ABSTRACT

The improvement in the operation of a paper mill, whereby re-usable long fibers are recoverable from mill waste effluent, wherein the fibers are entrapped in contaminating impurities comprising coarse particles along with fibrous-and-non-fibrous fines. The present improvement provides a fiber recovery section whereby a suspension of the entrapped fibers is supplied under pressure to a sieve bend type of screen, effecting the decontamination of the fibers, and delivery of recovered fibers suitable for paper making.

11 Claims, 11 Drawing Figures
FIG. 7
SAMPLE NO. 1
MILL EF FLUENT
75 TIMES ENLARGED

FIG. 8
SAMPLE NO. 2
SCREEN OVERFLOW
(WITHOUT CYCLONE CLEANER 56)
75 TIMES ENLARGED

FIG. 9
SAMPLE NO. 3
SCREEN UNDERFLOW
(WITHOUT CYCLONE CLEANER 56)
75 TIMES ENLARGED
FIG. 10
SAMPLE NO. 4
UNDERFLOW FROM CYCLONE 56
30 TIMES ENLARGED

FIG. II
SAMPLE NO. 5
OVERFLOW FROM SCREEN 53 WITH CYCLONE CLEANER 56
75 TIMES ENLARGED
SYSTEM FOR RECOVERY OF FIBER FROM PAPER MILL EFFLUENT, INCLUDING A SIEVE BEND SCREEN

This application is a continuation of Ser. No. 175,498 filed Aug. 27, 1971, now abandoned, which in turn is a continuation in-part of Ser. No. 834,168 filed June 17, 1969, now abandoned.

BACKGROUND OF THE INVENTION

It is conventional in paper making operations to utilize large quantities of water as a carrying medium to facilitate the handling of fiber or pulp as well as to carry the fiber in a desired manner into the paper sheet being formed on a paper making machine. Further, substantial quantities of water are used both continuously and intermittently to wash unwanted fiber from various units or components of the mill equipment. In many mills a number of techniques are employed to permit the reuse of these large quantities of water so as to reduce plant water requirements and to reduce the volume of waste or effluent water from the mill. Such techniques are particularly utilized with respect to the water drained from the newly formed sheet in the paper machine, known as white water. Commonly a system, known as a saveall system, is employed to separate the fiber which has carried through the sheet from the bulk of the white water liquid so as to permit reuse of the water for washing operations and to recover this fiber for reuse. However, these known water reuse techniques have been generally confined to the steady state and continuous operations of the mill. In contrast, at times of abnormal operations and when changing production runs, as well as to a lesser extent during normal operations, considerable quantities of water and fiber escape through floor drains and crest overflows. Occasionally this loss is accidental as by spillage, but frequently the loss is intentional through the dumping of chests and other equipment during grade change and by washing operations. As a result the mill sewer carries away substantial quantities of water and fiber from the paper making operation. This fiber-containing mill effluent represents a substantial loss of valuable material and presents a waste disposal problem.

OBJECTS OF THE INVENTION

It is an object of the present invention to provide a method of treating a paper mill effluent stream to recover reusable fiber therefrom.

Another object of this invention is to provide a method for processing a paper mill effluent stream to remove reusable solids therefrom so as to reduce the load on any waste treatment equipment provided for handling the effluent stream.

A further object of the invention is to provide a method for recovering usable fiber from a paper mill effluent stream so as to facilitate, and to permit greater flexibility in mill operations by making the disposal of fiber to the sewer less of an economic loss and/or a waste treatment problem.

The technical aspects and the economical significance of this invention may be best understood by reference to the drawings wherein

FIG. 1 represents a simplified mill flow sheet illustrating plant sources of fiber losses and contamination, that combine to produce the final mill effluent, including embodiments of a treatment section for fiber recovery from the mill effluent.

FIG. 2 to 6 show other embodiments of the fiber recovery treatment section.

FIGS. 7, 8 and 9 are microphotographs of the fiber recovery section in the flowsheet of FIG. 1.

DESCRIPTION OF THE INVENTION

Paper mills lose between 1 to 3 percent of their production to the waste effluent stream. Much of this is a reusable fiber. These losses result from grade changes, clean-ups, trim, excess white water, and spills. These losses can be categorized as two types. The first type of loss is a continuous one in which a portion of the white water from the paper machine is sewered. Normally every paper machine has a saveall device which will take a major portion of the white water and clarify it, returning the fiber to the papermaking process and the water to the machine for shower usage. However, no paper machine has a completely closed system and therefore a varying percentage of the total white water is untreated by the saveall and therefore ends up in the mill effluent stream. While this flow will contain some good fiber, a major portion of these fibers will be less than 0.1 mm in length and therefore may not be desirable for re-use. Short fibers or fines give a slow draining characteristic to the paper machine furnish, in which case the speed and capacity of the paper machine are negatively affected.

The second source, and the one which is normally the major source of fiber loss from the papermaking process, occurs during a grade change. Because of the large, expensive nature of papermaking equipment, it is paramount that a grade change be completed in as short a time as possible to minimize machine downtime. To expedite grade changes the contents of various stock chests and white water chests are emptied to the sewer with no attempt for fiber recovery. All of this fiber constitutes good fiber and therefore is reusable.

In order to recover such fiber, the present invention provides a method wherein the effluent stream from a paper mill is treated on a sieve bend screen such as described in U.S. Pat. No. 2,916,142. In such an application of the screen, the effluent stream is directed at a substantial velocity along the plane of a screening surface having a plurality of slots there through which extend substantially transversely to the direction of the feed flow. In this manner, solid particles which are smaller than the size of reusable fiber along with most of the carrier liquid are deflected by dynamic forces through the slots. The longer reusable fiber in the range of plus 150 mesh or in the order of plus 0.1 mm fiber, and some of the carrier liquid are retained at substantial velocity on the screen surface and travel to the discharge end thereof. By this screening technique the solids loading of the mill effluent is reduced by 25 to 75 percent thus decreasing the requirements for waste treatment.

It has been found that such a sieve bend screen is able to efficiently recover the long fiber fraction from the total solids in the paper mill waste stream. The drainage characteristic of the pulp is expressed in a numerical system known as the Canadian Freeness Standard. The higher the number, the more free or better draining is the pulp. For example, the solids in the mill effluent
may exhibit a Canadian freeness of 150 to 200. The recovered fiber from the sieve bend screen may exhibit a Canadian freeness in the range of 500 to 700. This is a demonstration of the classification performance and upgrading quality of the screen. Another reason for improved freeness was the removal of coating and filler materials. These non-fibrous constituents, which may range from 30 to 40 percent in the untreated effluent stream, are reduced to 2-6 percent in the recovered fiber flow. In order for this pulp to be used on a paper machine that uses secondary (waste) fiber for furnish, the desired freeness should be a minimum 300 CFS, however, because the freeness was so high, 600 to 680 CFS, this pulp could be reused on a paper machine using virgin pulp for furnish.

Several different techniques may be employed for utilizing the oversized or recovered fiber from the sieve bend screen. First, the recovered fiber may be directed to the broke system where it mixes with the pulp regenerated from broke. Subsequently, the recovered fiber along with the broke fiber may be introduced to the machine chest of the paper machine where it mixes with the other furnish. Alternatively, as the recovered oversized from the sieve bend screen has a solids consistency of about 3 to 6 percent, this recovered fiber stream may be directed to the machine chest since the solids consistency of the stock therein is in this same range. Further, as mentioned above, the recovered fiber stream from the sieve bend screen may be dewatered so as to obtain a valuable dry product which can be disposed of in the commercial secondary fiber market.

Inasmuch as the sieve bend acts as a classifying device, it retains with the recovered long or usable fiber particles of large size which may be present in the mill sewer. A coarse screening or straining operation may be used upstream of the sieve bend screen to remove large foreign objects and protect the DSM screen. However, particles such as shives may remain with the recovered fiber to be removed during reuse of the fiber. For example, if the recovered fiber is returned directly or indirectly to the machine chest, such shives are removed by the hydrocyclonic cleaners customarily located downstream of the chest and upstream of the wire of the paper machine.

In the above-described manner, the present invention provides a method of treating paper mill effluent on a sieve bend screen to recover usable fiber therefrom so as to reduce product losses and to reduce the magnitude of the waste treatment problem generated by the mill effluent stream.

By reference to the drawings it will be understood that the invention is directed to improvements in the operation of a paper mill, to the end of effecting the profitable recovery of re-useable fibers from mill effluent that may be heavily contaminated with miscellaneous entrapped impurities collected in the effluent sewer from all over the plant. Such mill stock losses result variously from excess white water, dumping of pulp at grade changes, for instance from the supply, broke, and machine chests, as well as from the sawell operation, also from spillage into floor drains, and from the rejects from the hydrocyclonic pulp cleaners preceding the paper machine. The contaminating substances in the mill effluent may comprise fillers, coatings, dust, and sand particles, slimes and shives, as well as undesirable fibrous fines, all form agglomerates with the fibers to be recovered in the operation of this invention.

Normally, such plant effluent collected through the paper mill effluent sewer, must be subjected to a waste disposal treatment operation, to meet anti-pollution requirements, before it can be released into receiving open waters. Conventionally such a disposal operation involves feeding the mill effluent to a continuous clarifier-sedimentation unit which delivers an overflow to be subjected to secondary treatment before release into open waters, and an underflow containing the bulk of the collected impurities. This underflow is subjected to dewatering preferably on a continuous rotary filter from which the filtrate liquid is returned to the clarifier, while the filter cake material may be disposed of for example by combustion. Separating re-useable fibers in the manner of this invention is not only profitable of itself, but by the same token reduces the load on the waste disposal treatment system.

The recovery of the fibers in the manner of this invention represents an improvement affecting the operation and economy of the paper mill as a whole, as well as of the waste disposal system, be it that the recovered fibers are re-used in the plant itself, or re-used in operations externally of the plant.

Significance of this invention appears from the fact that paper mill operators are aware of the aforementioned effluent fiber losses running an average of 1 to 3 percent and sometimes greater of the paper mill production. In fact, such fiber losses are currently indicated in the operating records of the plant. But according to this invention, these fibers are largely recoverable intact and decontaminated in spite of the entrapment in the aforementioned impurities and fines, and in a form of a high-freeness dewatered pulp (having a freeness of from 400 to 600 freeness points) re-useable in the paper making process of the plant itself, or else fit for sale and paper making in another plant.

Thus, in view of this invention, the above indicated customary effluent fiber losses need not be considered as unavoidable by the paper mill operators, requiring waste disposal treatment, but can be turned into a substantial profit over and above the cost of the recovery process and with prompt amortization of the recovery equipment and installation cash, even while relieving the above mentioned waste disposal operation of the equivalent of said recovery.

Briefly, the invention comprises subjecting the mill effluent to a de-contaminating classifying treating operation which involves passage over the sieve bend type of screen (above referred to) which thus was found to be capable of rapidly dynamically separating long high grade fibers intact from the aforementioned agglomerates and freed of entrapped contaminating substances as well as fines. The recovered fibers appear in the form of a high-freeness, highly concentrated yet pulpable re-useable pulp. Any minor amount of residual impurity particles in the thus recovered pulp may be subsequently intercepted by the pulp cleaners ahead of the paper machine, within the plant itself, or where this pulp is re-used externally of the plant, may be subjected to a cleaning operation depending upon the product quality desired.

Referring to FIG. 1 of the drawings the simplified flowsheet shown is that of a paper mill embodying the invention. This illustrates particularly the plant sources of fiber losses and contamination, that combine to pro-
duce the final mill effluent having the criteria set forth above, and from which recovery is to be made of fiber losses heretofore considered irretrievable.

Reduced to the simple terms of this example, the heart of the paper mill is the paper machine 10 receiving the feed pulp or "furnish" at a suitable dilution, that is with a fiber content in the order of \( \frac{1}{4} \) to 2 percent. This pulp is fed to the fast running paper forming wire screen of the machine, but with fiber losses 11 occurring through the wire as so called "white water", usually recovered in connection with Save-all operation. Such conventional recovery is here represented as by a continuous rotary drum filter apparatus 12, or so called Decker. A tank 13 collects the "white water" containing these fibers in suspension, and there is a feed line 14 leading to the Save-all from the tank.

The resulting filter cake 15 containing undamaged high quality fibers, after repulping, is returned to the machine furnish via line 16 while the filtrate liquid through line 17 is re-used in supplying the showers required in the operation of the paper machine.

The feed pulp or machine furnish is provided from various supply chests, namely the pulp storage chest 18 which, for storage purposes, receives a virgin fiber pulp supply 19 of concentration in the order of 4-6 percent with agitating devices 20 effective to prevent settling. From supply chest 18, this virgin pulp is transferred via line 21 to the machine chest 22 again to be agitated as by mixer 23, with dilution control from a controlled water supply 24 to a fiber concentration of about \( \frac{1}{4} \) percent. A pulp cleaning station as represented by a hydrocyclone 25 interposed between the machine chest and the paper machine, effectively removes from the feed pulp residual undesirable constituents such as shives, dirt, and sand, appearing as rejects in the cyclone underflow 26.

In addition to the mixture of virgin pulp supply and Save-all recovered pulp, the feed pulp or machine furnish may also contain pulp recovered from defective or off-quality paper runs delivered by the paper machine. This repulped paper material or so called "broken" contains mostly high quality re-usable fibers, but it is collected in the broke chest 27, in order to be supplied via transfer line 28 to the machine chest at a controlled or metered rate for blending to the proportion required in the machine furnish. The control of this blending operation is necessary since the broke contains additives and sizing substances that would otherwise build up in the circuit beyond tolerance.

The regular production of the paper machine may be interrupted by a run of defective broke paper at 30 to be repulped in the agitator-equipped collecting tank 31 whence a pump 32 and transfer pipe 33 may deliver this reconstituted pulp to the broke chest 27.

The paper mill produces a mill waste effluent collected in a common sewer 34 from various sources and locations throughout the plant, such as from overflows 34a, 40, 36 of the respective pulp supply chests, overflow 37 from the white water collecting tank 13, overflow 38 from the Save-all filter vat, as well as underflow 26 from the hydro-cyclone cleaners. Still other effluent fiber losses are due to supply chest dumping on grade changes, as indicated by dumping lines 39, 35, and 41, dumping from the Save-all through line 42, and dumping from white water supply tank 13 through dumping line 43. Then there is the continuous condition of excess white water delivered through line 44 from a down stream portion of the paper forming wire screen. While the pump overflows and dumpings may contain undesirable shives and some contaminating material, a substantial or major portion of the aforementioned contaminating substances reaches the sewer in the form of rejects from the cleaners, spillage, dirt, floor drains, sand, dust, all being entrapped in agglomerates with one another and with the undamaged fibers and the fines.

The mill waste effluent thus constituted, eventually collects in the sump or pit 45 whence a pump 46 would normally deliver it to waste disposal as indicated by the valve delivery line 46a. An example of such waste disposal is here shown to comprise a clarification-sedimentation station as represented by a continuous settling tank 47 delivering overflow liquid 48 which in turn may be subjected to secondary purification treatment as indicated by arrow A-1, before being re-used or being released into open waters. The sludge obtained in the underflow from the settling tank may be dewatered as on a belt type rotary drum filter 49 from which the filter cake may be sent to an incinerator or combustion unit, as indicated by the directional arrow A-2. Here too we find that overflow 51 or dumping 52 from the vat of the belt filter into the sewer, may add to the contamination of the fibers normally lost in the mill effluent. Underflow 26 from cyclonic cleaner 25 instead of going to the sewer, may be sent directly to the clarifier 47 as indicated by pipe connection 26a.

According to one embodiment in FIG. 1, the mill waste effluent from pit or sump 45, instead of being sent directly to waste disposal settling tank 47, is shunted to a sieve bend type of screen 53 by way of valve line 53a. In this way, the sieve bend type of screen is effective dynamically to decontaminate as well as to dewater the re-usable fibers and to deliver them at 54 freed of fines in the form of a concentrated yet pumpable re-usable pulp. The remaining of the aforementioned impurities and fines along with the major portion of the effluent or carrier liquid, represent the underflow 55 from this screen, to be delivered to the clarifier tank 47.

In cases where the pulp containing the recovered fibers is of a quality re-usable in the plant itself, a line 56 may be provided for delivering it to the broke storage chest 27, to be metered or proportioned out together with the broke into the machine chest 22. Thus any residual impurities or shives that may have escaped the sieve bend in the recovered pulp will then be intercepted in the hydro-cyclonic cleaner station 25.

Alternatively, the directional arrow A-3 indicates the condition where the recovered pulp due to grade changes or the like is passed on for a different kind of paper making in another mill. Control valves K-1 and K-2 indicate this alternative.

Still referring to the flow sheet of FIG. 1, depending upon plant conditions and upon the character and impurities content of the mill effluent, it may be desirable to provide an hydro-cyclonic cleaner 56 ahead of the sieve bend screen 53, effective to intercept the coarser impurity fraction that might have too high a wearing effect upon the screen. This cyclone receiving pressure feed 57 from sump pump 46 delivers an overflow 58 under a required operating pressure to the screen while underflow 59 discharges into clarifier 47. Valves V-1 and V-2 may be operated to either include or exclude the cyclone 56. The screen thus delivers an over-
flow of decontaminated pulp containing good quality re-usable fibers, while discharging into the clarifier an underflow containing fibrous and nonfibrous impurities.

The recovery of this pulp not only reduces the conventional load upon the waste disposal section, but also amortizes the cost of the recovery equipment and of the waste disposal section, while even paying for their combined operation and producing a net payout.

An example of the economy thus attainable is as follows:

For a plant discharging 5 million gallons/day of waste effluent:

Installed Cost of the fiber recovery system substantially as shown in flowsheet of FIG. 1. (Including Sieve bend type screen, pumps, piping, foundation) –

<table>
<thead>
<tr>
<th>Fiber recovery/year:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000 tons at $50.00/ton = $100,000.00</td>
</tr>
<tr>
<td>Payout: $100,000.00</td>
</tr>
<tr>
<td>$100,000.00 = 1 Year of operation amortizes the installed cost.</td>
</tr>
</tbody>
</table>

Payout for the following years:

<table>
<thead>
<tr>
<th>Cost of Power and Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>$100,000.00 approx.</td>
</tr>
<tr>
<td>$10,000.00</td>
</tr>
<tr>
<td>$10,000.00</td>
</tr>
<tr>
<td>Net Payout /year</td>
</tr>
<tr>
<td>$80,000.00 (before taxes)</td>
</tr>
</tbody>
</table>

In addition to these savings there is gained a corresponding reduction of the load on the final waste disposal equipment.

The embodiment of FIG. 2 of the fiber recovery section differs from the one just described, in that an hydro-cyclonic cleaner 60 follows the sieve bend screen 53. A pump 61 and a supply of rediluting water 62 are here required to provide feed pressure and an operating condition for the cyclone, but a relatively smaller cyclone will handle the overflow pulp from the screen which contains a portion of the mill effluent impurities but which is then delivered as cyclone overflow 63 in a decontaminated state for re-use. Cyclone underflow 64 containing the impurities discharges into clarifier 47, which impurities comprise coarse impurities mixed with straw fibrous and non-fibrous fines.

The embodiments of the fiber recovery section shown in FIGS. 3, 4 and 5, represent a group that differs from the embodiments in FIGS. 1 and 2, in that the sequence of the sieve bend screen and clarifier is reversed, and whereby that the filter operation is eliminated. With such an arrangement in its simplest form as shown in FIG. 3, mill effluent from sump 45 is pumped directly to a clarifier 64 delivering overflow liquid 65 to be subjected to secondary treatment, and an underflow 65s containing the original mixture of fibers and impurities to be pumped and delivered under pressure to a sieve bend screen 66.

The screen overflow 67 contains the re-usable fibers partially decontaminated in that it still contains a coarse impurity fraction including shives rejected by the screen, and may require a washing treatment by the consumer, unless it is converted as is into a lower grade of paper. The screen underflow 68 contains the bulk of the feed liquid along with the bulk of the fibrous and non-fibrous fines. This underflow through line 69 is pumped back into the clarifier 64. As these underflow impurities may gradually build up in this circuit of the recovery system, excessive build-up will eventually eliminate itself in the overflow which may be subjected to the aforementioned washing treatment if desired. On the other hand, provision may be made for periodically tapping of underflow impurities for example at point P-1 or point P-2. By comparison with the embodiments of FIGS. 1 to 3, it will be noted that with the FIG. 3 embodiment a relatively smaller sieve bend screen is required, due to the shrinkage of feed volume by the removal of overflow liquid from the clarifier.

The FIG. 4 embodiment of the fiber recovery section differs from that of FIG. 3 by the addition of a hydro-cyclonic cleaner 70 interposed between the clarifier and the sieve bend screen. That is to say, the underflow 71 from the clarifier is pumped through the cyclone 70 at a pressure sufficient not only to effect therein the desired separation of the coarse impurity fraction from the re-usable fibers and fines, but also to provide the feed pressure required by the sieve bend screen. Cyclone overflow 72 representing the partially decontaminated pulp, receives a controlled amount of diluent liquid 73 sufficient to satisfy optimum operating requirement of the screen, while cyclone underflow 74 carrying away a coarse impurity fraction thereby additionally protects the screen from excessive wear. This cyclone underflow maybe disposed of in any practical manner, while underflow 75 from the screen is pumped back into the clarifier. Excess build-up of fibrous and non-fibrous fines in the circuit, as in FIG. 3 may be allowed to eliminate itself by way of the clarifier overflow, or may be tapped off for example at point P-3.

The FIG. 5 embodiment of the fiber recovery section, differs from that of FIG. 4 in that a hydro-cyclone cleaner 75a is placed outside the circuit, receiving overflow 76 pumped from the sieve bend screen, along with a controlled amount of diluent water 77 for optimum cyclone operation. Underflow 78 from this cyclone may be disposed of in any practical manner including a suitable dewatering operation, while underflow 79 from the screen carrying the bulk of the liquid and of the fibrous and non-fibrous fines, is returned to the clarifier.

The embodiment in FIG. 6 illustrates the alternate use of the treatment principles of FIG. 3 and FIG. 4, but with the difference that the underflow 80 from the sieve bend screen instead of being returned directly to the clarifier tank, is subjected to a dewatering operation. The alternate modes of operation, that is with or without the use of the hydro-cyclone cleaner 81, is indicated by valves V-4, V-5 and V-6, operable to include or exclude the hydro-cyclone in the operation. The present example shows a bowl type dewatering centrifuge 82 which at the wide end delivers overflow 83 into a reservoir 84 from which it may be pumped via line 85 to the clarifier. The highly concentrated separated waste product solids 86 is delivered from the narrow end of the centrifuge.

The micro-photograph of specimens in FIGS. 7, 8 and 9 illustrate the results attainable by subjecting the mill effluent to fiber recovery treatment according to the embodiment in FIG. 1, which by-passes the cyclone cleaner 56.

Accordingly, the FIG. 7 specimen of the mill effluent designated as Sample No. 1, clearly shows potentially re-usable long fibers entrapped in agglomeration of the aforementioned various impurities including coarse and fines. The specimen in FIG. 8, designated as Sample No. 2, shows the appearance of recovered fibers in
3,833,468

9

a pulp decontaminated in accordance with this invention, still containing a stray quantity of coarse impurity particles rejected by the screen. The specimen of FIG. 9, designated as Sample No. 3, shows the separated impurities, namely fibrous and non-fibrous fines contained in the underflow from the screen. However, when by the proper setting of valves V-1, V-2 and V-3, the waste effluent is first passed through the cyclone cleaner 56, this treatment step removes the coarse fraction of the contaminating impurities along with some stray fibers in the underflow, as shown in the specimen of FIG. 10, and designated as Sample No. 4.

Due to the elimination of this coarse fraction, the sieve bend screen will be burdened only with the bulk of recoverable fibers mixed with the fibrous and non-fibrous fines. After separation of the fines fraction contained in the screen underflow, the screen overflow will contain the recovered fibers in a highly decontaminated state, as shown in the specimen of FIG. 11 and designated as Sample No. 5.

I claim:

1. In a paper mill wherein a prepared feed pulp is furnished to the paper machines, the combination which comprises

a collecting system for waste derived from various sources such as chests dumping, white water waste, spillage, and flow drains, containing long fibers entrapped in substantial quantities of contaminating matter clinging to said fibers, such as miscellaneous fibrous and non-fibrous impurity solids and dirt along with shives and fines,
a treatment system for the disposal of collected waste effluent,
a fiber decontamination and recovery station functionally interposed between said waste collecting system and said waste disposal system, comprising a screen providing a substantially upright screen surface having a configuration of the type whereby a liquid fraction is separable from a slurry due to successive longitudinally oriented changes of direction of the slurry flowing from the upper to the lower end of the screen, said screen surface being composed of transversely extending longitudinally spaced screen elements forming between them transverse slots for the passage of said liquid fraction,

and means for feeding said liquid effluent to said screen under pressure at a rate sufficient to cause the separation thereof into a pumpable overflow fraction passing from the screen surface, and delivered from the bottom end of the screen containing cleansed long re-usable fibers separated and freed from their entrainment in said contaminating matter and fines by the operation of said screen, and a screen underflow fraction passing through said screen, containing said contaminating matter along with fines in a major portion of the waste stream liquid, for disposal in said waste disposal system.

2. The apparatus according to claim 1, wherein said waste disposal treatment system comprises a continuous settling tank receiving as feed the underflow fraction from said screen, and delivering separated liquid and sludge containing said impurities, and means for concentrating said sludge to wet cake consistency.

3. In a paper mill wherein a prepared feed pulp is furnished to the paper machine, and wherein mill waste effluent is collected for disposal from various plant sources,
a fiber recovery system for said mill waste effluent containing long re-usable fibers entrapped in contaminating matter such as miscellaneous fibrous and non-fibrous impurity solids and dirt along with shives and fines, which recovery system comprises hydrocyclonic cleaning apparatus, means for pressure-feeding said mill effluent thereto, effective to cause said cleaning apparatus to deliver a cyclone underflow fraction containing a coarse fraction of the impurities separated from said mill waste effluent, and a cyclone overflow fraction containing said re-usable fibers as well as fines and the balance of the impurities,
a screen providing a substantially upright screen surface having a configuration of the type whereby a liquid fraction is separable from a slurry due to successive longitudinally oriented changes of direction of the slurry flowing from the upper to the lower end of the screen, said screen surface being composed of transversely extending longitudinally spaced screen elements forming between them transverse slots for the passage of said liquid fraction, and means for feeding said cyclone overflow fraction to said screen, at a rate sufficient to cause the separation thereof into a screen overflow fraction passing from the screen surface, and delivered from the bottom end of the screen, and adapted for re-use, containing said re-usable fibers freed of contaminating matter and of fines, and deliver a screen underflow of material passing through the screen, containing said contaminating matter along with fines for disposal.

4. The apparatus according to claim 3 with the addition of a continuous settling tank, and means for delivering the underflow from said screen to said settling tank effective to deliver separated water and a sludge containing said impurities.

5. The apparatus according to claim 4, with the addition of means for delivering the underflow from said hydrocyclonic cleaning apparatus to said settling tank.

6. In a paper mill wherein a prepared feed pulp is furnished to the paper machine, and wherein mill waste effluent is collected for disposal from various plant sources,
a fiber recovery system for said mill waste effluent containing long re-usable fibers entrapped in contaminating matter such as miscellaneous fibrous and non-fibrous impurity solids and dirt along with shives and fines, which recovery system comprises a screen providing a substantially upright screen surface having a configuration of the type whereby a liquid fraction is separable from a slurry due to successive longitudinally oriented changes of direction of the slurry flowing from the upper to the lower end of the screen, said screen surface being composed of transversely extending longitudinally spaced screen elements forming between them transverse slots for the passage of said liquid fraction,
3,833,468

8. The apparatus according to claim 7 with the addition of supply means adding diluent water to said cyclone overflow.

9. In a paper mill wherein a prepared feed pulp is furnished to the paper machine, and wherein mill waste effluent is collected for disposal from various plant sources,
a fiber recovery system for said mill waste effluent containing long re-usable fibers entrapped in contaminating matter such as miscellaneous fibrous and non-fibrous impurities and dirt along with shives and fines,
which recovery system comprises a continuous clarifier feed supply means for supplying mill waste effluent to said clarifier operable to produce an overflow of supernatant liquid, and an underflow mixture of fibers and mill effluent impurities,
a screen providing a substantially upright screen surface having a configuration of the type whereby a liquid fraction is separable from a slurry due to successive longitudinally oriented changes of direction of the slurry flowing from the upper to the lower end of the screen, said screen surface being composed of transversely extending longitudinally spaced screen elements forming between them transverse slots for the passage of said liquid fraction,
means for supplying said clarifier underflow to said screen at a rate sufficient to cause the separation thereof into a screen overflow fraction passing from the screen surface, and delivered from the bottom end of the screen and adapted for re-use, containing said re-usable fibers freed of contaminating matter and of fines, and underflow material passing through said screen, containing said contaminating matter along with fines in a major portion of the mill stream liquid,
and hydrocyclonic cleaning apparatus having means for pressure-feeding said screen overflow thereto, and means for supplying diluent water for the operation of said hydrocyclonic cleaning apparatus, said pressure-feeding means together with said diluent water effective to cause said hydrocyclonic cleaning apparatus to deliver a cyclone underflow fraction containing residual impurities not removed by the screen, and deliver a cyclone overflow fraction containing re-usable decontaminated fibers.

7. In a paper mill wherein a prepared feed pulp is furnished to the paper machine, and wherein mill waste effluent is collected for disposal from various plant sources,
a fiber recovery system for said mill waste effluent containing long re-usable fibers entrapped in contaminating matter such as miscellaneous fibrous and non-fibrous impurities and dirt along with shives and fines,
which recovery system comprises a continuous clarifier, feed supply means for supplying mill waste effluent to said clarifier operable to produce an overflow of supernatant liquid, and an underflow mixture of fibers and mill effluent impurities,
a screen providing a substantially upright screen surface having a configuration of the type whereby a liquid fraction is separable from a slurry due to successive longitudinally oriented changes of direction of the slurry flowing from the upper to the lower end of the screen, said screen surface being composed of transversely extending longitudinally spaced screen elements forming between them transverse slots for the passage of said liquid fraction,
means for supplying said clarifier underflow to said screen at a rate sufficient to cause the separation thereof into a screen overflow fraction passing from the screen surface and from the bottom end of the screen and adapted for re-use, containing re-usable fibers freed of contaminating matter and of fines, and a screen underflow of material passing through the screen, containing said contaminating matter along with fines for disposal,
and hydrocyclone apparatus having means for pressure-feeding said screen overflow to said cyclone means, effective to cause said cyclone means to deliver re-usable fibers as cyclone overflow, adapted for re-use, and separated from cyclone underflow containing impurities not removed by said screen.

10. The apparatus according to claim 9, with the addition of supply means for adding diluent water for the operation of said hydrocyclone apparatus, said diluent being introduced into said cyclone means together with the screen overflow being fed to said cyclone apparatus.

11. In a paper mill wherein a prepared feed pulp is furnished to the paper machine, and wherein mill waste effluent is collected for disposal from various plant sources,
a fiber recovery system for mill waste effluent containing long re-usable fibers entrapped in contaminating matter such as miscellaneous fibrous and non-fibrous impurities and dirt along with shives and fines,
which recovery system comprises a continuous clarifier,
feed supply means for supplying mill effluent to said clarifier operable to produce an overflow of supernatant liquid, and an underflow substantially containing the original mixture of long fibers and mill effluent impurities,
an hydrocyclone cleaner apparatus having means for pressure-feeding said clarifier underflow to said cycler,
clone cleaner apparatus, effective to cause said cleaner apparatus to deliver a cyclone underflow fraction containing a coarse fraction of the impurities separated from said mill waste effluent for disposal, and a cyclone overflow fraction containing said re-usable fibers as well as fines and the balance of the impurities,
a screen providing a substantially upright screen surface having a configuration of the type whereby a liquid fraction is separable from a slurry due to successive longitudinally oriented changes of direction of the slurry flowing from the upper to the lower end of the screen, said screen surface being composed of transversely extending longitudinally spaced screen elements forming between them transverse slots for the passage of said liquid fraction,
means for supplying said cyclone overflow fraction to said screen at a rate sufficient to cause the separation thereof into a screen overflow fraction passing from the screen surface, and delivered from the bottom end of the screen and adapted for re-use, containing said re-usable fibers freed of contaminating matter and of fines, and a screen underflow of material passing through the screen, containing said contaminating matter along with fines for disposal.

* * * *