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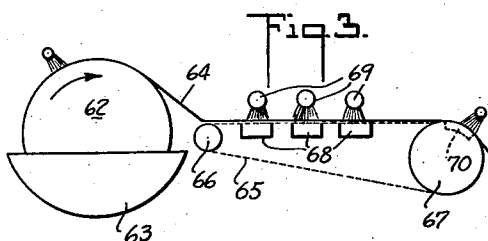
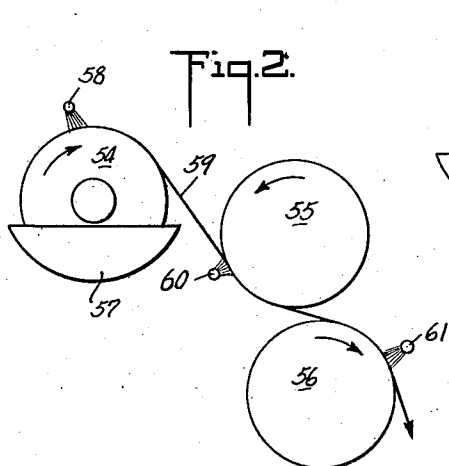
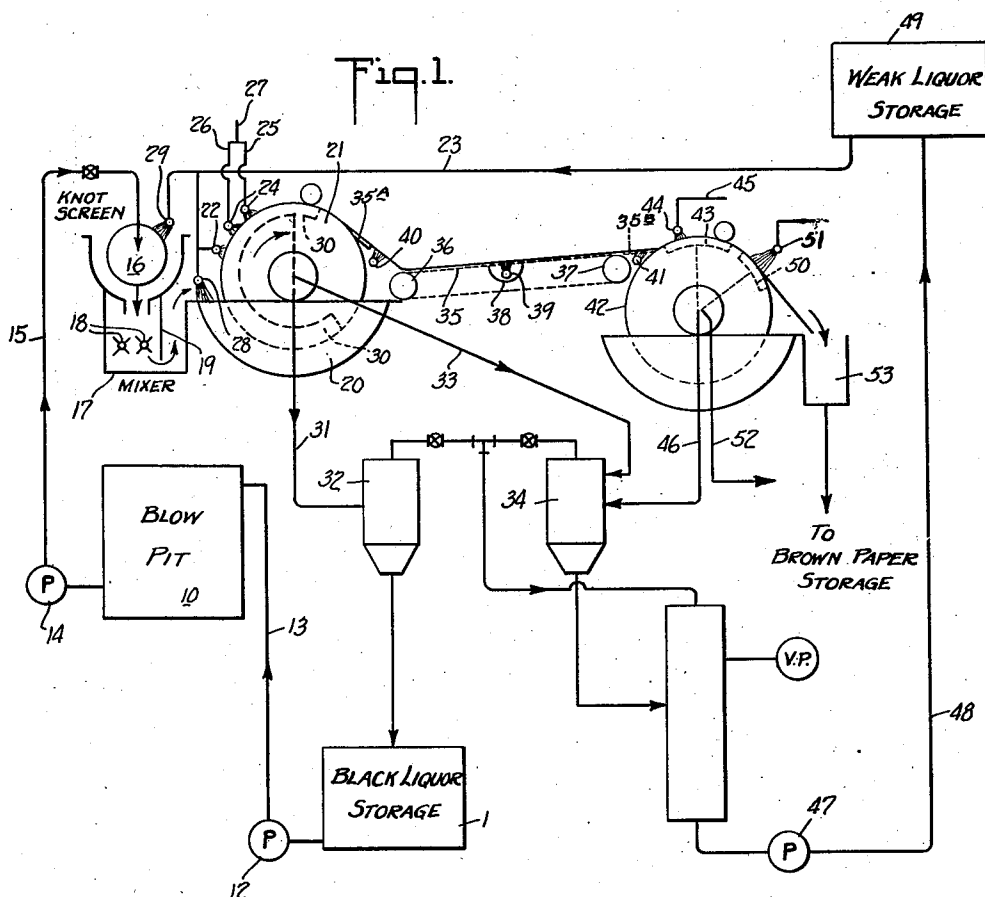
F. J. LANG ET AL

2,360,779

METHOD OF SCREENING AND WASHING PAPER PULP

Filed July 31, 1940

2 Sheets-Sheet 1



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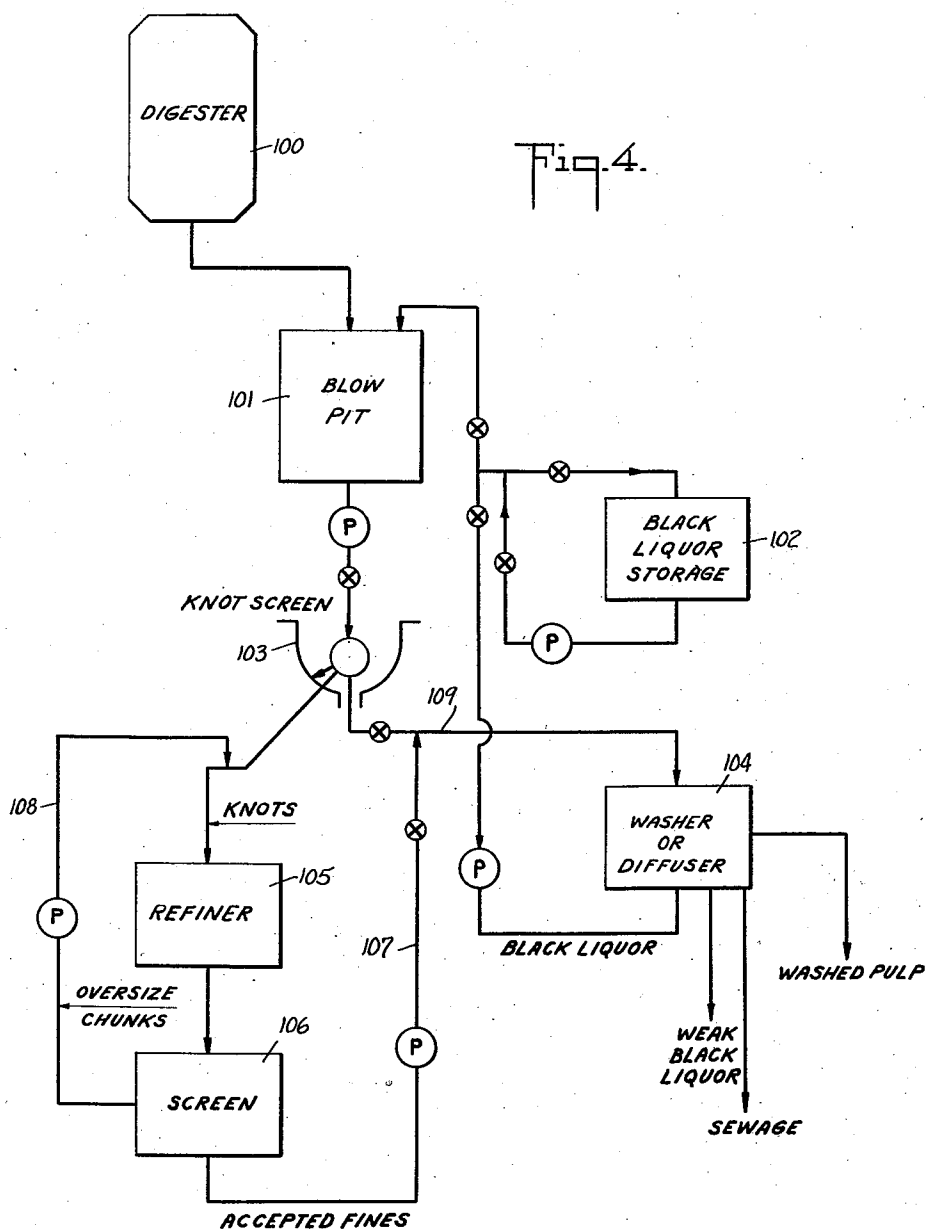
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METHOD OF SCREENING AND WASHING PAPER PULP

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UNITED STATES PATENT OFFICE

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METHOD OF SCREENING AND WASHING
PAPER PULP

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Our invention relates to the washing of pulverulent or fibrous materials or mixtures of pulverulent and fibrous materials. Such washing may be carried out merely to dehydrate such materials or to cleanse them for the purpose of improving their color or (and most frequently) to recover from suspensions of such materials some of the chemicals which may be in solution in the liquid vehicle.

For the purpose of this description our process and apparatus will be described primarily with reference to the washing of kraft and soda wood pulps in which connection the broadest utility of the invention will be apparent. We do not, however, intend to limit ourselves to the washing of these particular pulps, nor, indeed, to the washing of any particular material since our invention has considerable value in connection with other pulps or pulplike masses or pulverulent solids such, for example, as calcium carbonate sludge.

One object of our invention is to reduce the amount of power consumed per ton of material treated.

A further object of our invention is to minimize the size and capacity, and therefore the cost, of the auxiliary pumping equipment essential in connection with the establishment and utilization of a vacuum.

A further object of our invention is to minimize foaming due to the chemicals entrapped in the masses handled.

A further object of our invention, and one having particularly to do with the washing of wood pulps, is to transfer the removal of knots to a step in advance of the washing process and to eliminate it as a step subsequent to the washing.

These and other objects will be made clear from the following description taken in connection with the annexed drawings in which

Fig. 1 is a schematic view or flow diagram of an alkaline pulp washing system embodying the principles and apparatus of the invention;

Fig. 2 is a schematic view illustrating a modified arrangement of the pulp washers;

Fig. 3 is a view similar to Fig. 2 but illustrating another modification of the invention; and

Fig. 4 shows an arrangement which is particularly useful in kraft pulp mills using diffusers to wash the pulp.

In either the kraft or the soda process wood is digested primarily by the application of caustic soda and the result is the formation of numerous sodium salts such as sodium resinate, sodium

oleate, sodium linoleate, sodium lignate and other essentially soapy compounds. When the cook is completed the pulp is blown from the digester and may then be given any of several different preliminary treatments. These various treatments are largely a matter of choice, dictated by the experience of the particular plant operator or perhaps by the exigencies of the particular equipment at any given plant. For example, the pulp may be given a preliminary drainage to remove a very strong black liquor; the pulp may then be rediluted either with weak black liquor or a mixture of weak and strong black liquors, all of these treatments being preliminary to the washing step with which we are here concerned. On the other hand, the pulp from the digester may, without any drainage, be subjected to such additional dilution as may be required for ease of handling, and the dilution may be done with weak black liquor, strong black liquor or a mixture of strong and weak black liquors. In any event, the pulp as it is prepared for our treatment is in the form of a suspension of fibre in a fairly concentrated black liquor. This liquor contains valuable chemicals, but is so laden with soapy material as to be particularly susceptible to foaming.

In the ordinary washing process, the pulp is diluted with weak black liquor to a point where it becomes a sufficiently fluid mass to be capable of being picked up by a rotating drum surfaced with a wire mesh and subject to internal suction. This suction draws the liquid through the pulp and forms a blanket or mat of fairly dehydrated pulp, the mat being of considerable thickness and lying on the surface of the drum. As the drum rotates the mat is carried over to the opposite side where the suction is discontinued. The mat is then delivered off the drum and falls into a vat where it is again diluted and the process repeated on a second drum. This can be carried out over as many stages as may be deemed necessary to accomplish any desired degree of washing.

It is necessary by previous methods not only to dilute, but to agitate the pulp between each stage of washing, in order to break the pulp up into a fluid suspension capable of being picked up by each subsequent drum. A relatively large quantity of foam is inevitably formed and as a result the vacuum pumping apparatus connected with each drum must be of sufficient size and capacity to handle not only a very considerable volume of liquor, but also to handle air entrapped in the foam. As a further result the power con-

sumption of the pulping system is large and there is always present the danger of undue foaming due to the soapy chemicals entrapped in the pulp.

Foaming is objectionable primarily because the foam has a tendency to rise out of and overflow the vats, carrying with it valuable chemicals which are accordingly lost. The foaming tendency is greatest as the pulp approaches the first washing stage and for this reason it has heretofore been considered impossible to remove the knots and oversized chunks from the pulp prior to the washing operation. The ordinary operation of a knoter produces considerable agitation of the pulp passing therethrough and has so great a tendency to aerate the pulp that it tends to cause excessive foaming. On the other hand, it would be of great advantage to remove the knots prior to washing as the knots form localized channels for the passage of wash water through the mat, resulting in non-uniform washing throughout localized and recurrent areas as the drum progresses. An even greater ill effect of the presence of the knots (or uncooked chips) lies in the porous, absorbent character of the particles themselves. They are saturated with the black cooking liquor, but due to their physical characteristics and their large volume relative to their exposed surface, the washing is not effective to remove the liquor. So long as the knots and uncooked chips remain in the mass, the entire mass will be polluted by liquor exuded from these particles. This effect is sufficient to render the entire mass susceptible to foaming so long as the particles are not removed. The effect of forming localized channels will exist regardless of the character of the oversized particles but if the particles be porous, pollution will result from the presence of the particles themselves. This effect will occur wherever the condition occurs, whether in pulps or in other suspensions.

It has long been the practice to remove knots and chips from sulphite pulp prior to washing, but this practice has been considered impossible in alkaline pulps due to the foaming tendency of the liquor. Our process is applicable wherever the liquor has such a foaming tendency and has especial advantage where the oversize particles are of a porous nature.

In the case of kraft board mills using diffusers to wash the pulp, our process offers an exceptional advantage as will be hereinafter described.

We have found that a knot remover may successfully be operated in advance of the washer provided it be driven at a speed only sufficient to permit clearance of the holes in the knot removing screen and thus to avoid clogging.

Fig. 1 illustrates schematically our general arrangement of equipment for carrying out our process. Pulp comes from a digester (not shown) to the blow pit 10 where it is diluted with black liquor from the black liquor storage tank 11 supplied to the blow pit by pump 12 through a pipe line 13. The diluted pulp is then transferred by a pump 14 from the blow pit 10 through a pipe 15 to a knot screen 16. This screen is caused to rotate very slowly, slower in fact than it has heretofore been considered possible efficiently to operate such a screen. We have found that an average peripheral speed of 5 feet per minute is about the maximum speed at which a knoter can be operated in this position without foaming and this maximum speed is independent of either the length or diameter of the knoter screen.

The knoter screen is of comparatively coarse mesh and all of the acceptable pulp flows through the mesh and into a vat 17, the knots and oversized chunks being retained on the screen and ultimately rejected. In the vat 17 the accepted pulp is agitated by very slowly moving agitators 18 and flows under a baffle 19 into a vat 20 where it is picked up by a suction action on a drum 21. The pulp forms a relatively thick layer on the surface of the drum and while still subjected to suction passes under a number of nozzles 22 which are supplied by a pipe line 23 with weak black liquor obtained as hereinafter set forth. While still subjected to a suction the pulp mat may be passed under a number of nozzles 24 which are supplied through suitable pipe lines 25, 26 and 27 with fresh water if so desired. The pipe line 23 may be extended beyond the nozzles 22 to provide a set of nozzles 28 with weak black liquor which may be sprayed on the entrance lip of the vat 20 to keep the lip clean. The pipe line 23 may also be utilized to supply a set of nozzles 29 with weak black liquor which may be sprayed on the outer surface of the knoter screen 16 to dislodge particles from the openings therein.

As shown in the drawings, a vacuum sector 30 (which may conveniently comprise a plurality of separate sections not illustrated) is arranged within the drum 21. It is necessary for successful washing of this type to have the vacuum sector underlying the drum extend for several degrees on the trailing side beyond the point where the spray from the nozzles is applied to the mat. This is necessary to enable a complete drawing through of the liquor supplied by means of the sprays. It would accordingly be a difficult (though not necessarily impossible job) to design a single drum which would accommodate a series of washings together with intermediate application of liquid as hereinafter more fully disclosed. The use of a single drum would, however, be difficult since not much more than fifty per cent (50%) of the surface of the drum is available for spraying and sucking action, and to accommodate the number of washings and liquor applications illustrated in the diagram in Fig. 1 would require a very large drum and would therefore involve considerable engineering difficulties.

The suction applied through sector 30 draws the weak black liquor and fresh water through the pulp, thereby mixing the weak black liquor and water with the strong black liquor originally in the pulp. The mixed liquors pass through a pipe line 31 to a foam-trap 32 and pass at once to the black liquor storage tank 11. As a matter of convenience, an additional line 33 may take a portion of these liquors to a separate foam trap 34 so that the liquors may be fed to the weak liquor storage system for the purpose of adjusting the concentration of chemicals in that system.

As the pulp approaches the trailing edge of the vacuum sector 30 in the first drum the suction is discontinued and the pulp is doctored off by doctor 35A onto a conveyor 35 which consists of an endless belt run over sheaves 36 and 37. This belt is porous and a water box 38 extends across its width and carries a spray line 39 supplying fresh hot water in the amount of from $\frac{1}{2}$ to $\frac{3}{4}$ of a pound per pound of stock (air-dry) passing over the conveyor. The water box or the jets may be used to apply a reagent of some sort to the material being washed. For example, in the case of pulp, the application of caustic soda will be beneficial in a subsequent bleaching process.

This could, of course, be applied by means of any of the sprays playing on the washer drums. To obtain the same concentration by such means, however, a great deal more of the reagent would have to be used than in the form of application shown herein, since obviously the volume of fluid supplied by means of sprays per unit weight of solids washed is enormously greater due to the necessity for drawing it through the mass than is the case in the water box 38 which merely saturates the mass presented to the box. Our method and apparatus are therefore decidedly more economical. It will be noted that sprays 40 and 41 are applied respectively to the pulp mat as it leaves the drum 21 and as it approaches the drum 42. These sprays may have the same function as the water box 38. In practice a set-up may be maintained by the use of all three or of any one. It may in some cases be advantageous to dispense with the water box 38 and to rely on one or both of the sprays 40 and 41 adjacent the respective drums. Such an arrangement will permit the use of a solid instead of a foraminous belt. A solid belt is mechanically easier to guide and adjust than a foraminous belt.

The blanket of pulp passes from the conveyor 35 over a foraminous guide or support 35B to a second drum 42 where it is picked up by a suction applied to a segment 43. A series of nozzles 44 supplied by a pipe line 45 extends across the width of the second drum 42 and supplies fresh hot water at the rate of about 1 pound of water for each pound (air dry) of pulp passing over the drum. This water is drawn through the vacuum segment 43, through a pipe line 46, to the aforementioned foam trap 34 and the residual liquor is forced by a pump 47 through a pipe 48 to a weak liquor storage tank 49. A second vacuum segment 50 is provided in the second drum 42. As the pulp passes over the second segment 50 it is subjected to a spray of fresh cold water supplied by nozzle 51 in the aggregate amount of about 1 pound per pound (air dry) of pulp. The liquor drawn through the second segment 50 has so low a concentration of chemicals (less than 1° Baumé) that it is not worth salvaging in the evaporation process, and this liquor is therefore discarded via a pipe line 52.

The stock leaving the second drum goes to a vat 53 whence it is piped to the normal brown stock storage tank.

A variation of the above arrangement of washer drums is illustrated in Fig. 2 in which three drums 54, 55 and 56 are provided. In using this system stock would be fed from the knoter to a vat 57 underlying the first drum 54 and corresponding to the drum 21 illustrated in Fig. 1. In passing over the first drum 54 the stock will be supplied with weak black liquor through sprays 58 as in the case of the drum 21 of Fig. 1. From the first drum 54 the stock in the form of a web 59 in unbroken condition will be transferred to a second drum 55 which will, however, pick up the opposite face of the web. In passing over a portion of the surface of the second drum 55 the stock will pass a spray 60 supplying either weak liquor or fresh water which will be drawn through the blanket of pulp just as weak liquor is drawn through the blanket of pulp by the second drum 43 of Fig. 1. The sprays operating on the drum 55 will usually be supplied with liquor drawn through the pulp passing over the third drum 56 now to be described.

The vacuum operating within the second drum 55 will be cut off at a predetermined point on the

periphery of that drum and the pulp mat will be permitted to leave the surface of the drum 55 and will pass to the surface of a third drum 56 which operates on the same side of the mat as did the first drum 54. In passing over the third drum 56 the pulp will pass under a fresh water spray 61 which will be drawn through the blanket of the pulp mat as previously described. The usual operation would be for the liquor drawn through the second drum 55 to be used as a spray for washing the stock on the first drum 54 and for the liquor drawn through the third drum 56 to be used as a spray for washing the stock on the second drum 55.

Such arrangements for "counter current" washing are old and well-known, and it is considered unnecessary to illustrate all of the piping in connection with the disclosure of Fig. 2.

Fig. 3 introduces still another variation. Here a drum 62 operates in a vat 63 which would receive the stock from the knoter in the manner as the drum 21 of Fig. 1. The stock picked up and passing over the drum 62 will be sprayed and the liquor drawn through the stock and delivered to the black liquor storage tank. The web 64 of stock leaving the drum 62 is picked up on a conveyor belt 65 which passes over sheaves 66 and 67 and is synchronized to match the peripheral speed of the drum 62. Belt 65 is porous and any desired number of suction boxes 68 may be placed thereunder in a position to draw liquid through the pulp mat. Suitable sprays 69 are arranged above each of the boxes. These sprays may be operated on the familiar counter current principle, that is, the spray of the first of the suction boxes would be supplied by liquor drawn through the second suction box and the spray above the second suction box would be supplied with liquor drawn through the third suction box. If desired, a suction segment 70 can be placed in the sheave 67 and a fresh water spray directed on it in which case the liquor drawn through the suction segment 70 would supply the spray over the third suction box. In the absence of such a suction segment the spray over the third suction box would probably be supplied with fresh water.

The feature which all of these various forms have in common is that the stock is not broken up and diluted intermediate the several washing stages with the result that all of the stored liquor at every stage may be maintained considerably more concentrated than would be the case were sufficient water added to the system to dilute the stock to the requisite point for being picked up from slurry by any of the several drums. It will be understood that suitable doctor blades and guides may be provided to remove the mat from and to guide the same into contact with the washer drums.

Referring back to Fig. 1, it will be obvious that the amount of water added by means of the water box 38 is negligible in comparison with the amount of water which would have to be added to dilute the mat coming from drum 21 to a consistency which would enable the pulp suspension to be picked up from slurry and handled by the drum 42. Accordingly, the concentration of chemicals extracted by the drum 42 through the pipe line 46 is very much greater than would otherwise be the case and the concentration of the entire weak liquor system is much greater. Since the weak liquor system supplies the wash liquor to the drum 21 the concentration of chemicals in the black liquor storage tank is very much

increased, with a consequent saving in the amount of steam required to bring the black liquor into condition for burning in the recovery furnaces. It is, moreover, obvious that the size and number of pumps, and, consequently, the power required for the operation of the system are very much reduced by eliminating the enormous amount of liquor which would have to be added to the mat coming from one stage in order to fit it for pick-up operations by the subsequent stage, as well as by eliminating the quantities of air which would be entrapped in the course of such dilution. For example, the consistency of the stock as it comes from one stage is probably about 95% water, while the consistency of the pulp to enable the drum to pick it up and handle it would have to be in the neighborhood of 98% or 99% water. At the 95% consistency there are present 19 pounds of water for each pound of stock, but at the 99% consistency there are 99 pounds of water for each pound of stock. In other words, for every pound of pulp there must be added 80 pounds of water in order to dilute it for proper presentation to each stage of the washer. The pulps and piping are therefore called upon to handle almost four times as much water as is the case through the use of our invention. The cost of the equipment and the amount of power and the task of ultimate evaporation of the black liquor are all therefore approximately four times as high by present methods as they are when our invention is used. In large scale operations involving hundreds of tons of pulp per day this difference is of enormous importance.

The arrangement shown in Fig. 4 is particularly useful in connection with kraft board mill operation, though its principles may be applied in other connections. Pulp and black liquor are blown from a digester 100 into a blow-pit 101 where it may be diluted as desired. A suggested means of dilution is to supply black liquor to the blow-pit from the black liquor storage tank 102.

Stock is pumped from the blow pit to a knot screen 103 from which the accepted stock goes through a pipe line 109 to a washing device 104. This device may be either a washer of the type illustrated in Fig. 1 or a diffuser of the type very largely used in kraft pulp mills, the precise type of washer being immaterial, though naturally this arrangement offers an additional advantage in connection with a washer of the type shown in Fig. 1 for reasons hereinabove discussed.

The knots, uncooked chips and other oversized particles separated from the mass by the knot screen are fed to a refiner 105 which may be of any desired type and which acts to crush and otherwise disintegrate the lumps into particles of a size compatible with the stock accepted by the knot screen. From the refiner 105 the disintegrated lumps proceed to a screen 106 which accepts only such finely sized particles as will be compatible with the accepted pulp. These particles pass through a pipe line 107 and join the stream of accepted stock going through line 109 to the washer or diffuser. The oversized particles retarded by the screen 106 are pumped through a line 108 back to the stream of oversized particles going from the knot screen 103 to the refiner 105 where they are once more subjected to a disintegrating process.

While this system would not be satisfactory for the production of high grade papers it offers very considerable advantage for the production of coarse papers and board and by removing the

oversized particles it increases the efficiency of the washer since after washing there is no source of chemical pollution of the stock. As previously mentioned, the presence of relatively coarse knots and lumps would make it impossible to obtain a complete wash of the pulp in the sense of a complete removal of the black liquor. When the knots are preliminarily removed the washing, whether on filter drums or diffusers, is entirely effective and the stock is ready for delivery to the refiners and then to the paper or board machine.

It will be understood that the knots and oversized chips accepted by the screen 106 will have lost the characteristics which render them harmful in the washing process. These finely divided fibrous particles may be washed clean in the usual pulp washing device employed.

In certain mills and in the manufacture of certain grades of paper it may not be desirable to return the accepted comminuted knots and uncooked chips to the pulp system. In such cases the accepted fines from screen 106 may be diverted from the system and utilized or otherwise disposed of in any suitable manner.

While our process has been described with particular reference to the washing of alkaline pulps, it is obviously applicable to the washing of any form of suspension such as sewage, bagasse and other mixtures. We do not, therefore, intend in any way to limit the scope of our invention except as set forth in the subjoined claims which are to be broadly construed.

We claim:

1. The method of screening and washing pulp digested by an alkaline process and suspended in black liquor resulting from said digesting process which comprises passing said pulp suspension over a rotary knoter for the separation of knots and uncooked chips from the suspension of pulp particles of acceptable size, rotating said knoter at a peripheral speed not exceeding five feet per minute whereby substantially to avoid foaming of the black liquor in which said pulp is suspended, removing said suspension of pulp particles of acceptable size free from knots and chips from said knoter, and washing said pulp particles to remove substantially all of the alkaline cooking liquor in which they were digested.

2. The method of screening and washing pulp digested by an alkaline process and suspended in black liquor resulting from said digesting process which comprises passing said pulp suspension over a rotary knoter for the separation of knots and uncooked chips from the suspension of pulp particles of acceptable size, rotating said knoter at a peripheral speed not exceeding five feet per minute whereby substantially to avoid foaming of the black liquor in which said pulp is suspended, passing said suspension of pulp particles of acceptable size and free from knots and chips from said knoter to a series of washing stations, washing said pulp particles by subjecting the same to suction and spraying by wash liquid in each of said washing stations, and using fresh hot water as the wash liquid in at least the last of said washing stations whereby to remove substantially all of the black liquor in which said pulp initially was suspended.

3. The method of screening and washing pulp digested by an alkaline process and suspended in black liquor resulting from said digesting process which comprises passing said pulp suspension over a rotary knoter for the separation of knots and uncooked chips from the suspension of pulp

particles of acceptable size, rotating said knotter at a peripheral speed not exceeding five feet per minute whereby substantially to avoid foaming of the black liquor in which said pulp is suspended, forming said pulp particles of acceptable size free from knots and chips into a mat, passing said mat through a succession of washing steps in which one side thereof is subjected to suction while the other side thereof is sprayed with washing liquid, and finally passing said mat through a washing station in which one side thereof is subjected to suction while the other side thereof is sprayed with fresh hot water whereby substantially to remove all of the black liquor in which said pulp initially was suspended.

4. The method of washing pulp suspended in a liquid to remove substantially all of said suspension liquid which comprises forming a mat of said pulp upon the surface of a rotary washing screen by suction acting to draw a portion of the suspension liquid from said pulp through said screen, rotating said screen while applying suction to one side of said mat and simultaneously spraying the opposite side of said mat with washing liquid, removing said mat from said rotary washing screen and passing said mat without disintegrating the same into suspension in a body of liquid to a second rotary washing screen, spraying the first named side of said mat with washing liquid while passing the same from said first rotary washing screen to said second rotary washing screen, rotating the said second rotary washing screen while applying suction to one side of said mat and simultaneously spraying the opposite side of said mat with washing liquid, and removing said mat from said second rotary washing screen.

5. The method of washing pulp suspended in a liquid to remove substantially all of said suspension liquid which comprises forming a mat of said pulp upon the surface of a rotary washing screen by suction acting to draw a portion of the suspension liquid from said pulp through said screen, rotating said screen while applying suction to one side of said mat and simultaneously spraying the opposite side of said mat with washing liquid, removing said mat from said rotary washing screen and passing said mat without disintegrating the same into suspension in a body of liquid to a second rotary washing screen, spraying the first named side of said mat with washing liquid while passing

the same from said first rotary washing screen to said second rotary washing screen, rotating the said second rotary washing screen while applying suction to one side of said mat and simultaneously spraying the opposite side of said mat with washing liquid, the final washing liquid at least comprising fresh hot water, and removing said mat from said second rotary washing screen.

6. The method of screening and washing pulp digested by an alkaline process and suspended in black liquor resulting from said digesting process which comprises passing said pulp suspension over a rotary knotter for the separation of knots and uncooked chips from the suspension of pulp particles of acceptable size, rotating said knotter at a peripheral speed not exceeding five feet per minute whereby substantially to avoid foaming of the black liquor in which said pulp is suspended, passing said suspension of pulp particles of acceptable size free from knots and chips from said knotter into a vat, forming a mat from said pulp suspension on the surface of a rotary washing screen, subjecting one side of said mat to suction as the same passes over said washing screen whereby to remove a portion of the suspension liquor therefrom, simultaneously spraying the opposite side of said mat with weak black liquor, removing said mat from said rotary washing screen and passing said mat without disintegrating the same into suspension in a body of liquid to a second rotary washing screen, spraying the first-named side of said mat with fresh hot water as the mat is being transferred from said first rotary washing screen to said second rotary washing screen, subjecting said first-named side of said mat to suction as the same passes over said second rotary washing screen and spraying the opposite side of said mat first with a weak black liquor and thereafter with fresh hot water while suction is applied to said first-named side, said last-named weak black liquor being obtained from said last spraying step in which said mat is sprayed with fresh hot water, and passing said mat to a vat in which it is disintegrated into suspension in a suitable liquid whereby to form a pulp suspension substantially free from the alkaline cooking liquor in which said pulp was digested.

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