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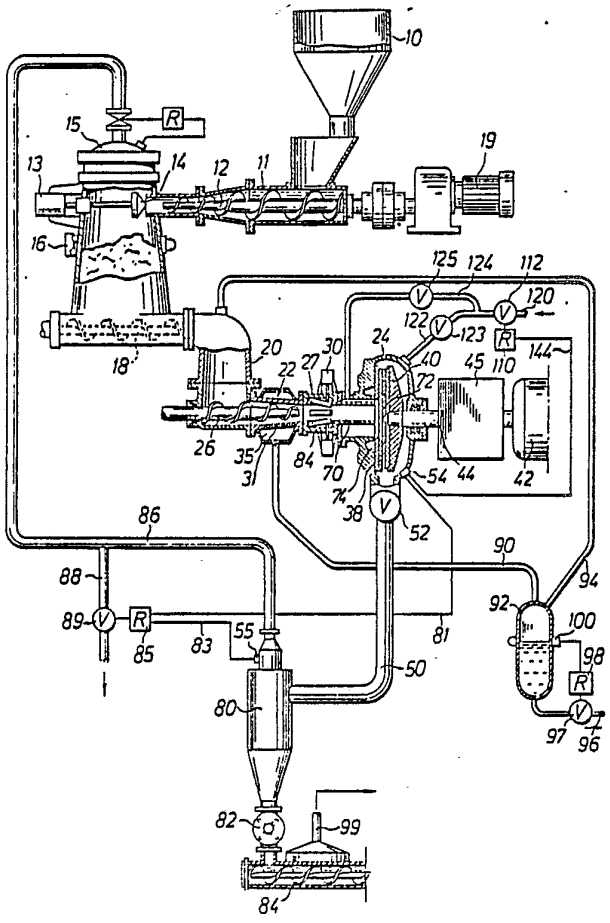
(54) Title: METHOD AND APPARATUS FOR PRODUCING FIBRE PULP FROM FIBROUS LIGNOCELLULOSE CONTAINING MATERIAL

(57) Abstract

In a method and device for producing fibre pulp from fibrous lignocellulose containing raw material, such material is subjected to preheating in a preheater (15) by means of steam and thereafter to grinding at increased pressure of steam or gas between grinding discs which rotate relatively to one another (38, 40) in a grinding apparatus (26) into fibre pulp which is propelled from the apparatus housing (36) by means of the steam or gas into a separation device (80) which is similarly maintained under steam pressure and in which the steam is separated from the pulp. The material is conveyed not only to the preheater but also from the latter to the grinding apparatus via a steamtight conveyor (11, 22). An increased pressure of steam or gas is created at this stage in the grinding apparatus compared to that in the preheater such that the steam proceeding from the grinding apparatus to the receiving device is conveyed further by means of this higher pressure to the preheater, there being responsible for preheating the material to over 100°C.



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Method and apparatus for producing fibre pulp from fibrous lignocellulose containing material

This invention relates to a method and apparatus for producing fibre pulp from fibrous lignocellulose containing raw materials, in which the material is preheated in a preheater by means of steam, and in which the preheated material thereafter is ground at an increased pressure of steam or gas, between grinding discs which rotate relatively to one another in a grinding apparatus into a fibrous pulp, which is propelled from the apparatus housing by means of the steam or gas to a separation device which is similarly maintained under steam pressure and in which the steam is separated from the pulp. The raw material consists of chips from softwood or hardwood, bamboo, straw, bagasse, etc., which while undergoing fragmentation in the grinding apparatus may be either chemically treated or untreated. The grinding apparatus comprises at least two grinding units, such as of the disc type having flat or conical grinding surfaces or a combination thereof, which rotate relatively to one another.

Depending on the type of fibrous material produced, a varying amount of electrical or steam energy (50 - 2,000 kWh/ton) is required at a process temperature of 250° - 100°C. It is generally true that the amount of energy required for fragmentation decreases with increasing temperatures of the material supplied to the grinding device. This is explained by the fact that the work required for fibre separation depends on the temperature to which the fibrous material holding together, and the fibres enclosing the middle lamellae, are heated during the grinding process, especially during the latter's initial stage. The middle lamellae are largely composed of lignin, which during heating and rising temperatures gradually softens and is gradually transformed from a rigid to a relatively liquid condition. This fact is utilized in a number of pulp production processes to reduce the electrical energy required for this purpose, whereby the material is heated, prior to fragmentation, by means of a direct supply of live steam or steam generated in the course of the fragmentation process.

Enclosing the grinding unit in a pressure-proof housing enables the fragmentation or grinding of the material supplied in an already-heated condition to take place while the conditions of increased pressure and temperature which are favourable to the process are maintained. The fibrous material produced from the fragmentation process is discharged from the pressurized grinding housing into a receiving device which is similarly maintained at overpressure which is equal to or somewhat lower than that maintained in the discharge zone of the grinding housing. The receiving device, in which the fibre pulp is separated from the steam accompanying it from the grinding device, is provided with an arrangement for discharging the fibrous material from the receiving device while maintaining the pressure of steam in the said receiving device, and without any major simultaneous discharge of steam with the fibrous material.

The steam separated in the receiving device has previously been used to preheat the material under atmospheric conditions to about $100^{o}C$ before being fed under pressure-proof conditions into the preheater, which operates under pressure and which is connected directly to the grinding device. The heating of the material is achieved by supplying live pressurized steam to the preheater, or, for fragmentation processes requiring greater amounts of electrical energy, by reintroducing steam from the inlet zone of the grinding device.

The purpose of the invention is, with application of a grinding process of a known nature (cf. for example, Swedish Patent 413.601), to enable the grinding to take place at a favourably high pressure and temperature, and, at the same time, to enable re-cycling of the electrical or steam energy supplied for this purpose for preheating to the highest possible temperature of the material in the preheater. This is achieved essentially in that the material is conveyed not only to the preheater but also from the latter to the grinding apparatus via a pressure-proof conveyor, and in that a higher pressure of steam or gas is generated in the grinding apparatus than in the preheater such that the steam proceeding from the grinding apparatus to the receiving device is conveyed further, by means of this higher pressure, to the preheater, there being responsible for preheating the material to over 100^{o}.
The invention also comprises an arrangement suitably-designed for application of the method.

At the same time as the grinding process according to the invention can be carried out under the most favourable conditions of temperature and pressure, the steam energy generated during the grinding process or supplied as live steam is re-cycled in the preheater, reducing considerably the energy consumption required for carrying out the process. Because of the relatively high temperature to which the fibrous material is exposed, the invention is particularly suitable for the manufacture of porous and hard fibreboards, in which the requirements are less exacting as regards whiteness in the fibre pulp. At the same time, fragmentation of the fibres, which results in the exposure of fibrils in such products, is not required to be performed to such an extent, and the overall process becomes less energy-consuming in the grinding apparatus. This means, again, that a supply of energy in the form of live steam is required in the grinding device in order to bring about the intended pressure distribution for the conveying of steam in the system and the high preheating temperature in the preheater. According to the invention, the expensive steam requirement is reduced to a minimum by utilizing entirely or in part the pressurized steam which can be recycled from the receiving device.

It is understood that the pressure obtained from the outlet zone of the grinding device, with or without the addition of a lesser volume of fresh steam at the inlet zone of the separate grinding device, can, by virtue of the turbo effect of the grinding device and the electrical energy supplied for the fragmentation, despite resistance and pressure losses in pipes, valves and regulating devices, be brought to a level such that the temperature and degree of processing for the material conveyed to the grinding device from the separate preheater is equal to, or deviates only to a negligible extent from that which has been attained previously by the addition of live steam at the preheating device directly (openly) connected to the grinding device.

The invention can also be said to be distinguished in that the raw material, before being conveyed by means of an, in principle, pressure-sensitive feeding device to a grinding device operating at increased pressure and temperature, is exposed to preheating to a temperature in excess of $100^{o}C$, but not in excess of the temperature maintained in the outlet zone of the grinding device, whereby the volume of steam required for such preheating is mainly conveyed from the outlet zone of the

The device will be described in greater detail hereinafter, with reference to a preferred embodiment shown as an example in the attached drawings.

Figure 1 is a more or less schematic side view, partly in section, showing equipment for carrying out the process according to the invention.

Figure 2 shows the grinding apparatus which forms part of the equipment and a pressure-sensitive conveyor connected with it, drawn to an enlarged scale and in a vertical section.

On the drawings, the reference numeral 10 designates a feed hopper for the raw material, for example wood chips, which are conveyed by a screw conveyor 11 into a preheater 15. At this stage, the material is compressed by the conveyor's screw 12 which is driven by a rotor 19, forming a steam-tight plug of the material. The degree of compression is regulated by means of a pneumatically-operated counterpressure device 13 working in conjunction with a conical valve piece 14 which rests against the material plug being fed in.

With the passage of the conical valve piece, the material plug is broken up and the material drops down into the vertical preheater 15, in which a level of material is maintained which results in the desired dwell-time in the preheater vessel. This material level is maintained in that a level regulator 16 acts upon the speed of the feed screw 12 by means of the driving device 19. The material heated in the preheater vessel 15 is discharged at the bottom of the preheater by means of a conveyor 18 via a sealed conveyor 20 to the intake section of conveyor 22 which compresses the material, in order to bring about a fundamentally steam-tight conveying of the material from the preheater 15 to the grinding apparatus or disc refiner 24.

The conveyor 22 comprises, in the same way as the feed conveyor 11 in the embodiment example, a conical tube which tapers internally in the direction of the material flow, in which tube a screw 26 of the same shape operates. Connected to the discharge side of the tube, if required for performing the process, is a counterpressure device 27, which may

be a tubular connector in which flaps 28 are pivotally disposed for actuation by piston servomotors 30 so as to be swung into the inner bore 32 of the connector piece, which bore suitably forms a cylindrical extension of the discharge area of the screw feeder compressing the material, and thus when actuated reduces the throughflow area of this bore.

In this manner, the degree of compression of the preheated material supplied to the grinding device 24 can be varied to the required extent, while the liquid (water) accompanying the material is simultaneously pressed out through perforations 31 in the compression tube into a funnel 35 connected by pressure-proof means to this tube, from which funnel the expelled water is removed via a pipe 90 into a tank 92, the overpressure in which is equal to or in the vicinity of the pressure of steam maintained in the supply tube 20 in that a conduit 94 connects the tank 92 with the supply tube 20. The level of liquid in the tank 92 is monitored by a level-sensor 100 and a regulating device 98 controlled therefrom for a valve 97 provided in the discharge pipe 96 from the tank.

The grinding device or defibrator 24 comprises grinding discs which are disposed in a housing 36, in the embodiment example a stationary grinding disc 38 which is secured rigidly to the housing, and a grinding disc 40 which is mounted on a drive shaft 44, which is driven by a motor 42.

When the primary material has been compressed by conveyor 22 and the counterpressure device 27, it advances further through a pipe 70, suitably having a cylindrical bore, the free end of which is located closely adjacent to the rotating grinding disc 40. Furthermore, the pipe 70 is arranged eccentrically relative to the axis of rotation of the grinding disk in order to enhance the breaking-up of the highly compressed plug before the pulp material is introduced into the grinding space 48 between the grinding discs. The plug may suitably be broken up by one or more vanes 72 on the disc 40 directly in front of the mouth of the pipe 70. Through a pipe 74, water may be added to the material when it is introduced into the grinding space 48, to compensate for the water expelled in the conveyor. A conveyor of the type described here is known by virtue of Swedish Letters Patent 419.659.

A servo motor 45 is disposed between the motor 42 and the rotating grinding disc 40, in known manner, as shown, for example, in Swedish Patent 179,337, which servo motor, by means of an axially-displaceable non-rotatable piston, transmits the pressure of a hydraulic pressure medium through bearings to the rotating axle 44 in order to create the high pressure which is required for grinding the material as it passes radially outward in the grinding space 48 between the two facing grinding discs. A drain pipe 50 is connected to grinding disc housing 36, through which pipe the fibrous material produced in the grinding apparatus is conveyed or propelled, at no loss of pressure, into a receiving tank 80, preferably of the cyclone type, in which fibre and steam are separated from one another. In the embodiment example, the separated fibre is discharged from a rotating valve 82, in principle pressure-proof, to a receiver/conveyor device 84, wherein the moisture accompanying the fibrous material is vaporized and drawn off via a collecting hood 89 for possible re-use in any other part of the units in the installation which operates at atmospheric pressure.

The pressure level in the receiving tank 80 is regulated to the desired value by means of a differential regulator 85, which senses, by means of the sensor devices 54 and 55, via the pipes 81 and 83, the pressure both in the housing 36 for the grinding apparatus and in the receiving vessel 80, and automatically maintains a pressure differential between them, in the embodiment example normally 0.1 - 0.7 kg/cm^2. The steam pressure in the grinding housing may rise to 7 - 12 kg/cm^2. The temperature of the steam in the outlet from the grinding housing may be in the range of 115 - 125, to 150 - 170^{o}C, to which temperature the material is therefore heated in the preheater, regardless of the inevitable pressure and temperature losses on the way to the preheater.

A valve 52 may be disposed in the pipe 50 between the grinding device 24 and the receiving vessel 80. By this valve, it is possible to regulate the speed of discharge of the fibrous material from the grinding housing, with regard to the overall length of the pipe 50.

The material supplied to the preheater 15 is heated by means of steam drawn off from the receiving vessel 80 via a pipe 86, which steam is at a level of pressure less than that maintained in the grinding housing, only with such loss of pressure required for conveying the treated fibrous material from the grinding housing 36, via the receiving vessel 80 to the preheater 15, normally 0.1 - 2.0 kg/cm^2.

The grinding disc housing 36 is supplied with live steam via pipes 120, 124 and 122 before, and, where required, after the passage of the ground material through the grinding space 48 between the grinding discs. The purpose of the live steam is to maintain a pressure which is required for the process. This pressure is balanced by means of a regulating device 110 which actuates a valve 112 located in the pipe 122 and which senses the pressure at the outlet to the grinding housing via a pipe 114. The live steam supplied is conveyed, together with the steam generated by electrical energy supplied during the grinding process, to the preheater 15 with only a minimal loss of pressure and temperature.

The distribution of the steam supply via the two pipes 122, 124 is regulated by means of valves 123, 125. Pipe 122 is only required to be switched in at extremely low levels of steam generation between the grinding discs in order then to be able to maintain the required pressure and preheating temperature in the vessel 15. In many cases, the pipe 122 may be dispensed with.

The arrangement with separate pressure vessels, i.e. preheater 15, grinding housing 36 and receiving vessel 80 thus makes it possible for the material input in the process to be heated in the preheater 15 to a temperature closely coinciding with the temperature which is maintained in the grinding disc housing, for example, at its inlet, using solely pressurized steam re-cycled from the process.

By using the turbo effect of the grinding device 40 together with the electrical energy supplied during the fragmentation process, it is possible to increase the pressure which is maintained at the outlet for the grinding housing 36 to a level enabling the steam re-cycled to the preheater 15 to be maintained at a pressure which is higher than the steam pressure maintained in the preheater.

Thus, the material supplied to the grinding device 24 can, given this arrangement, be maintained at the same temperature as could be achieved in previous designs only by supplying live steam to the preheater, a fact implying substantial (40 - 80%) savings in heat energy for heat-processing the material.

Any surplus of supplied or generated steam is drawn off via a steam pipe 88, thereby allowing the steam pressure maintained in the system to

be kept at a constant level, at the same time as it is possible to maintain the required minor pressure differential between the grinding housing 36 and the receiving vessel 80 at the desired level. A valve 99 is disposed in the pipe 88, the setting of which valve can be monitored by the regulating device 85.

Obviously, the invention is not limited to the disclosed embodiments, but may find a variety of expressions within the scope of the inventive concept. Thus, it is conceivable for a gas, for example air, to be introduced into the steam atmosphere in order to bring about the envisaged levels of pressure and temperature in the enclosed system.

PATENT CLAIMS

1. Method for producing fibre pulp from fibrous lignocellulose containing raw material, in which the material is preheated in a preheater by means of steam, and in which the preheated material thereafter is ground at an increased pressure of steam or gas, between grinding discs which rotate relatively to one another in a grinding apparatus, into a fibrous pulp, which is propelled from the apparatus housing by means of the steam or gas to a separation device which is similarly maintained under steam pressure and in which the steam is separated from the pulp, being characterized in that the conveying of the material not only to the preheater but also subsequently from the latter to the grinding apparatus is performed by a steam-proof conveying device, and in that a higher pressure of steam or gas is created in the grinding apparatus than in the preheater, such that the steam proceeding from the grinding apparatus to the receiving device is conveyed further by means of this higher pressure to the preheater, there being responsible for preheating the material to over 100^{o}C.

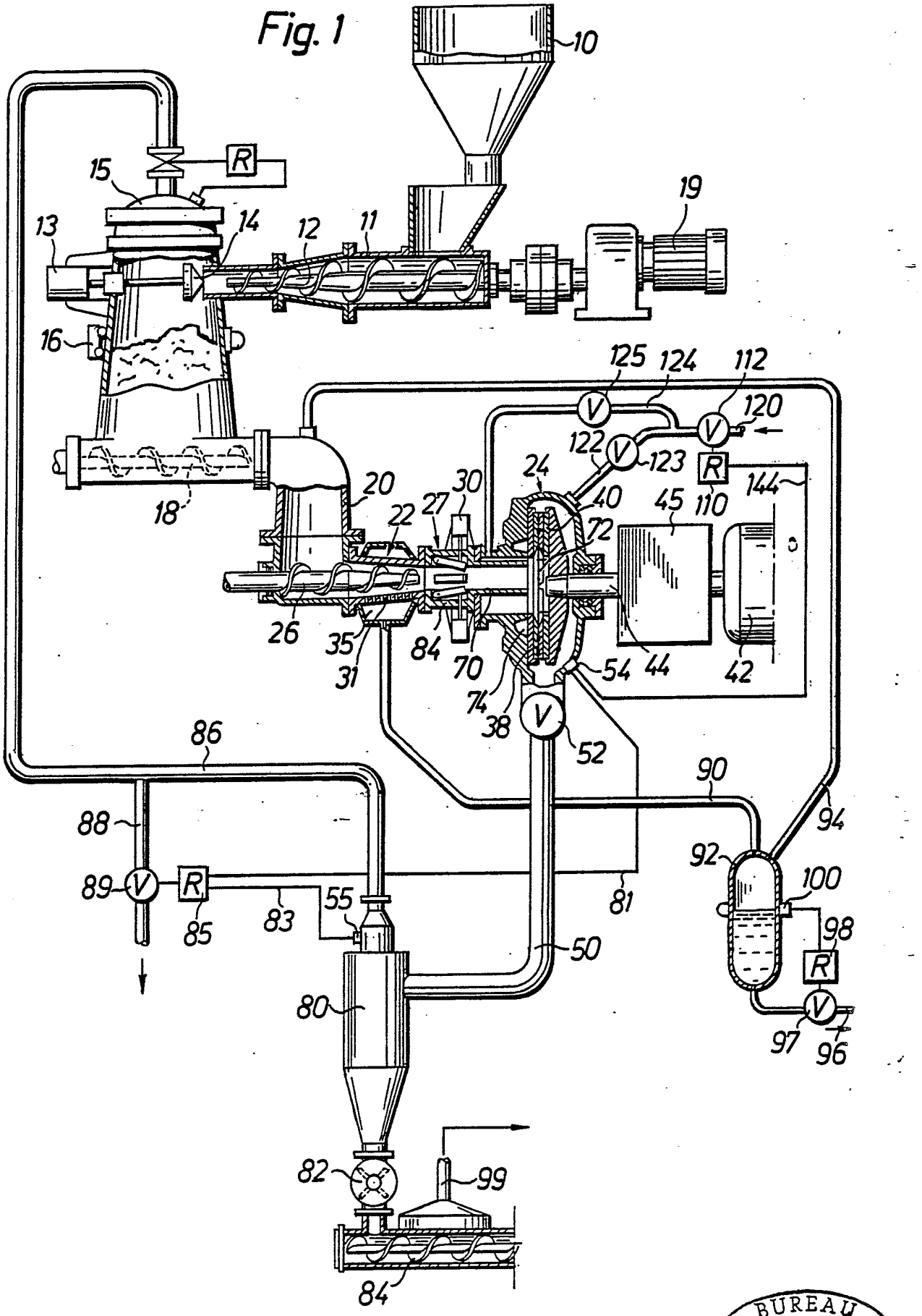
2. The method according to claim 1, being characterized in that live steam or gas is introduced into the material in the grinding apparatus housing before, and also possibly after the material has passed between the grinding discs, at which stage the live steam or gas is maintained at a pressure and temperature which ensures heating of the material to above 100^{o}C, preferably 125 - 150^{o}C.

3. Device for carrying out the method according to claim 1 for producing fibre pulp from fibrous lignocellulose containing raw materials, including a preheater into which raw material is introduced via a steam-proof conveying device, together with steam to preheat the material, a conveyor for transporting the preheated material to a grinding apparatus comprising grinding discs which rotate relatively to one another, and which are arranged in a housing and are connected to an externally sealed receiving device, to which the ground fibre pulp is propelled by means of steam within the grinding housing, which steam is separated in the receiving device from the fibre pulp, said device being characterized in that the conveyor is designed for steam-tight conveying of the material from the preheater to the grinding apparatus and in that the receiving device is connected by a pipe to the preheater such that

steam or gas at a higher pressure and temperature than in the receiving device and the preheater is generated in or introduced into the grinding apparatus, such steam or gas being conveyed via the pipe to the preheater and is there responsible for heating the material to over 100°C.

4. Device according to claim 3, characterized in that the grinding apparatus is arranged to be supplied with live steam or gas at such an overpressure and temperature that it is at least partially responsible for preheating the material in the preheater to the intended temperature before the material is conveyed to the grinding apparatus.

Fig. 1



SUBSTITUTE SHEET

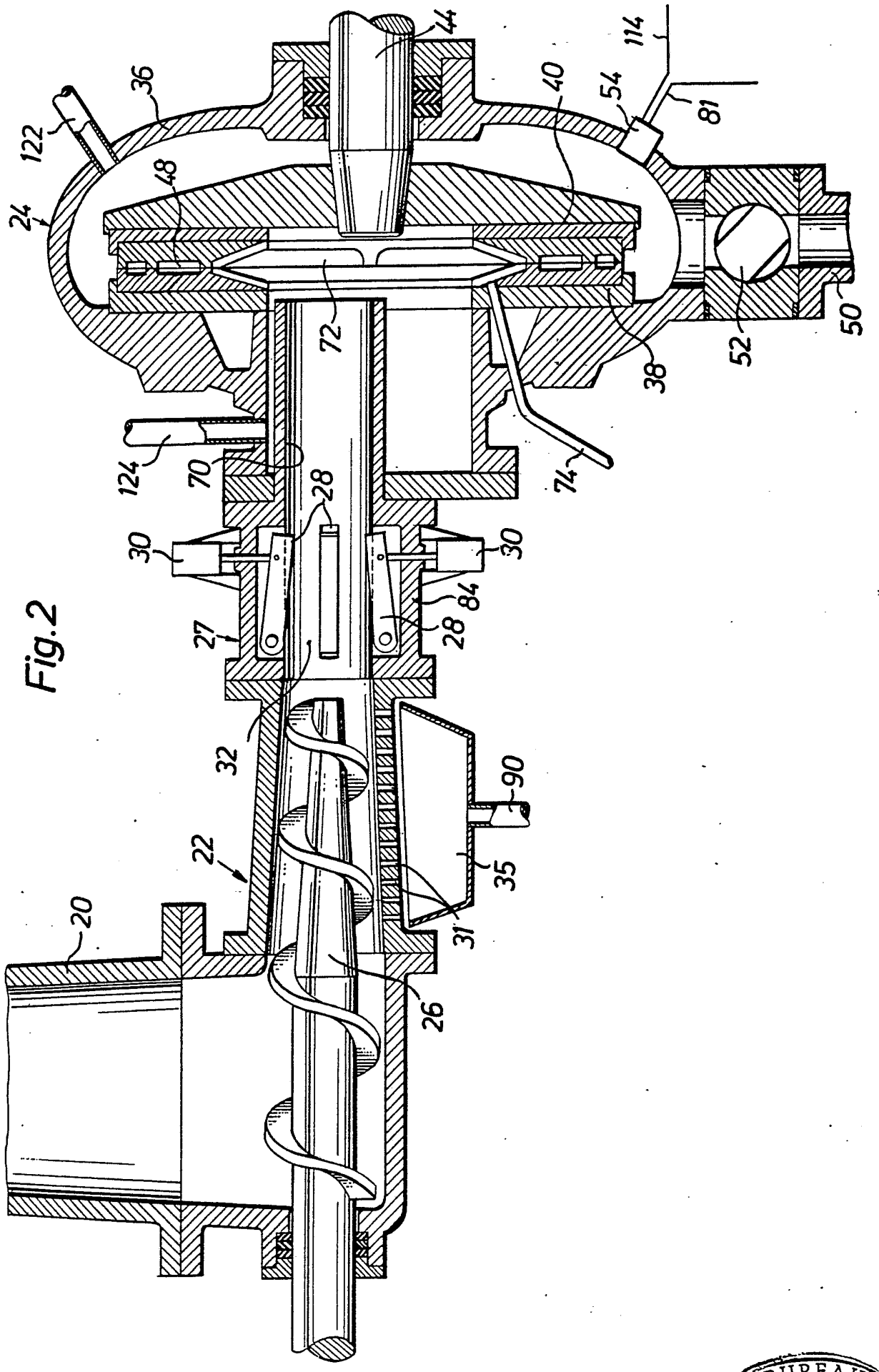


Fig.2

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE83/00048

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC 3

D 21 B 1/12

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC 3	D 21 B 1/00,02,04,12,14,30; B 02 C 7/11, 23/00; D 21 D 1/20, 1/30 .../...

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [5]

SE, NO, DK; FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category [6]	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
A	SE, B, 359 332 (R B REINHALL) 27 August 1973 & US, A, 4 236 959	
A	SE, B, 372 299 (R B REINHALL) 16 December 1974 & US, A, 3 910 505	
A	SE, B, 413 601 (AMERICAN DEFIBRATOR INC) 9 June 1980 & US, A, 4 235 665 & DE, B, 2 729 348	
A	SE, B, 413 784 (ISEL SA) 23 June 1980 & US, A, 4 136 831 & DE, A, 2 734 832	
A	SE, B, 419 659 (R B REINHALL) 17 August 1981 & US, A, 4 283 252 & DE, A, 2 711 567 & FR, A, 2 344 666	

[6] Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

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IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
1983-04-29	1983 -05- 10
International Searching Authority [1]	Signature of Authorized Officer [20]
Swedish Patent Office	Klaus-Christian Korn

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

II Fields Searched (cont)

US Cl 162:23, 27, 28;
241:15, 16, 18, 24, 27, 28, 29, 33, 36, 37, 63, 64, 152, 244-254, 259-261.3

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [10]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers ...., because they relate to subject matter [12] not required to be searched by this Authority, namely:

2. ☐ Claim numbers....., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out [13], specifically:

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [11]

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.