CONTINUOUS DIGESTING SYSTEM
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This invention relates to a continuous digester system for producing pulp and, more particularly, to a continu-
ous digester system having improved mechanisms for intro-
ducing the chips to the digester and withdrawing the
cooked pulp therefrom.

In the past, digestor design has been controlled by the

economics of chemical recovery. The liquor ratio, that
is, the ratio of the weight of chemical solution to weight
of dry wood has always been kept at a minimum, and,
more specifically, a liquor ratio of between 3:0:1 and
4:0:1 has been used in order to minimize both the
heat required to bring the digestor charge to cooking

temperature and the heat required to evaporate the spent
black liquor.

This low ratio of between 3:0:1 and 4:0:1 creates con-
ditions which result in poor quality and lack of uniform-
ity in the pulp. First, with this low ratio there is not
quite enough liquor to cover the chips in the digestor.

Since fresh liquor enters into the chips and reaction pro-

ducts leave the chips and return to the main body of
liquor by differential processes, the availability of fresh
chemical to the chips will vary with the degree of pack-
ing of the chips in a digestor. Many digestors are equipped
with devices for effecting circulation of the liquor in or-
der to improve the chip-liquor contact. However, in
these cases channeling often occurs in the digestor, sup-
plying an excess of liquor at some points and a deficiency
at others. This channeling of liquor also results in hot
spots and thus causes a lack of uniformity in the

temperature of the digestor charge.

The second serious fault inherent in low liquor ratios is
the necessary high concentration of digestion chemi-
cals needed at the start of the cook in order to insure a
sufficiently high concentration near the end of the cook
to supply driving force for the digestion reaction. If the
liquor ratio can be increased without economic penalty,
the initial concentration of digestion chemicals therein
may be markedly reduced, the strength of the liquor near
the end of the cook being just as high as if a high chemi-
ical concentration, low liquor ratio cook were performed.
If the digestor can be designed to permit the use of high
liquor ratios, any suitable low initial concentration may
be used. This provides a choice of various combinations
of concentrations and temperatures not available with
low-liquor-wood ratios.

However, high liquor ratios are prohibited by economic
considerations in both batch digestors and in the continu-
ous digestors presently available. If, for example, twice
as much liquor is placed in the digestor with the chips,
twice as much steam is needed to heat the digestor charge.
Also, if twice as much spent liquor leaves the digestor
with the blown pulp, evaporator steam consumption will
double. Chemical losses will also increase because twice
as much of the chemical must be handled in the recovery
system. It can thus be seen that a high external liquor ratio,
that is, a high ratio of liquor to wood entering the
digestor system, cannot now be tolerated because of cost.
Therefore, advantages of uniformity of cooking and low
initial concentration characteristic of high liquor ratios,
cannot be utilized effectively in the prior art batch and
continuous digestor systems.

Accordingly, it is an object of this invention to pro-
vide an improved digestor system for continuously pro-
ducing pulp of uniform, high quality from wood or other

cellulosic material.

It is a further object of this invention to provide an
improved digestor system, as aforesaid, in which two
distinct liquor ratios are used, one of which is a high
ratio of liquor to wood inside the digestor to provide a
uniform pulp while the other is a low ratio of liquor to
wood outside the digestor to insure operation economy.

It is a further object of this invention to provide an
improved digestor system, as aforesaid, in which the pulp
is discharge from the digestor without the use of a blow,
that is, a reduction of digestor pressure to atmospheric,
which normally causes high heat loss due to the sudden
flash of steam created thereby.

It is a further object of the invention to provide an
improved digestor system which utilizes either standard,
commercially available equipment or equipment which
may be easily and inexpensively fabricated.

Other objects and advantages of this invention will be-
come apparent to those acquainted with systems of this
type upon reading the following disclosure and inspect-
ing the accompanying drawing, which is a schematic
diagram of the system to which the invention relates.

The invention provides a means of changing the liq-
uer/wood ratio at each succeeding step so that each step
in the process is performed at the most favorable con-
sistency.

Thus the mixture of cooking liquor and wood is pumped
at approximately 4% consistency because pumps for
this service perform best at this consistency. The mix-
ture of liquor and chips requires steam to bring the mix-
ture up to digestor temperature. Four percent consis-
tency is equivalent to 24 lbs. liquor per lb. of oven-dry
wood. This would require an excessive amount of steam.
Accordingly the No. 1 liquor transfer pump removes liquor
from the mixture until there remains only that liquor
required to provide sufficient chemical to react with and
remove substantially all the lignin and leave a small
residual of chemical to force the reaction right up to the
end of the cook.

The chips are moved through the digestor during which
time the pulping reaction occurs. The cooked pulp exiting
from the digestor is fed through a flow sensing device
and then to a second press where some of the spent diges-
tor liquor is expressed therefrom. Part of this spent
liquor is returned and mixed with the chips entering the
digestor and the balance is sent to the recovery system.
The pulp and spent liquor mixed therewith exiting from
the press define the external liquor ratio which is a mea-
sure of the heat leaving the system and which, in any
event, will be much less than the internal liquor ratio.
This mixture of pulp and liquor exiting the press at di-
gested temperature is fed into a dilution tank where it is
mixed with a suitable diluent and is then fed to the pulp
washing system. This diluent is usually dilute black liq-
uer from the washing system. Suitable pressures are
maintained on the streams entering and leaving the di-
gestor so that the chips are continuously fed therethrough
and cooked pulp is removed therefrom while a suitable diges-
ting pressure is maintained within the digestor.

With the mixture of cooking liquor entering at 4%
consistency, the transfer is designed to have an output
consistency ranging from 20% to 40%.

As there are 24 pounds of liquor per pound of oven-
dried wood at 4% consistency, and from 4 pounds to 1½
pounds at 20 and 40% respectively, the transfer will re-
move from 20 pounds to 22½ pounds of liquor per pound
of wood.

Heating up only 2½ to 5 pounds of mixture of wood
and cooking liquor to digestor temperature would con-
stitute an attractive steam demand but presents a diffi-
cult material handling problem; and does not provide a su-
nicient volume of liquor to effectively wet all the chips
in their passage through the system.
The accompanying drawing is a schematic representation of apparatus for carrying out the invention. Accordingly, referring to the drawing spent black liquor from the second liquor transfer press 36, still substantially at digester temperature and pressure, is recycled to the digester and added to the high consistency mixture to dilute it to the desired liquor ratio. This new liquor ratio may range from a low of 5 to 1 up to a high of 10 to 1. The recycle black liquor may be introduced by means of an injector which not only provides the necessary energy to inject the liquor but also provides the heat necessary to bring the mixture of chips and cooking liquor up to digester temperature plus the heat losses in the system. The recycle black liquor and steam may be added directly to the digester or, preferably, mixed with the output of the liquor transfer press just prior to entering the digester.

There is a residual active chemical in the recycle black liquor which must be taken into account. A concentration for the original cooking liquor is selected so that the mixture of wood, cooking liquor, steam and recycle black liquor will give the desired starting concentration for the liquor ratio selected and (at the end of the cook) will give the required minimum residual concentration.

**Example No. 1:** Calculation of White Liquor and Residual Liquor Concentrations

Assume:
- Moisture in chips—50%
- Yield oven-dried—50%
- Starting concentration—35 grams per liter
- Density of liquor in digester—1.150
- Chemical consumption= 0.24 gram Na₂O per gram of wood dissolved
- Density of white liquor at 99 grams per liter 1.111

Then:
- Per 100 grams of wood, oven-dry—
  - 100×50%/50 = 50 grams wood dissolved
  - 0.24×12 = 12 grams Na₂O consumed
- At start of cook, the moisture in the wood is trapped in the hollow lumens. Therefore, this moisture is not part of the liquor at the start of the cook.

\[
100 \times (10-1) \times 0.35 = 27.4 \text{ grams Na}_2\text{O at start of cook}
\]

\[
1.150 \times 1000
\]

27.4—12.0 = 15.4 grams Na₂O at the end of the cook

At the end of the cook, the moisture in the wood is part of the total liquor, and:

\[
100 \times 10 \times 1.150 \times 1000 = 0.870 \text{ liter total liquor per 100 grams oven-dry wood}
\]

15.4

0.870 = 17.7 grams per liter in residual liquor

After leaving No. 1 liquor transfer there will remain 100 grams oven-dry wood, 100 grams moisture and 200 grams white liquor. Similarly, on a 100 pound oven-dry wood basis, there will be 100 pounds moisture and 200 pounds white liquor. To heat this from 150° F. to 365° F. will require:

\[
4(365-150)(100 \times 1+100 \times 0.34+200 \times 0.94)
\]

= 67,100 B.t.u.

67,100/857 = 78 lb. steam at 365° F. (150 pounds per square inch) per 100 lb. wood, or 78 grams per 100 grams wood

To the 400 grams of wood, moisture and white liquor leaving No. 1 liquor transfer, there are added 78 grams of steam and 622 grams of recycle black liquor containing 17.7 grams Na₂O per liter.

\[
(622 \times 17.7)/(1000 \times 1.150) = 9.5 \text{ grams Na}_2\text{O in recycle liquor}
\]

\[
27.4-9.5 = 17.9 \text{ grams Na}_2\text{O to be provided in the}
\]

4 200 grams of white liquor from No. 1 liquor transfer

\[
200/(1000 \times 1.111) = 0.180 \text{ liter}
\]

17.9/0.180 = 99.4 grams per liter required in the white liquor.

This is normally available in the average white liquor coming from the recovery system. If this concentration is higher than required, it is diluted with black liquor to the desired concentration. If the concentration from recovery is lower than required, a new internal liquor ratio is selected and the calculation repeated until a suitable set of conditions has been achieved.

**Example No. 2:** Calculation of Temperature in Dilution Tank

Assume:
- Liquor ratio of 5 to 1 from transfer No. 2 at 365° F. 4% consistency in dilution tank. 24 to 1 liquor ratio.
- 24—3 = 21 pounds dilution liquor required at 150° F.
- Let \( x = \) equilibrium temperature of the mixture in dilution tank.

\[
[(100x 0.94) + (300x 0.94)] = 265 - x
\]

\[
x = 177° F.
\]

(Using a specific heat of 0.34 for pulp and 0.94 specific heat of black liquor).

Referring to the drawing, the cellulose material, which may be shredded chips prepared in accordance with the disclosures of application Serial No. 578,378, filed April 16, 1956, now abandoned, or application Serial No. 369,740, filed July 22, 1955, now U.S. Patent No. 2,904,460, is fed, usually after being weighed, onto a conveyor 10. The chips are fed by the conveyor into a mixing tank 11 and fresh digestion liquor, sometimes hereinafter referred to as white liquor, is added thereto. The white liquor is ordinarily at the temperature at which it is pumped from the causticizing system, usually in a range of 150°—180° F. The white liquor is pumped by a pump 13, through a meter 14 and a valve 15, into the tank. The valve 15 is controlled by a liquid level control 16. Sufficient white liquor is added to the tank 11 so that the chips therein can be kept in uniform suspension by the agitator 12 and can be readily pumped. The quantity of white liquor may be varied to give a consistency within the range of 2—10% and is not critical, since all excess over digester requirements is removed by the first liquor transfer press 18 and is returned to the mixing tank 11.

The chip suspension discharged from the tank 11 passes through a pump 17 to the first liquor transfer press 18. In addition to moving the chips, a primary purpose of the pump 17 is to provide a hydrostatic pressure sufficient to equalize or slightly exceed the steam pressure in the digester plus what ever friction is developed in the system. Many types of pumps may be used for this purpose, such as a high-head centrifugal, a multi-stage centrifugal or a progressive cavity pump.

The first liquor transfer press 18 may be substantially the same as that shown in U.S. Patent No. 2,664,814 and consists of a screw of decreasing pitch, said screw rotating in a perforated barrel. The annular area of the press decreases from the entrance to the exit thereof. Thus, the chips are pressed together and the white liquor therein is expelled therefrom through the perforations in the barrel. It is possible to remove sufficient liquid such that the chips exiting from the press will be at a consistency of between 20 and about 40 percent. The amount of white liquor in contact with the chips as the chips leave the press determines the external liquor ratio and is so related that it is sufficient to insure completion of the desired pulping reaction. It should be pointed out that the press 18 does not operate against digester pressure. Rather, there is a hydrostatic pressure built up by the
pump 17 equal to or slightly greater than the steam pressure in the digester 19. The excess liquor, expelled from the barrel by the liquid transfer pump 18, flows through a throttle valve 20 to prevent loss of pressure in the press and thence back to the mixing tank 11 whereupon it is mixed with fresh chips and is used to transport such chips from the tank 11 through the pump 17 to the press 18. The pressed chips, entering the digester 19, are mixed with spent liquor from the discharge end of the digester. The spent liquor is substantially at full digester pressure, for example, at 150 pounds per square inch and 366°F. The chips and their accompanying white liquor, before mixing with the spent liquor, are at a temperature in the range of about 150 to 180°F. Since the spent liquor mixed at this point is substantially at digester temperature and pressure, it is foreseen from the spent liquor storage tank 21 through the conduit 22. A valve 23 is provided in conduit 22 and the setting of said valve is controlled by a metering device 24 in order to maintain the proper rate of flow of the spent black liquor. The black liquor then passes into an injector unit 26 where steam is fed theretoe and then the mixture is injected into and mixed with the chips exiting from the press. The steam not only serves to inject the spent liquor into the digester but also serves to heat the chips and the white liquor to the digester temperature.

The mixture of the white liquor and the chips from the press, the spent liquor and the condensed steam determines the internal liquor ratio, that is, the liquor to wood ratio within the digester. It is obvious that the internal liquor ratio is higher than the external ratio and may be set at any desired value by adding more or less spent liquor without any substantial penalty to steam economy. The only effect of increases in the internal liquor ratio will be to decrease the pulp capacity of the digester.

The digester 19 may take a variety of different forms. In the preferred form of the digester shown in the drawing, the digester includes a cylindrical tank 28 having an inlet opening 29 at the bottom thereof and an outlet opening 23 at the top thereof. The effective length of the digester is adjusted so that a sufficient volume will be provided to insure the required tonnage of production at the liquor-to-wood ratio selected and the proper retention time for the cook. A slowly rotating screw 31 is disposed within the digester and is driven by a suitable motor 32, preferably having a suitable variable speed driving mechanism.

The angle of the helix and the speed of rotation of the screw are selected so that the vertical component just equals the upward bulk flow rate of the suspension of chips and liquor in the digester. This flow rate is a function of the net area of the digester and the volume of the suspension per unit of time.

Some of the chips may contain sufficient entrained air to cause them to tend to float rapidly to the top of the digester. However, the settling rate of over half of the chips in the suspension will normally be greater than the buoyant rate and they will tend to settle out of suspension towards the bottom of the digester. Either phenomenon would adversely affect the uniformity of the finished pulp.

As the suspension enters the bottom of the digester it is encompassed by a pair of upper and lower flights which may be considered as a continuously moving compartment. Any chips tending to float upward by the upper flight and any chips tending to settle out of suspension would be lifted by the bottom flight and cause all the chips to remain with the liquid with which they entered the digester until discharged at the top, thus assuring a uniform dwell time in the digester and preventing the admixture of one layer of suspension with an adjacent layer.

Assuming an entering liquor ratio of 10 pounds liquor to 1 pound oven-dry wood, and a yield of 50%, one half the wood will have reacted and been taken in the liquor. The liquor ratio at the discharge end of the digester would then be ½ pound wood to 10¼ parts liquor, or 21:1, equivalent to a pulp consistency at discharge of 4.55% which is suitable for flowing through the balance of the system.

A relief line 33 is provided at the top of the digester for drawing off air, noncondensible gases and volatile organic compounds such as turpentine, etc. The capacity of the digester system may be increased by using one or more of these digester bodies in series. For example, if the digester is of such dimensions and the pitch and speed of the screw are so designed to provide one hundred tons of pulp per day at a cooking time of thirty-five minutes and an internal liquor ratio of ten to one, production may be doubled by using two digester bodies in series. The speed of the pump 17, and transfer screw in this case must be doubled so that the total retention time of the chips in the two digesters together will be equal to the total cooking time of thirty-five minutes.

The cooked pulp leaves through the exit opening 23 and passes through a condenser 34. The condensate has a suitable flow sensing device 35, such as a magnetic flow meter, a venturi meter or a similar instrument, for providing a signal, either electrical, mechanical or fluid pressure, proportional to the flow through the conduit 34. After passing through the meter 35, the pulp flows into a second liquor transfer pump 36 which is similar to the transfer pump 18 previously described. In this press, the decreasing annular space and decreasing axial pitch of the screw squeeze out the excess spent liquor which passes through the perforations in the barrel. Since the pulp and spent liquor are still at the digester temperature and pressure, the expressed spent liquor is also at the digester temperature and pressure, and it flows into the strong spent liquor storage tank 21. The required amount of this spent liquor is returned to the digester 19 through the conduit 22 in the manner previously described to provide the proper internal liquor ratio as discussed above. It can be seen that part of this spent liquor may be circulated back to the digester without the need of any heating other than that required to make up for heat losses.

A liquid level controller 37 in the strong liquor tank 21 insures that all of the spent liquor entering the tank, in excess of that used for recirculation, will be drawn off through the conduit 38 to the recovery system. Since the liquor sent to the recovery system is also at digester temperature and pressure, its heat content can be used effectively in the evaporators of the recovery system.

Returning now to the pulp stream, the squeezed pulp will leave the liquor transfer pump 36 and enter the dilution tank 39 whose outflow is determined by the design of the press, for example, ranging from about 20 to about 40 percent dry fiber. The pulp is then fed to a dilution tank 39 where a suitable diluent, such as dilute black liquor from the pulp washers, normally at a temperature of 150° to 150° F. is flowed thereinto and is mixed therewith by an agitator 41. The quantity of black liquor from the washing system can be varied to give any desired final pulp consistency, such as from 2–10%, for pumping purposes. The equilibrium temperature within the dilution tank 39 is always kept below 212° F. and, thus, the liquor will not flash into steam but will remain in the liquid phase in the dilution tank. In order to maintain pressure equilibrium in the system and to control the flow of the pulp into the dilution tank, it is necessary that the
dilution tank be pressurized. Accordingly, a suitable gas pressure source is connected thereto by a conduit 42, said conduit having a control valve 43 therein. The gas pressure source may be either air or some other non-condensible gas and, as shown, is usually compressed air. When the gas pressure within the tank 39 is maintained at the same pressure as the digester, no flow of pulp can occur. As the gas pressure is decreased outwardly through the pipe of the digester to the dilution tank occurs, the rate of flow being determined by the pressure difference between the pressure in the digester and the pressure in the dilution tank 39. The flow meter 35 in the conduit 34 is made to control the rate of flow of the pulp into the dilution tank 39. Thus, as the flow meter senses an increase in flow over the desired rate, the meter transmits a signal to the pressure control valve 43 and this, in turn, increases the gas pressure in the dilution tank. This increase in gas pressure decreases the rate of pulp flow. Conversely, if pulp flow falls below the predetermined desired rate, the flow meter transmits a reverse signal to the gas pressure control valve 43, thereby reducing the pressure in the dilution tank 39 to provide an increase in pulp flow. Thus the pressure within the dilution tank 39 controls the flow of pulp thereinto and by properly coordinating the flow meter device 35 and valve 43 it is possible to attain a substantially steady continuous flow of pulp into said tank while maintaining proper pressure within the digester.

A liquid level controller 44 maintains a constant level of pulp suspension in the dilution tank 39. This level may be located in a portion of reduced cross-section of the tank so that a minimum, still surface of the suspension will be presented to the gas phase, insuring a minimum of gas solution into the hot pulp suspension. The liquid level controller 44 is used to speed of the final stock pump 46 if a positive displacement pump is used; or it may be utilized to vary the opening of the throttling valve for adjustable orifice. The pump 46 transports the dilute pulp suspension through a consistency regulator 47, thence to the pulp washing system.

A flow meter 48 may, if desired, be used after the consistency regulator to indicate and record the pulp flow. From this pulp flow rate and the consistency provided by the regulator it is possible to compute the weight of dry pulp being produced during a unit of time. At the other end of the digester system, the combination of recorded weight of chips and the moisture content of the chips as determined from an automatic chip sampling device make it possible to calculate the weight of chips fed to the digester system per unit of time. From these data a true value of pulp yield and tonnage may be obtained continuously making it possible to adjust the digester controls as required to insure uniformity of yield and production.

It is apparent that the digester system can be adapted for use with any suitable cellulose raw material, such as wood, bagasse, cotton or flax stalks, bamboo stalks and other annuals. The digesting liquor may be alkali white liquor as used in the Kraft process, caustic soda as used in the soda process, bisulphite liquor with a soda, magnesium, ammonium or calcium base; sodium sulphite and carbonate as used in the neutral sulphite semichemical process, or any other suitable digestant. Similarly, the end product may be a fully cooked pulp, a high yield pulp, or a semichemical pulp requiring further mechanical subdivision.

While the vertical upflow type of digester equipped with a vertical, rotatable, helical screw disclosed in the drawing, is the preferred type of digester for use in the system, it is apparent that the system can also be used to advantage with existing types of conventional stationary, vertical, downflow type digesters or continuous, horizontal tube digesters.

It has been found that subdivided chips prepared as disclosed in applications Serial Nos. 369,740, now U.S. Patent No. 2,904,460 and 578,378, filed April 16, 1956, now abandoned, which have a large specific surface, require an increase in the liquor-to-wood ratio to properly wet all the surface and insure an ample supply of chemical for each particle. By providing the digestion chemical at a high concentration and subsequently diluting this with recycled spent liquor as the chips enter the digester, a high liquor ratio can be achieved without substantially increasing the steam requirements as the recycled spent liquor is already at substantially digester temperature. Since the prevailing temperature in the liquor is below 210°F, the conditions are unfavorable to either penetration of the liquor into the structure of the chips or an active reaction between the digesting chemicals and the lignin in the wood. Consequently, the pulping reaction cannot start until the chips and liquor enter the digester and their temperature is rapidly raised therein. Therefore, the pulping reaction is obliged to start in the digester at the outside surface of the chip and progress in a radial direction toward the center of the chip.

While a particular preferred embodiment of the invention has been referred to hereinabove, the invention contemplate modifications or changes therein as lie within the scope of the appended claims.

What is claimed is:

1. A system for continuously discharging pulp from a digester, including: a conduit connected to the discharge end of said digester; control means in said conduit responsive to the flow of pulp in said conduit for providing a signal proportional thereto; a liquid transfer press connected to said conduit for receiving pulp flowing therethrough, said press including means for expressing digestion liquor, at digester temperature, from the pulp as same passes therethrough so that the expressed liquor can be stored in a pressurized tank for reuse and the pulp exiting from said press is at a high consistency; a pressurized dilution tank connected for receiving pulp exiting from said press, said dilution tank being closed; means connected to said dilution tank for continuously supplying a non-condensible gas under pressure into said dilution tank to provide pressure on the pulp in said dilution tank and on the discharge end of said press; said last-named means being connected for responding to a signal from said control means so that the pressure within said tank will be proportional to the flow of pulp through said conduit; means for feeding a dilution liquid into said dilution tank and equalizing the same with the pulp therein; a liquid level controller connected to said dilution tank for maintaining a substantially constant liquid level therein; and pump means for withdrawing dilute pulp from said dilution tank in such a manner as to cause a smooth controllable flow of pulp and a release of the dilution tank pressure therewith.

2. A continuous digestion system, including: a digester; a feed mechanism for continuously feeding chips of cellulosic material to said digester, said feeding mechanism including a mixing tank for receiving chips and mixing same with digestion liquor to form a pumpable slurry, a pump connected for withdrawing the slurry from said mixing tank and pressurizing same to a value in excess of the pressure within said digester, a first liquid transfer press connected for receiving the pressurized slurry from said pump, said first press including means for expressing liquor from the slurry as same passes therethrough without substantially changing the pressure on said chips so that the chips exiting from said press are at a high consistency and are acted upon by a pressure in excess of that necessary to move same into the digester; means for mixing steam and spent digestion liquor with the chips exiting from said first press while maintaining the pressure thereon so that the chips and liquor entering said digester are at substantially the same pres-
3,096,234 sure and temperature as the contents of said digester and are in a fluid condition; a discharge mechanism for continuously withdrawing pulp from said digester, said discharge mechanism including a conduit connected to the discharge end of said digester, control means in said conduit responsive to the flow of pulp therethrough for providing a signal proportional to such flow, a second liquor transfer press connected to said conduit for receiving pulp flowing therethrough, said second press including means for expressing digestion liquor from the pulp as same passes therethrough so that the pulp exiting from said second press is at a high consistency; a high pressure storage tank for receiving expressed liquor; a pressurized dilution tank connected for receiving pulp exiting from said second press, said dilution tank being closed and pressure tight, means connected to said dilution tank for continuously supplying a non-condensable gas under pressure into said dilution tank to provide pressure on the pulp in said dilution tank and on the discharge end of said second press, said last-named means being connected for responding to a signal from said control means so that the pressure within said dilution tank will be proportional to the flow of pulp through said conduit, means for feeding a dilution liquor into said dilution tank and means for mixing same with the pulp in said dilution tank; a liquid level controller connected to said dilution tank for maintaining a substantially constant liquid level therein; and pump means for withdrawing diluted pulp from said dilution tank in such a manner as to cause a smooth controllable flow of pulp and a release of the dilution tank pressure thereon.

4. A continuous digester system for cooking cellulosic material comprising:
   a mixing tank;
   a pump for feeding cellulosic material mixed with an excess of digestion liquor from said tank at a hydraulic pressure slightly greater than the pressure at the discharge end of the hereinafter-mentioned first press and greater than the steam pressure in the hereinafter-mentioned digester;
   a first liquor transfer press for receiving material from said pump and for squeezing out liquor therefrom without changing the pressure thereon;
   means for conducting the liquor expressed by said first press back to said mixing tank, the cellulosic material leaving the press with only sufficient liquor to supply slightly more chemicals than is required by the digestion reaction, means for mixing the material leaving said first press with steam and sufficient hot recirculated, spent liquor to provide a fluid condition at a pressure slightly higher than that in the hereinafter-mentioned digester;
   a vertical, cylindrical digester and means for admitting said material into the bottom thereof;
   a screw in said digester for forwarding said material through said digester at such a speed that said material will not settle out of its liquor but will travel at the same speed as the liquor;
   a control device for producing a signal proportional to the rate of flow of material therethrough and means for feeding the material exiting from the top of the digester through said control device to produce a signal therefrom;
   a second liquor transfer press for receiving the material from the control device to express the hot spent liquor therefrom;
   a pressurized dilution tank for receiving the pressed material from the second press and means for diluting and cooling the pressed material in the dilution tank;
   means to continuously supply a non-condensable gas under pressure to said dilution tank which in turn will provide a hydraulic pressure on the diluted material and on the discharge end of the second liquor transfer press;
   means for varying the pressure of said gas in said dilution tank in response to said control device to control the rate of flow of material through the system;
   a liquid level control device in said dilution tank for maintaining a substantially constant liquid level in the dilution tank, means for withdrawing the material from the dilution tank to cause a smooth, controllable flow of material therefrom and a release of the dilution tank pressure on said.

5. A continuous digestion system, including:
   a digester;
   a feed mechanism for continuously feeding chips of cellulosic material to said digester, said feeding mechanism including a mixing tank for receiving chips and mixing same with digestion liquor to form a pumpable slurry;
a pump connected for withdrawing the slurry from said mixing tank and pressurizing same to a value in excess of the pressure within said digester;  
a first liquor transfer press connected for receiving the pressurized slurry from said pump, said first press including means for expressing liquid from the slurry as same passes therethrough without substantially changing the pressure on said chips so that the chips exiting from said press are at a high consistency and are acted upon by pressure in excess of that necessary to move same into the digester;  
means for mixing steam and spent digestion liquor with the chips exiting from said first press while maintaining the pressure therein so that the chips and liquor entering said digester are at substantially the same pressure and temperature as the contents as said digester and are in a fluid condition;  
a discharge mechanism for continuously withdrawing pulp from said digester, said discharge mechanism including a conduit connected to the discharge end of said digester;  
a second liquor transfer press connected to said conduit for receiving pulp flowing therethrough, said second press including means for expressing digestion liquor from the pulp as same passes therethrough so that the pulp exiting from said second press is at a high consistency;  
a high pressure storage tank for receiving expressed liquor;  
a pressurized dilution tank connected for receiving pulp exiting from said second press, said dilution tank being closed and pressure tight;  
means connected to said dilution tank for continuously supplying a noncondensible gas under pressure into said dilution tank to provide pressure on the pulp in said dilution tank and on the discharge end of said second press;  
control means for controlling the pressure within said dilution tank;  
means for feeding a dilution liquid into said dilution tank and mixing same with the pulp therein;  
a liquid level controller connected to said dilution tank for maintaining a substantially constant liquid level therein;  
and pump means for withdrawing diluted pulp from said dilution tank in such a manner as to cause a smooth controllable flow of pulp and a release of dilution tank pressure thereon.  
6. A continuous digestion system, including:  
a digester, said digester having an entrance opening adjacent the lower end thereof and an exit opening adjacent the upper end thereof;  
a rotatable screw within said digester forming continuously upwardly moving compartments controlling the movement of the chips suspended in liquor fed into said digester through said entrance opening and moving said chips upwardly at the same rate as the liquor to said exit opening;  
a feed mechanism for feeding chips of cellulosic material to said digester, said feeding mechanism including a mixing tank for receiving chips and mixing same with digestion liquor to form a pumpable slurry;  
a pump connected for withdrawing the slurry from said mixing tank and pressurizing same to a value in excess of the pressure within said digester;  
a first liquor transfer press connected for receiving the pressurized slurry from said pump, said first press including means for expressing liquid from the slurry as same passes therethrough without substantially changing the pressure on said chips so that the chips exiting from said press are at a high consistency and are acted upon by pressure sufficient to move same into the digester;  
means for conducting the liquid expressed by said first press back to said mixing tank;  
means for mixing steam and spent digestion liquor with the chips exiting from said first press while maintaining the pressure therein so that the chips entering said digester are at substantially the same pressure and temperature as the contents of said digester;  
a discharge mechanism for continuously withdrawing pulp from said digester, said discharge mechanism including a conduit connected to the discharge end of said digester;  
a second liquid transfer press connected to said conduit for receiving pulp flowing therethrough, said second press including means for expressing digestion liquor from the pulp as same passes therethrough so that the pulp exiting from said second press is at a high consistency;  
means for conducting the liquid expressed by said second press and injecting same with steam into the chips after they exit from said first press;  
a pressurized dilution tank connected for receiving pulp exiting from said second press, said dilution tank being closed and pressure tight;  
means connected to said dilution tank for continuously supplying a noncondensible gas under pressure into said dilution tank to provide pressure on the pulp in said dilution tank and on the discharge end of said second press;  
control means for controlling the pressure of the noncondensible gas applied to said dilution tank;  
means for feeding a dilution liquor into said dilution tank and means for mixing same with the pulp in said dilution tank;  
a liquid level controller connected to said dilution tank for maintaining a substantially constant liquid level therein;  
and pump means for withdrawing diluted pulp from the dilution tank in such a manner as to cause a smooth controllable flow of pulp and a release of the dilution tank pressure thereon.  

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