March 26, 1940. T. L. DUNBAR 2,195,378

PROCESS OF PRODUCING CELLULOSIC PULP

Original Filed Nov. 22, 1935 2 Sheets-Sheet 1

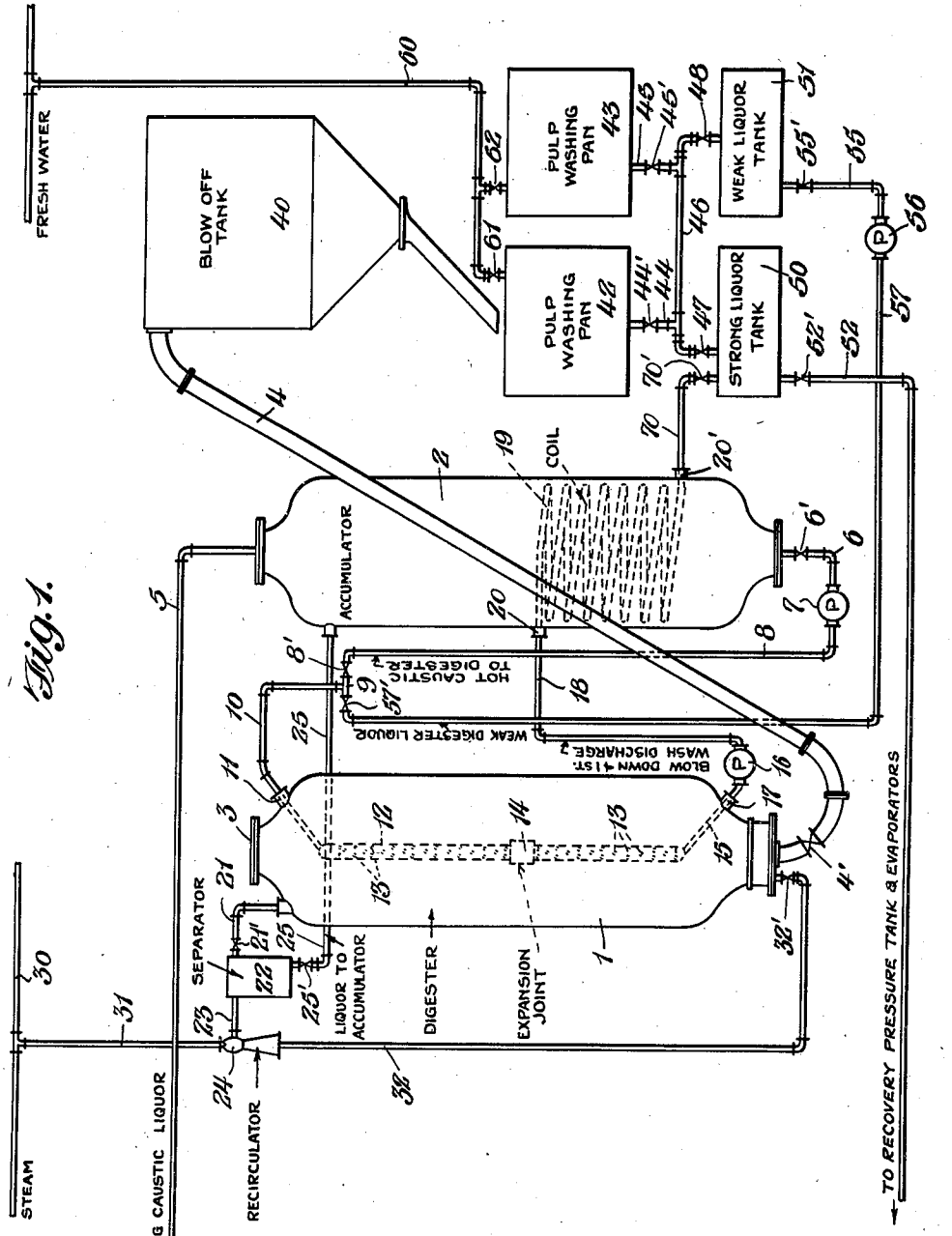


Fig. 1.

Inventor

THOMAS L. DUNBAR

By Raymond J. Morton

Attorney

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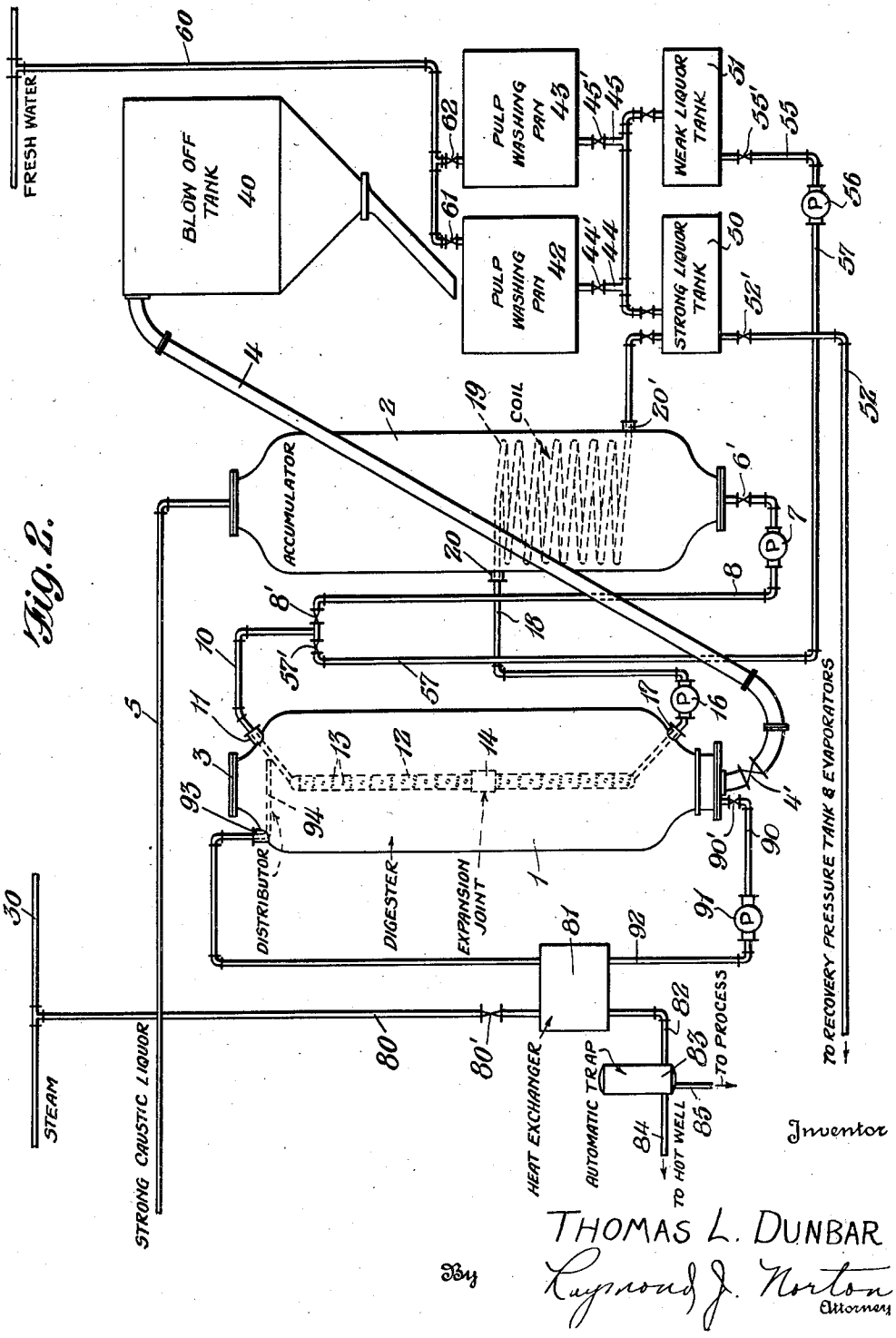


Fig. 2.

Inventor

THOMAS L. DUNBAR

By Raymond J. Norton

Attorney

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2,195,378

PROCESS OF PRODUCING CELLULOSIC PULP

Thomas L. Dunbar, Watertown, N. Y., assignor to Chemipulp Process, Inc., Watertown, N. Y., a corporation of New York

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20 Claims. (Cl. 92—7)

This invention relates to improvements in the treatment of cellulosic materials, more particularly to an improved method of and apparatus for producing pulp.

The present invention pertains to the production of pulp by alkaline digestion, that is to say to the soda process or a modification thereof such as the well known sulphate process.

As is known the soda process of treating wood presents some disadvantages. As compared to the sulphite process, the soda process results in a greater loss in cellulosic material due to the excessive degradation of the woody constituents caused by the rather drastic action of the caustic on the wood. Again, although the chemical reactions involved are relatively rapid, the entire process requires considerable time because of the prolonged period involved in washing the pulp. Yet again while the recovery of soda as a chemical process is comparatively simple, yet it adds considerably to the cost of the pulp. The apparatus involved in the recovery step is the most expensive section of the mill and the efficiency of the recovery system is the most important factor in operative cost.

According to the present method, economies are effected throughout the production process. The present improved method involves the optimum utilization of heat units of the system to preheat the digestion liquor; this digestion liquor is subsequently utilized to impregnate and cook the cellulosic material. Uniformity of temperature in the digester itself is insured by utilizing a simple and economic circulating system. The improvement also involves a special type of feeding circuit whereby the chips are contacted with the digestion liquor in such a manner as to provide for uniform reaction throughout the cellulosic mass in the digester.

It is thus an object of the present invention to provide an improved method of digesting pulp with alkaline reagents.

Another object is to achieve marked thermal economies in the production of pulp by the soda (or equivalent) process.

A further object is to provide a novel method of producing pulp by the soda or sulphate process, permitting the use of either direct or indirect steaming.

A still further object is to insure economies in the caustic recovery system.

Yet another object is to diminish concentration of the cooking liquor while producing a pulp of high quality.

Yet a further object is to provide an improved two stage soda cook.

With these and other equally important and related objects in view, the invention comprehends the concept of producing pulp by uniformly contacting a mass of cellulosic material with a caustic liquor which is accumulated in a pressure vessel, the temperature of which liquor has been raised to optimum degree by heat exchange with hot digestion fluids.

As will be seen more fully hereinafter, the principles of the present invention may be utilized in a method involving either direct steaming or indirect steaming. By reason of a special flow of the fluids during the treatment marked economies in the subsequent recovery system are attained.

In order more clearly to describe the invention, preferred embodiments are shown in the accompanying drawings, in which:

Figure 1 is a diagrammatic illustration of one type of system involving the direct steaming.

Fig. 2 is a view similar to Fig. 1 showing a modified or indirect steaming method.

As will be seen upon reference to Figure 1, the major elements in the system include the digester 1 and the accumulator 2. The digester may be of the usual type employed in the art and is provided with a detachable manhole cover 3 permitting the admission of chips, and the blow-off line 4, controlled by valve 4', permitting the discharge of the digested pulp.

The accumulator 2 may be of any suitable size and construction and preferably should have a capacity for three of four digester charges. The accumulator may be tubular in shape (as shown) or may be of spherical configuration. A feed line 5 leads from the make up system and discharge strong caustic liquor into the accumulator at the upper or any other desired section. A fluid discharge line 6 controlled by valve 6' is connected to the accumulator, preferably at the lower portion thereof, through which liquor may be forced into digester 1 or any other digester of a battery. If desired the accumulator 2 may be elevated with respect to the digester 1 so as to advantageously utilize a gravity flow in filling the digester.

The feeding circuit likewise includes the pump 7, the discharge of which is connected to line 8. At its upper end line 8 is provided with the control valve 8' and connects with header 9. From header 9 a line 10 leads into the upper portion of the digester through a suitable packing 11.

Interiorly of the digester the line 10 communicates with the axially positioned pipe 12.

As shown, this is positioned substantially on the longitudinal axis of the digester and is formed with the perforations 13. An expansion joint 14 is interposed in the distributor pipe 12 so as to permit linear expansion due to thermal changes. While the single joint is shown positioned at or near the center of the pipe, it will be appreciated that such joint may be placed at one or both ends of the pipe or at any other suitable point.

The lower end of the pipe 12 is connected through line 15 to the pump 16. The pipe 15 is provided with a suitable bushing or packing 17 to insure a tight joint at the point where it projects through the digester. The discharge side of pump 16 is connected through line 18 to the closed coil 19 located within the accumulator. Suitable glands or packings 20 and 20' are provided at each end of the coil 19 to insure a pressure tight connection.

The digester likewise is provided with a top relief line 21 having a control valve 21' which connects with the separator 22. A vapor discharge line 23 leads from the separator to the recirculator 24 and a liquid draw-off line 25 controlled by valve 25' discharges condensate or liquor from the separator 22 directly to the accumulator.

A steam header 30 is provided with a branch 31 which leads to the recirculator 24. This recirculator may be of any suitable type, such as the well known eductor whereby high velocity fluids such as steam passing through line 31 establishes an area of reduced pressure within the element 24 and induces a flow of fluid through the line 23. The discharge side of recirculator 24 is connected to the recirculating pipe 32 which, as shown, enters the bottom of the digester. Flow of fluids through this recirculating line may be controlled by the valve 32'.

The digester blow-off line 4 leads, as shown, to the blow-off tank 40. This may be of any desired type known in the art and may comprise the typical blow-pit or any suitable form of steam separator in which the pressure is suddenly released to separate the steam and by reason of the violent evolution of the steam to effect disintegration of the chips to the fibrous condition.

From the tank or separator 40 the stock flows by gravity to the washing pans 42 and 43. These may be of the well known construction and may comprise iron tanks having perforated false bottoms. In the pans the stock is washed either by first flooding with weak liquor from a previous wash and subsequently with hot water which produced the weak liquor for the first wash and finally with hot water which latter was run to the sewer.

As will appear more fully hereinafter, the alkali recovery system of the present invention differs from prior practice in that the preliminary wash of the pulp and the consequent recovery of a large quantity of the residual alkali is effected in the digester itself.

The pans 42 and 43 are provided with the draw-off lines 44 and 45, flow of liquid through which is controlled by valves 44' and 45' respectively. Lines 44 and 45 empty into the line or header 46 which connects with strong liquor tank 50 through the valved branch 47 and with the weak liquor tank 51 through the valved branch 48.

The tank 50 is a pressure tank and liquor from the tank 50 is discharged as desired through valve 52' and line 52 to the evaporator and alkali recovery system.

Weak liquor tank 51 is provided with the draw-off line 55 in which is interposed a control valve 55'. Line 55 is connected with pump 56 and the pressure side of the pump is connected with line 57. Line 57 connects through valve 57' to the digester feed line 10.

Wash water, at any desired temperature, is fed to the washing pans through the line 60 and valved branches 61 and 62.

In carrying out the process the manhole 3 is removed and chips are admitted to the digester either by gravity flow or by utilizing a chip filling device. After filling, the cover 3 is bolted on, valves 21', 32' and 57' are closed, valves 8' and 6' are opened and pump 7 is operated to force preheated alkaline liquor from the accumulator through lines 8 and 10 to the distributor pipe 12.

As is known, the hot alkaline liquor acts relatively rapidly on the chips. To insure uniform distribution and chemical action the entering liquor is contacted with the chips substantially throughout the length of the digester by means of the apertures 13. The liquor forced into the digester along its central axis is thus uniformly distributed throughout the body of the chips. The pump 7 is maintained in operation with valves 21' and 32' closed until the digester is filled to the desired level. Thereafter the steam circulating circuit may be operated, in a manner to be more fully described, or prior to such recirculation the pump 7 may be continued in operation until a high hydrostatic pressure of the order of 50 lbs. per sq. in. or more is established in the digester. The preheated alkaline liquor under such pressure rapidly and uniformly permeates the chips, thus insuring equalized temperature throughout the mass and a uniform reaction.

After the digester has been filled with liquor either under atmospheric pressure or under the high hydrostatic pressure as described, the temperature of the mass is uniformly increased. To do this the valves 21' and 32' are opened and steam from header 30 is passed through line 31, recirculator 24 and line 32.

In these circumstances liquor is relieved from the digester through the line 21 to the separator 22. In this element the relief separates into vaporous and liquid components. The vapor space of the separator, as noted, is connected through the line 23 to the low pressure zone of the recirculator 24. Hence the high velocity steam passing from line 31 through eductor 24 withdraws the flash steam separated in element 22 and the mixture is then passed to the bottom of the digester. In this manner the temperature of the liquor in the digester cycle is progressively raised to the desired reaction value.

The liquor from separator 22 may be passed either continuously or intermittently through valve 25' and line 25 to accumulator 2. Line 25, it will be understood, may be provided with a check valve to avoid undue back pressure from the accumulator to the separator. This hot liquor thus is directly mixed with the preheated liquor maintained in the accumulator.

Because of the utilization of the accumulator, thus insuring adequate supply of preheated liquor, the action of the caustic liquor on the chips is very rapid. Furthermore, due to the high initial temperature of the liquor, there is very little dilution of this liquor by steam condensation. By minimizing or reducing such dilution, a reduction in the initial concentration of the cooking liquor is achieved while at the same time maintaining a high yield and quality of the prod-

uct, thus establishing a definite saving in soda consumption.

Furthermore, as will be appreciated, this treatment involving the initial contact of the chips with hot alkali liquor permits the employment of a two stage cook. In these circumstances after the chips have been thoroughly penetrated with the hot alkaline digestion liquor the unabsorbed strong liquor may be drawn off to the accumulator early in the cook, in a manner more fully to be described, and may be replaced with a weaker liquor or with hot water to complete the cook and effect substantial savings in soda cost and a reduction in bleach.

After the cellulosic material within the digester 1 has been reacted with the hot caustic for the desired cooking period, the liquor is withdrawn in a novel manner. At the end of the cook the steam through line 30 is shut off and pump 16 is operated, valve 8' being closed. The hot liquor then is discharged through the coil 19 into the strong liquor tank. In passing through coil 19 the hot liquor gives up a considerable quantity of its heat, due to the indirect heat exchange, to the mass of strong caustic liquor within the accumulator, thus markedly preheating such liquor. The liquor withdrawn from the digester is passed thence through line 70 and valve 70' to the strong liquor pressure tank. The liquor entering this tank, while diminished in temperature by reason of the heat exchange in the accumulator, is still hot. From tank 50 liquor may be fed through valve 52' and line 52 directly to the evaporators. It will be appreciated that since the liquor to be recovered, passing through line 52, is still at a relatively high temperature, the load on the evaporators is very materially reduced. This is a particularly valuable feature of the invention, especially when the evaporator unit comprises a multiple effect vacuum apparatus.

After evaporation the liquor is calcined and causticized for the recovery of caustic soda in the well known manner. The strong caustic liquor is fed from the recovery apparatus, in the manner described, through the line 5, to the digestion system. In the accumulator, as described, it is preheated by indirect heat exchange with the hot alkaline liquor discharged from the digester and passing through coil 19.

In the present process, as has been indicated hereinbefore, the digester itself may be employed for the first washing. To accomplish this liquor from weak liquor tank 51 is picked up by pump 56 and forced through line 57 and valve 57', line 10 and distributor 12 to the digester. Here again the distributor functions very effectively as a washing element inasmuch as it uniformly distributes the hot washing liquor throughout the mass of chips. The pump 56 is continued in operation until the digester is filled or substantially filled with the hot washing liquor. Thereafter this liquor may be circulated through the digester by slightly opening the steam valve in circulator 24.

It is particularly to be observed that with the structure shown in Fig. 1, the operation may be very materially expedited by pumping in the weak liquor for the first wash cycle as the hot strong liquor is withdrawn from the bottom of the digester, that is to say at the termination of the cooking cycle. In this type of operation, as will be appreciated, the pumps 56 and 16 may be operated simultaneously so that as the hot alkaline liquor is withdrawn from the digester through the distributor pipe 13, the weaker wash liquor enters the top of the digester and is distributed through the upper section of the chips. In these circumstances the chips are rapidly drained, due to the action of pump 16, and are immediately contacted with the washing fluid. After the strong caustic liquor has been removed from the digester, which may rapidly be determined by a suitable recording mechanism or by test, the pump 16 is stopped while pump 56 is continued in operation to fill the digester to the desired extent.

It will also be appreciated that if desired the first washing with the weak liquor may be carried out under any desired degree of pressure. To accomplish this it is necessary only to operate the pump 56 to the desired extent.

It will thus be seen that the several elements embodied in the digester cycle perform a number of functions or, stated differently, the digester unit is effectively utilized in a number of cycles in the operation. Thus the steam recirculation line 24—32—21 serves not only to increase the temperature of the caustic liquor to bring it up to the desired reaction value, but it also functions in and adds considerably to the effectiveness of the first wash. Likewise the distributor pipe 12 serves as a feeding conduit during the cooking cycle, a drawoff line at the end of the cooking cycle, and a feeding line during the first washing cycle.

As is understood, during the first wash cycle the wash liquor takes up a considerable quantity of the residual alkali in the chips. At the termination of this first washing cycle a portion of the now strengthened wash liquor may be discharged into the strong liquor tank through the pump 16, line 18 and coil 19, and a digester may be blown in the usual manner to the blow-off tank 40. The pulp material from tank 40 may then be discharged to the washing pans 42 and 43 where washing is effected by hot water passed through line 60 in the well known manner. The wash liquor may be discharged from tanks 42 and 43 optionally to tanks 50 or 51 or otherwise disposed of.

As is known, although the actual cooking cycle in a sulphate process is relatively short, a considerable period of time is consumed in washing. Thus in most operations the net total washing time may extend from eleven to eighteen hours per charge. In the present process by carrying out the initial washing in the digester and particularly by initiating this washing immediately after the termination of the cook, marked economies in the washing are effected while insuring a high recovery of caustic.

The advantages of the pressure accumulator 2 in this type of operation will be appreciated. By such employment, as has been noted hereinbefore, the chips are initially contacted with caustic at a high optimum temperature, thus accelerating the cooking cycle while permitting the use of lower concentrations of cooking liquor. The employment of the accumulator in conjunction with coil 19 as a heat exchange medium conserves the thermal values in the process.

As already mentioned, the principles of the invention may be embodied in a process utilizing indirect cooking. Such a system is shown in Figure 2. In this structure the association of the digester, accumulator and washing system is substantially the same as that shown in Figure 1 and functions similarly. In this unit the temperature of the caustic liquor in the digester is elevated by indirect heating with steam and recirculation is effected under positive pump pressure.

As shown, the steam passes from the header 30 through the line 80, controlled by valve 80', to the heat exchanger 81. The condensate from the heat exchanger passes through line 82 to an automatic selector trap 83 of any preferred type, such for example as the Martina trap. This element, as will be appreciated, functions to selectively divert pure condensate through the line 84 to the hot well, and condensate contaminated with caustic through the line 85 either to some stage in the process or to the sewer. It will be appreciated that where condensate is not intended to be used for the boiler feed, such trap may be omitted.

Associated with the exchanger 81 is a circulating line adapted to withdraw liquor from and reintroduce it to the digester. The digester is provided with a drawoff line 90, having the control valve 90', which line is connected to the suction side of pump 91. The pressure side of the pump is connected to line 92, a portion of which is comprised in the heat exchanger 81. Line 92 enters the digester at an upper section thereof through a suitable tight fitting 93 and terminates within the digester in a perforated distributor section 94. While the digester recirculating line, as shown, functions to withdraw liquor from the bottom and reintroduce it at the top of the digester, it will be appreciated that, with suitable connections, this flow may be reversed.

The operation of this type of structure is essentially similar to that shown in Fig. 1 and previously described. The digester may be first filled with chips through the manhole cover 3 and thereafter contacted with caustic liquor which has been preheated in the accumulator with hot reaction products. The digester may be filled with caustic liquor at substantially atmospheric pressure or, as previously explained, pump 7 may be continued in operation until a high hydrostatic pressure is built up within the digester. After the digester has been filled the caustic liquor is recirculated directly to and from the digester through the circuit 90—91—92—81—94. Hot caustic liquor may be thus recirculated to and from the digester until the mass is completely digested. In lieu of this type of operation, as has already been explained, a two-stage cook may be utilized, in which case after a predetermined period of circulation the excess strong caustic may be drawn off from the digester and replaced with hot water or with a caustic liquor of similar or different characteristics from that first employed and at a lower concentration.

At the termination of the cook, in the manner already described, the major quantity of the residual alkali may be washed or dissolved out of the pulp while it is retained in the digester by forcing wash liquor through the circuit 55—56—57—10—13. The introduction of the wash liquor may be effected contemporaneously with the drawoff of the cooking liquor, as has already been explained.

After the preliminary wash in the digester the pulp may be blown through open valve 4' to the blowoff tank 40 and then subjected to the successive washings in the manner hereinbefore described.

In this operation also decided economies in the recovery of caustic are achieved by forcing strong caustic liquor, while at an elevated temperature, directly to the evaporator, thus diminishing the load on this element and accelerating the recovery. It will be appreciated that the chemical characteristics and the temperature of the liquor fed from accumulator 2 to the digester may be controlled within wide limits. While the liquor within the accumulator is shown as being heated by indirect heat exchange with not reaction products, it will be understood that this type of heating may be supplemented by heat derived from separate steam coils positioned interiorly or exteriorly of the accumulator and in some circumstances, if desired, by the introduction of direct steam into the accumulator.

The length of the cooking cycle, as is well understood by those skilled in the art, will vary depending upon such factors as the initial temperature and concentration of the digestion liquor and the type of wood. Deciduous woods may be effectively delignified in a considerably shorter period than coniferous woods. In the present process the cooking cycle is effectively shortened due to the vigorous circulation and to the initial high and maintained temperature. The utilization of the preheated caustic, particularly in conjunction with a high pressure saturation further accelerates the cooking reaction.

While the invention has been explained with relation to the employment of soda or sulphate liquors, it will be understood that the process applies equally to the several modifications of such alkaline digestion liquors, such as alkaline digestion processes involving the use of adjuvants, such as sodium sulphite, thio-sulphate and the like.

While preferred modifications of the invention have been described, it is to be understood that these are given didactically to more clearly explain and illustrate the process and not as the specific or exclusive combination of steps which may be utilized to produce the novel results. The invention is conceived to reside in the concept of processing cellulosic materials, utilizing the advantageous factors herein described.

I claim:

1. A process of producing chemical pulp which comprises charging a mass of woody material to a digester; accumulating a large volume of hot alkaline liquor in a pressure vessel; forcing the liquor from such vessel to the digester and evenly distributing the liquor over the material in the digester; recirculating the liquor directly to and from the digester while adding heat units thereto, and maintaining such circulation until the material has been digested; withdrawing hot liquor from the digester and utilizing such liquor to preheat the liquor in the pressure vessel.

2. A process of producing pulp which comprises filling a digester with fibrous material; accumulating a large volume of hot alkaline liquor under pressure in a separate vessel, forcing the liquor from such vessel into the digester along the central axis thereof; recirculating the liquor directly to and from the digester while adding heat units thereto and maintaining such circulation until the material has been digested; withdrawing hot liquor from the digester and passing it, in indirect heat exchange relationship, through the liquor in the pressure vessel.

3. A process of producing pulp which comprises filling a digester with cellulosic material; accumulating a large volume of hot alkaline liquor in a pressure vessel; forcing hot liquor from the vessel directly into the digester; passing hot liquor from the digester through the heat exchange to preheat the liquor in said vessel, and then passing such digestion liquor to an evaporator without further cooling.

4. In an alkaline digestion system for produc-

ing chemical pulp, that improvement which comprises utilizing hot cooking liquor withdrawn from a digester to preheat a body of alkaline liquor in a pressure accumulator, and then passing the cooking liquor while still hot to an evaporator and subsequently calcining the concentrate.

5. A process of producing pulp which comprises filling a digester with cellulosic material, establishing a large volume of hot strong liquor in a pressure accumulator; forcing liquor from the accumulator to the digester and cooking the material in the digester with such hot liquor for a predetermined period; then withdrawing the hot alkaline liquor from the digester and introducing a weaker alkaline liquor into the digester and completing the cook with such weaker liquor.

6. A process of producing pulp which comprises filling a digester with cellulosic material, storing a large volume of hot, strong alkaline liquor in a pressure accumulator; forcing hot liquor from the accumulator to the digester to establish a high hydrostatic pressure on the liquor; cooking the material in such liquor for a predetermined time, then withdrawing such hot alkaline liquor and introducing a weaker liquor into the digester and completing the cook with such weaker liquor.

7. A process of producing pulp which comprises filling a digester with cellulosic material, establishing a large volume of hot, strong alkaline liquor in a pressure accumulator; forcing liquor from the accumulator to the digester and cooking the material with hot liquor for a predetermined period while recirculating the liquor directly to and from the digester; then withdrawing the hot alkaline liquor from the digester and introducing a weaker alkaline liquor into the digester and completing the cook with such weaker liquor.

8. A process of producing pulp which comprises filling a digester with cellulosic material, establishing a large volume of hot, strong alkaline liquor in a pressure accumulator; forcing hot alkaline liquor from the accumulator to the digester to establish a high hydrostatic pressure on the liquor; cooking the material in such liquor for a predetermined period of time while recirculating the liquor directly to and from the digester; then withdrawing such hot alkaline liquor and introducing a weaker liquor into the digester and completing the cook with such weaker liquor.

9. A process of producing pulp which comprises filling a digester with cellulosic material; establishing a large volume of hot, strong alkaline liquor in a pressure accumulator; forcing hot liquor from the accumulator to the digester to establish a high hydrostatic pressure on the liquor, cooking the material in such high pressure liquor for a predetermined period of time, then withdrawing such hot alkaline liquor and introducing a weaker liquor into the digester, such weaker liquor being under less hydrostatic pressure than the said strong liquor, and completing the cook with such weaker liquor.

10. A process of producing pulp which comprises charging a digester with cellulosic material; establishing a large volume of hot strong caustic liquor in a pressure accumulator, forcing liquor from the accumulator to the digester in sufficient amounts to establish a high hydrostatic pressure in the digester; recirculating the high pressure alkaline liquor directly to and from the digester; subsequently withdrawing the hot liquor from the digester and passing it in indirect heat exchange relationship with the liquor in the accumulator.

11. A process of producing pulp which comprises charging a digester with cellulosic material, establishing a volume of hot, strong caustic liquor in an accumulator; heating the liquor in the accumulator by indirect heat exchange with hot digestion fluids; forcing hot liquor from the accumulator to the digester, introducing steam into the digester and utilizing such steam introduction to withdraw liquor from and recirculate it back into the digester.

12. A process of producing pulp which comprises filling a digester with cellulosic material; accumulating a large volume of hot, strong liquor in a pressure vessel, forcing liquor from the vessel to the digester and cooking the material with the hot liquor for a predetermined period, then withdrawing the hot alkaline liquor from the digester and utilizing such withdrawn liquor to preheat the liquor in the pressure vessel; introducing a weaker alkaline liquor into the digester and completing the cook with such weaker liquor; and during the cooking period recirculating alkaline liquor directly to and from the digester while adding steam directly thereto.

13. A process of producing pulp which comprises charging a digester with cellulosic material, establishing a large volume of hot, strong caustic liquor in an accumulator, forcing liquor from the accumulator to the digester in sufficient amounts to establish a high hydrostatic pressure in the digester; forcing steam into the digester and utilizing the flow of steam to withdraw liquor from and reintroduce it into the digester; withdrawing hot alkaline liquor from the digester at the termination of the cooking period and utilizing such hot liquor to preheat the liquor stored in the pressure accumulator.

14. A process of producing pulp which comprises charging a digester with cellulosic material, establishing a large volume of hot, strong caustic liquor in a pressure accumulator; forcing liquor from the accumulator to the digester; withdrawing hot liquir from the digester under pump pressure and reintroducing it into the digester during the cooking period; withdrawing hot digestion liquor at the termination of the cook and forcing such hot liquor in indirect heat exchange relationship through the alkaline liquor maintained in the said accumulator.

15. A process of producing pulp which comprises charging a digester with cellulosic material; accumulating a volume of hot caustic liquor in a pressure vessel, pumping the liquor from said pressure vessel to the digester and distributing such liquor into the material in the digester laterally along the longitudinal axis of the digester; subsequently withdrawing liquor from the bottom section of the digester and contemporaneously introducing a washing liquor into the upper portion of the digester.

16. A process of producing pulp which comprises charging a digester with cellulosic material; accumulating a volume of hot caustic liquor in a pressure vessel, pumping the liquor from said pressure vessel to the digester and distributing such liquor into the material in the digester laterally along the longitudinal axis of the digester; subsequently withdrawing liquor from the bottom section of the digester and contemporaneously introducing a washing liquor into the upper portion of the digester, and utilizing such

withdrawn liquor to preheat the alkaline liquor in the accumulator.

17. A process of producing pulp which comprises filling a digester with fibrous material, accumulating a large volume of hot alkaline liquor under pressure in a pressure vessel, forcing the liquor from such vessel into the digester along the central axis thereof; recirculating the liquor directly to and from the digester while adding heat units thereto and maintaining such circulation until the material has been digested; withdrawing hot liquor from the digester and passing it, in indirect heat exchange relationship, through the liquor in the pressure vessel and additionally heating the liquor in the pressure vessel by introducing direct steam thereto.

18. A process of producing pulp which comprises filling a digester with cellulosic material, accumulating a large volume of hot alkaline liquor in a pressure vessel; forcing hot liquor from the vessel directly to a digester; passing hot liquor from the digester, in indirect heat exchange relationship, through the liquor in the pressure vessel to preheat the liquor in said vessel, additionally heating the liquor in said vessel by introducing direct steam therein, and then passing such digestion liquor to an evaporator without further cooling.

19. A process of producing pulp which comprises filling a digester with cellulosic material, establishing a large volume of hot, strong alkaline liquor in a pressure accumulator; forcing hot alkaline liquor from the accumulator to the digester to establish a high hydrostatic pressure on the liquor; cooking the material in such liquor for a predetermined period of time while recirculating the liquor directly to and from the digester and indirectly heating the liquor during such recirculation; then withdrawing such hot alkaline liquor and introducing a weaker liquor into the digester and completing the cooking with such weaker liquor.

20. A process of producing pulp which comprises charging the digester with cellulosic material, establishing a large volume of hot, strong caustic liquor in an accumulator, forcing liquor from the accumulator to the digester in sufficient amounts to establish a high hydrostatic pressure on the digester, recirculating the high pressure liquor to and from the digester while adding heat during the recirculation; withdrawing hot alkaline liquor from the digester after a predetermined cooking period and utilizing such hot liquor to preheat the liquor stored in the pressure accumulator.

THOMAS L. DUNBAR.