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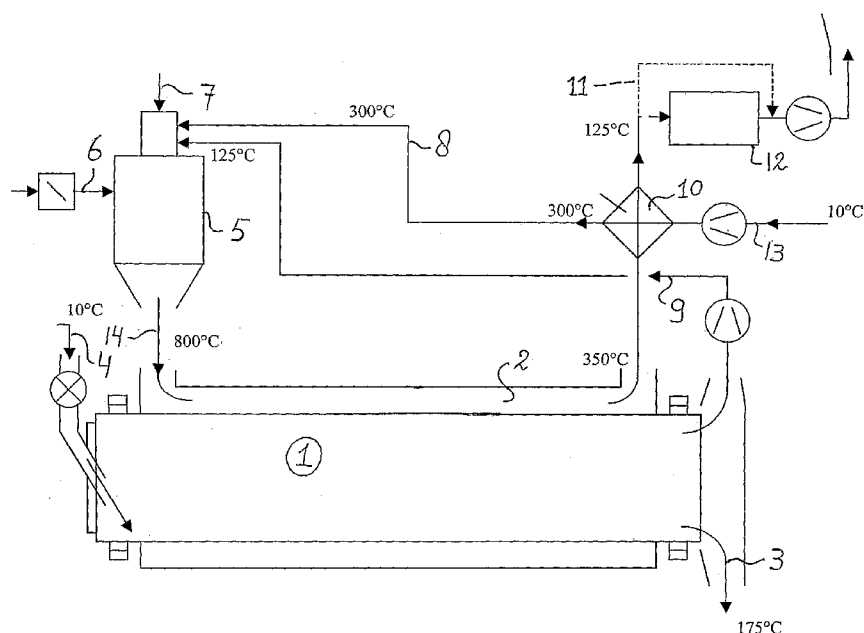
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(54) Title: RECYCLING BITUMEN CONTAINING USED MATERIAL



(57) Abstract: The invention relates to a method to recycle within an installation a continuous flow of asphalt granules, wherein a wall, contacting the granules, is heated at the side facing away from the granules, and heats the granules. The process is carried out at a pneumatic pressure head at moist conditions. The granules released from the installation are directly or via a mixer supplied to an asphalt spreading machine to be applied into a road surface.

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RECYCLING BITUMEN CONTAINING USED MATERIAL

This invention relates to a method and device to recycle bitumen containing used material, such as asphalt. In the following, this material is termed PR (asphalt granules), unless stated differently.

Until now it was common to pour road material, roof covering material or other PR as bulk material into a spinning drum with approximately horizontal spinning axis and to expose the PR within the drum to the direct heat radiation and hot combustion gases of a within the drum burning, open flame. Subsequently the thus treated PR is fed to an asphalt installation and therein mixed with pre heated, fresh mineral granules, bitumen and additives. Due to (process) technical aspects the amount of PR in the new asphalt is limited to 50%. The most important aspect is that, prior to mixing in the mixer the PR in the drum of the prior art can not be heated further than clearly below (approx. 130 degrees Celsius) the asphalt application temperature (approx. 175 degrees Celsius) due to emission problems, while because of that the fresh mineral granules have to be heated to clearly beyond (approx. 220 degrees Celsius) the asphalt application temperature, to be able to obtain the desired asphalt application temperature for the end product (mixture of PR and fresh material).

In the mean time from the British patent publication GB2312949 a batch wise operating, mobile asphalt heating installation (on the market known as Polybatcher) is disclosed, of which the spinning drum is heated externally by the open flame of gas burners. Through the same opening the drum is both filled and emptied with asphalt material, for which reason the drum has to be stopped. It is thus impossible, to continuously process a quantity asphalt material substantially more than the fill capacity of the drum. Besides, the fill capacity of the drum of the prior art is low (not more than 100 litres), such that the Polybatcher is merely suited for in situ heating of a small quantity new asphalt material for e.g. small repairs or to install a ramp at a residence. The Polybatcher is not designed to process PR, and the skilled man will also not think of doing that.

It is now proposed, to heat a the PR within the drum contacting wall at the side opposite the PR, and to arrange that

this heated wall heats the contacting PR. According to a practical embodiment the drum wall will be heated externally and will heat the along the internal side of the spinning drum wall tumbling, rolling and advancing PR. According to another practical
5 embodiment, the PR within the drum is contained within parallel, longitudinally extending pipes, wherein the wall of said pipes is heated externally and heats the PR moving along the internal side of said wall.

Thus the PR contacts a spinning wall part and is heated by
10 it.

Preferably the PR is like bulk material. It will be appreciated that "bulk material" means solid material like debris, grains, particles, flakes, humps, etc., such that is can be poured or cast.

15 Thus it is for the first time possible to apply PR, from the drum, directly at the desired application temperature without the requirement of additional mixing with fresh minerals, bitumen or additives, into the road surface.

Preferably recycling is on a continuous or semi-continuous
20 basis. This particularly means, that PR is supplied through the one opening and discharged through the other opening. These openings can be present at the same or opposite sides of the installation. Preferably a more or less continuous stream of PR through the installation is maintained, while without
25 interruption a quantity PR is processed, which is substantially bigger than the fill capacity of the installation.

Preferably the PR is processed without altering the inclination of the element(s) passed by the PR. Structurally this means, that said elements can be designed with a fixed spinning
30 axis, yielding a simplification and cost reduction. The installation is further preferably stationary, such that it can be dimensioned for large scale recycling.

One can indeed speak of a tempered, indirect heat exchange towards the PR with this invention, however in this way it can
35 be guaranteed that the least possible amount of bituminous gas is released and preferably merely steam. It can also be guaranteed, that the atmosphere within the drum, to which the PR within the

drum is exposed, is inert relative to the PR. Thus the PR can be heated at a higher temperature within the drum, to even the typical asphalt application temperature ($\pm 175^{\circ}\text{C}$). It is thus possible, to use a substantial higher part PR, more than 50% and preferably more than 80%, even 100%, to make fresh asphalt. The bitumen quality is also maintained, such that adding of fresh bitumen can be limited/avoided.

Preferably adding/removing of PR takes place such that within the installation a pressure can be maintained that is different from the environment. For that the supply and/or discharge of PR goes through a sluice or such sealing device. In combination or as alternative the supply and/or discharge of gases and/or liquids is carried out such that within the installation a pressure can be maintained that differs from the environment, for which a convenient seal can be applied.

Preferably the installation has a pre heating part in which PR is indirectly heated by rest heat from the installation, e.g. from released steam. The pre heating part can be double walled. It can contain a the PR contacting and heating, spinning wall. For improved heat exchange the side of the wall contacting the PR can be provided with its contact surface increasing and/or movement of the PR influencing elements, such as ribs.

Preferably the PR is heated in a damp environment. Ideally, at the desired end temperature of the PR (between approx. 130 en 165 $^{\circ}\text{C}$), there still takes place that water goes into the atmosphere within the the PR containing space (e.g. the drum). The humidity and pneumatic pressure within the installation are adapted correspondingly. Therefore humid PR is preferably supplied to the installation, preferably with a humidity of at least approx. 0.5 or 1.0 or 1.5 wt%.

Further advantages of the invention are a limitation of the exhaust of odour in relation with the recycling-volume; lower energy consumption per unit product (both by a higher process efficiency and by a higher part recycle material within the end product); cleaner waste or discharged gasses (such as exhaust gasses), possibly such that the exhaust can be completely or partly ejected into the atmosphere without filtering. Besides, this

method and the corresponding apparatuses can be applied to heat/dry recycling asphalt without the requirement to simultaneously have a parallel switched minerals drum operating.

The drawing shows in fig. 1-2 schematically non-limiting 5 examples of embodiments.

According to the example of fig. 1 the double walled drum is used with a horizontal or from the PR entrance (left in the drawing) downward inclined extending body axis. The internal drum wall is driven by a motor (not shown) to spin around. The external 10 drum wall is mounted rotation fixed. At the external side the internal drum wall is provided with inward projecting fixed blades, planks or such projections to, while the drum spins around, convey the into it poured PR in longitudinal drum direction towards the PR exit (to the right in the drawing). Said PR transport is possibly 15 gravity supported due to the inclined attitude of the drum.

The annular gap shaped space between both drum walls has at the PR entrance a gas entrance to be fed by a heating gas, stemming from a hot gas generator (e.g. the hot combustion gasses of a burner). At the PR exit there is a gas exit for the heating 20 gas which, through a heat exchanger, is led to a chimney, possibly after passing a (cloth) filter.

PR is poured into the drum as a continuous stream of bulk material through the entrance and advances through it, while tumbling/rolling/sliding, towards the PR exit while in the means 25 time it is heated by contact with the drum wall. At the PR exit from the drum released gasses (e.g. steam and bitumen gas) are preferably fed to the hot gas generator. At the PR exit released PR can directly or via a mixer be supplied to an asphalt spread machine to be applied into the road surface.

30 With the embodiment as shown, the heating gas and PR flow in the same direction along the drum wall. In an alternative embodiment these two substances can flow mutually opposite (counter flow). In that case the locations of the gas entrance and gas exit are changed.

35 In another alternative the entrances and exits for PR and hot gasses could be changed, such that the PR flows through the annular gap between the internal and external drum wall, while

the heating gas flows within the internal drum wall.

In the example of fig. 2 a single walled main drum is used, to which a drum like, double walled pre heating part is connected upstream. The main drum has double walled pipes, extending 5 lengthwise of the main drum. In the illustrated embodiment there are six such pipes. However that can be less or more, e.g. three, four, five or seven. The pipes are fixedly located within the drum and the drum is turned around its longitudinal axis. The pipes provide a capacity increase at equal space consumption by 10 the installation. The heated surface area increases and the payload ration decreases. A compact and simple structure of the sealing structures between the moving and stationary parts of the drum is possible. The pipes are preferably arranged with their body axis at substantially equal distance to the body axis of 15 the main drum, such as the drawing also shows. If the drum spins, the pipes follow a circle while turning around.

From the left hand side of the drawing, PR is continuously fed to the pre heating part via a sluice. Within the pre heating part the PR is indirectly heated by from the PR within the main 20 drum stemming steam/moisture and possibly different hot gasses. The steam then condenses and is discharged as condensate.

From the pre heating part the PR arrives into the main drum. There it is distributed over the pipes via a distribution element that is provided in the main drum. Hot gas from a generator is 25 also supplied to the main drum. In the illustrated example a supply channel for the hot gas extends centrally through the pre heating part and debouches at the upstream end in the main drum, centrally between the pipes. Via a manifold the hot gas is distributed over the annular spaces of the double walled pipes. The hot gas flows 30 through the double wall of the pipes towards the downstream end of the main drum (to the right in the drawing) and arrives there via a manifold into a central discharge channel. Subsequently the gas is partly recirculated towards the generator and the rest comes, after passing of a heat exchanger, into the atmosphere. 35 The heat exchanger is located within the supply channel for the combustion air.

The hot gas thus remains outside the space within the main

drum external of the double walled pipes.

The PR leaves the main drum also to the right in the drawing and arrives e.g. within a mixer in which the PR, minerals and/or different substances can be added.

5 The PR within the installation is present within a space that is sealed from the environment. The hot gas passes through the installation in a closed circuit. The steam and other gasses coming from the PR are collected and in a closed circuit passed on to a heat exchanger and preferably substantially as condensate
10 discharged to the environment. The PR within the installation is preferably exposed to pneumatic over pressure. To obtain that, in the moisture circuit (coming from the PR) a sealing member is preferably provided.

The drawing illustrates several preferred design parameters,
15 such as temperatures (in °C) and flow rate (in e.g. Nm³/h). A variation of 10% or 20% to these values is possible. E.g. the PR enters the installation at a temperature of approximately 10 °C, exits the pre heating part and the main drum at a temperature of approximately 70 respectively 130-165°C. From the PR stemming
20 moisture/steam of approx. 110 °C is collected and supplied to the pre heating part and exits it as condensate with a temperature of approx. 90°C, such that most of the heat energy is transferred. Hot gas is supplied at a temperature of approx. 800°C and cools to approx. 425°C due to heating of the PR.

25 Alternatives are also feasible, all belonging to the invention, e.g. wherein the inner drum wall is stationary and containing e.g. a spinning conveyor screw or different conveying element, to in that manner convey the PR through the drum. Therefore, all described or in the drawing illustrated features
30 in isolation or arbitrary combination determine the subject matter of this invention.

Reference signs in the drawing

- 1 drum (length 12, diameter 3 meter)
- 35 2 double wall (stationary)
- 3 end product 80 ton/h
- 4 unprocessed granules 80 ton/h 3.5% moisture

5	hot gas generator	6	additional cooling air
7	burner 720 m ³ gas/h (9m ³ /ton)		
8	combustion air 7200 Nm ³ /h		
9	steam + bitumen gas 3600 Nm ³ /h		
5 10	heat exchanger	11	alternative track
12	cloth filter	13	environmental air
14	hot gas 11.500 Nm ³ /h	15	recirculation valve
16	cross section drum with six tubes		
17	condensate	18	steam
10 19	chimney	20	pre heating

CLAIMS

1. Method to recycle within an installation bitumen containing used material, e.g. bulk material, wherein a wall contacting the
5 material is heated at the side facing away from said material, and said wall heats the contacting material, wherein said wall preferably spins and wherein preferably the material through the one opening is supplied and through the other opening is discharged such that a more or less continuous flow is maintained.
- 10 2. Method according to claim 1, wherein within the installation the material is heated at above 130, 140, 150, 160 or 170 degrees Celsius, such as at the typical asphalt application temperature (approx. 175 degrees Celsius), and/or the installation/wall has the contact surface area increasing and/or movement of the
15 material influencing elements.
3. Method according to claim 1 or 2, wherein it is operated such that the material within the installation is exposed to a relative to the environment different pneumatic pressure, preferably pressure head, e.g. in that the supply and/or discharge
20 of the material and/or gasses/liquids goes through a sealing feature.
4. Method according to any of claims 1-3, wherein the installation has a preferably double walled pre heating part in which the material is indirectly heated by rest warmth from the
25 installation, e.g. from released moisture/steam.
5. Method according to any of claims 1-4, wherein the material is heated at moist conditions, preferably such that at the desired end temperature of the material (e.g. between approx. 130 en 165 °C), there is still water going into the atmosphere within the
30 space containing the material.
6. Method according to any of claims 1-5, wherein the material is supplied to the installation while moist, preferably with a moisture content of at least approx. 0,5 or 1,0 or 1,5 wt%.
7. Method according to any of claims 1-6, wherein material that
35 is released from the installation is directly or via a mixer supplied to a road production machine, such as an asphalt laying machine to be applied into a road surface, and/or the material

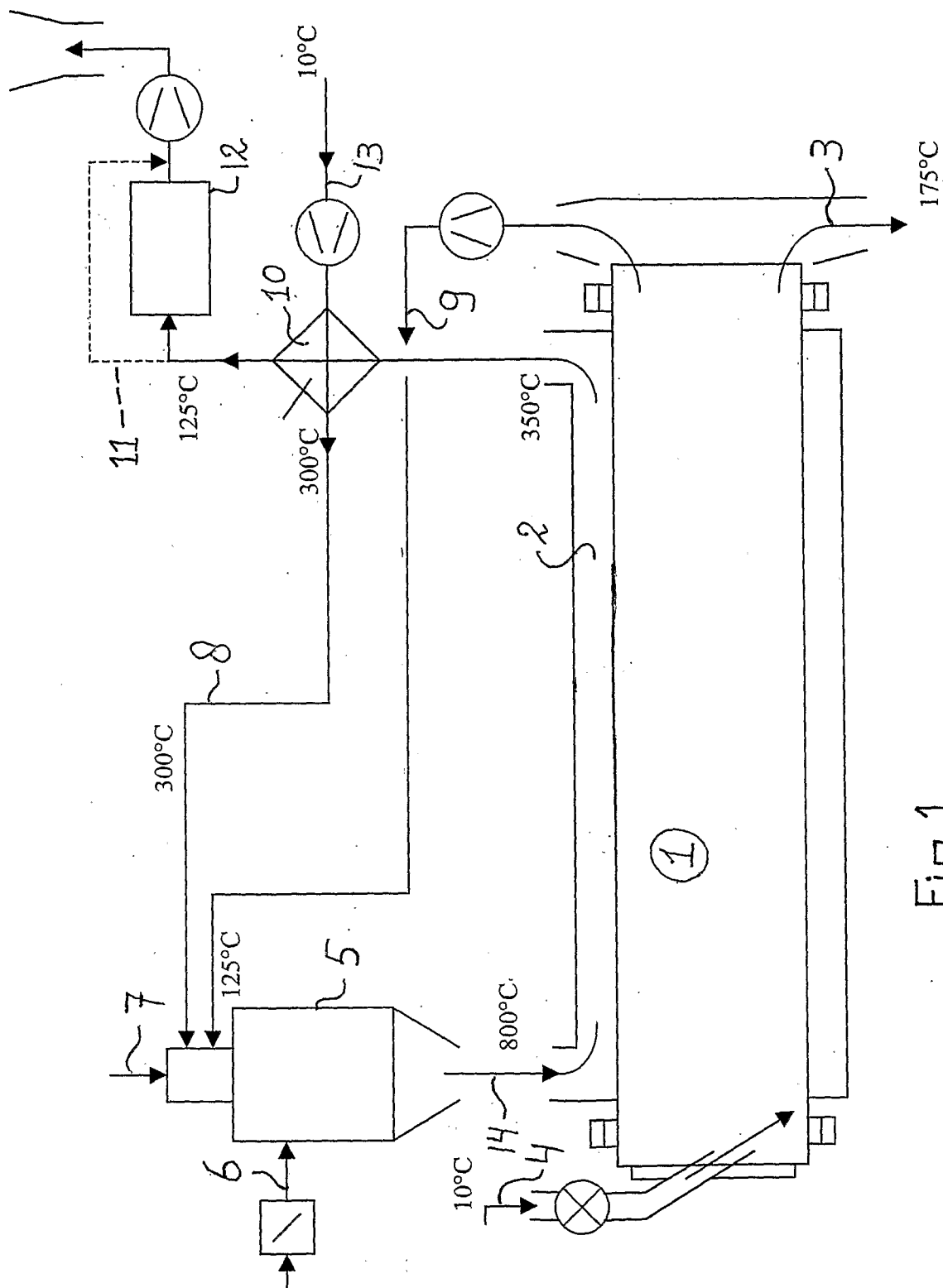
moves tumbling/rolling/sliding through the installation.

8. Method according to any of claims 1-7, wherein the material is present within preferably three, four, five, six or seven tubes extending longitudinally co-extensive and the wall of said tubes is heated externally, and/or wherein the inclination of the element(s) through which the material passes, is not changed.

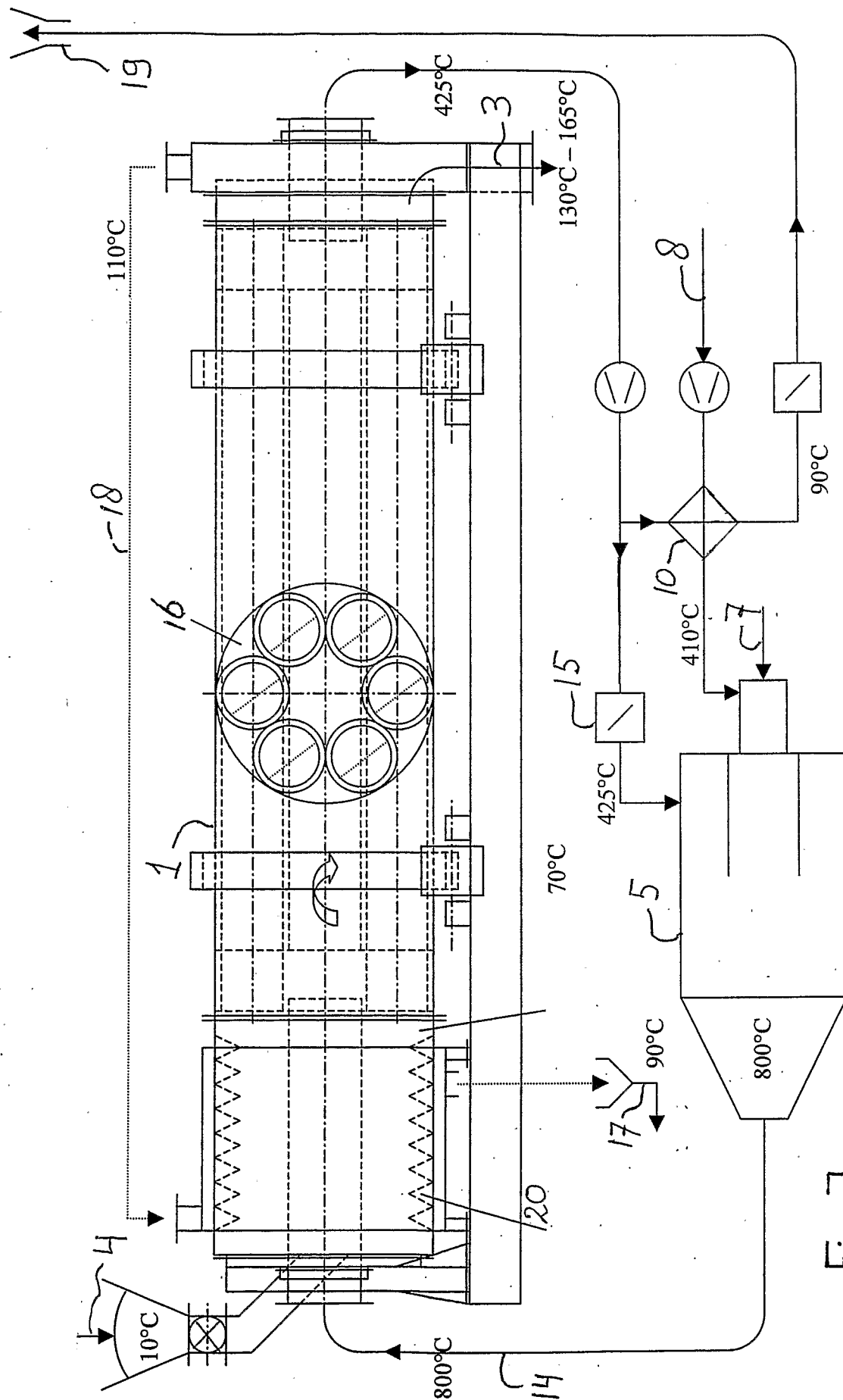
9. Method according to any of claims 1-8, wherein the material enters the installation at a temperature between approximately 0 en 20 degrees Celsius, exits the pre heating part and the main drum at a temperature of approximately 70 respectively 130-165 degrees Celsius, steam stemming from the material at approximately 110 degrees Celsius is collected and supplied to the pre heating part and exits it as condensate at a temperature of approximately 90 degrees Celsius, such that most of its warmth energy is transferred within the pre heating part, hot gas at a temperature between approximately 400 and 900 degrees Celsius, such as about 800 degrees Celsius, is supplied and by virtue of heating of the material cools to between approximately 300 and 500, such as 425, degrees Celsius.

10. Method according to any of claims 1-9, wherein the material within the installation is present within a space sealed from the environment, the hot heating gas flows in closed circuit through the installation, the steam and other gasses coming from the material are collected and brought in closed circuit to a heat exchanger and are preferably substantially as condensate discharged to the environment.

11. Device with means to carry out the method according to any of claims 1-10.







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INTERNATIONAL SEARCH REPORT

International application No
PCT/NL2007/000092

A. CLASSIFICATION OF SUBJECT MATTER

INV. E01C19/10

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)

E01C

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 practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 378 162 A (BRACEGIRDLE PAUL E [US]) 29 March 1983 (1983-03-29) column 4, line 51 - column 6, line 26 column 7, line 59 - column 8, line 45 column 11, lines 6-27; claim 7	1,3,5-7, 9-11
X	US 6 267 493 B1 (SWISHER JR GEORGE W [US] ET AL) 31 July 2001 (2001-07-31) column 3, lines 3-42; figure 4 column 6, lines 23-28	1,2,8
X	NL 7 708 800 A (MOEL WEGENBOUWMAATSCHAPPIJ B V) 13 February 1979 (1979-02-13) page 1, line 15 - page 2, line 21 page 2, line 31 - page 3, line 6	1,2,4, 9-11

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Further documents are listed in the continuation of Box C.

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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
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- *Z* document member of the same patent family

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