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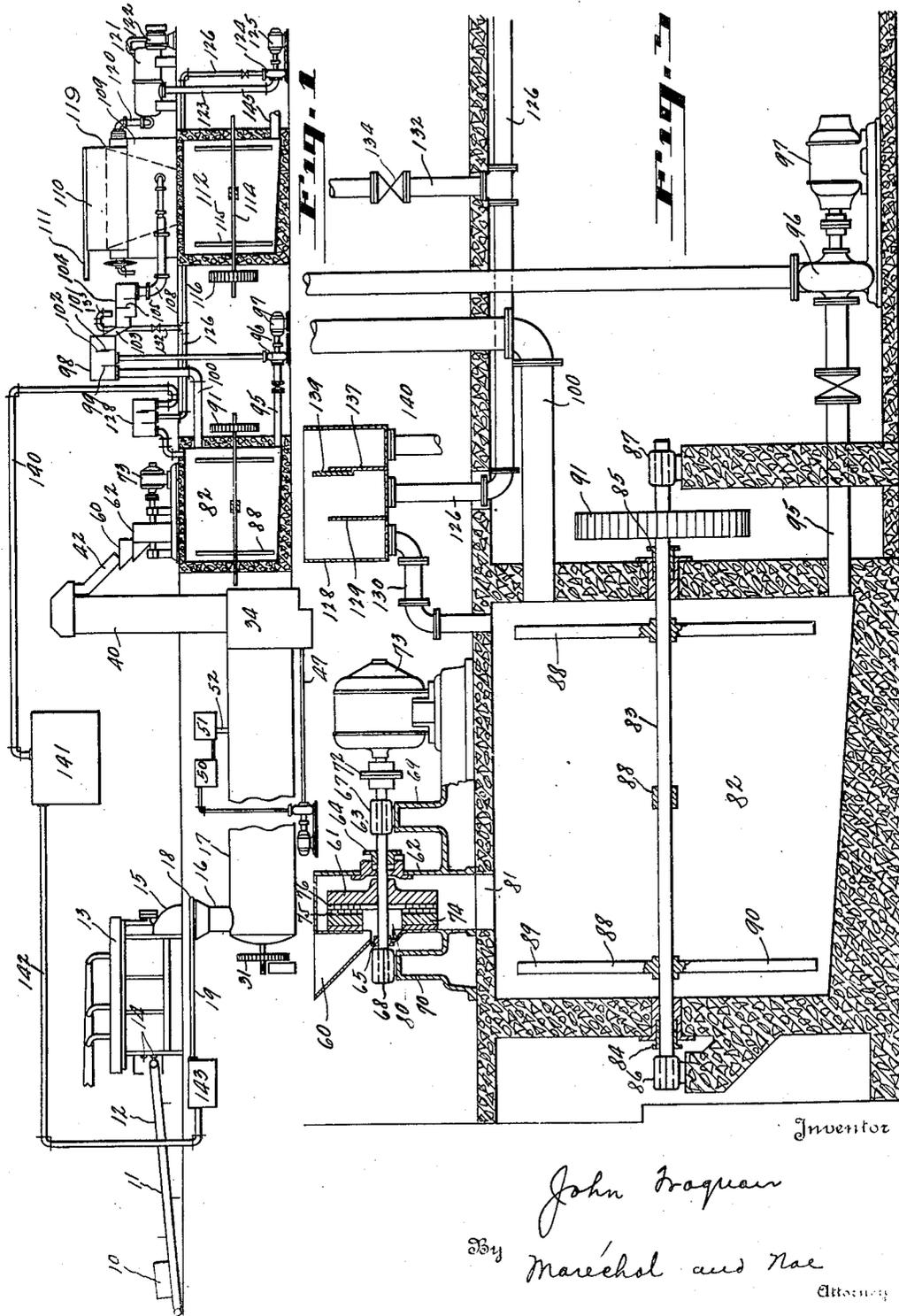
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PAPER MANUFACTURE

Filed Jan. 10, 1927

2 Sheets-Sheet 1



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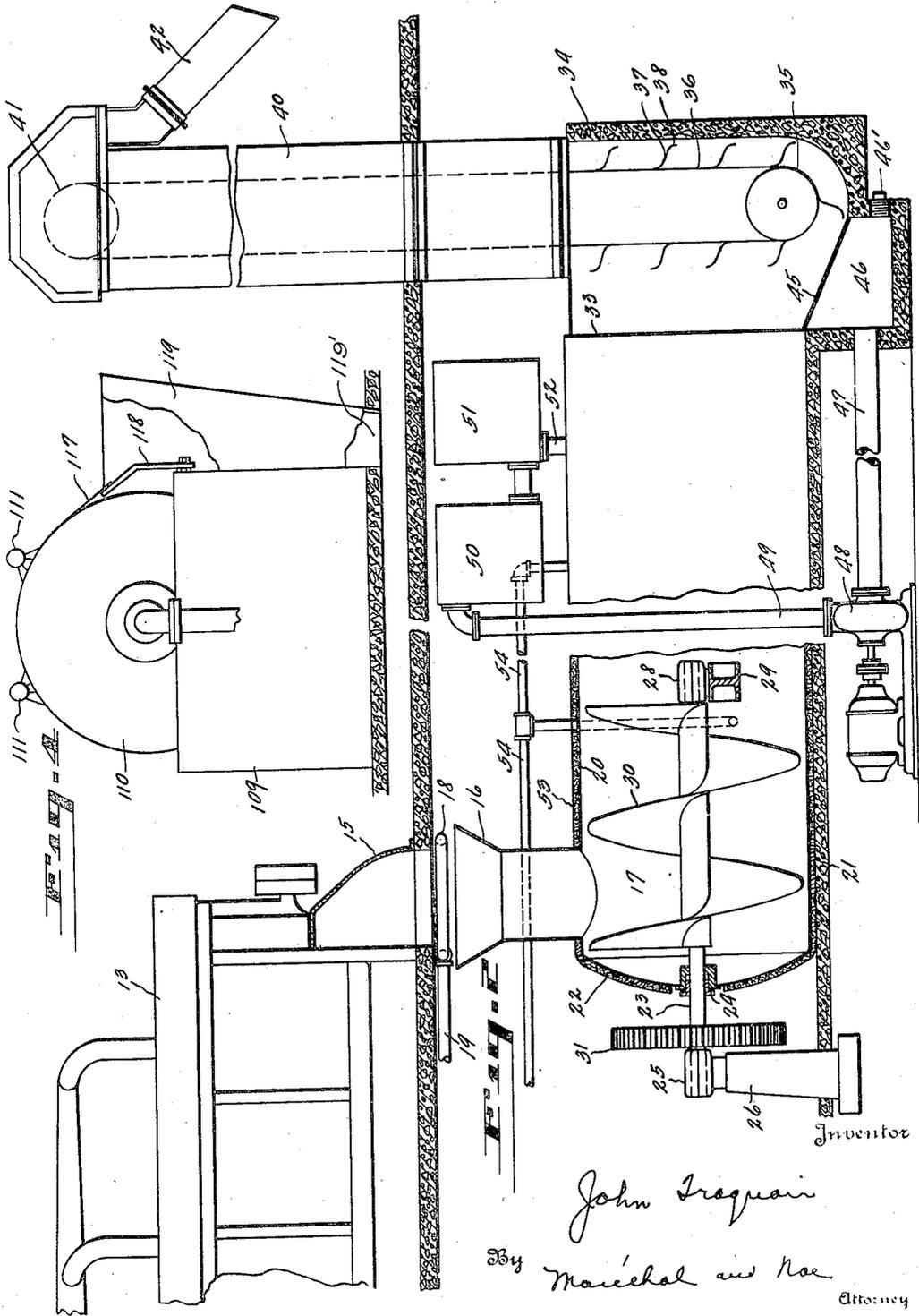
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PAPER MANUFACTURE

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2 Sheets-Sheet 2



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## PAPER MANUFACTURE

Application filed January 10, 1927. Serial No. 160,096.

This invention relates to the manufacture of paper, and particularly paper such as strawboard, and the like.

One of the principal objects of this invention is to provide a superior method of, and apparatus for, treating raw materials such as straw, cereal grasses, and the like in the manufacture of paper.

Another object of the invention is to provide such a method, and apparatus, which functions to produce a large yield of higher grade paper-forming stock from a given quantity of raw material.

Still another object is to provide such a method and apparatus which functions continuously and are self-contained, thus eliminating the practical difficulties attendant upon disposal of the waste materials produced in other methods of treating such raw materials.

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

In the drawings in which like characters of reference designate like parts throughout the several views thereof,

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

Fig. 2 is an enlarged side elevational view partly in section of the steeping tank and related parts;

Fig. 3 is an enlarged sectional view through the defibering apparatus and related parts; and

Fig. 4 is an end elevation of the rotary vacuum filter with parts broken away to more clearly illustrate the construction thereof.

The method of the present invention is adapted particularly to the treatment of straws, cereal grasses and the like in the manufacture of paper board and the like, and the apparatus illustrated is particularly designed to handle such materials. While various kinds of straws and cereal grasses may be utilized the invention is described in connection with the use of straw such as wheat

straw. And the term "straw" as hereinafter used is not meant to be a limitation but merely as designating all analogous materials.

The method heretofore used in this country for the manufacture of strawboard consists in cooking the straw by boiling it in a strong lime solution under pressure. The strawboard which is thus produced has a limited utility, because of the darkness of its color, and the fact that it is hard and brittle and of quite limited strength. In addition the lime appears to combine with some of the constituents present in the straw forming lime compounds which cannot be effectively removed from the straw pulp, and which impart to the resulting strawboard a disagreeable and objectionable odor. Furthermore, and this is of even greater moment, chemicals used in this method of treatment do not adapt themselves to recovery, and consequently a large amount of exhausted chemicals and straw material are lost in the process. The wasted material and chemicals are customarily flowed directly into nearby streams; and the resulting stream pollution is so objectionable that the legislatures in many States have passed measures against such practices; in some States laws have been passed which prohibit the installation of additional mills for the manufacture of paper which are not provided with some means for the recovery or the disposal of the waste other than by dumping into streams. And as no such means have been heretofore known, the installation of new strawboard mills in those States has practically ceased.

According to the present invention a method for treatment of straws and the like in the making of paper-forming stock is provided which produces a finished paper free from the quite objectionable odor, and dark color resulting from the usual lime cook method, and which in addition has much greater strength than paper made from the same raw materials by other methods of straw treatment; a method, furthermore, which utilizes materials which may be recovered and thus used over and over to provide a continuous, self-contained process,

without the production of stream polluting wastes.

Straw consists of a plurality of bundles of fibers of cellulose, which are held together by glue-like substances which may be termed bonding materials and include pentosans and lignins. The outer layer of the straw which appears as a glaze is composed largely of silicon compounds which add stiffness and rigidity to the straw. When the straw is treated in caustic, such as sodium hydroxide, the silicon compounds are readily dissolved with a consequent wilting of the straw. However the pentosans and lignins are of a more resistant character and are not as easily affected by the treating liquor, although some portions of them are also dissolved. Furthermore, such severe temperature treatment as is ordinarily used in the usual caustic soda cook for paper making pulp is found to injure the cellulose fibers themselves. These cellulose fibers are divided into what is known as alpha cellulose,—which is the most resistant cellulose,—beta cellulose which is less resistant, and gamma cellulose which is the least resistant. In the rigorous treatment as heretofore used, the character of each of these forms of cellulose is affected, to decrease its strength; and as a consequence the resultant paper-forming stock is of an inferior grade.

According to the present method the straw is immersed in a steeping liquor of controlled characteristics where it is "steeped" at a controlled temperature below the boiling temperature of such liquor. The steeping liquor, which is caustic in character, is so constituted and the temperature and pressure at which the steeping is carried on is such that the primary action is a softening of the bonding material holding the cellulose fibers together, so that by mechanical treatment the fibers may be readily separated—that is, "defibered". But by thus controlling the character of the steeping liquor and the nature of the steeping action, only a small proportion of the original straw is destroyed and at the same time the fibers remaining as such are not materially affected. By this method the finished stock usually contains in excess of 60% to 70% of the original raw materials. A substantial portion of the lignins and pentosans remain in the stock, these materials having no injurious effect upon the ultimate product.

In carrying out this method the straw in its natural state is placed in a steeping liquor consisting of a mild solution of caustic soda in water, maintained at a temperature somewhat below the boiling temperature of the caustic solution. In addition to a large yield, strawboard when prepared by this method is found to be, generally, three times as strong and to have a lighter color than straw-

board prepared by the methods heretofore known, such as the lime cook.

Referring to the drawings, apparatus constituting a preferred embodiment of the invention is illustrated, which apparatus is adapted for carrying out the method above described. Bales of straw as indicated at 10 are placed upon an endless conveyor belt 11 which is adapted to be driven at suitable speed by any suitable mechanism which is not illustrated. The conveyor belt is marked in definite lengths as indicated at 12, and a bale of straw is adapted to be placed between each two markers, as the conveyor belt 11 travels toward the duster mechanism indicated at 13. By regulating the speed of the conveyor belt, the feeding of the straw can be controlled as desired. After being placed upon the conveyor belt 11, the bales 10 of straw are broken open before being fed into the duster mechanism 13. The duster mechanism may be of the conventional type used in the industry for dusting old papers, and the like, and needs no further illustration here. Toothed rolls 14 are provided for pulling the straw and feeding it into the duster. The loose dusted straw feeds through the discharge chute 15 of the duster mechanism 13 directly into the feeding hopper 16 of the steeping tank 17. A spray pipe 18 suitably perforated on the under side is adapted to spray hot caustic liquor upon the straw as it feeds into the hopper 16 to thereby wet the straw to facilitate its passage into the steeping tank 17. The spray pipe 18 is connected by pipe 19 with the suitable source of hot fresh caustic liquor, which may come directly from the recovery plant for the spent liquor.

The construction of the steeping tank is particularly illustrated in Fig. 2. As shown the tank comprises an elongated preferably cylindrical casing 20 which is normally kept substantially filled with the steeping liquor. The tank 17 rests upon a suitable foundation 21. Passing through the inlet end 22 of the tank is a shaft 23 provided with a stuffing box 24 to prevent leakage, the shaft 23 being supported by an exterior bearing 25 carried by a suitable pedestal 26 from the foundation 21. The opposite end of the shaft is supported by a bearing 28 carried by a cross bear or beam 29, which beam 29 is fastened on opposite sides to the interior of the tank 17. The shaft 23 carries within the tank 17 suitable means for forcing the steeping material toward the outlet end of the steeping tank, this means being illustrated as a helical screw 30. The shaft 23 carries on the exterior of the tank, means, shown as a gear 31, which may be driven from any suitable source of power (not shown) in order to rotate the screw 30. The tank 17 is generally of considerable length,—from 20 to 50 feet, but it is not necessary that the screw 23 extend the whole length

of the tank, and it may be terminated a short distance beyond the inlet end, as shown. Especially is this so, if sufficient steeping liquor is used with the straw so that it will be floated along with the liquor. Very successful results are obtained when as much as 20 parts of liquor are used to 1 of straw, at which proportion the straw moves easily.

The outlet end of the steeping tank 17, as indicated at 33, is open to permit the free flow of the steeping material through this end. A discharge chamber is built up about this end of the tank as indicated at 34. Supported on a roll 35 which is journaled in opposite sides of the chamber 34 and running thereover is an endless bucket elevator indicated at 36. The elevator is provided with a plurality of perforate buckets 37 which may be constructed somewhat in the form of a pitchfork having a plurality of curved prongs 38. Any suitable form of perforated bucket elevator may be used. A suitable supporting and enclosing structure 40 is provided for the upper end of the elevator, and a second roll 41 journaled in this supporting structure carries the bucket elevator at this end. Either of the rolls 35 or 41 may be positively driven by any suitable mechanism (not shown) in order to elevate the steeped material from the steeping tank 17 and discharge it through the chute 42. As the buckets or forks conveying the straw pass above the liquid level, the liquor retained therein drains rapidly back into the steeping tank. The height of the elevator is so proportioned that a large percentage of the steeping liquor is thus returned to the steeping tank, the straw passing through the chute 42 preferably carrying about five to six parts of liquor to one of straw.

The steeping liquor is preferably maintained hot, but below the boiling point. It is found that the time of steeping and the temperature of steeping are interdependent, the hotter the steeping liquor the less time required for the proper softening of the straw. Very suitable results have been obtained by maintaining the steeping liquor at a temperature of about 90 degrees centigrade, and so proportioning the speed of the screw conveyor 30 that the straw is allowed to steep for approximately half an hour. It is found that quite dilute steeping liquor functions satisfactorily, and satisfactory results are obtained by steeping in as dilute a liquor as 1% NaOH or even less. The concentration may be varied between 1% and 5% with satisfactory results, but apparently increasing the concentration above 5% does not seem to produce advantages sufficient to make the increased concentration desirable. For wheat straw, a concentration of about 2% gives very satisfactory results.

Any suitable means may be employed for maintaining the steeping liquor at the prop-

er temperature. In the present construction, the fresh caustic make-up liquor which is introduced through the spray pipe 18 is preferably heated to about 95 to 100 degrees centigrade, and this serves to maintain the temperature at the inlet end of the steeping tank. In order to maintain the temperature adjacent the outlet end of the steeping tank, a recirculating and heating mechanism is provided. As shown, between the outlet end of the steeping tank 17 and the supporting framework of the chamber 34, there is a perforated plate 45 which covers a small pit 46, serving as a trap to collect and retain dirt washed out of the straw during the steeping. A clean-out opening closed by a plug 46' is provided for periodical cleaning out of the pit 46. Extending from the pit 46 is a circulation pipe 47, which leads to a pump 48, the pump in turn discharging into a pipe 49 and forcing the liquor through a suitable conventional filter indicated at 50 and thence through a suitable conventional heater indicated at 51 which serves to heat the recirculated liquid to about 95 degrees centigrade. The liquor from the heater 51 is discharged through a pipe 52 back into the steeping tank adjacent the outlet end thereof, and thus maintains the liquor at the end of the tank heated to the desired temperature. Satisfactory results are obtained when the pipe 52 discharges into the tank at a point about two-thirds of its length from the inlet end. The tank 17 is preferably lagged with suitable heat-insulating material, as indicated at 53. Steam connections 54 having nozzles for injecting steam into the steeping tank 17 are provided. It is usually necessary to use the steam connections only for starting the steeping operation to initially raise the temperature of the steeping liquor to the normal operating point, the temperature thereafter being maintained by the devices mentioned; but steam may be introduced whenever needed.

The fresh caustic liquor introduced through the pipe 18 may be the regenerated liquor which comes from the recovery as previously described. The liquor at the inlet end of the steeper thereby contains the highest percentage of causticity, while the liquor at the outlet end of the steeping tank has its causticity largely reduced or spent. Thus a concentration gradient of causticity is maintained throughout the steeping tank from the inlet end to the outlet end, and the liquor which passes off with the straw through the chute 42 is practically spent liquor, so that little active caustic liquor is removed from the steeping tank.

The steeped material passing from the chute 42 is discharged directly into the hopper 60 of the defibering mechanism which is illustrated in larger detail in Fig. 3. This mechanism is adapted to separate or "de-

fiber" the steeped material into its fibers. According to this invention the steeped material is defibered by passing the steeped material between spaced high-speed relatively moving surfaces. For this purpose a high-speed rotating plate mill is provided, the stock passing between the relatively moving surfaces of the plates of the mill. As illustrated, a rotating plate 61 is fastened within a cylindrical casing 62 upon a shaft 63 extending through one side of the casing 62 through a stuffing box 64 to the exterior thereof and extending through the opposite side of the casing to the exterior thereof through a stuffing box 65. Bearings 67 and 68 for the shaft 63 are carried on opposite sides of the casing 62 by suitable pedestals 69 and 70 respectively. The shaft 63 is connected preferably through a flexible coupling 72 to the shaft of an electric motor 73. Mounted within the casing 62 is a second preferably stationary plate 74. Each of the plates 61 and 74 is provided with teeth or studs as indicated at 75 and 76 respectively. The plates 61 and 74 are positioned in spaced relation and the teeth are adapted to intermesh as shown. Preferably the shaft 63 is constructed for endwise adjustment so that the plate 61 may be adjusted relative to the plate 74 to vary the distance between these plates.

The plate 74 is provided with a central opening 80 into which the hopper 60 discharges. The stock is thus fed centrally into the space between the plates 61 and 74, and is then discharged by centrifugal force between these plates. The plate 61 is adapted to be rotated at a high speed in order to secure a large centrifugal force for the defibering action. Very satisfactory results have been obtained by constructing the plates of a diameter of from 30 to 36 inches, and by rotating the plate 61 at a speed of 1200 to 1800 R. P. M. The extremely vigorous and rapid expulsion of the steeped and softened material past the high-speed relatively moving surfaces effectively tears the fibers apart. While it is thought preferable to provide the plates with teeth as shown, satisfactory results may also be secured by smooth surfaced plates spaced close together to produce the desired effect. Moreover while one of the plates is shown herein as being rotatable, it is to be understood that both of the plates may be rotated if desired, as long as high-speed relatively moving surfaces are provided.

The defibered material is discharged through an opening 81 formed at the under side of the casing 62 into a pit or chamber 82 forming a stock chest. Passing transversely through the chamber 82 is a shaft 83, which extends through stuffing boxes 84 and 85 to the exterior of the pit 82 and is provided with exterior bearings 86 and 87. Fastened to the shaft 83 within the chest 82 are a plurality of

agitators or mixing arms 88, shown to be three in number. These agitators 88 may be of any suitable construction, and are provided to stir up and mix the stock within the chest 82. As shown each agitator comprises two diametrically opposed blades, indicated at 89 and 90, the blades of adjacent agitators being disposed at different angles. The shaft 83 is provided with a pulley or gear 91 and may be driven from any suitable source of power.

The bottom of the chest 82 is provided with a discharge pipe 95 within which is connected a pump 96, illustrated as of the centrifugal type, driven by a motor 97. The discharge end of the pipe 95 feeds the stock into the central compartment of a conventional head box 98, which is provided with an overflow partition 99, by which the excess of stock pumped thereto may be discharged into a return pipe 100 which feeds back into the chest 82. The head box is also provided with a second partition 101 having an opening, the size of which may be controlled by a slide or gate-valve 102, so that a controlled amount of the stock may be discharged through a chute 103 into a conventional mixing box 104. The mixing box 104 is provided with a plurality of staggered baffles indicated at 105 to thoroughly mix the stock passing therethrough. The mixing box 104 discharges into a pipe 108 which feeds into an open tank 109. Rotatably mounted and dipping within the stock within the tank 108 is a rotary vacuum filter indicated at 110. This rotary filter may be of any conventional construction, for example—of the type known commercially as the "Oliver filter," such filters being well known in the art, and so is not particularly illustrated herein. This filter 110 comprises a perforated rotary screen divided into compartments of definite suction areas. The screen dips into the stock within the tank 109, the suction causing the fibrous material to accumulate on the surface of the screen. As the screen rotates carrying the filtered defibered material above the liquid level within the tank, sprays of water or other washing liquid are directed from suitably disposed spray pipes 111 upon the stock on the filter. The material is thus washed practically free of the spent treating liquor, which may be termed the black liquor. As the filter continues to rotate, the material which has been thus washed arrives at an area which is not subject to suction, and at this point a flexible scraper member 117 carried by a rigid plate member 118 fastened to the side of the tank 109, scrapes this material from the filter, causing it to slide down the plate member 118 over the edge of the tank 109 into a chute 119 which discharges at 119' into a stock chest 112. The stock chest 112 is also provided with an agitating shaft 114 provided with agitators 115 and a driving pulley or gear 116. As the fibrous material accumulates upon

the screen of the rotary vacuum filter 110, the black liquor is sucked through into the interior of the filter, and the remaining black liquor in the fibrous material is washed out by the sprays directed upon the fibrous material, so that the black liquor is substantially all removed from the fibrous stock. Preferably controlled amounts of spray are added to the fibrous stock upon the filter, so that the black liquor is substantially all washed out, the washing water taking its place, but so that unnecessary dilution of the black liquor is avoided. The black liquor sucked from the fibrous material to the interior of the filter 110 passes by the pipe 120 to the vacuum tank 121 provided in connection with the vacuum filter. This vacuum tank 121 is also of conventional construction, such as is used in connection with rotary vacuum filters of this character, the vacuum tank being provided with a vacuum pump 122 for producing the necessary suction. For withdrawing the black liquor from the vacuum tank 121 against suction existing therein, a pipe 123 is tapped into the bottom of the vacuum tank 121, and a centrifugal pump 124 operated by a motor 125 is positioned within the pipe 123. The pump 124 discharges into a pipe 126, which in turn discharges into the central compartment of a second head box 128. The head box 128 is provided with an overflow partition 129 whereby the excess of black liquor is discharged into a pipe 130, which in turn discharges into the chest 82. The black liquor thus removed from the fibrous stock in the rotary vacuum filter is returned to the chest 82 to make down or dilute the stock discharged into the chest through the defibering apparatus. As previously described the stock passing from the chute 42 of the elevator preferably contains about 5 to 6 parts of liquor to 1 part of fibrous material. The black liquor is added to this stock within the chest 82 to dilute the same to a consistency which can be readily pumped through the pipes. A satisfactory consistency for this purpose comprises about a 5% stock, which means that the stock contains approximately 1 part of fibrous material to 19 parts of liquor. By making down the stock within the chest 82 with the spent black liquor, rather than with fresh water, the black liquor is not diluted. Preferably the stock is further diluted before passing into the open tank 109 of the rotary vacuum filter 110. For this purpose a pipe 132 is tapped into the pipe 126, the pipe 132 discharging at 133 into the top of the mixing box 104. A valve 134 is provided to control the flow through the pipe 132. Satisfactory results are obtained by making down the stock to a consistency of about 1% before passing through the rotary vacuum filter.

The head box 128 is also provided with a second partition 137 having an opening con-

trolled by a gate valve 139. In this manner controlled amounts of the black liquor pumped to the head box 128 are discharged into the pipe 140 which leads to the recovery plant indicated at 141. The amount of black liquor discharged to recovery is preferably comparable to the amount of liquor carried over by the steeped material from the steeping tank to the defibering apparatus. And likewise the amount of fresh regenerated caustic liquor introduced from recovery into the steeping tank is preferably comparable to the amount of liquor removed from the steeping tank with the steeped material, the amount of black liquor discharged to recovery thereby being comparable to the amount of fresh caustic liquor introduced into the steeping tank. In this manner, the liquor is maintained in controlled amounts throughout the system. The recovery plant is adapted to treat the spent black liquor to regenerate the same to form again active caustic liquor. The plant is not illustrated herein as it may be of entirely conventional form, such as used in the recovery of black liquor formed in the digesters in the manufacture of soda pulp. The steps in the recovery or regeneration of the liquor are well known, and consist essentially of evaporation of the liquor, burning of the residue to black ash, the lixiviation of the black ash, and the causticization of the extracted liquor. From the recovery plant 141, a pipe 142 leads the regenerated or active caustic liquor through a conventional heater indicated at 143 to the spray pipe 19.

Thus a self-contained process for the manufacture of paper-forming stock from straw or like materials is provided, in which the chemicals used can be recovered so that there is little loss of chemicals in the process, and stream pollution is entirely avoided. The recovery of the black liquor can be effected economically, inasmuch as the black liquor is not diluted to an economically objectionable extent with wash water during the process.

The stock chest 112 is provided with an outlet pipe 145, through which the stock is adapted to be pumped to a head box from which it is flowed upon a forming machine to form strawboard. If desired the stock in the chest 112 may be given additional treatment, such as being run through a second rotary vacuum filter, in which case the weak wash liquor from the second rotary vacuum filter would be used as the wash water for the first rotary vacuum filter. Also this may be followed by refining and screening, although these additional treatments are not usually necessary in the manufacture of strawboard.

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:

5 1. In the preparation of paper-forming stock from raw material such as straw, the self contained method which comprises main-  
10 taining a supply of mild alkaline steeping liquor maintained at a temperature below the boiling temperature of said liquor and at a low pressure, passing said raw material at a predetermined rate through such alkaline  
15 liquor, to loosen the bonding constituents thereof, withdrawing the steeped material form said liquor removing from said with-  
drawn material black liquor retained in said material and resulting from such steeping  
20 action, reconditioning such black liquor to form fresh steeping liquor, and adding such reconditioned steeping liquor to said main-  
tained supply to make up for the volume of spent liquor withdrawn with the steeped ma-  
terial.

25 2. In the preparation of paper-forming stock from raw material such as straw, the self contained method which comprises main-  
taining a supply of mild heated sodium hydroxide liquor at substantially atmospheric  
30 pressure and a temperature below the boiling temperature of such liquor, continuously passing said raw material at a predetermined rate through such liquor to soften the bond-  
ing constituents thereof, withdrawing the  
35 steeped material from said supply of liquor, mechanically defibering the steeped material, removing from said material black liquor retained in said material and resulting from  
40 such steeping action, subjecting the removal black liquor to a reconditioning action to pro-  
duce fresh, sodium hydroxide liquor, and adding such produced liquor to the main-  
tained supply to make up for the volume of spent liquor withdrawn with the steeped ma-  
45 terial.

3. A continuous self-contained process for the preparation of pulp from raw material  
such as straw, which consists in the steps of maintaining a quantity of steeping liquor,  
50 continuously passing said raw material through the steeping liquor to effect a controlled steeping thereof, removing the steeped material from the steeping liquor, draining  
a portion of the retained steeping liquor  
55 from such steeped material and returning said drained liquor to the main supply, then subjecting said material to a defibering treat-  
ment, removing from said material liquor still retained therein, reconditioning said re-  
60 moved liquor, and returning said recondi-  
tioned liquor to the steeping liquor to main-  
tain the volume and strength of said steep-  
ing liquor.

4. In the preparation of pulp from raw ma-  
65 terial such as straw, wherein the material is

steeped in a steeping tank having an inlet at one end thereof and an outlet at an opposite end thereof, the method which comprises maintaining in said steeping tank a supply  
70 of heated steeping liquor controlled as to volume, strength and temperature, introduc-  
ing said material into said steeping tank at the inlet end thereof at a predetermined rate, moving said material through said tank, re-  
75 moving said material from said tank at the outlet end thereof, at a rate corresponding to the rate of introduction of said material, draining a portion of liquor from the removed  
material and returning said drained liquor  
80 to the steeping tank, and introducing heated  
fresh steeping liquor into said tank in an amount comparable to the amount of liquor  
removed with said material.

5. In the preparation of pulp from raw ma-  
85 terial such as straw, wherein the material is steeped in a steeping tank having an inlet at one end thereof and an outlet at an opposite  
end thereof, the method which comprises maintaining in said steeping tank a supply of  
90 heated steeping liquor controlled as to volume, strength and temperature, continuously in-  
troducing said raw material into said steep-  
ing tank at the inlet end thereof, moving said  
95 material through said tank, removing said material from said tank at the outlet end thereof, said material tending to retain some  
substantially spent steeping liquor therein,  
draining a portion of said retained liquor  
100 from the removed material and returning said liquor to the steeping tank, and introducing  
fresh steeping liquor at the inlet end of said  
105 tank in an amount comparable to the amount of spent liquor removed with said material, whereby a concentration gradient of active  
liquor is maintained in said steeping tank  
ranging from the fresh liquor at said inlet end  
to spent liquor at said outlet end.

6. A self-contained process for the prepa-  
110 ration of paper-forming stock from raw ma-  
terials, such as straw, which consists in treat-  
ing said material in steeping liquor, removing  
said steeped material from said steeping li-  
quor, defibering said material, adding to said  
115 defibered material liquor removed from pre-  
viously treated material, filtering said de-  
fiberated material to remove it from said li-  
quor, and then returning a portion of said li-  
quor to be added to subsequently produced de-  
fibered material and returning the balance of  
120 said liquor to recovery.

7. A self-contained process for the prepa-  
125 ration of paper-forming stock from raw ma-  
terials, such as straw, which consists in treat-  
ing said material in steeping liquor, removing  
said steeped material from said steeping li-  
quor, removing a part of the steeping liquor  
130 from said material, defibering said steeped  
material, adding to said defibered material  
additional liquor removed from previously  
treated material, filtering said defibered ma-  
130

terial to remove the fibrous material from said liquor, returning a controlled portion of said liquor to recovery and returning the balance of said liquor to dilute subsequently produced defibered material, regenerating said returned portion of liquor, and introducing fresh regenerated liquor into said steeping liquor in an amount comparable to the amount of liquor removed from the steeping liquor by said steeped material, the controlled portion of said liquor returned to recovery being comparable to the amount of fresh liquor introduced into said steeping liquor.

8. Apparatus of the character described comprising, in combination, a steeping tank adapted to contain a steeping liquor, means for continuously introducing a fibrous material to be treated into said steeping tank, means for moving said material through said tank, means for continually removing said steeped material from said tank, and means for defibering said steeped material after its removal from said tank.

9. Apparatus of the character described comprising, in combination, a steeping tank adapted to contain a steeping liquor, means for continuously introducing a fibrous material to be treated into said steeping tank, means for moving said material through said tank, means for continually removing said steeped material from said tank, said removing means being constructed to permit draining of said removed material to free the same of a portion of the steeping liquor retained therein, and mechanical means for defibering said drained material.

10. Apparatus of the character described, comprising an elongated steeping tank adapted to contain a steeping liquor and having an inlet open to atmosphere adjacent one end thereof, means for continually introducing fibrous material into said tank through said inlet, means for moving said material through said tank towards the other end thereof, said tank having an outlet opening upwardly adjacent said other end, and an elevating mechanism dipping within said tank at the outlet end thereof, said mechanism being constructed to continuously remove said steeped material from said tank and permit draining thereof back into said tank.

11. Apparatus of the character described, comprising a steeping tank adapted to contain a steeping liquor, means for introducing a fibrous material into said tank, means for removing steeped fibrous material from said tank, a heater, and means for passing steeping liquor from the tank through said heater and back into the tank.

12. Apparatus of the character described, comprising a steeping tank adapted to contain a steeping liquor, a hopper for said tank providing an inlet for fibrous material, means for continuously feeding fibrous material to

said hopper, and a spray pipe associated with said hopper and adapted to direct a spray of steeping liquor upon said fibrous material to assist the feeding of said material into said tank.

13. Apparatus of the character described, comprising a steeping tank adapted to contain a steeping liquor, means for introducing fibrous material into said tank, means for removing steeped fibrous material from said tank, a recirculating passage associated with said tank, means for forcing steeping liquor through said recirculating passage, a heater for said liquor within said passage, and a sediment trap associated with said recirculating passage.

14. Apparatus of the character described, comprising, in combination, a steeping tank adapted to contain a steeping liquor and to receive fibrous material to be treated therein, mechanical means comprising spaced high-speed relatively moving surfaces associated with said steeping tank and adapted to receive steeped material therefrom to defiber the same, and means for feeding said steeped material from said steeping tank to said defibering means, said feeding means including an elevating mechanism constructed to permit draining of said steeped material during the time of passage from said steeping tank to said defibering means.

15. Apparatus of the character described, comprising means for steeping a fibrous material in a steeping liquor, means for defibering said steeped material, and means for adding spent steeping liquor to said defibered material to permit of pumping and filtering said defibered material without materially altering the concentration of the steeping liquor therein.

16. Apparatus of the character described, comprising means for steeping a fibrous material in a steeping liquor, means for defibering said steeped material, means for adding spent steeping liquor to said defibered material to permit of pumping and filtering said defibered material without materially altering the concentration of the steeping liquor therein, means for removing said steeping liquor from said defibered material, and means for returning a portion of said removed liquor to be added to subsequently defibered material.

17. Apparatus of the character described, comprising means for steeping a fibrous material in a steeping liquor, means for defibering said steeped material, means for adding spent steeping liquor to said defibered material to permit of pumping and filtering said defibered material without materially altering the concentration of the steeping liquor therein, means for returning a portion of said filtered liquor to be added to subsequently defibered material, means for subjecting another controlled portion of said filtered liq-

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uor to a recovery process, and means for introducing fresh steeping liquor from such recovery means into said steeping means, the controlled portion of said spent liquor returned to recovery being comparable to the amount of fresh steeping liquor introduced into said steeping means.

18. In the preparation of paper-forming stock from raw material such as straw, the method which comprises partially cooking for less than three hours said raw material to effect softening of the raw fibrous material without pulping thereof and to loosen and soften the bonding constituents holding the fibers together while leaving a substantial proportion of the bonding constituents undissolved in the mass in a mild caustic solution maintained at an elevated temperature below the boiling point of said solution and at substantially atmospheric pressure, the quantity of caustic solution being materially in excess of the amount of raw material being treated, removing said softened material from out of the cooking solution and draining liquor from the removed material, and then defibering said material in the presence of retained cooking liquor to reduce the softened material to pulp.

19. In the preparation of paper-forming stock from raw material such as straw, the method which comprises continuously introducing said raw material into a maintained supply of mild caustic cooking solution maintained at an elevated temperature below the boiling point of said solution and at substantially atmospheric pressure, to effect softening of the raw material without pulping thereof and to loosen and soften the bonding constituents holding the fibers together while leaving a substantial proportion of the bonding constituents undissolved in the mass, continuously removing the softened material from out of the maintained supply of cooking solution and draining liquor from the softened material, and continuously defibering said drained and softened material in the presence of retained liquor to reduce the softened material to pulp.

20. In the preparation of paper-forming stock from raw material such as straw, the method which comprises continuously passing said raw material through a large excess of a maintained supply of a mild alkaline steeping liquor so proportioned to the amount of raw material that the latter tends to float along in the liquor, continuously removing steeped material from said liquor, draining a portion of the retained liquor from such steeped material and returning said drained liquor to the main supply, and adding fresh steeping liquor to said maintained supply to make up for the volume of liquor removed with said material.

21. Apparatus of the character described, comprising in combination, a steeping tank

adapted to contain a maintained supply of steeping liquor, means for continuously introducing fibrous material into said tank, means for passing said fibrous material through the liquor within said tank, means for continuously removing steeped material from said tank, means for removing retained liquor from said steeped material, reconditioning means for said liquor, means for passing said removed liquor to said reconditioning means, and means for introducing fresh steeping liquor from said reconditioning means into said steeping tank in an amount comparable to the amount of liquor removed with said steeped material.

22. Apparatus of the character described, comprising in combination, a steeping tank adapted to contain a maintained supply of heated steeping liquor, means for continuously introducing fibrous material into said tank, means for passing said fibrous material through the liquor within said tank, means for continuously removing steeped material from said tank and for draining a portion of the retained liquor in said removed material and returning the drained liquor to said tank, means for removing liquor still retained in said steeped material therefrom, reconditioning means for said liquor, means for passing said removed liquor to said reconditioning means, a heater, and means for passing fresh steeping liquor from said reconditioning means through said heater and thence into said steeping tank.

23. In the preparation of stock for the manufacture of strawboard, the method which comprises steeping straw in an excess of an alkali metal hydroxide solution at an elevated temperature controlled below the boiling point of said solution and at substantially atmospheric pressure, to thereby soften the bonding portion of the straw without deleteriously affecting the fibrous portion thereof, removing the steeped material from said solution, then passing the softened steeped material through mechanical defibering means to suitably separate the material into its fibers with a substantial proportion of the bonding portion remaining undissolved therein, and washing and screening said defibered material.

24. In the preparation of pulp from raw fibrous material such as straw, the method which comprises partially cooking the raw fibrous material in a heated dilute alkali metal hydroxide liquor of a strength less than 6% at substantially atmospheric pressure and at a temperature below the boiling point of the liquor for a period of time of less than three hours, to cause reaction of a substantial proportion of the hydroxide liquor with said fibrous material to effect softening of the raw fibrous material without pulping thereof and to loosen and soften the bonding constituents holding the fibers together while

leaving a substantial proportion of the bonding constituents undissolved in the mass, the raw fibrous material being treated and submerged in excess of ten times its own mass

of the cooking liquor, separating the excess cooking liquor from the softened material, and then subjecting the softened material to a defibering treatment to reduce the material to pulp.

25. In the preparation of pulp from raw fibrous material such as straw, the method which comprises partially cooking the raw fibrous material in a heated dilute alkali metal hydroxide liquor of a strength less than 6% at substantially atmospheric pressure and at a temperature below the boiling point of the liquor for a period of time of less than three hours, to cause reaction of a substantial proportion of the hydroxide liquor with said fibrous material to effect softening of the raw fibrous material without pulping thereof and to loosen and soften the bonding constituents holding the fibers together while leaving a substantial proportion of the bonding constituents undissolved in the mass, the raw fibrous material being treated and submerged in excess of ten times its own mass of the cooking liquor, then subjecting the softened material with retained chemical liquor to a mechanical defibering treatment effective to reduce the softened material into pulp, separating remaining chemical liquor from the pulp and washing the pulp.

26. In the preparation of pulp from raw fibrous material such as straw, the method which comprises continuously introducing the raw fibrous material into a maintained bath of mild heated alkaline cooking liquor of a strength less than 6% and maintained at an elevated temperature below the boiling point of the liquor and substantially at atmospheric pressure, the bath containing a mass of liquor in excess of ten times the mass of raw material therein so that the raw material tends to float along in the liquor, moving the fibrous material through the liquor of the bath at a predetermined rate to give a partial cooking of the fibrous material without pulping thereof and a softening of the bonding constituents holding the fibers together without solution of a substantial proportion of the said bonding constituents, continuously removing the softened material out of the bath of cooking liquor and draining excess liquor therefrom, and then subjecting the softened material to a defibering treatment to reduce the material to pulp.

27. In the preparation of pulp from raw fibrous material such as straw, the method which comprises partially cooking the raw fibrous material in an alkali metal hydroxide liquor to cause softening of the fibrous material without destruction of a substantial proportion of the bonding constituents holding the fibers together, removing the partial-

ly cooked fibrous material, and subsequently adding to the material liquor removed from previously treated fibrous material to make down the material to a suitable consistency for further treatment without undue dilution of the liquor with water.

28. In the preparation of pulp from raw fibrous material such as straw, the method which comprises partially cooking the raw fibrous material in a mild alkali metal hydroxide liquor at an elevated temperature controlled below the boiling point of the liquor and at atmospheric pressure for a period of time in excess of twenty minutes but less than three hours, to thereby effect softening of the bonding materials holding the fibers together without pulping of the fibrous material, removing the partially cooked and softened material from the liquor, and then subjecting the removed material to an active defibering treatment to reduce the material to pulp.

29. In the preparation of pulp from raw fibrous material such as straw, the method which comprises passing the raw fibrous material through a maintained supply of mild heated steeping liquor maintained at an elevated temperature below the boiling point of the liquor at substantially atmospheric pressure and at a predetermined rate, to effect a partial cooking of the raw fibrous material with softening of the bonding constituents holding the fibers together without pulping of the fibrous material, removing the partially cooked and softened material upwardly out of the maintained supply of liquor after a predetermined time of treatment therein in excess of twenty minutes, and then subjecting the removed material to an active defibering treatment to reduce the material to pulp.

In testimony whereof I hereto affix my signature.

JOHN TRAQUAIR.

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