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(71) **Applicant: DESTRA GMBH** [AT/AT]; Riedstrasse 65, 1140 Vienna (AT).

(72) **Inventor; and**
(71) **Applicant: GRANDO, Patrizio** [IT/IT]; Via Circonvallazione, 16, 36020 Cismon Del Grappa (VI) (IT).

(72) **Inventor: BARTASHOV, Victor**; Riedstrasse 65, 1140 Vienna (AT).

(74) **Agent: BONINI, Ercole**; Studio Bonini Srl, Corso Fogazzaro, 8, 36100 Vicenza (IT).

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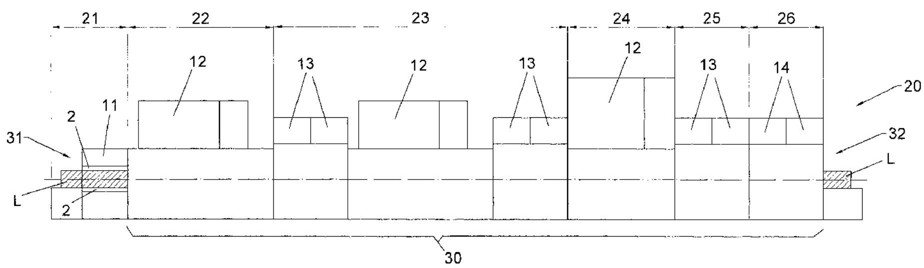
(54) **Title:** METHOD FOR PROCESSING FIBROUS MATERIALS AND SYSTEM IMPLEMENTING SAID PROCESSING METHOD

Fig.2



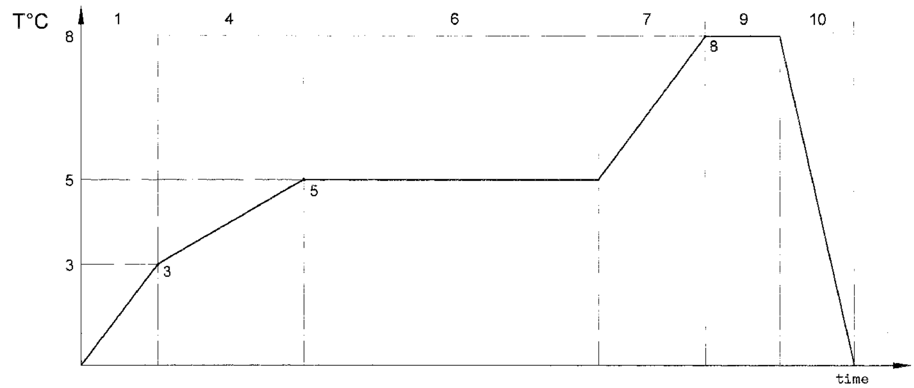


Fig.1

(57) **Abstract:** The invention is a method for processing mineral fibre (L) with the addition of a binding agent comprising phenol-formaldehyde in aqueous suspension, comprising the following steps: heating the mineral fibre (L) up to a first temperature (3) included between 20°C and 70°C by means of infrared rays (11); heating the mineral fibre (L) from the first temperature (3) included between 20°C and 70°C up to a second temperature (5) not exceeding 100°C by means of radiofrequency (12); maintaining the mineral fibre (L) at the second temperature (5) not exceeding 100°C; heating the mineral fibre (L) from the second temperature (5) to a third temperature (8) included between 120°C and 190°C; maintaining the mineral fibre (L) at the third temperature (8) included between 120°C and 190°C; cooling down the mineral fibre (L).

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METHOD FOR PROCESSING FIBROUS MATERIALS AND SYSTEM IMPLEMENTING SAID PROCESSING METHOD.

DESCRIPTION

The invention concerns a method for processing fibrous materials, for example mineral fibres such as rock wool and similar products.

The invention concerns also a system that implements said processing method.

As is known, rock wool is an artificial product deriving from the transformation of mineral substances of various nature which are melted and transformed into long filaments that solidify when they are hit by a cooling air stream.

Successively, the filaments are mixed with a binding agent, preferably but not exclusively comprising phenol-formaldehyde in aqueous suspension, and then are arranged in superimposed layers in such a way as to form a continuous thick mat which is introduced in a drying oven.

In order to give a solid consistency to the continuous fibre mat made as described above, a hot air stream whose temperature ranges from 260°C to 280°C is produced inside the drying oven, wherein said hot air stream hits the continuous mat and causes first the evaporation of the water contained in the binding agent and then the polymerization and the consequent hardening of the phenol-formaldehyde compound.

Once the processing cycle has been completed, the product leaving the oven appears as a soft continuous mat that can be cut to size in order to obtain panels in various lengths whose thermal insulation and sound absorption characteristics make them particularly suited to be used in the building construction and in the furniture sectors.

Said known production process, however, poses some recognized drawbacks, the most significant and important of which is represented by the high cost that the manufacturer must bear in order to heat the large quantities of air required by the drying and polymerization process to which the phenol-formaldehyde binding agent dispersed in the fibrous mass must be subjected.

The processing cycle becomes particularly expensive when the thickness of the fibrous mass exceeds 100 mm, as it is difficult to make the heat necessary for the polymerization of the phenol-formaldehyde binding agent penetrate in depth and reach the core of the fibrous mass.

Another disadvantage is represented by the high cost of the drying systems, which are provided with special conveyors with reeds.

A further drawback concerns the high energy consumption of the processes of known type, which varies from 250 to 300 kWh per ton of treated product and is due to the need to heat not only the processing air but also the internal masses of the dryer, whose weight often exceeds 100 tons.

The present invention intends to overcome all of the drawbacks and limitations described above.

In particular, it is a first object of the invention to develop a method for processing mineral fibre materials which, compared to the known processing methods, requires the consumption of a smaller amount of energy for the same quantity of treated material.

It is another object of the invention to develop a processing method that does not require the use of dryers with considerable mass, which involve high heating costs.

It is another, yet not the least object of the invention to develop a processing method and a processing system suited to implement said method - both being the subject of the present invention - which make it possible to carry out the same processing cycles as the known dryers, yet with considerably reduced energy consumption.

The objects illustrated above are achieved by a processing method and by a system according to the main claim, to which reference is made.

Other characteristics of the method and the system of the invention are described in the dependent claims.

Advantageously, the method of the invention ensures better control of the product and better quality of the processing cycle compared to the known methods.

Still advantageously, the system of the invention which implements said method has a lower cost compared to the known systems used to carry out the same processing cycle on the same mineral fibre.

The objects and advantages described above are highlighted in greater detail in the description of a preferred embodiment of the invention, which is provided here below by way of non-limiting example with reference to the attached drawings, wherein:

- Figure 1 shows the thermal cycle of the method which is the subject of the invention;

- Figure 2 shows a schematic view of the processing system which is also the subject of the invention and which allows said thermal cycle to be carried out.

The method of the invention concerns the processing of mineral fibre **L** with the addition of a binding agent comprising phenol-formaldehyde in aqueous suspension, wherein said processing is carried out through the thermal cycle described here below with reference to Figure 1.

The invention concerns also the processing system indicated as a whole by **20** and shown in Figure 2, through which the thermal cycle shown in Figure 1 is carried out.

The term “mineral fibre” is used here below to indicate any mineral reduced to the fibrous state, for example the so-called “rock wool” or mineral wool, and the like.

The method comprises a plurality of processing steps which take place in the processing system **20**, inside a processing tunnel **30** between an entry station **31** and an exit station **32**, and during which, as can be observed with reference to the thermal cycle illustrated in Figure 1, the mineral fibre **L** undergoes a series of heating cycles and a final cooling cycle.

With reference to Figures 1 and 2, the mineral fibre **L** to be treated is interposed between two containment surfaces **2** spaced from and opposing each other, which exert a compression force on the fibre **L**, said compression force having the purpose of giving the same fibre **L**, since the beginning of the processing cycle, the stable shape which it will assume once the processing cycle has been completed, after the polymerization of the phenol-formaldehyde binding agent.

Preferably but not exclusively, the containment surfaces **2** are constituted by two opposite powered belts, parallel to and spaced from each other, which make the fibre **L** to be treated move forward along the processing tunnel **30** from the entry station **31** to the exit station **32**.

The thermal cycle includes a first step **1** during which the mineral fibre **L** is heated up to a first temperature **3** included between 20°C and 70°C, preferably but not necessarily equal to 50°C, by means of an infrared ray source **11**.

During the first heating step **1**, the heat produced by the infrared ray source **11** hardens the external surface of the fibrous mass **L**, thus creating a containment casing which gives stability and shape to the fibre mass itself during all the successive processing cycles.

The first step **1** is followed by a second step **4**, in which the mineral fibre **L** is heated up to a second temperature **5** not exceeding 100°C by means of a radiofrequency source **12**.

The heating speeds during the first step **1** and the second step **4** can be the same or be different from each other and they are selected by the system operator according to the expected final characteristics of the product.

During the second step **4** the molecular vibration produced by radiofrequency, as is known, gradually heats the water of the suspension of the phenol-formaldehyde binding agent until it starts boiling when reaching the second temperature **5** whose value, as already explained, does not exceed 100°C.

Successively, the heating cycle with water evaporation continues during the third step **6**, during which the mineral fibre **L** is maintained at the second temperature **5**, not exceeding 100°C, through a heating cycle carried out by means of one or more radiofrequency sources **12** which, due to their own nature, heat the fibrous mass from the inside.

The heat then diffuses spontaneously towards the outside until reaching the entire volume of the fibrous mass, which is maintained at a temperature not exceeding 100°C.

This heat diffusion process during which the temperature is maintained at a value not exceeding 100°C is guaranteed also by the simultaneous action of one or more hot air sources **13**.

The radiofrequency sources **12** and the hot air sources **13** are arranged so that they alternate with each other in succession, one after the other.

In the specific case described herein with reference to Figure 2, during the third step **6** a radiofrequency source **12** is used, upstream and downstream of which there is a hot air source **13**, so that outside the fibrous mass each hot air source **13** makes the heat generated by the fibrous mass itself uniform, as it does with the heat generated by the radiofrequency source **12** adjacent to it, wherein said heat spontaneously tends to move from the inside of the same fibrous mass towards the external surface.

Different configurations are however possible, which comprise a different number of radiofrequency sources **12** and hot air sources **13** and different mutual positions of the same.

The duration of the third step **6** and the arrangement and number of the radiofrequency sources **12** and hot air sources **13** are selected according to the quantity of water contained in the phenol-formaldehyde binding agent and to the mass of the mineral fibre **L** to be treated, in order to obtain, at the end of the third step **6**, a fibrous mass substantially without water.

Then the fourth step **7** is performed, during which the mineral fibre **L**, now completely dried, is heated from the second temperature **5** not exceeding 100°C up to a third temperature **8** included between 120°C and 190°C by means of a radiofrequency source **12**.

Obviously, practical embodiments in which more radiofrequency sources **12** are used are also possible.

During the fourth step **7**, the radiofrequency source **12** heats the fibrous mass from the inside, until it reaches the third temperature **8** in a variable time interval to be selected by the user, wherein said third temperature is preferably but not necessarily set at 190°C.

Also in this case, the heat generated by the radiofrequency source **12** propagates from the inside of the fibrous mass towards the outside and the temperature increases gradually owing both to the heat produced by radiofrequency and to the exothermic reaction that develops during the polymerization of the phenol-formaldehyde binding agent.

Thus, the polymerization process takes place at increasing temperature during the fourth step **7** and, once the third temperature **8** has been reached, it continues during the successive fifth step **9** at the temperature **8** which is maintained constant for a variable time at the discretion of the manufacturer, by means of one or more, preferably one hot air source **13**.

The polymerization of the phenol-formaldehyde binding agent consolidates the mineral fibre **L** which assumes in a stable manner the configuration defined by the powered belts **2** between which it is interposed.

Once the fifth step **9** has been completed, a sixth step **10** follows, during which one or more, preferably one source of cold air **14** lowers the temperature of the fibrous mass down to a value which is set in advance by the manufacturer.

The method for processing the mineral fibre **L** which has been described above is implemented by a system schematically illustrated in Figure 2, where it is indicated as a whole by **20**, and comprising a processing tunnel **30** inside which there are the already mentioned opposing powered belts **2** which make the mineral fibre **L** interposed between them move forward along the processing tunnel **30** and through the processing stations.

Several configurations of the tunnel **30** are possible and the powered belts **2**, or other elements equivalent to them, can develop in a continuous or discontinuous manner, depending on the configuration and type of the radiofrequency sources **12**, the hot air sources **13** and the cold air sources **14** used.

Upstream of the tunnel **30** there is an entry station **31** suitable for the introduction of the mineral fibre **L** to be treated, downstream of the tunnel **30** there is an exit station **32** for the exit of the treated mineral fibre **L** and between the entry station **31** and the exit station **32** there are the processing stations arranged in succession one after the other and comprising:

- a first station **21** preferably but not exclusively equipped with an infrared ray source **11** suited to heat the mineral fibre **L** up to a first temperature **3** included between 20°C and 70°C. Preferably, said first temperature **3** is equal to 50°C;
- a second station **22** preferably but not exclusively equipped with a radiofrequency source **12** suited to heat the mineral fibre **L** up to a second temperature **5** not exceeding 100°C. Preferably, said second temperature **5** is equal to 100°C;
- a third station **23** equipped with one or more radiofrequency sources **12** and one or more hot air sources **13** arranged so that they alternate with each other in succession, one after the other, preferably two hot air sources **13**, of which one is arranged upstream and one is arranged downstream of a radiofrequency source **12** according to the direction of advance of the mineral fibre **L** along the tunnel **30** in order to maintain the mineral fibre **L** at the second temperature **5**;
- a fourth station **24** preferably but not exclusively equipped with a radiofrequency source **12** suited to heat the mineral fibre **L** up to the third temperature **8** included between 120°C and 190°C. Preferably, said third temperature **8** is equal to 190°C;
- a fifth station **25** preferably but not exclusively equipped with a hot air source **13** suited to maintain the mineral fibre **L** at the third temperature **8**;
- a sixth station **26** preferably but not exclusively equipped with a cold air source **14** suited to cool down the mineral fibre **L**.

From an operating point of view, the mineral fibre **L** to be treated is introduced in the system **20**, where it is interposed between the powered belts **2**; while passing through the several stations that make up the system, the mineral fibre is subjected to the processes described above, which comprise the following steps, in the given order:

- heating with surface hardening in the first station **1**;
- drying through water evaporation from the phenol-formaldehyde suspension in the second station **4** and in the third station **6**;
- heating and successive hardening through polymerization of the phenol-formaldehyde in the fourth station **7** and in the fifth station **9**;
- cooling in the sixth station **10**.

The method and the system described above are suited to process mineral fibres of any type, in particular the mineral fibre **L** which is defined “rock wool” in the market.

Upon implementation, the method and the system of the invention can be subjected to modifications and variants which have neither been described herein nor illustrated in the attached drawings.

It is understood, however, that any variants and modifications which have not been described and illustrated herein but fall within the scope of the following claims must in any case be all considered protected by the present patent.

CLAIMS

1) Method for processing mineral fibre (L) with the addition of a binding agent comprising phenol-formaldehyde in aqueous suspension, **characterized in that** it comprises a plurality of processing steps during which said mineral fibre (L) is interposed between two opposing containment surfaces (2), said steps comprising:

- a first step (1) during which said mineral fibre (L) is heated up to a first temperature (3) included between 20°C and 70°C by means of at least one infrared ray source (11);
- a second step (4) during which said mineral fibre (L) is heated from said first temperature (3) up to a second temperature (5) not exceeding 100°C by means of at least one radiofrequency source (12);
- a third step (6) during which said mineral fibre (L) is maintained at said second temperature (5);
- a fourth step (7) during which said mineral fibre (L) is heated from said second temperature (5) up to a third temperature (8) included between 120°C and 190°C;
- a fifth step (9) during which said mineral fibre (L) is maintained at said third temperature (8);
- a sixth step (10) during which said mineral fibre (L) is cooled down.

2) Method according to claim 1, **characterized in that** during said first step (1) said two containment surfaces (2) exert a compression force on said mineral fibre (L).

3) Method according to any of the preceding claims, **characterized in that** during said third step (6) said mineral fibre (L) is maintained at said second temperature (5) by means of one or more radiofrequency sources (12) in combination with one or more hot air sources (13).

4) Method according to any of the preceding claims, **characterized in that** during said fourth step (7) said mineral fibre (L) is heated up to said third temperature (8) by means of the heat produced by at least one radiofrequency source (12) in combination with the heat produced by the exothermic reaction that polymerizes said phenol-formaldehyde binding agent.

5) Method according to any of the preceding claims, **characterized in that** during said fifth step (9) said mineral fibre (L) is maintained at said third temperature (8) by means of at least one hot air source (13) in combination

with the heat produced by the exothermic reaction polymerizing said phenol-formaldehyde binding agent.

6) Method according to any of the preceding claims, **characterized in that** during said sixth step (10) said mineral fibre (L) is cooled down by means of at least one cold air source (14).

7) Method according to any of the preceding claims, **characterized in that** said first temperature (3) is equal to 50°C.

8) Method according to any of the preceding claims, **characterized in that** said second temperature (5) is equal to 100°C.

9) Method according to any of the preceding claims, **characterized in that** said third temperature (8) is equal to 190°C.

10) Method according to any of the preceding claims, **characterized in that** said mineral fibre (L) is rock wool.

11) System (20) for processing mineral fibre (L), in particular rock wool, with the addition of a binding agent comprising phenol-formaldehyde in aqueous suspension, said mineral fibre being interposed between two containment surfaces (2), said system (20) comprising a processing tunnel (30) inside which there are said containment surfaces (2) which develop over its entire length and in which there are a plurality of processing stations (21, 22, 23, 24, 25, 26) arranged in succession one after the other between an entry station (31) for the introduction of said mineral fibre (L) to be treated into said tunnel (30) and an exit station (32) for the exit of said treated mineral fibre (L) from said tunnel (30), **characterized in that** said processing stations comprise:

- a first station (21) equipped with at least one infrared ray source (11) suited to heat said mineral fibre (L) up to a first temperature (3) included between 20°C and 70°C;
- a second station (22) equipped with at least one radiofrequency source (12) suited to heat said mineral fibre (L) up to a second temperature (5) not exceeding 100°C;
- a third station (23) equipped with one or more radiofrequency sources (12) and one or more hot air sources (13) arranged so that they alternate with each other in succession, one after the other, in order to maintain said mineral fibre (L) at said second temperature (5);
- a fourth station (24) equipped with at least one radiofrequency source (12)

suited to heat said mineral fibre (L) up to a third temperature (8) included between 120°C and 190°C;

- a fifth station (25) equipped with one or more hot air sources (13) suited to maintain said mineral fibre (L) at said third temperature (8);
- a sixth station (26) equipped with one or more cold air sources (14) suited to cool down said mineral fibre (L).

12) System (20) according to claim 11, **characterized in that**:

- said first station (21) comprises an infrared ray source (11) suited to heat said mineral fibre (L) up to said first temperature (3);
- said second station (22) comprises a radiofrequency source (12) suited to heat said mineral fibre (L) up to said second temperature (5);
- said third station (23) comprises a radiofrequency source (12) and two hot air sources (13), of which one is arranged upstream and one is arranged downstream of said radiofrequency source (12) according to the direction of advance of said mineral fibre (L) along said tunnel (30) in order to maintain said mineral fibre (L) at said second temperature (5);
- said fourth station (24) comprises a radiofrequency source (12) suited to heat said mineral fibre (L) up to said third temperature (8);
- said fifth station (25) comprises a hot air source (13) suited to maintain said mineral fibre (L) at said third temperature (8);
- said sixth station (26) comprises a cold air source (14) suited to cool down said mineral fibre (L).

13) System (20) according to claim 11 or 12, **characterized in that** said first temperature (3) is equal to 50°C.

14) System (20) according to any of the claims from 11 to 13, **characterized in that** said second temperature (5) is equal to 190°C.

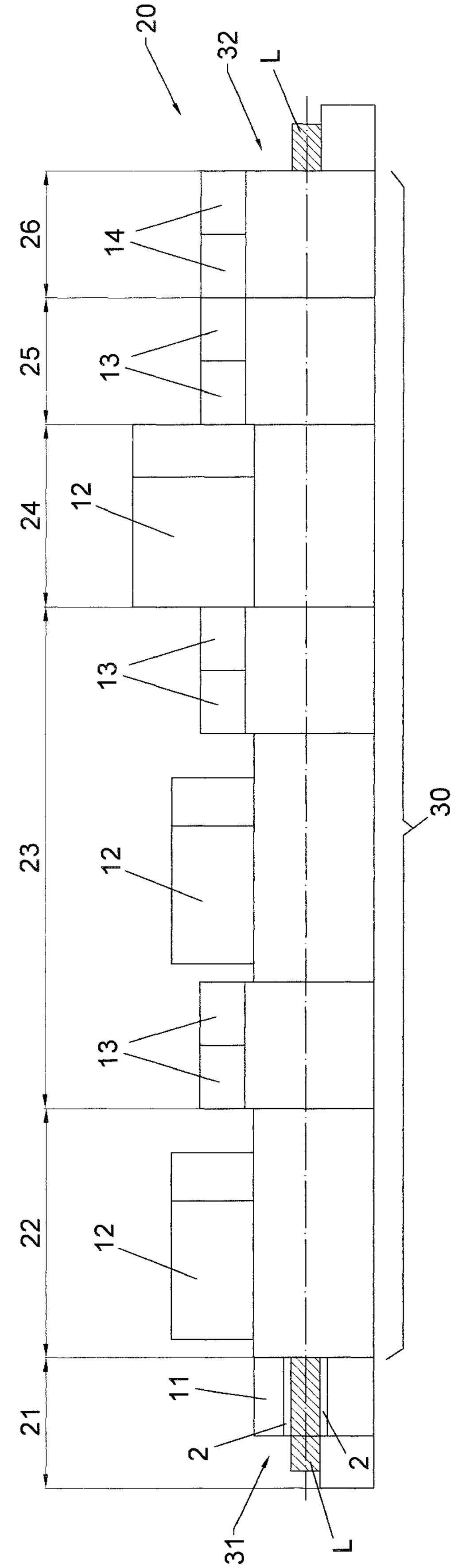

Fig.2

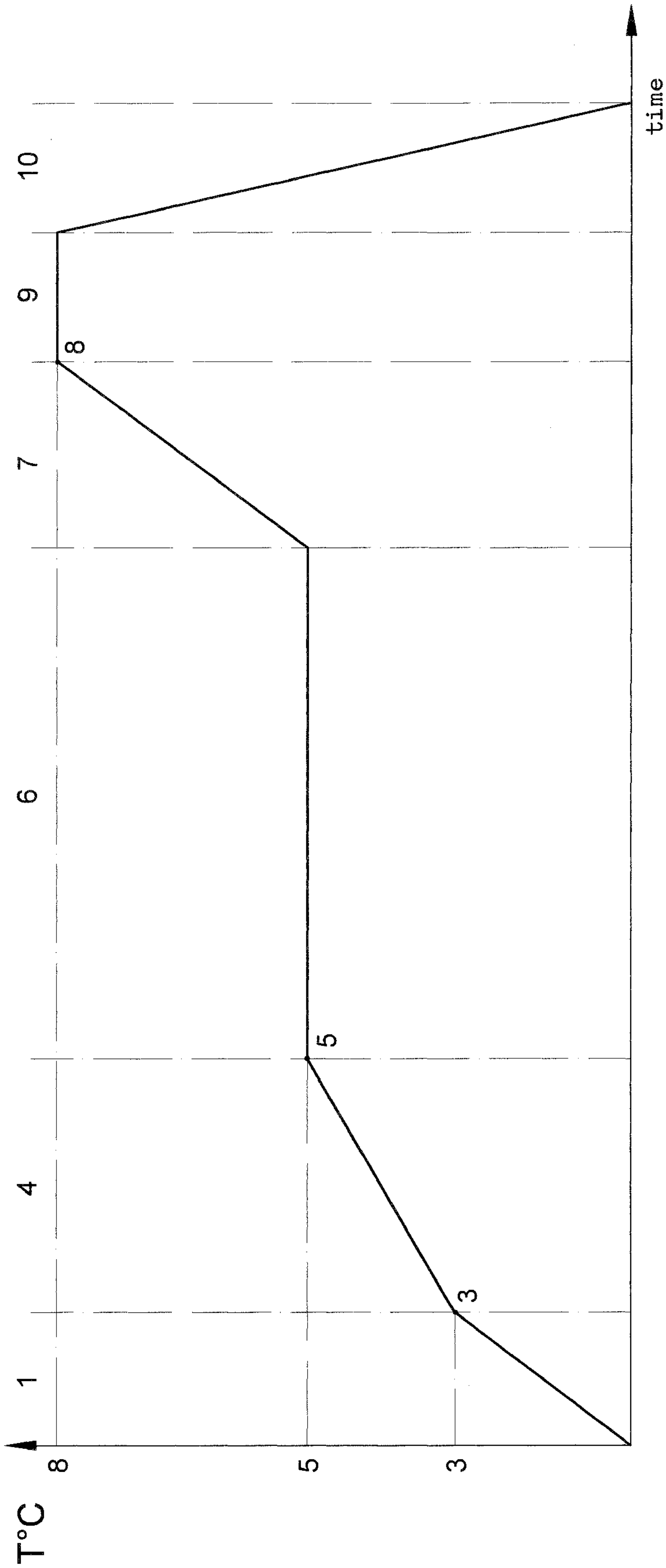

Fig.1

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV. C03C13/06 C03C25/34 C03C25/00 D06M10/00 D06M10/10
D06M15/356 C03B37/12 C03B37/01 B29C35/02 D04H13/00
ADD.

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)
C03C D06M C03B B29C D04H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	AT 516 749 A4 (DESTRA GMBH [AT]) 15 August 2016 (2016-08-15) the whole document -----	1-14
A	US 2015/190948 A1 (NGUYEN CHRISTINE [FR] ET AL) 9 July 2015 (2015-07-09) the whole document -----	1-14
A	US 2014/319721 A1 (CELLE PIERRE [FR] ET AL) 30 October 2014 (2014-10-30) the whole document -----	1-14

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 March 2018	29/03/2018

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Heer, Stephan

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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