Jan. 9, 1934. O. KREISSLER 1,942,760

PROCESS FOR MAKING PULP FROM FIBROUS MATERIAL

Filed Sept. 30, 1932 2 Sheets-Sheet. 1

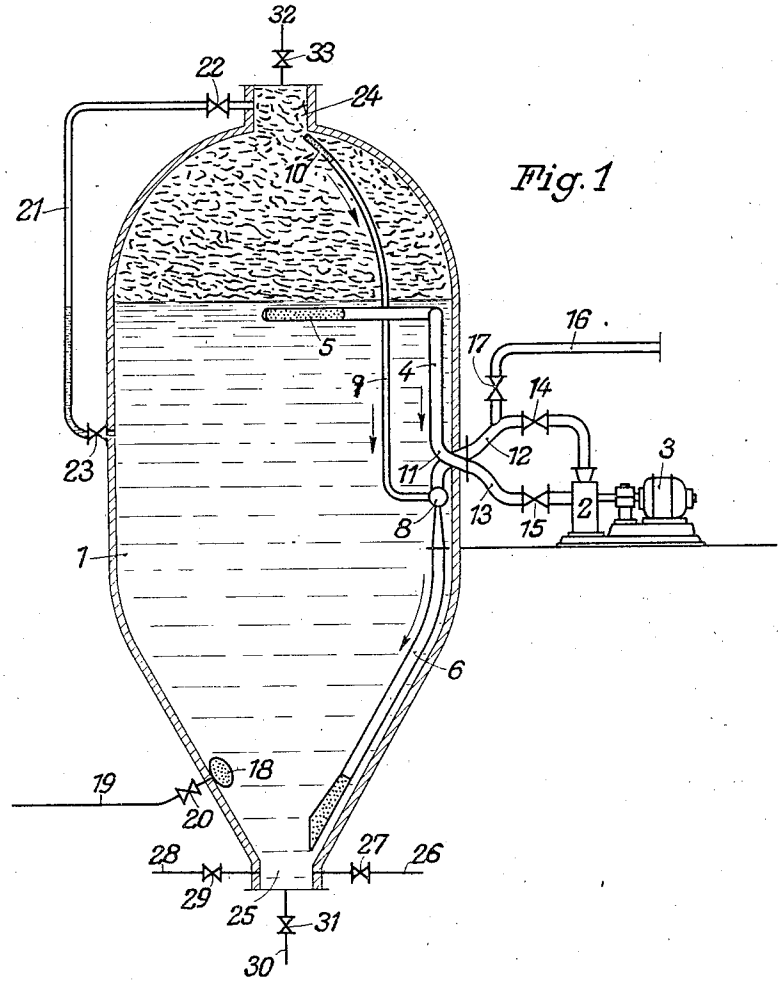


Fig. 1

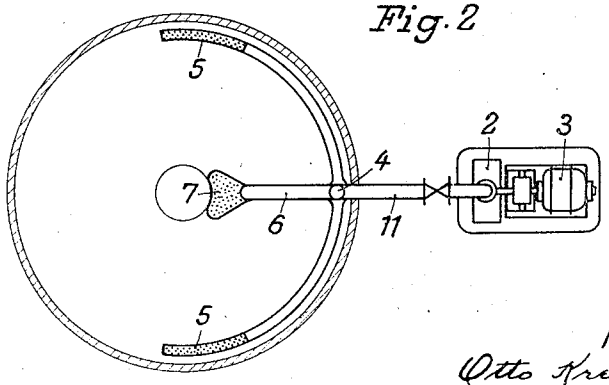


Fig. 2

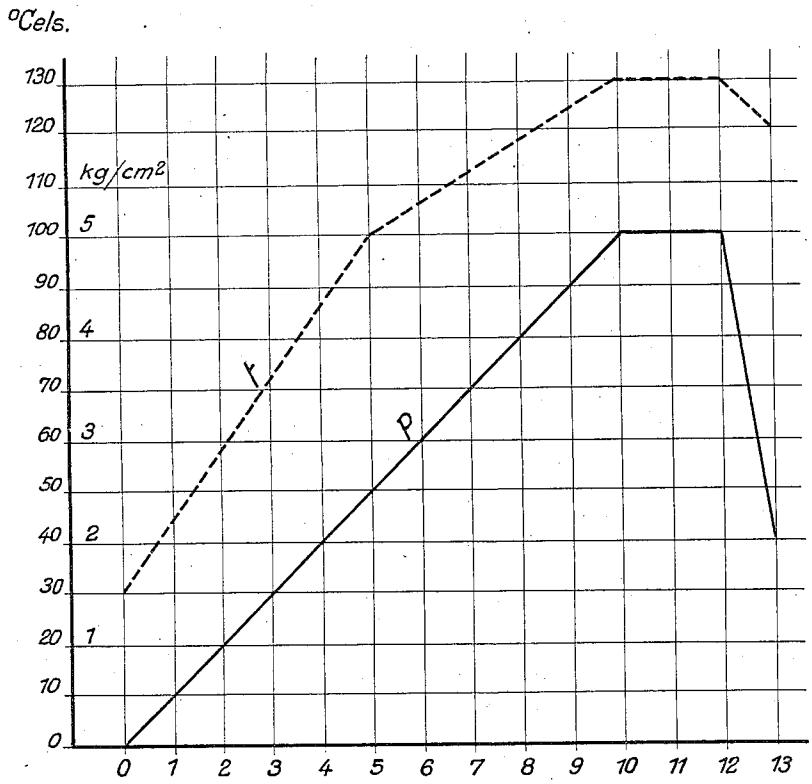
Inventor:
Otto Kreissler,
By Byrne Townsend & Potter,
Attorneys.

Jan. 9, 1934. O. KREISSLER 1,942,760

PROCESS FOR MAKING PULP FROM FIBROUS MATERIAL

Filed Sept. 30, 1932 2 Sheets-Sheet. 2

Fig. 3



Inventor:
Otto Kreissler,
By Byrnes Townsend & Brotter,
Attorneys.

Patented Jan. 9, 1934 1,942,760

UNITED STATES PATENT OFFICE

1,942,760

PROCESS FOR MAKING PULP FROM FIBROUS MATERIAL

Otto Kreissler, Frankfort-on-the-Main, Germany, assignor to American Lurgi Corporation, New York, N. Y., a corporation of New York

Application September 30, 1932, Serial No. 635,673, and in Germany February 17, 1932

14 Claims. (Cl. 92—7)

This invention relates to a process for making pulp from fibrous material.

In making wood pulp, especially with sulphite liquor, it has hitherto been the custom to fill the digester charged with wood completely with the liquor, steam being then admitted in order to obtain the requisite cooking temperature. The steam condensed, and the condensed water increased the volume of liquid in the digester. Moreover, gases, especially sulphur dioxide, were disengaged from the liquor during the cooking process. The rise of pressure, through the increased volume of liquor and the disengaged gases, attained the maximum working pressure (about 5 atmospheres) for which the pulp digesters are usually designed, in a comparatively short time (usually about 2–3 hours) after the commencement of the cooking process. In order to relieve the pressure, it was therefore necessary to open relief pipes in the upper part of the digester from time to time. In the early stages of the cooking process, the chief portion of the discharge through these pipes consists of liquor, which was either cooled and mixed with fresh liquor, or passed to another digester without intermediate cooling with fresh liquor. In the further course of the cooking process, when the level of the liquor in the digester had fallen, gases were mainly drawn off on the relief pipes being opened, these gases being utilized in the same way as the relief liquor. For the most part, the discharged liquor and gases had to be stored before being used again, because the operations cannot be regulated so as to enable the relieved liquor and gases to be utilized immediately in another digester.

This method of procedure is attended with a number of serious drawbacks. In the first place, liquor and gas are withdrawn from the cooking process and require special apparatus for their recovery and utilization. These quantities of liquor and gas also carry away considerable quantities of heat from the digester, thus causing corresponding heat losses. In the digester itself, the liquor was raised to cooking temperature prior to the expulsion of the liquor and gases, and this heating effect was obtained by the condensation of corresponding amounts of steam, the portion of the latter required for heating the discharged liquor and gases being unprofitably expended, for the most part, whilst the corresponding water of condensation from that steam needlessly diluted the liquor in the digester.

Moreover, the existing method of working has the drawback of necessitating the use of liquors with a very high SO_2 content, in order to enable the liquor, progressively becoming weakened or diluted through the continuous loss of gas during the cooking process, to remain sufficiently strong to convert the wood into cellulose up to the end of the cooking process. It is well known, however, that such initially high SO_2 content in the liquor has an unfavourable effect on the character of the fibre, during the early stage of cooking, that is to say, the fibres that are first converted into cellulose are already attacked by the strong SO_2, whereas the bulk of the fibre has not yet been converted.

The composition of the liquor removed from the digester during the several stages of relieving and blowing off was not always the same. At the commencement of the cooking process it was substantially higher in sulphur dioxide than during the further course of the process, the result being to cause special difficulties in re-utilizing the expelled liquor. The amounts of liquor and gas drawn off from the digester being very considerable, it was not directly possible to blend the several concentrations accurately and bring the liquor, freshly prepared with the aid of the relief liquor, to the same standard for all cooks. Consequently, each succeeding cook was affected in a different way, and prevented the attainment of a uniform quality of cellulose throughout. Furthermore, the irregular composition of the liquor, resulting from the relieving and the re-employment of the relieved gases and liquids, also has an important influence on the length of the cooking process, thereby causing irregular working loads throughout the entire series of operations, including the raising of steam, preparation of the liquor and wood material and so forth. Finally, the relieving of the gas and liquor is attended with special losses of material.

It has also been proposed to supply heat to the digester in a more uniform manner, and to mix the liquor in that vessel, the arrangements adopted consisting of such propulsive devices as pumps or injectors. These serve to transfer liquor from a given point of the digester—the top for example—to the bottom or middle, or to one or more other places. In the case of these appliances, the liquor was also, in some cases, heated up outside the digester, on its way from one point of the digester to another. Where this heating was not resorted to, the circulating devices were also disposed inside the digester itself. Even these proposals, however, failed to remove the drawbacks

arising from the increase of pressure during the cooking process and, in particular, the repeated relieving of liquor and removal of gases, in order to relieve the pressure, were inevitable if the capacity of the digester was to be fully utilized, that is to say, the charge of wood in the digester was not to be reduced.

The process of the present invention enables these defects to be overcome. It consists in that, although the digester is fully charged with wood at the outset, it is no longer completely filled with liquor, the amount of the latter being reduced approximately by the quantity necessarily removed during the cooking process by the expulsion of liquor and gas, in the method of working hitherto pursued. It has been ascertained that, by operating according to the process of the present invention, the quality of the cellulose does not suffer in any way but, on the contrary, is substantially improved inasmuch as, at the commencement of cooking, such portions of the wood as are not covered by the liquor are not subjected to any damage. As the cooking progresses, the wood sinks down to such an extent that the whole is submerged in the liquor, and, from that time onward any damage is naturally impossible.

If however, it should be desired to employ special measures to ensure that the wood exposed at the commencement of cooking is protected against damage, this protection can be obtained by impregnating the exposed wood with liquor before cooking commences.

According to the present invention, the preferred method of penetrating with liquor the wood that is exposed in the upper part of the digester before cooking commences, consists in pumping the digester full of liquor at the outset. It is preferable to keep the pump running until the pressure in the digester has risen to about 3 atmospheres, or to a degree corresponding to the normal maximum working pressure of 5 atmospheres or more. When this has been done, the liquor in excess over the limit according to the present invention, is drawn off, for example from the lower part of the digester without opening the top part of the digester, after which the cooking is commenced. Drawing off the liquor from the lower part of the digester, sets up a negative pressure in the upper part, and during the removal of the liquor, part of the air contained in the chips of wood in the top, escapes from the interior of the latter and is at once replaced by liquor. In consequence of the partial vacuum, sufficient gas is liberated by the cooking liquor to allow the liquor to be withdrawn to the extent prescribed by the invention, without any necessity for readmitting air into the upper part of the digester. Finally, this complete filling of the digester with liquor and then withdrawing a portion of the latter effects the complete evacuation of the air in the upper part of the digester.

The liquor to be withdrawn prior to cooking may, however, be taken from any other part of the digester, such as at the top or the middle. In such case the requisite pressure drop for the outflow of liquor from the digester can be produced by means of a pump, or the like, or the vacuum set up in the upper part of the digester through the withdrawal of liquor may be wholly or partially nullified by admitting gases into the digester, preference being naturally given to gases which are favourable for the cooking process, such as sulphur dioxide, relief gases from other digesters, or roasting-furnace gases. Both measures may, of course, be applied simultaneously, the liquor being withdrawn below and the gases admitted into the digester in such quantities as to set up a positive pressure, in the upper part, which facilitates the withdrawal of the liquor.

It has been found in practice that, in the process according to the invention, the pressure in the digester barely exceeds the permissible pressure, throughout the cooking process, so that it is hardly necessary to draw off any of the liquor, or any substantial quantities of gases during the cooking process. At the most, even in cooking with highly concentrated liquor, it is only necessary to remove small quantities of gas during the last few hours, and, in consequence, nearly all the sulphur dioxide present at the outset of cooking is retained until the end.

This advantage can also be utilized by employing very weak initial liquors, such as tower liquors, for cooking. Practical experience has shown that, when weak liquors are used, the digester can be run at very low maximum temperatures, such as 125° C., without any increase in the length of the operation and without having to draw off any gas during the cooking process. This method furnishes a pulp of the best quality and purity, equal to that otherwise obtainable only by indirect cooking, that is to say, in which the heat is indirectly supplied to the cooking liquor. In using strong liquor according to the present invention, it is unnecessary to draw off any gas until the main conversion of the wood into cellulose has been effected. For example, in the case of the known processes carried on with the digester completely filled with liquor, the first withdrawal of gas commenced at a temperature of 70–80° C., whereas, in applying the invention, blowing off the gas—and that to a smaller extent—does not become necessary until the temperature has reached 130° C. and more.

According to the present invention, the circumstance that, owing to the reduced charge of liquor, larger quantities of gas can be stored in the upper part of the digester, is utilized to advantage by continuously returning these gases to the lower part of the digester. At the same time, this measure helps to lessen the increase of pressure in the digester, because, under the increased liquid pressure in the lower part of the digester, larger quantities of gas are absorbed. This circumstance also increases the strength of the liquor to a certain extent, thereby naturally facilitating the cooking process. A point that must be regarded as a particular advantage of the invention is that the heat supplied to the digester is solely expended in effecting the cooking process. It will be evident that, in consequence, and because smaller quantities of liquor have to be heated, the heat consumption for each cooking is very favourable. Moreover, under such optimum conditions of the consumption of heat and liquor, all the digesters in a mill can be arranged and operated so that each works independently and the working conditions (strength of liquor, temperature and pressure) being always constant, it is now possible, for the first time, to obtain a product of uniform quality and quantity from all units.

The return of the gases from the upper part of the digester into the cooking process can be effected by known devices, such as compressors, turbo-blowers or injectors. Such injectors can be operated, for instance, by the steam which has to be employed for the cooking in any case.

Moreover, the liquor itself can also be employed, for example in injectors, for conveying the gases, when the liquor is circulated in the digester in known manner.

The devices for circulating liquor and gases are preferably arranged in the digester itself, in known manner, in order to prevent heat and other losses. The return pipe for the gases can be connected either with the suction or delivery pipe for circulating the liquor. The gas pipe may also be connected to the delivery or suction pipe of the liquor circulator, by means of a branch pipe. If necessary, the gas-return pipe can be connected to a pipe, coming from outside and serving to introduce the other gases into the cooking process. The liquor itself can also be circulated, in known manner, either from below upwards, or vice versa, or vertically or laterally from the centre outwards, and the return of the gases can also be arranged in the same manner. Of course, in all these cases, there is no necessity for the liquor circulation and the return of the gases to be combined.

If the circulation of the gases and liquor be combined in such a manner that the gases and liquor mingle at those points in the circulation where the maximum pressure prevails, the reabsorption of the gases into the liquor is effected in the most favourable manner. In any event, the circulation of the gases and liquor in the process according to the invention also contributes substantially to maintaining the concentration of sulphur dioxide in the liquor, up to the end of the cooking process, at a level hitherto unattainable by employing initial liquors of the same concentration. For example, in practical working, where the initial liquor contained 4.1% of sulphur dioxide, the SO_2 content of the end liquor still amounted to 2%.

It follows therefore that, according to the invention, the amount of the decomposing agent, at the beginning of the cooking process, is small by comparison with the conditions in the known processes, the liquor in action towards the end of the process contains substantially more of said agent than in the known processes. This accounts for the fact that the cellulose obtained in accordance with the invention is of excellent quality, as the result of its uniform treatment throughout the entire cooking process.

With the process according to the invention, relief gases are not formed until the cooking is finished and the positive pressure in the digester has been sufficiently lowered to enable the contents of the digester to be drained off. In operating with high initial concentrations and cooking temperatures above 125–130° C., it is also occasionally necessary to remove relief gases during the final hours of the cooking process. Such gases, however, can be easily utilized in the cooking plant, since their volume is small and their composition always uniform.

They may be introduced, for example, into tower liquor, storage tanks, or into other digesters operating in the initial stage. In the latter case, the process according to the invention affords the further advantage that pressure-increasing conveying devices are not unconditionally required, since, in operating in accordance with the invention, the pressure in the several digesters increases uniformly and gradually. Accordingly, in all cases, gases from a digester which has been cooking for a long time can be allowed to flow directly into another digester which has been started later. This was impracticable in the known processes, because the maximum permissible working pressure in each digester was already obtained in the early stage, for example after cooking had been in progress for 2–3 hours.

According to the invention, the removal of the relief gases can also be considerably accelerated by increasing, with the aid of known conveying devices, such as injectors, blowers or compressors, the inherent positive pressure by which the gases are conveyed from the digester that is to be relieved to the point of utilization. When the cooking is finished, the digester can be made ready for the draining off of the charge by admitting water or similar liquids and thereby completely displacing the gases present in the digester. In such case no alteration is needed in the conveying device or in the utilization of the gases.

By the process according to the invention, the agents employed in the cooking process are therefore utilized to a maximum extent. In particular, with this maximum utilization of the liquor employed and the steam required for cooking, no special plant for the recovery of heat and sulphur dioxide is required any longer.

In various cases it has already been the practice to fill the digester only partially with liquor, for instance with rotary digesters, or when returning the gases from the upper part of the digester to the lower. In all such cases, however, the charge of wood in the digester has been reduced in the same degree, and therefore the capacity of the digester could not be utilized to the full. On the other hand, with the process according to the invention, the digester is completely filled with wood, and even mechanical filling devices can be employed. They have, moreover, special advantages, since the saving in steam and sulphur, and also the quality of the resulting pulp then attain a maximum.

In order more clearly to understand the nature of the present invention, reference will be made to the accompanying drawings, which illustrate diagrammatically and by way of example, one embodiment of the invention in which Figure 1 is a cross section and Figure 2 a horizontal section of the digester, Fig. 3 being a graph illustrative of temperature and pressure gradients attendant upon the cooking operation of the present invention.

1 is the digester. The arrangement for circulating the liquor in the digester consists of the pump 2—driven, for example, by an electro-motor 3—the intake pipe 4, with the two branches 5, and the delivery pipe 6 terminating in a perforated member 7. The gases from the upper part of the digester are returned to the cooking liquor by the injector 8, mounted in the delivery pipe 6 of the pump 2, and the intake pipe 9, terminating in the strainer 10 high up in the digester. For the purpose of connecting the delivery pipe 6 and intake pipe 4 with the externally mounted pump 2, they are passed into a single conduit 11 provided in the wall of the digester and from which the delivery pipe 12 and intake pipe 13, fitted with the throttles 14 and 15 respectively, lead to the pump 2. A pipe 16, provided with the valve 17, for throttling the steam for the cooking process, opens into the pipe 12.

The pipe 19, fitted with the strainer 18 and throttle 20, serves for drawing off liquor from the digester. The gauge 21, fitted with the cocks 22 and 23 serves for inspecting the height of liquor in the digester. 24 is the inlet and 25 the outlet of the digester. Steam can be introduced

into the digester through the pipe 26, whilst the pipe 28 can be employed for charging the digester with liquor. These pipes also are provided with throttles, 27 and 29 respectively. The pipe 30, with valve 31, serves to admit water into the digester. Gases can be led out of the digester through the pipe 32, provided with valve 33.

In working with this apparatus, the process according to the invention is carried out, for example, in the following manner:—

The digester 1, with a capacity, for example, of 225 cu. metres, is charged with chips, either by gravity from the chip bin overhead, or by means of a mechanical filling apparatus, the outlet 25 having first been closed. The valve 29 is then opened and liquor is admitted into the digester through the pipe 28, the inlet 24 being left open. When the digester has been completely filled with liquor, and the interstitial air in the chips displaced, the inlet 24 is closed, but the pump supplying the digester with liquor is left running until a pressure of, for example 3 atmospheres, or also the maximum permissible working pressure of the digester, is attained. The valve 29 is then closed and the valve 20 in the pipe 19 opened. Liquor is then allowed to draw off through the pipe 19 to such an extent that no further withdrawal will be required during the cooking process, 26 cu. metres for example being run off in the case of a completely filled digester of 225 cu. metres capacity. The quantity of liquor removed can be accurately determined by watching the gauge glass 21 in which, after the cocks 22 and 23 have been opened, the liquor attains the same level as in the digester. The digester top is kept shut while the liquor is being run off. Since pulp digesters, as a rule, are sufficiently tall, and gases are disengaged from the cooking liquor when negative pressure sets in, the vacuum produced in the upper part of the digester while the liquor is running off, cannot interrupt the flow of the latter.

When the level of the liquor in the digester has fallen to the desired extent, the valves 20, 22 and 23 are closed, and cooking is commenced by starting the liquor pump 2 and opening the valve 17 in the steam pipe 16. If desired, the steam for cooking, or additional steam for that purpose, can be admitted into the digester by opening the valve 27 in the pipe 26. The pump 2 draws the liquor in through the intake branches 5 and pipe 4, from the upper part of the digester, and forces it through the pipe 6 and perforated head 7 into the bottom of the digester. In addition, the gases collecting in the upper part of the digester are drawn off through the pipe 9 and injector 8 and are mixed with the circulating liquor in said injector and also in the pipe, being more or less completely absorbed by the liquor, so that the gases and liquor enter the bottom of the digester together.

In the event of the maximum working pressure of, for example, 5 atmospheres, being attained in the digester before the end of the cooking process, the valve 33 may be opened, to allow gas to escape through the pipe 32 and relieve the digester pressure. This pipe 32 also serves for carrying off the gases after the cooking is finished. During this latter relieving of the gases, water can be admitted into the digester through the pipe 30. When the digester pressure has fallen to a sufficient extent, the pulp is discharged through the outlet 25, and the digester is ready for a fresh charge.

Figure 3 shows the course of the temperature and pressure in a cooking operation according to the invention. The pressure p in the digester rises gradually and steadily, and the maximum pressure is not attained until cooking has continued for 10 hours at a temperature of 130° C., so that it is not until the end of that period that the withdrawal of gas will be required if the cooking temperature is to be further increased.

I claim:

1. A process for making pulp from fibrous material with sulphite liquor which comprises charging the digester before cooking begins with a quantity of liquor which is smaller than usual by the amount that would otherwise have to be removed by relieving and blowing-off, without reducing the quantity of wood charged into the digester, and irrigating the wood above the level of the liquor with cooking liquor and thereupon carrying out the cooking in the usual manner.

2. A process for making pulp from fibrous material with sulphite liquor which comprises charging the digester before cooking begins with a quantity of liquor which is smaller than usual by the amount that would otherwise have to be removed by relieving and blowing-off, without reducing the quantity of wood charged into the digester, and irrigating the wood above the level of the liquor with cooking liquor at the commencement of the cooking process.

3. A process for making pulp from fibrous material with sulphite liquors which comprises filling the digester full of both wood and cooking liquor before cooking commences, drawing off so much of the liquor as would otherwise have to be removed by relieving and blowing-off, thereupon commencing cooking and circulating the liquor and returning the gases from the upper part of the digester into the cooking liquor.

4. A process for making pulp from fibrous material with sulphite liquors which comprises filling the digester full of both wood and cooking liquor before cooking commences, subjecting the liquor to pressure, drawing off so much of the liquor as would otherwise have to be removed by relieving and blowing-off, thereupon commencing cooking and circulating the liquor and returning the gases from the upper part of the digester into the cooking liquor.

5. A process for making pulp from fibrous material with sulphite liquors which comprises filling the digester full of both wood and cooking liquor before cooking commences, subjecting the liquor to a pressure which can be increased to the maximum permissible working pressure of the digester, drawing off so much of the liquor as would otherwise have to be removed by relieving and blowing-off, thereupon commencing cooking and circulating the liquor and returning the gases from the upper part of the digester into the cooking liquor.

6. A process for making pulp from fibrous material with sulphite liquors which comprises filling the digester full of both wood and cooking liquor before cooking commences, maintaining a vacuum in the upper part of the digester, drawing off so much of the liquor as would otherwise have to be removed by relieving and blowing-off, thereupon commencing cooking and circulating the liquor and returning the gases from the upper part of the digester into the cooking liquor.

7. A process for making pulp from fibrous material with sulphite liquors which comprises filling the digester full of both wood and weak cooking liquor before cooking commences, drawing off so much of the liquor as would otherwise

have to be removed by relieving and blowing-off, thereupon commencing cooking and circulating the liquor and returning the gases from the upper part of the digester into the cooking liquor.

8. A process for making pulp from fibrous material with sulphite liquors which comprises filling the digester full of both wood and cooking liquor containing 2 to 4% sulphur dioxide before cooking commences, drawing off so much of the liquor as would otherwise have to be removed by relieving and blowing-off, thereupon commencing cooking and circulating the liquor and returning the gases from the upper part of the digester into the cooking liquor.

9. A process for making pulp from fibrous material with sulphite liquors which comprises filling the digester full of both wood and weak digester liquor, drawing off so much of the liquor as would otherwise have to be removed by relieving and blowing-off, thereupon commencing cooking at a low maximum cooking temperature and circulating the liquid without circulating the gases.

10. A process for making pulp from fibrous material with sulphite liquors which comprises filling the digester full of both wood and strong cooking liquor, drawing off so much of the liquor as would otherwise have to be removed by relieving and blowing-off, thereupon commencing cooking and circulating the liquor and only returning the gases from the upper part of the digester into the cooking liquor when the temperature reaches 120–130° C.

11. Process of making pulp by cooking fibrous material with sulphite liquor, distinguished by the fact that the cooker is filled completely with the material to be cooked, before the cooking, but is filled with liquor only so far that the material to be cooked is at first not completely immersed therein, as long at the beginning of the cooking as the cooking temperature exhibits a low degree of heat preventing discoloration of the cooking material above the level of immersion, complete immersion of the material in the liquor occurring only upon increase of the cooking temperature in connection with the rise in the level of the liquor produced by the boiling.

12. Process according to claim 11, distinguished by the fact that the cooker first is filled entirely before the cooking operation both with the material to be cooked and with the liquor, and then only is the reduced liquor filling produced before the cooking begins.

13. Process according to claim 11, distinguished by the fact that the cooker first is filled entirely before the cooking operation both with the material to be cooked and with the liquor, the latter being under pressure, and then only is the reduced liquor filling produced with production of a partial vacuum in the upper cooker chamber filled with material to be cooked, before the cooking begins.

14. Process according to claim 11, distinguished by the returning of expelled gases and of the liquor from the upper part into the lower part of the cooking chamber by a pump in which both the gas and the liquor lines are arranged inside the cooker and the two are connected together by a jet apparatus fed by the liquor pipe, whereby the gases are drawn off from the space above the liquor level and moved with the aid of the jet apparatus fed by the liquor pipe inside the cooker.

OTTO KREISSLER.