



(51) International Patent Classification:

D21B 1/12 (2006.01) D21D 1/30 (2006.01)
D21B 1/06 (2006.01) D21J 1/20 (2006.01)
D21H 11/08 (2006.01)

(21) International Application Number:

PCT/FI201 1/050642

(22) International Filing Date:

7 July 2011 (07.07.2011)

(25) Filing Language:

Finnish

(26) Publication Language:

English

(30) Priority Data:

20105786 9 July 2010 (09.07.2010) FI

(71) Applicant (for all designated States except US): **UPM-KYMMENE CORPORATION** [FI/FI]; Etelaesplanadi 2, FI-00130 Helsinki (FI).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **TIENVIERI, Taisto** [FI/FI]; Lempaalantie 41 A 11, FI-37630 Valkeakoski (FI).

(74) Agent: **TAMPEREEN PATENTTITOIMISTO OY**; Hermiankatu 1 B, FI-33720 Tampere (FI).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM,

AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

(54) Title: A METHOD AND A SYSTEM FOR PRODUCING RAW MATERIAL FOR THERMAL INSULATION

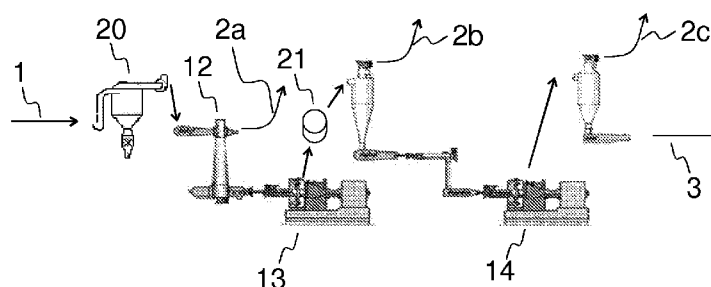


Fig. 2

(57) Abstract: A system and a method for producing fibrous raw material for thermal insulation in a thermomechanical process. In the production, cellulose-based chips (1) are conveyed from storage (10) to the removal of impurities; the impurities are separated from the chips (20), and the purified chips are conveyed to a first refiner (13); and the chips are refined to form refined pulp in at least the first refiner. The dry matter content of the refined pulp downstream of the first refiner is preferably at least 60%. In an example, the finished raw material has a freeness value, by CSF (Canadian Standard Freeness) measurement, higher than 750 ml, and a long fiber content, by BMcN measurement (+28 mesh), higher than 85%, and a fines content (200 mesh) lower than 5%.



WO 2012/004459 AI

A METHOD AND A SYSTEM FOR PRODUCING RAW MATERIAL FOR THERMAL INSULATION

Field of the invention

5

The invention relates to a method for producing fibrous raw material for thermal insulation. The invention relates to a system for producing fibrous raw material for thermal insulation. The invention also relates to fibrous raw material for thermal insulation.

10

Background of the invention

Wool boards are used for thermal insulation in buildings. They are made by scattering or blowing a mixture containing dry fiber material, thermally activated plastic material and additives onto a planar support (a wire or a plate) to form a layer of desired thickness, and treating it by compressing at an elevated temperature. In this way, an insulation wool board or mat is produced. For example, publications DE-1 005 682 9 and EP-1 027 505 discuss the manufacture of insulation material from pulp. The documents show how thermal insulation boards can be made of dry wood fibers and plastic or adhesive. Document EP-1 027 505 presents that the fibers are made, for example, by a conventional cooking process which is also known as chemical pulping. The pulp prepared in this way is fed onto a wire to form a band-like sheet which is dried and rolled up for storage. In the chemical process, lignin contained in the raw material is removed from the pulp. In a known way, pulp can also be prepared by mechanical refining, wherein the lignin contained in the wood raw material remains in the pulp.

It is known that mechanical pulping consumes a lot of energy, typically for example 3.5 MWh per ton. In the mechanical pulping, the temperature has an effect on the quantity of fiber material to be obtained, and thermomechanical pulping (TMP) is also a commonly used term. Furthermore, in connection with the mechanical pulping it is also possible to apply chemical processes, wherein the process is called a chemithermomechanical pulping (CTMP) process. For example, publication EP-0 500 999 discloses how fibers made by the CTMP process can be used to make thermal insulation boards. In gen-

eral, pulp made by said processes can be utilized as raw material for paper and in the manufacture of wool boards.

5 In thermomechanical pulping, a lot of water is also used. Water is used to lubricate and cool the refiners and thereby to prevent the heating and burning of the wood raw material. In these processes, energy is used for refining wood chips in the refiners, and part of the energy is released with water evaporating in the refiners. Vapour produced in the process is utilized, among other things, in the drying and heating of the wood chips. The energy
10 consumption can be influenced, among other things, by means of the process temperatures and by heat recovery. Such energy saving solutions are described in publication US 7,540,938.

15 Because cellulose is organic material, it constitutes a substrate that is susceptible to microbial growth when wet. Thus, when pulp made by the above-described methods is applied in the manufacture of thermal insulation, the pulp must be dried before it is used. Typically, at the final stage of pulping, the pulp is dried to a dry matter content of at least about 75%, for example by hot-air blowers, which requires a lot of energy.

20

Summary of the invention

It has been surprisingly found that the raw material for thermal insulation can also be made by the TMP process with a significantly smaller quantity of
25 water, or the use of water can even be totally eliminated by selecting the raw materials and the process parameters according to the requirements of the final product on one hand and according to the properties of the raw material on the other hand. Thus, the raw material for thermal insulation, obtained from the process, is substantially dry, and no separate driers are needed. It is
30 thus possible to significantly reduce the consumption of energy for unnecessary drying and to reduce the production costs.

The method according to the invention is presented in claim 1. The system according to the invention is presented in claim 17. The raw material according
35 to the invention is presented in claim 25.

Furthermore, an embodiment of the invention has the particular advantage that it can be implemented by existing production equipment, and that current thermomechanical processes and systems can be modified to correspond to the new process. In this way, systems can be modified at low cost, if necessary, for the production of raw material for thermal insulation. It is thus possible to reuse an old, redundant system in a new process, or to modify current systems for the new method and to meet the needs.

In the new process, process parameter values are used which have not been experimented before and which fall outside the range of a normal pulping process. Such parameters include, for example, the specific energy used in the refiner or refiners, and the rotational speed of the refiners.

It has also been found that the fibrous raw material used as insulation material does not need to be as finely ground as the pulp used for papermaking. As a result, it is possible to apply such process parameters that are not suitable for making raw material for paper. The application of these parameters reduces the amount of energy needed in the refiners and reduces the amount of water needed in the process, or even totally eliminates the need for water. Consequently, in the process, a reduction in the dry matter content of the raw material or pulp is avoided, and the aim is to avoid washing and the use of water in connection with the refining. As a result, the advantage is also achieved that no additional energy needs to be consumed for removing added moisture.

According to an embodiment of the new process, the wood chips used as raw material are not washed with water, but impurities are separated by means of warm air. According to another embodiment, the raw material is refined by applying relatively little energy, wherein the energy consumed is not sufficient to heat and ignite the raw material in the refiner, and it becomes unnecessary to add water into the refiner to prevent heating or a fire and thereby to remove added water from the finished pulp.

Brief description of the drawings

In the following, the invention will be described in more detail in view of different examples and with reference to the appended drawings, in which

- Fig. 1a shows a production process of prior art in a process flow chart,
- Fig. 1b shows a production process of prior art, and the equipment used therein,
- Fig. 2 shows the process according to a first embodiment for producing fibrous raw material, and the equipment used therein,
- Fig. 3 shows the process according to a second embodiment for producing fibrous raw material, and the equipment used therein,
- Fig. 4 shows the process according to a third embodiment for producing fibrous raw material, and the equipment used therein, and
- Fig. 5 shows the process according to a fourth embodiment for producing fibrous raw material, and the equipment used therein.

Detailed description of the invention

In Figures 1 to 5, the same numerals or symbols are used for corresponding parts of the method and the system. This also shows that the equipment of a conventional TMP process can be applied in the method and equipment of the new TMP process.

A conventional thermomechanical pulping process (TMP process) is shown in Figs. 1a and 1b. Figure 1a shows a flow chart of the process, and Fig. 1b also shows schematically some equipment applied at the initial end of the process.

Produced wood chips are stored, for example, in a silo or in an open depot. In Fig. 1a, the wood chips 1 are first fed into the pulping process, for example into a wood chip silo, where they are first preheated in the silo 10 at a temperature of 100°C, if this is necessary because of ambient conditions. For the preheating, for example vapour produced in refining is utilized. After the treatment, the wood chips are washed in a washing unit 11. The washing is performed with hot water, for example at 70 to 80°C, and it involves the

separation of sand, metal bits and other impurities from the wood chips. In connection with the washing, water 4 is supplied into the process and is heated, for example, by means of vapour produced in refining. At this stage, the dry matter content in the mixture of wood chips and water is typically about 3 to 4%. The warm water increases and evens out the moisture of the chips. Recirculated water is typically used for the washing. After the washing, the mixture of wood chips and water is led to dewatering, after which the chips are typically conveyed by a screw conveyor to a preheater, and the chips are preheated by vapour in a preheater 12. A difference to the conditions prevailing in the silo 10 is that this preheating typically takes place under slight overpressure and at a temperature slightly above 100°C (for example, under an overpressure of 100 kPa and at a temperature of 120°C or lower). In the following, the term pressure refers to an effective overpressure higher than the prevailing pressure. Because of the pressure, water vapour 2a can be released or discharged from the preheating. In other parts of the process, vapour produced in the refiners is utilized for heating and drying. By means of the heating, the moisture of the wood chips evens out and the detachment of fibers is facilitated.

After sufficient preheating, the chips are typically fed by a screw conveyor to a feed screw for a refiner and further to a first refiner 13. At this stage, the dry matter content of the wood chips is typically about 20 to 27%. In this example, the refiner is a single disc refiner (SD), which is a disc refiner or a conical refiner, and in which one disc rotates, another one being stationary. A refining process for forming coarsely refined pulp is performed in the first refiner 13. In the refining process, the chips are crushed into pin-like pieces and further into fiber bundles and single fibers. In the refiner, part of the energy consumption of the refiner is taken for heating the wood material, for which reason vapour 2b can be separated from the coarse pulp obtained from the refiner, by means of a vapour separating device, typically a cyclone. At this stage, the dry matter content of the once-refined pulp is typically 24 to 40%. In view of the energy consumption of the refining process, the dry matter content is preferably low at this stage. The energy consumption is monitored, for example, by monitoring the loading of the motors of the refiner. In particular, the blade gap of the refiner and the method of refining influence the energy consumption of the refiner. The so-called specific energy consumption and the refining conditions thus have a significant effect on the refined

pulp. It is also typical to add dilution water into the refiner to influence the refining conditions and the consistency of the refined pulp.

Once-refined pulp is further fed into a second refiner 14, for example by blowing with vapour or by means of a screw conveyor. In both refiners 13, 14, a pressure of about 300 to 500 kPa is typically prevailing, and the temperature in the refiners is about 143 to 159°C. Vapour 2c can also be separated from the refined pulp downstream of the second refiner 14, typically by means of a cyclone.

In the refined pulp produced in this way, the fibers are normally not rectangular, and because of this, they are subjected to removal of latency in a latency removal container 15, to which the refined pulp is typically led from the vapour separation cyclone by means of a screw conveyor. In the latency removal process, the refined pulp is normally diluted to a consistency of 2 to 4% at a temperature of 70 to 80°C.

After this, the pulp is led to a screening device 16, which is typically a pressure screen, whose operation is based on a pressure plate, and to a drier 17 and finally to a storage 18. In the screening, coarse and long fibers are typically removed, and the reject can be refined again and admixed to the pulp. Normally, refined pulp made by the TMP process is dried separately either in a flash drier or in a drying machine. In a drying machine, a pulp mat is formed of the refined pulp, and these mats are rolled up for the time of storage. The finished raw material typically has a dry matter content higher than 75%. The finished refined pulp 3 is transported to an insulation material factory according to the use. Before the refined pulp stored in this way can be used as raw material for wool boards, the pulp mats must be shredded to fibers again.

Dilution water is used in refiners for various reasons. The dilution water lubricates and cools the refiner and has an effect on the consistency of the refined pulp. It has been surprisingly found that raw material for thermal insulation can also be made with a significantly smaller amount of water, or the use of water can even be totally eliminated by selecting the raw materials and the process parameters, for example the refining conditions, on one hand according to the requirements of the final product and on the other

hand according to the properties of the raw material. It is thus possible to significantly reduce the energy consumption and the production costs.

Furthermore, the method can be implemented with existing production equipment even if the use of water was totally abandoned. This is possible, for example, by selecting suitable process parameters so that one refiner used in the process is only applied for drying and for increasing the dry matter content of the raw material.

It is significant that the fibrous raw material for thermal insulation does not need to be quite as fine as the raw material for paper, or even the raw material for wool boards of prior art. Thus, the refiners can be used to make more coarsely refined pulp, and a larger blade gap can be applied, wherein the energy consumption of the refiners is reduced, and the use of dilution water, for example for reducing the consistency or for preventing the burning of the refined pulp, can be reduced or totally abandoned. The fibrous raw material for thermal insulation can be coarser than before, and it can have a greater fiber length. Furthermore, such raw material has a substantially lower water retention capacity than pulp used as raw material for paper. For these reasons, a low specific energy can be used with the refiners, wherein the need for cooling and lubrication is reduced or eliminated by selecting the refining conditions in a suitable way. Consequently, the fibrous raw material made of refined pulp obtained already after the refining is sufficiently dry with respect to its dry matter content, typically at least 75%, and separate driers will no longer be needed. The finished raw material is obtained from the vapour separation cyclone, for example from its screw conveyor. Furthermore, curled fibers can also be accepted as raw material, wherein there is no need for removing the latency, and there is thus no need for the latency removal container 15.

To enable the operation of the refiner, the new TMP process is also significantly influenced by the properties of the wood chips, particularly the dry matter content. This is taken into account in the control parameters of the process, particularly in the refining conditions.

The fibrous raw material for the TMP process is cellulose based raw material, for example wood, preferably softwood and particularly spruce. The target is

a fiber distribution having a high content of long fibers and a low content of fines. It is also possible to use hardwood, for example aspen and birch. Wood chips are made of wood by methods known as such. The wood chips have preferably been chipped and sieved in such a way that the chips supplied into the preheating silo 10 are substantially elongated in shape. Because of the processing conditions, it is also possible to use chips of other shapes as the raw material, and the moisture content of the raw material or the size of the chips are not of great significance, as long as the moisture content of the raw material is taken into account in the selection of the process parameters in a way to be described hereinbelow. Sawdust is also useful for partly replacing larger chips.

According to a first embodiment of the process, the chips used as raw material are not washed with water, wherein an unnecessary drop in the dry matter content of the chips is avoided, and thereby also unnecessary heating or application of energy for removing moisture.

According to a second embodiment of the process, the chips are fed into a refiner under a suitable pressure, particularly under an elevated pressure, wherein the preheater 12 of prior art is not necessary. In these embodiments, the chips are refined in the first refiner by applying relatively little energy, wherein the energy applied is not sufficient to overheat or ignite the chips in the refiner, and the addition of water into the refiner is avoided.

In a third embodiment of the new process, a suitable coarseness of the refined pulp is achieved already in the first refiner, and the refined pulp is dried downstream of the first refiner. The dry matter content of the refined pulp downstream of the first refiner is preferably more than 60%. This drying can also be performed with the second refiner. The second refiner is thus used as a through drying machine. If the dry matter content of the refined pulp downstream of the first refiner is about 60% or higher, the drying can be performed in the second refiner, so that it will not be necessary to modify the system of prior art and to include a separate drier. Thus, refiner lines of prior art can be converted to a separate fibre board pulp line at very low investment costs, or refiners of prior art can be applied in the production process of wool boards. In some embodiments, the heat released with vapour in the

process is recovered. If a separate drier is used, the drying is accomplished, for example, by means of hot air.

The above-mentioned first embodiment is illustrated in Fig. 2. In this embodiment, the chips are blown by means of a blowing device to a separator, for example by means of hot air produced by a fan to an air density separator (ADS) 20, in which impurities, such as rocks and bits of iron, are separated from the chips. The chips are dried by the hot air which is provided by means of a heat exchanger, in which the air is heated by means of vapour obtained from the refiners. This separation replaces the washing with water by means of corresponding equipment 11 known from the process steps of prior art (cf. Fig. 1b).

In view of the subsequent steps of the process, it is the dry matter content of the raw material used that is significant. The most common raw materials are fresh chips, with a dry matter content of about 45%, and dry chips, with a dry matter content of about 89%.

Downstream of the air separator 20, the chips are guided to, for example, a screw conveyor and from there to a preheater 12. The chips are preheated under a pressure of, for example, 80 to 150 kPa and at a temperature of 117 to 128°C. In the preheating, it is possible to utilize vapour 2b or 2c obtained from the refiner. The preheating temperature and pressure correspond to each other according to the saturated water vapour pressure. Preferably, the preheating pressure is 170 kPa, wherein the temperature is about 130°C, because such a selection enables the use of high energy in the refiner, wherein the once-refined pulp to be made comprises long fibers.

A second embodiment is shown in Fig. 3. In the solution of Fig. 3, preheating in the preheater 12 can be replaced by increasing the feed pressure used in the refiner 13, wherein the temperature of the refiner also rises in a way corresponding to the vapour pressure. For example, by applying a refiner feed pressure of 220 kPa, the corresponding temperature being about 136°C, separate preheating will not be necessary. This is not possible in all TMP processes, but in many new processes it is possible to increase the refiner feed pressure and thereby to bypass the preheating and to transfer the chips

to the refiner 13 directly from the air separator 20 by applying, for example, a screw conveyor.

As shown in Figs. 2 and 3, the first refiner is a single disc refiner (SD), which is a disc refiner or a conical refiner, and in which one disc rotates, the other being stationary. The second refiner shown is also a single disc refiner.

In the first and second embodiments, the specific energy applied for the first refiner 13 is 833 kWh per ton or lower, in some cases only about 80 kWh per ton, without dilution waters and under a high pressure of 300 to 400 kPa, wherein the temperature is 143 to 151 °C, and a low blade rotation speed, for example 1000 to 1200 rpm, is applied. Specific energy refers to the quantity of energy used in a refiner per ton of raw material fed into the refiner. Compared to a conventional TMP process, in which the energy consumption is in the order of 2.0 to 2.2 MWh per ton (typically divided between two refineries), the heat formation is considerably lower in this embodiment. However, because energy is introduced into the process, the chips are dried during the refining. No dilution water is added into the refining, because the water contained in the chips and the water of the vapour are sufficient to make the chips a good fibrous raw material for thermal insulation. The chips do not burn in the blade gap, because the requirements of the fibrous raw material for thermal insulation allow the use of a large blade gap and thereby said low specific energy level of the refiner. In a conventional TMP process, the rotational speed of the refineries is typically 1500 to 1800 rpm. In these embodiments, a lower rotational speed gives coarser once-refined pulp containing longer fibers and having desired properties. Preferably, coarse feeding or retaining blades are used in the first refiner, wherein the once-refined pulp comprises long fibers, is coarse and free from fines, in which pulp the fibers are flat. What is decisive is the dry matter content achieved at the first refiner.

Increasing the consumption of energy will also give a higher dry matter content. According to some typical examples, the dry matter content of the chips being 45% and the specific energy of the first refiner being 500 kWh per ton, the dry matter content of 64% for the refined pulp can be achieved; and in a corresponding manner, the dry matter content of the chips being 89% and the specific energy of the first refiner being 83 kWh per ton, the dry matter content of 95% for the refined pulp can be achieved.

In some embodiments, a screening device 21 is applied downstream of the first refiner, to screen the once-refined pulp coming from the first refiner according to the fiber size. Too large fibers are recirculated and mixed with the chips 1 to be refined again. The screening device 21 is placed upstream of the cyclone, in which vapour is separated from the refined pulp. The screening device is preferably a blow-off pipe screening device which is presented in publication WO 01/42556 A1 and in which coarser fibers and fiber bundles are separated out of the refined pulp by means of a high speed as well as a mixture of refined pulp and, for example, air or vapour.

In processes according to the first and second embodiments, the dry matter content of the once-refined pulp obtained from the first refiner can be higher than 60% but clearly lower than 75%, so that the once-refined pulp has to be dried further. This is, for example, a situation in which the dry matter content of the chips used as raw material is about 45%. In said embodiments, the second refiner is applied for drying once-refined pulp to desired dry matter content. In the second refiner, a lower specific energy is further applied, for example 125 to 250 kWh per ton.

Preferably, in the second step, the aim is not to refine the refined pulp but the blade of the refiner is selected so that heat develops in the fibers but the fiber is not modified and the fibre distribution is not affected. Consequently, the blades load the fiber material but no fines are released from the surface of the fibers and the fibers are not fibrillated. The heat and vapour developed in this process dry the once-refined pulp in such a way that downstream of the second refiner, the dry matter content of the refined pulp is at a desired level, preferably higher than 75%.

According to a typical example, the dry matter content of refined pulp downstream of the first refiner is 64%, and the specific energy of the second refiner is 250 kWh per ton, wherein the resulting dry matter content of the pulp refined by the refiners and dried is 85%.

A third embodiment of the process is shown in Fig. 4. The raw material used in it consists of dry chips, and the coarseness and the energy level of the first refiner are set such that by selecting the refining conditions to be suitable,

raw material of sufficient quality for thermal insulation is obtained already by the first refiner. In this embodiment, the refining of the chips is performed by applying only one refiner. Thus, the raw material used consists of sufficiently dry chips, wherein the dry matter content is higher than 45% and the specific energy of the first refiner is low, typically lower than 800 kWh per ton, or preferably lower than 500 kWh per ton. Thus, the dry matter content of the refined pulp obtained already from the first refiner is higher than 75%. This is sufficiently dry as raw material for thermal insulation. In the third embodiment, it is also possible to use fresh chips, whose dry matter content is typically 45%, as raw material, but in this case a separate drier is needed downstream of the first refiner, if no second refiner is available, for example as a through drying machine. Such drying can be implemented by known methods (cf. Fig. 1, drier 17), but this is not reasonable in view of energy efficiency. However, it should be noted that the water retention capacity of the fibrous raw material for thermal insulation is substantially lower than that of paper pulp. Thus, the drying consumes less energy than the drying of a corresponding quantity of paper pulp. The application of the second refiner as a drier corresponds to said first or second embodiment of the process.

The specific energy to be used in the refiners in the different embodiments will depend on the dry matter content of the raw material supplied into the process, as well as on the embodiment itself: whether once-refined pulp is dried further, or whether only one refiner is used. The specific energy of the refiner will be determined according to the raw material. By calculation, it is possible to find out - when the raw material used is known - what kind of specific energies of the refiner or refiners can be used to produce raw material for thermal insulation having a dry matter content of at least 75%, without a need for further drying of the raw material or the refined pulp by means of a separate drier.

In a fourth embodiment of the process, the vapour 2a, 2b and 2c developed in the preheating or in the refiners is utilized for heating the air needed in the air separator 20 and for drying the chips. This is illustrated in Fig. 5, in which air 50 is led via a heat exchanger 51 to the air separator 20. In a corresponding manner, the vapours formed in the refiners are led as a heat source into the same heat exchanger. Thus, no external heating will be necessary. The heat contained in the vapours 2b, 2c from the refiners can also be

recovered in a preheater according to the first embodiment (see Fig. 2, pre-heater 12). In a corresponding manner, the heat recovery can naturally be included in the second and third embodiments (see Figs. 3 and 4). Furthermore, the heat recovery can be included in the first embodiment (see Fig. 2)
5 by leading the vapour 2a released from the preheater 12 into the heat exchanger 50.

The fibrous raw material 3 for thermal insulation obtained by the above embodiments is light in colour and thereby well suited for the production of
10 thermal insulation boards. The colour is influenced by the process conditions applied and the raw material.

According to a typical example, the fibrous raw material for thermal insulation obtained from the process is coarse, and its standardized freeness value
15 (CSF, Canadian Standard Freeness) is higher than 750 ml. The fiber distribution, in turn, is more than 80% of so-called long fibers (+28 mesh as a measurement wire) and less than 5% of so-called fines (200 mesh as a measurement wire), measured by a Bauer McNett fractioning device (BMcN).

20 For transferring the chips used as raw material, the refined pulp and the finished fibrous raw material in the presented process, it is possible to apply devices known as such, including various conveyors and transfer devices, such as above-mentioned screw conveyors, belt conveyors, transfer devices based on gravity, or devices utilizing air blowing.

25

The invention is not limited solely to the above-presented embodiments and examples, but it can be varied within the scope of the appended claims.

30

Claims

1. A method for producing fibrous raw material for thermal insulation in a thermomechanical process comprising:
- conveying cellulose based chips (1) from storage (10) to removal of impurities;
- characterized in that the method also comprises:
- separating impurities from the chips and supplying the purified chips to a first refiner (13); and
 - refining the chips to refined pulp in a first refiner (13), the dry matter content of the refined pulp downstream of the first refiner being preferably at least 60%.
2. The method according to claim 1, characterized in performing the refining by using a first refiner (13) which is a single disc refiner.
3. The method according to claim 1 or 2, characterized in controlling the process in such a way that the dry matter content of the finished fibrous raw material obtained is at least 75%.
4. The method according to any of the claims 1 to 3, characterized in performing, downstream of the first refiner (13), drying of the refined pulp by using a second refiner (14), to which the refined pulp is led via vapour separation, and increasing the dry matter content of the refined pulp in the second refiner (14).
5. The method according to claim 4, characterized in performing the drying by using the second refiner (14) without substantially affecting the fiber distribution of the refined pulp.
6. The method according to any of the claims 1 to 5, characterized in conveying the purified pulp downstream of the removal of impurities directly, without preheating after the purification, to the first refiner (13).

7. The method according to any of the claims 1 to 6, **characterized** in blowing the chips from storage (1) by means of hot air to the removal of impurities, and separating the impurities from the chips by means of air.
- 5 8. The method according to claim 7, **characterized** in supplying vapour (2b, 2c) from vapour separation and producing the hot air (51) for the blowing by means of a heat exchanger (50) and vapour.
- 10 9. The method according to any of the claims 1 to 8, **characterized** in performing the grinding of the chips by means of not more than two refiners, and applying a specific energy consumption not higher than 800 kWh per ton, preferably not higher than 500 kWh per ton, in the refiner/refiners.
- 15 10. The method according to any of the claims 1 to 3, **characterized** in performing the drying of refined pulp downstream of the first refiner (13) by using a separate drier, and increasing the dry matter content of the refined pulp in said drier.
- 20 11. The method according to any of the claims 1 to 10, **characterized** in that the finished refined pulp has a freeness value, by CSF (Canadian Standard Freeness) measurement, higher than 750 ml, and a long fiber content, by BMcN measurement (+28 mesh), higher than 85% and a fines content (200 mesh) lower than 5%.
- 25 12. The method according to any of the claims 1 to 11, **characterized** in conveying the purified chips to the first refiner (13) without washing with water.
- 30 13. The method according to any of the claims 1 to 12, **characterized** in conveying the refined pulp downstream of the refining to screening of the fibrous pulp and from there to vapour separation and then to storage of finished fibrous raw material (3) having a desired dry matter content.
- 35 14. The method according to any of the claims 1 to 13, **characterized** in carrying out the refining by using the first refiner (13) in such a way that the refining is accomplished without dilution water.

15. The method according to any of the claims 1 to 14, **characterized** in carrying out the grinding and drying of the chips by applying a thermomechanical process which is at least partly modified from the production of pulp used as raw material for paper to the production of fibrous raw material for thermal insulation.

16. The method according to claim 15, **characterized** in utilizing at least one refiner intended for production of raw material for paper, in a modified way for the production of fibrous raw material for thermal insulation.

10

17. A system for producing fibrous raw material for thermal insulation in a thermomechanical process, the system comprising:

- conveyor and transfer devices for conveying cellulose based chips (1) from storage (10) to the removal of impurities;

15 **characterized** in that the system further comprises:

- a separator (20) for separating impurities from the chips, and conveyor and transfer devices for conveying purified chips to a refiner; and
- a first refiner (13) for refining the chips to refined pulp, the first refiner (13) being further adapted to refine the chips to refined pulp whose dry matter content is preferably at least 60%.

20

18. The system according to claim 17, **characterized** in that the first refiner (13) is a single disc refiner.

25

19. The system according to claim 17 or 18, **characterized** in that the system further comprises, downstream of the first refiner (13), a second refiner (14) adapted for drying refined pulp and increasing the dry matter content of refined pulp without substantially affecting the fiber distribution of the refined pulp.

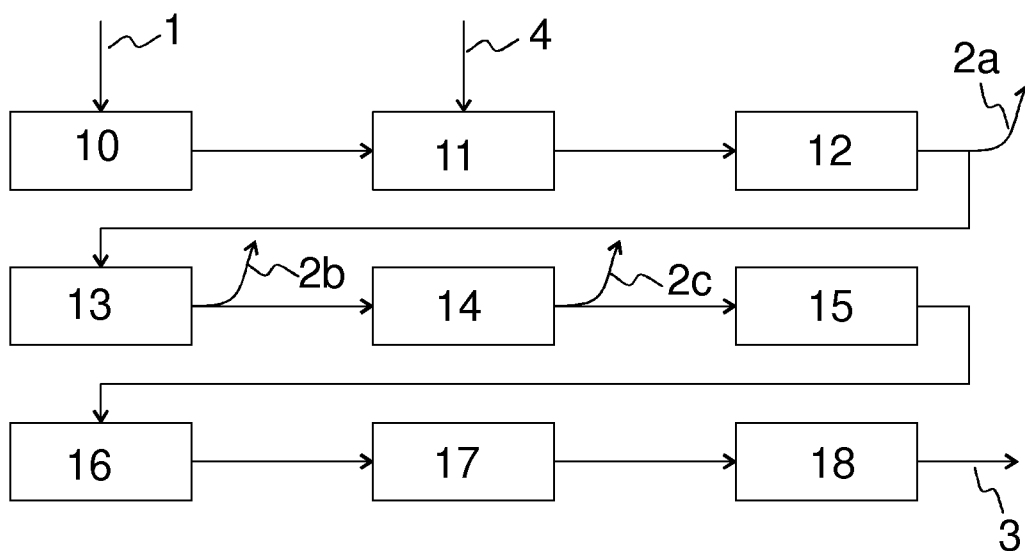
30

20. The system according to any of the claims 17 to 19, **characterized** in that the system further comprises conveyor and transfer devices for conveying purified pulp downstream of the removal of impurities directly, without pre-heating after the purification, to the first refiner (13).

35

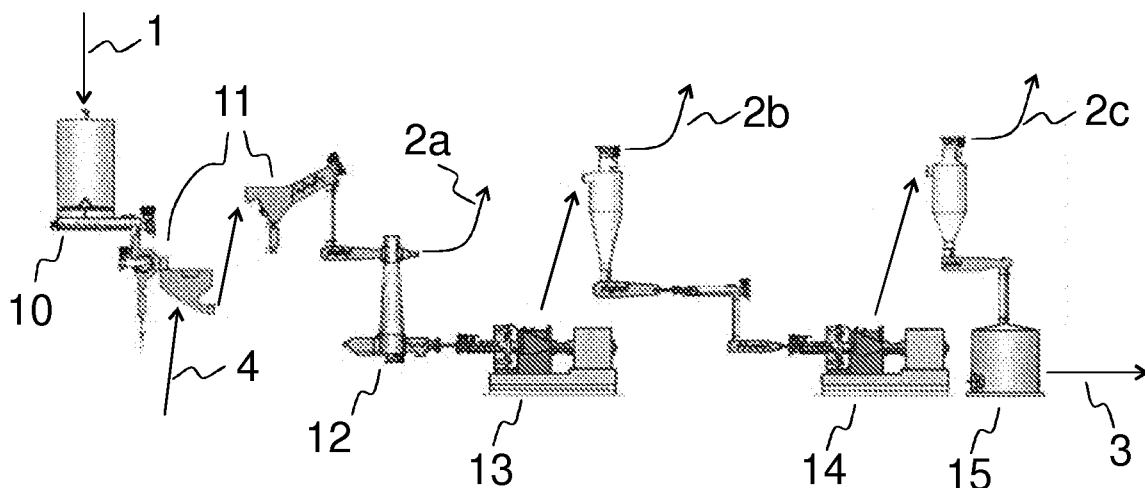
21. The system according to any of the claims 17 to 20, **characterized** in that the system further comprises blowing devices for blowing the chips by means of hot air from storage (1) to the removal of impurities, said separator being adapted to separate impurities from the chips by means of air.
- 5
22. The system according to any of the claims 17 to 21, **characterized** in that the separator (20) and the conveyor and transfer devices are adapted to convey the purified chips without washing to the first refiner.
- 10
23. The system according to any of the claims 17 to 22, **characterized** in that the system also comprises:
- a screening device (21) for screening the refined pulp after the refining,
 - vapour separation devices for performing vapour separation after the screening, and
 - 15 - conveyor and transfer devices for conveying the finished fibrous raw material (3) having the desired dry matter content, to storage.
- 20
24. The system according to any of the claims 17 to 23, **characterized** in that at least part of said system for refining and drying chips has been converted from a thermomechanical process that has been applied for the production of pulp intended as raw material for paper.
- 25
25. Fibrous raw material for thermal insulation, **characterized** in that the finished raw material has a freeness value, by CSF measurement (Canadian Standard Freeness), higher than 750 ml, and a long fiber content, by BMcN measurement (+28 mesh), higher than 85%, and a fines content (200 mesh) lower than 5%.
- 30
26. The raw material according to claim 25, **characterized** in that it has been refined and dried by applying a thermomechanical process.

1 / 3



- PRIOR ART -

Fig. 1a



- PRIOR ART -

Fig. 1b

2 / 3

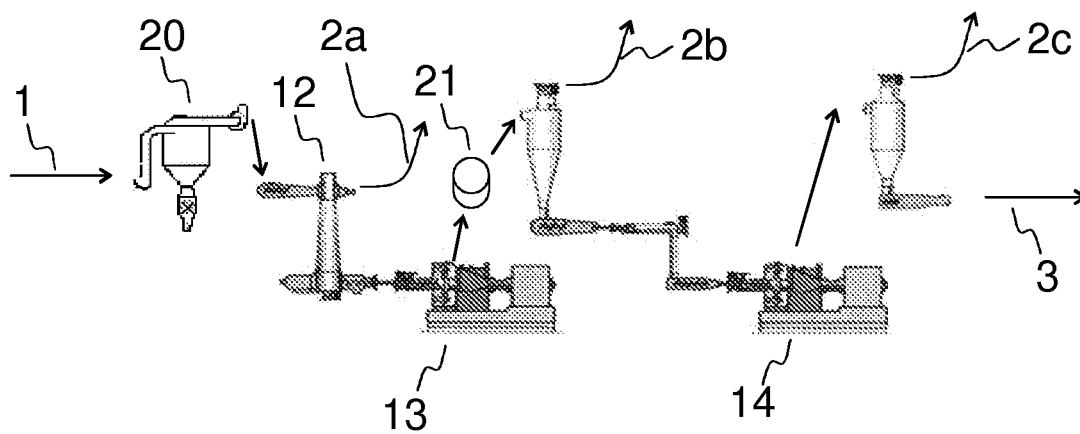


Fig.2

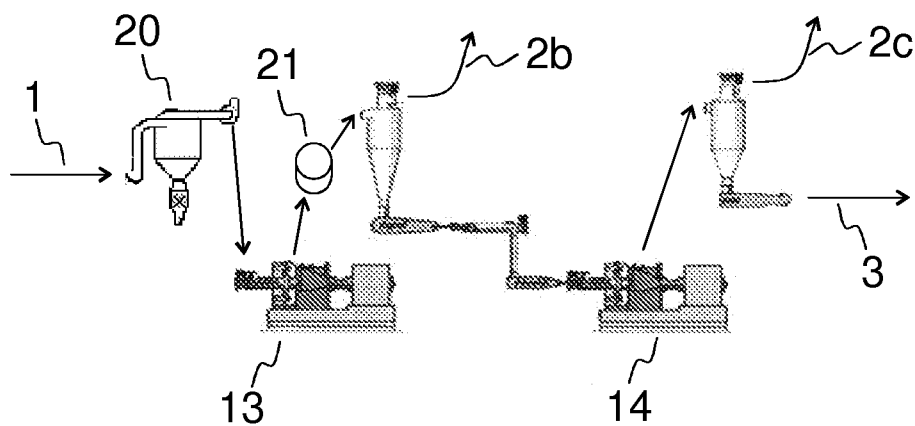


Fig.3

3 / 3

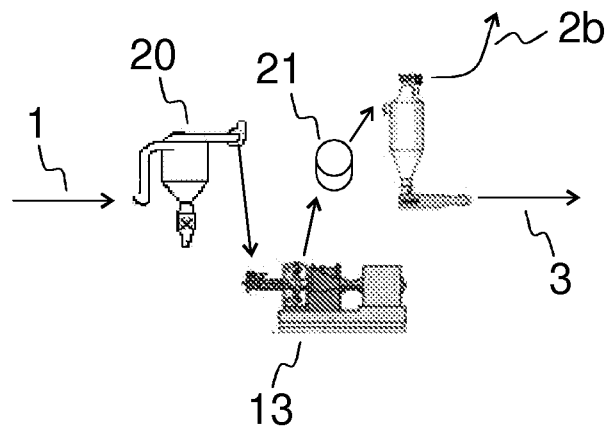


Fig.4

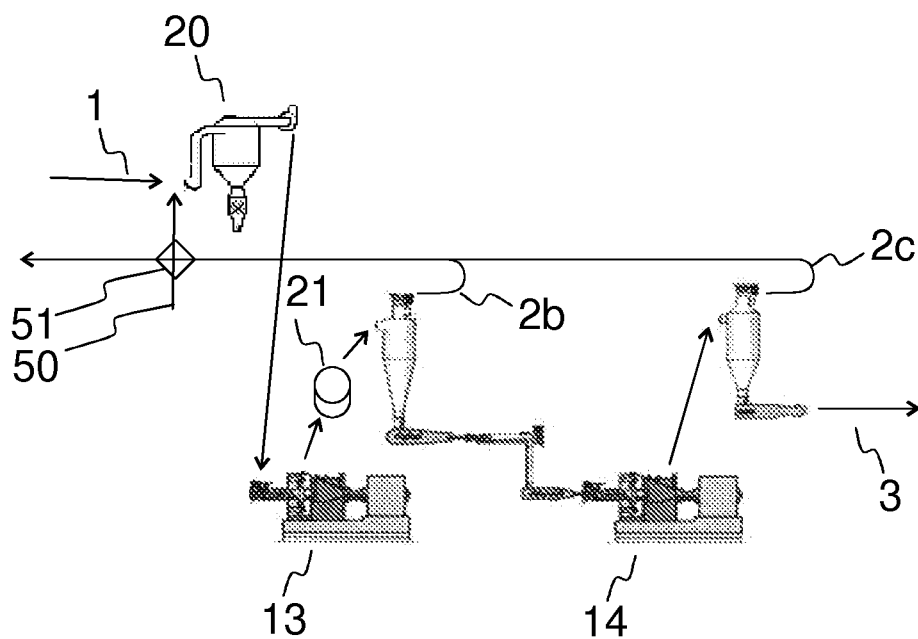


Fig.5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI201 1/050642

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: D21 B, D21 H, D21 D, D21 J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
FI, SE, NO, DKElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 401 2279 A (SELANDER STIG et al.) 15 March 1977 (15.03.1977) abstract; column 5, line 30 - column 6, line 16; figure	1, 2, 4-8, 10, 12-24
Y	US 2872337 A (HERITAGE CLARK C et al.) 03 February 1959 (03.02.1959) column 2, lines 39-55; column 3, lines 3-13; figure 1	1-8, 10, 12-24
Y	US 440777 1 A (BETZNER WILLIAM E et al.) 04 October 1983 (04.10.1983) abstract; column 3, lines 6-60; figure	1-8, 10, 12-24
Y	US 4457804 A (REINHALL ROLF B) 03 July 1984 (03.07.1984) abstract; column 3, lines 23-32 and 50-64; column 4, lines 55-59; figure 1	2
A	EP 0572388 B1 (SCA RESEARCH AB - MOELNLYCKE AB) 10 May 1995 (10.05.1995) claims 1-7	25, 26



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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

"E" earlier application or patent 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

"P" document published prior to the international filing date but later than the priority date claimed

"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 when the document is taken alone

"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

"&" document member of the same patent family

Date of the actual completion of the international search

25 November 2011 (25.11.2011)

Date of mailing of the international search report

29 November 2011 (29.11.2011)

Name and mailing address of the ISA/FI
National Board of Patents and Registration of Finland
P.O. Box 1160, FI-00101 HELSINKI, Finland
Facsimile No. +358 9 6939 5328Authorized officer
Matti Pasanen
Telephone No. +358 9 6939 500

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI201 1/050642

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category ¹ *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 117086 A (WESSEM JAN CAREL VAN) 22 May 19 19 (22.05. 19 19) page 2 , line 14 - page 3 , line 8 ; claims 1-3 ; figure 1	1-24

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI201 1/050642

CLASSIFICATION OF SUBJECT MATTER

Int.Cl.

D21B 1/12 (2006.01)

D21B 1/06 (2006.01)

D21H 11/08 (2006.01)

D21D 1/30 (2006.01)

D21J 1/20 (2006.01)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI20 11/050642

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

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

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
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, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

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

Invention I: Claims 1-24 relate to a method and a system for producing fibrous raw material for thermal insulation in a thermomechanical process

Invention II: Claims 25 and 26 relate to fibrous raw material for thermal insulation.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ 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 claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/FI201 1/050642

Patent document cited in search report	Publication date	Patent family members(s)	Publication date
US 401 2279 A	15/03/1 977	CA 1027404 A 1	07/03/1 978
		JP 50095505 A	30/07/1 975
		RO 86235 A 1	15/03/1 985
		NO 74471 1 A	28/07/1 975
		FR 2256286 A 1	25/07/1 975
		BE 823905 A 1	27/06/1 975
		IT 1028055 B	30/01/1 979
		NL 741 6790 A	01/07/1 975
		DD 115877 A5	20/1 0/1 975
		FI 368774 A	29/06/1 975
		AT 346065B B	25/1 0/1 978
		AU 7645574 A	17/06/1 976
		DE 2458929 A 1	10/07/1 975
		ZA 7407793 A	31/1 2/1 975
		SE 731 7565 A	30/06/1 975
		SE 376267 B	12/05/1 975
.....			
US 2872337 A	03/02/1 959	None	
.....			
US 440777 1 A	04/1 0/1 983	JP 58194529 A	12/1 1/1 983
		EP 0092699 A2	02/1 1/1 983
		AU 1073683 A	03/1 1/1 983
		AU 549980B B2	20/02/1 986
		CA 1174422 A 1	18/09/1 984
.....			
US 4457804 A	03/07/1 984	US 4283252 A	11/08/1 981
		JP 5301 0702 A	31/01/1 978
		NO 770975 A	20/09/1 977
		FR 2344666 A 1	14/1 0/1 977
		FI 770862 A	20/09/1 977
		CA 1065663 A 1	06/1 1/1 979
		BR 7701 695 A	08/1 1/1 977
		DE 271 1567 A 1	22/09/1 977
		GB 1572648 A	30/07/1 980
		SE 7603464 A	20/09/1 977
		SE 419659 B	17/08/1 981
.....			
EP 0572388 B 1	10/05/1 995	US 6458245 B 1	01/1 0/2002
		US 5607546 A	04/03/1 997
		NO 923 151 A	12/08/1 992
		FI 923605 A	12/08/1 992
		WO 9112367 A 1	22/08/1 991

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/FI201 1/050642

Patent document cited in search report	Publication date	Patent family members(s)	Publication date
		NZ 237067 A	25/1 1/1 993
		JP H05503966 A	24/06/1 993
		ES 2072603T T3	16/07/1 995
		DK 0572388T T3	28/08/1 995
		DE 691 09696T T2	14/09/1 995
		CA 2073763 A 1	14/08/1 991
		BR 9 106034 A	02/02/1 993
		AU 647780B B2	31/03/1 994
		AT 122420T T	15/05/1 995
		SE 900051 5 A	14/08/1 991
		SE 466060 B	09/1 2/1 991
.....			
GB 117086 A	22/05/1 9 19	None	
.....			