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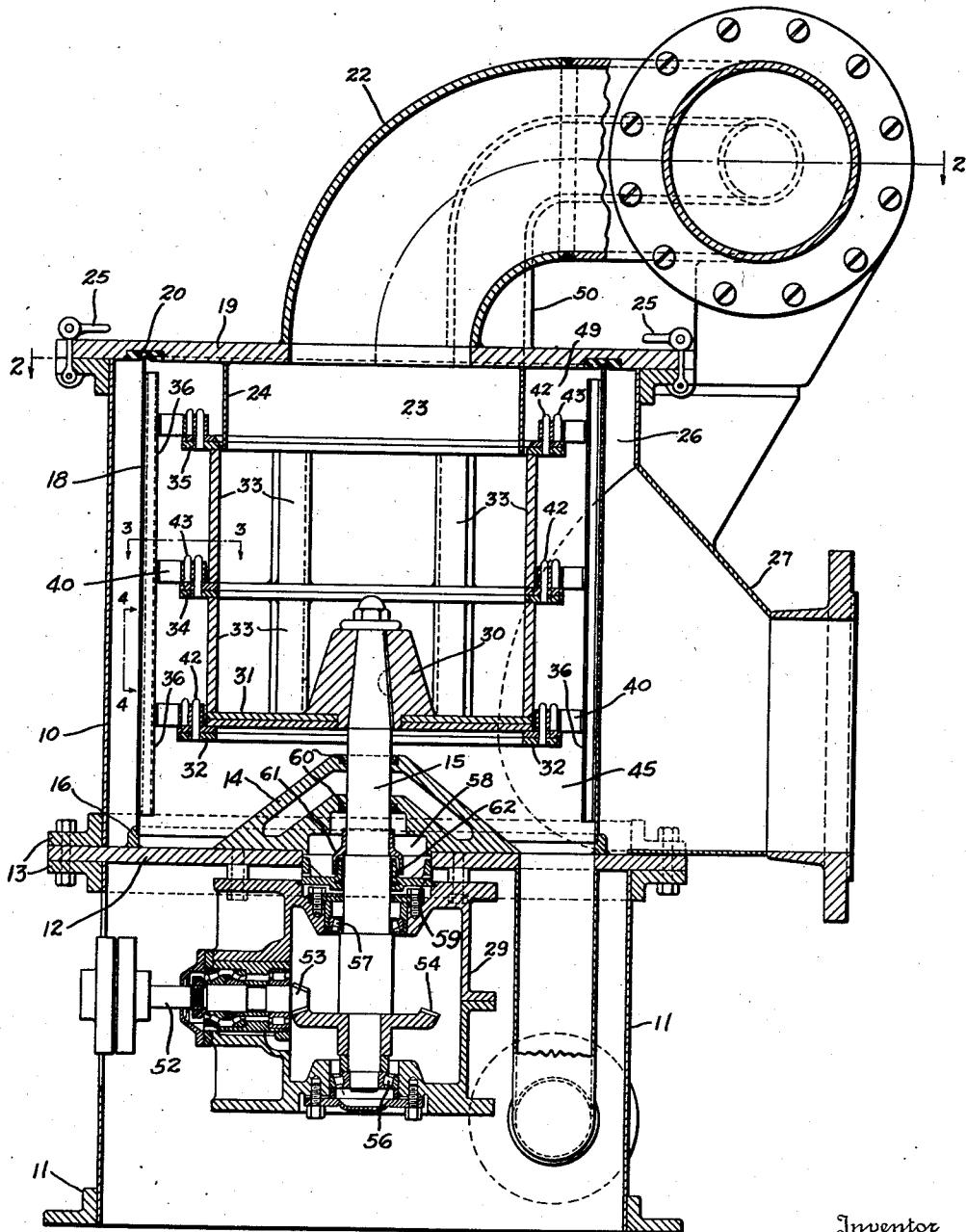
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APPARATUS FOR SCREENING PAPER STOCK

Filed July 19, 1939

2 Sheets-Sheet 1



Inventor

Fig. 1

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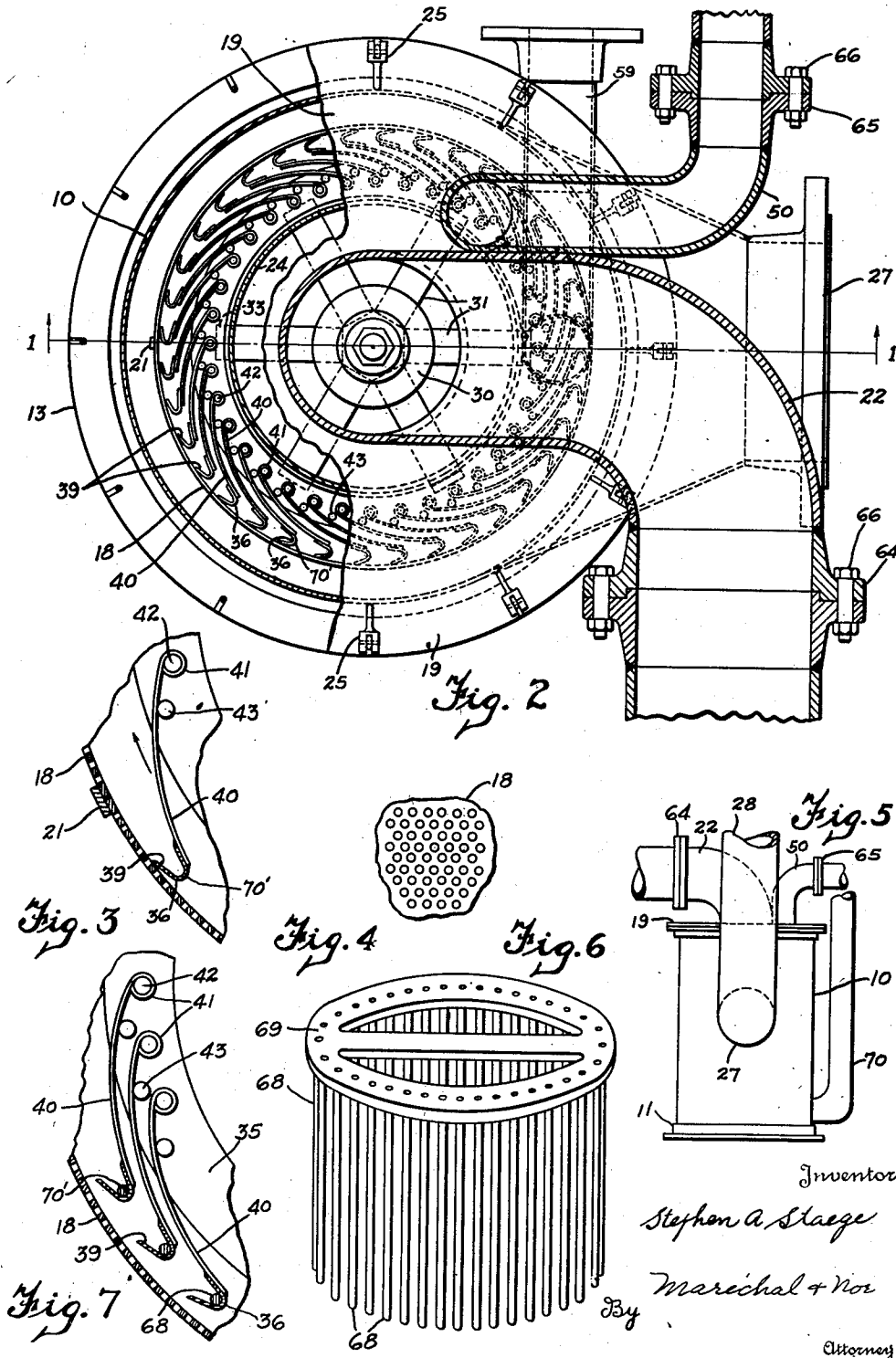
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2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE

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APPARATUS FOR SCREENING PAPER STOCK

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7 Claims. (Cl. 92—34)

This invention relates to screens for screening paper stock, and the like.

One object of the invention is the provision of apparatus for screening paper stock and the like and providing supply and discharge chambers on opposite sides of a cylindrical screening surface, and incorporating a rotatable series of blades which operate in contact with the supply side of the screen at a comparatively slow speed of rotation to scrape the fibers gently from the screen and keep the screen openings clean, the blades being comparatively large in number to provide a very rapid succession of scraping actions for the screen holes.

Another object of the invention is the provision of apparatus for screening paper stock or the like, providing supply and discharge chambers respectively on the inner and outer sides of a vertical cylindrical screening surface within which is a rotatable series of scraping blades which in normal operation have a maintained scraping contact with the supply side of the screening surface, the blades being comparatively large in number but operating at a comparatively slow rotational speed to provide a very rapid succession of cleaning actions on the perforations of the screen without creating a large centrifugal force on the fluid in the supply chamber.

Another object of the invention is the provision of an apparatus of large capacity for screening paper stock and the like, so arranged as to provide a comparatively slow movement of the stock towards a stationary cylindrical screen by reason of a pressure head on the supply side of the screen, the screen having a comparatively large number of cleaning blades which move at a low rate of speed in contact with the supply side of the screen and provide a very rapid succession of gentle cleaning actions on the screen perforations which keep the screen free of any accumulation or matting of the fibers.

Another object of the invention is the provision of a screening apparatus of the character mentioned having provision for removing the lighter impurities and the heavier impurities by gravity action which are passed to collecting chambers provided at opposite ends of the screening apparatus and both in communication with only the peripheral portions of the supply chamber.

Another object of the invention is the provision of a screening apparatus of the character mentioned and having a large number of slowly rotatable screen cleaning blades supported in such a manner as to insure a maintained yielding contact

of the blades with the supply side of the screening surface during normal operation.

Another object of the invention resides in the method of screening paper stock and the like in which the stock is supplied to a screen, under a pressure head, the supply side of the screen being cleaned by a very rapid succession of comparatively slow speed scraping actions which clean the fibers from the screen openings and produce only a negligible centrifugal force outwardly towards the screen surface.

Other objects and advantages of the invention will be apparent from the following description and claims, taken in connection with the accompanying drawings, in which:

Fig. 1 is a vertical sectional view of a screening apparatus embodying the present invention, the section being taken on the line 1—1 of Fig. 2;

Fig. 2 is a horizontal sectional view through the screening apparatus on the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary section on the line 3—3 of Fig. 1;

Fig. 4 is a fragmentary section on the line 4—4 of Fig. 1;

Fig. 5 is a side elevation of the screening apparatus, shown on a small scale;

Fig. 6 is a perspective view of a tool for retracting the scraping blades from the screen; and

Fig. 7 is a sectional view showing the operation of the retracting tool.

Referring more particularly to the drawings, in which like reference numerals designate like parts in the several views, the screening apparatus, shown as a preferred embodiment of the present invention, comprises a cylindrical shell or housing 10 of sheet metal suitably supported at its lower end on the base structure 11. The lower wall of the housing is formed by a horizontal annular bottom plate 12 bolted or otherwise secured to peripheral flanges 13 which are welded to the shell 10 and to the base structure 11 respectively. The central portion of plate 12 carries an upwardly tapering block 14 enclosing an upwardly extending rotatable shaft 15.

Secured to the upper side of the plate 12, as by means of welding, is a ring 16 which is grooved to receive and support a vertically extending cylindrical screen 18. The latter is provided with screening holes which are preferably from about .02 to .08 inch or more in diameter, the larger holes being employed for screening stock to be made into paperboard and the smaller holes for stock used in the manufacture of high-grade paper. These holes are so spaced that the total

open area is from 20% to 50% of the perforated area of the screen.

The screen 18 is preferably adapted for ready removal in an upward direction from ring 16, being held in the groove of the ring by a cover plate 19 having a ring 20 of rubber which yieldingly presses against the top of the screen when the cover plate is secured in its normal position, indicated in Fig. 1. The screen is preferably a curved metal plate secured at its adjacent ends by a metal connection strip 21 which extends vertically overlapping the abutting ends of the screen, and welded thereto. The lower end of this strip fits in a vertical groove in the ring 16 so that rotational movement of the screen is prevented.

Paper stock or the like is supplied to the screen through a stock supply pipe 22 which extends to the supply chamber 23 of the screening apparatus, the pipe 22 extending to a supply vat in which the level is sufficiently high so that the stock may be supplied with a head of from 30 to 60 inches or more to the supply chamber 23, or the stock may be supplied from a pump operating to create a pressure equivalent to such pressure head. An upper portion of the supply chamber 23 is partly defined by a wall 24 carried by the cover plate 19 and providing a continuation of the stock supply passage, this wall 24 extending downwardly to a level somewhat below the top of the screen. A series of quickly operable fastening clamps 25 serves to hold the cover in position.

The discharge chamber 26 which receives the screened stock that has passed through the openings in the screen extends annularly, as shown, on the outer side of the screening surface and at one side is provided with an inwardly flaring discharge passage 27 having connection to a discharge pipe 28 which preferably extends upwardly to a point above the top of the screen surface as indicated in Fig. 5, or to a receiving vat the level of which is preferably above the level of the top of the screening surface. The horizontal spacing between the screen and the housing 10 may be greater adjacent the discharge passage 27 and considerably reduced at the side opposite by positioning the housing eccentrically with respect to the screen so that the velocity of the stock flow through the chamber 26 may be substantially equalized at all points, although, as shown, the housing and the screen are arranged coaxially.

The rotatable shaft 15, which is rotatably mounted within a suitable bearing housing 29 bolted to the bottom plate 12, is detachably connected to a hub 30, having several radially extending arms 31. The outer ends of these arms are attached to an annular ring 32 and vertical struts 33 extending upwardly from ring 32 form supports for additional rings 34 and 35, these parts being welded together and providing a skeleton structure which is rotatable with the shaft. This structure carries a series of screen cleaning blades 36 having forwardly inclined scraping portions which operate in contact with the supply side of the screening surface, moving at a comparatively slow rate of speed so as not to create any considerable centrifugal force on the stock in the supply chamber. When a large number of such blades are used rapidly succeeding passes of the blades over each hole will be secured, without the necessity of such high operating speeds as will set up considerable and disturbing centrifugal forces or undue agitation of the body of stock inside the screen. By avoiding such undue agitation and preventing unduly high centrifugal forces, the main body of stock within the screen is main-

tained comparatively quiescent, even when large volumes of stock are being passed through the screen, and consequently heavy impurities can settle by gravity to the bottom of the screen and not be thrown outwardly by the centrifugal force to pass through the holes of the screen along with the screened stock. And by using a sufficiently large number of blades, passing over the holes at a comparatively low rate of travel, the blades nevertheless will operate along the supply side of the screen to give such rapid succession of gentle cleaning actions that the stock will be prevented from matting to plug up or clog the holes and also from matting or collecting in advance of the blades to give a maintained accumulation which will produce an objectionable matting of the fibers. In operation the satisfactory results of this invention are attained when the blades are operated at such low angular velocity as to produce centrifugal forces which are negligible with respect to the discharge of heavy impurities through the screen and yet are moved across the screen and the holes thereof and through the body of stock adjacent the screen at such rate that the rapid succession of movements gives gentle cleaning actions whereby the fibers are prevented from accumulating and matting over the holes to plug or clog them up and are prevented from maintained accumulation in front of the respective blades to give an undesirable matting over of the fibers.

In the embodiment of the invention as herein illustrated, in which a two foot diameter screen is used, the blades, as illustrated for example in Fig. 2, are spaced about two inches apart around the supply side of the screening surface, and 36 such blades are illustrated. With such a construction a rapid succession of gentle cleaning actions may be secured so that such accumulation or matting of the stock is prevented, and at the same time with speeds of rotation which are sufficiently low to prevent objectionable centrifugal forces as stated. With the number of blades and the dimensions stated, and using stock of such consistency as is ordinarily screened in a paper mill—generally, stock of a consistency of about $\frac{1}{2}\%$ —the gentle cleaning actions referred to can readily and satisfactorily be secured with most stocks when the shaft carrying the blades is rotating at 75 R. P. M. Of course, as is well understood, a pulp screen such as herein described is generally utilized for screening the finally prepared stock, before it goes to the paper making machine, and such stock will vary widely in its characteristics depending upon whether the fibers are derived from wood or rags, whether they have been separated by one or another of the several chemical cooks used or are so-called groundwood, and the extent to which they have been cut and fibrillated and hydrated during the preparatory action in the beaters, jordan, etc. A so-called slow stock of a given consistency would respond somewhat differently from a free stock, and as is well known in the industry comparatively small percentage variations of fiber content or consistency may cause great differences in operating variations. Therefore, while satisfactory results have been secured in a machine of the dimensions referred to and with the number of blades stated and when operating at some 75 R. P. M., the operating speed of the blades may be varied, and may necessarily be varied, both above and below that particular speed which is specified as illustrative of a satisfactory operating condition but within the conflicting require-

ments stated that the speed should be slow enough to prevent objectionable centrifugal force which would interfere with the gravity separation of heavy material such as particles of metal and the like and yet to give sufficient relative movement of the blades with respect to the stock and over the holes to prevent the fibers from maintained accumulation or matting in advance of the blades and over the holes. Satisfactory results have been attained with 36 blades in the machines of the dimensions stated, operating as low as 50 R. P. M. with some stocks, satisfactory results have been attained with most stocks operating at 75 R. P. M., but with some stocks the speed should be increased to meet the conditions of causing negligible centrifugal force and yet causing the gentle cleaning actions which will prevent the maintained accumulation or matting of the fibers between the scraper blades and over the holes.

With the blades so operated as to cause 30 to 40 passes over each hole per second the actual accumulation of a mat within the hole itself has been found satisfactorily prevented in all commercial operations, and the proper gentle washing action which prevents any accumulation or matting of fibers in advance of the blades may be maintained with comparatively slow rates of travel of the blades as attained by a low R. P. M. of the order stated, satisfactory results being secured in actual practice with the construction described with rotational speeds of the order of one and two turns per second. The large number of blades also provides a well distributed outward pressure on the screen contributing to the internal fluid pressure on the screen to maintain it in a truly circular form and permitting an unusually large open area as compared to the total plate area.

Each blade is preferably a stainless steel strip about $\frac{1}{2}$ of an inch in thickness, arranged vertically, and having a length substantially equal to the height of the perforated part of the screen. The scraping portions of the blades are forwardly inclined in the direction of rotation and in an outward direction, preferably at a small acute angle of about 15° , as shown. The straight scraping edges 39 of the blades operate in contact with the screen 18, since the blades are yieldingly carried by flexible steel strips 40, to which they are welded. The inner ends of each of the strips 40 is formed to provide an eye 41. The eyes of the strip are mounted loosely on the pins 42 which are fixed on the rings 32, 34 and 35, while other pins 43 which also project from the rings 32, 34 and 35 are so positioned as to maintain a tension in the strips 40, and hold the scraping edges of the blades against the screen. The strips 40 extend outwardly and rearwardly of the direction of rotation at a small acute angle to the screen, preferably of the order of about 15° , so that any blade may yield backwardly and inwardly if it encounters an obstruction that might be lodged in one of the screen openings, without applying an excessive or destructive force on the blade. In normal operation the forwardly inclined scraping portions of the blades operate with a maintained yielding contact with the screen and quietly scrape off any fibers tending to accumulate on the screen.

The discharge side of the screen is preferably maintained completely submerged by having the pipe 28 extend up to a point above the top of the screen. The stock which enters the supply chamber flows down into the space within the screen and as the rotating blades move through

the stock flowing outwardly in the screen to pass through the holes these blades cut across the streams of stock which are flowing radially outward through the holes and tend to change the radial direction of movement and also tend to carry the stock within the zone of the blades in a rotational direction. The resultant is the gentle cleaning action referred to with any tendency to accumulation of fibers over the holes being prevented by the rapidly succeeding scraping actions of the blades and the gentle washing action which results from the relative movement of the blades with respect to the stock causing such gentle cleaning that no maintained accumulation of fibers ahead of the blades occurs. Of course, it is physically impossible to avoid the creation of some centrifugal force as the blades move around inside the screen, but at the slow rate of angular travel which has been found to give the satisfactory gentle cleaning and non-mat forming action referred to, the centrifugal forces created are so slight with respect to the large body of stock within the screen and the rotation of the whole mass of stock, because of the skeleton formation of the revolving blade structure, is so gentle that whatever of centrifugal forces result are negligible with respect to the gravity separation of heavy impurities within the body of the stock. This condition has been satisfactorily attained while still providing such movement of the blades to cut through the radially flowing streams of stock and such relative movement of the blades with respect to the zone of stock adjacent the screen that the accumulation or matting of fibers over the holes or around the screen and in advance of the blades is prevented. Thus even though the outer portions of the cylindrical body of stock within the screen may move around at a very slow rate of speed along the inner side of the screening surface by the rotational action of the scraping blades there is no objectionable centrifugal force created, and only the gentle cleaning action which maintains the holes and the surface of the screen and the blades washed free from any maintained accumulation or matting of fibers. Due to the small radial extent of the blades the inner portions of the cylindrical body of stock will have merely a downward and outward movement. As the stock fibers approach the openings in the screen, they will move at a comparatively slow speed, their speed of movement however increasing as they enter the openings in the screen so that the stock fibers tend to go through the screen openings aligned with the direction of flow and parallel to one another. Any heavier impurities such as sand or other heavy particles present in the stock settle downwardly by gravity action instead of passing through the screen, and since the speed of rotation of the peripheral portions of the stock in the screen is very small, the heavier impurities will not be thrown out forcibly against the screen surface and may settle rapidly to a point below the screen and thus enter the collecting chamber 45 in which the heavier rejects accumulate, and from which they may be periodically or continuously withdrawn at a suitable rate, as by means of a conveyor which operates in a withdrawal tube 10 extending to a point above the level of the screen. With the construction of screen as described above this action is effectively obtained with the blades operating at a peripheral speed of about 500 feet per minute, the actual speed for securing the desired results

depending to some extent upon the individual design as to diameter and speed of rotation.

The lighter impurities as well as air present in the stock entering the supply chamber will rise by gravity action in the slowly circulating peripheral portions of the body of stock, and pass above the upper ring 35 into the compartment 49 provided at the top of the screen. The discharge pipe 50 for the lighter rejects projects upwardly and is preferably provided as an integral part of the cover plate 19. The passage through the pipe 50 is periodically opened to permit the discharge of a portion of the material collected in the compartment 49.

In accordance with the present invention, the power required for rotating the screen scraping blades is only about 3 to 4 H. P. in a screen having an unusually great screening capacity and capable of screening stock having a consistency of only a very small fraction of one per cent or up to 3% or more. The flow of stock through the screen is continuous as distinguished from a back and forth pulsating movement, the continuous flow being under a very substantial head so that the stock passes freely through the perforations in the screen which are continuously kept clean. Since the open area of the screen is from 20% to 50% of the total screen area and since the holes are cleaned a great many times per second, the consistency of the stock on the discharge side of the screen will be substantially the same as that on the supply side of the screen and the same as the stock coming through the supply pipe. Furthermore with a comparatively slow speed of rotation of the blades, the stock supplied to the screening apparatus will not be beaten or pulped to any appreciable degree, the action of the screening blades being essentially a cleaning or scraping action. In view of the comparatively large rate of flow through the screen, only a very small fractional part of the stock fibers will be actually engaged by the scraping edges of the blades.

Rotational movements of the shaft 15 are imparted by means of a power driven shaft 52 operating speed reduction gearing in the housing 29. As shown the shaft 52 is provided with a bevel pinion 53 which meshes with a bevel gear 54 provided on the lower end of the shaft 15. The shaft is rotatably supported by antifriction bearings 56 and 57 which serve to locate the shaft 15 against axial movement. Above the bearing 57 is a space 58 provided by the upper portion of the stationary bearing housing and the lower part of the conical block 14, this space forming a discharge path communicating with discharge passages 59 to relieve any water or stock that might leak past the sealing washers 60 of suitable water packing material arranged in the conical block 14. An overhanging shell 61 fixed on the shaft projects over the stationary ring 62 which projects upwardly from the top wall of the housing and prevents any leakage liquid that finds its way into the space 58 from leaking into the roller bearing of the drive unit.

The interior of the screening apparatus is readily accessible for cleaning purposes, since the cover plate 19 may be readily removed from the top of the shell 10 and the scraping blades are then accessible for inspection or replacement. The cover 19, as shown is integrally or rigidly connected to the pipes 22 and 50 which curve upwardly and oppositely so as to extend coaxially. The coaxially extending portions of these pipes are rotatably carried in flanges 64 and 65 re-

spectively and are normally secured thereto by readily removable bolts or clamps 66, which, when loosened, permit the cover 19 to be swung upwardly, provided the quick acting clamp or bolts 25 which normally hold the cover 19 in place are first removed. When the cover is raised the screen 18 may be readily pulled upwardly for inspection or replacement or both the inner and outer sides of the screen may be cleaned without withdrawing it. To withdraw or replace the screen quite readily, the blades 36 are pulled inwardly free of contact with the screen, preferably by means of a special tool which permits all of the blades to be pulled in at the same time. This tool designated 68 and shown in part in Figs. 6 and 7 comprises a disk 69 somewhat smaller in diameter than the screen, and having a series of depending rods rigid therewith and corresponding in number and spacing to the blade arrangement. With the rods engaged with all of the spring strips 40, a small rotational movement of the disk 69 will simultaneously force all of the blades inwardly by flexing the strips 40, until the rods seat in the curved portions 70 of the blades. The blades will then be in such a position that the disk 69 will remain in this position and the screen may be lifted out or applied with ease. After removing the screen the tool is removed and the blades themselves, together with their respective spring strips 40, can be removed by merely withdrawing them upwardly.

While the method herein described, and the form of apparatus for carrying this method into effect, constitute a preferred embodiment of the invention, it is to be understood that the invention is not limited to this precise method and form of apparatus, and that changes may be made in either without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. A screen of the character described for screening fibrous material comprising a fixed vertically extending cylindrical screening surface, means providing supply and discharge chambers respectively on the inner and outer sides of said screening surface, means for supplying material to the top of said supply chamber, a rotor operable in the supply chamber and having an annular series of blades provided with screen cleaning portions inclined forwardly toward the screening surface in the direction of rotation and having a maintained scraping engagement with the screening surface in normal operation, means for rotating said rotor at a comparatively slow rate of speed, the blades being of a comparatively large number with a plurality of blades in each quadrant of the rotor so that each opening in the screen is cleaned by the scraping action of the blades up to 30 to 45 times per second although the centrifugal force on the material being screened at the screening surface is substantially negligible, means for withdrawing heavy matter settling in the supply chamber from the bottom of the supply chamber, and means for maintaining the discharge chamber completely filled with screened material.

2. A screen of the character described for screening fibrous material comprising a vertical cylindrical screening surface, means providing supply and discharge chambers respectively on the inner and outer sides of said screening surface, means for supplying fluid to the top of the supply chamber, a rotor operable within the screening surface and having an annular series

of blades provided with screen contacting portions that are inclined forwardly toward the screening surface in the direction of rotation, said blades each having a yielding connection to the rotor at a point substantially ahead of a radial plane through the point of engagement of the blade with the screen, and means for imparting a slow rotation to said rotor, the blades being of a comparatively large number with a plurality of blades in each quadrant of the rotor so that each opening in the screening surface is cleaned by the scraping action of the blades at a rate up to 30 to 45 times per second although the centrifugal force on the material being screened at the screening surface is substantially negligible.

3. A screen of the character described for screening fibrous material in liquid suspension comprising a vertical cylindrical screening surface, means providing supply and discharge chambers respectively on the inner and outer sides of said screening surface, an annular series of blades provided within the screening surface, said blades having a short radial extent compared with the radial thickness of the liquid in the supply chamber and having forwardly inclined screen contacting portions, means supporting said blades for yielding outward movement of their screen contacting portions so that the blades have a maintained contact with the screen surface in normal operation, and means for slowly rotating said blades to avoid creating any substantial centrifugal force on the material being screened at the screening surface, the blades being of a comparatively large number with a plurality of blades in each quadrant of the screen so that each opening in the screening surface is cleaned by the blades up to 30 to 45 times per second.

4. A screen of the character described for screening fibrous material in liquid suspension comprising a vertically extended cylindrical screening surface, means providing a supply chamber on the inside of said screening surface and a discharge chamber on the outside thereof, a rotor operable in said supply chamber having an annular series of blades, means for mounting said series of blades on said rotor providing for maintained scraping engagement thereof with said screening surface in normal operation, and means for driving said rotor at a comparatively slow rate of speed of about 75 R. P. M. to maintain the centrifugal force on said fibrous material insufficient to prevent gravity separation of heavy impurities and to maintain movement of said blades over said screening surface in rapid succession to provide a washing action preventing the matting or accumulation of the fibrous material over the surface of the screen and upon the leading surfaces of the blades.

5. A screen of the character described for screening fibrous material in liquid suspension comprising a vertically extended cylindrical screening surface, means providing a supply

chamber on the inside of said screening surface and a discharge chamber on the outside thereof, a rotor operable in said supply chamber having an annular series of blades, means for mounting said series of blades on said rotor providing for maintained scraping engagement thereof with said screening surface in normal operation, and means for driving said rotor at a comparatively slow peripheral speed of about 500 feet per minute to maintain the centrifugal force on said fibrous material insufficient to prevent gravity separation of heavy impurities and to maintain movement of said blades over said screening surface in rapid succession to provide a washing action preventing the matting or accumulation of the fibrous material over the surface of the screen and upon the leading surfaces of the blades.

6. A screen of the character described for screening fibrous material in liquid suspension comprising a vertically extending cylindrical screening surface, means providing a supply chamber on the inside of said screening surface and a discharge chamber on the outside thereof, a rotor operable in said supply chamber having an annular series of blades including a plurality of blades in each quadrant thereof, means for mounting said series of blades on said rotor providing for maintained scraping engagement thereof with said screening surface in normal operation, and means for driving said rotor at a comparatively slow rate of speed of about 75 R. P. M. to maintain the centrifugal force on said fibrous material insufficient to prevent gravity separation of heavy impurities, and to maintain movement of said blades over said screening surface in rapid succession to provide a washing action preventing the matting or accumulation of the fibrous material over the surface of the screen and upon the leading surfaces of the blades.

7. A screen of the character described for screening fibrous material in liquid suspension comprising a vertically extended cylindrical screening surface, means providing a supply chamber on the inside of said screening surface and a discharge chamber on the outside thereof, a rotor operable in said supply chamber having an annular series of blades including a plurality of blades in each quadrant thereof, means for mounting said series of blades on said rotor providing for maintained scraping engagement thereof with said screening surface in normal operation, and means for driving said rotor at a comparatively slow rate of speed of about 75 R. P. M. to maintain the centrifugal force on said fibrous material insufficient to prevent gravity separation of heavy impurities and to maintain movement of said blades over said screening surface in rapid succession at a rate up to 30 to 45 passes per second to provide a washing action preventing the matting or accumulation of the fibrous material over the surface of the screen or upon the leading surfaces of the blades.

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