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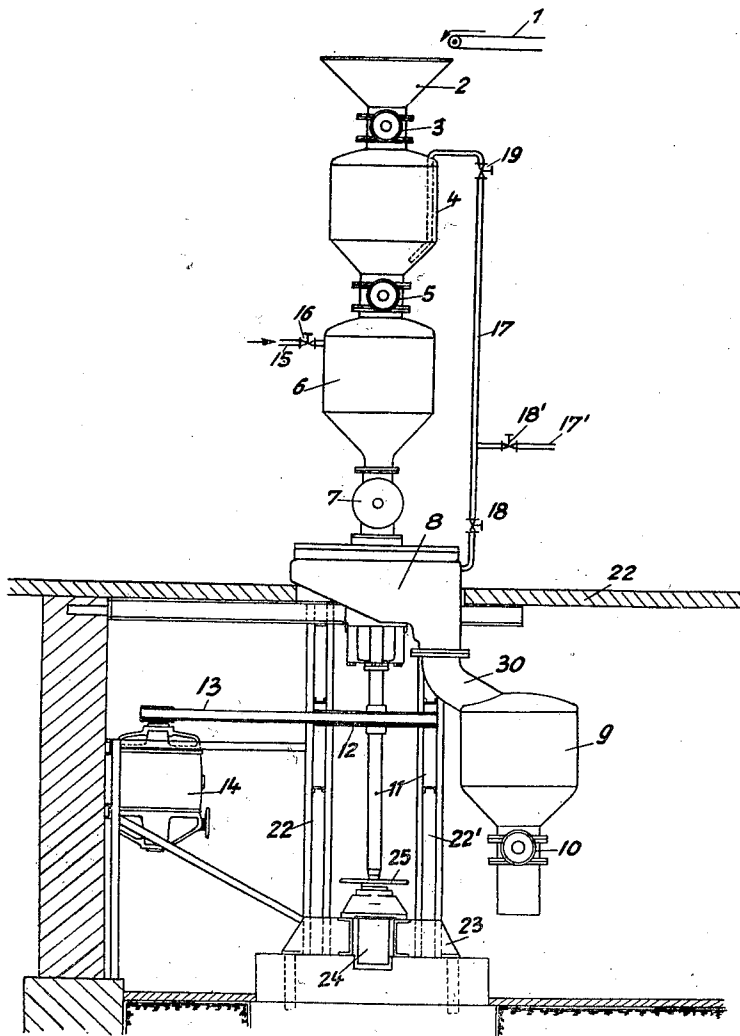
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METHOD AND APPARATUS FOR DISINTEGRATING FIBROUS MATERIALS

Filed June 13, 1938

3 Sheets-Sheet 1

Fig. 1



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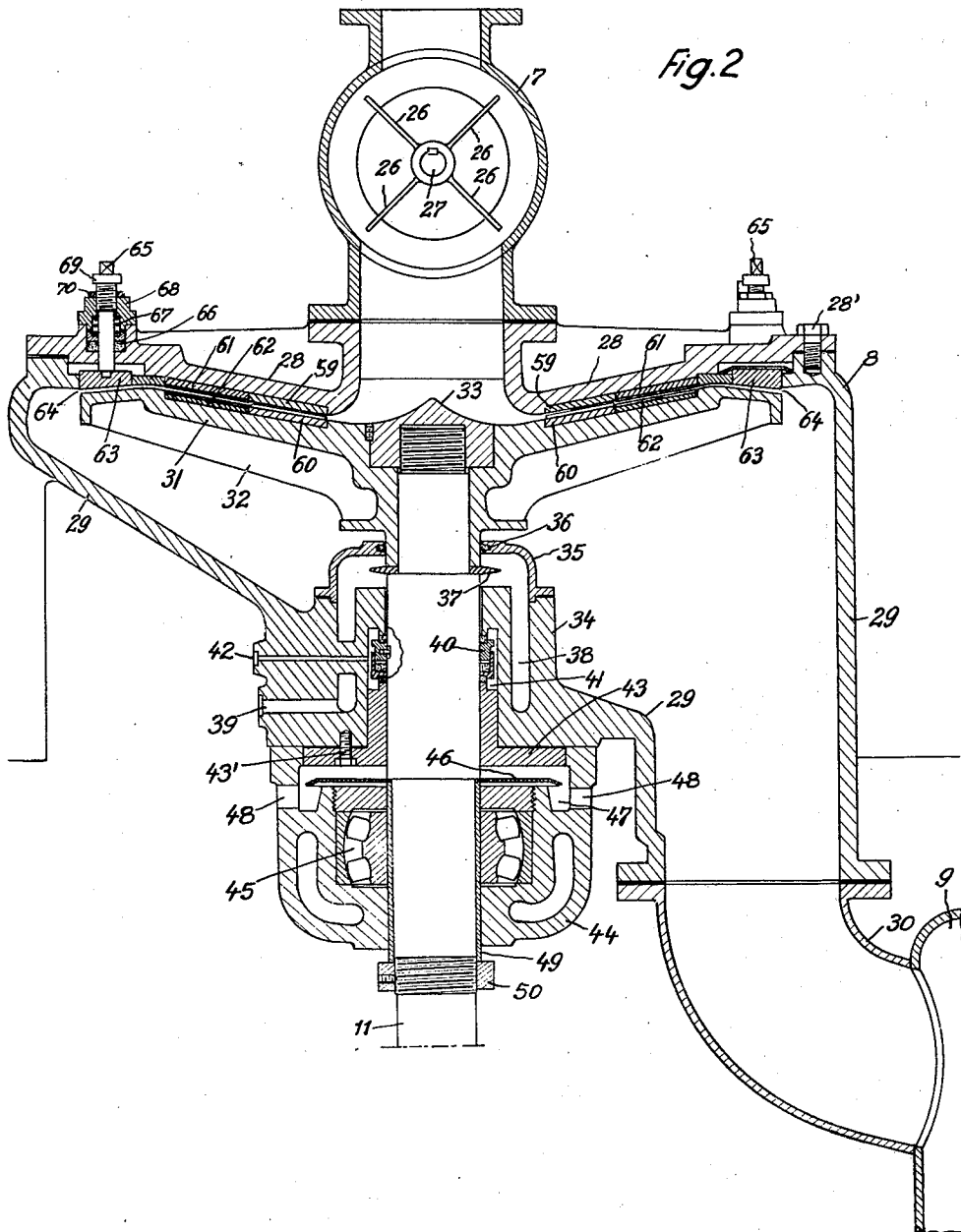
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METHOD AND APPARATUS FOR DISINTEGRATING FIBROUS MATERIALS

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3 Sheets-Sheet 2



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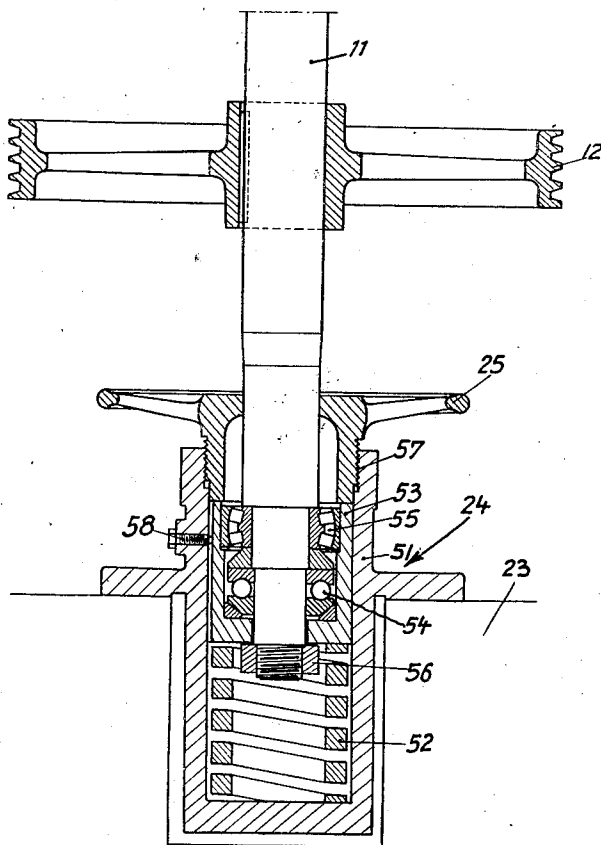
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3 Sheets-Sheet 3

Fig. 3



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UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR DISINTEGRATING FIBROUS MATERIALS

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The invention relates to a method and an appliance for breaking down vegetable fibrous material by means of mechanical comminution.

In the manufacture of the ingredients for making paper cardboard, insulating and like hard sheets, the vegetable fibrous material, such as wood, straw, bamboo or the like is usually broken up by chemical action, although either a mechanical or a combined mechanical and chemical process may be employed. It is, for example, known to carry out the mechanical breaking up of wood, not previously treated chemically, in a cross beater under the simultaneous action of steam at a pressure of at least 3.5 atm. It is further known to submit chopped and steamed straw as well as steamed chaff to a preliminary treatment before the disintegration proper, by "cooking" them in the usual way in a digester with or without chemicals. The treated, pre-comminuted raw materials are then further comminuted, according to their degree of disintegration for instance in rod mills until the desired unravelling has taken place.

Moreover, an apparatus is known which allows of mechanically breaking down fibrous material under the influence of very high pressures in a continuous process but this otherwise useful apparatus possesses drawbacks in so far as on the one hand it is rather expensive and on the other hand allows of obtaining only a certain limited degree of disintegration. The complicated design of this apparatus is mainly due to the fact that high pressure prevails in the continuously working disintegrating device and that the material to be treated must always be fed into the device against this pressure. In this apparatus the distance between the driven grinding disc and the stationary grinding disc can be adjusted but even this does not allow of regulating the time of passage of the material through the appliance for all different distances between the grinding disc necessitated by the degree of the mechanical disintegration.

The present invention purports to eliminate these drawbacks and consists in the first place in that the cross section of the aperture for discharging the material, which has been comminuted between the grinding surfaces of the comminuting appliance, can be adjusted independently of the relative distance between the grinding surfaces. In this case it is convenient for the driven grinding disc to be adapted for adjustment with respect of the stationary disc. Where the breaking down of the material is effected under pressure the mill preferably works

continuously, thus enabling a degree of disintegration and comminution to be obtained which depends directly upon the duration of the operation. A plurality of antechambers or compartments precede the mill, of which the first can be closed in relation to the feed hopper and also in relation to the second antechamber by means of slides or valves, while a charging appliance is disposed between said second antechamber and the mill.

The invention also includes other features of construction and arrangements of parts, all of which will be apparent from the following description, in which an embodiment of apparatus in accordance therewith is described by way of example, reference being made to the accompanying drawings.

In the drawings:

Figure 1 is a general view of the apparatus in elevation;

Figure 2 is a vertical longitudinal section through the charging appliance and the mill; and

Figure 3 is a vertical section through the step bearing for the mill shaft.

Similar reference numerals denote similar parts in the several figures.

1 designates a charging or feeding appliance which conveys the fibrous material to be treated to a hopper 2. The hopper 2 is connected to a pre-steaming container 4 through a shut-off valve 3. The conical lower part of the pre-steaming container 4 is connected by means of a further shut-off valve 5 to the steaming container 6, which is also formed with a conical lower part. A charging device, indicated generally at 7 and which, as shown in Figure 2, comprises a plurality of blades 26 secured on a rotatable shaft 27, is connected to the said lower part of the container 6, and has its discharge aperture leading to the mill 8 for the fibrous material. The discharge aperture is connected by means of a pipeline 30 to a container 9 for collecting the broken down material. The container 9 is provided at its lower end with a shut-off valve 10.

The shaft 11 of the mill passes upwardly through the inclined bottom of the mill 8, a belt pulley 12 being fixed on said shaft to drive the mill from an electromotor 14 by means of a belt 13.

A live steam pipeline 15 provided with a valve 16 is connected to the container 6. The housing of the mill 8 is connected, by means of a pipeline 17 provided with two valves 18, 19, to the pre-

steaming container 4. Reserve steam can further be fed to the line 17 from a line 17' through a valve 18'.

The mill 8 is supported in a ceiling 22 which is connected to a foundation 23 by means of a frame 22'. The lower end of the shaft 11 is carried in a step bearing 24, disposed in the foundation 23. 25 designates a handwheel for the vertical adjustment of the shaft 11 and with it the rotating grinding disc.

The grinding mill for the fibrous material which, as a unit, is designated by the numeral 8, possesses a conical or dished cover 28 and a housing having a bottom 29 which inclines at one side towards the axis and is connected by means of the pipeline 30 to the collecting container 9. 31 designates a rotating grinding disc reinforced by radial ribs 32 and secured on the upper end of the shaft 11 by means of a nut 33 screwed over the end of said shaft. The shaft 11 passes through a tubular projection 34 extending upwardly from the bottom of the housing 29 and closed off on the side toward the interior of the mill by means of a cap 35, said cap having a packing joint 36 to separate the shaft from the interior of the mill. The shaft also carries a splash ring 37 which centrifuges any moisture which may have found its way downwardly through the packing, into a chamber 38 from which it can be drained by means of a discharge duct 39. In order to catch any moisture which despite the packing 36 and the splash ring 37 may run along the shaft, a further chamber 41 is provided in the wall of the projection 34 and contains an additional packing unit designated generally by the numeral 40. The chamber 41 communicates with a drain duct 42. The packing 40 is held in position within the wall of the projection 34 by means of a bush 43, which in turn is secured to said projection as by a bolt 43'.

Below the region at which the shaft 11 passes through into the mill housing it is surrounded by a rigidly secured bearing cap 44 fitted with a radial bearing 45. In order to ensure that this bearing is adequately protected against moisture a splash ring 46 is provided above the bearing, which ring centrifuges any moisture into an annular chamber 47 in the wall 44 from whence it can be drained off through apertures 48. The splash ring 46 is held in position by means of a bush 49 which is pushed over the shaft and in turn held by means of a nut 50.

The step bearing for the lower shaft end is shown in Figure 3 and consists of a bush 51 which is let into the foundation 23. This bush at its lower part encloses a powerful coil spring 52 bearing at one end against the closed lower end of the bush 51 and at the other end against a sleeve 53. The sleeve 53 is axially displaceable but is secured against radial displacement by a bolt 58 which is threaded through the wall of the bush 51 and projects into a longitudinal groove in said sleeve. The sleeve houses a thrust bearing 54 and a radial bearing 55, and with these bearings is forced by a nut 56, screwed over the end of the shaft 11, to bear at its upper end against the lower face of the handwheel 25, which latter is screwed into the bush 51 as by a thread 57 thereon. The spring 52 tends to move the sleeve 53 and with it the shaft 11 and the grinding disc 31 upwardly. When the handwheel 25 is screwed outwardly of the bush 51, the spring 52 forces the shaft upwardly by a corresponding distance and reversely when the handwheel 25 is screwed inwardly of the bush

51, the sleeve 53 and with it the shaft 11 and the grinding disc 31 are moved downwardly simultaneously compressing the spring 52.

The inside of the cover 28 carries grinding surfaces 59, 61 (Figure 2) opposite which corresponding grinding surfaces 60, 62 are arranged upon the upper side of the grinding disc 31. The cooperating grinding surfaces 59, 60 are designed in the manner of a crushing mill with vertical rollers owing to the fact that ribs of semi-circular section are formed on the surfaces 60 and if desired also on the surfaces 59. Opposite the peripheral portion of the grinding disc 31 a ring 63 is arranged on the cover 28 and is adapted to cooperate as a grinding surface with said peripheral portion of the grinding disc 31. The surfaces 59, 60, 61, 62, the ring 63 and the peripheral portion of the disc 31 form between them an annular channel 64 through which the material passes during the grinding operation. In order that the duration of the passage of the material through the mill can be regulated, the ring 63 is adapted for adjustment. For this purpose pressure screws 65, the lower ends of which engage against the ring 63, are mounted in the cover. For the purpose of packing the screws 65 where they pass through the cover 28 a packing 66 is provided and held by a gland 68, a spring 67 being interposed between said gland and packing. An enlarged portion 69 of the bolt 65 is screwed from above into the gland 68 and held in position by means of a lock nut 70. When the bolts 65 are rotated they move upwardly or downwardly within the glands 68 according to direction of rotation so that the ring 63 can be adjusted towards or away from the disc 31.

The apparatus functions in the following manner when comminution of the material is effected under pressure.

The material to be treated is conveyed into the hopper 2 by means of the charging means 1. It is then conveyed into the pre-steaming chamber 4, upon opening the valve 3, the valve 5 and the valves 18, 18' and 19 remaining closed. The valve 3 is then closed and the steam valves 18', 19 are opened.

The pressure prevailing in the pre-steaming chamber 4 is preferably lower than that used for the final disintegration and may, for example, amount to 2-4 atm. Where the fibrous material has been submitted to a preliminary chemical treatment as, for example, by being in known manner soaked in lyes, the disintegrating chemicals are conveyed to the individual fibres in concentrated form owing to the steam pressure prevailing in the chamber, so that thorough disintegration takes place already in said chamber.

When the fibrous material has remained in the presteaming chamber 4 for a sufficient length of time depending upon its nature and the degree of disintegration desired, the valve 5 is opened while the valve 3 and the steam valves 16, 18, 18', 19 remain closed. Owing to the compression in the chamber 4 as compared with the pressure prevailing in the chamber 6 at the moment the valve 5 is opened the fibrous material is automatically blown from the chamber 4 into the chamber 6. Thereupon the valve 5 is closed and the valve 16 opened. The steam flowing in through the line 15 possesses the pressure desired for the final disintegration, for example, 10 atm.

When the fibrous material has remained in the container 6 sufficiently long to attain the state necessary for the commencement of the mechanical disintegration, the charging device 7 is set

in operation and gradually conveys the fibrous material in measured quantities into the mill 8, where it is deposited on the central part of the disc 31. Due to the steam pressure in the chamber 6 the weight of the material and the centrifugal action of the disc 31, which has in the meantime been set in rotation, the material is conveyed through the space 64 between the grinding surfaces towards the periphery, being at the same time comminuted. During the gradual emptying of the container 6 or, alternatively, during the last period thereof, the steam valve 16 may be closed, so that the steam in the container 6 slowly expands.

During the passage of the fibrous material through the charging arrangement 7 and through the mill 8 a portion of the steam from the container 6 reaches the discharge end of the mill where it may be at a pressure of, for example, 4 atm. This steam is preferably conveyed into the pre-steaming container 4 by opening the valves 18 and 19 while the valve 18' remains closed, the said container 4 having meantime been refilled with fresh fibrous material.

When the contents of the chamber 6 have been passed through the mill 8, this chamber is again filled with material preliminarily treated in the chamber 4. Filling of the container 6 from the container 4 is effected by opening the valve 5 while the valve 3 and the valves 16, 18, 18' are closed. When the chamber 6 is full its inlet valve 5 is closed and the steam valve 16 reopened, while in continuance of the operation the container 4 is refilled with fresh fibrous material by opening the slide valve 3, whereupon the valve 3 is closed and the valves 18 and 19 opened. The line 17' with the valve 18' is provided for starting purposes and for making possible the pre-steaming in the container 4 during the period when no exhaust steam is available from the mill 8. In addition this line 17' may also act as a supply line for auxiliary steam, whenever the exhaust steam from the mill 8 is insufficient.

A further steam line, not shown in the drawings, may be connected to the container 4, for the purpose of draining off the steam remaining in this container after the fibrous material therein has been discharged into the container 6, so that this steam also may be utilized as exhaust steam and heat losses due to the escape of this steam when the slide valve 3 is opened may be avoided.

In the apparatus according to the invention the advantages of a fully continuous process have been deliberately sacrificed in consideration of the fact that owing to the varying nature of the raw materials supplied, regulation of the degree of disintegration must be the prime factor. Due to the disintegrating arrangement according to the invention a very uniform final product can be obtained even if the nature of the raw materials varies, and even if a coarser or finer unraveling is desired and, finally, even if the difference in pressure between the feed and the discharge end of the mill varies. The fact that the ring 63 is adjustable makes it possible to keep the duration of passage of the material through the space constant and to adjust it to the most favourable values, even if the aforesaid conditions vary. The adjustable ring 63 furthermore constitutes a controlling means both for the material passing through the mill as well as for the steam flowing therein. In the example illustrated, this means is a part of the stationary grinding surface but it may equally well consist

of a separate member connected to the disintegrating device. The adjustability of the grinding disc 31 which is known per se allows of a coarser or finer comminution during the operation, the grinding disc moving away from the stationary disc when starting and until the slot 64 has become filled with fibrous material, and the grinding surfaces also moving apart when hard bodies such as, for example, metal particles, get into the mill.

The substantially vertical disposition of the grinding surfaces 59—62 has the further advantage that the centrifugal force is caused to co-operate in the uniform distribution of the material over the entire grinding surface.

The disintegrated material discharged from the mill reaches the chamber 9 through the line 30, from whence it can be discharged by gravity, or by means of compression prevailing also in this chamber, into the open or into transportable containers by opening the valve 10.

The above described arrangement is of course only given by way of example. The mechanical comminution may, for example, be combined with a simultaneous chemical comminution, or again the chamber 9 may be dispensed with. Moreover, it is not absolutely necessary to use two disintegrating containers 4 and 6 in succession. On the contrary the container 4 could be connected direct to the mill through the charging device, although the use of a second container has the advantage of more economic operation, as it forms a kind of sluice by means of which steam losses are reduced when feeding in fresh material.

The plant may also be driven without pressure, but in that case it is preferable to use a constant flow of water for the purpose of feeding the material through the mill. This process is also capable of being carried out continuously.

The preferred field of application of the invention is that of preparing fibrous material for the manufacture of sheets used in constructional work and for insulating purposes, although it can also be applied with advantage in other spheres, for example, to the production of half-stuffs used in the cellulose industry.

What I claim and desire to secure by Letters Patent of the United States is:

1. Apparatus for grinding particularly fibrous materials comprising in combination a grinding chamber, two vapor chambers adapted to soften the binding substance of the fibrous materials aligned upon said grinding chamber in superposed position, a third vapor chamber arranged below said grinding chamber, vaportight closing means between the uppermost and the second of said chambers, further vaportight closing means arranged in the charge opening of said uppermost chamber and in the discharge opening of said third chamber, a feeding means arranged between said second vapor chamber and said grinding chamber for feeding the softened fibrous material into said grinding chamber, a stationary grinding face and a coating axially adjustable rotatable grinding face in said chamber, said stationary face having a central grinding area and being provided with a marginal axially adjustable ring member serving as an additional grinding face and forming a grinding and discharge area with the opposite marginal area of said rotatable grinding face, to adjust independently from each other the clearance between said marginal ring member and its opposite marginal area and the clearance between said stationary face and said rotatable face.

2. Apparatus for grinding particularly fibrous materials comprising the combination with a grinding chamber, of two vapor chambers adapted to soften the binding substance of the fibrous materials aligned in superposed position upon said grinding chamber, a third vapor chamber arranged below said grinding chamber, vapor-tight closing means between the uppermost and the second of said chambers, further vaportight closing means arranged in the charge opening of said uppermost chamber and in the discharge opening of said third chamber, a feeding device arranged between said second vapor chamber and said grinding chamber for stepwise feeding the softened fibrous material into said grinding chamber, said uppermost vapor chamber and said grinding chamber being connected by a vapor pipe adapted to be closed, a stationary grinding face and a coating axially adjustable rotatable grinding face in said chamber, said stationary face having a central grinding area and being provided with a marginal axially adjustable ring member serving as an additional grinding face and forming a grinding and discharge area with

the opposite marginal area of said rotatable grinding face, whereby the clearance between said marginal ring member and its opposite marginal area and the clearance between said stationary face and its coating rotatable face are adjustable independently from each other.

3. The method of stepwise treating, softening and grinding fibrous materials, which method comprises charging a closed container with the material to be treated and feeding steam of a comparatively low pressure into said container, conveying the thus pre-steamed material into a second closed container and feeding steam into said second container of a pressure substantially higher than the steam pressure of said first container, feeding the steamed materials step by step into a grinding chamber while maintaining a substantial difference of the pressure above said grinding chamber and below said grinding chamber, grinding the steamed material in said grinding chamber, conveying the ground material to a storage container, and recovering the steam in said storage container.

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