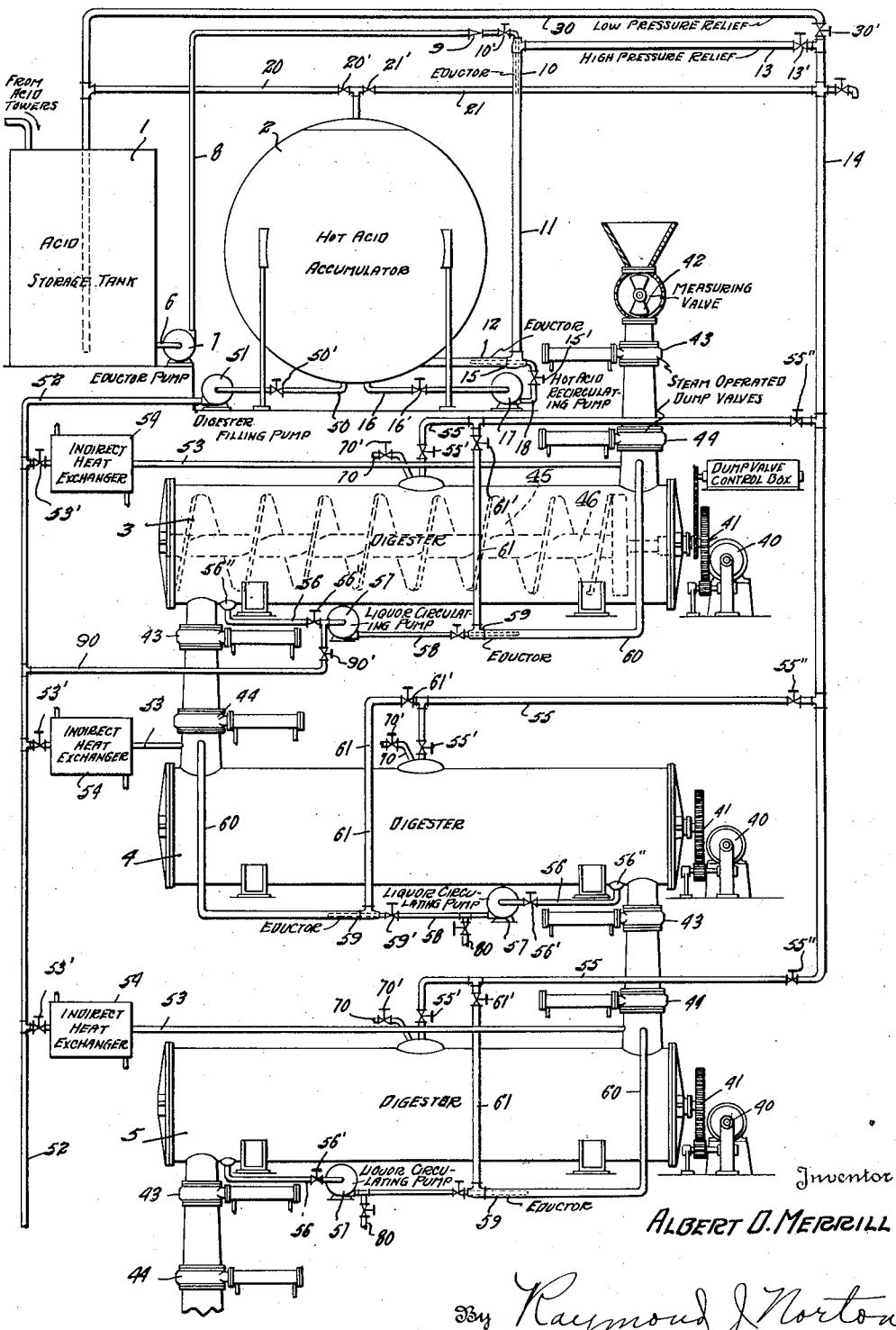
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METHOD AND APPARATUS FOR DIGESTING CELLULOSIC MATERIALS

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METHOD AND APPARATUS FOR DIGESTING CELLULOSIC MATERIALS

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This invention relates to improvements in methods and apparatus for digesting cellulosic material.

The digestion of fibrous material, such as wood chips, has heretofore largely been carried out by the batch method. In a typical operation a large digester is filled or packed with chips, the digesting reagent admitted and cooking is carried out for a prolonged period of time. Upon completion of the cook the existent pressure is relieved and the digested pulp is discharged to the pit.

Such a batch method inherently requires a protracted time of treatment and, for a large capacity, a relatively large number of digesters in a battery or unit.

It has been suggested heretofore to effect the digestion of fibrous material in a continuous manner. Such prior methods have sought economies of operation by providing for a continuous regulated passage of the fibrous material through an elongated digester or series of digesters, thus making continuous use of the apparatus. These prior methods, however, have not provided for maximum thermal economies or for optimum preconditioning of the chips and the reagent.

According to the present process cellulosic material which is to be delignified may be treated in a continuous operation, which operation includes two distinct phases or types of treatment. In the first the raw material is contacted with hot preconditioned digesting liquor under a relatively high hydrostatic pressure and at elevated, but below reaction, temperatures. The temperature and pressure conditions and the speed of flow of the materials through the first stage are so controlled that the chips are uniformly permeated or saturated with hot acid which is below the reaction or cooking temperature. Thereafter the material is substantially continuously conveyed to the second phase of the treatment in which the pressure and temperature conditions are adjusted to insure proper cooking. It is known that the yield and quality of pulp produced, as for example by the sulphite process, is in a large measure dependent upon the degree to which the chips are penetrated with the liquor prior to actual digestion or cooking. With optimum penetration prior to cooking, a number of advantages are secured. With preliminary uniform saturation with hot acid, subsequent differential cooking of portions of the mass or sections of the individual chips is substantially eliminated, thus avoiding losses due to uncooked cores or shives. In addition ultimate economies in the amount of acid actually required for cooking and consequent savings in heat units are effected.

Under the principles of the present invention such economies are coupled with the economies effected in a continuous, as distinguished from a batch, operation to provide a process which is as novel as effective.

Considered briefly therefore, the invention contemplates a continuous process in which, in the first stage or phase, the raw material is contacted with hot acid maintained just below reaction temperatures and under a high hydrostatic pressure. Preferably also in this first stage this hot high pressure acid is recirculated to and from the first phase unit so as to equalize the temperatures and insure uniform contact. Thereafter the material is continuously conveyed to another unit or units in which a lower operating pressure and a higher temperature is maintained so as to effectively cook or digest the mass. The chip saturating and cooking units are coupled in a novel manner with other units provided for the purpose of regenerating or recuperating the thermal and chemical values of the cooking liquor.

An object of the invention therefore is to provide a novel continuous method of digesting fibrous material.

Another object is to provide a continuous process for digesting fibrous material in which, in a continuous operation, the raw material is subjected to a preconditioning treatment, followed by digestion.

A further object is to provide a novel apparatus for a continuous treatment of fibrous materials to produce pulp therefrom.

Yet another object is to provide a novel method of recuperating chemical and thermal values in a continuous process of producing pulp.

With these and other equally important objects in view, the invention comprehends the concept of continuously treating pulp with a digestive reagent and so controlling the operation that in the initial stages of treatment the cellulosic raw material is thoroughly saturated with acid at a uniform temperature and is thereafter continuously submitted to cooking or digesting conditions.

In order to more readily explain the invention a typical physical embodiment is shown diagrammatically in the single figure of the accompanying drawing.

As shown in the drawing, the major elements of the apparatus include the acid storage tank

1, hot acid accumulator 2 and a series of tubular digesters 3, 4 and 5.

The accumulator is preferably spherical in shape and is of sufficient capacity to hold from about one and one-half to three charges of acid. This element, as will be understood more fully hereinafter, serves as a thermal and chemical recuperator and provides a source from which hot preconditioned acid liquor may be withdrawn as required.

The digesters 3, 4 and 5, together with the feeding and discharging mechanism, may be similar to those described in the United States patent to Braun 1,938,802. These are so constructed and arranged that a differential pressure and temperature, and if desired a differential speed of flow of the chips may be maintained in the separate units.

As indicated hereinbefore, in the first digester 3 chips are contacted with hot preconditioned acid at a temperature of from approximately 70° C. to about 120° C. A high hydrostatic pressure of the order of aproximately 50 to 90 lbs. is maintained on the acid so as to accelerate penetration of the hot acid into the interior of the chips. The speed of flow of the material through this element is so controlled and so correlated with the temperature and pressure of the acid that upon discharge the chips are thoroughly saturated with the acid. In normal operations this time of contact in element 3 may vary from one-half an hour to three or four hours. In most circumstances a soaking period of one and one-half hours is sufficient.

The hot acid saturated chips are then conveyed to digester 4 where they are subjected to cooking conditions of temperature and pressure. Thus in digester 4 the chips may be contacted with hot acid and the mass maintained under a pressure of the order of 70 lbs. more or less. In this element heat units are added to the acid so as to raise the temperature to optimum cooking temperature. Preferably, although not necessarily, the temperature of the acid is raised by introducing direct steam. The temperature of the mass may ultimately be raised to the order of from 130° C. to 140° C. An optimum maximum pressure of approximately 70 lbs. is maintained by operating the relief lines in the manner well known to those skilled in the art.

The actual digestion may be carried out in a plurality of digesters, as heretofore indicated. Thus after a preliminary digestion treatment in digester 4 the cellulosic mass may be conveyed to digester 5 and cooked therein under any suitable temperature and pressure which, if desired, may be different from that obtaining in digester 4. Also, if desired, a different digesting agent may be employed in the latter digesters of the battery.

After the mass has thoroughly been digested it may be discharged to a blow-pit, washed and then bleached, or may be treated in any other manner, as for example according to the method described in Patent 1,938,802.

The apparatus is so constructed as to secure maximum recovery of the heat units and chemical values of the cooking liquor.

The storage tank 1 is connected by line 6 to the intake of pump 7. Relatively cool acid is forced by pump 7 through line 8 and check valve 9 to eductor 10 and thence through drop leg 11 and branch 12 to the accumulator. The eductor 10 is suitably connected through branch 13, controlled by valve 13', to the high pressure header 14. Thus the stream of cool acid passing through eductor 10 absorbs and condenses the hot relief fluids in this line. This action not only preheats and enriches the stream of cool acid but also concomitantly reduces the pressure in line 13, thus minimizing back pressure on the digesters and accelerating the flow of relief fluids by establishing a decided pressure gradient.

In the preferred form of apparatus a second eductor 15 is interposed in accumulator feed line 11—12. The liquid inlet of this eductor is connected to an acid recirculating line. As shown, acid may be withdrawn from a lower portion of the digester through line 16, controlled by valve 16' and forced by pump 17 through line 18 to the eductor. When valve 16' is opened and pump 17 is operated liquor is continuously withdrawn from the accumulator and forced at any desired velocity through eductor 15 to intimately contact with the fluids flowing downwardly through drop leg 11, thus further condensing and absorbing components of this stream and supplementing the pressure control effected by the action of eductor 10. The flow of fluids through eductors 10 and 15 are controlled by eductor valves 10' and 15' respectively.

The pressure and temperature conditions within the accumulator may be very accurately controlled. To achieve this the vent line 20, having a pressure regulating valve 20', is provided which leads from the upper or vapor space of the accumulator to the body of liquid in the storage tank 1. The valve 20' may be so adjusted that when the pressure in the accumulator rises above a predetermined value, say of the order of from 25 to 100 lbs. more or less, gases and/or vapors automatically are vented to the storage tank to be absorbed in the cooler liquor therein.

Likewise a by-pass line 21, provided with a pressure regulating valve 21', leads from the header 14 to the accumulator. This valve may be set at any desired pressure differential of the order of from one to five pounds or more. Thus when the pressure in the relief line 14 exceeds the pressure in the accumulator by this predetermined amount, the valve 21' automatically operates and relief fluids are by-passed around the eductor and passed directly to the accumulator. The accumulator, it will be understood, is provided with a gauge glass (not shown). Liquid level indicating and/or recording instruments may likewise be employed.

A low pressure relief line 30 may be connected through suitable branch lines to the several digesters or may be so connected by means of the main header 14. During cooking operations, as is well understood by those skilled in the art, the low pressure relief fluids may be passed through this line directly to the liquor in the storage tank by proper manipulation of valve 30'.

The digester units preferably are of the type fully described in the U. S. Patent 1,938,802 mentioned above. Each unit is provided with a perforated rotatable screw 45, mounted on shaft 46, which latter is suitably driven, as by the motor 40, through the transmission mechanism 41. The motors are connected in circuit in the manner described in the patent noted above.

The measuring valve 42 and the feeding valves 43 and 44 similarly are of the type described in the prior patent referred to. These are operated in definite predetermined sequence by means of suitable steam cylinders. With this type of mechanism chips are fed through the automatic chip feeder 42 and thence through the valves 43 and 44 into the digester under such circum-

stances that definite predetermined conditions may be maintained in each digester independently of the others.

Digestion liquor is fed independently to the several digesters of the unit. As shown on the drawing, hot acid from the accumulator may be drawn through line **50**, controlled by valve **50'**, and forced by the pump **51** to the acid header **52**. Branch lines **53** lead from the main acid line **52** to each of the digesters. Preferably there is interposed in the branch acid feeding lines a heater **54**, by means of which the temperature of the acid passing to each digester may be controlled. Such heater may be of the indirect type, of which the heating medium may be steam, suitable electrical units, hot spent liquor and the like. The flow of acid through the several lines **53** is controlled by valve **53'**.

The acid feed line **53** discharges into the digester **3** at any suitable point, as for example adjacent the chip inlet conduit. In these circumstances when the apparatus is being charged hot acid from the line **53** may be intimately contacted with the incoming chips. The upper section of each digester is provided with the overhead relief line **55**, having interposed the control valve **55'**. This line, as shown, connects with the main header **14** and preferably is provided with a second control valve **55''**.

In accordance with the principles already expressed, means are provided to recirculate the liquor directly and independently to and from each digester. A drawoff line **56** is connected through a suitable filter or strainer **56''** to a lower section of the digester. The outlet of line **56** is connected to the suction side of pump **57**. Flow of liquor from the digester to the pump may be controlled by valve **56'**. The circulating liquor picked up by pump **57** is forced through line **58**, through eductor **59** and line **60** and is discharged into the upper portion of the digester.

The eductor **59** is connected by means of the vapor line **61** to the vapor space of the digester. Connection between the eductor and digester is controlled by the valve **61'**. It will be appreciated that in the operation of a given digester when valve **55''** is closed and valves **55'** and **61'** are opened, gases and vapors may be withdrawn from the vapor space of the digester and aspirated by means of the stream of recirculating liquor flowing through the eductor to be condensed and absorbed in this liquor. In this manner the pressure within a given digester may be controlled and the acid concentration of the liquor maintained at any desirable high value.

It will be understood that the ends of lines **55**, within the digesters, are provided with suitable strainers to prevent clogging with pulp. The line **55** may also be provided with a branch line which is connected to a lower portion of the digester and operable as a side relief to withdraw liquor and maintain any desired liquid level within a particular unit. Similarly such side relief line may be directly connected to the header **14** instead of through the branch line **55**.

Each digester may be provided with the air vent line **70**, controlled by valve **70'**. Such line may be operated, when starting the system, to vent air from the units. Such venting of air facilitates the penetration of the chips with the acid and permits a more accurate control of the chemical character of the liquor. After the air in the system has been vented, which is apparent upon the discharge of dry SO_2 gas, such valves may be closed.

The acid recirculating lines of digesters **4** and **5** may be provided with valved branches **80**. These preferably are connected on the pressure side of pumps **57** and may be operated to discharge liquor from a given digester for the purpose of controlling the liquid level at any desired value or, in the case of the last digester of the unit, to completely drain the digester of acid. In this latter case it will be appreciated that by providing appropriate branch connections to line **56** the pump **57** may be utilized to charge the digester **5** with another liquid such as wash water, alkaline liquor, bleach liquor and the like.

According to a major purpose of the invention the element **3** is employed as a high pressure high temperature soaker. To subserve this purpose, if desired, a separate branch line **90** having the control valve **90'** may be connected to the acid line **52** and to the suction side of pump **57**. By closing valve **56'** and opening valve **90'** the pump **57** may be utilized to pump in additional liquor to build up a high hydrostatic pressure in element **3**. After the desired predetermined pressure has been established valve **90'** may be closed and valve **56'** opened and the hot acid then recirculated to and from the digester **3**. While the recirculation circuit has been shown as from the bottom to the top of the digesters, it will be understood that such flow may be in the opposite direction, i. e., from the upper to the lower section of the digester.

As indicated hereinbefore, heat units may be added to the digestion liquor by means other than the indirect heat exchanger **54**. Preferably such additional heating is accomplished by introducing direct steam. This may be done through means connected through the bottom of the digester or by introducing steam directly into the recirculating line. In this latter case the steam not only imparts additional heat to the mass but also assists in the recirculation. In order not to complicate the drawings, such steam lines have been omitted.

It will be understood that the digesters are provided with heat and pressure indicating and recording devices so as to permit an accurate check and control of the operations.

The operation of the system will have been appreciated from the foregoing description. Fresh acid is fed from the acid system to the storage tank **1** and is fed thence, in the manner described, by the pump **7** through the line **8** to the hot acid accumulator **2**. Heat units are imparted to the mass of acid within the accumulator and the temperature is raised by the constant or intermittent addition of hot SO_2 gases and/or liquors introduced therein from the relief lines. In order to maintain the temperature of the acid in the accumulator at an elevated and predetermined value, additional heating means may be inserted, for example in the accumulator liquor recirculation circuit **16—17—12**. In starting up the unit the digester **3** may first be filled with chips either by way of the valves **42**, **43** and **44** or initially directly through a separate manhole (not shown) provided on this element. After the digester has been filled, hot acid is introduced. Alternatively the chips and acid may be fed in simultaneously so that each increment of chips which is introduced into the digester is immediately contacted and wetted with the acid. During the filling operation the valves **50'**, **53'** and **70'** are opened and the valves **55'**, **61'** and **56'** are closed. In these circumstances predetermined amounts of chips are in-

troduced from the hopper through the segmental measuring valve 42 and then into the digester by means of the sequential operation of valves 42 and 43, in the manner more fully described in the prior Patent 1,938,802. At the same time pump 51 operates to force hot acid from the accumulator through the heat exchanger 54 and line 53 into the digester. During this passage the acid is heated up to the desired temperature by controlling the speed of flow and/or temperature of the heating medium in the indirect heat exchanger.

During the filling operation the air contained in the digester is displaced by the entering acid and chips and escapes through the vent 7. When the digester is filled valve 70' is closed and additional acid is introduced by way of line 53 until a high hydrostatic pressure of acid is built up. Preferably, as indicated hereinbefore, acid is introduced until a hydrostatic pressure of the order of from 50 to 90 pounds is established. In the preferred mode of operation, however, after filling the valve 53' is closed and valve 90' is opened, valve 56' being closed. The pump 57 is operated and forces additional quantities of hot liquor into the digester through the line 60 until the desired pressure is established.

After the digester is filled with chips and hot liquor at high pressure, valve 90' and/or valve 53' are closed and valve 56' opened. Pump 57 operates to withdraw liquor from the bottom of the digester through line 56 and force it through the circuit 58—60 into the digester. This recirculation of the hot liquor, under a high pressure, tends to equalize the temperature of the mass and to facilitate impregnation of the cellulosic material with the acid. This recirculation may be continued through the soaking period or until such time as is required, in a particular case, to equalize the temperature. During this operation, as will be understood, the mass of chips is slowly conveyed, by means of the helical screw, from the inlet to the discharge end of the digester. This movement is so correlated with the temperature and pressure factors noted above that upon discharge from element 3 the chips are thoroughly permeated with hot acid at uniform temperature. The mass of chips is forced or discharged over a suitable wier positioned near the discharge end of the digester and is fed in a substantially continuous flow, in the manner described in the prior patent referred to, through the valves 43 and 44 into the digester 4.

During the soaking operation, whenever the circumstances require, valves 55' and 61' may be opened, valve 55'' being closed. In these circumstances gases and/or vapors evolved in the digester will be aspirated through the line 61 and condensed and absorbed in the eductor 59 by the recirculating stream of acid. This type of operation is sometimes advisable when a very high soaking temperature is employed, coupled with a high acid concentration. In this manner not only may the temperature of the acid be maintained at a substantially uniform value but the concentration of the acid likewise retained at a high value.

It has been found that when chips are thoroughly saturated with acid, subsequent cooking may be carried out with a relatively small quantity of acid. In the older practice it was thought necessary to maintain the chips actually immersed in liquor throughout the cooking period. When, however, complete saturation of the chips is effected before cooking, effective digestion may be carried out with a relatively low liquid level, that is to say a liquid level below the chip level. This type of operation permits marked economies in the amount of the liquid reagent employed and corresponding savings in chemical and steam costs. Such a type of low liquid level operation is contemplated and may be carried out in the present continuous process.

As explained in the first phase of the process, that is as carried out in the element 3, the chips are thoroughly penetrated with hot acid. This material is then discharged, in the manner described, into the first digestion stage or element 4. During the initial operations, as the first charge of chips is being discharged into the digester 4, the valve 70' is opened while valves 55', 56' and 61' are closed. Concomitantly with the admission of the saturated chips hot acid liquor is introduced into the digester 4 through line 53. As the acid and chips enter the air contained within the digester is correspondingly displaced and escapes through the vent 70. When the air is completely discharged from the digester, which is noted by the discharge of dry SO_2 gas, the valve 70' is closed and valves 55', 56' and 61' are opened. The circulating pump 57 is started. In these circumstances the stream of recirculating acid passing through the eductor 59 absorbs and condenses the gases passing overhead through line 61. It is particularly to be observed that a decided pressure differential obtains between the digester 3 and the digester 4. In the preferred mode of operation soaking is carried out at high pressure. After the termination of the soaking period the pressure is reduced very decidedly, for example from the order of 80 or 90 pounds more or less down to about 30 pounds. The advantages of this type of operation is that the lower pressure permits a maximum quantity of steam and hence of heat units to be admitted at the commencement of the cook. This is permitted by reason of the thorough saturation period and eliminates the necessity heretofore obtaining of bringing up the steam pressure slowly.

In conducting the operations, therefore, the pressure on the chips in the digester 4 is initially reduced down to the order of 30 pounds more or less. During this period acid, preheated to the desired optimum degree, is introduced through line 53. The quantity introduced is controlled so as to secure the desired liquid level. During this period direct steam may be introduced in the digester 4 either directly through suitable inlet lines in the bottom of the digester or by way of the acid recirculating line 58.

During this operation, as will be understood, the motor 40 is operated and the mass of chips undergoing digestion is moved slowly towards the discharge end of digester 4. Upon introduction of direct steam the pressure builds up rather rapidly from the order of 30 pounds more or less to the desired operating value, which, as is known, may be of the order of 70 pounds more or less. Due to the introduction of steam the temperature correspondingly increases and rises from the starting value, which may be of the order of from 70 to 100° more or less, up to a value of 130 to 140° C.

As is known in the art, upon a continuous introduction of steam the liquid level increases due to condensation. This liquid level may be maintained at the desired value by drawoff of some of the liquor on side relief. In the present operation such side relief liquor may be withdrawn

through the line **55** by opening valve **55'** or by opening a separate side relief line, or if desired by discharging some of the acid content through the discharge line **80**. Usually this side relief is operated between the fourth and sixth hour of the operation. Similarly, as is known in the art, as the reactions proceed gases are evolved. In order to maintain the desired operating pressure these gases may be relieved by withdrawal through the line **55** by opening valves **55'** and **55''**. In the present operations it is particularly to be noted that the acid concentration may be maintained at a relatively high value and the gas pressure to a considerable degree controlled by recycling a portion of the evolved gases through line **61** to be condensed and absorbed in the liquor.

The mass of cellulosic material undergoing digestion in the described manner passes from the inlet to the discharge end of the digester **4**. The speed of flow is controlled in the manner described so as to retain the pulp in the digester for a predetermined period of time. Then the partially digested chips are discharged continuously through valves **43** and **44** into digester **5**.

In the initial stages of operation, as has been described hereinbefore, valve **70'** may be opened for a short period of time to evacuate the digester of contained air. Thereafter this valve is closed. As the partially digested chips are admitted to digester **5** a predetermined quantity of hot fresh acid is introduced through the line **53**. During the period of digestion in this element hot liquor may be recirculated continuously or intermittently through the acid recirculation line **55—60**. Similarly, during digestion in this stage gases may be vented from the upper portion of the digester and passed through eductor **59** to be condensed and absorbed in the recirculating stream of acid. The pressure and liquid level conditions in digester **5** may be controlled in the manner previously described, namely by operating the top and side reliefs or by withdrawing predetermined quantities of liquor through the line **80**. It will be understood that the liquor withdrawn from line **80** may, if desired, be passed directly to the hot acid accumulator to be mixed with fresh liquor therein.

In the manner well known in the art steam is shut off some time prior to completion of the cook and the pressure may be reduced from the optimum working pressure of approximately 70 to 75 pounds down to 20 or 30 pounds more or less. After this reduction in pressure the material may be discharged from the digester **5** directly to a blow-pit. Thus in accordance with the present invention the last digester of the unit preferably is operated at a lower pressure than the previous digesters so as to prevent disintegration of the pulp upon discharge.

The discharged pulp may then be treated in the usual manner, that is to say it may be subjected to the typical washing and bleaching operations.

It will be observed that the present type of process presents many advantages. Operating according to the present method the cellulosic raw material may be continuously impregnated with hot acid under the optimum temperature and pressure conditions and then continuously digested with minimal quantities of the digesting reagent. In these circumstances continuous use is made of the apparatus and the operation is so controlled that maximum economies of time, heat and chemical costs are effected.

If desired, elements of apparatus other than those shown may be employed to secure the advantages set forth herein. Thus if desired the temperature of the liquor in the several units may be regulated by inserting a heat exchanger in the recirculation circuit **56—57—58—60**. If desired, the flow and/or temperature of the heating medium through the exchanger may be controlled by means of a thermostat responsive to the temperature of the liquor within the digesters **3**, **4** or **5**.

Likewise the acid concentration in the several units may automatically be controlled, as for example by providing a source of SO_2 gas and admitting this into a digester, an eductor line or recirculating line, in amounts controlled by an electrolytic cell responsive to concentration changes in the liquor.

Similarly, if desired, the existing high pressure in the accumulator may be utilized to force liquor into the digesters; when this pressure diminishes below a predetermined amount the charging pump **51** may then automatically be cut in to positively force the remainder of the charge of liquor.

Again hot gases, vapors and/or liquors removed from one digester may be passed directly to an anterior or posterior digester, thus to this extent utilizing the digesters as acid accumulators.

While a preferred modification of the invention, involving the utilization of the continuous saturating and digesting phases has been described, it is to be understood that this is given merely to exemplify the broad principles of the correlation of these two treatments in a continuous manner. It will be apparent to those skilled in the art that these principles may be incorporated in other specifically different types of continuous methods, utilizing for example different types of raw materials or different types of digestion liquors, or specifically different methods of continuously recuperating or recovering the chemical and thermal values while securing optimum temperature and pressure control. All such ramifications or modifications of the process are considered to be comprehended within the spirit of the invention.

I claim:

1. A continuous process for digesting fibrous material which comprises feeding the material through a plurality of chambers, subjecting the material in each chamber to contact with heated chemical liquor, maintaining the material in each chamber at a predetermined pressure and temperature independently of the pressure and temperature conditions in the other chamber, circulating the liquor directly to and from each chamber and utilizing the recirculating stream of liquor to withdraw and condense volatiles evolved in such chamber.

2. A continuous process of pulping fibrous material which comprises feeding the fibrous material substantially continuously through a series of connected chambers, saturating the material in the first chamber with hot chemical liquor and under a high hydrostatic pressure and without any substantial cooking, and cooking the material in a subsequent chamber with chemical liquor maintained at reaction temperatures, circulating the liquor to and from said second chamber and utilizing the circulating stream to withdraw and condense volatiles evolved in said second chamber.

3. A continuous process of digesting fibrous materials which comprises passing a stream of

fibrous material through a confined passageway, saturating the material with hot chemical liquor and without effecting any substantial digestion in the first part of the passageway, and positively digesting the material with hot chemical liquor in the latter part of the passageway circulating the liquor to and from said latter part of the passageway and utilizing the circulating stream to withdraw and condense volatiles evolved in said latter part of the passageway.

4. An apparatus for digesting fibrous material comprising a series of connected chambers, means to force a stream of fibrous material through the chambers, means to recirculate a digestion liquor independently to and from each of the chambers, and means to withdraw vapors and gases from each chamber and to absorb such vapors and gases in the said recirculating liquor.

5. An apparatus for digesting fibrous material comprising a series of connected chambers, means to force a stream of fibrous material through the chambers, a liquid recirculation line connected directly to each chamber, a pump in such line, and a vapor line connected at one end to an upper portion of the chamber and at the other to the said liquor recirculating line.

6. An apparatus for digesting fibrous material comprising a series of connected chambers, means to force a stream of fibrous material through the chambers, a liquid recirculation line connected directly to each chamber, an eductor connected with said line and a conduit connecting the eductor to the vapor space of the chamber.

7. An apparatus for digesting fibrous material comprising a hot liquor accumulator, a series of interconnected chambers, means continuously to force a stream of fibrous material through the chambers, means to force liquor from the accumulator to each of the chambers, an eductor, a valved conduit connected at one end to an upper portion of a chamber and at the other end to an eductor, and a conduit connecting the eductor with the accumulator.

8. An apparatus for digesting fibrous material comprising a hot liquor accumulator, a series of interconnected digester chambers, means continuously to force a stream of fibrous material through the chambers, means to force liquor from the accumulator to each of the chambers, means to withdraw top and side relief fluids from the digesters, said means including a valved conduit connecting the digesters and the accumulator, and an eductor interposed in the conduit.

9. A process of digesting the fibrous material which comprises positively and substantially continuously moving a stream of fibrous material through an elongated passageway, circulating a stream of digestion liquor to and from a portion of the passageway and utilizing said circulating stream to withdraw and condense gases and vapors evolved in the passageway; confining the volume of hot acid in an accumulator, pumping a stream of make-up liquor to said accumulator through an eductor, connecting the eductor to said passageway and utilizing said stream of makeup liquor to withdraw and condense volatiles evolved in the passageway.

10. A process of digesting fibrous materials which comprises positively and substantially continuously moving a stream of fibrous material through an elongated passageway, recirculating liquor under high hydrostatic pressure to and from a portion of the passageway; recirculating liquor under a considerably lower pressure to and from another portion of the passageway and utilizing the said recirculating streams to withdraw and absorb volatiles evolved in the said respective portions of the passageway.

11. A process of digesting fibrous materials which comprises positively and substantially continuously moving a stream of fibrous materials through an elongated passageway, recirculating liquor under high hydrostatic pressure to and from a portion of the passageway; recirculating liquor under a considerably lower pressure to and from another portion of the passageway and utilizing the recirculating stream to withdraw and condense volatiles evolved in the said respective portions of the passageway; confining a volume of hot acid under pressure in an accumulator, pumping a stream of make-up liquor to said accumulator through an eductor, connecting the eductor to the said portions of the passageway and utilizing said stream of make-up liquor to withdraw and condense volatiles evolved in the passageway.

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