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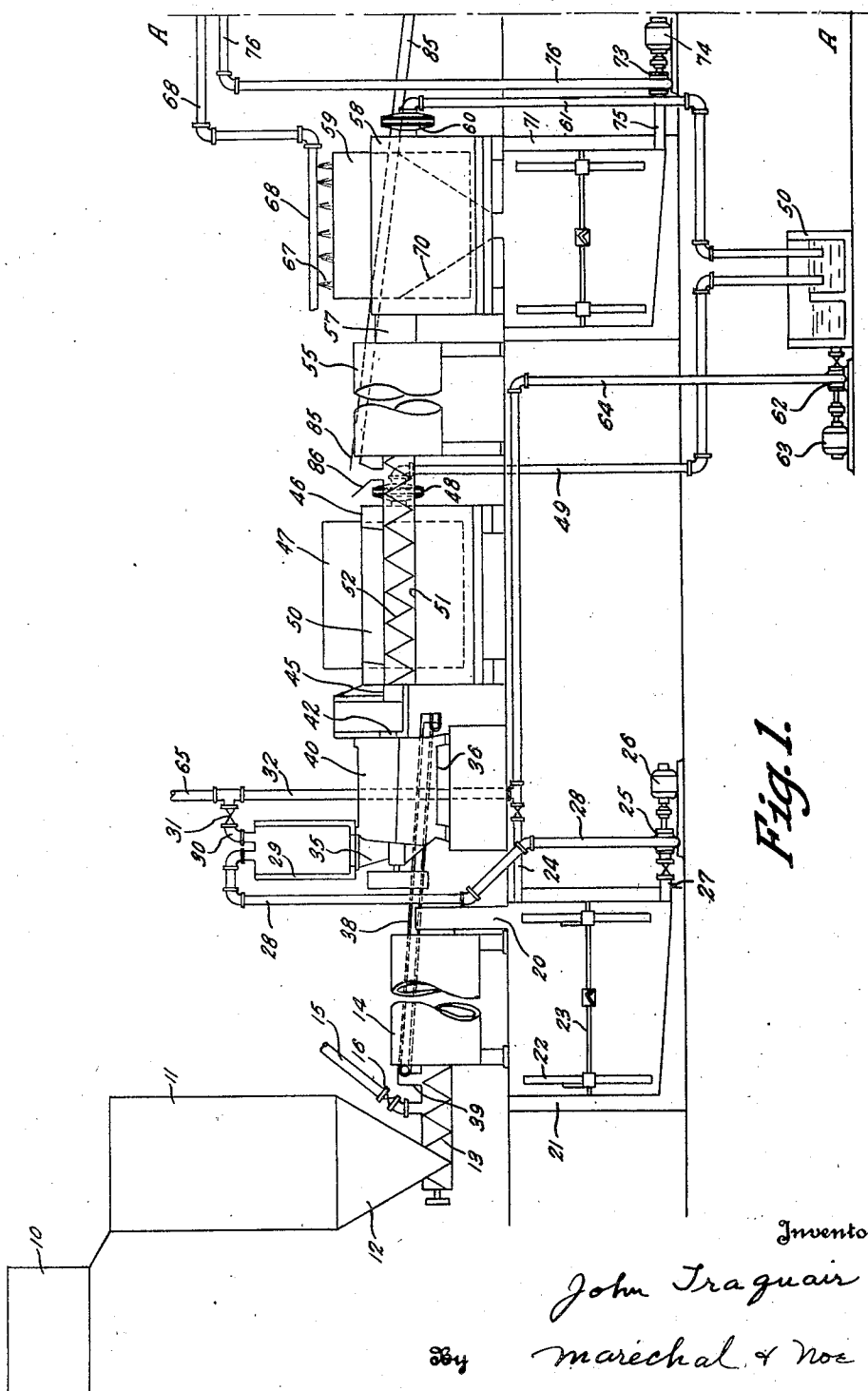
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PAPER MANUFACTURE

Filed July 11, 1931

2 Sheets-Sheet 1



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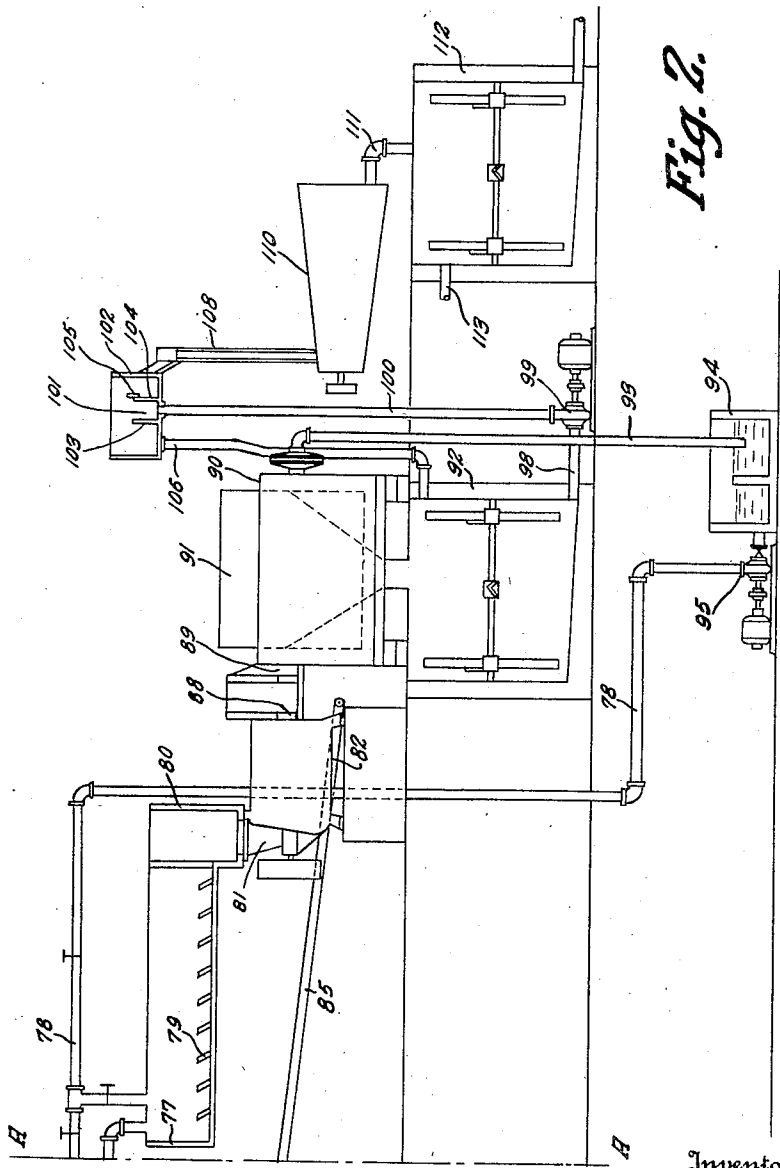


Fig. 2.

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PAPER MANUFACTURE

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20 Claims. (Cl. 92—6)

This invention relates to the manufacture of paper.

One of the principal objects of the invention is to provide a superior method of, and apparatus for, pulping raw fibrous material to give a larger yield of better grade paper forming stock from a given quantity of raw fibrous material at a lesser cost, and by a treatment which eliminates the use of digesters or cooking equipment as well as the use of boiling or highly heated cooking liquors.

Another object of the invention is to provide such a method of, and apparatus for, the disintegration of raw fibrous material primarily by mechanical means, which gives a satisfactorily defibered pulp suitable for the manufacture of better grades of paper, such as a supercalendered paper, and which at the same time gives a pulp of such freeness that it can be readily formed on a regular paper making machine into a good soft pliant sheet of paper, the pulp being also of good color and free from objectionable staining or discoloration.

Still another object of the invention is to provide such a method and apparatus which function continuously and are self-contained, admit of recovery of chemicals used, eliminate waste and stream pollution, and provide for recirculation and reuse of the chemical containing liquor of the system with resultant economy and increased effectiveness in the pulping operations.

Other objects and advantages of the invention will be apparent from the following description when taken in connection with the accompanying drawings and appended claims.

In the drawings, which illustrate a preferred embodiment of apparatus for carrying out the method of this invention—

Fig. 1 is a side elevational view, somewhat diagrammatic, of a portion of the apparatus constructed in accordance with this invention and adapted for carrying out the method of this invention; and

Fig. 2 is a side elevational view, also somewhat diagrammatic, of another portion of the apparatus, Figs. 1 and 2 when placed end to end on the line A—A disclosing the complete apparatus.

This is a continuation in part of my copending application Serial No. 300,207, filed August 17, 1928 for Paper manufacture.

The method of the present invention is applicable to the treatment of various types of fibrous materials, but has been more particularly practiced in connection with the pulping of wood. For purposes of description, therefore, and

without intending any limitations, this invention is described in connection with the pulping of wood chips; and more particularly wood chips from various deciduous or non-resinous broad-leaf woods, also called the hard woods, such as chestnut, gum, poplar, birch, and the like. The method is applicable to the treatment of cull lumber, slabs and waste wood from furniture and box factories, saw mill waste, leached chips from tannin extract mills, and the like. The methods heretofore generally used for the pulping of wood for the better grades of paper consist in cooking the wood by boiling under pressure with strong chemical cooking liquor, as exemplified in the well known soda, sulfite and kraft processes. In all these processes where the wood is subjected to cooking treatment, the yield is quite low, seldom attaining 50% and generally being around 40% or lower. In these processes, the bonding materials, such as the lignins and pentosans, holding the individual fibers as well as the fiber bundles cemented together in the raw material, are generally dissolved out and removed; and in the rigorous chemical treatment involved some of the cellulose itself is lost or converted into inferior compounds.

According to the present invention, a method for the treatment of fibrous materials, such as wood, in the making of satisfactorily pulped paper forming stock is provided, in which substantially all of the cellulose of the original material and a large proportion of the bonding constituents remain in the pulp, thereby giving high yields and at the same time a good grade of pulp. Moreover, digestion or cooking of the fibrous materials with liquors at high temperatures is dispensed with, providing for economy in chemicals and steam consumption. A continuous process for the reduction of fibrous material primarily by mechanical means is afforded, which gives increased mill production, is self-contained and utilizes chemicals that may be recovered, and provides for efficient recirculation and reuse of the chemical containing liquor of the system.

There are numerous proposals in the prior art relating to the treatment of fibrous material, such as wood, by a chemical softening without pulping, followed by a mechanical disintegration or grinding to pulp. However, so far as I am aware, none of these processes have come into commercial use for the manufacture of the better grades of paper for the reason that the pulp formed contains too many shives and unreduced fiber bundles, which show up as specks in the finished paper sheet, as to render it unsuited

for incorporation in paper of this character, particularly paper which is to be supercalendered. A rod mill has been proposed as a disintegrating agency for this purpose, but these same objections obtain. More severe grinding, or mechanical disintegration in a rod mill, will reduce the amount of shives in the pulp, but other objections then arise, particularly that of pulp freeness. Excessive grinding produces a very slow highly hydrated pulp which is not suitable for the formation of a soft pliant sheet of paper. Also, excessive grinding of the pulp results in a discoloration which cannot be readily removed, and which prevents such pulp from being satisfactorily employed in the manufacture of white or light colored papers.

In accordance with the present invention, the pulping of the fibrous material, such as raw wood, may be effected, without any preliminary chemical cooking or softening treatment, by coordinated stages of mechanical disintegration which are so correlated as to overcome the objections enumerated above and to give a pulp having the desired freeness for the manufacture of the better grades of paper, and which at the same time is substantially free from the presence of objectionable shives and fiber bundles and also free from objectionable discoloration.

Referring to the drawings, there is illustrated at 10 a conventional hog or chipper for the reduction of the fibrous material or wood into subdivided pieces or chips, which are supplied into a storage bin 11. The bin is provided with a conical lower end 12 feeding into a screw conveyor 13 which positively forces the chips into a mechanical disintegrator such as a rod mill 14. If desired, a shredder may be used before and in series with the rod mill. The disintegrator here shown as a rod mill may be of conventional construction, having a rotary shell or casing supported by trunnions and containing therein a plurality of elongated rods which roll and cascade as the casing is rotated, to thereby pound and impact upon the fibrous material to effect its mechanical disintegration. Opening into the screw conveyor 13 is an inlet pipe 15 having a suitable control valve 16 for the supply of a caustic liquor along with the fibrous material to the mill.

As stated in the copending application referred to above, this liquor may be hot or cold; but contrary to the natural expectations I have discovered that better results are obtained in the pulping of hard wood chips such as gum or chestnut, by the use of cold caustic liquor,—that is, liquor which is at normal atmospheric temperatures or which is not heated materially above 50° C. It has heretofore been considered that the time of treatment in the mill and the temperature of the caustic liquor are interdependent,—that is, the hotter the liquor the less time required to give the same disintegrating effect. I have found that this is not the case, but that the totally unexpected result of a superior disintegration from the commercial aspects is attained with the use of caustic liquor in the cold, when using hard wood chips of the character specified. This has enabled the use of highly heated liquors to be avoided, effecting considerable economy in steam consumption and fuel, and at the same time has provided for high capacity of the mill operating in the cold.

As representing a suitable and preferred form of disintegrator, the rod mill 14 is illustrated and described herein. However it is to be understood that any suitable disintegrating mill, or com-

bination of mills, can be used, which functions to subject the raw material to a pounding, rubbing or shredding action to subdivide the material into fibers and adapt them for formation of a suitable sheet on the forming machine. For example, a disintegrating mill of the swing hammer type may be used. This may be followed by a rod mill or refiner of any type which subjects the material to the action of grinding surfaces, which are preferably composed of inserts of carborundum or other suitable abrasive stonelike material.

The caustic soda solution and the wood in the form of chips are thus added directly to the rod mill. The amount of water in the caustic soda solution is preferably adjusted so that the consistency of the fibrous material discharged from the mill is in excess of 15% and is preferably between 20% and 30%,—that is, 20 to 30 parts of oven dry fiber in 100 parts of the mixed mass of fiber and solution. The concentration of caustic soda solution is also controlled so as to provide a regulated amount of chemical with respect to the quantity of wood. Very satisfactory results have been secured where the caustic content on the weight of the wood is varied between 2% and 15%; but in general, a percentage of caustic alkali of about 7% to 10% on the weight of the wood is preferred. A caustic soda solution containing about 50 grams per liter of NaOH will provide the desired consistency and the desired chemical content in the case of wood having between 10% and 40% of moisture content.

The time of treatment in the disintegrating apparatus is also controlled to give a regulated disintegration, but to avoid excessive grinding. For example, a time of treatment of about 10 to 30 minutes in a rod mill gives very satisfactory results. This is readily controlled by the rate of feed of the chips to the mill, which in turn is regulated by the rate of travel of the screw conveyor. The addition of caustic is coordinated with the rate of supply of chips by manipulation of the valve 16 in accordance with the rate of travel of the screw conveyor, so as to give the desired consistency in the mill. As the casing of the rod mill rotates, the tumbling and cascading of the rods within the casing effects a pounding, rubbing and impacting treatment of the fibrous material, which in the presence of the caustic liquor effectively disintegrates or defibers this material. It is found that the uncooked fibrous material in the presence of the caustic liquor possesses characteristics which permit effective mechanical disintegration without the consumption of excessive power.

As shown, the material discharged from the rod mill is passed through the chute 20 into a stock chest 21 containing suitable agitators 22 mounted on a shaft 23 driven by any suitable means. A pipe 24 opens into the stock chest 21 to supply dilution liquor thereto in order to make down the material to a consistency suitable for pumping,—for example a consistency of about 5% or less. The liquor supplied through pipe 24 is preferably caustic containing liquor removed from previously treated fibrous material, so that the caustic liquor of the system is not unduly diluted with water and the active chemical content is largely retained in the fibrous material.

A pump 25 suitably driven as by a motor 26 draws the diluted material through pipe 27 and forces it through pipe 28 to a mixing box 29 into which additional dilution liquor is introduced by pipe 30 having a control valve 31. This

is shown as a branch of pipe 24, being connected thereto by an upstanding leg 32, so that the additional dilution liquor added at that point is also the caustic containing liquor removed from previously treated fibrous material. The additional dilution liquor is controlled so as to further reduce the consistency of the fibrous material down to less than 1%, preferably about $\frac{1}{2}$ %, for screening.

The diluted material passes through the inlet 35 into a suitable screening device illustrated diagrammatically at 36, which may be of entirely conventional construction as is customarily employed for the screening of pulp stock. Thus this screen may be of the vibrating plate type, or may be a centrifugal screen, its function being to remove larger or coarser undefibered particles and shives from the partially disintegrated fibrous material so that the material which passes through the screen can be effectively reduced to pulp in a second mechanical disintegrating or impacting treatment. The screen employed at this point is a coarse screen having holes about .065 of an inch in diameter or a flat type of screen having slots from .012 to .020 of an inch wide. This means that only the larger undefibered particles and coarser shives are removed by the screen, the smaller fiber bundles and shives passing readily through openings of this size together with separated fibers, and the dilution liquor. Very satisfactory results are secured by employing a flat screen having slots of about .016 of an inch in width, or an equivalent centrifugal screen, and regulating the first rod milling as to time, or rate of feed and discharge, so that sufficient disintegration and defibering is secured as to give a screen rejection at the screen 36 of an amount of fibrous material equivalent to about 15% to 25% on the dry weight of the fibrous material being treated.

The screen rejections or tailings are discharged from the screen in the ordinary manner, and these are conveyed, as by a suitable conveyor 38, back to and discharged into the screw conveyor 13 as indicated at 39. Another very satisfactory method of arranging this equipment is to position the mixer 29 and screen 36 at an elevation above the chip storage 11 so that the rejections from the screen can be discharged onto an inclined chute which feeds back into the chip storage. The tailings are thus returned for further processing, together with fresh fibrous material, in the first rod mill.

It is to be noted that the partially defibered material which has been mechanically disintegrated at high consistency is made down to screening density with waste caustic containing liquor from the washing at a subsequent step, and that the diluted material is screened in the presence of the caustic containing liquor and without washing. The result is that the material passing through the screen retains an effective active caustic content to facilitate its further disintegration to pulp, while the liquor used in the cycle is undiluted with water so as to avoid undue dilution of the caustic content and to provide for economy in the recovery of the liquor, avoiding large evaporation costs. The type of screen shown diagrammatically in the drawings is a centrifugal type of conventional construction, which operates in a well known manner to discharge the finer more defibered material through the outlet 42, while the coarser particles, which are screened out, are discharged through an opening at the

bottom of the screen and are fed onto the conveyor 38.

The screened material discharging at 42 passes by pipe 45 into the vat 46 of a suitable thickener, which may be of the usual construction of a decker or Oliver filter. As shown, this thickener includes a rotary driven roll 47 which dips within the stock within tank 46, the roll being provided with rotating compartments which are connected to and disconnected from a suitable source of suction at predetermined points of the cycle of rotation in the usual manner. The rotary roll is provided with a perforate fabric or other foraminous surface, upon which the fibrous content of the stock accumulates as the roll rotates beneath the level of the stock in the vat, the liquid of the stock being drawn through the perforate surface into suction compartments and discharged through the hollow trunnion 48 into the water leg or gravity leg 49, which delivers the liquor into a tank 50 arranged at an elevation sufficiently below the thickener to provide the desired suction by the action of the gravity leg. The web formed on the surface of the rotary roll is carried up above the liquid level upon continued rotation of the roll, while being subjected to further suction or draining action to further thicken the material, and at a predetermined point in the rotation of the roll, the suction is disconnected from the compartments, and the mat or fibrous material is removed from the surface of the roll by a suitable flexible scraper 50 which feeds the material over the side of the upper end of the tank 46 into a trough 51 containing a feeding screw 52 driven by any suitable means.

The feeding screw 52 forces the material into a second rod mill 55 which is constructed similarly to the rod mill 14. The operation of the thickener 47 is preferably so controlled that the material is supplied to the second rod mill 55 at a consistency below 10%, generally between 3% and 8%. The thickener is also preferably operated without the use of washing sprays, so that the caustic containing liquor is not diluted at this point, and so that the second mechanical disintegration or rod milling is also carried out in the presence of retained caustic liquor. Very satisfactory results have been secured by rod milling the screened and partially disintegrated material at a consistency of about 5%, and with a regulated feed of material to the mill to provide for a rod milling time of substantially 10 to 30 minutes. Generally a somewhat shorter time can be utilized in this second stage of the rod milling than in the previous stage.

The result of this coordinated multi-stage impact disintegrating treatment with intermediate screening in the presence of caustic liquor is found to give an effective disintegration of more resistant fibrous materials, such as hard woods, to a satisfactory stage of pulping, without objectionable discoloration which is found to result with the excessive grinding required to reduce the material in a single stage of grinding. The removal of the coarser particles after the first disintegration enables the screened material to be more uniformly and effectively reduced in the presence of retained caustic and without prolonged grinding, so that the resultant pulped material remains free and of good character and is not objectionably hydrated or gelatinized.

The material discharged from the second rod mill 55 passes through pipe 57 into the tank 58

of a second thickener, constructed in the manner of the first mentioned thickener and having a rotary roll 59 dipping within the stock within the tank. As a web forms on the fabric or wire surface of the roll 59, liquor of the stock passes through the surface and is discharged from the rotary compartments of the roll through the hollow trunnion 60 into the gravity leg 61, which may also discharge into the tank 50, the latter tank thus being a common collecting tank for both of the thickeners and serving to receive the waste caustic containing liquor removed from the fibrous material. In practice, it is found that the liquor thus removed and supplied to tank 50 may contain about 10 grams of active caustic alkali per liter. This liquor is returned from tank 50 by a pump 62 driven by motor 63 through pipe 64 which supplies the branches 24 and 32. Any excess liquor over that required for dilution at the branch 24 and at the pipe 31 is passed by pipe 65 to a suitable point of discharge for recovery or otherwise. The excess caustic containing liquor discharged at 65 can be economically and effectively passed through a conventional recovery system, including evaporating the liquor, burning it to ash, lixiviating the ash, and causticizing the lixiviated solution, to convert it into fresh caustic soda according to soda pulp mill practice.

The web formed on the cylinder 59 is carried up above the level of the liquor in tank 58 due to rotation of the roll, and may be subjected to washing sprays 67 from a suitable pipe 68, connected to a suitable supply of wash liquid such as the pipe 78, to wash out remaining caustic containing liquor. Preferably the quantity of wash liquid or water supplied at the sprays 67 is just sufficient to displace the liquor content of the mat carried on the surface of the roll, so that undue dilution of the liquor is thereby avoided. The washed material is removed from the surface of the roll 59 by a flexible scraper (not shown) and directed by a suitable chute indicated at 70 into a stock chest 71 constructed similarly to the stock chest 21.

This stock is withdrawn from chest 71 by pump 73 driven by motor 74 through pipe 75 and discharged by pipe 76 into the inlet end of a conventional riffler 77 where additional dilution liquor is supplied by pipe 78 in order to make down the stock from a consistency of about 5% to 8% to a consistency of less than 1%, generally about $\frac{1}{2}\%$. The riffler comprises an inclined trough throughout the length of which are arranged upstanding transverse baffles or sediment catchers 79, which serve to remove heavier particles, such as grit and impurities, which settle out of the flowing stream of diluted pulp stock and are caught behind the baffles 79.

The dilute stock discharges from the riffler at 80 and is supplied by the inlet 81 to a second screening device indicated generally at 82, and which may be constructed similarly to the screen 36. This screen, however, is a fine screen adapted to remove or separate from the pulp stock undefibered shives and fiber bundles which are of such a size as would show up as specks of appreciable size such as to be visible to the naked eye in a sheet of finished paper, such as supercalendered paper. For this purpose, there is provided a very fine cylindrical screen having openings of approximately .035 of an inch in diameter; or if a flat screen is used, this has slots about .008 of an inch in width. This fine screening serves to eliminate any remaining fiber bundles or shives of objectionable size, so that the second rod milling or disintegrating treatment can be carried out without prolonged treatment such as to deleteriously affect the freeness, color or other characteristics of the pulped material. The feed to the second rod mill is preferably regulated and adjusted so that the screenings or tailings resulting from the fine screening amount to about 5% to 15% on the dry weight of the stock passed to the fine screen, when an .008" screen is employed. The stock may be washed at this screen in the ordinary manner for the purpose of facilitating the passage of the pulp through the fine openings of the screen. The tailings are discharged onto a suitable conveyor or other feeding mechanism 85 which feeds them back to a hopper 86 feeding into the screw conveyor 52 which supplies the second rod mill 55. In this manner, the fine screenings are returned for reprocessing in the second rod mill, whereas the coarse screenings form the first screen 36 are returned for reprocessing in the first rod mill 14. This further facilitates the effective handling and proper disintegration of the material without undue grinding of any portion thereof.

The pulp stock passing through the screen 83 discharges at 88 into a supply pipe 89 which feeds into the tank 90 of a third thickener or Oliver filter, similar to the thickener 47. Here the stock is thickened from dilute screening consistency down to about 4% to 7% by the roll 91, and may be further washed by suitable sprays (not shown), if desired, and is discharged in the customary manner by flexible doctor and chute into the stock chest 92. The liquor removed from the stock by roll 91 passes by the gravity leg 93 to a receiving tank 94, from where it may be withdrawn by pump 95 and forced through the pipe 78, and pipe 68 and thus partly used over again in the cycle for dilution of the material passing to the riffler and fine screen, and for washing at the thickener 59.

The screened pulp thus supplied to the stock chest 92 may be used directly in paper, such as paper board, or for newsprint, where light colored species of wood such as gum are used. This material may be very satisfactorily used for the making of pressed board, binder board and the like. Where better grades of paper are desired, the pulped material is subjected to a refining process and also may be bleached. This is true where the pulp so produced is to be used in the manufacture of printing paper or other light colored papers that are supercalendered. For this purpose, the stock in chest 92 is withdrawn through pipe 98 by pump 99 and forced through pipe 100 into the central compartment 101 of a headbox 102. This is provided with an overflow 103 and with a controlled feeding device or weir 104 having an adjustable slide or gate 105. An excess of pulp stock is supplied to the headbox by pipe 100, a controlled portion of this passing through a regulated notch or feeding slot in the weir 104 regulated by the slide 105, the excess being returned over overflow 103 and through pipe 106 to the stock chest 92. The regulated supply of pulp stock passes through pipe 108 into a suitable refiner 110, which is illustrated in the drawing as a jordan. Any suitable type of refiner which serves to brush out the fibers and prepare them for formation on a forming machine may be used, such for example as a rotary disk or attrition mill of well known conventional construction. Where a rod mill

is used as a refiner, this is operated upon pulp stock at dilute consistency, such as about 5% or less, the stock passing through the mill in a treating time of about ten to twenty minutes so as to give the previously disintegrated material a refining action.

The material discharging at 111 from the refiner passes into a stock chest 112. The rate of grinding or refining is adjusted so that the freeness of the pulp discharged to chest 112 is at a desired figure, as for example around 250 to 300 as measured on the arbitrary scale of the Green freeness tester.

Where a lighter colored pulp is to be produced a small amount, such as about 1% to 3% on the dry weight of the bleached pulp, of a suitable bleaching agent may be added to the stock in chest 112, as by pipe 113. Inasmuch as this pulp stock contains a substantial proportion of the non-cellulosic bonding constituents, a reducing bleaching agent, such as sulfur dioxide or an analogous reducing bleach, is used, rather than the usual oxidizing, chlorinating or hypochlorite bleaches which will attack the bonding constituents and cause discoloration, necessitating further processing and reducing the yield. This bleached pulp stock may then be further washed, as on an Oliver filter (not shown) of the type previously described, and then may be supplied directly to a forming machine to form a sheet of good grade printing or light colored paper, such as is suitable for supercalendering operations.

Where a white or light colored pulp is desired, it has been found that the tendency toward staining or discoloration by a treatment in the disintegrating mill is minimized by the addition of a small amount of a reducing chemical along with the material supplied to the mill. For example, the addition of a small amount of sodium sulfite or sodium hydrosulfite to the caustic soda solution which is introduced together with the raw fibrous material to the disintegrating mill, has been found to be beneficial, particularly where an iron rod mill is employed. While the action or reaction of such chemical has not been definitely ascertained, the effect is probably a retarding of oxidation of some constituent of the wood, in the presence of iron, rather than a solvent effect on the wood. Beneficial results may also be secured in grinding in an iron mill by the use of a small amount of alkali metal phosphate, such as sodium phosphate, as any iron which finds its way into the pulp as a hydroxide of iron eventually forms a light colored phosphate of iron, thereby overcoming any staining or discoloration. While staining due to excessive grinding cannot be practically prevented by chemical means such as described above, this minimizing or prevention of some staining due to the presence of iron is important where light colored pulps are to be produced. And by the present invention, in which the grinding is carried out in several coordinated stages at appropriate pulp densities in the presence of caustic liquor, together with the coordinated screenings in the presence of caustic as described, discoloration due to excessive grinding is avoided, while still improved results may be secured by the addition of small amounts of non-staining chemicals as described above to the caustic soda solution used in the mill. For example, where the caustic soda solution containing 50 grams of NaOH per liter, very satisfactory results have been secured by the addition of about five grams of sodium sulfite per liter and

about two grams of sodium phosphate per liter, to minimize staining where an iron rod mill with common steel rods is employed for grinding. For the production of colored boards and paper board, the staining of the pulp may be disregarded, but the described process of the coordinated stages of mechanical disintegration with intermediate screening is found desirable in order to give a pulp of the proper freeness and having other desirable characteristics.

While the method herein described, and the form of apparatus for carrying this method into effect, constitute preferred embodiments 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. In the manufacture of pulp from raw uncooked hard deciduous wood chips, the method of which comprises introducing the raw uncooked chips together with cold caustic liquor at a temperature below 50° C. into a rod mill, and continuously passing the chips through the rod mill while subjecting the chips to rod milling treatment in the presence of the cold caustic liquor.
2. In the manufacture of pulp from raw hard deciduous wood chips, the method which comprises introducing the wood chips together with cold caustic liquor at a temperature below 50° C. into a rod mill, the quantity of liquor being proportioned to the quantity of wood chips to give a consistency in excess of 15%, and continuously passing the chips through the rod mill while subjecting the chips to rod milling treatment in the presence of the cold caustic liquor.
3. In the manufacture of pulp from undefibered fibrous material, the method which comprises mechanically disintegrating the fibrous material in the presence of a solution of caustic alkali, making down the partially disintegrated fibrous material to lower consistency with caustic containing liquor removed from previously treated fibrous material, screening coarser pieces and shives from the made down partially defibered fibrous material in the presence of retained caustic alkali, and further disintegrating the screened partially defibered fibrous material to pulp.
4. In the manufacture of pulp from undefibered fibrous material, the method which comprises mechanically disintegrating the fibrous material in the presence of a solution of caustic alkali at a consistency in excess of 15%, making down the partially disintegrated fibrous material to lower consistency with caustic containing liquor removed from previously treated fibrous material, screening the made down partially defibered material to remove coarser pieces and shives therefrom, subjecting the screened partially defibered fibrous material to a further mechanical disintegration in the presence of retained solution of caustic alkali at a consistency below 10%, and returning the screened tailings for further treatment with fresh fibrous material in the first mentioned mechanical disintegrating treatment.
5. In the manufacture of pulp from raw undefibered fibrous material, the method which comprises subjecting the raw undefibered fibrous material to a multistage rod milling treatment in the presence of a solution of caustic alkali, an initial rod milling treatment being carried out

at a consistency in excess of 15% and a subsequent rod milling treatment being carried out at a consistency below 10%, fine screening the disintegrated material to remove therefrom fiber bundles and shives of a size such as to show up as specks in the finished sheet to thereby give a pulp substantially free from such objectionable fiber bundles and shives, and returning removed shives and fiber bundles for reworking in the process.

6. In the manufacture of pulp from raw undefibered fibrous material, the method which comprises rod milling the raw fibrous material in the presence of a solution of caustic alkali at a consistency in excess of 15%, coarse screening the partially disintegrated material in the presence of retained caustic alkali without washing to remove coarser undefibered particles therefrom, subjecting the screened fibrous material to a second rod milling treatment in the presence of retained caustic alkali, fine screening the disintegrated material to remove remaining shives and fiber bundles which would show up as objectionable specks in the finished sheet of paper, returning the coarser pieces removed in the coarse screening to the first mentioned rod milling treatment, and returning the removed shives and fiber bundles from the fine screening to the second mentioned rod milling treatment.

7. In the manufacture of pulp from undefibered fibrous material, the method which comprises mechanically disintegrating the fibrous material in the presence of chemical containing liquor at a consistency in excess of 15%, diluting the partially disintegrated material with chemical containing liquor removed from previously treated fibrous material to a consistency less than 10%, subjecting the diluted material to a second mechanical disintegrating treatment at this low consistency, thickening the disintegrated material to remove chemical containing liquor therefrom, and returning removed chemical containing liquor for use in the mentioned dilution step.

8. In the manufacture of pulp from undefibered fibrous material, the method which comprises mechanically disintegrating the fibrous material in the presence of a caustic liquor also containing a stain reducing chemical.

9. Apparatus of the character described, comprising in combination, a mechanical disintegrator, means for feeding undefibered fibrous material and liquor into said disintegrator, a screening device, means for feeding material discharged from said disintegrator to said screening device, whereby larger undefibered portions are removed from the material while liquor is retained therein as it passes through said screening device, a second mechanical disintegrator, means for feeding the screened material with retained liquor to said second mechanical disintegrator, means for removing liquor from the material discharged from said second mechanical disintegrator, and means for returning removed liquor to be fed with fresh fibrous material into said first mechanical disintegrator.

10. Apparatus of the character described, comprising in combination, a mechanical disintegrator having a casing with spaced and freely communicating inlet and outlet ports and having a plurality of smooth surfaced impact elements providing a pounding action without grinding, means for continuously feeding undefibered fibrous material and liquor into the inlet port of said disintegrator, the material continu-

ously feeding through said disintegrator casing and discharging from the outlet port as fresh material is continuously fed to said inlet port, a fine screen, means for feeding disintegrated fibrous material discharged from said disintegrator to said fine screen, a refiner of the Jordan type, and means for feeding fibrous material passing through said fine screen to said refiner.

11. Apparatus of the character described, comprising in combination, a first rod mill, a coarse screen, a second rod mill, a fine screen, means for passing fibrous material through said mills and screens in the order named, means for returning tailings from said coarse screen to said first mentioned rod mill, and means for returning tailings from said fine screen to said second mentioned rod mill.

12. Apparatus of the character described, comprising in combination, a mechanical disintegrator, means for feeding undefibered fibrous material and chemical containing liquor into said disintegrator, means for diluting partially disintegrated fibrous material discharged from said disintegrator with chemical containing liquor removed from previously treated fibrous material, a second mechanical disintegrator, and means for feeding the fibrous material along with dilution liquor to said second disintegrator.

13. Apparatus of the character described, comprising in combination, a mechanical disintegrator, means for feeding undefibered fibrous material and chemical containing liquor into said disintegrator, means for diluting partially disintegrated material discharged from said disintegrator with chemical containing liquor removed from previously treated fibrous material, a screen, a thickener, a second mechanical disintegrator, a fine screen, and means for passing the fibrous material from said first mentioned disintegrator through said devices in the order named.

14. Apparatus of the character described, comprising in combination, a first mechanical disintegrator, a screen, a first thickener, a second mechanical disintegrator, a second thickener, means for passing fibrous material through said devices in the order named, and means for returning liquor removed from fibrous material by each of said thickeners to said system in advance of said screen.

15. Apparatus of the character described, comprising in combination, a first rod mill, a coarse screen, a first thickener, a second rod mill, a washer, a fine screen, a thickener, a refiner, and means for passing fibrous material through said devices in the order named.

16. In the manufacture of pulp from undefibered fibrous material, the method which comprises mechanically disintegrating by a pounding and impact treatment the fibrous material in the presence of a caustic liquor also containing a sulfite.

17. In the manufacture of pulp from undefibered fibrous material, the method which comprises rod milling the fibrous material in the presence of a caustic liquor also containing a phosphate.

18. In the manufacture of pulp suitable for making printing paper from raw undefibered fibrous material, the method which comprises mechanically disintegrating by a pounding and impact treatment the raw fibrous material in the presence of a chemical liquor to obtain a substantial reduction of the fibrous material to separated fibers, fine screening the reduced material

to remove therefrom substantially all fiber bundles and shives of a size such as to show up as specks in the finished sheet to thereby give a pulp substantially free from such fiber bundles and shives, and then subjecting the screened pulp to a reducing bleach.

19. In the manufacture of pulp suitable for making printing paper from raw undefibered fibrous material, the method which comprises mechanically disintegrating by a pounding and impact treatment the raw fibrous material in the presence of a solution of caustic alkali to effect only a partial reduction of the fibrous material, coarse screening the partially reduced fibrous material to remove coarser pieces therefrom, subjecting the screened partially reduced fibrous material to a further mechanical disintegration by a pounding and impact treatment in the presence of a solution of caustic alkali to obtain a substantial reduction of the fibrous material to separated fibers, fine screening the reduced material to remove therefrom substantially all fiber

bundles and shives of a size to show up as specks in the finished sheet to thereby give a pulp substantially free from such fiber bundles and shives, and then subjecting the screened pulp to a reducing bleach.

20. In the manufacture of pulp from undefibered fibrous material, the method which comprises mechanically disintegrating the fibrous material in the presence of a chemical softening liquor to effect only a partial reduction thereof, making down the partially reduced fibrous material to lower consistency with chemical containing liquor removed from previously treated fibrous material, removing coarser pieces and shives from the made down partially reduced fibrous material while leaving chemical containing liquor therein, and then further mechanically disintegrating the resultant partially reduced fibrous material in the presence of retained chemical containing liquor.

JOHN TRAQUAIR.

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