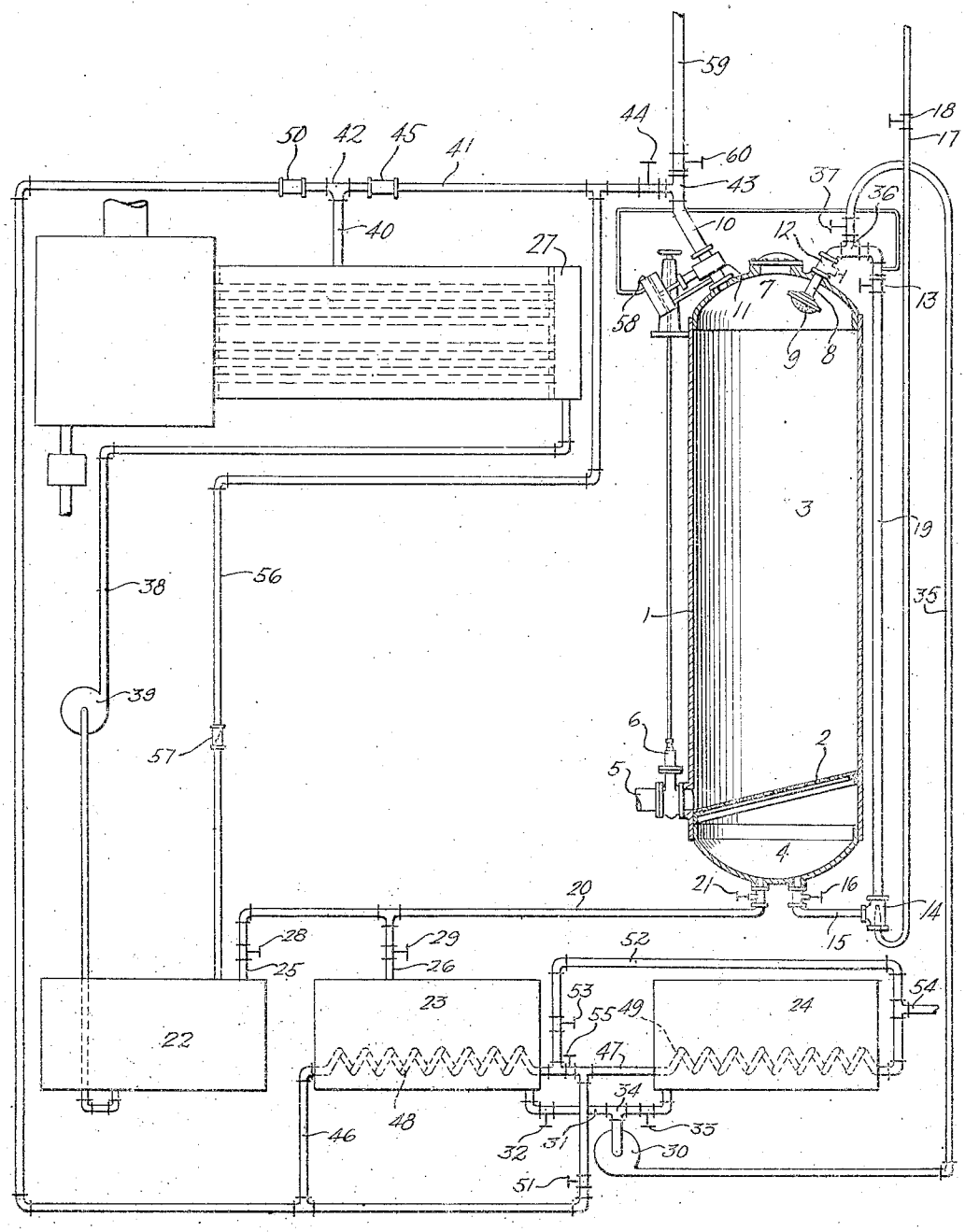
Oct. 18, 1927. 1,645,754

W. H. HOWELL, JR

METHOD AND APPARATUS FOR PRODUCING PAPER PULP

Filed Sept. 10, 1926



INVENTOR
WALLACE H. HOWELL, JR.
BY
Newell & Spencer
ATTORNEYS

Patented Oct. 18, 1927. 1,645,754

UNITED STATES PATENT OFFICE.

WALLACE H. HOWELL, JR., OF WILLSBORO, NEW YORK.

METHOD AND APPARATUS FOR PRODUCING PAPER PULP.

Application filed September 10, 1926. Serial No. 134,600.

This invention relates to improved method and apparatus for producing paper pulp by cooking wood and other cellulosic materials with chemical cooking liquors.

Chemical cooking processes for the production of pulp from wood and other cellulosic materials entail a large consumption of fuel for heat and power. In the processes used hitherto, there have been very large wastes of heat usually in the form of steam. This is particularly true in the alkaline pulp process such as the soda process and the so-called sulfate process, but is also applicable in a lesser degree to acid process such as the various sulfite processes.

In the soda and sulfate processes, wood or other cellulosic material is cooked by means of liquors containing caustic soda in the soda process and a mixture of caustic soda, sodium sulfide and small amounts of sodium sulfate and carbonate in the sulfate process. The cooking usually takes place in digesters of large size having a capacity, for example, of about 4½ cords of wood in the form of chips. A large amount of liquor containing caustic soda, with or without sodium sulfide, as the case may be, is also introduced into the digester and is heated and circulated through the chips by means of steam.

The steam is usually passed through an injector where it picks up liquor from a liquor chamber in the bottom of the digester and introduces the liquor into the top of the digester, at the same time heating it. The circulation of liquor, of course, depends on a difference in pressure between the steam supply and the interior of the digester and the circulation, rapid at first, gradually slows down as the liquor is heated up and the pressure in the digester approaches that of the steam supply, when the digester is said to be "up to pressure". In order to continue circulation, it is then necessary to lower the pressure in the digester which is effected by bleeding steam into the atmosphere until the pressure drops sufficiently to cause a resumption of circulation. The heat represented by this steam is lost and as in the ordinary cook, it takes about 2 hours to bring the digester up to pressure and thereafter, steam must be bled about every 45 minutes for another 3 or 4 hours, the loss of steam is high and a further disadvantage lies in the fact that the circulation is uneven, being fast at first and slowing up gradually as the digester comes up to pressure, in most cases practically ceasing, until steam is bled when circulation again starts at a fairly rapid rate and again slows down as the digester comes up to pressure. In the ordinary process, therefore, circulation is uneven and relatively slow and considerable amounts of steam are wasted by bleeding into the atmosphere.

At the completion of the cook, a valve is opened in a large pipe connected to the lower portion of the digester and steam, pulp and liquor is forced out into the open tank called a "blow pit" where the steam escapes into the atmosphere and is wasted, entailing a loss in the soda process of about 2200 pounds of steam per cord of wood or when translated into terms of fuel, about 314 pounds of coal.

The pulp and liquor is also considerably cooled in the blow pit and is then passed into large tanks provided with perforated bottoms and known as wash pans where the liquor is allowed to drain off into a large liquor reservoir or tank and the pulp is successively washed with weak spent liquor and with water, the last washing producing the spent liquor to be used in the first washing of the next batch. The water used is usually cold or at most warm and both the spent liquor and concentrated wash liquor produced are considerably cooler than the original liquor present. As a result, a large amount of heat is lost by cooling of the liquor and since it is customary to concentrate the liquor and burn it in a rotary furnace in order to recover its inorganic solid content, additional steam is required to heat the liquor up in the evaporator and the loss in heat therefore constitutes a direct waste.

The customary processes are also open to the disadvantage that when the pulp is washed with cool or warm liquor or water, much of the lignin which has been loosened and partially dissolved by the cooking process is precipitated or set and contaminates the pulp, rendering it dark colored and requiring a considerably larger quantity of bleaching powder in the bleaching of the pulp.

In my co-pending application, Serial No. 13,082, filed March 5, 1925, I have described a process and apparatus for the cooking of wood with chemical liquors in which the liquor is removed from the pulp in the digester without blowing and is passed, while still hot, into the evaporator, which is in

turn heated by steam taken from the digester and which would otherwise be wasted if the digester were blown into a blow pit as in the usual process. I have also described in the above mentioned application the use of hot water or liquor for washing the pulp in order to prevent setting of the lignin and to remove it as thoroughly as possible, at the same time preventing lowering of temperature of the spent liquor after the concentrated wash liquor is added to it. The present application is in part a continuation of my aforementioned application and includes improvements in the process therein described.

It is an object of the present invention to retain the heat economy of the process of my prior application, above referred to, and at the same time to increase the efficiency and speed of the cooking process itself. Other and further objects and advantages of my invention will be apparent from the following, more detailed description thereof in connection with soda and sulfate processes in which the present invention presents peculiar advantages. Many of the advantages, however, are available in the sulfite processes and it should be understood that the invention is in no sense limited to soda and sulfate processes.

According to the present invention, wood or other cellulosic material is cooked with a soda or sulfate liquor in a digester of design similar to that described in my prior application and provided with a liquor chamber and chip chamber separated by a perforated plate, the upper portion of the chip chamber constituting a steam space. The steam space of the digester is connected as shown therein to the steam space of the evaporator through a pipe provided with a suitable control valve and reducing valve. Instead, however, of operating the digester in the usual manner, that is to say, introducing steam until the digester comes up to pressure and then bleeding at intervals to maintain circulation, I provide a control to maintain a permanent minimum pressure differential between the interior of the digester and the source of steam supply so that as soon as the pressure in the digester approaches that of the steam supply, steam will be continuously bled into the evaporator to maintain the predetermined differential and correspondingly a predetermined speed of circulation. The differential may be brought about in any suitable manner by means of automatic valves, by manual control or in any other desired or convenient manner.

Instead of providing a vigorous circulation of liquor only when the pressure in the digester and correspondingly the temperature of the liquor is relatively low, I provide a continuous, vigorous circulation up to the maximum temperature of the digester and by this means, I am enabled to cook more quickly and more thoroughly and to produce a pulp of higher quality and freer from shives, and at the same time, I am enabled to reduce the period of cooking without deleterious effects on the pulp and without strengthening the concentration of the liquor which permits me to produce a fibre which is relatively less attacked than in the ordinary process and yields a pulp and paper which is stronger, more uniform and more satisfactory. All these advantages are obtained without any further consumption of fuel or waste of steam since the increased amount of steam bled to provide for vigorous circulation is all utilized.

The treatment of the pulp and liquor after the cook is completed is the same as in my prior application, that is to say, when the cook is completed, steam is exhausted to the evaporator and liquor is permitted to drain off either directly into the evaporator or into a receiving tank in which it is not permitted to become cooled much below its boiling point at atmospheric pressure. Washing is then carried out either by water or by dilute wash liquor, the hot water or hot liquor being introduced into the upper portion of the digester. The pulp is thus maintained at a high temperature preferably in the neighborhood of 180–212° F., and in no case below 140° F., so that there is no serious setting of lignin. Where desired and where the concentration is sufficient, the wash liquor may be mixed with the original spent liquor and passed through the evaporator.

It will be seen that I retain the advantages of the method of my prior application in that the pulp is washed hot and lignin is not permitted to set and at the same time a rapid and thorough draining of liquor under the slowly diminishing steam pressure in the generator is obtained and little or no heat contained in the liquor is wasted. In addition, my present invention possesses the advantages of enhanced speed of circulation which is accurately under the control of the operator and which can be varied to suit the particular conditions of individual cooks.

The steam bled from the digester during cooking passes through a reducing valve into the evaporator which may be of any type, such as, for example, the well known Yaryan evaporator described in my prior application. The flow of bled steam is usually not in excess of that required to run the evaporator and is generally a smaller quantity. When, however, a digester is blown, the sudden increase in steam, even when passing through a reducing valve, may be in excess of that which can be effectively taken care of by the evaporator and this is particularly true where the evaporator runs with low pressure steam, for example, 25 lbs. as

against about 120 lbs., which is common practice in the digesters. It may, therefore, happen that when a digester is blown, the evaporator cannot take care of the large amount of steam given off sufficiently rapidly and the digester may, therefore, drop in pressure too slowly. In order to permit the digester to empty at a speed sufficient to reduce its pressure approximately to that of the evaporator within a period of time about sufficient to drain the pulp, I preferably provide for the utilization of the excess steam in heating the water which is to be used for washing the pulp in the digester or for heating dilute wash liquor where this is employed in a two-stage wash. This portion of the steam may be taken off from the main steam line to the evaporator through a suitable manually controlled valve or automatic valves may be provided, permitting steam to flow into the evaporator as long as the pressure therein remains below a predetermined amount and permits steam flow into water or liquor heaters when the evaporator pressure increases beyond a certain figure. Any suitable type of water or liquor heater may be used such as steam coils in series or parallel, or the steam may be directly injected into the water or wash liquor. One form of heater is shown in the drawings, but it should be understood that any suitable type of heater may be substituted therefor.

The drawings illustrate diagrammatically an arrangement of apparatus, partly in section, embodying the features of the present invention.

The digester 1 is similar in shape and construction to digesters used at present and is shown diagrammatically without insulation in order to simplify the drawing. Similarly, all pipes are shown as uninsulated, whereas in practice, of course, a suitable insulation will be provided. The digester is divided by the perforated bottom 2 into a large chip chamber 3 and a smaller liquor chamber 4. A pipe 5 controlled by gate valve 6 serves for removing the pulp after cooking and washing. The digester head contains the customary manhole 7 for charging chips and is further provided with a liquor spray pipe 8 and nozzle 9 and a steam relief pipe 10 controlled by a valve 11, the liquor spray pipe 8 being also provided with suitable shut-off valves 12 and 13.

The liquor chamber 4 is connected to a steam injector 14 of conventional design through pipe 15 controlled by valve 16. Pipe 17 provided with control valve 18 connects the injector 14 to a high pressure steam source, while pipe 19 connects the injector with the liquor spray pipe 8.

A second pipe 20 provided with a valve 21 leads from the liquor chamber 4 to the tanks 22 and 23 through the pipes 25 and 26 controlled by the valves 28 and 29. A wash water tank 24 connected to a source of water, (not shown), communicates with the bottom of the tank 23 through the pipe 31 provided with valves 32 and 33. The T connection 34 between valves 32 and 34 permits the flow of liquor from the pipe 31 into the wash liquor pump 30, which, in turn, is connected to the liquor spray pipe 8 through the pipe 35 and T 36, flow being controlled by the valve 37.

A liquor evaporator 27 of the well known Yaryan type takes liquor from the tank 22 through the pipe 38 by means of the pump 39. The steam space of the evaporator is connected to the steam relief pipe 10 through the pipes 40 and 41 and T's 42 and 43, the pipe 41 being provided with the shut-off valve 44 and the automatic reducing valve 45 between the T's 42 and 43. This pipe extends beyond the T 42 and connects with the pipes 46 and 47, leading into the heater 48 of tank 23 and the heater 49 of tank 24, respectively. An automatic valve 50 is also provided in the pipe 41 between the T 42 and the pipe 46 and a shut-off valve 51 is incorporated in the same pipe beyond the connection with the pipe 46. A by-pass pipe 52 provided with a shut-off valve 53 connects the exhaust of the heater 48 to the exhaust steam main 54, by-passing the heater 49. A shut-off valve 55 is placed in the pipe 47 between the points where the pipes 41 and 52 join pipe 47. Pipe 56 provided with a check valve 57 joins the steam space of tank 22 to the pipe 41 between the valves 44 and 45.

Only one effect of the evaporator is shown diagrammatically, but it should be understood that in actual practice, a plurality of effects are utilized. In a similar manner, tanks 22, 23 and 24 are shown diagrammatically and without insulation, but it should be understood that in practice, the tanks, and particularly tank 22, together with the pipes 20 and 38 are heavily insulated to reduce the loss of heat by radiation to a minimum.

In operation, the digester is charged with chips and liquor in the usual manner. The valves 6, 21 and 37 are closed and the valves 12, 13, 16 and 18 are opened. The valve 11 is automatically retained in a closed position by the diaphragm 58, which is controlled by the differential in pressure existing in the pipe 19 and in the digester, the valve being set to open only when the differential drops below a certain predetermined minimum, for example, 5 lbs., when the steam pressure in pipe 13 is about 120.

Steam rushes through the injector 14, picking up liquor flowing through the pipe 15 and sprays this liquor through the nozzle 9 onto the chips, the liquor flowing down through the chips and perforated bottom 2 back to the liquor chamber 4. The steam not only causes the liquor to circulate, but also gradually heats it up, thus gradually raising

the steam pressure in the chip chamber of the digester. When the pressure within the digester reaches a certain figure, which may, for example, be 5 lbs. less than the steam pressure, the valve 11 is opened and steam is bled out through it. This steam is permitted to flow through pipe 41 by opening the valve 44 and is prevented from escaping to the atmosphere through the pipe 59 by closing the valve 60. Steam is more or less continuously bled through the valve 11 as long as the digester continues to cook and a continuous vigorous circulation of liquor is thereby insured which results in a very even cook and considerably reduces the time required.

After the cook is over, the steam valve 18 is closed and the valve 11, of course, automatically opens, rapidly discharging steam through the pipe 41. At the same time, the valves 21 and 28 are opened and valve 29 is closed, the liquor thereby draining into tank 23 under the gravity head augmented by the steam pressure in the digester which is lowered gradually through the valve 11 and pipe 41.

After the steam in the digester has dropped to the pressure existing in the evaporator, about 25 lbs., valves 32 and 37 are opened and the pump 30 is started, forcing dilute wash liquor from the tank 23 through the pipe 35, T 36 and spray nozzle 9 into the digester. The hot liquor flowing through the chips washes out some of the cooking liquor adhering to the chips and removes much of the softened and partially emulsified lignin, the temperature, of course, being maintained at a high point, due to the fact that the liquor introduced is close to the boiling point. The wash liquor, after passing through the chips and being enriched by the cooking liquor adhering to the chips, flows through the pipe 20 into the tank 22 where it is mixed with the original spent liquor.

After the washing with dilute liquor is complete, valves 28 and 31 are closed and valves 29 and 33 are opened, hot water from the tank 24 being circulated by means of the pump through the pipe 35, connection 36 and nozzle 9 into the digester completing the washing of the pulp therein, the dilute wash liquor flowing through the pipes 20 and 26 into the tank 23. After the wash is complete, valves 21, 29, 33 and 37 are closed, valve 6 is opened and valves 13 and 18 may also be opened, the pulp being blown out through the pipe 5 by steam pressure. After the pulp is blown out, valve 18 is closed and any steam condensed can be drained off through the pipe 20 by opening the valves 21 and 29. The digester is then ready for a second cook and the cycle described above is repeated.

Liquor from the tank 22, which has not been cooled to a substantial degree, is continuously circulated by means of the pump 39 through the pipe 38 into the first effect of the evaporator and this flow of liquor will usually take place continuously, as in practice a purality of digesters will be connected to a single set of water and liquor tanks and a single evaporator, although, for simplicity, only a single digester is illustrated in the drawing. When operating with a plurality of digesters, for example 5 or 6, in the case of a mill of ordinary size, the digesters are cooked and blown in rotation so that one of the digesters is always being blown or the pulp being washed therein, thus insuring a continuous flow of liquor to the tank 22 and providing a continuous supply of steam to the pipe 41.

While the digesters are cooking and the only steam passing into the pipe 41 is that being bled through the valves 11 in order to maintain circulation, the amount of steam is usually not greatly in excess of the requirements of the evaporator and accordingly, after passing through the reducing valve 45 and being reduced in pressure from approximately 120 lbs., to about 25 lbs., it serves to heat the first effect of the evaporator. When, however, the supply of steam is in excess of the heating requirements of the evaporator, the pressure in the pipe 40 gradually rises until it exceeds the pressure at which the valve 50 opens. Ordinarily, this opening pressure is adjusted so that the valve 50 will open when the pressure materially exceeds 25 lbs., for example, the valve 50 may advantageously open at 30 lbs., the particular steam pressure being dependent on the operating conditions of any given installation. When valve 50 opens, the exhaust steam passes on through the pipe 41 and into the heaters 48 and 49, serving to heat up water in the tank 24 and dilute liquor in the tank 23. The flow through the heaters may be in series or in parallel or a combination of series and parallel as will be readily apparent from a consideration of the pipe and valve connections. For most purposes, a parallel circulation is advantageous as the heating demands of the tanks 23 and 24 are not necessarily uniform and when a parallel flow is used by closing the valve 55 and opening valves 51 and 53, the proportion of steam flowing through the different heaters can be adjusted to suit varying needs.

When a digester is first blown and the valves 21 and 28 are opened, the liquor from the chip chambers rushes into tank 22, where the pressure is reduced from about 120 lbs., to 25 lbs. Since the liquor usually is approximately at the boiling point under 120 lbs. pressure, a considerable evolution of steam will take place in tank 22 and this steam passes off through the pipe 56 controlled by the valve 57 which may be a

manual valve, but is preferably a check valve as illustrated. Not only does the steam thus formed result in a removal of water from the liquor and reduce accordingly the amount of water which must be evaporated in the evaporator, but this steam is permitted to flow through pipe 41 and performs the additional function of adding its heat to the steam used in heating the first effect of the evaporator. A double saving is thereby obtained since an amount of water corresponding to twice the weight of steam evolved in tank 22 is removed from the liquor.

The washing in the digester is carried out at a high temperature and preferably at a temperature not greatly below the boiling point of the liquor at atmospheric pressure, i. e., about 200–212° F., although, in certain cases, a somewhat lower temperature may be used, particularly in the second washing step with water, since most of the lignin is removed by washing with the dilute liquor, and if this first step is carried out with a high temperature, the water wash can be carried out at a somewhat lower temperature. Of course, the dilute wash liquor will be somewhat cooler, but this is not a serious objection as the waste steam from the digester is used to heat the spent liquor. Preferably, however, I heat both the water and the spent liquor and carry out the washing at a uniformly high temperature.

It should be understood that the tank 22 is not of the same design as is the liquor receiving tanks of the ordinary pulp mill. On the contrary, the tank 22 is preferably kept as small as possible and is thoroughly insulated, thereby conserving the maximum amount of heat in the liquor.

I have illustrated a process in which the pulp is washed in two stages and I have found that this process, which follows the ordinary practice of two-stage wash, is very satisfactory and constitutes the preferred embodiment of my invention. It will be understood, however, that it is perfectly practicable to wash in a single step with hot water where this may be desirable for certain purposes. The wash liquor produced, however, becomes progressively more dilute and if all of the liquor is to be evaporated, the amount of water which must be removed is very considerably increased. For this reason, the two-stage wash, first with dilute liquor and then with water, is generally economically more advantageous, although, of course, my invention is not limited to such a sequence.

The pipe 59 and valve 60 are shown as leading away from the steam circuit and may either lead directly to the atmosphere, acting in the nature of an emergency valve to reduce an excessive pressure, for example in the case of temporary stoppage in the pipe 41, or the pipe 59 may be connected to other apparatus in the pulp mill which requires exhaust steam for heating purposes. Thus, for example, a certain amount of steam may be led through the pipe 59 into drying rolls where the pulp produced is made into rolls for shipment or where a paper mill is combined with the pulp mill. Other apparatus requiring steam heat may also be connected to the pipe 59, such as for example, liquor heaters and the like. In a similar manner, any steam passing out through the pipe 54 may be utilized for further heating. In fact, excess steam may be tapped off from any portion of the exhaust steam circuit shown and utilized for heating or for any other purpose.

It should be noted that in the drawing the arrangement of steam pipes is shown purely diagrammatically and in no sense indicates the structural placement. Thus, for example, the steam pipe 41 passes to a lower level than the heaters in tanks 23 and 24 in order to obviate a confusion of piping. In practice, of course, the piping will usually be arranged so that there is a steady slope in order to provide for proper drainage of condensate or, if a steam pipe passes as shown diagrammatically in the drawing, suitable condensate traps must be provided.

In general, it should be understood that in an actual installation, the arrangement of piping and other accessories will be dictated by the same conditions as in an ordinary installation and the present drawing is intended merely to schematically indicate the steam circuits, without in any sense limiting the apparatus placement or structural design.

Coil heaters are shown in tanks 23 and 24 and for many purposes, these heaters are very satisfactory. However, the liquor and water in tanks 23 and 24 may be heated by direct injection of steam or by a combination of direct injection and indirect heating by means of steam coils, steam jackets or the like. A combination of these two methods may also be used, for example, indirect heating in tank 23 and steam injection in tank 24. This system has the advantage that the hot condensate in tank 24 is added to the volume of hot water therein. It, however, possesses the disadvantage that excessive steam flow may cause flooding of the tank. These respective advantages and disadvantages of various direct and indirect steam heating means are, of course, well known and the best combination for any particular plant will naturally be determined in each individual instance by the operating conditions and the present invention is not limited to any particular heating design or arrangement.

It is usually unnecessary to heat the liquor in tank 22, but in some cases, particularly where a large number of digesters are used

and the tank 22 may be of considerable size, it may be desirable to heat the liquor in this tank by the exhaust steam and a suitable heater may be incorporated therein. Of course, an indirect heater is preferably used as steam injection would result in dilution which is the very thing to be avoided as all of the water thus introduced would have to be finally evaporated.

Other modifications of operation of my invention will be clear to those skilled in the art and are included within the scope of the invention.

The charges of wood chips and liquor, steam pressure and the like may be substantially the same in my improved process as in the ordinary processes which are at present practiced in producing soda and sulfate pulp. The more rapid circulation which is possible by means of the present invention, however, frequently permits a shorter cooking time or a reduction in liquor concentration or amount or both, the savings varying, of course, with the quality of pulp desired and it is an advantage of the present invention that pulp of a given quality can be produced from any given grade of wood with a minimum of cooking time and liquor strength. The particular balance of these factors will be determined by the pulp quality desired and by the value of time saved in cooking. It is an advantage of the present invention that it is adaptable to mills of the most varied design and can be fitted in with advantage in plants having operating conditions of the most varied kind.

What is claimed as new is:

1. The method of cooking cellulosic material which comprises subjecting the material to the action of a chemical liquor in a digester, circulating the liquor by means of steam, and continuously maintaining such circulation by bleeding steam from the digester, said steam being utilized to heat the first effect of an evaporator and passing the liquor after completing the cook through said evaporator.

2. The method of cooking collulosic material which comprises subjecting the material to the action of a chemical liquor in a digester, circulating the liquor by means of steam, continuously maintaining such circulation by bleeding steam from the digester, said steam being utilized to heat the first effect of an evaporator, and passing said liquor without considerable cooling into said evaporator.

3. The method of producing pulp which comprises cooking cellulosic material in a digester with a chemical liquor, circulating said liquor by means of steam, maintaining a continuous circulation by bleeding steam from the digester into the first effect of an evaporator, continuing the bleeding until the cook is completed, blowing steam from the digester into the evaporator, removing the liquor from the cooked material, and without substantial cooling passing said liquor through the evaporator.

4. The method according to claim 3 in which the pulp is washed in the digester at a temperature sufficiently elevated to prevent setting of lignin to a substantial extent.

5. The method according to claim 3 in which the pulp is washed in the digester first with dilute wash liquor and then with water at a temperature sufficiently high to prevent substantial setting of lignin, the concentrated wash liquor produced from the first stage being mixed with the spent liquor drained from the chips and passed through the evaporator.

6. The method according to claim 3 in which the pulp is washed in the digester first with dilute wash liquor and then with water at a temperature sufficiently elevated to prevent substantial setting of lignin and causing the steam bled and blown from the digester in excess of the evaporator requirements to pass in heat exchanging relation with the dilute wash liquor and with the wash water whereby they are heated up to an elevated temperature.

7. The method according to claim 3 in which the spent cooking liquor after removal from the digester is permitted to expand to a lower pressure without substantial cooling whereby steam is evolved, and passing said steam through the steam portion of the evaporator.

8. Apparatus for cooking cellulosic material comprising in combination a digester, a perforated partition in said digester separating it into a chip chamber and liquor chamber, a source of steam under high pressure, means for introducing said steam into the chip chamber, means for causing said steam to inject liquor from the liquor chamber into the chip chamber, a steam bleeder pipe connected to the upper portion of the chip chamber, a valve, said bleeder pipe connecting to the steam space of the evaporator, and means for continuously bleeding steam into the evaporator whenever the pressure differential between the steam source and the digester drops below a predetermined minimum.

9. An apparatus according to claim 8 in which means is provided for drawing off liquor from the liquor chamber of the digester and introducing it without substantial cooling into the evaporator.

10. Apparatus according to claim 8 in which a steam bleeding pipe is provided with a reducing valve.

11. Apparatus according to claim 8 in which means are provided for introducing washing fluid into the chip chamber.

12. Apparatus for cooking cellulosic material comprising in combination a digester

provided with a perforated partition dividing it into a chip chamber and a liquor chamber, a source of high pressure steam connection from said steam source through an injector into the upper portion of the chip chamber, means for causing liquor to flow from the liquor chamber into the injector, an evaporator, a steam bleeding connection between the chip chamber and the evaporator, means for effecting continuous bleeding whenever the pressure differential between the steam source and the digester interior falls below a predetermined minimum, means for blowing steam into said evaporator, means for introducing washing fluid into the chip chamber, means for withdrawing liquor from the liquor chamber and introducing it into the evaporator without substantial cooling, pipe connections between the steam space of the evaporator and wash liquor heaters, and means for causing steam bled or blown to pass through said heaters whenever the steam supply is in excess of the requirements for heating the evaporator.

13. Apparatus according to claim 12 in which a reducing valve is provided in the steam bleeding pipe between the digester and the evaporator, and an automatic valve is provided in the connection between the evaporator and the wash water heaters, said valve being opened by a steam pressure in excess of that required for operation of the evaporator.

Signed at Willsboro, N. Y., this 6th day of September, 1926.

WALLACE H. HOWELL, JR.