April 10, 1934. A. LEMBERGER ET AL 1,954,012

MANUFACTURE OF CELLULOSE AND THE LIKE

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Fig.1.

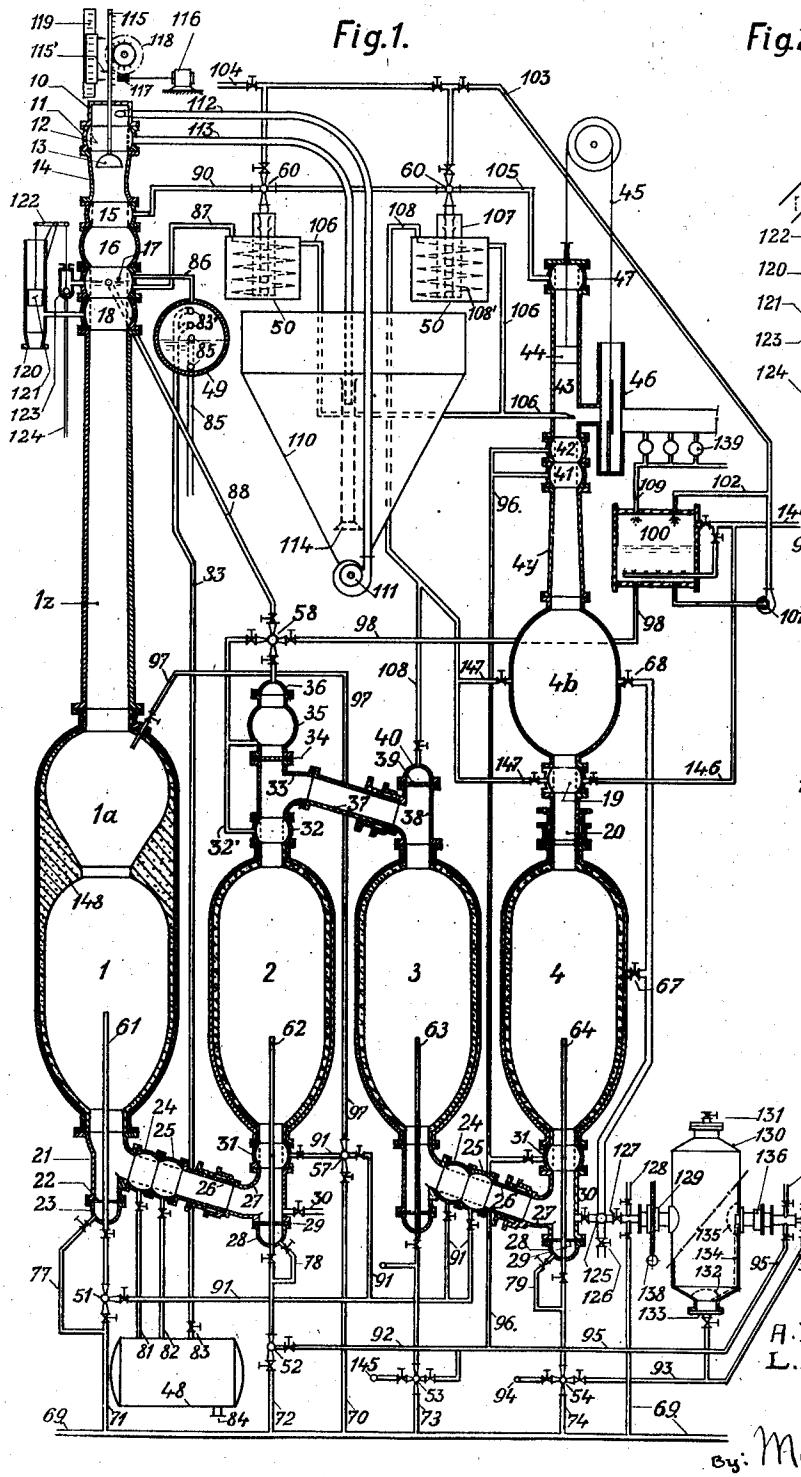
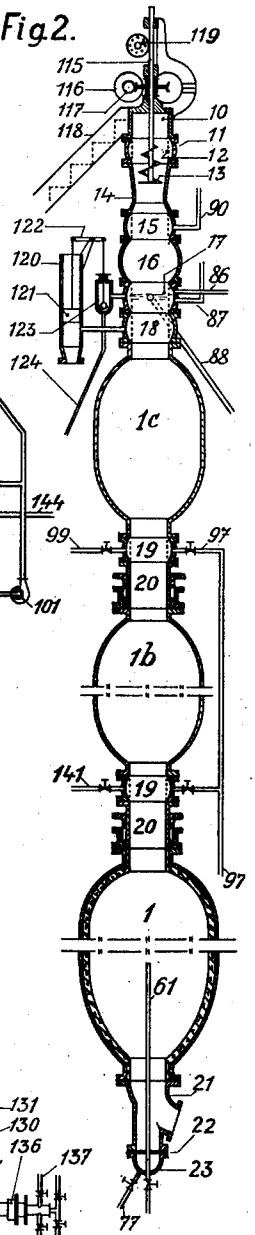


Fig.2.



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MANUFACTURE OF CELLULOSE AND THE LIKE

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This invention relates to a process for digesting cellulose and similar materials which avoids various disadvantages of known processes such as those in which the digestion is carried out in stages and obtains various important advantages. The new process consists in this that during digestion the material to be treated is passed continuously through a series of as great a number of digesters as possible which ensures a uniform uninterrupted operation. In this way it is also possible to secure an uninterrupted feeding of the necessary chemicals into and through the apparatus and their conveyance away.

The process according to the present invention and its advantages will be best understood from the description of constructional examples, suitable for carrying out the new process. In the accompanying drawing Figure 1 shows the first constructional example diagrammatically in vertical section.

Figure 2 shows a modified construction of the pre-digester.

The digester shown in Fig. 1 consists suitably of a first digester of as large dimensions as possible, the so-called preliminary digester 1, and of a main digester 2 which is disposed next to it, preferably somewhat lower, and may be smaller. Next to this main digester 2 preferably at the same height and of the same size is a third digester, the so-called enriching digester 3 as a quiescent digester and next to the latter, preferably at the same height, a fourth digester, a so-called final digester 4. These digesters may each or all of them consist of two or more superposed digesters forming groups bearing the same name and serving the same purpose.

The pre-digester 1 and the main digester 2 are connected with the bottom by a pipe consisting of a bend 21 connected to the bottom end of the pre-digester 1 and of a bend 27 connected to the bottom end of the main digester 2 and of intermediate pieces 24 and 25 of the so-called separators. The separators have an outer casing consisting of an acid-proof material, preferably acid-proof cast steel, or are provided with an acid-proof inert lining and an internal, preferably cylindrical sieve of resistant material. The pulp cannot penetrate into the space between the casing and the sieve of the separator, but the liquid, the gases and the steam can do so. The outer casings of the insertions 24 and 25 are provided with branches for connecting up pipe lines 82. To the separator 25 is connected a nozzle which extends into a stuffing box 26 connected to the bend 27. In this way heat expansions in the plant are compensated. Between the bend 27 and the digester 2 is a further insertion (separator) 31 similar to the insertions 24 and 25, which is provided with a branch for connecting up a pipe line. The bend 21 is provided at the bottom with a bell-shaped extension 23 in which a sieve 22 is inserted. To this extension 23 there is connected on the one hand a pipe line 71 and on the other hand a riser 61 for wet steam and liquor and at the side branch a branch-pipe 77 for superheater steam. Similarly the bend 27 is also provided with a bell-shaped extension 28 containing an inserted sieve 29 and connected with a riser 72 and 62 and a branch pipe 78 both for wet steam and liquor. The main digester 2 and the quiescent digester 3 are connected at the top by a pipe. This pipe consists of a bend 33 which is connected with an interposed separator 32 to the main digester 2. From the separator 32 a pipe line 32' is branched off. This bend 33 is also provided with a branch having a bell-shaped closure 35 and an inserted sieve 34, to which the pipe line 88 is connected. To this bend 33 is connected a connecting pipe 37 by means of a stuffing box and also a bend 38 which is connected to the quiescent digester 3.

The bend 38 is also provided with a bell-shaped extension 40 having an inserted sieve 39, which is connected with a pipe line 108. The enriching digester 3, the quiescent digester, is connected to the final digester 4 by a bottom connecting pipe which again consists of a bend 21 with a branch and a bell-shaped closure 23 having an inserted sieve 22, to which is connected a pipe line 73 and in the digester 3 a riser 63. To the bend 21 are connected the insertions (separators) 24 and 25 from which pipes 91 branch off. To the insertion 25 there is again connected the connecting pipe with a stuffing box 26, which leads to the bend 27 which is connected with an interposed separator 31 to the digester 4. To the separator 31 are connected pipe lines 96. On the bend 27 is a bell-shaped closure 28 with an inserted sieve 29, pipe lines 74 and 79 and a riser 64 being connected thereto.

The first and the last digester are provided at the top with an extension of the digester neck, $1z$ and $4y$ which is made of as large a diameter as possible. The extension $1z$ of the first digester 1 widens conically downwards and mainly serves the purpose of mounting the automatic regulating and feeding device for the raw material with a casing for forming a compacted plug of material in the superposed part 14 for separating the gas and the air, for mounting the au-

tomatic regulating device for the additional liquor 120—124; and for mounting separators 17 and 18. Of these the separator 17 serves the purpose of introducing different circulating liquors, waste gases and exhaust steam through the pipes 86, 87, 88 and a separator 15 for carrying away the unexhausted gas and steam mixture through the pipe 90. The space between these two separators 15 and 17 may be utilized for providing a steam space by the provision of an extension 16 of any suitable length.

The extension 4y of the neck of the last digester 4 mainly serves the purpose of mounting a regulating device for an automatic pulp overflow 46 and for containing the liquor separators 41, 42 and the gas and steam separator 47. This digester extension 4y is either cylindrical or flares conically downwards or upwards. The two digester neck extensions are connected by the digesters 1, 2, 3, 4 so as to be in communication with one another and assist one another in regulating the liquid column in the digester system. Above the separator 15 and the intermediate piece 14 is a separator (air separator) 11, to which is connected a pipe line 113 for conveying away air. Above this air separator 11 is an end piece (cowl) 10, to which is connected tangentially a pipe 112 for introducing the material mixed with air. This end piece 10 is only lightly covered.

In the insertion (separator) 11 and partly in the extensions 14 and 10 there moves a stamper 13 in the form of a cone, a hemisphere or the like which is connected to a guide bar 115 which has lateral teeth on its upper part which projects to the outside. With these teeth a partially toothed wheel (toothed segment) 118 meshes. The latter is driven through transmission gear 117 by a motor 116. When the toothed segment 118 engages with the rack 115, the stamper 13 is raised. As soon as the last tooth of the toothed segment 118 ceases to engage, the stamper 13 falls on to the introduced material, whereupon on re-engaging with the toothed segment 118 it is raised again. In this way the raw materia. is compacted in the insertion 14 and thus forms a plug of material (separating wall) which separates the gases in the digester from the outside air. The rack 115 bears a stop 115' which moves between two stops on a contact disc 119 of a rheostat and thereby influences an electric motor for feeding the raw material through the pipe 112, thus automatically regulating the feed.

The insertion (separator) 18 is connected to a vessel 120 containing liquor, in which a float 121 moves, which by means of its guiding rod influences either a rheostat for regulating a pump motor for the feed of the additional liquor or, through a system of levers 122, a regulating member 123 for the feed pipe 124 directly, the arrangement being such that the additional liquor is fed into the insertion (separator) 18 in such a manner that the level in the same remains constant. A regulation of the circulating liquors and of the digesting liquor may be effected in the same way.

For the raw material a storage hopper 110 is provided at the lower tapered end of which a blower 111 is mounted, so that the raw material is drawn by suction from the storage hopper and is blown through the pipe 112 in to the top part (cowl) 10 tangentially and draws the air by suction through the sieve 12 of the insertion 11 and the pipe line 113, 114 which is flared at the bottom into the lower end of the hopper.

In the extension 4y of the final digester 4, in the upper part of the same, two insertions (liquor separators) 41 and 42 and lateral connecting branches for a common pipe 96 (for conveying away the liquor) are provided. To the upper insertion 42 is connected an extension 43 of the extension, to which is connected laterally a chamber in which an overflow 46 is provided. The height of the upper edge of the overflow weir can be balanced by vertically sliding its upper movable part, for instance by a counterpoise, or can be regulated by means of a float 44 provided in the extension 43 and connected with the weir by a cord 45. To this overflow is connected a pipe for conveying away the completely digested pulp, for instance to filter coils 139 or the like.

In the constructional form shown in Fig. 2 the stamper 13 according to Fig. 1 is replaced by a vertical worm 13 which is driven by means of a worm-wheel transmission gear 117 from a counter-shaft 116 or by a motor and owing to its rotary motion smoothes the surface of the introduced material. The shaft 115 of the worm 13 is capable of sliding up and down in the hub of the horizontal worm-wheel, but is coupled with the same by means of a spring and groove so as to rotate with it, such that when the supply of material becomes too great the worm 13 works itself up in the material, carrying its shaft 115 with it, which with its milled-in teeth displaces, a rotary rheostat 119 and thus regulates the motor for the supply of the raw material. The backlash is then formed in the rheostat 119 itself. The material may be fed either by means of the blower 111 according to Fig. 1 or by means of a conveyor worm 118', as shown in Fig. 2, or by employing any similar known arrangements, the speed and delivery being regulated by motors and resistances, such as 119. When too much material rises in the upper stamping space of the extension 1z of the digester neck for any reason, for instance owing to a too great supply or swelling of the material, the worm 13 with its shaft 115 rises to such an extent that the spring keys leave their grooves in the hub of the worm-wheel for preventing the parts being damaged, a further supply of raw material being stopped by the rheostat 119. The propeller at the same time ceases to rotate. As soon, however, as the level of the material has fallen again to a sufficient extent, the further rotation of the worm-wheel will cause the shaft 115 with its spring keys to engage owing to gravity with the propeller in the guiding grooves in the hub of the wheel and to start rotating again. On the level of the material falling, the shaft 115 will adjust the rheostat in such a manner as to cause a more rapid feed of raw material.

In place of single digesters, groups of digesters consisting of two or more superposed and interconnected digesters may be used, such that they replace the single digesters already referred to. The digesters 2, 3, 4 and so on may also be so arranged that they are placed at different heights, such that by this means different pressures and temperatures and different duration of their action and the like, may be obtained. When several digesters are placed one above the other, the upper digesters may also with advantage be used as quiescent digesters, that is to say, digesters without independent steam heating.

The arrangement of several digesters one above the other may also be such that the extension of the digester neck 1z on the first digester 1 may be completely omitted (Fig. 2). The main ad-

vantage of this is that everywhere, where there is a frequent or considerable withdrawal of incompletely digested pulp in front of the weir 46 at the end of the final digester 4, either for the purpose of filling a so-called improving digester or for other purposes, owing to such an upper digester being of greater circumference, the liquid column cannot sink so low that this would, by altering the pressure, have a detrimental effect on the digestion as might occur through improper handling in simple tubular extensions 1z with their relatively small circumference.

A further advantage of such upper digesters is, that with their large capacity, they serve more advantageously as impregnation digesters in which the pulp remains longer and thereby undergoes an advantageous impregnation for a longer time.

The principal object of such upper digesters is that with their large capacity they prevent a mixing before the proper time of the raw and scarcely impregnated material with the partly digested mass which might occur through oversights in the operation of the steam inlet, so that the pulp instead of being heated and fed forward quietly, is stirred up and mixed. In this way, a non-uniform digestion of the material would be caused which, in the subsequent digestion, would have to be repaired as far as possible at the cost of the amount and the quality. It is, therefore, better the more transferences there are, that is, the more digesters are arranged above the preliminary digester and the higher the position of the uppermost digester. The digesters may become gradually smaller towards the top.

Fig. 1 illustrates diagrammatically an arrangement according to the invention with two preliminary digester, arranged one above the other, and two final digesters. Fig. 2 is a modification of this arrangement with three preliminary digesters.

A digester 1b, if necessary 1b, 1c (Fig. 2) above the pre-digester 1 is arranged at a suitable height such that the uppermost digester 1b or 1c reaches up to the regulating device 120 to 123, which serves the purpose of maintaining the height of the liquid column in the digesters. The pre-digester 1b is smaller than the lower pre-digester 1 and the pre-digester 1c is also smaller than the pre-digester 1b. (The separator 18 is connected directly to the uppermost pre-digester 1b or 1c).

Where a large, old pre-digester 1 (Fig. 1) is available, and there is not room for two upper digesters 1b, 1c (Figure 2), or where an old construction does not allow of such a load, the lower larger digester may be divided into two digesters 1 and 1a which may be effected for example with sulphite digesters lined with concrete by means of a concrete intermediate cover 148. This intermediate cover has in the middle a large passage opening to which are joined, above and below, walls connecting it with the wall of the digester so that they do not obstruct the passage of the raw material from above, and all the gases and vapours from the below. In digesters which are not lined with concrete, for example for the alkali process, such an intermediate cover may be constructed of sheet metal, there being an annular hollow space in the intermediate cover. The intermediate cover 148 is preferably so constructed that the lower part 1 of the digester remains larger than the upper part 1a.

All these adaptations have the further advantage that in exceptional cases, more particularly when forced production at the expense of quality is necessary, in the lower digester, or in the lower part 1 of the digester, the material can be pre-digested above the boiling temperature instead of being merely heated without considering the agitation or mixing of the material which is so much less dangerous and more similar passages 148 there are, or the more digesters are placed one above the other and the higher the uppermost pre-digester is arranged. In this case also, inattention to the operation of the steam inlet can have no bad effect. The division of the large pre-digester 1 is also to be particularly recommended where only a single pre-digester with a high extension 1z of the neck of the digester is used (Figure 1).

The connections of the pipe lines and other auxiliary arrangements in the example shown will be best understood by the following description of the mode of operation.

The height of the upper digester neck extension 1z on the digester 1 is made to correspond to the working method adopted in each case. For the sulphite process, for instance, three atmospheres will suffice in the middle of the digester and a corresponding liquid temperature of about 134° C. which corresponds approximately to a liquid column of about 20 m. This will already allow of the production of a nice, white, firm cellulose. In order to obtain a greater production, a longer extension of the digester neck (superposed part) is preferably used. In the conditions shown in the drawing, in Fig. 1 for instance, the pre-digester is assumed to be 16 m. high and the superposed part up to the level of the liquor, that is, up to the first separator 18 about 18 m. high. This corresponds in the middle of the digester to a liquid column of 26 m. and in view of the great density of the digester contents to a pressure of about 3⅔–3¾ atmospheres and a liquid temperature of approximately 140–141° C. In the middle of the lower calotte this will already correspond to a pressure of 4¼ atmospheres and a liquid temperature of about 145–146° C., although far lower values would suffice for the preliminary digesting process.

The other digesters 2 and 3 measured in the middle of the digester have in view of the great density and immobility of the mass and its conductive resistance a pressure of approximately 4–4¼ atmospheres which corresponds to a liquid temperature of about 144–146° C. measured in the middle of the digester. Measured in the middle of the lower calotte this already corresponds to a pressure of about 3½–4¾ atmospheres and a liquid temperature of about 148–150° C. In the lower connecting pipes these values are still higher.

For obtaining greater uniformity it is advisable to use a greater number of smaller digesters, preferably several digesters superposed one on the other or placed next to one another.

In the case of the last digester, instead of or preferably in addition to the superposed part 4y, one or more outlet members (for instance slide valves) may be provided, which may be used for the frequent removal of the completely or almost completely digested pulp.

The raw material (wood chips, chaff or the like), which has been introduced into the digester neck extension (superposed part) 1z of the pre-digester 1 and has been stamped down or smoothed out in the superposed part, sinks in the same, the forward feed being assisted by the downwardly flaring conical shape of the super-

posed part. Through the continuous feed of the material an approximately constant material level is maintained in the superposed part 1z. The supply of material is regulated as described above according to the demand or according to the progress of the treatment of the material. The restarting of the forward feed of the material may be notified to the attendants for instance through an electric conductor in the form of an optical or acoustic signal in a control cabin and registered there.

The constructional form for the production of sulphite cellulose shown by way of example operates in the following manner:

The digester is filled up to a certain height with fresh liquor, and, at the same time, the chaff is fed in through the superposed part 1z into the pre-digester 1 from above, steam being allowed to enter gradually at the bottom, first into the pre-digester 1 through the pipe 71 and the perforated distributing pipe 61. Owing to the inclined position of the bottom pipe connecting the digesters and owing to the rising pressure in the pre-digester, even the still rough wood chips in the liquor will pass to the lowest part of this inclined connecting pipe where they are whirled up by the steam entering gradually from the pipe 72 through the branch pipe 78 and the inserted sieve 29 and carried away into the main digester 2. Later the perforated distributing pipe 62 at this point also will become operative. Fresh liquor may be admitted by way of the regulating arrangement 12, 123 through the supply pipe 124 into the pre-digester 1, so that the contents of the main digester 2 will soon pass through the upper connecting pipe into the quiescent digester 3 and will pass from the latter through the lower connecting pipe into the final digester 4. In the meantime steam has been caused to enter here as well, through the pipe 74, the branch pipe 79, the inserted sieve 29 and subsequently through the perforated distributing pipe 64 as well and digestion has taken place actively in the main digester 2, while material has been continuously fed into the pre-digester 1. As soon as the digesters 3 and 4 have become more filled, digestion will take place actively in the final digester 4. In the upper bend 33 above the main digester 2 an injector 58 is interposed in the pipe 88. As soon as the digesting process commences in all the digesters, the injector 58 is put in operation first with live steam and subsequently with a steam and gas mixture from the digester 2, the excess liquor being thereby driven out of the main digester 2 through the pipe 32', 88 and the separator 17 into the digester 1. To the injector 58 a pipe may be connected from the lower separators 24, 25 of the quiescent digester 3, for returning the circulating liquor which has been further used up in the digesters 2 and 3 back to the pre-digester 1. In the constructional form shown in Fig. 1 the liquor used up in the digesters 2 and 3 is returned through pipes 91 on the one hand to the injector 51 in the steam supply pipe 71 and on the other hand mainly by way of the injector 57 and the pipe 91, 97 to the upper part of the pre-digester 1. When the quantity of liquor becomes sufficient, that is, when the liquid column in the plant reaches the requisite height, the float 121 becomes operative and cuts off the supply of additional liquor through 124 and 123.

As soon as the level of the liquid column in the final digester 4 or in its extension or superposed part 4y has reached the separator 41, the pipe 96 is connected to the lower injector 52 in the steam pipe 72 for the main digester 2 and the first fairly rich circulating liquor is pumped over from the final digester 4 through the perforated distribution pipe 62 into the main digester 2, even highly superheated steam being sufficiently cooled down or moistened by the liquor without loss.

During the further course of the digesting process a branch pipe 78, can deliver from the lower injector 52 into the lower connecting pipe 27 between the pre-digester 1 and the main digester 2, so that the first fairly pure circulating liquor from the final digester 4 or some other pure and good liquor is forced in at this point as a washing liquor, after the final liquor from the pre-digester 1 in the separators has been allowed to flow out through the pipes 81, 82 into the receiver 48. This washing liquor removes most of the final liquor still adhering to the material, is separated off again in the separator 31 and conveyed through the pipe 91 to the injector 57 which forces the washing liquor into the pre-digester 1, where it is utilized again and led off with the completely spent final liquor. The completely spent, highly heated final liquor which has been freed from gas by the superheated steam and has been conveyed into the receiver 48 is completely freed in the said receiver owing to sudden expansion from SO_2, which gas is led away for being recovered and the resultant hot waste liquor, freed from SO_2 and greatly enriched with incrustations, can thereupon be easily treated without the addition of live steam, so as to obtain various by-products.

Besides the receiver 48 another receiver 49 placed at a higher level, namely in the neighbourhood of the upper end of the superposed part 1z may with advantage be provided, which is connected to the lower receiver 48 by a pipe 83 which has a number of apertures 83' opening at different levels in the receiver and provided with closing means. The upper receiver 49 has an outlet 85. The upper receiver is filled only up to the level of the overflow 85, while the lower receiver 48 is full.

When the apparatus is operating normally the fresh liquor is also fed to the final digester 4, being introduced through a pipe 147 into the separator 31 between the digesters 4 and 4b above the sieve in the separator so that the pulp passing into the last digester is treated with fresh liquor. The digesting liquor separated off in the separators 41 and 42 for the injector 52 is therefore used up to a relatively small extent, so that with or without an addition of SO_2 it is very effective in the main digester 2 and in the enriching digester 3 acting as a quiescent digester and is then added for being completely used up through the pipe 91, 97 and the injector 57 in the digester 1 to the fresh raw material.

As soon as it has been found by taking samples that the cellulose in the upper part of the superposed part 4z of the final digester 4 or in the overflow chamber connected to the latter has been sufficiently digested, the over-flow weir is properly adjusted, so that the pulp will flow fairly uniformly to the rest of the plant in which it is being treated.

The gases mixed with steam coming from the receiver 49 are led away through the pipe 86 by way of the separators 17 and 15 and the pipe 90. The common pipe 90 meets the pipe which branches off from the upper part of the superposed part 4y through the separator 47 and through which the gas and steam mixture from the final digester 4 is conveyed away. The two pipes are

connected up to an injector 60. The vapours are in this injector condensed by the water under pressure coming through a pipe 104 and the gas and water mixture is conveyed through a cooling plant 107—108' in a tank 50 for causing the gas to be absorbed and for obtaining the so-called gas liquor (that is, free, aqueous sulphurous acid or water and condensate enriched with gaseous SO_2). The gas liquor thus obtained is conveyed through its own higher liquid column through a pipe 108 back to any of the digesters, preferably to the quiescent digester 3 through a branch 40, where owing to the material being in a quiescent state there is no such great danger of the rapid disintegration of the liquor as in the other digesters. Instead of using fresh water from the mains the injector 60 can also be fed with a fairly rich liquor pressed out of the finished pulp through the pipe 130, which liquor is separated off in the filter presses 139 and is led through the pipe 109 into an absorber 100, is atomized in the latter and preliminarily enriched with freshly produced or compressed SO_2 gas from the pipe 144 and conveyed by means of a circulating pipe 101. The excess delivered by the pump is caused to pass through a branch pipe 102 into the same absorber 100 where it is atomized, to circulate continuously and to be enriched with SO_2. A further pipe 98 connects the absorber 100 with the injector 58 for further conveyance to the separator 17 or to the digester extension 1z of the pre-digester 1. The injector 58 which was at first driven with fresh steam is when in full operation fed with the steam and gas mixture from the main digester 2, which has been separated by the sieve 34 in the extension 35 from the pulp and has accumuated at this highest point, the circulating liquor from the separator 32 and the cooled, enriched, pressed-out liquor from the absorber 100 being further heated and if necessary enriched.

For producing the gas liquor a new process and a new apparatus are used, consisting in this, that the liquid intended for the absorption of the gases passes preferably under pressure through the suction and pressure injector 60, being at the same time used as the driving medium for the latter or by way of a nozzle or mixing arrangement mixed with the SO_2 gases first into a drum 107 which is disposed in cold water in an outer vessel 50. In the drum 107 the mixture of liquid and gas is guided to the bottom of the vessel through a pipe which is perforated in its lower part. The gas not yet absorbed in the pipe rises again in the drum 107 in the form of bubbles and is thus further absorbed in a finely divided state. The remainder of the gases collects under the upper end wall of the drum 107 and is drawn in by suction again and again through the pipe which where it enters the drum 107 is formed as an injector, or through an injector part extending into the drum or similar arrangement by the pressure liquid and driven to the bottom of the drum 107. By this means the liquid is thoroughly saturated with SO_2 gases. In this case of over-saturation the remainder of the non-absorbed gases passes, finely divided in the liquid, with the latter through a cooling coil 108' connected to the drum 107 and lying in water, in which coil further absorption takes place owing to a further cooling. The gas liquor thus produced is then itself passed under the action of gravity into the quiescent digester or digesters 3 which are under full pressure, but more particularly for the impregnation of the raw material into the separator 17. For this reason this arrangement is placed at a suitable height.

The over-flowing cooling water which has been heated in the coil vessel 50 is conveyed through a pipe 106 into the upper part 43 of the superposed part 4y of the final digester 4, where it dilutes the pulp before reaching the weir 46 without chilling it, so that the digested pulp can be easily washed and bleached.

The superposed parts 1z and 4z of the digesters and bends 21, 27, 33, 38, the insertions 26, 37 and the casings of the separators 24, 25, 31, 32, 41, 42, 47, 11, 15, 17, 18, will preferably be made of a special metal or special steel, which is capable of resisting the action of liquors or acids.

For subsequent treatment or improvement with alkaline liquors it is preferable to erect separate improving digesters for which purpose the rotary agitating digesters of iron or steel are suitable which have proved satisfactory in the sodium cellulose industry. It will be found advisable to make such improving digesters of so-called non-rusting acid-resisting steel or iron with rivets of the same material, in which case the riveting may be carried out in the cold state.

The improving digesters are with advantage connected to the final digester 4, the arrangement being such that the first improving digester 130 is directly connected, as indicated in the drawing, and then the other improving digesters are connected by means of extended branches of a double cross pipe 125 in both directions (not shown in the drawing).

In the drawing there is shown by way of example a direct connection with the final digester 4, which connection might be made on three sides of the final digester by means of a slide valve 67, a slide valve 68 and by means of a slide valve 126 which is connected by a pipe to the slide valve 30 below the final digester 4. All these slide valves lead to the cross-piece 125 which is connected over a further slide valve 127 with the hollow gudgeon 129 of the agitating digester 130. Behind the slide valve 127 are connected a steam pipe 69 and a supply pipe 128 for liquor or washing water. One arm of the double cross-piece 125 may be provided with a small pulp slide valve for the withdrawal of samples, the other lateral arms being closed by blind flanges so as to allow of further improving digesters being connected up. The double cross pipe 125 can, however, as shown in the drawing be connected through the slide valve 30 to the lower connecting pipe 27 leading to the digester 4 so that should occasion arise it is possible to withdraw a less-digested cellulose.

The liquor outlet pipes 93, 95 and 133 from the improving digester may be connected to the digesting liquor pipes 94, 54 and 96 for continuous digestion.

According to the invention the internal pressure in the various digesters is produced not by steam but by a liquid column whereby a liquid temperature corresponding to this liquid column can be obtained. The values are dependent not only on the height but also on the density and the different resistances of the pulp in the digesters, which factors may be made as high as is required by the raw material and the kind of digesting process employed.

For producing sodium and sulphate straw cellulose, the normal plant shown in the drawing will suffice, even for very large outputs. As, however, when producing cellulose from our cereal straw, maize, rice, esparto, bamboo, reed and

the like raw materials containing much salicic acid, the recovery of the soda from the liquors is made difficult and uneconomic by the accumulation of salicic acid, it is preferable with the new process to pre-digest with sulphite liquor and only at the end to re-digest with sodium liquor. In this case only small quantities of alkalies will be required, the final liquor of which may be atomized with great advantage to the sulphite digesting liquor for the preliminary sulphite digesters, where it can still do good service and when completely spent be used with the sulphite waste liquor for various by-products. With this combined and cheap process instead of a brown pulp a whitish pulp is obtained which can be easily completely bleached, is much firmer and has many more valuable properties than the brown pulp hitherto obtained by the costly sodium or sulphate process.

For producing the sodium and sulphate wood cellulose for which the resinous pinewood, the red beech and similar kinds of wood are suitable, the plant shown in the drawing can be used for the purely alkaline process but without an inner lining, being, however, constructed for a greater pressure. It is simpler, more rational and preferable in this case as well, when employing the new continuous digesting process, to work according to the cheaper sulphite process as described for straw pulp and only at the end to re-digest with the expensive alkaline liquor.

By the arrangement of several digesters one above the other, it also becomes possible to vary the treatment of the last digesting liquor which is thoroughly saturated with incrustations and is, therefore, too thick for impregnation, and this liquor is added only to the raw material which has already been fully impregnated in an upper digester. It is taken by the separators 24, 25 from the passage between the digesters 3, 4 and by means of the conduit 91, the injector 57 and the conduit 97, is fed into the pre-digester 1 (Fig. 1) at the top, or into a separator 19 between the pre-digesters 1 and 1*b* or 1*c* and 1*b* (Fig. 2). For impregnating the raw material which is fed from the storage container 110 by means of fans 111 through a feeding device, for example 112, 113, and is preliminarily steamed in the preliminary steamer 16, it is of advantage to use a thin gas liquor, or single gas liquor, which is obtained from the residual gases in the recovering apparatus 50, and is introduced through the pipe conduit 87. This thinly liquid and concentrated gas liquor forces its way into the pores of the fibres which have been opened by the steaming and swelling and in between the fibres of the raw material where it combines with the gases which have already forced their way in and which have risen from the lower pre-digester or are fed to the separator 17 from the main digester 2, from the conduit 86 and from the upper receiver 49 through the conduit 86 etc., and thereby causes that in the subsequent digesting of the material the decomposition begins in the interior and proceeds from the inside towards the outside so that through the introduction of the thick last circulation liquor, which contains much incrustation, the premature decomposition of the exterior fibre layers is avoided since these outer fibre layers remain protected from premature decomposition and attack by the incrustations which surround them.

In order that the entry of this end liquor which has been completely used in the large pre-digester 1, into the main digester 2, and the unnecessary dilution of the better digestion liquor supplied there may be avoided, there is placed between the pre-digester 1 and the main digester 2 a pulp washer which consists in this, that in the separators 24 and 25 interposed in the lower connecting conduit between the digesters 1 and 2 the end spent liquor is removed as long as it shows that it is completely used up, if necessary, until the material is completely thickened.

The exhausted end liquor may, for example, in passing out of the pre-digester 1, be further treated in the knee piece 2 with superheated steam which is supplied through the branch 77 of the conduit 69, 71 below the sieve plate 22. At this stage, superheated steam does no harm but decomposes the end liquor to such an extent that it drives out the SO_2 gas and carries it back into the pre-digester 1.

The pulp which is to pass from the digester 1 into the digester 2 is concentrated, that is, it is to a large extent freed from the spent waste liquor accompanying it, but the gas liquor forced into the pores and the firmly adhering incrustations go with it. The pulp thus reaches the lowest part of the connection in the inlet knee 27 under the main digester 2 where it is diluted and agitated by the steam liquor mixture which enters through the injector 52 and the branch tube 78 under the sieve plate 29. The better digesting liquor used here flows through the conduit 96 to the injector 52. The waste liquor still adhering to the exterior of the pulp is thereby washed away, while the impregnating liquor which has been forced into the raw material and the firmly adhering incrustations suffer little loss, because the operation proceeds rapidly and in the following separator 31, shortly before entering the main digester 2, the resulting washing liquor is again withdrawn and led to the injector 57 through a tube 91, which injector delivers it together with the circulation liquor supplied through the conduit 91, from the digester 3 through the pressure conduit 97 into the separator 19 or through a perforated distributing tube or the like, directly into the pre-digester 1.

The pulp which again has been concentrated by the removal of the liquor in the separator 31 and has been completely freed from the waste liquor, that is, has been thoroughly washed, is diluted at the same time in the digester 2 with the above mentioned better circulation liquor through the perforated distribution tube 62. From the last digester 4 in which the fresh liquor introduced is only slightly exhausted, and in the upper separators 41, 42 of which the liquor is separated from the digested cellulose and led through the pipe conduit 96 to the injector 52 and in this with the steam, if necessary, superheated and mostly absorbed by the liquor, it is heated so that only any excess remaining after sufficient cooling or moistening is delivered together with the heated liquor into the main digester 2.

A similar washing may take place during the digestion with small deviations and under the digester 4. A closer description of this is not necessary, since the process will be quite clear from the drawing together with the above description. For washing the pulp before entering the last digester proper, the pure fresh liquor is always used as washing liquor. The resulting liquor (mixed liquor) which is withdrawn after the washing is always led back one stage, that is into the preceding digester, so that the liquor is entirely used up.

In the second or a further removal of the di-

gestion liquor, its decomposition is not carried out by directly supplying superheated steam, because at this stage superheated steam introduced directly would damage the pulp.

In the main digestion in the digester 2, the internally impregnating gas liquor, is also digested, so that a part of the interior incrustation is released and passes over into the digestion liquor. This digestion liquor (circulation liquor) is, for the most part, withdrawn from the pulp again in the separator 32 on leaving the digester 2 and is supplied through a tube to the injector 58 in which it is mixed with the concentrated pressed liquor coming from the concentrating apparatus 100 through the conduit 98, and, further, is enriched with the gases from the digester 2 collected in the superposed part 35, 36, and is driven in a hot condition through the pressure conduit 88 into the separator 17 before entering the pre-digester 1c or the superposed part 1z (Fig. 1). There the liquor is mixed with the strong gas liquor flowing in through the conduit 87 and is drawn away for impregnating the raw material, while the small amounts of incrustation carried with it begin to adhere to the outer layers, which process is assisted by diffusion. Where an intermediate diffusion digester 1b (Fig. 2) is present, this enriched liquor with little incrustation may also be introduced before the raw material.

Also the main digester 2 and the enriching digester (quiescent digester) 3 may consist of two or more digesters placed one above the other.

From the main digester 2 the pulp passes through the upper connecting pipe 32—38 into the adjacent digester. In this quiescent digester the impregnation liquor which has been digested in the main digester 2 and which has been partly removed is replaced by concentrated thin liquid gas liquor with the object of further impregnation or is enriched; the further impregnating process is assisted by diffusion in the quiescent state. The strong gas liquor is led from the recovery apparatus 50 through the conduit 108 into the sieve chamber 40 and through its sieve plate 39 into the upper knee piece 38 of the digester under the action of gravity. The mixed liquor in the quiescent digester 3 can also be concentrated by the digester waste gas or compressed SO_2 gas introduced in the opposite direction through the perforated distributing tube 63 and supplied through the conduit 145.

This renewed impregnation is the principal object of the quiescent digester or the quiescent interval and has great importance for the further digestion process. In the further digestion process the procedure is repeated as explained above according to the number of digesters. The more often the pulp is further impregnated during a quiescent interval in the digestion, the more uniform and capable of being bleached is the pulp. For this purpose and, for example, a construction with an upper quiescent digester and a further quiescent digester may be employed.

The individual digesters are connected in series by stuffing box tubes 20, 26, 37, which act, at the same time, as extension members which make possible easier replacement of the packings and also make the vibrations or stresses of the digesters harmless.

For preliminarily steaming the raw material which is introduced, it is also possible to use exhaust steam from an external source, and also the exhaust steam from the digester with a small pressure to overcome the resistance in passing through the raw material. When external exhaust steam is used in the upper part of the predigester, a great saving in live steam is obtained. As already stated, the hot gas steam mixture from the waste liquor and from the upper receiver 49 is used, which is not led directly into the recovery apparatus 50 for producing the waste gas liquor from the various excess gases or waste gases, but indirectly through the pre-steaming apparatus 14—17 where this and similar gases and vapours are usefully employed, and are partly absorbed. Only the residue cooled by the fresh raw material is sucked into the cooler 107 of the so-called recovery apparatus 50 for absorption in the pressure liquid for producing the gas liquor through the separator 15, the pipe conduit 90 by means of the liquid injector 60, which is driven by the pressure water 104 or by the pressed out liquor 103 which has been enriched in the enriching apparatus 100 and put under pressure by means of the liquor pump 101. The same applies to the gas steam mixture in the pipe conduit 80 which operates the injector 58 and originates in the main digester 2.

Below each upper digester (1b, 1c and 4b) there is interposed a separator 19 which serves to introduce SO_2 in gaseous form, if necessary, in excess through conduits 99 or 141. or 146. In this way, on the one hand, the spent digesting liquor (circulation liquor) may be concentrated and the impregnating and acid bleaching process furthered, and on the other hand, more gas liquor, partly serving this purpose, but acting more quickly can be produced. The same applies to the introduction of the compressed gases in the quiescent digester 3 through the inlet tube 145 and the perforating distributing tubes 63, and to the gas inlet 144 in the enriching apparatus 100.

The separators 19 also serve for introducing circulation liquor (digestion liquor) for example into the pre-digester or to gas liquor into the upper final digester (bleaching or acid bleaching digester) 4b (Fig. 2) through a conduit 147.

The main digester 2 has at the top at the highest point of the connecting pipe on the knee piece 32 a gas vessel 35, with a lower sieve plate 34, for keeping back the pulp and with a connecting pipe to the injector 58 which is joined to the cover 36, for operating the injector with the gas and vapour set free in the two digesters. In the gas vessel 35, the escaping gases and vapour collect more easily above the sieve plate 34 and the more uniform removal of gas and operation of the upper injector 58 is ensured. The removal of the pulp may also occur prematurely, that is before the over-flow 46 either periodically, for example for filling the improving digesters, or partially and continuously for simultaneous working up of a part of the cellulose which is not completely digested. The removal is then effected, for example by means of a pulp slide 67 and 68, on the final digester, or by means of the slide valves 30 on the lower connecting pipes which also are used for completely emptying the digesters for repair, in which case the residual pulp can be completely digested in the improving digester.

As a rule, however, the pulp is recovered in the extension of the neck of the digester of the final digester 4 or 4b, or in the superposed part 43 connected with the final digester beside which the adjustable overflow slide 46 is built. The adjustment slide of the overflow slide valve 46 is, of course, always so much smaller than the slide of the front liquid column the greater are the losses in the operation which are caused by the immobility of the compact mass and resistances

in the curves, passages and narrow places, compressing devices, and the like. Thin pulp requires a higher thicker pulp, a lower adjustment of the over-flow slide 46. This adjustment is, however, effected automatically by connecting the over-flow slide 46 through a rope 45 with the float 44 in the superposed part 43. When there is a larger pressure on the float 44 through the floating in of the thinner pulp, the float 44 rises and allows the over-flow pulp 46 to sink so that more thin pulp can flow away. If, on the other hand, the pulp is thicker, its flow into the superposed part 43 is less rapid, the float 44 sinks and raises the over-flow slide 46 so that less of the thick pulp flows over. Consequently, on the one hand, the liquid column (pulp column) above the pre-digester cannot rise or fall too far, and consequently the flow of pulp for treatment is uniform and independent of the thickness of the material, of thick pulp less and of thin pulp, on the other hand, more is allowed to pass on the slide 46; both pulps, however, are compacted in the worm members 139 to the same density, and consequently also to the same amounts after which only they are delivered to the mills and then again diluted to the same amounts and further treated. The liquor pressed out which is still good but diluted by the warmed cooling water supplied through the conduit 106 is introduced into the enriching apparatus 100, as far as possible in an atomized state through the conduit 109, in which apparatus it is enriched with the pure SO_2 gas (for example compressed SO_2 gas) introduced through the pipe 144, or the like. From this enriching apparatus 100, which may preferably consist of larch wood, the liquor containing gas which is kept in circulation by the pump 101 is, therefore, well enriched, and is partly passed through the conduit 98 to the injector 58, and is, further, used for impregnating the raw pulp, while a part is circulated through the conduit 102 through an excess pressure valve provided in the pipe conduit 103, or is forced through the pipe 103 into the recovery apparatus 50 where this liquor instead of pressure water or together with the same, operates the injector 60 and is further considerably enriched. Several such enriching apparatus 100 and, more particularly, several recovery apparatus 50 which are connected by any pipe conduits may also be erected.

The gases and vapours which rise from the finished pulp in the superposed part 43 are likewise led through the separator 47 by a pipe 105 to the suction and pressure injector 60 where, together with the exhaust gases supplied from the preliminary steamer 16 through the separator 15 and the conduit 90 they are used in the recovery apparatus 50 (as above described) for the production of gas liquor.

The sulphite digesters have hitherto been lined with an acid-resisting lining. This has hitherto been made of sheet lead but now is only made of acid-resisting concrete and tiling or the like which often requires repairing and other large expenditure. According to the present invention even for the sulphite process unlined digesters are used which may consist not of ordinary steel or iron sheet but of other materials which require no protection. For this purpose it may be made of non-corroding acid-resisting steel or of a special iron having such properties or also of other materials which possess such properties and also of sheets and rivets of similar or dissimilar material, for example, cold riveted or also welded. They may also be made of different parts of such materials screwed together by means of flanges or of such or similar materials or compositions or alloys cast in separate parts, which are left rough on the inside and are screwed together at the outside, the flanges forming stiffening ribs. Different materials of the same or similar properties may be used for different parts. Cast and screwed digesters will naturally be used more for smaller digesters, for example, for the upper digesters of the continuously working digestion plant in which the pressure is so small that digesters of special cast iron may be used directly and without danger, more particularly because in them, and also outside there are no considerable variations of temperature. For the large and lower digesters riveted digesters are preferably used. Amongst the materials referred to steel alloys, for example, chromium, nickel, molybdenum, steel, amongst others, and also iron alloys as, for example, the so-called neoferrochrome and, finally, the so-called iron-bronze amongst others, may be used.

Instead of the injectors, partly or wholly rotating pumps may be used for the liquor circulation, in which case it is directly possible to introduce the digestion vapour into the pressure conduit so that this does not reach the digester alone and directly, and possibly in a superheated state, but is taken up by the liquor and only any excess in a cooled or saturated state is carried with the liquor into the digester in finely divided form. In certain circumstances steam of lower pressure than the prevailing digester pressure, such as waste steam and exhaust steam, may be introduced into the suction conduit through nozzles distributed at various points and so introduced to the digester. The introduction of such low pressure steam into the suction conduit, more particularly when the liquor is being supplied, may preferably be carried out near to the pump where the pressure is equalized.

The separators used in the arrangement described can also be cleaned during the operation, that is, the inner sieves may be freed from fur, pulp residue, mud and the like, by nozzles or spraying tubes, roses or the like for live steam, gas or solvents being arranged between the casing and the inner sieve. These media may be introduced separately or together.

The cellulose produced according to the method described may be bleached with alkaline manganates, peroxides, hypochlorites, aqueous solution of chlorine, chlorine gas or other media. All these and other treatments may with advantage be carried out in the so-called improving digesters 130 connected to the end digester. The digested cellulose is introduced into the improving digester, is there freed from liquor, if necessary is pressed with steam, air or gas pressure, is washed and if necessary pressed out again, then a part is mixed with a bleaching agent, is again compacted and washed and in the unbleached condition further steam is injected or the material is completely bleached. In this case the bleach with aqueous chlorine solution or even with pure chlorine gas bleach can with great advantage be led directly from the tanks with liquid chlorine according to the raw material to be treated. In order to assist the bleaching process in the improving digesters at a suitable time, for example, air, oxygen, carbon dioxide or a liquid dilute acid or another agent which assists the bleaching action may be added during the operation.

The apparatus according to the invention is

also especially suitable for carrying out a new method of digesting cellulose in the factory with pure or nearly pure gas liquor, that is aqueous solution of the SO_2 gas or free sulphurous acid without or with very small additions of lime or other bases.

This method which perhaps has hitherto been known only through laboratory experiments has very many advantages and in all cases with the assistance of this apparatus can be used in factory operation since only in this or a similar apparatus can the very unstable gas liquor which very easily loses the gas which is only loosely absorbed be advantageously employed. This liquor is continuously concentrated during the digestion process and the gas set free is mostly carried along with vapours or mixed therewith, while the excess of this gas is used continuously and in the shortest way for concentrating and for producing new gas liquor.

The advantages of such a method of digestion with free sulphurous acid at a very low temperature but under sufficient pressure are very important as regards the output, strength, purity and capability of bleaching of the pulp, so that a great economy is the result especially with the low price of liquid sulphurous acid prevailing at the present day.

Through the use of liquid sulphurous acid a series of expensive arrangements can be dispensed with, more particularly the inconvenient liquor plants from the treatment of pyrites up to and including tower operation and the separate recovery of the waste gases which, however, is only partly effected in periodic operation.

The liquor referred to better called acid as distinct from the lime-containing liquor from the towers, is chemically and mechanically quite pure without loam and earthy substances, without arsenic, selenium, iron and the like, and does not deposit any lime, either mono-sulphite or gypsum, on the apparatus and on the fibres. The fibres remain pure and therefore form an excellent pulp which is especially suitable for artificial silk, more particularly transparent artificial material, the best kinds of paper and similar valuable products. The apparatus may forthwith be constructed more particularly for this purpose, if necessary, also with indirect or mixed steam heating.

What we claim is:—

1. An apparatus for digesting cellulose and similar materials comprising a battery of digesters, devices for continuously regulating the introduction of the raw materials and of the chemicals, and devices for continuously regulating the removal of the digested cellulose, the chemicals, and end liquors, the digesters forming communicating vessels in order that the raw material may be continuously supplied and may pass through in a continuous stream; the end digester consisting of a plurality of digesters connected one above another to form an aggregate.

2. An apparatus for digesting cellulose and similar materials comprising a battery of digesters, devices for continuously regulating the introduction of the raw materials and of the chemicals, and devices for continuously regulating the removal of the digested cellulose, the chemicals, and end liquors, the digesters forming communicating vessels in order that the raw material may be continuously supplied and may pass through in a continuous stream, and connections between the digesters, arranged alternating at the top and the bottom, which are made to slope so that they form an incline for the better movement of the mass.

3. An apparatus for digesting cellulose and similar materials comprising a battery of digesters, devices for continuously regulating the introduction of the raw materials and of the chemicals, and devices for continuously regulating the removal of the digested cellulose, the chemicals, and end liquors, the digesters forming communicating vessels in order that the raw material may be continuously supplied and may pass through in a continuous stream, and sloping connecting pipes between the digesters and inlets for steam liquor or gas arranged at the lowest points of the connecting pipes for loosening and feeding the material forward at these points.

4. An apparatus for digesting cellulose and similar materials comprising a battery of digesters, devices for continuously regulating the introduction of the raw materials and of the chemicals, and devices for continuously regulating the removal of the digested cellulose, the chemicals, and end liquors, the digesters forming communicating vessels in order that the raw material may be continuously supplied and may pass through in a continuous stream, and sloping connecting pipes between the digesters and an outlet for gases and vapours at the highest point of the upper connecting pipe.

5. An apparatus for digesting cellulose and similar materials comprising a battery of digesters, devices for continuously regulating the introduction of the raw materials and of the chemicals, and devices for continuously regulating the removal of the digested cellulose, the chemicals, and end liquors, the digesters forming communicating vessels in order that the raw material may be continuously supplied and may pass through in a continuous stream, and an automatic regulating apparatus in the inlet conduit of the first digester for regulating the introduction of the raw material according to the progress of the digesting process.

6. An apparatus for digesting cellulose and similar materials comprising a battery of digesters, devices for continuously regulating the introduction of the raw materials and of the chemicals, and devices for continuously regulating the removal of the digested cellulose, the chemicals, and end liquors, the digesters forming communicating vessels in order that the raw material may be continuously supplied and may pass through in a continuous stream, and an automatic regulating apparatus in the inlet conduit of the first digester for regulating the introduction of the raw material, and a signalling device, acted on by the automatic regulator, for indicating the state of the introduction of material.

7. An apparatus for digesting cellulose and similar materials comprising a battery of digesters, devices for continuously regulating the introduction of the raw materials and of the chemicals, and devices for continuously regulating the removal of the digested cellulose, the chemicals, and end liquors, the digesters forming communicating vessels in order that the raw material may be continuously supplied and may pass through in a continuous stream, and a pulp-overflow corresponding to the height and density of the liquid column in the digesters joined to the extension of the neck of the end digester.

8. A method of digesting cellulose and similar materials in which the raw material passes continuously through a battery of digesters on account of the hydrostatic pressure in the battery,

characterized by the feature that fresh liquor is continuously supplied to the already digested pulp, where, after being slightly used up, it is continuously withdrawn from the pulp and is supplied to the preceding digester aggregate, in counter current and after repetitions, according to the number of digesters, it is finally supplied to the fresh raw material, and, after being used more rapidly, is led away continuously and uniformly into the first digester as end liquor.

9. A method of digesting cellulose and similar materials in which the raw material passes continuously through a battery of digesters on account of the hydrostatic pressure in the battery, characterized by the feature that in the continuous working process, the pulp is first treated in some digesters, according to the sulphite process, and only then in further digesters, according to the soda process, or any other special process, the end liquors from the final process, for example the alkali end liquors being added to the circulating sulphite digesting liquor in the preceding digesters.

10. A method of digesting cellulose and similar materials in which the raw material passes continuously through a battery of digesters on account of the hydrostatic pressure in the battery, characterized by the feature that the end liquor, after being utilized in the first digester, is removed, after which the pulp before passing into the main digester is treated with a part of a better, purer and stronger digesting liquor as washing liquor, and then is again freed from the greater part of this liquor and is thus thoroughly washed, after which the pulp is mixed with the next better liquor and passes into the main digester, while the waste washing liquor, in order that it may be completely utilized, is led back into the first digester, which washing process may also be carried out with other digesters with the passage at the bottom.

11. An apparatus, having steam injectors employed for delivering the hot circulating digestion liquor and means for cooling steam which is too hot and preheating fresh liquor before entering the end digester.

12. An apparatus for digesting cellulose and similar materials comprising a battery of digesters, devices for continuously regulating the introduction of the raw materials and of the chemicals, and devices for continuously regulating the removal of the digested cellulose, the chemicals, and end liquors, the digesters forming communicating vessels in order that the raw material may be continuously supplied and may pass through in a continuous stream, and means for removing the end liquor from the first digester and a branch conduit for super-heated steam arranged in front of the means for removing the end liquor through which the remaining SO_2 gases from the liquor are set free and returned to the digester.

13. An apparatus for digesting cellulose and similar materials comprising a battery of digesters, devices for continuously regulating the introduction of the raw materials and of the chemicals, and devices for continuously regulating the removal of the digested cellulose, the chemicals, and end liquors, the digesters forming communicating vessels in order that the raw material may be continuously supplied and may pass through in a continuous stream, and passages for gases and liquor and regeneration devices provided in the passages.

14. An apparatus for digesting cellulose and similar materials comprising a battery of digesters, devices for continuously regulating the introduction of the raw materials and of the chemicals, and devices for continuously regulating the removal of the digested cellulose, the chemicals, and end liquors, the digesters forming communicating vessels in order that the raw material may be continuously supplied and may pass through in a continuous stream, and passages between the individual digesters and separators arranged in the passages for separating the liquids, gases and vapour from the mass, or supplying them to the mass.

15. An apparatus for digesting cellulose and similar materials comprising a battery of digesters, devices for continuously regulating the introduction of the raw materials and of the chemicals, and devices for continuously regulating the removal of the digested cellulose, the chemicals, and end liquors, the digesters forming communicating vessels in order that the raw material may be continuously supplied and may pass through in a continuous stream, and means for separating the liquids, gases and vapour from the mass consisting of an insertion, the outer coating of which is made of a material resistant to the acid, or the liquor, or is lined with such and has an inner cylindrical sieve consisting of a material which is resistant to the acid, or the liquor, the outer casing being provided with branches for the introduction and removal of chemicals, gases and vapour.

16. An apparatus for digesting cellulose and similar materials comprising a battery of digesters, devices for continuously regulating the introduction of the raw materials and of the chemicals, and devices for continuously regulating the removal of the digested cellulose, the chemicals, and end liquors, the digesters forming communicating vessels in order that the raw material may be continuously supplied and may pass through in a continuous stream, and injectors for supplying heating steam to the digesters so that the digestion liquor is actively circulated and preheated while the steam is cooled.

17. An apparatus for digesting cellulose and similar materials comprising a battery of digesters, the digesters forming communicating vessels in order that the raw materials may be continuously supplied and may pass through in a continuous stream, devices for continuously regulating the introduction of the raw materials and of the chemicals, and devices for continuously regulating the removal of the digested cellulose, the chemicals, and end liquors, and extensions of the necks of the first and last digesters for maintaining the necessary pressure and temperature within the battery, and a separator for removing SO_2 gases in the neck extension of the first digester arranged below the inlet for the raw material.

18. An apparatus for digesting cellulose and similar materials comprising a battery of digesters, devices for continuously regulating the introduction of the raw materials and of the chemicals, and devices for continuously regulating the removal of the digested cellulose, the chemicals, and end liquors, the digesters forming communicating vessels in order that the raw material may be continuously supplied and may pass through in a continuous stream, and digesters arranged one above the other and stuffing box pipes which also act as expansion members for connecting such digesters together.

19. An apparatus for digesting cellulose and similar materials comprising a battery of digest-

ers, devices for continuously regulating the introduction of the raw materials and of the chemicals, and devices for continuously regulating the removal of the digested cellulose, the chemicals, and end liquors, the digesters forming communicating vessels in order that the raw material may be continuously supplied and may pass through in a continuous stream, and an upper container for the waste liquor placed somewhat lower than the level of the liquid column in the digesters, a lower container connected therewith for the passage of the waste liquor from the digesters, and regulating closing members for the inlet height in the upper container for the purpose of maintaining the liquid level in the digesters.

20. An apparatus for digesting cellulose and similar materials comprising a battery of digesters, devices for continuously regulating the introduction of the raw materials and of the chemicals, and devices for continuously regulating the removal of the digested cellulose, the chemicals, and end liquors, the digesters forming communicating vessels in order that the raw material may be continuously supplied and may pass through in a continuous stream, and an upper container for the waste liquor which is placed somewhat lower than the level of the liquid column in the digesters, and a steamer in the raw material inlet to which the gases and vapours released in the upper container are led.

21. An apparatus for digesting cellulose and similar materials comprising a battery of digesters, devices for continuously regulating the introduction of the raw materials and of the chemicals, and devices for continuously regulating the removal of the digested cellulose, the chemicals, and end liquors, the digesters forming communicating vessels in order that the raw material may be continuously supplied and may pass through in a continuous stream, and an automatic regulating apparatus in the inlet conduit of the first digester for regulating the introduction of the raw material according to the progress of the digesting process, and having a vertical screw arranged in the inlet for pressing the raw material which is introduced.

22. An apparatus for digesting cellulose and similar materials comprising a battery of digesters, devices for continuously regulating the introduction of the raw materials and of the chemicals, and devices for continuously regulating the removal of the digested cellulose, the chemicals, and end liquors, the digesters forming communicating vessels in order that the raw material may be continuously supplied and may pass through in a continuous stream, and separators at the inlet of the first digester for introducing and removing steam and gases, and a member disposed between such separators in which the falling raw material is steamed and swollen by rising SO_2 gases.

23. A method of impregnating raw material and fibres in a battery of digesters, characterized by the feature that before the raw material enters the first digester, first moist SO_2 is supplied to it and after it has swollen but still before its entry into the first digester, a thin gas liquor is supplied which in the pores of the raw material combines with the gaseous SO_2 which has been forced in so that an effective opening of the raw material from the inside takes place.

24. A method of impregnating raw material and fibres, characterized by the feature that before the raw material enters the pre-digester, first moist SO_2 is supplied to it and after it has swollen but still before its entry into the pre-digester, a thin gas liquor is supplied which in the pores of the raw material combines with the gaseous SO_2 which has been forced in so that an effective opening of the raw material from the inside takes place; and after the impregnation, and before the beginning of the digestion, the last circulation liquor which is saturated with dissolved incrustations is supplied to the raw material, which incrustations enclose the outer layers of the steamed and impregnated raw material and protect them from premature opening by steam and stronger liquor.

25. A method of impregnating raw material and fibres, characterized by the feature that before the raw material enters the pre-digester, first moist SO_2 is supplied to it and after it has swollen but still before its entry into the pre-digester, a thin gas liquor is supplied which in the pores of the raw material combines with the gaseous SO_2 which has been forced in so that an effective opening of the raw material from the inside takes place; and the fibres digested in the main digester, after the removal of the liquor, are saturated again in a so-called concentrated quiescent digester with fresh, strong gas liquor which, if necessary, is assisted with the introduction of gaseous SO_2 after which the fibres, after the removal of the outer liquor and after addition of fresh liquor, are digested in a further digester, if necessary, in further digesters, or the process is repeated and finally the pulp is completely digested with a fresh liquor in an end digester.

26. A method of bleaching cellulose in a battery of digesters, characterized by the feature that a fully digested pulp, without interrupting its progress through the system of digesters is finally supersaturated with gaseous SO_2, or with gas liquor, whereby the raw cellulose not only takes on a lighter colour, but also its bleaching capability and purity are increased.

27. An apparatus for digesting cellulose and similar materials comprising a battery of digesters, devices for continuously regulating the introduction of the raw materials and of the chemicals, and devices for continuously regulating the removal of the digested cellulose, the chemicals, and end liquors, the digesters forming communicating vessels in order that the raw material may be continuously supplied and may pass through in a continuous stream, and means for automatically regulating the overflow of pulp from the end digester consisting of an overflow sluice and a float connected therewith disposed before the pulp out-flow.

28. A process for digesting cellulose and similar materials, characterized by the continuous passage of the raw material through a battery consisting of one or more digesters, characterized by the feature that the liquor led away from one digester is supplied to a preceding digester as fresh liquor, so that liquor which is very much enriched in incrustations reaches the first digester.

29. A process for digesting cellulose and similar materials, characterized by the continuous passage of the raw material through a battery consisting of one or more digesters, characterized by the feature that for steaming the fresh raw material, and for commencing the digestion thereof in the upper parts above the first digester, waste steam, or exhaust steam, of quite small pressure from an external source is used.

30. An apparatus for continuously digesting cellulose or similar materials having several di-

gesters arranged one above another so that the mass to be treated passes progressively and continuously from one digester to another, a regulating member for maintaining the liquid column in the digesters, the uppermost pre-digester or end digester reaching up to the regulating member for maintaining the liquid column in the digesters.

31. An apparatus for continuously digesting cellulose and similar materials having several digesters arranged one above another so that the mass to be treated passes progressively and continuously from one digester to another, and stuffing box pipes which also form expansion members connecting the individual digesters together.

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