(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 889 568 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
01.07.2015 Bulletin 2015/27

(21) Application number: **13306872.6**

(22) Date of filing: **26.12.2013**

(51) Int Cl.:
F27D 15/02 *(2006.01)* ***C10B 39/02*** *(2006.01)*
F28F 5/02 *(2006.01)*

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(71) Applicant: **Technip France**
92400 Courbevoie (FR)

(72) Inventor: **Bohm, Karl-Andreas**
40883 Ratingen (DE)

(74) Representative: **Blot, Philippe Robert Emile**
Cabinet Lavoix
2, place d'Estienne d'Orves
75441 Paris Cedex 09 (FR)

(54) Rotary cooler

(57) The rotary cooler (2), comprises a drum (11) having a drum axis, the drum (11) being rotatable about the drum axis, an inlet through which the material is fed into the drum (11), the inlet comprising an inlet chute (9) intended to receive material from a rotary kiln (1) and an outlet through which the material is discharged from the drum (11). The inlet (10) further comprises an inlet cone (13), extending between the inlet chute (9) and the drum (11). The inlet cone (13) is connected to the drum (11) so as rotate about the drum axis together with the drum (11), and has a frustoconical shape diverging from the inlet end thereof towards the outlet end thereof, and comprising a frustoconically shaped double walled envelope (17, 18) receiving a circulation of cooling liquid.

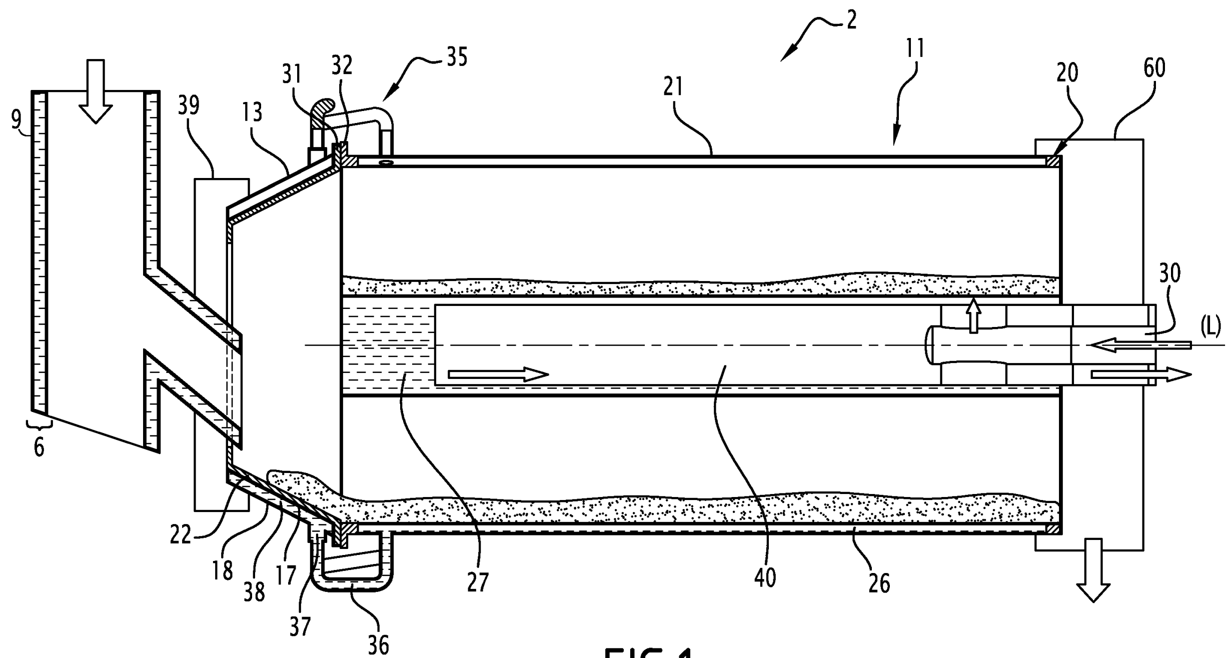

FIG.1

EP 2 889 568 A1

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] The present invention concerns a rotary cooler for cooling material discharged from a rotary kiln, in particular coke discharged from a calcination kiln, comprising a drum having a drum axis L, the drum being rotatable about the drum axis L, an inlet through which the material is fed into the drum, the inlet comprising an inlet chute intended to receive the material from the rotary kiln and an outlet through which the material is discharged from the drum.

[0002] Rotary coolers of the above-mentioned type are intended for cooling the extremely hot, and often even incandescent, material discharged from a rotary kiln or similar equipment.

[0003] For example, in the case where the rotary cooler is part of a coke calcining system, the calcined coke is discharged from the kiln into the rotary cooler at temperatures which can reach up to 1400°C.

[0004] The rotary coolers are thus continuously subjected to very high temperature material flows. As a consequence, these rotary coolers fail rather quickly and have to be renewed or repaired at regular intervals. Since rotary coolers are heavy industrial installations, their renewal induces very high costs.

[0005] One purpose of the invention is to provide a rotary cooler which has an increased lifetime and induces reduced costs.

[0006] To that end, the invention relates to a rotary cooler according to claim 1.

[0007] The rotary cooler may also comprise one or more of the following features, taken alone or in any technically possible combination:

- the double walled envelope of the inlet cone comprises an inner wall and an outer wall delimiting between them a cavity for receiving the circulation of cooling liquid.
- at least half of the volume of the cavity is filled with the cooling liquid.
- the inner wall of the inlet cone has a frusto-conical shape centred on the drum axis L and delimits the interior volume of the inlet cone.
- the inlet cone is attached to the drum through a removable attachment means.
- the inlet cone is lined interiorly with a layer of wear and shock resistant material, said layer of wear and shock resistant material being self-supporting and forming a removable portion of the inner wall of the inlet cone.
- the inlet comprises a stationary inlet part, relative to which the inlet cone is rotatable about the drum axis L, the rotary cooler comprising a sealing means for sealing the stationary inlet part against the inlet cone.
- the drum comprises a double walled exterior shell and a plurality of product chambers for transporting the material through the drum arranged in the interior volume delimited by the exterior shell, a circulation of cooling liquid being defined inside the double walled exterior shell and between the product chambers.
- it further comprises a cooling liquid exchange system for circulating the cooling liquid between the drum and the inlet cone.
- the cooling liquid exchange system comprises a plurality of connection tubes spaced angularly about the drum axis L, each connection tube connecting the double walled shell of the drum to the cavity delimited between the inner and outer walls of the inlet cone so as to allow the circulation of cooling liquid between the drum and the cavity through the connection tubes.
- the inlet chute comprises a double walled envelope receiving a circulation of cooling liquid.
- it further comprises, at the outlet thereof, a stationary discharge housing covering the outlet end of the drum and an outlet sealing system for sealing the discharge housing against the drum.
- it comprises a sweep air system and a controller configured for controlling said sweep air system in order to prevent the entry of air into the drum through the outlet of the rotary cooler.
- the sweep air system comprises a first pressure gauge arranged at the inlet of the rotary cooler for measuring a first pressure value DP1 at the inlet of the rotary cooler and a second pressure gauge arranged at the outlet of the rotary cooler for measuring a second pressure value DP2 at the outlet of the rotary cooler, the controller being configured for determining a difference between the first pressure value and the second pressure value and for controlling said sweep air system depending on the difference such that the pressure at the inlet of the rotary cooler becomes equal, equal or greater or greater than the pressure at the outlet of the rotary cooler.
- the sweep air system comprises a fan and wherein the controller is configured for adjusting the speed of rotation of the fan depending on the difference between the first measured pressure value DP1 and the second measured pressure value DP2 such that the pressure at the inlet of the rotary cooler becomes equal or greater than the pressure at the outlet of the rotary cooler.

[0008] The present invention also concerns a rotary cooler for cooling material discharged from a rotary kiln, in particular coke discharged from a calcination kiln, comprising a drum having a drum axis L, the drum being rotatable about the drum axis L, an inlet through which the material is fed into the drum and an outlet through which the material is discharged from the drum, the inlet and the outlet being located at opposite ends of the drum taken along the direction of the drum axis L, characterized in that the rotary cooler comprises a sweep air system and a controller configured for controlling said sweep air system in order to prevent the entry of air into the drum through the outlet of the rotary cooler.

[0009] The rotary cooler may also comprise one or more of the following features, taken alone or in any technically possible combination :

- the sweep air system is able to prevent the entry of air into the drum through the outlet of the rotary cooler by creating a depression at the outlet of the rotary cooler compared to the inlet thereof.
- the sweep air system comprises a first pressure gauge arranged at the inlet of the rotary cooler for measuring a first pressure value DP1 at the inlet of the rotary cooler and a second pressure gauge arranged at the outlet of the rotary cooler for measuring a second pressure value DP2 at the outlet of the rotary cooler, the controller being configured for determining a difference between the first pressure value and the second pressure value and for controlling said sweep air system depending on the difference such that the pressure at the inlet of the rotary cooler becomes equal or greater than the pressure at the outlet of the rotary cooler.
- the sweep air system comprises a fan and wherein the controller is configured for adjusting the speed of rotation of the fan depending on the difference between the first measured pressure value DP1 and the second measured pressure value DP2 such that the pressure at the inlet of the rotary cooler becomes equal or greater than the pressure at the outlet of the rotary cooler.
- the outlet of the rotary cooler comprises a stationary discharge housing and wherein the rotary cooler further comprises an outlet sealing system arranged between the discharge housing and the drum for sealing the discharge housing against the drum.
- the outlet comprises a stationary discharge housing and the rotary cooler further comprises a sweep air duct connected to the discharge housing of the rotary cooler and intended for carrying a dust carrying flow of gas from the drum to an afterburner.
- the fan is arranged in the sweep air duct.
- it further comprises a fresh air valve for the intake of outside air into the sweep air duct and a valve control device, configured for controlling the opening of the fresh air valve depending on a flow of gas through the sweep air duct.
- the valve control device is configured for controlling the opening of the fresh air valve such that the velocity of the flow of gas through the sweep air duct is greater that a predetermined threshold.
- the fresh air valve is located upstream of the fan relative to the direction of the gas flow through the sweep air duct.
- it further comprises a flow meter for measuring the gas flow through the sweep air duct, said flow meter being located downstream of the fresh air valve relative to the direction of gas flow through the sweep air duct.
- the inlet of the rotary cooler comprises an inlet chute intended to receive the material from the rotary kiln and an inlet cone, extending between the inlet chute and the drum and intended for distributing the material discharged from inlet chute into the drum, the inlet cone being connected to the drum so as rotate about the drum axis L together with the drum, and the inlet cone having a frustoconical shape diverging from the inlet end thereof towards the outlet end thereof, and comprising a frustoconically shaped double walled envelope receiving a circulation of cooling liquid.

[0010] The invention also concerns an installation comprising a rotary kiln, a rotary cooler such as defined above, arranged at an outlet of the rotary kiln and intended for cooling the material discharged from the rotary kiln, and an afterburner connected to an inlet of the rotary kiln, and intended for burning waste gas formed in the rotary kiln.

[0011] The installation according to the invention may comprise one or more of the following features:

- it further comprises a sweep air duct connected to the outlet of the rotary cooler at one end and to the afterburner at its other end and intended for transporting coke dust removed from the rotary cooler to the afterburner.
- the sweep air system comprises a first pressure gauge arranged at the inlet of the rotary cooler for measuring a first pressure value DP1 at the inlet of the rotary cooler and a second pressure gauge arranged at the outlet of the rotary cooler for measuring a second pressure value DP2 at the outlet of the rotary cooler, the controller being configured for determining a difference between the first pressure value and the second pressure value and for controlling said sweep air system depending on the difference such that the pressure at the inlet of the rotary cooler becomes equal or greater than the pressure at the outlet of the rotary cooler, and wherein the installation further comprises a third pressure gauge intended for measuring a third pressure value PT3 at the outlet of the rotary kiln, said controller being configured for controlling the pressure PT1 at the inlet of the rotary cooler such that the pressure at the inlet of the rotary cooler is greater than the pressure at the outlet of the rotary kiln.

[0012] The invention also related to a method for operating a rotary cooler as defined above, comprising a step of controlling the sweep air system so as to prevent the entry of outside air into the drum mainly through the outlet of the rotary cooler.

[0013] The invention will be better understood upon reading the following specification, given only by way of example and made in reference to the appended drawings, wherein:

- Figure 1 is a general schematic overview of the rotary cooler according to the invention;
- Figure 2 is a cross-sectional view of the rotary cooler of Figure 1 taken along a transverse plane;
- Figure 3 is a schematic perspective view of the rotary cooler according to the invention;
- Figure 4 is a schematic view of an installation comprising the rotary cooler of Figure 3;
- Figure 5 is a perspective view of the inlet end of the rotary cooler;
- Figure 6 is a sectional view of the inlet end of the rotary cooler, taken along a vertical longitudinal plane;
- Figure 7 is a schematic front view of the outlet end of the rotary cooler which shows the sweep air system;
- Figure 8 is a schematic view of the sweep air system intended to prevent entry of outside air through the outlet end of the drum of the rotary cooler.

[0014] In the following specification, the terms "inlet" and "outlet" are used with reference to the usual direction of the flow of the material through the installation.

[0015] The words "inner" and "outer" are used with reference to the drum axis L, an "inner" part of an element being located radially closer to the drum axis L than an "outer" part of this element.

[0016] In the entire specification, the cooling liquid is in particular water, for example process water. Alternatively, the cooling liquid may be a mixture of process water and chemicals, used to prevent corrosion of the drum 11 of the rotary cooler 2, depending on the water quality.

[0017] A rotary cooler 2 according to the invention is shown schematically in Figure 1. It is intended for cooling material discharged from a rotary kiln 1 located upstream of the rotary cooler 2, and more particularly granular, free-flowing or dusty hot material.

[0018] The rotary cooler 2 is advantageously part of an installation 3 such as the one shown schematically in Figure 4.

[0019] The installation 3 is advantageously a coke calcining installation intended for calcining green coke resulting, for example, from oil refining processes, in order to produce calcined coke.

[0020] The installation 3 comprises a rotary kiln 1, intended e.g. to receive a feed of green petroleum coke at its inlet 8, and to transform it into calcined petroleum coke. The outlet 5 of the rotary kiln 1 is connected via a kiln transfer chute 4 to the inlet 10 of the rotary cooler 2, which is intended for cooling the material, in particular the hot calcined coke, discharged from the rotary kiln 1. The hot material is progressively cooled during its passage through the rotary cooler 2, and the material, in particular the cooled calcined coke, is discharged at the outlet 12 of the rotary cooler 2.

[0021] The installation 3 shown in Figure 4 further comprises an afterburner 7. The afterburner 7 is connected to the rotary kiln 1, and more particularly to the inlet 8 of the rotary kiln 1, as shown schematically by the arrow between the rotary kiln 1 and the afterburner 7 in Figure 4. It is intended for burning the waste gas, also called flue gas, formed in the rotary kiln 1.

[0022] In a conventional manner, the rotary kiln 1 comprises an induced draft fan (not shown), which is intended for controlling the draft of the the rotary kiln 1 measured at the kiln discharge in order to control the calcining or combustion process taking place therein. The induced draft fan is further controlled for creating a flue gas circulation in countercurrent to the flow of material through the rotary kiln 1, towards the afterburner 7, waste heat recovery, flue gas treatment systems and stack (not shown) which is located close to the flue gas treatment system.

[0023] In the example shown in Figure 4, the afterburner 7 is further connected to the outlet 12 of the rotary cooler 2 by means of a sweep air duct 82 (see Figure 8), as shown schematically by the arrow between the rotary cooler 2 and the afterburner 7 in Figure 4. In this example, the afterburner 7 is also used for burning the sweep air and the coke dust removed from the rotary cooler 2.

[0024] The rotary cooler 2 will now be described in more detail. The rotary cooler 2 comprises a drum 11 extending along a drum axis L, an inlet 10, through which the material is fed into the drum 11, and an outlet 12, through which the material is discharged from the drum 11. The inlet 10 and the outlet 12 are located at opposite ends of the drum 11, taken along the direction of the drum axis L. More particularly, the inlet 10 is located at an inlet end of the drum 11 and the outlet 12 is located at an outlet end of the drum 11.

[0025] The inlet 10 of the rotary cooler 2 is shown in more detail in Figures 5 and 6. It comprises an inlet chute 9 and an inlet cone 13.

[0026] The inlet chute 9 is stationary during the operation of the rotary cooler 2. The drum 11 is rotatable about the drum axis L relative to the inlet chute 9. The inlet cone 13 is rotatable with the drum 11 about the drum axis L.

[0027] The inlet chute 9 extends between the outlet 5 of the rotary kiln 1, more particularly the kiln transfer chute 4, and the inlet cone 13. More particularly, the inlet chute 9 extends into the inlet cone 13 at the inlet end of the inlet cone 13. The inlet chute 9 comprises a double walled shell 6 allowing for the circulation of cooling liquid between the walls of the double walled shell 6 of the inlet chute 9.

[0028] The inlet cone 13 extends between the inlet chute 9 and the drum 11. It is intended for transferring the material discharged from the inlet chute 9 into the drum 11. It is more particularly intended for distributing the material discharged from the inlet chute 9 into the drum 11.

[0029] The inlet cone 13 is rigidly connected to the drum 11 so as to be rotatable about the drum axis L together with the drum 11. Advantageously, the inlet cone 13 is connected to the drum 11 through removable attachment means, in particular through fast connection means. More particularly, in the example shown in the Figures, the inlet cone 13 and the drum 11 comprise facing flanges 31, 32, which are detachably connected to one another through the removable attachment means, for example through bolts or screws.

[0030] The inlet cone 13 has a frusto-conical shape, diverging from the inlet end thereof towards the outlet end thereof. It is centred on the drum axis L.

[0031] It comprises an inner cone wall 17 and an outer cone wall 18. The inner and the outer cone walls 17, 18 jointly delimit a double walled envelope intended for the circulation of cooling liquid there between. The inner cone wall 17 is spaced apart from the outer cone wall 18. A cavity 38 is thus delimited between the inner cone wall 17 and the outer cone wall 18. The cavity 38 extends around the entire circumference of the inlet cone 13. In use, the cavity 38 is intended to contain cooling liquid.

[0032] The inner and the outer cone walls 17, 18 each have a frusto-conical shape centred on the drum axis L. The distance between the inner cone wall 17 and the outer cone wall 18 is substantially constant along the entire length of the inlet cone 13, taken along the direction of the drum axis L.

[0033] More particularly, the distance between the inner cone wall 17 and the outer cone wall 18, taken along a radial direction, is equal to about 80 mm.

[0034] Advantageously, in use, more than 50% of the volume of the cavity 38 is occupied by cooling liquid.

[0035] The inner cone wall 17 delimits the interior volume of the inlet cone 13. It is intended to be in contact with the material flowing through the drum 11.

[0036] The inner cone wall 17 has a shape diverging from the inlet end of the inlet cone 13 to the outlet end thereof. The interior volume of the inlet cone 13 opens out into the drum 11 so as to allow the product flow from the inlet cone 13 into the drum 11.

[0037] The inlet cone 13 is advantageously further lined interiorly with a layer of shock and wear resistant material 22. Advantageously, the layer of shock and wear resistant material 22 is made of steel plates with a ceramic layer applied on their side intended to be in direct contact with the hot material. This ceramic layer is reinforced by honeycomb shaped steel inserts. In particular, the ceramic layer comprises silicon carbide (SiC), also called carborundum.

[0038] Advantageously, the outer cone wall 18 is made of steel.

[0039] The inner cone wall 17 comprises a steel wall lined interiorly with the layer of shock and wear resistant material.

[0040] Advantageously, the layer of shock and wear resistant material 22 is self-supporting. It forms a removable portion of the inner cone wall 17. More particularly, it is removably attached to the steel wall of the inner cone wall 17.

[0041] The layer of shock and wear resistant material 22 is advantageously intended to be replaced partly or in total in a period not less than once per year in a planned maintenance shut down.

[0042] The word "wear" in particular designates the breaking off of thin layers of material.

[0043] The rotary cooler 2 further comprises drive means configured for rotating the drum 11 about the drum axis L. The drive means comprise one electric main motor and one electric auxiliary motor and a chain or belt gear connected between the electric motors and the drum 11 for transmitting the rotation of the electric motor to the drum 11. The drum 11 is supported on two riding rings connected to the drum 11, these riding rings being supported on two roller stations. These drive means are conventional and will therefore not be described in more detail in the specification.

[0044] The inlet cone 13 is fixedly attached to the drum 11. It is therefore driven in rotation by the drive means together with the drum 11.

[0045] As can be seen in Figure 1, the rotary cooler drum 11 comprises an external shell 20 delimiting an internal volume for the transport of the material through the rotary cooler 2. The external shell 20 is e.g. substantially cylindrical of axis L. It comprises an outer shell wall 21 and an inner shell wall 26. The shell 20 thus has a double wall.

[0046] The diameter of the inner cone wall 17 at the outlet end thereof is substantially equal to the inner diameter of the external shell 20, i.e. to the diameter of the inner shell wall 21.

[0047] In the example shown in the Figures, the rotary cooler 2 is a sectional cooler. As can be seen in particular in Figures 2 and 5, the drum 11 comprises a plurality of product chambers 23 arranged in the internal volume delimited by the external shell 20. Each product chamber 23 is intended for transporting the material from an inlet end of the drum 11 up to an outlet end of the drum 11. Each product chamber 23 extends substantially along the entire length of the drum 11. Each product chamber 23 forms a sector of the drum 11.

[0048] Each product chamber 23 comprises an inner wall 24, an outer wall 25 and two lateral walls 26, extending between the inner wall 24 and the outer wall 25. The outer walls 25 of the product chambers 23 jointly form the inner wall shell wall 21 of the shell 20. The inner walls 24 of the product chambers 23 delimit between them a central passage 27 extending through the drum 11. The lateral walls 26 of adjacent product chambers 23 delimit between them radial flow passages 28, which open out into the double walled external shell 20 at their radially outer end and into the central passage 27 at their radially inner end. The drum 11 further comprises a closure plate (not shown) closing the radial flow passages 28 and the central passage 27 at the inlet end thereof. This closure plate extends substantially perpendicular to the drum axis L.

[0049] Advantageously, the closure plate is lined, on its face directed towards the inlet cone 13, with a layer of shock and wear resistant material such as the one described above for the inlet cone 13.

[0050] The product chambers 23 may further comprise internal transport shovel blades 29 for facilitating the transport of the material through the rotary cooler drum 2. These internal transport shovel blades 29 may for example comprise straight blades arranged parallel to the drum axis L and/or inclined transport shovel blades, which are inclined toward the drum axis L as shown in Figures 5 and 6.

[0051] The rotary cooler 2 further comprises a cooling circuit. This cooling circuit is intended for indirectly cooling the material as it flows through the rotary cooler 2.

[0052] Furthermore, the cooling circuit is intended for cooling the inlet chute 9, the inlet cone 13 and the drum 11, and more particularly the walls of the product chambers 23.

[0053] More particularly, the cooling circuit comprises a first cooling circuit for cooling the inlet cone 13 and the drum 11. It further comprises a second cooling circuit for cooling the inlet chute 9. Advantageously, the pressures and/or flow rates of the cooling liquid in the first and second cooling circuits are different. These two circuits may be fed from a same buffer tank.

[0054] The cooling liquid for cooling the drum 11 and the inlet cone 13 is supplied at the outlet end of the drum 11.

[0055] More particularly, the first cooling circuit comprises a liquid supply 33 and a rotating liquid supply conduit 30 connected to the liquid supply 33, through which the cooling liquid is supplied into the drum 11. The liquid supply conduit 30 extends into the drum 11 from the outlet end of the drum 11. More particularly, it extends into the central passage 27.

[0056] The first cooling circuit further comprises, inside the drum 11, the radial flow passages 28 between the product chambers 23, the space between the internal and the external walls 21, 26 of the shell 20 and the central passage 27.

[0057] The conduit 30 inside the drum 11 is rotating together with the drum 11. A connection with a non rotating pipe of the liquid supply 33 is placed outside the drum 11.

[0058] The first cooling circuit further comprises a cooling liquid exchange installation 35 intended for circulating the cooling liquid between the drum 11 and the inlet cone 13.

[0059] The cooling liquid exchange installation 35 comprises at least one connection tube 36 which connects the cooling liquid circuit of the drum 11 to the inside of the double wall of the inlet cone 13 so as to create a fluid communication between the drum 11 and the inlet cone 13.

[0060] More particularly, the cooling liquid exchange installation 35 comprises a plurality of connection tubes 36 which are angularly spaced about the drum axis L. In particular, the connection tubes 36 are regularly distributed about the entire circumference of the inlet cone 13.

[0061] For each connection tube 36, the outer cone wall 18 of the inlet cone 13 comprises a through-hole 37 opening into the cavity 38 delimited between the inner and the outer cone walls 17, 18 of the inlet cone 13. Each connection tube 36 is connected to this through-hole 37 at one of its ends and to the double walled shell 20 of the drum 11 at its other end. More particularly, the connection tube 37 is connected to the inlet cone 13 through a flange connection and to the drum 11 via a fast connection coupling.

[0062] The cooling liquid exchange installation 35 is adapted for both supplying the cooling liquid to the inlet cone 13 and for evacuating the cooling liquid from the inlet cone 13 as the drum 11 and the inlet cone 13 rotate about the drum axis L.

[0063] More particularly, connection tubes 36 of the cooling liquid exchange installation 35 first supply cooling liquid from the drum shell 20 to the inlet cone 13 and later return heated cooling liquid from the inlet cone 13 to the drum 11 when the drum 11 has turned about the drum axis L of an angle of about 180°.

[0064] As shown in Figure 1, the first cooling circuit further comprises an evacuation conduit 40 for evacuating the cooling water warmed by its passage through the drum 11 and through the inlet cone 13. The evacuation conduit 40 extends through the drum 11 in the central passage 27 up to the outlet end of the drum 11. The warmed cooling liquid is evacuated from the drum 11 at the outlet end thereof.

[0065] The first cooling circuit thus allows for the circulation of cooling liquid between the product chambers 23, inside the double wall of the external shell 20, i.e. between the outer wall of the exterior shell 20 and the outer walls 25 of the product chambers 23, and inside the double wall of the inlet cone 13.

[0066] The fresh cooling liquid is introduced into the drum 11 at the outlet end thereof and flows through the drum 11 towards the inlet end thereof, more particularly up to the closure plate. From there, one fraction of the cooling water flows through the cooling liquid exchange installation 35 into the inlet cone 13, while the rest of the cooling liquid flows around the product chambers 23, including inside the double envelope of the shell 20.

[0067] The cooling liquid is supplied to the inlet cone 13 by free flow via the cooling liquid exchange installation 35 connecting the double wall of the inlet cone 13 to the double wall of the drum 11.

[0068] The fraction of cooling liquid from the inlet cone 13 flows back into the drum 11 through the cooling liquid exchange installation 35 as the drum 11 rotates around the drum axis L.

[0069] The fraction of cooling liquid having flown around the product chambers 23 and the cooling liquid from the inlet cone 13 then flow back towards the outlet 12 of the drum 11 through the evacuation conduit 40.

[0070] As mentioned above, the rotary cooler 2 further comprises a second cooling circuit for cooling the inlet chute 9 of the rotary cooler 2. The second cooling circuit is configured for creating a cooling liquid circulation inside the double walled shell 6 of the inlet chute 9. The second cooling circuit comprises second cooling liquid supply means. These second liquid supply means may be identical with the first cooling liquid supply means.

[0071] The rotary cooler 2 further comprises an inlet sealing system. The inlet sealing system minimizes the entry of air from the environment, also called ambient air, into the rotary cooler 2 at the inlet end thereof. Advantageously, it also participates in accommodating the heat expansion of the drum 11 or of the inlet cone 13. It is arranged at the inlet 10 of the rotary cooler 2, between the inlet cone 13 and a stationary part of the inlet 10, in particular a stationary inlet housing 39. The inlet housing 39 at least partly surrounds the inlet chute 9 at the outlet end thereof and the inlet cone 13 at the inlet end thereof. The inlet housing 39 can be moved in translation relative to the inlet cone 13 during maintenance operations. It is intended to be stationary during operation of the rotary cooler 2.

[0072] As will be explained later, the rotary cooler 2 further comprises an outlet sealing system 41 arranged at the outlet 12 of the rotary cooler 2. The outlet sealing system 41 minimizes the entry of air from the environment into the drum 11 at the outlet end thereof. The outer sealing system comprises graphite blocks shaped according to the radius of the external shell 20 of the drum 11 upon which they are intended to bear and which are kept tight to the external shell 20 by means of a steel rope which is kept under tension by springs and / or weights pulling at the steel rope.

[0073] The rotary cooler 2 according to the invention is particularly advantageous. In particular, it has the ability to accept much higher throughput capacities and a particularly high lifetime as compared to conventional rotary coolers. Moreover, it can be maintained at reduced cost.

[0074] Indeed, due to the fact that the inlet 10 of the rotary cooler 2 comprises, directly upstream of the drum 11, an inlet cone 13 having a double-walled envelope, receiving a circulation of cooling liquid, the inlet 10 of the rotary cooler 2 is very well cooled, and therefore wears out much slower from the contact with the hot material discharged from the rotary kiln 1 than the inlets of conventional rotary coolers.

[0075] The increased lifetime further results from the conical shape of the inlet cone 13, which reduces the retention time of material before entering the drum 11 by speeding up the flow of material into the drum 11 as compared to a cylindrical inlet. This feature also participates in reducing the heat in the atmosphere of the inlet cone 13.

[0076] Therefore, the features according to which the rotary cooler 2 has a conical inlet 13 and according to which this conical inlet 13 is cooled by a circulation of cooling liquid through its double walled envelope result in a significant improvement in the lifetime before repair or replacement of the drum 11.

[0077] The presence of a wear and shock resistant lining, which is also cooled by the cooling liquid circulation through the double wall of the inlet cone 13, further contributes to slow the wear of the inlet 10 of the rotary cooler 2 from the contact with the hot material discharged from the rotary kiln 1 as compared with conventional rotary coolers.

[0078] The fact that the wear and shock resistant lining is removable is also advantageous. Indeed, it allows increasing the lifetime of the inlet cone 13 even more since the lining can be removed and replaced easily when it is worn partly or as a whole without having to replace the entire inlet cone 13.

[0079] The ceramic lining elements on the closure plate can also be easily replaced during a normal maintenance shutdown.

[0080] Furthermore, the inner wall of the water cooled inlet chute 9 acts as a pre-cooler for the inlet area and helps to reduce the temperature inside the inlet 10. This leads to a cooling of the atmosphere of the rotary cooler 2 in that area in addition to that provided by the cooling of the inlet cone 13 by means of the cooling liquid circulation through its double walled envelope of the inlet cone 13, which further contributes to improving the lifetime of the inlet cone 13.

[0081] Providing a detachable inlet cone 13 is also advantageous. Indeed, the inlet cone 13 is a portion of the rotary cooler 2 which is subject to high wear, since it is in direct contact with the hot material discharged from the rotary kiln 1. Therefore, the inlet cone 13 wears out much faster than the drum 11, where the material has already been cooled compared to its original temperature. Since the inlet cone 13 is removable, it can be easily dismantled for repair at a work shop or replaced when it is worn out without having to replace the drum 11 itself.

[0082] It is also possible to pull back the inlet housing 39 which is supported by the chassis for the inlet chute 9, which itself is placed on rollers. By removing inlet housing 39, access to the inlet cone 19 is provided to perform minor repair works in situ without disconnecting the inlet cone 13 from the drum 11.

[0083] The outlet 12 of the rotary cooler 2 will now be described in more detail. The outlet 12 of the rotary cooler 2 comprises a discharge housing 60 through which the material is discharged from the rotary cooler 2. More particularly, the discharge housing 60 communicates with the drum 11. It receives the material discharged at the outlet end of the drum 11.

[0084] The discharge housing 60 covers the outlet end of the drum 11. It is stationary. The drum 11 is rotatable about the drum axis L relative to the discharge housing 60.

[0085] The discharge housing 60 comprises at least one discharge outlet, intended for discharging the material from the rotary cooler 2. In the example shown in the Figures, the discharge housing 60 comprises one main discharge outlet 62. The material discharged through the main discharge outlet 62 is intended to fall onto a belt conveyor 63, shown schematically in Figure 4, for being transported to a product silo.

[0086] The main discharge outlet 62 is provided with a slide gate 64, movable between a closing position, in which it closes the main discharge outlet 62 and a retracted position, in which the main discharge outlet 62 is open and material can be discharged from the rotary cooler 2, in particular via a double pendulum flap 64 (shown schematically in Figure 8), onto a belt conveyor 63.

[0087] In the example shown in the Figures, the discharge housing 60 further comprises an emergency outlet 66. The emergency outlet 66 may be provided with an emergency discharge duct 67 protruding downwards from the emergency outlet 66 in order to guide the material discharged through the emergency outlet 66. The emergency outlet 66 may be used in addition for discharging lumps of refractory material discharged from the kiln 1 into the coke cooler 11 which will be separated by means of a screen installed above the main discharge outlet 62.

[0088] According to another aspect, the rotary cooler 2 comprises systems for avoiding the entry of outside air into the drum 11, and more particularly the flow of such outside air towards the inlet of the rotary cooler 2.

[0089] The purpose of preventing outside air from entering the drum 11 is to limit the ability of the hot material discharged from the rotary kiln 1 to further burn inside the inlet 10 of the rotary cooler 2, in particular inside the inlet chute 9 and the inlet cone 13, due to the additional oxygen from the outside air, thereby generating additional heat with the risk of overheating parts installed at the inlet 10 of the rotary cooler 2.

[0090] Once the material has been divided into separate streams by being distributed into the product chambers 23 of the drum 11, the material can be efficiently cooled through the first cooling circuit described above, which prevents ignition of the material inside the drum 11.

[0091] As mentioned earlier, the rotary cooler 2 further comprises an outlet sealing system 41 arranged at the outlet 5 of the rotary cooler 2, for minimizing the entry of outside air into the drum 11 at the outlet end thereof. More particularly, the outlet sealing system 41 is arranged between the discharge housing 60 and the drum 11 for sealing the connection of the stationary discharge housing 60 to the drum 11. This sealing system 41 is centred on the drum axis L and extends across the junction between the discharge housing 60 and the drum 11. The outlet sealing system 41 is intended for preventing the entry of outside air into the drum 11 at the junction between the discharge housing 60 and the drum 11.

[0092] The outlet sealing system 41 comprises graphite segments which are kept under tension and in contact with the rotating drum 11 by means of a rope that is pulled by a spring and/or weights. The tensioned rope is attached to the discharge housing 60 at one of its ends.

[0093] The rotary cooler 2 further comprises an inlet sealing system as explained previously.

[0094] Sealing the rotary cooler 2 against entrance of outside air, for example through the first and second sealing systems, minimizes the entry of outside air into the drum 11. "Outside air" is ambient air, i.e. air from the environment 90 surrounding the rotary cooler 2.

[0095] The rotary kiln 1 forms a reservoir with a variable negative pressure relative to the atmospheric pressure. Material is discharged at the outlet 12 of the rotary cooler 2 at atmospheric pressure.

[0096] Even though, the rotary cooler 2 comprises a sealing system for sealing the rotary cooler 2 against the entry of outside air, and comprising, in particular, the inlet and outlet sealing systems, outside air may still penetrate into the rotary cooler 2, in particularly at the outlet 12 thereof, for example through the discharge housing 60, and more particularly through the product discharge outlets, such as the main discharge outlet 62, through the double pendulum flap, the emergency outlet 66, and to some minor extent, due to leakage of the sealing system of the rotary cooler 2. The outside air having leaked into the rotary cooler 2 at the outlet 12 thereof is called "leakage air" in the following.

[0097] According to the invention, the rotary cooler 2 comprises a sweep air system 75 and a controller 76 configured for controlling said sweep air system 75 in order to prevent the entry of outside air, in particular leakage air, into the drum 11 through the outlet 12 of the rotary cooler 2. The sweep air system 75 further prevents the backflow of air, and in particular leakage air, towards the inlet 10 of the rotary cooler 2 and thus to the rotary kiln 1.

[0098] More particularly, the controller 76 is configured for controlling the sweep air system 75 depending on a measured pressure difference DP between the inlet 10 and the outlet 12 of the rotary cooler 2.

[0099] More particularly, the controller 76 is configured for reducing the pressure at the outlet 12 of the rotary cooler 2 relative to the pressure at the inlet 10 of the rotary cooler 2, i.e. for creating a depression at the outlet 12 of the rotary cooler 2 compared to the inlet 10 thereof.

[0100] Thereby, the sweep air system 75 sucks in exhaust from the rotary kiln 1, also called sweep air, and, due to the pressure difference between the inlet 10 and the outlet 12, leakage air will not flow towards the inlet 10 of the rotary cooler, but will rather be sucked in with the sweep air by the sweep air system.

[0101] The sweep air system 75 is further configured for transporting this mixture of leakage air, sweep air and dust to the afterburner 7. For this purpose, the sweep air system 75 comprises a sweep air duct 82, connecting the outlet 12 of the rotary cooler 2, and more particularly the discharge housing 60, to the afterburner 7.

[0102] Advantageously, the sweep air system 75 comprises a first pressure gauge, located at the inlet 10 of the rotary cooler 2, and adapted for measuring the pressure PT1 at the inlet 10 of the rotary cooler 2, and a second pressure gauge, located at the outlet 12 of the rotary cooler 2, and adapted for measuring the pressure PT2 at the outlet 12 of the rotary cooler 2.

[0103] The controller 76 is configured for controlling the sweep air system 75 depending on the difference DP between the pressure PT1 measured by the first pressure gauge and the pressure PT2 measured by the second pressure gauge such that the pressure at the inlet 10 of the rotary cooler 2 becomes minimum equal or even greater than the pressure at the outlet 12 of the rotary cooler 2. The pressure PT2 is advantageously lower than the atmospheric pressure.

[0104] More particularly, in the example shown in the Figure 7, the sweep air system 75 comprises a fan 80 located at the outlet 12 of the rotary cooler 2, and the controller 76 is configured for controlling the sweep air system 75 by adjusting the speed of rotation of the fan 80 depending on the difference DP between the pressure PT1 measured by the first pressure gauge and the pressure PT2 measured by the second pressure gauge, such that, due to the controlled suction created by the fan 80 at the outlet 12 of the rotary cooler 2, the pressure at the intlet 10 of the rotary cooler 2 becomes equal or greater than the pressure at the outlet 12 of the rotary cooler 2.

[0105] The fan 80 is advantageously located in the sweep air duct 82 connecting the outlet 12 to the afterburner 7.

[0106] Thus, any backflow of gas, including leakage air, through the drum 11 from the outlet 12 towards the inlet 10 is effectively prevented. Entry of the leakage air into the drum 11 through the outlet 12 will be prevented since the leakage air will be sucked into the sweep air duct 82 by the fan 80.

[0107] The installation 3 further comprises a third pressure gauge adapted for measuring the pressure PT3 at the outlet 5 of the rotary kiln 1, more particularly above the kiln transfer chute 4. The pressure PT3 is set by the rotation speed of the induced draft fan of the rotary kiln 1.

[0108] The controller 76 is further able to control the sweep air system 75, and more particularly the rotation speed of the fan 82, such that the pressure PT1 at the inlet of the rotary cooler 2 is smaller, in particular slightly smaller, than the pressure PT3 at the outlet 5 of the rotary kiln 1 so as to prevent a flow of gas, in particular air, from the rotary cooler 2 into the rotary kiln 1. Indeed, the oxygen content in the rotary kiln 1, and in particular in the inlet chute 9 thereof should be precisely controlled.

[0109] The purpose of this control is to automatically adjust the pressure difference between the kiln outlet 5 and the inlet 10 of the rotary cooler 2 such that no gas is drawn from the rotary cooler 2 into the kiln 1 and no or only little gas is extracted out of the kiln 1 towards the rotary cooler 2.

[0110] Advantageously, the controller 76 is further able to control the draft inside the rotary cooler 2 by adjusting the amount of dust-carrying air (sweep air) extracted from the rotary cooler at the outlet end thereof, in particular by adjusting the speed of rotation of the fan 80.

[0111] The rotary cooler 2 further comprises a dust removal system 82 intended for removing the dust from the drum 11. The dust to be removed from the drum 11 results from the displacement of the material, and particularly of the coke, through the drum 11 and through the outlet 12, and in particular through the discharge housing 60. The thus removed dust is to be transferred and burned in the afterburner 7.

[0112] The dust removal system 81 is able to remove the dust from the drum 11 and to transfer this dust to the afterburner 7.

[0113] It comprises the sweep air duct 82, which connects the outlet 12 of the rotary cooler 2, and more particularly the discharge housing 60, to the afterburner 7. The sweep air duct 82 is intended for receiving a flow of dust-carrying gas coming from the drum 11 and for carrying it to the afterburner 7.

[0114] The dust removal system 81 further comprises a fresh air valve 84 configured for allowing the intake of outside air into the sweep air duct 82 and a valve control device 85, configured for controlling the opening of the fresh air valve 84 depending on the flow of gas through the sweep air duct 82. In Figure 8, the environment around the sweep air duct 82 is symbolized by the reference 90.

[0115] More particularly, the valve control device 85 is configured for opening the fresh air valve 84 in order to allow the intake of outside air into the sweep air duct 82 if the velocity of the flow of gas through the sweep air duct 82 is smaller than a preset threshold. This preset amount is equal to or greater than the flow of gas necessary for transporting the dust from the rotary cooler 2.

[0116] The fresh air valve 31 is located in the sweep air duct 82. It is configured in such a way that it allows the intake of outside air into the sweep air duct 82 when it is in an at least partly open configuration.

[0117] The dust removal system 81 further comprises the fan 80.

[0118] More particularly, in the example shown in the Figures, the fresh air valve 84 is located upstream of the fan 80 with respect to the direction of the flow of gas through the sweep air duct 82. When the fresh air valve 84 is opened, the fan 80 is able to suck outside air into the sweep air duct 82.

[0119] The dust removal system 81 further comprises a flow meter 86 for measuring the flow of gas through the sweep air duct 82. In the example shown in Figure 7, the flow meter 86 is located downstream of the fresh air valve 84 and the sweep air fan 31.

[0120] The valve control device 85 is configured for controlling the opening of the fresh air valve 84 depending on the flow of gas measured by the flow meter 86.

[0121] For example, it is configured for opening the fresh air valve 84 when the measured flow of gas is smaller than the preset threshold. Thus, outside air will be sucked into the sweep air duct 82 by the fan 80 through the fresh air valve 84 and the flow of gas through the sweep air duct 82 will be increased.

[0122] The valve control device 85 is further configured for opening the fresh air valve 84 by an amount depending on the difference between the measured flow of gas and the preset threshold.

[0123] The preset threshold is greater or equal to the minimum flow of gas needed for transporting the dust through the sweep air duct 82 to the afterburner 7. Advantageously, the flow of gas through the sweep air duct 82 should be sufficient for transporting the dust over a distance of close to 100 meters.

[0124] The purpose of the fresh air valve 84 is to ensure that the flow of gas through the sweep air duct 82 is always sufficient for transporting the dust through the sweep air duct 82 regardless of the speed of rotation of the fan 80, and even though, due to a very good gas-tightness of the rotary cooler 2, the flow of air through the drum 11 and through the outlet 12 is kept to a minimum.

[0125] Thanks to the dust removal system 81, the speed of rotation of the fan 80 can be regulated in order to control the pressure difference DP between the outlet 5 of the rotary kiln 1, and in particular the kiln transfer chute 4, and the inlet 10 of the rotary cooler 2, and between the inlet 10 and outlet 12 of the rotary cooler 2, so as to prevent any backflow of gas to the rotary kiln 1 or to the inlet 10, regardless of the effect of this pressure regulation on the flow of gas through the sweep air duct 82. Indeed, this effect can be corrected by an adequate control of the fresh air valve 84.

[0126] As stated above, preventing the entry of leakage air into the drum 11 through its outlet 12, and particularly its flow towards the inlet 10 of the drum 11 is particularly advantageous. Indeed, the circulation of air towards the inlet 10, where the material is very hot and even still incandescent, may lead to further ignition of the material entering the inlet cone 13 and thus cause additional thermal load to the steel parts of the inlet cone 13 itself and parts which keep the ceramic lining in place. Such an additional combustion considerably raises the temperature of the material in the inlet 10 and would therefore result in an increased wear or thermal overloading and damage of the inlet 10 of the rotary cooler 2. Preventing the entry of air through the outlet openings and sealing systems located at the inlet and outlet of the drum 11, and particularly its flow towards the inlet 10 of the drum 11 prevents such an additional combustion from occurring, and thus increases the lifetime of the elements of the inlet 10 which are in contact with the hot material discharged from the rotary kiln 1.

[0127] The inventors have further found out that a rotary cooler 2 comprising a cooled inlet cone 13 and a cooled inlet chute 9 as described above, as well as a controlled sweep air system 75 as described above for preventing the outside air from entering into the drum 11 through the outlet 12 of the rotary cooler 2 is particularly advantageous.

[0128] Indeed, these features have a synergistic effect on the increase of the lifetime of the rotary cooler 2. This is due to the combined effect of :

- subjecting the inlet 10 of the rotary cooler 2 to a particularly efficient cooling as defined above; and
- preventing additional combustion of the material from occurring at the inlet 10 before the material enters the drum 11 through adequate sealing of the cooler 2 and though the sweep air system 75.

[0129] The inventors have found out that, without the controlled sweep air system 75 as described above, the time between successive maintenance operations of the cooler 2, especially for the inlet 10 of the cooler 2, is limited to approximately 8 months for internals and a replacement of the entire cooler drum after approximately 8 years. Such maintenance operations require a shutdown of the production.

[0130] The combined presence of the controlled sweep air system 75 and of the cooled conical inlet 13 as described above increases the maintenance time between shut downs to min. 12 months for ceramic lining and maintenance operations of the cooler inlet 13 to more than 3 to 4 years in case of normal operation conditions.

[0131] Thanks to the removable attachment of the inlet cone 13 to the drum 11, the lifetime of the cooler 2 is even increased by at least two years compared with previous designs of sectional coolers.

[0132] The sweep air system 75 is further very simple to implement since it only requires placing a fan 80 into the sweep air duct 82, providing pressure gauges and programming the controller 76 adequately.

[0133] The invention further relates to a method for operating a rotary cooler as described above, comprising a step of controlling the sweep air system 75 so as to prevent the entry of outside air into the drum through the outlet 12 of the rotary cooler 2.

[0134] More particularly, the method comprises a step of advantageously creating a depression at an outlet end 12 of the rotary cooler 2 compared to the inlet 10 of the rotary cooler 2.

[0135] Controlling the sweep air system 75 so as to prevent the entry of outside air into the drum through the outlet 12 of the rotary cooler 2 comprises:

- measuring a first pressure value DP1 at the inlet 10 of the rotary cooler 2 and a second pressure value DP2 at the outlet 12 of the rotary cooler 2;
- determining a difference between the first pressure value and the second pressure value and;
- controlling the sweep air system 75 depending on the difference such that the pressure at the inlet 10 of the rotary cooler 2 becomes equal or greater than the pressure at the outlet 12 of the rotary cooler 2.

[0136] More particularly, controlling the sweep air system 75 depending on the difference such that the pressure at the inlet 10 of the rotary cooler 2 becomes minimum equal or even greater than the pressure at the outlet 12 of the rotary cooler 2 comprises adjusting the speed of rotation of the fan 80 depending on the difference between the first measured pressure value DP1 and the second measured pressure value DP2 such that the pressure at the inlet 10 of the rotary cooler 2 becomes greater than the pressure at the outlet 12 thereof.

[0137] The method further comprises controlling the fresh air valve 84 depending on a flow of gas through the sweep air duct 82.

[0138] More particularly, controlling the fresh air valve 84 comprises measuring the flow of gas through the sweep air duct 82, in particular downstream of the fresh air valve, and downstream of the fan 80.

[0139] Even more particularly, controlling the fresh air valve 84 comprises controlling the opening of the fresh air valve 84 such that the flow of gas through the sweep air duct 82 is greater that a predetermined threshold.

[0140] According to a particular embodiment, the method further comprises a step of measuring a third pressure value PT3 at an outlet 5 of the rotary kiln 1 and controlling the sweep air system, and more particularly the rotation speed of the sweep air fan 80, depending on the difference between the third pressure value PT3 and the first pressure value PT1 such that the first pressure value PT1 is smaller than the third pressure value PT3.

Claims

1. Rotary cooler (2) for cooling material discharged from a rotary kiln (1), in particular coke discharged from a calcination kiln, comprising a drum (11) having a drum axis (L), the drum (11) being rotatable about the drum axis (L), an inlet (10) through which the material is fed into the drum (11), the inlet (10) comprising an inlet chute (9) intended to receive the material from the rotary kiln (1) and an outlet (12) through which the material is discharged from the drum (11), **characterized in that** the inlet (10) further comprises an inlet cone (13), extending between the inlet chute (9) and the drum (11) and intended for distributing the material discharged from inlet chute (9) into the drum (11), the inlet cone (13) being connected to the drum (11) so as rotate about the drum axis (L) together with the drum (11), and the inlet cone (13) having a frustoconical shape diverging from the inlet end thereof towards the outlet end thereof, and comprising a frustoconically shaped double walled envelope (17, 18) receiving a circulation of cooling liquid.

2. Rotary cooler (2) according to claim 1, wherein the double walled envelope (17, 18) of the inlet cone (13) comprises an inner wall (17) and an outer wall (18) delimiting between them a cavity (38) for receiving the circulation of cooling liquid.

3. Rotary cooler (2) according to claim 2, wherein at least half of the volume of the cavity (38) is filled with the cooling liquid.

4. Rotary cooler (2) according to claim 2 or claim 3, wherein the inner wall (17) of the inlet cone (13) has a frusto-conical shape centred on the drum axis (L) and delimits the interior volume of the inlet cone (13).

5. Rotary cooler (2) according to any one of the preceding claims, wherein the inlet cone (13) is attached to the drum (11) through a removable attachment means.

6. Rotary cooler (2) according to any one of the preceding claims, wherein the inlet cone (13) is lined interiorly with a layer of wear and shock resistant material (22), said layer of wear and shock resistant material being self-supporting and forming a removable portion of the inner wall (17) of the inlet cone (13).

7. Rotary cooler (2) according to any one of the preceding claims, wherein the inlet (10) comprises a stationary inlet part (39), relative to which the inlet cone (13) is rotatable about the drum axis (L), the rotary cooler (2) comprising a sealing means for sealing the stationary inlet part (39) against the inlet cone (13).

8. Rotary cooler (2) according to any one of the preceding claims, wherein the drum (11) comprises a double walled exterior shell (20) and a plurality of product chambers (23) for transporting the material through the drum (11) arranged in the interior volume delimited by the exterior shell (20), a circulation of cooling liquid being defined inside the double walled exterior shell (20) and between the product chambers (23).

9. Rotary cooler (2) according to claim 8, further comprising a cooling liquid exchange system (35) for circulating the cooling liquid between the drum (11) and the inlet cone (13).

10. Rotary cooler (2) according to claim 9, taken in combination with claim 2, wherein the cooling liquid exchange system comprises a plurality of connection tubes (36) spaced angularly about the drum axis (L), each connection tube (36) connecting the double walled shell (20) of the drum (11) to the cavity (38) delimited between the inner and outer walls (17, 18) of the inlet cone (13) so as to allow the circulation of cooling liquid between the drum (11) and the cavity (38) through the connection tubes (36).

11. Rotary cooler (2) according to any one of the preceding claims, wherein the inlet chute (9) comprises a double walled envelope (6) receiving a circulation of cooling liquid.

12. Rotary cooler (2) according to any one of the preceding claims, further comprising, at the outlet (12) thereof, a stationary discharge housing (60) covering

the outlet end of the drum (11) and an outlet sealing system (41) for sealing the discharge housing (60) against the drum (11).

13. Rotary cooler (2) according to any one of the preceding claims, comprising a sweep air system (75) and a controller (76) configured for controlling said sweep air system (75) in order to prevent the entry of air into the drum (11) through the outlet (12) of the rotary cooler (2).

14. Rotary cooler (2) according to claim 13, wherein the sweep air system (75) comprises a first pressure gauge arranged at the inlet (10) of the rotary cooler (2) for measuring a first pressure value (DP1) at the inlet (10) of the rotary cooler (2) and a second pressure gauge arranged at the outlet (12) of the rotary cooler (2) for measuring a second pressure value (DP2) at the outlet (12) of the rotary cooler (2), the controller (76) being configured for determining a difference between the first pressure value and the second pressure value and for controlling said sweep air system (75) depending on the difference such that the pressure at the inlet (10) of the rotary cooler (2) becomes equal or greater than the pressure at the outlet (12) of the rotary cooler (2).

15. Rotary cooler (2) according to claim 14, wherein the sweep air system (75) comprises a fan (80) and wherein the controller (76) is configured for adjusting the speed of rotation of the fan (80) depending on the difference between the first measured pressure value (DP1) and the second measured pressure value (DP2) such that the pressure at the inlet (10) of the rotary cooler (2) becomes equal or greater than the pressure at the outlet (12) of the rotary cooler (2).

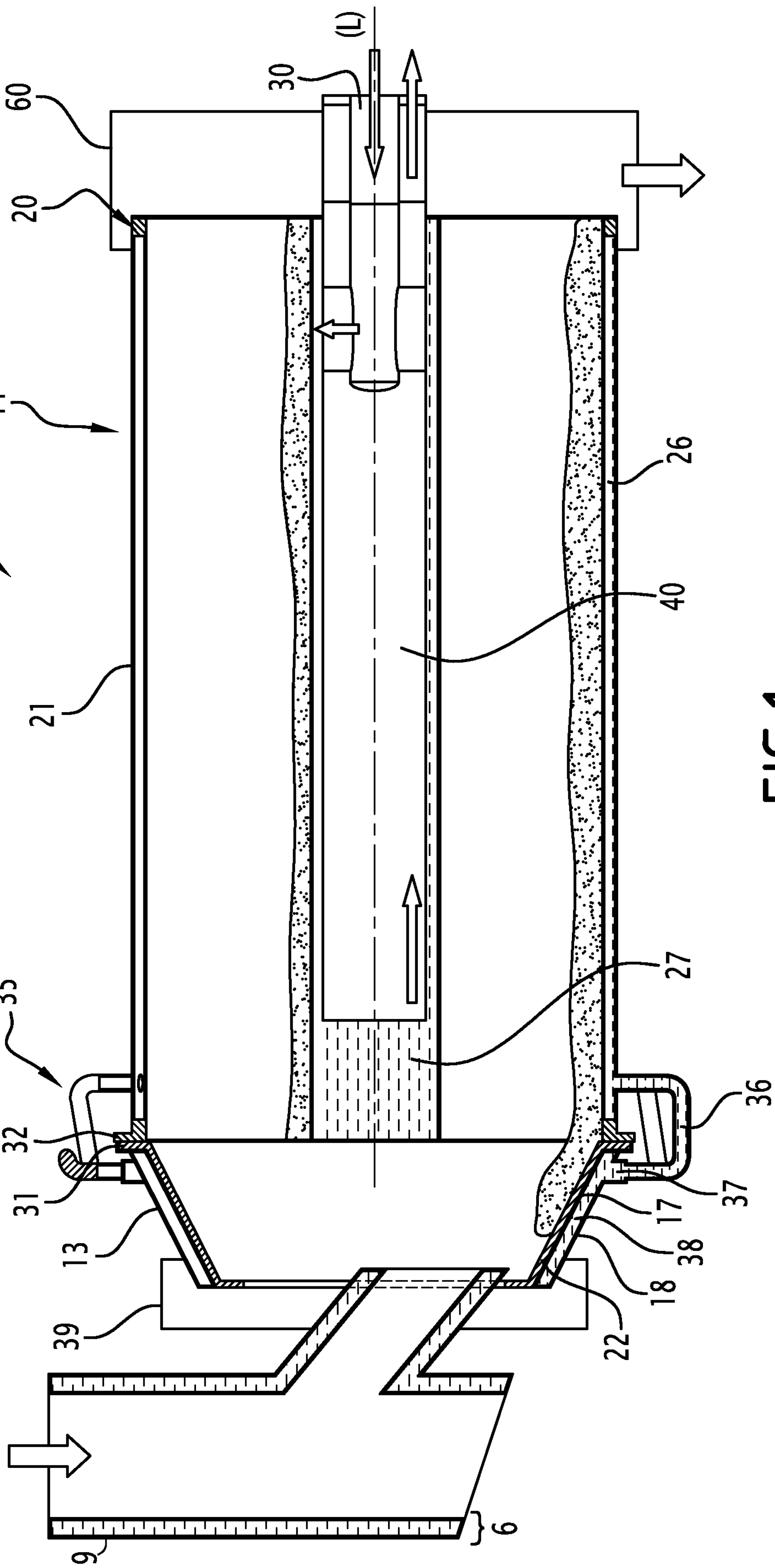

FIG.1

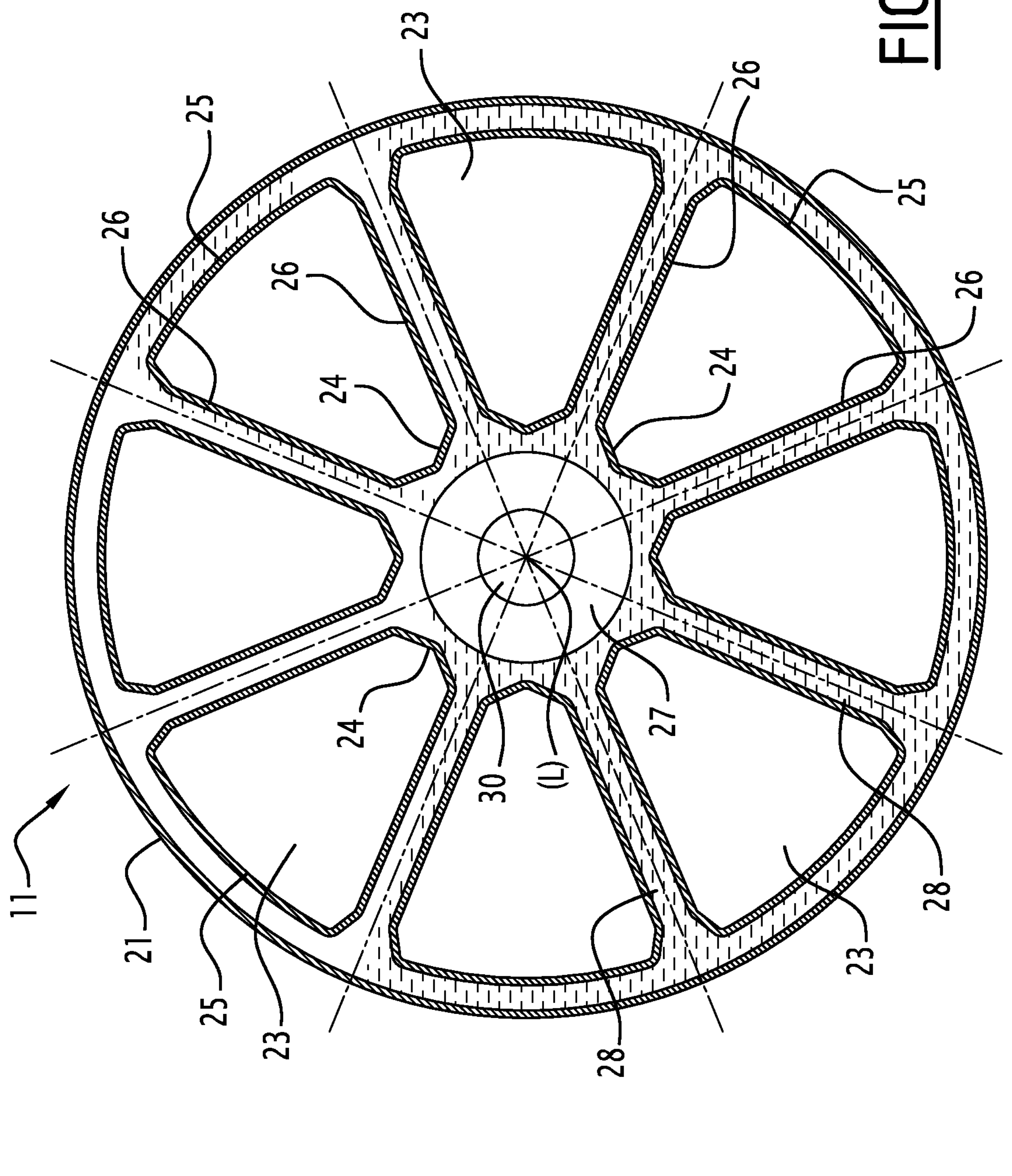

FIG.2

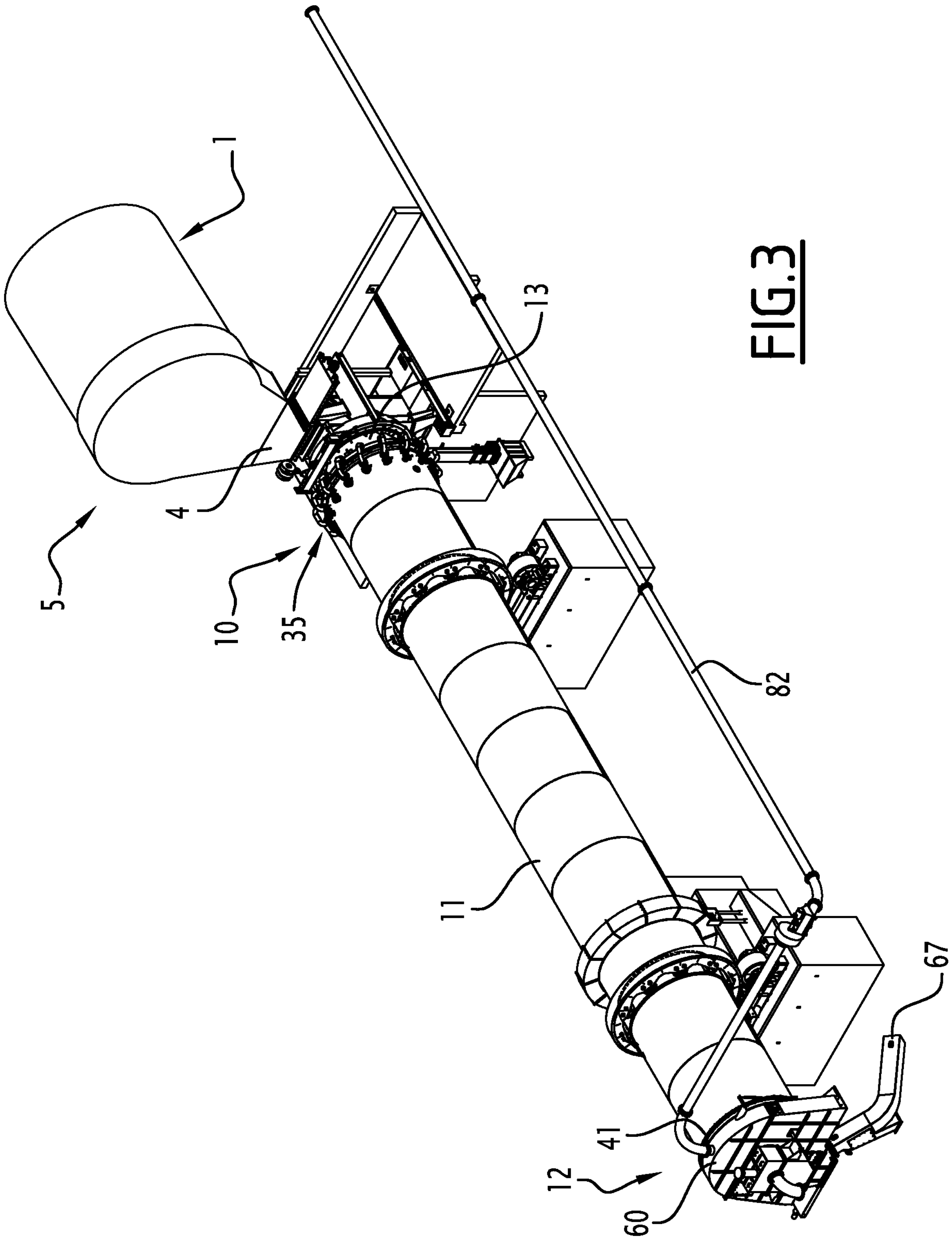

FIG.3

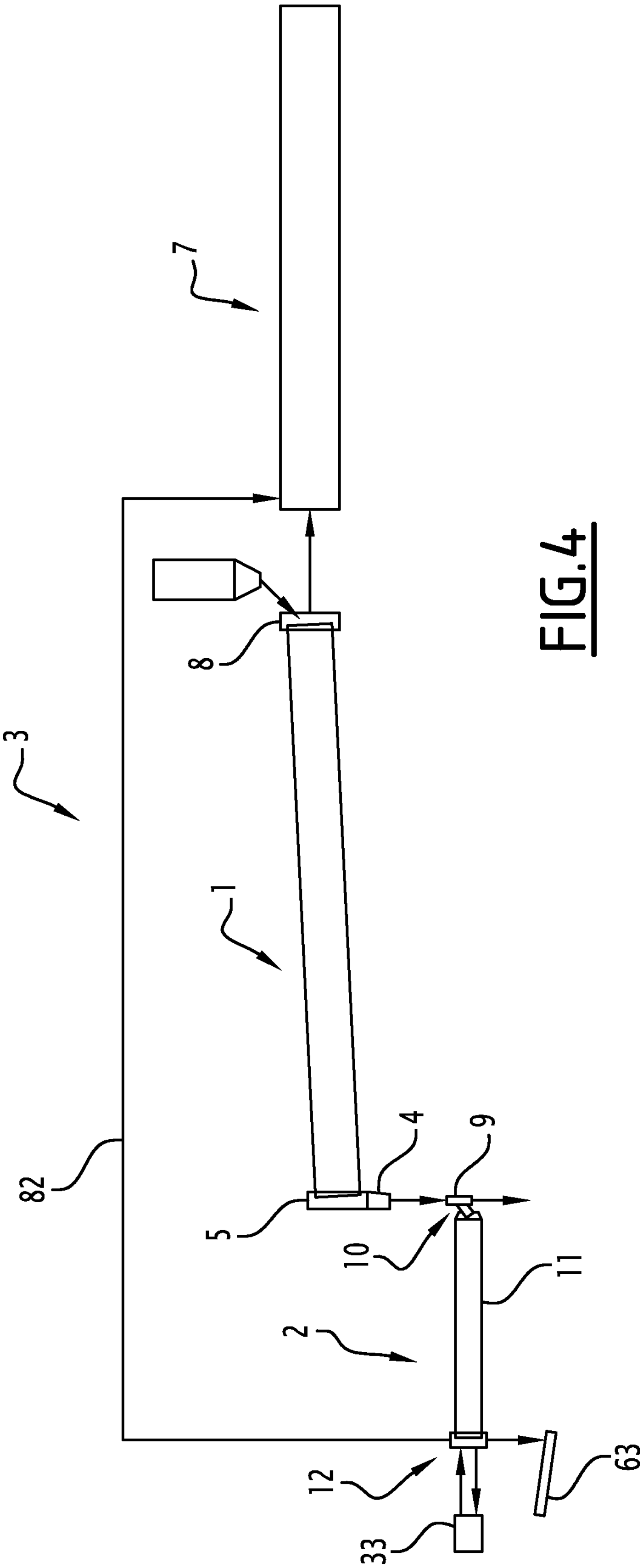

FIG.4

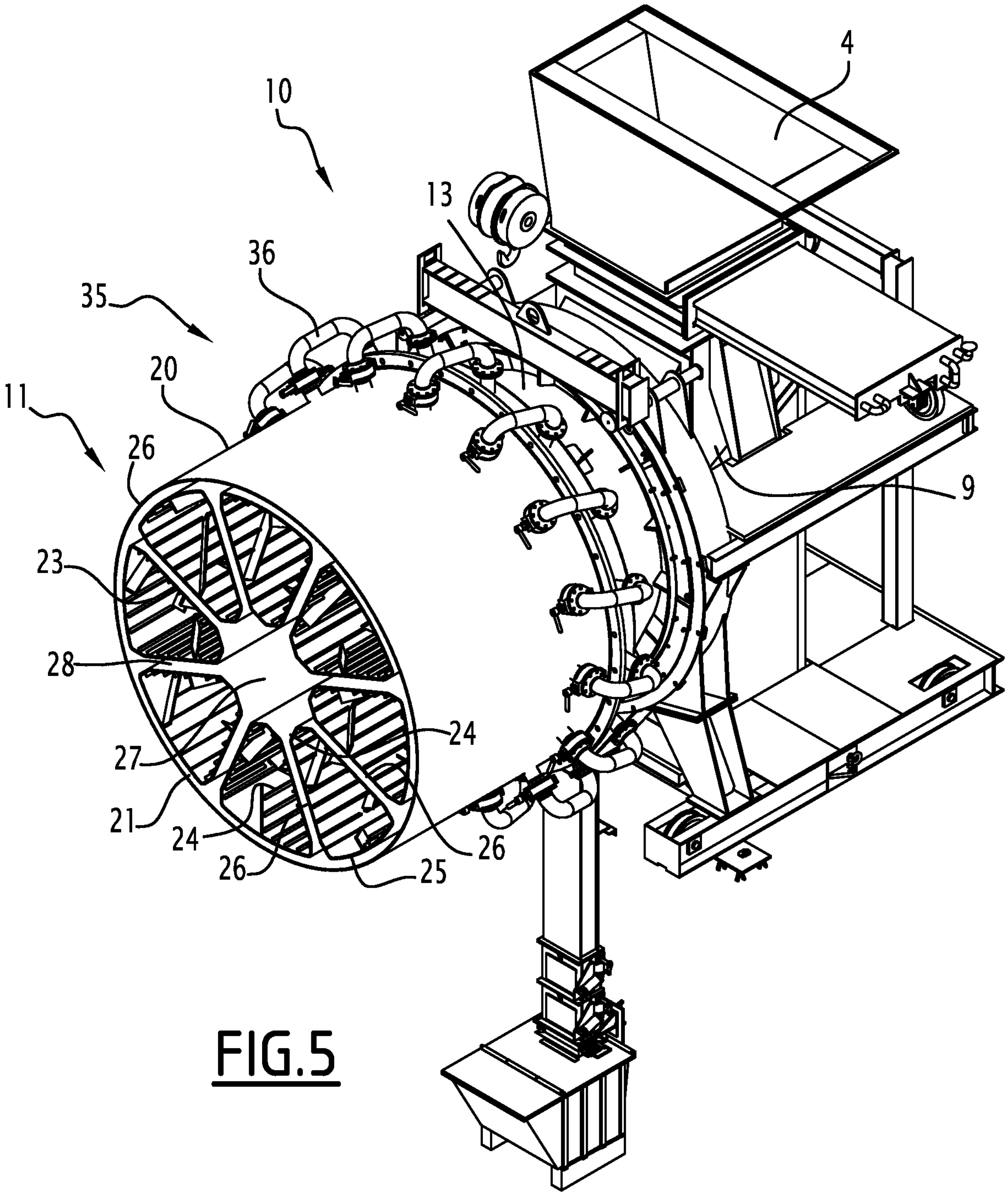

FIG.5

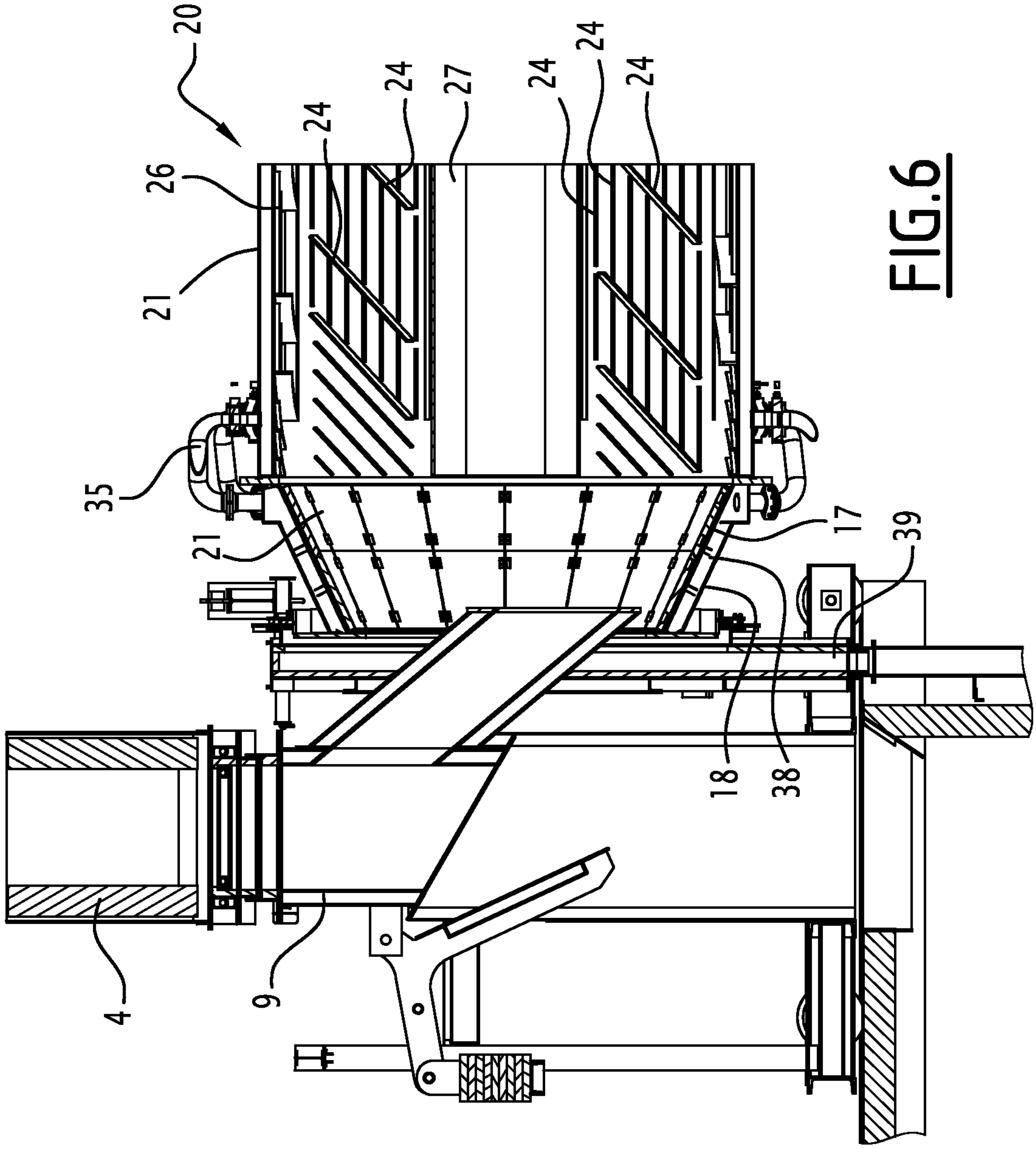

FIG.6

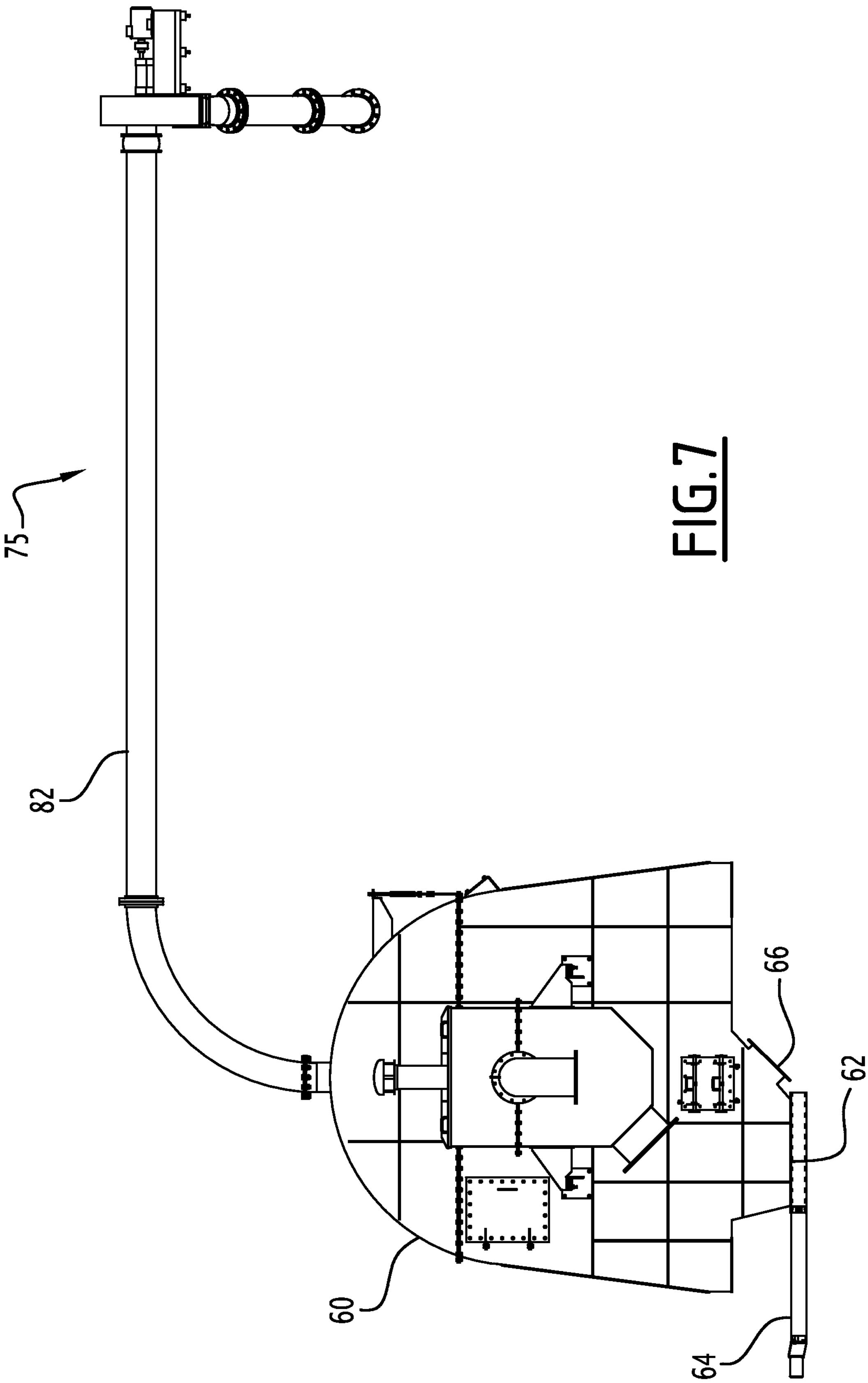

FIG.7

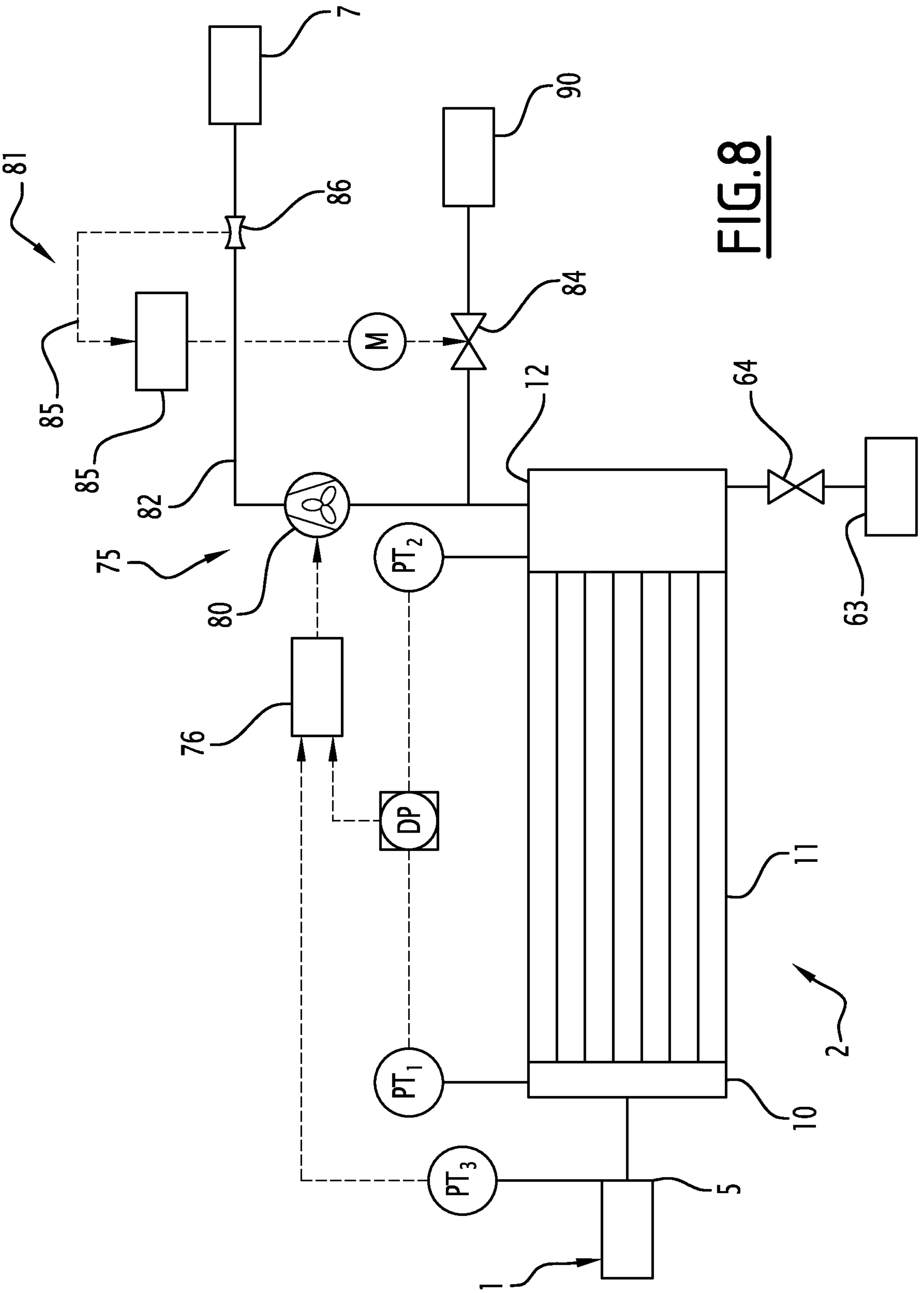

FIG.8

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 13 30 6872

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	JP 2010 025492 A (NHI CO LTD) 4 February 2010 (2010-02-04) * abstract; figure 1 * -----	1-12 13-15	INV. F27D15/02 C10B39/02 F28F5/02
Y	JP 2001 255077 A (DAIDO STEEL CO LTD) 21 September 2001 (2001-09-21) * abstract; figure 4 * -----	13-15	

TECHNICAL FIELDS SEARCHED (IPC)
F27D
F27B
F28F
C10B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	27 May 2014	Peis, Stefano

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 13 30 6872

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

27-05-2014

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2010025492 A	04-02-2010	NONE	
JP 2001255077 A	21-09-2001	JP 4273614 B2	03-06-2009
		JP 2001255077 A	21-09-2001

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82