a longitudinally wholly enclosed spiral path of travel, said frusto-conical jacket converging toward the base of said chamber.

12. A device for separating a fluid suspension of particles comprising in combination

(i) an accepts chamber at least partially bounded by a suspension-passing screen,

(ii) an accepts discharge conduit leading from said device, and

(iii) means for directing said suspension from a source to a sink against one side of said screen at a pre-determined and substantially constant velocity, said means comprising

(A) a frusto-conical jacket spaced from and surrounding said chamber,

(B) means for admitting said suspension to said jacket tangentially with respect to said chamber,

(C) means for circulating said suspension through an elongated closed spiral passageway around said chamber, which passageway is bounded externally by said jacket, in progressively restricted volume and at substantially constant velocity,

(D) means solely for momentarily and periodically interrupting the flow of a fraction of said suspension which is adjacent the sides of said screen and in co-incidence with the apertures thereof to prevent blinding by particles which have become lodged in said apertures, said last mentioned means comprising at least one elongated vane within said chamber parallel with and adjacent said perforated wall portion, said vane, for at least the major portion of its length having a transverse cross-sectional configuration which is curved between the leading and trailing edges thereof to present a concave surface facing said perforated portion, said leading edge being spaced further from said inner wall surface than said trailing edge, and

(E) means for rotating said vane,

the direction of travel of said suspension through said spiral passageway being the same as that of said vane, said interrupting means constituting the only means for varying the flow of said suspension through said screen.

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