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APPARATUS FOR CONTINUOUS DIGESTION OF FIBROUS MATERIALS

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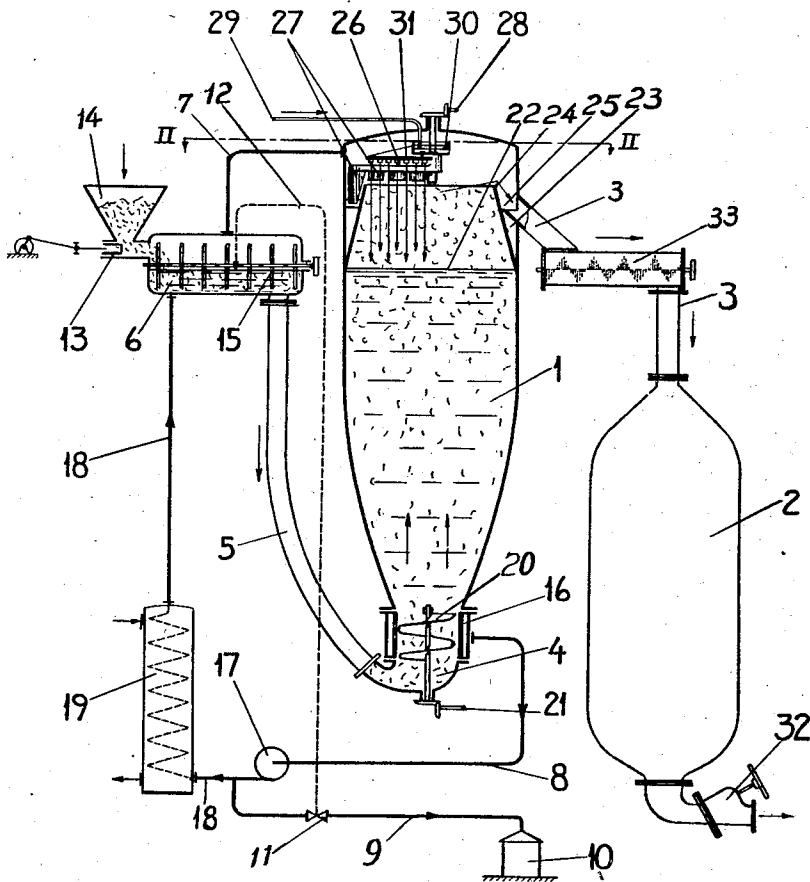


Fig. 1.

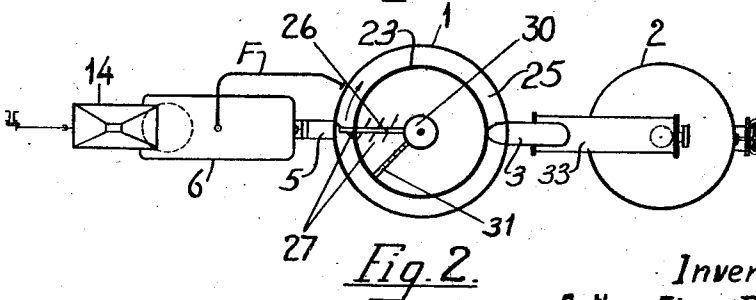


Fig. 2.

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APPARATUS FOR CONTINUOUS DIGESTION OF FIBROUS MATERIAL

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The present invention relates to an apparatus for continuous digestion of fibrous material with a digester liquor, for instance sulphate liquor, with the aid of increased temperature and pressure.

Up to the present day practically all paper pulp has been manufactured according to a periodic process, that is to say, the digester is filled with chips and digester liquor, and the temperature is raised by means of direct or indirect steam following a "digestion curve" to a predetermined temperature and pressure during a predetermined time, after which the digestion is completed, and the digester is afterwards "blown," after which the cycle is repeated with a fresh charge of chips. In view of the large volume to be heated the raising of the temperature always requires a long time, which is sufficient for the chips to become impregnated with the liquor before the desired final temperatures are reached, and in view hereof a uniform and even digestion can be accomplished.

The circumstances are different, however, in the case of a continuous digestion which meets with certain difficulties of a chemical as well as of a mechanical nature. Many methods have been designed and tested but so far without having led to results capable of application in actual practice. This is believed to be due in the first place to such methods not offering sufficient possibilities of control and regulation of the flow of the liquor and of the level of the same, or to the impregnation being insufficient, or to the heating taking place in such manner as to interrupt the continuity of the process.

Therefore, attempts have been made to effect improvements by dividing the process of treatment into several steps with repeated admission of liquor, or with gradually increased temperature or pressure, with intermediate washing, and so forth, but the apparatus required was complicated to so high a degree that it has found practically no use in practice.

It is the purpose of the present invention to solve the problem of effecting a continuous digestion in such a manner that complete control and regulation of the flow of liquor and of the level of the liquor is attained and simultaneously the temperature and pressure are maintained constant during the entire process.

The invention relates to an apparatus for continuous digestion of fibrous material in two steps, or several steps, according to which the fibrous material is continuously conveyed through suitable apparatus and is meanwhile treated with digester liquor, and the characterizing feature of the invention consists principally in that the digester liquor, or fresh liquor, is supplied in such manner and at such a point in the path of treatment of the material that a portion of the said

fresh liquor is caused to flow through the material in counter-current to the direction of movement of said material during the first step of treatment of the material, the said portion of the fresh liquor being gradually consumed while effecting a partial digestion of the material, while the second portion of the fresh liquor is caused to flow in the same direction as and along with the material during the second step of treatment.

This second portion of the fresh liquor which thus flows along with the material to the final discharge point, will thus be consumed and effect definitive digestion of the material. The portion of the liquor which flows in counter-current to the material, will reach the point of entry of the material in the form of black liquor, and the liquor flowing along with the material reaches the discharge point in the form of waste liquor. Liquor economy is thus assured. Simultaneously the advantage is attained that at the point of entry the material encounters black liquor and becomes impregnated by the same. During the continued movement of the material the said black liquor is gradually displaced and replaced by fresh liquor. In this way a more cautious digestion is attained, and in the second place a washing by displacement is effected of incrustated substances which have already been dissolved. The definitive digestion with fresh liquor flowing in the same direction during the second step can, therefore, be completed with comparatively small quantities of liquor, which results in a pulp being obtained which is stronger and which is also more easily bleached.

The accompanying drawing illustrates diagrammatically and by way of example an apparatus for carrying out the invention. Fig. 1 shows the apparatus partly in vertical section, and Fig. 2 shows a section on the line II—II in Fig. 1.

The apparatus diagrammatically illustrated in the drawing consists principally of two vertical digesters 1 and 2 the upper portions of which are connected by a conduit 3. The digester 1 serves for the treatment of the material during the first step of the process, and the digester 2 serves for the treatment during the second step. Accordingly, the material shall first pass through the digester 1 and afterwards through the digester 2, and the digester liquor shall be supplied at such a point in the path of treatment that during the first step of treatment the liquor flows in counter-current to the material. In the apparatus diagrammatically illustrated in the drawing the digester liquor is supplied to the top of the digester 1 by means of devices which are further described herebelow.

The cellulose-containing material, for instance wood chips, shall thus be charged into the digester 1 at the bottom of the latter. In order to facilitate this charging and simultaneously to

render possible a simple regulation of the level of the liquor in the digester, the following arrangement is provided. Connected to the lower end of the digester is an angle pipe 4 which communicates through a pipe 5 with a closed impregnating vessel 6 which is positioned approximately at the same height at which it is desired to maintain the level of the liquor in the digester 1. The upper portion of this impregnating vessel 6 communicates through a pressure equalizing conduit 7 with the upper portion of the digester 1 for the purpose of equalizing the pressure in these two communicating vessels.

A conduit 8, 9 leads from the lower portion of the digester 1 to the soda house 10, and in said conduit there is interposed a valve 11 which is actuated, as indicated by the dotted line 12, by the level of the liquor in the impregnating vessel 6, so that consequently, the discharge of excess liquor from the digester 1 will be controlled through the said valve from the level of the liquor in the impregnating vessel 6. Due to this arrangement the level of the liquor in the digester 1 will be maintained so much higher than the level in the vessel 6 that this difference of pressure just suffices for forcing the liquor through the digester 1 in counter-current to the material. Since the liquor that reaches the lower end of the digester 1, consists of black liquor, it will be understood that the liquid in the pipe 5 and in the impregnating vessel 6 consists of black liquor.

The impregnating vessel 6 is provided with a charging device 13 having a funnel 14 by means of which the fibrous material, for instance wood chips, is fed into the vessel, which latter is also provided with a stirring or mixing device 15 by means of which the chips are mixed with the black liquor in the vessel. In order to effect transportation of the fibrous material fed into the impregnating vessel, which is located at the higher level, to the lower end of the digester 1, which is located at the lower level, the invention provides for circulation of the black liquor from the impregnating vessel 6 through the pipe 5 to the bottom of the digester 1.

For this purpose a sieve chamber 16 is provided between the angle pipe 4 and the lower end of the digester 1, said chamber being connected through the conduit 8 to the suction side of a pump 17, the pressure side of which is connected through a conduit 18, which may suitably include a heat exchanger 19, to the impregnating vessel 6. The pump 17 thus draws black liquor from the sieve chamber 16 and forces such liquor to the impregnating vessel 6, so that circulation is set up through the latter and the pipe 5 to the lower end of the digester 1. A sufficiently strong circulation is maintained to effect a powerful downward flow of liquor through the pipe 5, which for this purpose is made with a comparatively small cross-sectional area, at so high a velocity of flow that the material is carried along and moved downwards in spite of its lower specific gravity. The quantity of liquor circulated in the unit of time is also maintained so great that it exceeds many times the quantity of material supplied per unit of time, which results in the material becoming so well distributed in the black liquor that any risk of congestion during the transportation is avoided. In the sieve chamber 16 the circulating liquor is of course separated from the material transported through the pipe 5 to the angle pipe 4.

Owing to the fact that the black liquor which circulates in the manner above described, flows through the heat exchanger 19, the quantity of heat required for heating the material fed into the impregnating vessel 6, is simultaneously supplied to said vessel. It will be understood, however, that the supply of heat may also be effected by means of a separate circulation circuit through the vessel 6 and a heat exchanger.

Upward movement in the digester 1 of the material supplied through the pipe 5 and the angle pipe 4 to the lower end of said digester is effected by means of a conveyer screw 20, propeller, or the like, provided in the lower portion of the said digester and driven from the outside by means of any suitable means diagrammatically illustrated at 21.

During the upward movement in the digester 1, the material which is impregnated with black liquor, encounters the digester liquor, or fresh liquor, supplied to the upper portion of the digester, and in this way the latter liquor gradually displaces the black liquor in the material. During this upward movement of the material in the digester, the material will finally rise above the level 22 of the liquor in the digester, and only afterwards is the discharge of material from the digester 1 to the digester 2 effected. It may be suitable to provide a slight contraction of the cross-section of this upper portion of the digester in order to facilitate the displacement of the liquor and to produce the necessary resistance so that the material shall not too easily rise above the level of the liquor. For this purpose the digester 1 is shown as provided in its upper portion with an inner wall or shell 23 which tapers upwards and is concentric to the wall of the digester, and the lower edge of which is attached to the wall of the digester. The upper edge of this shell forms an overflow edge 24 over which the material is fed into a flute or trough 25 provided intermediate the shell and the digester wall, and from which the abovementioned conduit 3 leads to the top of the digester 2, which is located at a lower level.

The said downward feed of the material is effected by means of a rotary scraper device 26 the rotating shaft of which is journaled in the top of the digester 1 coaxially with the axis of the digester, and which consists of one or more arms provided with a plurality of obliquely placed vanes or blades 27 which during rotation of the device sweep over the horizontal plane through the upper edge of the shell 23 and thus move the rising material outwards, and which also extend into the chute 28 and move the material in said chute towards the conduit 3. The said scraper device is driven from the outside by means of any suitable driving device diagrammatically illustrated at 29.

The supply of hot digester liquor, fresh liquor, is effected through a pipe 29 which passes through the top of the digester 1, and from which the fresh liquor flows into a cylindrical collecting receptacle 30 which in the instance illustrated is shown as provided on the shaft of the scraper device 26, and from which a spray pipe or pipes 31 extend which are attached to the said device and thus rotate with it. The outflow openings on the said spray pipe are arranged in such manner that the outflow through the same is increased with the distance from the axis of rotation, so that the fresh liquor is evenly distributed over the surface enclosed by the upper edge of the shell 23.

The material rising above the level 22 of liquor thus encounters during its movement through the shell 23 the hot fresh liquor supplied by means of the abovementioned spray device and which is evenly sprayed over the material which is thus washed from the accompanying partially consumed liquor which is gradually displaced and replaced by fresh liquor.

This mass of partially digested fibre is continuously scraped into the flute 25, as already mentioned, and is then transported through the conduit 3 into the digester 2 in which the final digestion is effected in the ordinary manner, the digestion of the material being thus completed. The completely digested pulp is discharged from the digester 2 along with the consumed liquor by means of any suitable sluice device 32 or in any other suitable manner.

It may be suitable to connect a defibrator mixer 33 in the conduit 3 between the digesters 1 and 2, by means of which the partially digested material from the digester 1 is treated in order to facilitate the final digestion in the digester 2.

That quantity of the fresh liquor supplied to the digester 1 which is not taken up by and does not follow the material transferred to the digester 2, will of course flow down to the level of the liquor in the digester 1, and according as fresh liquor is supplied in this manner, and while maintaining a constant level of liquor in the digester, the liquor in the digester moves downwards in countercurrent to the upward moving fibrous material. During the reaction meanwhile proceeding, the liquor becomes gradually weaker until finally it is drawn off from the sieve chamber 16 as black liquor through the conduit 8 and is drained to the soda house through the drain valve 11 controlled by the level of the liquor in the impregnating vessel 6.

The constructional form above described and diagrammatically illustrated in the drawing is only to be regarded as an example, and it will be understood that it may be modified in several ways in respect of its details without departing from the principle of the invention.

We claim:

1. Apparatus for continuous digestion of fibrous material, comprising a digester, means for effecting continuous supply of fibrous material to be treated to the lower end of said digester, means for draining waste digester liquor from said lower end of said digester, means for supplying fresh digester liquor to the upper end of said digester, an impregnating vessel located substantially at the same height as the level of the digester liquor in said digester, means for continuously charging material to be treated into said impregnating vessel, a pressure equalizing conduit connecting the upper portion of said impregnating vessel with the upper portion of said digester, a down-feed pipe connecting said impregnating vessel to the lower end of said digester, a second digester, means affording communication between said upper end of said first-mentioned digester and one end of said second digester, and means for effecting continuous transfer of material and digester liquor from said upper end of said first-mentioned digester through said communication means to said second digester.

2. An apparatus as claimed in claim 1, having a pump, a conduit connecting the suction side of said pump to the lower end of said first-named digester, and a conduit connecting the pressure side of said pump to said impregnating vessel.

3. An apparatus as claimed in claim 1, having a sieve chamber at the lower end of said first-mentioned digester, a pump, a conduit connecting the suction side of said pump to said sieve chamber, and a conduit connecting the pressure side of said pump to said impregnating vessel.

4. An apparatus as claimed in claim 1, having a sieve chamber at the lower end of said first-mentioned digester, a pump, a conduit connecting the suction side of said pump to said sieve chamber, a conduit connecting the pressure side of said pump to said impregnating vessel, and a heat exchanger connected in said last-mentioned conduit between the pressure side of said pump and said impregnating vessel.

5. An apparatus as claimed in claim 1, having conveyer means in the lower end of said first-named digester above the point of connection of said down-feed pipe to said lower end of said digester for feeding the material supplied through said pipe to said end of the digester upwards in the latter.

6. An apparatus as claimed in claim 1, having a sieve chamber at the lower end of said first-mentioned digester above the point of connection of said down-feed pipe to said lower end of said digester, and a rotary conveyer screw in said sieve chamber for feeding the material supplied through said pipe to said sieve chamber upwards in the digester.

7. Apparatus for continuous digestion of fibrous material, comprising a digester, means for effecting continuous supply of fibrous material to be treated to the lower end of said digester, means for draining waste digester liquor from said lower end of said digester, means for supplying fresh digester liquor to the upper end of said digester, a second digester, means affording communication between said upper end of said first-named digester and one end of said second digester, means for effecting continuous transfer of material and digester liquor from said upper end of said first-named digester through said communication means to said second digester, said means for effecting continuous transfer of material and digester liquor comprising a rotary scraper positioned in the upper end of said first-named digester and adapted upon rotation to scrape off the upper layer of material in said digester, and a flute in said digester for receiving the material from said rotary scraper, said flute being connected to said communication means.

8. An apparatus as claimed in claim 7, having a supply pipe for digester liquor at the top of said first-named digester, and a spray pipe communicating with said supply pipe and associated with said rotary scraper and rotatable therewith, said spray pipe having outflow openings arranged in such manner that during rotation of the scraper and spray pipe a uniform distribution of the digester liquor over the surface below is effected.

9. An apparatus as claimed in claim 7, having a shell located in the upper portion of said first-named digester and concentric with the wall thereof, the lower edge of said shell being attached to the wall of the digester, and the upper edge of said shell forming an overflow edge over which the material is scraped by the rotary scraper into the flute.

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