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(71) Applicant: **APPLIED MATERIALS, INC.** [US/US];
3050 Bowers Avenue, Santa Clara, California 95054 (US).

(72) Inventors; and

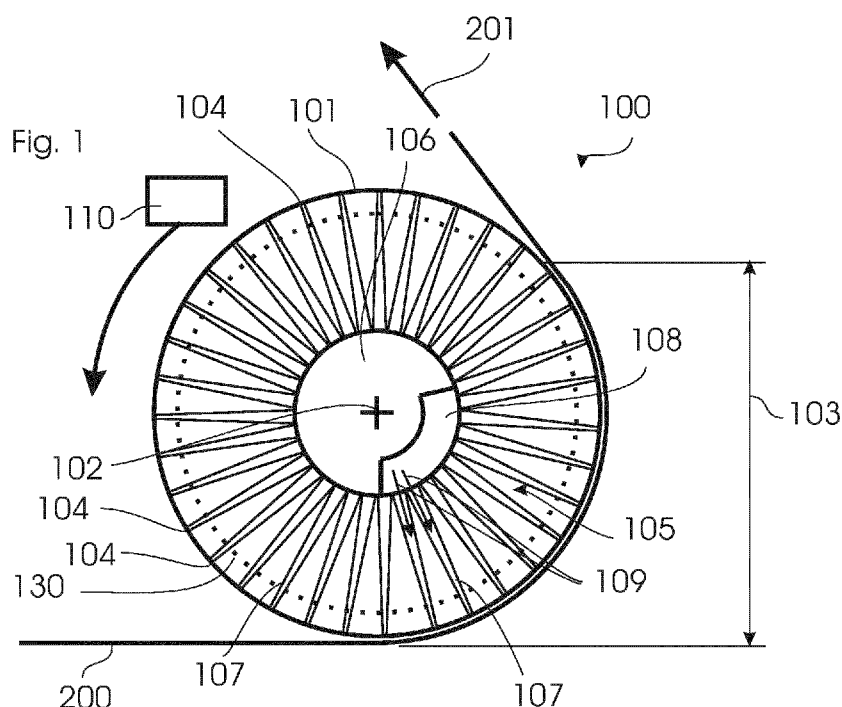
(71) Applicants (for US only): **METT, Valerius** [DE/DE];
Taunusring 25, 63755 Alzenau (DE). **DEPPISCH, Thomas** [DE/DE]; An den Bornwiesen 11, 63743 Aschaffenburg (DE). **WHITE, John M.** [US/US]; 28530 Hayward Blvd., Hayward, California 94542 (US). **HEIN, Ste-**

fan [DE/DE]; Amselweg 9, 63825 Blankenbach (DE). **BUSCHBECK, Wolfgang** [DE/DE]; Baumweg 37, 63454 Hanau (DE).

(74) Agent: **ZIMMERMANN & PARTNER PATENTANWÄLTE MBB**; Josephspitalstr. 15, 80331 München (DE).

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(54) Title: GUIDING DEVICES AND WEB COATING PROCESS



(57) Abstract: A roller device (100) for guiding a web (200) and for controlling the temperature of the web (200) in contact with the roller device in a web coating process under vacuum conditions is described. The roller device includes a curved surface (101) of the roller device (100) for contacting the web (200), wherein the curved surface (101) includes a web guiding region (103). The roller device further includes a group of gas outlets (104) in the curved surface (101) and a gas distribution system (105) for selectively providing the gas flow to a first subgroup of gas outlets (104) and for selectively preventing the gas from flowing to a second subgroup of the gas outlets (104). The roller device further includes a driving unit (110) for rotating the curved surface (101), wherein the curved surface (101) is adapted for inducing a movement of the web (200) upon rotation of the curved surface.

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GUIDING DEVICE AND METHOD FOR CONTROLLING THE TEMPERATURE OF A WEB IN A WEB COATING PROCESS

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FIELD

[0001] Embodiments of the disclosure relate to roller devices in web coating processes and to methods of guiding webs in web coating processes. In particular, embodiments relate to devices and methods for guiding and cooling
10 webs in web coating processes. Some embodiments relate to devices and methods for web guiding and cooling a web in a two-sided web coating process, such as in thin-film solar cell production, others to web guiding in the production of flexible displays.

15 BACKGROUND

[0002] In apparatuses and methods for coating a web, such as in the production of thin-film solar cells, the web to be coated is guided through a coating apparatus. For instance, a web may be guided past one or more deposition sources for depositing one or more layers of deposition material on
20 the web. Also, guiding the web may be useful for changing the moving direction of the web within a coating apparatus. Optimizing the size of the coating apparatuses using a guiding roller device is beneficial in view of the cost of ownership and the acceptance of the clients buying the coating apparatuses.

25 [0003] Another possible application of guiding the web is a two-sided coating of the web. When a web is to be coated from two sides, the roller devices are carefully designed and operated for avoiding damage of a first already coated side of the web during coating of the second side.

[0004] In many applications, in particular in thin-film solar cell production applications, guiding a coated web with rollers on the side of the web that is already coated may harm the coating. As a result, the coating apparatuses have been designed such that the contact of the rollers with the web is exclusively on
5 the rear (uncoated) side of the web. Due to the design limitations complex moving paths are designed within the coating apparatuses and/or the overall path length of coating apparatuses is substantially limited. In some applications, hover cushions are used for contactless guiding a web and avoiding damage of the coating on the web. In some applications, the coating
10 process takes place under vacuum conditions. The emitted gas for the hover cushion may be detrimental to the vacuum conditions.

[0005] In view of the above, a guiding device, a method for controlling the temperature of a web and contacting the web, and the use of a roller device for guiding and controlling the temperature of a web are provided that overcome at
15 least some of the problems in the art.

SUMMARY

[0006] In light of the above, a guiding device, a method for controlling the temperature of a web and contacting the web, and the use of a roller device for
20 contacting and controlling the temperature of a web according to the independent claims are provided. Further aspects, advantages, and features are apparent from the dependent claims, the description, and the accompanying drawings

[0007] According to embodiments described herein, a roller device for
25 guiding a web and for controlling the temperature of the web in contact with the roller device in a web coating process under vacuum conditions is provided. The roller device includes a temperature adjusting system for adjusting the temperature of the roller device and a curved surface of the roller device for facing and contacting the web. The curved surface is rotatable about

an axis of the roller device and includes a web guiding region. The roller device further includes a group of gas outlets disposed in the curved surface and adapted for releasing a gas flow, and a gas distribution system for selectively providing the gas flow to a first subgroup of the gas outlets and for
5 selectively preventing the gas from flowing to a second subgroup of the gas outlets. The first subgroup of the gas outlets consists of at least one gas outlet in the web guiding region and the second subgroup of gas outlets consists of at least one gas outlet outside of the web guiding region. The roller device further includes a driving unit for rotating the curved surface, wherein the curved
10 surface is adapted for inducing a movement of the web upon rotation of the curved surface.

[0008] According to one embodiment described herein, a method for controlling the temperature of a web in a web coating process under vacuum conditions is provided. The method includes moving the web over a
15 temperature controlled roller device in contact with the temperature controlled roller device in a web guiding region of the temperature controlled roller device. A gas is released from gas outlets disposed in the temperature controlled roller device to form a gas bearing between the temperature controlled roller device and the web for providing a thermal transition from the
20 temperature controlled roller device to the web. Releasing the gas includes releasing a gas flow from the temperature controlled roller device through a first subgroup of the gas outlets in the web guiding region and preventing the gas from flowing through a second subgroup of the gas outlets outside of the web guiding region.

25 [0009] According to one embodiment described herein, the use of a roller device for contacting and controlling the temperature of a web in a web coating process application under vacuum conditions is provided. The roller device includes a temperature adjusting system for adjusting the temperature of the roller device and a curved surface of the roller device for facing and contacting
30 the web. The curved surface is rotatable about an axis of the roller device and includes a web guiding region. The roller device further includes a group of gas

outlets disposed in the curved surface and adapted for releasing a gas flow, and a gas distribution system for selectively providing the gas flow to a first subgroup of the gas outlets and for selectively preventing the gas from flowing to a second subgroup of the gas outlets. The first subgroup of the gas outlets
5 consists of at least one gas outlet in the web guiding region and the second subgroup of gas outlets consists of at least one gas outlet outside of the web guiding region.

[0010] Embodiments are also directed to apparatuses for carrying out each of the disclosed methods and including apparatus parts for performing each
10 described method feature. The method features may be performed by way of hardware components, a computer programmed by appropriate software, by any combination of the two or in any other manner. Furthermore, embodiments are also directed to methods which the described apparatus operates with or which the described apparatus is manufactured by. The method includes
15 method features for carrying out functions of the apparatus or manufacturing parts of the apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Some of the above indicated and other more detailed aspects of
20 embodiments will be described in the following description and partially illustrated with reference to the figures. Therein:

Fig. 1 shows a sectional schematic view of a roller device according to embodiments described herein;

Fig. 2 shows a sectional schematic view of a roller device according to
25 embodiments described herein;

Fig. 3 shows a sectional schematic view of a roller device according to embodiments described herein;

Figs. 4 to 6 show schematic plan side views of roller devices according to embodiments described herein;

Fig. 7 shows a sectional schematic view of a roller device according to embodiments described herein; and

- 5 Figs. 8 to 9 show flow charts of methods for contacting a web and for controlling the temperature of the web according to embodiments described herein.

DETAILED DESCRIPTION OF THE DRAWINGS

- 10 [0012] Within the following description of the drawings, the same reference numbers refer to the same components. Only the differences with respect to the individual embodiments are described. The drawings are schematic drawings, not in every embodiment true to scale and serve for illustration.
- 15 [0013] A roller device as referred to herein may be a device which may be rotationally symmetric about a rotation axis. The roller device may be cylindrical, e.g. a drum, or be concave-cylindrical. The roller may also be a cone or a truncated cone. Typically, the roller device is rotatable about the rotation axis. In some embodiments, the roller device includes a stationary part
- 20 and a part, which can be rotated, e.g. about the stationary part. For instance, the roller device may include a stationary inner part (which may in some embodiments include the gas distribution system or components of the gas distribution system) and a rotary outer part, which rotates about the inner stationary part.
- 25 [0014] According to some embodiments, the roller device includes a curved surface. The curved surface may be the surface of the roller device. The curved surface of the roller device is adapted to be (at least partly) in contact with the web during operation of the roller device, e.g. in a web guiding region.

According to embodiments which can be combined with any other embodiments described herein, a curved surface can be rotationally symmetric surface. Typically, the curved surface is rotationally symmetric about an axis. In particular, the curved surface may be selected from a group consisting of a
5 cylindrical surface, a concave-cylindrical surface, a surface of a cone, and a surface of a truncated cone.

[0015] According to some embodiments, the curved surface of the roller device may have a contact to the web at contact locations, such as contact areas or punctual contact, during operation of the roller device in the web guiding
10 region. For instance, by the surface properties (such as roughness) of the curved surface of the roller device and/or the web, the web is in punctual contact with the curved surface at contact positions. The curved surface having a roughness may mean that the microscopic view of the curved surface shows “mountains and valleys”, wherein the punctual contact between the curved
15 surface and the roller device is at positions, where the roughness of the curved surface has “mountains.” According to some embodiments, which may be combined with other embodiments, the roughness of the curved surface of the roller device may typically be in a range between about 0.1 Rz and about 1.5 Rz, more typically between about 0.1 Rz and about 1.0 Rz, and even more
20 typically between about 0.2 Rz and about 0.8 Rz. In some embodiments, the roughness of the curved surface of the roller device is about 0.2 Rz.

[0016] According to some embodiments, the contact between the roller device (in particular the curved surface of the roller device) and the web may allow the web to be moved, when the roller device is driven. For instance, the
25 contact between the roller device and the web and the rotational movement of the roller device may carry the web being pulled with a defined (lowered tension).

[0017] Fig. 1 shows an embodiment of a roller device 100. The roller device 100 includes a curved surface 101. According to some embodiments
30 described herein, the curved surface 101 may be rotatable about a rotation axis

102 of the roller device. The curved surface 101 of the roller device 100 includes a web guiding region 103. In the web guiding region 103, the web 200 is in contact with the curved surface 101.

[0018] During operation, the web is guided over the web guiding region on
5 the curved surface. In some embodiments, the web guiding region may be defined as the area of the curved surface in which the web is in contact with the curved surface during operation of the roller device. The size of the web guiding region may depend on parameters such as the weight or area density of the web, the tension with which the web is pulled during operation, and
10 attractive or repelling forces such as electrostatic forces, e.g. if the surface is biased with a voltage or one or more e-chucks are provided at the curved surface. The size of the web guiding region depends on the enlacement angle, also called wrap angle, with which the web is wound around the curved surface of the roller device. For example, in Fig. 1, the enlacement angle is about 120°.

15 [0019] The embodiment of a roller device 100 shown in Fig. 1 further includes a group of gas outlets 104 disposed in the curved surface 101. The gas outlets 104 are adapted to release a gas from a gas distribution system 105 of the roller device 100, in particular in a direction substantially perpendicular to the curved surface 101 at the position, where the respective gas outlet gas is
20 located. In the example of a roller device 100 shown in Fig. 1, the gas outlets are distributed over the whole circumference of the roller device 100. In particular, the gas outlets 104 are distributed in a regular manner over the whole circumference of the roller device.

[0020] The feature “disposed in a regular manner” may be understood that
25 the distance of a first gas outlet and at least one neighbor gas outlet of the first gas outlet is identical to the distance of a second gas outlet with respect to at least one neighbor of the second gas outlet. In some embodiments, the feature “disposed in a regular manner” refers to a surface wherein a specific pattern can be assigned to a portion of the multitude of outlets and the same pattern
30 can be assigned to another portion of the multitude of outlets. In some

embodiments, the gas outlets may be disposed in an irregular manner over the circumference of the roller device.

[0021] According to embodiments which can be combined with any other embodiments described herein, any individual gas outlet, any subgroup of the
5 gas outlets or all gas outlets can be selected from the group consisting of: openings, holes, slits, nozzles, blast pipes, spray valves, duct openings, orifices, jets, outlets provided by a porous material and the like. According to some embodiments, the outlets are recesses in the surface that are typically funnel-shaped or cup-shaped with the recesses being fed with gas from the bottom of
10 the recesses or sideways. The gas outlets of the roller device described herein can also be openings of a porous layer. According to some embodiments, the gas outlets as referred to herein may have any suitable shape, such as substantially round, circular, elliptic, triangular, rectangular, quadratic, a polygon, an irregular shape, such as an irregular round shape, an irregular
15 angled shape, a shape being different from one gas outlet to the other, or the like. According to some embodiments, the gas outlets do not protrude out of the surface.

[0022] The term “substantially” as used herein may mean that there may be a certain deviation from the characteristic denoted with “substantially.” For
20 instance, the term “substantially circular” refers to a shape which may have certain deviations from the exact circular shape, such as a deviation of about 1 to 10% of the general extension in one direction. According to a further example, the term “substantially perpendicular” may refer to an arrangement of two elements with respect to each other deviating from the exact perpendicular
25 arrangement to a defined extent. For instance, the term “substantially perpendicular” may refer to an arrangement deviating from the exact perpendicular arrangement by up to 10°. The above description of the term “substantially” may be applied to other characteristics accordingly.

[0023] The roller device 100 according to embodiments described herein
30 further includes a gas distribution system 105. According to some

embodiments, the gas distribution system 105 includes a gas source 108 or a gas main feed. The gas distribution system 105 allows for selectively providing a gas flow to a first subgroup of the gas outlets. For instance, the roller device 100 with the gas outlets 104 and the gas distribution system 105 as exemplarily
5 shown in Fig. 1 provides a gas flow to the gas outlets 104 in the web guiding region 103 of the curved surface. The gas outlets being (temporarily) located in the web guiding region 103 may be denoted as a first subgroup of the gas outlets. According to some embodiments described herein, the gas distribution system 105 in the roller device 100 is adapted to selectively prevent the gas
10 from flowing to gas outlets of the roller device outside of the web guiding region 103. The gas outlets being (temporarily) located outside the web guiding region 103 may be denoted as a second subgroup of the gas outlets.

[0024] During operation, the membership of any single gas outlet to the first or second subgroup may change. In other words, an open gas outlet may
15 be closed at a later time and vice versa. In some embodiments, membership of the gas outlets to the first and/or second subgroup is changed during operation dependent on the rotation of the curved surface. The web guiding region may remain at a fixed position in space, and gas outlets entering the web guiding region by means of the rotation of the curved surface are opened (or connected
20 to the gas source), i.e., the membership is changed to the first subgroup. Gas outlets leaving the web guiding region by means of the rotation of the curved surface is closed (or disconnected to the gas source), i.e., the membership is changed to the second subgroup

[0025] The gas distribution system 105 of the roller device 100 according
25 to some embodiments described herein may be adapted to selectively provide and prevent gas flow in defined gas outlets by the size of the gas distribution system, the location of the gas distribution system, the shape and construction of the gas distribution system, the kinetic properties of the gas distribution system and the like. For instance, in the example of Fig. 1, the gas distribution
30 system 105 of the roller device includes a gas source 108 (also called a main gas feed) being arranged in or presenting a stationary part 106 of the roller

device. The gas source 108 has a size encompassing a section of the circumference of the stationary part of the roller device 100. The curved surface 101 of the roller device 100 is rotary and is able to rotate about the rotation axis 102 of the roller device 100 and, in particular, about the stationary
5 part of the roller device (including e.g. the gas source).

[0026] According to some embodiments described herein, the gas distribution system 105 may include gas channels 107 (also called individual gas outlet feeds). The gas channels may lead from the gas source 108 to the gas outlets 104 on the curved surface 101 when the respective gas outlet is in the
10 web guiding region 103. The gas channels may lead from the gas source 108 to the first subgroup of the gas outlets 104 on the curved surface 101. The gas distribution system 105 with a gas source 108 and gas channels 107 may be described as being partially rotary (e.g. the gas channels 107) and partly stationary (e.g. the gas source 108). With the gas channels 107 rotating about
15 the gas source 108, the gas distribution system 105 allows to selectively connect and disconnect the gas channels 107 to the gas source 108.

[0027] According to some embodiments, the gas distribution system 105, and in particular the gas source 108 provides a gas flow to the gas outlets 104 (as exemplarily shown by two arrows 109 in Fig. 1). In some embodiments, the
20 gas flow provided by the gas distribution system 105 to the gas outlets 104 is a gas flow still allowing the web 200 to be in contact (at least in punctual contact, as explained in detail above) with the curved surface 101. For instance, the gas flow may typically be between about 10 sccm and about 400sccm, more typically between about 20 sccm and about 300 sccm, and even more
25 typically between about 30 sccm and about 300 sccm. In some embodiments, the roller device according to embodiments described herein is adapted to a flow rate of the gas per area of the curved surface typically between 10 about sccm/m² and about 200 sccm/ m², more typically between about 20 sccm/ m² and about 150 sccm/ m², and even more typically between about 30sccm/ m²
30 and about 120 sccm/ m². In one example, the roller device may be adapted to a flow rate of the gas per area of the curved surface may typically be about

100sccm/ m². According to some embodiments, which may be combined with other embodiments described herein, the roller device may be adapted to a defined gas flow rate by one or more parameter of the roller device, such as for instance number of gas outlets on the curved surface, size of the gas outlets, fluid conductance of the gas distribution system, size of the gas source, capacity of the gas source, size and power of a pumping system for the gas, size and design of gas channels, choice and/or kind of a porous material at the curved surface, choice and/or kind of porosity of the porous material of the curved surface, number and size of holes in a coating of the porous material at the curved surface (explained in detail below), design of the gas distribution system, and/or the like.

[0028] According to some embodiments, which may be combined with other embodiments described herein, the number of gas outlets may typically be between 20 and 100, more typically between 30 and 100, and even more typically between 40 and 100, in particular for a roller device with gas channels (as exemplarily shown in Fig. 1). According to some embodiments, the curved surface may be partitioned into gas sections. In some embodiment, each gas section has several gas outlets. In some embodiments the number of gas outlets in the web guiding region is between 5 and 20. The number of gas outlets for a porous layer of the roller device (as will be explained in detail below) may typically be at least 5000, more typically at least 6000, and even more typically at least 8000. According to some embodiments, the number of gas outlets is between 20 and 100 or the roller device includes a porous layer providing the gas outlets.

[0029] According to some embodiments, which may be combined with other embodiments described herein, a gas outlet as referred to herein may have a cross section size of typically between about 0.1 mm and about 1mm. The cross section size may be measured as the minimum cross-section of the gas outlets at the curved surface. In some embodiments, the fluid conductance of the gas outlets may typically be between about 0.001 liter/sec and about 0.1 liter/sec, more typically between about 0.005 liter/sec and about 0.08 liter/sec,

and even more typically between about 0.009 liter/sec and about 0.05 liter/sec. In one embodiment, the fluid conductance of the gas outlets may be about 0.01 liter/sec.

[0030] According to some embodiments, the gas flow being provided in
5 direction to the web 200 during operation of the roller device 100 may result in a gas bearing, especially a hydrodynamic or thermic gas bearing, between the web 200 and the curved surface 101 of the roller device. In some embodiments, the gas bearing may also be denoted as a kind of thin or small gas cushion outside the contact locations between the web and the curved surface. It may be
10 understood that the web being in contact with the curved surface of the roller device and having a gas bearing between the web and the curved surface may be in contact at some contact locations of the curved surface (e.g. punctual locations provided by the roughness of the curved surface) and may have gas bearings between the locations of contact. Between the contact locations (such
15 as areas or points of the curved surface) of the web and the curved surface, gas bearings may be formed by the gas flow released from the gas outlets. According to some embodiments, which may be combined with other embodiments described herein, the pressure in the gas bearing(s) is typically between about 0.1 mbar to about 10 mbar, more typically between about 1mbar
20 and 10 mbar. In some embodiments, the gas bearings between the web and the curved surface may fill the voids (or valleys) present due to the roughness of the curved surface of the roller device and the web, especially outside of contact locations between the web and the curved surface. A thickness of the gas bearing may correspond to the roughness of the combination of the curved
25 surface of the roller device and the web being in contact with each other.

[0031] According to some embodiments, a plurality of gas bearings is formed between the web and the curved surface by the gas flow released from the gas outlets. In some embodiments, one gas bearing is provided being interrupted by the contact points or contact areas between web and the curved
30 surface.

[0032] The gas bearing(s) between the web and the curved surface may provide and improve the thermal transition between the roller device and the web, e.g. for cooling or heating the web during operation of the roller device. For instance, the roller device may include a temperature adjusting system
5 (exemplarily shown as temperature adjusting system 130 including a channel in Fig. 1), e.g. for cooling or heating the roller device. The gas bearing(s) provided by a roller device according to embodiments described herein help to increase the thermal transition between the web and the roller device. According to some embodiments described herein, during the coating the web
10 temperature is beneficially kept below a defined upper limit (e.g. the glass transition temperature). For instance, the layer properties of the deposited coating layer may depend on the deposition temperature.

[0033] In known system, gas cushions were formed for guiding and transporting the web in a contactless manner (referred to herein as contactless
15 guiding systems). In the contactless guiding systems, for forming a gas cushion able to carry the web to be coated, the gas is provided with a flow rate of about 100 times the flow rate used in the roller device according to embodiments described herein. For instance, for forming a gas cushion for contactless guiding a web, a flow rate of about 30 000 sccm is used. The contactless
20 guiding systems with the high gas flow rate and the gas cushion for contactless guiding the web over the roller device has drawbacks in view of the vacuum environment of the roller device. The vacuum environment is disturbed by the amount of the gas cushion used for contactless guiding the web over the roller device. Providing a gas cushion for contactless guiding the web over the roller
25 device has drawbacks regarding the process quality.

[0034] The roller device according to embodiments described herein does not have the drawbacks of the contactless guiding systems. The roller device being in contact with the web is driven and is able to induce a movement of the web. For instance, the curved surface and the web provide respective surface
30 properties for allowing the web to be moved together with the rotation of the curved surface of the roller device. According to some embodiments, the

surface properties of the curved surface and/or the web may be the roughness, the coefficient of friction, the material, the temperature, the humidity, and the like. The roller device according to embodiments described herein allows increasing the thermal transition between the web and the roller device.

5 [0035] Further, the contactless guiding system as known has the drawback of coating the roller device, when the web is damaged. In particular, the gas outlets may be coated by the coating material. For instance, if a porous material is used for the roller device (as will be explained in detail below), the pores of the roller device may get clogged by the coating material if the web is broken
10 at a point.

[0036] The roller device according to embodiments described herein allows solving the problems of known system, in particular the problems of the contactless guiding system. For instance, the risk of substrate damage is reduced with less pulling power of the web, which gets possible to use due to
15 the increased thermal transition effect, such as the cooling effect. A higher deposition rate (coating speed) results in a higher heat load towards the web. For using a high deposition rate (e.g. for accelerating the coating process), a proper thermal contact from the web towards the roller device is useful as provided by the roller device according to embodiments described herein. The
20 increased thermal transition effect of the roller device according to embodiments described herein stands in connection with the lowered pulling power and the driving unit of the roller device.

[0037] The roller device according to embodiments described herein may for instance beneficially be used in a two-sided or double-sided coating
25 process. A two-sided or double-sided coating process is a process for coating both sides of a web, in particular sequentially. The web being already coated on a first side is guided by a roller device according to embodiments described herein for coating the second side of the web. In particular, in a two-sided or double-sided coating process, the speed of the moving web may be chosen as
30 high as possible, but a film damage of the film already deposited on the web is

to be avoided. Damaging of the coated side happens for instance, when the web having one side already coated is guided with too high tension over the roller device or a guide roller or when the web becomes too hot during coating of the second side. According to some embodiments, the coated film on the first side of the web has already degassed prior to the coating of the coating of the second side. A degassed web results in a lower heat transfer. The roller device according to embodiments described herein allows for increasing the thermal transition between the web and the curved surface, compensating the lower heat transfer of the degassed web (in a two-sided coating process).

10 [0038] In particular in applications, wherein the substrate has a rather slow moving speed (such as a moving speed between about 0.1 m/min to 15 m/min, typically from 20 cm/min to 10 m/min, such as about 1m/min) and the pulling force (e.g. provided in direction of arrow 201 in the example of Fig. 1) is respectively low, the web may be heated by the coating process to an undue
15 extent. When the web moves slowly while being coated, the heat transfer from the deposition process is greater than at fast moving speeds of the web. An increased thermal transition effect of the web decreases the risk for damages of the web and/or in the coating.

[0039] The pulling force of the web being limited, the roller device
20 according to embodiments described herein includes a driving unit (such as driving unit 110 shown in Fig. 1) for rotating the roller device during operation and for moving the web being in contact with the roller device, in particular the curved surface of the roller device. For instance, going exemplarily to Fig. 1, the web may be pulled in direction of arrow 201, in particular with a reduced
25 tension for avoiding damage to the web and/or the coating on one side of the web. The pulling force for pulling the web with a slow speed may be supported by the rotation of the roller device. For instance, the driving unit may be a tendency drive.

[0040] According to some embodiments, additional guiding roller devices
30 may be provided in the coating apparatus, in which the roller device according

to embodiments described herein is used. The additional guiding roller devices may be arranged in front of or after the roller device according to embodiments described herein. In some embodiments, the additional roller devices may be driven by one or more driving units, in particular for maintaining a defined
5 tension of the web before or after the roller device according to embodiments described herein.

[0041] In some embodiments, the roller device according to embodiments described herein may include a power unit or second driving unit for pulling the web.

10 [0042] According to some embodiments, which may be combined with other embodiments described herein, the additional driving units, the second driving unit and the driving unit for driving the curved surface of the roller device according to embodiments described herein may be controlled based on the tension or traction of the web. For instance, the tension of the web may be
15 measured (e.g. at several positions in the coating apparatus) and the additional driving units, the second driving unit and the driving unit of the roller device according to embodiments described herein may be controlled accordingly, especially for maintaining or reaching a defined tension. In some embodiments, the additional roller devices and the roller device according to embodiments
20 described herein may be driven for avoiding slipping of the web.

[0043] A web as used with the embodiments described herein can typically be characterized in that the web is bendable or flexible. The term “web” may be synonymously used to the term “strip”. For instance, the web as described in embodiments herein may be a foil or other synthetic substrate. For example,
25 the web may be selected from a group of substrates consisting of steel substrates, stainless steel substrates, polymer substrates, PET substrates, COP or COC substrates, PEN substrates, and polyamide substrates. According to some embodiments, which can be combined with any other embodiment described herein, the web has a thickness from 10 μm to 600 μm , more
30 typically from 15 μm to 500 μm , such as 20 μm or 100 μm . According to some

embodiments, the second driving unit may be adapted for pulling a flexible web, in particular a flexible web having a thickness of between about 10 μm to 600 μm .

[0044] According to some embodiments, which may be combined with
5 other embodiments described herein, the gas for the gas flow of the gas distribution system 105 may be selected from the group consisting of: inert gases, argon, helium, nitrogen, hydrogen, silane and any mixtures thereof. In some embodiments, the gas emitted from the gas outlets is a gas having a heat conductivity of at least 0.01 W/mK, more typically of at least 0.05 W/mK,
10 even more typically of at least 0.1 W/mK and even more typically of at least 0.15 W/mK.

[0045] The low gas flow of the roller device according to embodiments described herein provides a possibility of omitting sealing or the like for protecting the vacuum environment of the coating process, in which the roller
15 device according to embodiments described herein is used. The gas bearings being formed while the web is in contact with the roller device, are small enough (i.e. contain an amount of gas that is small enough) to not substantially influence the vacuum environment, or are small enough to at least not disturb the vacuum environment used for the coating process. For specifically sensitive
20 processes, or if the risk of a pollution of the vacuum environment is still to be reduced, some embodiments may have further features for providing the thermal transition effect of the web in contact with the roller device and for actively preventing the vacuum environment from being polluted.

[0046] Fig. 2 shows an embodiment of a roller device. The roller device
25 100 has a curved surface 101 being in contact with the web 200 to be coated. The web 200 may be pulled in direction of arrow 201 and is further driven by the rotation of the curved surface. A driving unit 110 is provided for rotating the roller device 100.

[0047] The embodiment of a roller device 100 exemplarily shown in Fig. 2
30 has a gas distribution system 105 including a gas source 108 and gas channels

107. According to some embodiments described herein, the gas channels 107 fluidly connect the gas source 108 with the gas outlets 104 provided on the curved surface 101 of the roller device. By the rotation of the curved surface 101 about the axis 102, the stationary part of the gas distribution system 105
5 (i.e. the gas source 108) can be connected to different gas outlets, e.g. the gas outlets in the web guiding region of the roller device. The features described above with respect to Fig. 1 may also be applied to the embodiment of Fig. 2.

[0048] The roller device 100 according to embodiments described herein as shown in Fig. 2 further provides a vacuum generating system for selectively
10 providing a vacuum to one or more of the gas outlets of the group of gas outlets. Similar to the gas source, the vacuum generating system 111 can be selectively connected to the gas channels 107, in particular by the rotation of the roller device 100. In some embodiments, the vacuum generating system may be arranged in the stationary part of the roller device. In particular, the
15 curved surface 101 of the roller device 100 with the gas outlets 104 rotates about the vacuum generating system 111 during operation of the roller device 100.

[0049] The vacuum generating system may include a pump (such as a vacuum pump) providing suction through the gas channels 107 presently
20 connected to the vacuum generating system. For instance, arrows 112 of Fig. 2 show the suction of the vacuum generating system. According to some embodiments, the vacuum generating system provides suction in a direction away from the web and towards the vacuum generating system 111. With the vacuum generating system, the gas released from the gas source to form
25 hydrodynamic thermal bearing(s) between the web and the roller device being in contact with the web may be removed, in particular before the web leaves the web guiding region or before the web is not in contact with the curved surface of the roller device anymore. The vacuum environment of the roller device is protected by the vacuum generating system.

[0050] Fig. 3 shows a roller device 100 according to embodiments described herein. The roller device 100 is similar to the roller device as exemplarily shown in Fig. 1. The (detailed) features described with respect to Fig. 1 may also be applied to the embodiment of Fig. 3. The embodiment of a roller device 100 of Fig. 3 further includes a sealing. In some embodiments, the sealing may be made of a plurality of single sealing devices 113, such as sealing devices being made from a (at least partially elastic) material. According to some embodiments, the sealing devices may for instance be lip sealing devices. The sealing may prevent or limit the amount of gas of the gas bearing spreading into the vacuum environment of the roller device 100. In some embodiments, the sealing devices seal the gas flow with respect to the web to be coated and the vacuum condition of the coating process. For instance, the sealing devices seal the gas bearing from the vacuum environment of the roller device, in particular at least at one side.

[0051] The sealing devices 113 may be arranged in a direction substantially perpendicular to the circumferential direction of the roller device 100. According to some embodiments, the sealing devices 113 may be arranged substantially perpendicular to the radial direction of the roller device 100. In some embodiments, the sealing devices 113 may be described as being arranged in a width direction of the roller device 100.

[0052] Figs. 4 to 6 show a schematic plan view of the roller device 100, in particular in direction of arrow 115 as shown in Fig. 3. The plan view shows the curved surface 101 of the roller device, the gas outlets 104, and the sealing. Fig. 4 shows a sealing of the roller device 100 including sealing devices 113 extending in the width direction of the roller device 100. The sealing device 113 divides the curved surface 101 of the roller device 100 in segments. In some embodiments, the segments are smaller than the space from one compartment of the coating apparatus to another.

[0053] In Fig. 5, the sealing includes sealing devices 113 extending in width direction of the roller device and circumferential sealing devices 114

extending substantially in circumferential direction on the curved surface 101 of the roller device 100. The two circumferential sealing devices 114 shown in Fig. 5 may have a distance to each other. For instance, the distance between the two circumferential sealing devices 114 may be chosen dependent on the web width to be coated. In some embodiments, the circumferential sealing devices 114 can be adjusted to the individual coating and the respective web width.

[0054] According to some embodiments, the sealing may provide individually pressurized pockets on the backside of the web (i.e. the side of the web not being presently coated during operation of the roller device). In particular, if the vacuum generating system as described with respect to Fig. 2 is combined with the sealing as described herein, each pocket formed by the sealing (e.g. the sealing devices 113 together with the circumferential sealing devices 114) may provide an individual pressure. The pressure in the individual pockets may depend on the rotational position of the pocket.

[0055] According to some embodiments, which may be combined with other embodiments described herein, the gas outlets of the curved surface of the roller device may be arranged substantially at a central position in width direction of the roller device (as for instance shown in Figs. 4 and 5). In some embodiments, the gas outlets may be arranged at any suitable position of the curved surface. For instance, the gas outlets may be arranged in one row at one side in width direction of the roller device. According to some embodiments, the gas outlets may individually be placed.

[0056] Fig. 6 shows a schematic plan view of a roller device 100 and the curved surface 101 having the gas outlets 104 in a position at the side of the curved surface, i.e. in distance to the central position in width direction. In Fig. 6, the sealing is provided by the circumferential sealing devices 114 only.

[0057] According to some embodiments described herein, the curved surface may be partitioned in width direction of the roller device, e.g. for adapting the roller device to different web widths. For instance, the roller device may be adapted for a web width of typically between about 0.5 m to

about 2 m, more typically between about 1 m and about 2 m, and even more typically between about 1.2 m and about 1.8 m. In some embodiments, the roller device may be adaptable to a web width of between 1 m and 1.4 m. The partitioning to segments may provide an adapted distribution of gas outlets, such as a different number of gas outlets, a different density of gas outlets on the curved surface, a different size of the gas outlets and the like. In some embodiments, the gas source may be dividable in different sections providing gas for the different segments of the roller device (in particular in width direction).

[0058] In some embodiments, which may be combined with other embodiments described herein, the roller device may have one or more E-chuck devices. In particular, the one or more E-chuck devices may hold the web and/or provide an attraction force for holding the web in contact with the curved surface of the roller device. According to some embodiments, each segment of the curved surface (being for instance provided by the structure of the curved surface, the sealing, and may also be provided by another partition, which may in some embodiments even be virtual) may include an individual E-chuck tile. The individual E-chuck tile may provide a suitable attraction force to the web, e.g. depending on the rotational position of the roller device. In some embodiments, the individual E-chuck tiles are controlled to be operated depending on the position of the segment in or outside the web guiding region. According to some embodiments, the E-chuck tiles may be controlled to be operated dependent on the position of the respective segment with respect to the gas source 108 of the gas distribution system 105 and/or with respect to the vacuum generating system 111. In some embodiments, the roller device may include sensors and control units for sensing the rotational position of the roller device, and in particular the rotational position of each segment. The control unit may control the operation of the E-chuck depending on the sensed data.

[0059] Fig. 7 shows an embodiment of a roller device 100. The roller device 100 exemplarily shown in Fig. 7 includes a gas distribution system including a gas source 108. The gas source 108 may be positioned in a

stationary part of the roller device 100. The curved surface 101 of the roller device 100 is rotatable about the rotation axis 102 of the roller device 100. The curved surface 101 of the roller device 100 includes a web guiding region 103. The web 200 may be pulled in direction of arrow 201. A driving unit 110 is
5 provided for rotating the curved surface 101 and, in particular for moving the web being in contact with the curved surface.

[0060] According to some embodiments, which may be combined with other embodiments described herein, the roller device 100 as shown in Fig. 7 includes a backing structure 120 for supporting a porous layer 123. The porous
10 layer 123 may provide the curved surface 101 being in contact with the web 200 to be guided by the roller device 100. The porous layer 123 may further provide the gas outlets 104 for releasing gas into direction of the web 200 in the web guiding region 103 during operation of the roller device. In some embodiments, the backing structure may include supporting bars 121 and areas
15 122 for the gas release. In particular, the supporting bars 121 and the areas 122 are arranged in an alternating manner over the circumference of the roller device.

[0061] According to some embodiments, the porous layer 123 may be made from a porous material providing a plurality of gas outlets by the porosity
20 of the material. The porous material may be suitable for releasing a gas, in particular He, Ar, and/or H₂, in direction of the web. For instance, the porous material may have a density typically between about 60% and about 85%, more typically between about 65% and about 80%, and even more typically between about 65% and about 75%. In one example, the porous material has a
25 density of about 70%. In some embodiments, the porous material may be a sintered material. For instance, the porous material may be a metal, such as stainless steel, sintered stainless steel, aluminum, chromium, or a metal alloy.

[0062] According to some embodiments, the porous material may be processed, e.g. polished or the like, for influencing the roughness of the porous
30 material and the curved surface in contact with the web during operation. In

some embodiments, which may be combined with other embodiments described herein, the porous material may be coated with a layer of a material having a lower roughness than the porous material. For instance, the porous material may be coated with a metal layer, such as a Cr layer. According to 5 some embodiments, the coating layer on the porous layer, or even the porous layer itself, may have additional gas outlets being processed into the layer, such as by drilling, laser cutting, or the like.

[0063] According to some embodiments described herein, the roller device according to embodiments described herein may be a temperature controlled 10 roller device. The temperature controlled roller device may allow the web to be cooled by the thermal transition between the curved surface and the web, and in particular by the increased thermal transition via the gas bearings.

[0064] For instance, the roller device according to embodiments described herein may include a temperature adjusting system, such as a temperature 15 adjusting system 130 as exemplarily shown in Fig. 1. The temperature adjusting system of the roller device according to embodiments described herein may include a system of channels disposed in the roller device for cooling or heating the roller device. The channels of the temperature adjusting system of the roller device may be disposed close to the surface. The term 20 "close to" typically relates to a distance of less than 5 cm, more typically less than 2.5 cm, and even more typically less than 1 cm between the surface oriented side of the channels and the surface. The channels are typically adapted for receiving a fluid. The fluid is a fluid suitable for cooling and/or heating and shall be called cooling fluid.

25 [0065] According to some embodiments, which may be combined with other embodiments described herein, the roller device may be controlled to a temperature typically between about -30°C and about +170°C, more typically between about -20°C and about + 150°C, and even more typically between about -20°C and about + 80°C. In particular, for temperatures up to 100°C, 30 even more particularly for temperature below room temperature, the cooling

fluid is typically a water-glycol mixture. In other applications, in particular in those applications where the surface is heated, the cooling fluid is typically a heat transfer oil. The used cooling fluid is suitable for temperatures up to typically 400°C, even more typically up to 300°C. The heat transfer oil that is
5 typically used in embodiments described herein is made on the basis of petroleum such as naphthene or paraffin. Alternatively, the heat transfer oil can be synthetic such as an isomer composite.

[0066] According to some embodiments, which may be combined with other embodiments described herein, the roller device may typically have a
10 width in the range from 0.1 to 4 m, more typically from 0.5 to 2 m, such as 0.6, 1.0 , or 1.4 m. According to some embodiments, the roller device may be adapted for guiding a web having a width of up to 2m. The height of the roller device may range from 5 cm to 2 m.

[0067] The roller device can be adapted for use in a web coating process
15 application, e.g. a vacuum deposition process, chemical vapor deposition (CVD), a physical vapor deposition (PVD), such as evaporation or sputtering or plasma enhanced chemical vapor deposition (PECVD). The roller device can, e.g., be used in industrial production of flexible photovoltaic webs, flexible electronics, flexible displays, high barrier coatings, and packaging
20 material processing. For instance, coating may be performed by evaporating material or sputtering. In some embodiments, the coating material is selected from the group consisting of: amorphous silicon, protocrystalline silicon, silicon oxide (SiO₂), nanocrystalline silicon, transparent and conductive oxide (TCO) layer material, indium tin oxide (ITO), zinc oxide (ZnO), aluminum-
25 doped zinc oxide (ZAO), contact layer material, e.g. copper (Cu), CuNi, silver (Ag), aluminum (Al) and molybdenum (Mo).

[0068] According to some embodiments, a coating apparatus is provided. The coating apparatus includes a vacuum chamber, within which the at least one roller device according to any embodiment described herein is placed. The
30 coating apparatus may include a vacuum system including at least one vacuum

pump for evacuating the vacuum chamber. Further, according to embodiments which can be combined with any of the embodiments described herein, the coating apparatus may include at least one coating tool for coating the web, such as a coating material source or the like. The coating tool can be selected
5 from the group including, e.g. coating tools for CVD, PVD, plasma enhanced chemical vapor deposition (PECVD) and sputtering. Further, the coating apparatus includes a roller device according to any embodiment described herein.

[0069] In some embodiments, which can be combined with any of the
10 embodiments described herein, the web temperature control and guiding takes place under vacuum conditions. For instance, the pressure in the vacuum chamber may range from 10^{-5} to 20 mbar, in particular between 10^{-4} mbar to about 10^{-2} mbar. According to some embodiments, the Vacuum pressure within a vacuum chamber may locally vary. In particular, in a coating area where
15 process gases are present, the vacuum pressure may typically range from 10^{-4} to 10^{-2} mbar in sputter application, e.g. with nitrogen or argon as process gases, and from 1-10 mbar in CVD or PECVD applications, e.g. using hydrogen and/or silane as process gas. Outside of the coating area, vacuum pressures may be less than the pressures in the coating area. The gradient is typically
20 maintained by a vacuum pump system. Sputtering is typically accomplished under a pressure of between 10^{-2} mbar and 10^{-4} mbar.

[0070] According to some embodiments which can be combined with any of the embodiments described herein, the roller device may have a non-rotatable curved surface. For instance, the curved surface of the roller device
25 surface may have an oval or partly oval such as an elliptic or partly elliptic cross-section.

[0071] According to embodiments described herein, a method for controlling the temperature of a web in a web coating process under vacuum conditions is provided. Fig. 8 shows a flow chart of a method for controlling
30 the temperature according to embodiments described herein. In block 801, the

method includes moving a web to be coated over a temperature controlled roller device. In particular, the method for controlling the temperature may be a method for controlling the temperature of a web in a two-sided coating process. The web to be coated may already have a coating on one side. In some
5 embodiments, the web to be coated, or having already a coating on one side, may be a web as described in detail above, such as a flexible web. According to embodiments described herein, the web moving over the roller device stands in contact with the curved surface of the roller device. For instance, the contact between the web and the roller device may be a punctual contact, as described
10 in detail above. The above features described with respect to the roller device as such may be applied to the method as well.

[0072] According to some embodiments, the roller device being a temperature controlled roller device may include a temperature adjusting system, including for instance cooling or heating channels for cooling or
15 heating the roller device. The web is in contact with the roller device in a web guiding region of the temperature controlled roller device, as exemplarily shown as web guiding region 103 in Fig. 1.

[0073] Block 802 of the flowchart in Fig. 8 includes releasing a gas from gas outlets disposed in the temperature controlled roller device, in particular in
20 a curved surface of the temperature controlled roller device. For instance, the gas may be supplied by a gas source being fluidly connected to the gas outlets in the curved surface by gas channels in the temperature controlled roller device. According to some embodiments, the gas source may be arranged in a stationary part of the temperature controlled roller device and the gas channels
25 as well as the gas outlets may be arranged in a rotatable part of the temperature controlled roller device. The gas released from the gas outlets forms a gas bearing between the temperature controlled roller device and the web for providing a thermal transition from the temperature controlled roller device to the web. As explained in detail above, the web and the curved surface may
30 stand in punctual contact with each other. The gas bearings may be formed

between the points of punctual contact between the web and the curved surface of the roller device.

[0074] According to some embodiments, the gas flow is released from the temperature controlled roller device through a first subgroup of the gas outlets
5 in the web guiding region. For instance, a gas source is arranged so that only a part of the gas outlets, i.e. the gas outlets in the web guiding region or a first subgroup of the gas outlets, is provided with a gas flow from the gas source.

[0075] In block 803, the gas is prevented from flowing through a second subgroup of the gas outlets outside of the web guiding region. Releasing,
10 respectively preventing, the gas flow may be effected by opening, respectively closing, the first, respectively second, subgroup of gas outlets. In particular, opening the first subgroup of the gas outlets may include connecting the first subgroup to the gas source. The term “connecting” in particular includes “bringing into fluid communication”. Similarly, closing the second subgroup
15 may include disconnecting the second subgroup from the gas source.

[0076] For instance, the gas source is designed and positioned so that the first subgroup of the gas outlets may be fluidly connected to the gas source, while the second subgroup of the gas outlets is disconnected from the gas source. In one example, the gas source may be designed so as to extend over a
20 part of the circumference (such as a sector) of the roller device. According to some embodiments, which may be combined with other embodiments, a curved surface of the roller device including the gas outlets is rotated so that the first subgroup passes (and connects to) the gas source in the web guiding region and the second subgroup roller device is outside the web guiding region
25 and is disconnected from the gas source. In some embodiments, the roller device, and in particular the gas distribution system of the roller device includes gas channels able to connect the gas source with the first subgroup of gas outlets in the web guiding region. In some embodiments, the roller device, and especially the curved surface of the roller device includes a layer of porous
30 material for providing the gas outlets, as exemplarily shown in Fig. 7.

- [0077] Fig. 9 shows a flow chart of an embodiment of a method for guiding a web and for controlling the temperature of a web by a temperature controlled roller device. The blocks 801 to 803 may be the same as described above with respect to the embodiment of Fig. 8. In block 804, the method further includes
- 5 driving the temperature controlled roller device by a driving unit. Fig. 1 shows an example, where the web 200 is pulled in direction of arrow 201. The movement of the web resulting from the web being pulled may drive the roller device or may at least initiate a rotational movement of the roller device. The driving unit may rotate the curved surface of the roller device.
- 10 [0078] According to some embodiments, the gas is released from the gas outlets with a flow rate of between 30 sccm and 300 sccm. For instance, the gas flow depends on the size of the coating drum and coating width. In some embodiments, the flow rate of the gas per area of the curved surface may typically be between 10 about sccm/m² and about 200 sccm/ m², more typically
- 15 between about 20 sccm/ m² and about 150 sccm/ m², and even more typically between about 30sccm/ m² and about 120 sccm/ m². In one example, the flow rate of the gas per area of the curved surface may typically be about 100sccm/ m². According to some embodiments, which may be combined with other embodiments described herein, the number of gas outlets on the curved surface
- 20 may be 2000 and 20000 per m², more typically between 4000 and 15000 per m², and even more typically between 5000 and 10000 per m² of the curved surface of the roller device. According to some embodiments, the curved surface of the roller device may be partitioned into sections, such as typically between 10 and 50 segments, more typically between 15 and 40 segments, and
- 25 even more typically between 20 and 30 segments. In some embodiments, the number of gas outlets in one section may be between 20 and 100. In some embodiments, the roller device includes a porous layer providing the gas outlets. In some embodiments the number of gas outlets in the web guiding region is between 100 and 10000.

[0079] In some embodiments, a method for coating a web in a vacuum coating process is provided including the method for controlling the temperature of the web according to embodiments described herein.

[0080] According to some embodiments, the method for controlling the temperature of the web may be used in a two-sided or double sided coating process. For instance, if a first side of the substrate is already coated, the pulling force for the web is limited for preventing damage of the coated layer in the guiding and coating process of the second side of the web. Further, a high deposition rate increases the heating of the web due to and during the coating process. The heat load on the web is increased. The increased heat load may increase the risk of substrate damage. Controlling the temperature of the web with a method according to embodiments described herein allows coating the web with an appropriate deposition rate and, at the same time, preventing the web from an inappropriate high temperature, resulting e.g. in a lowered risk of web damage.

[0081] According to embodiments described herein, the use of a roller device for contacting and controlling the temperature of a web in a web coating process application under vacuum conditions is described. The roller device includes a temperature adjusting system 13 exemplarily shown in Fig. 1, such as a cooling system for cooling the roller device. The roller device to be used for contacting and controlling the temperature of the web further includes a curved surface for facing and contacting the web. The curved surface is rotatable about an axis of the roller device and includes a web guiding region. In Figs. 1 and 7, the web guiding region is exemplarily denoted with reference sign 103. The roller device includes a group of gas outlets disposed in the curved surface and adapted for releasing a gas flow, in particular in direction of the web to be temperature controlled and contacted by the roller device.

[0082] According to embodiments described herein, the roller device includes a gas distribution system for selectively providing the gas flow to a first subgroup of the gas outlets and for selectively preventing the gas from

flowing to a second subgroup of the gas outlets. The first subgroup of the gas outlets consists of at least one gas outlet in the web guiding region and the second subgroup of gas outlets consists of at least one gas outlet outside of the web guiding region.

- 5 [0083] In some embodiments, the use of a roller device for temperature controlling and contacting the web during a vacuum coating process may method features as exemplarily described above.

[0084] According to some embodiments, the use of a roller device according to embodiments described herein takes place in a two-sided or
10 double-sided coating process of the web, as in detail explained above. In some embodiments, the roller device to be used for temperature control and contacting a web may include a driving unit for rotating the curved surface of the roller device. According to some embodiments, the roller device to be used for temperature control and contacting a web may be a roller device as shown
15 in Figs. 1 to 7 and as described in detail above.

[0085] According to some embodiments, contacting the web with the curved surface of the roller device is in particular helpful for controlling the temperature of the web. As explained in detail above, the punctual contact and the gas bearings provided between the contact positions between the web and
20 the roller device increase the thermal transition between the (cooled) roller device and the web. An effective thermal transition between the web and the curved surface can be provided and the quality of the coating process can be increased.

[0086] It may be understood that all features described above with respect
25 to the roller device as such or the coating apparatus including the roller device according to embodiments described herein may be applied to the method embodiments and the use embodiments described herein.

[0087] While the foregoing is directed to embodiments, other and further embodiments may be devised without departing from the basic scope, and the scope is determined by the claims that follow.

CLAIMS

1. A roller device (100) for guiding a web (200) and for controlling the temperature of the web (200) in contact with the roller device in a web coating process under vacuum conditions, comprising:
 - 5 - a temperature adjusting system (130) for adjusting the temperature of the roller device (100);
 - a curved surface (101) of the roller device (100) for facing and contacting the web (200), wherein the curved surface (101) is rotatable about an axis (102) of the roller device and comprises a web guiding region (103);
 - 10 - a group of gas outlets (104) disposed in the curved surface (101) and adapted for releasing a gas flow;
 - a gas distribution system (105) for selectively providing the gas flow to a first subgroup of the gas outlets (104) and for selectively preventing the gas from flowing to a second subgroup of the gas outlets (104);
 - 15 wherein the first subgroup of the gas outlets consists of at least one gas outlet in the web guiding region (103) and the second subgroup of gas outlets consists of at least one gas outlet outside of the web guiding region (103); and
 - 20 - a driving unit (110) for rotating the curved surface (101), wherein the curved surface (101) is adapted for inducing a movement of the web (200) upon rotation of the curved surface.
- 25 2. The roller device according to claim 1, wherein the roller device is adapted to provide a gas flow of between 20 sccm/m² and 150 sccm/m².
3. The roller device according to any of the preceding claims, wherein the curved surface (101) comprises a roughness allowing punctual contact of the

web (200) with the roller device (100) and allowing the gas flow to fill the voids between different contact locations between the web and the curved surface.

- 5 4. The roller device according to any of the preceding claims, wherein the roller device (100) further comprises one or more sealing devices (113; 114) for sealing the gas flow with respect to the web (200) to be coated and the vacuum condition of the coating process.
- 10 5. The roller device according to any of the preceding claims, wherein the roller device (100) further comprising: a vacuum generating system (111) for selectively providing a vacuum to one or more of the gas outlets (104) of the group of gas outlets.
- 15 6. The roller device according to any of the preceding claims, wherein a membership of the individual gas outlets (104) to either the first subgroup or the second subgroup is variable in dependence of the rotation of the curved surface (101).
- 20 7. The roller device according to any of the preceding claims, wherein the gas distribution system (105) comprises: a gas source (108); and individual gas channels (107) in fluid communication with the gas outlets (104), the individual gas channels (107) being adapted for selectively connecting the gas source (108) to the first subgroup of the gas outlets (104) and for selectively
25 disconnecting the gas source (108) from the second subgroup of the gas outlets (104).
8. The roller device according to claim 7, wherein the gas source (108) is non-rotatable, the gas channels (107) are rotatable together with the curved surface

(101), and the gas channels (107) are adapted to selectively connect to or disconnect from the gas source (108) depending on their relative position with respect to the gas source (108) upon rotation.

- 5 9. The roller device according to any of the preceding claims, wherein the gas outlets (104) are provided by a layer of porous material (123) of the curved surface (101).

- 10 10. Method for controlling the temperature of a web (200) in a web coating process under vacuum conditions, comprising:

- moving the web (200) over a temperature controlled roller device (100) in contact with the temperature controlled roller device in a web guiding region (103) of the temperature controlled roller device;
- 15 - releasing a gas from gas outlets (104) disposed in the temperature controlled roller device (100) to form a gas bearing between the temperature controlled roller device (100) and the web (200) for providing a thermal transition from the temperature controlled roller device to the web;
- 20 - wherein releasing the gas comprises releasing a gas flow from the temperature controlled roller device (100) through a first subgroup of the gas outlets (104) in the web guiding region (103); and
- preventing the gas from flowing through a second subgroup of the gas outlets (104) outside of the web guiding region (103).

11. The method according to claim 10, further comprising rotating the temperature controlled roller device (100) by a driving unit (110), wherein rotating the curved surface (101) induces a movement of the web (200).

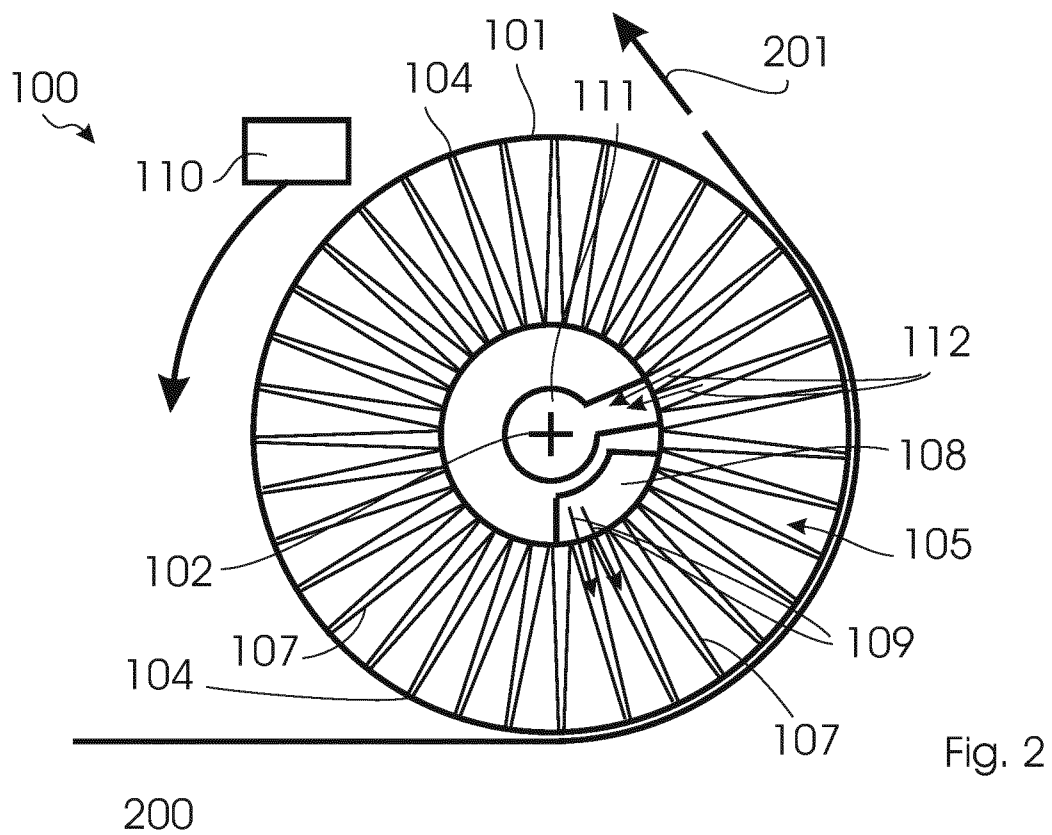
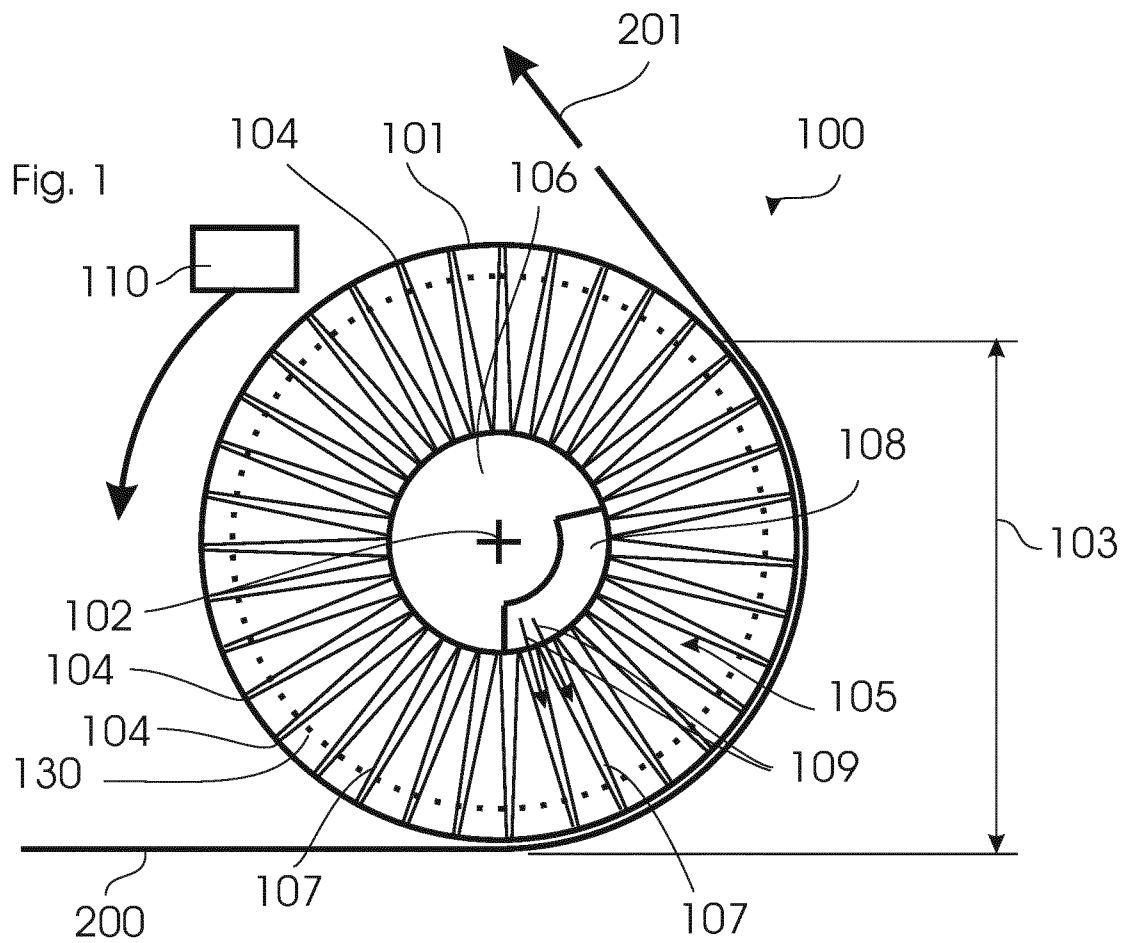
5 12. The method according to any of claims 10 to 11, wherein releasing the gas from the gas outlets (104) includes releasing the gas with a flow rate of between 30 sccm and 300 sccm.

13. Use of a roller device (100) for contacting and controlling the temperature
10 of a web (200) in a web coating process application under vacuum conditions, the roller device comprising:

- a temperature adjusting system (130) for adjusting the temperature of the roller device (100);
- 15 - a curved surface (101) of the roller device (100) for facing and contacting the web (200), wherein the curved surface (101) is rotatable about an axis (102) of the roller device and comprises a web guiding region (103);
- a group of gas outlets (104) disposed in the curved surface (101) and adapted for releasing a gas flow;
- 20 - a gas distribution system (105) for selectively providing the gas flow to a first subgroup of the gas outlets (104) and for selectively preventing the gas from flowing to a second subgroup of the gas outlets (104);
- 25 - wherein the first subgroup of the gas outlets consists of at least one gas outlet in the web guiding region (103) and the second subgroup of gas outlets consists of at least one gas outlet outside of the web guiding region (103).

14. Use of a roller device according to claim 13, wherein the roller device (100) is a roller device according to any of claims 1 to 9.

15. Use of a roller device according to any of claims 13 to 14, wherein the
5 roller device (100) is used in a two-sided coating process of the web.



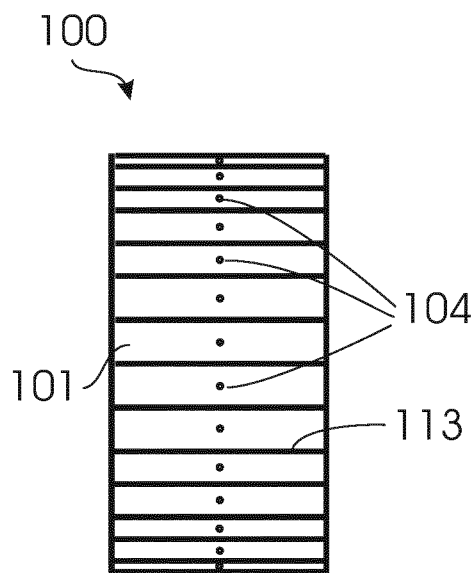
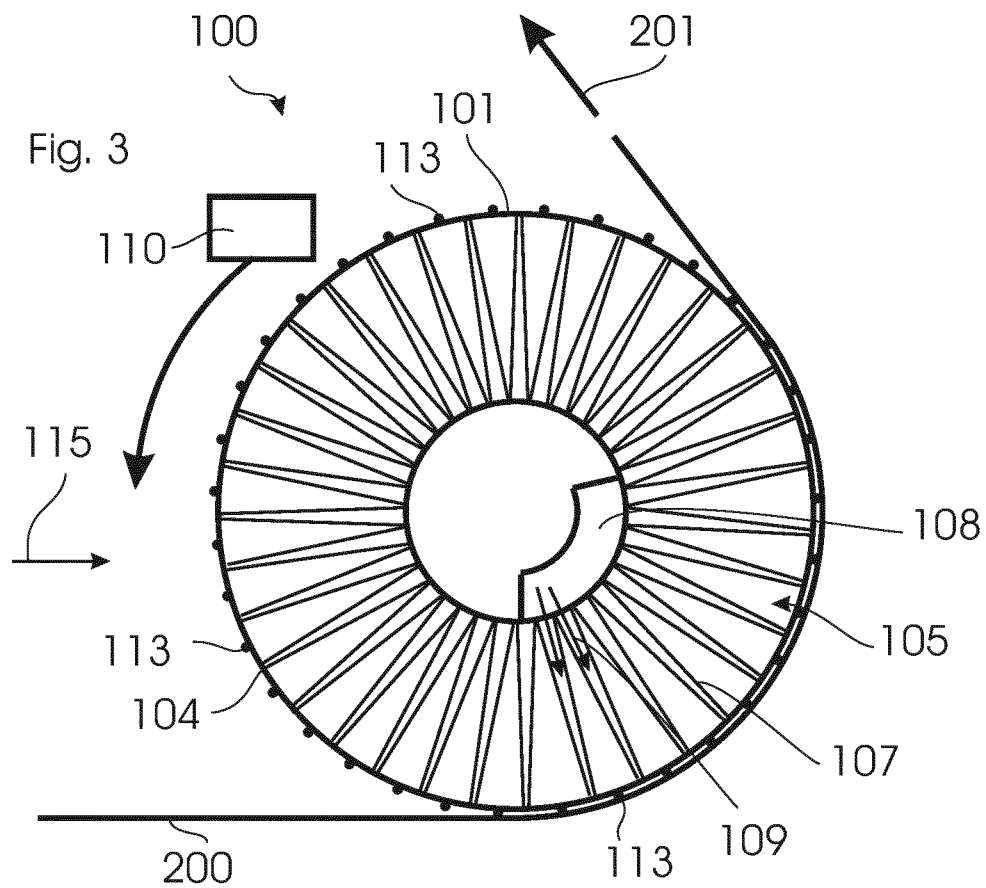


Fig. 4

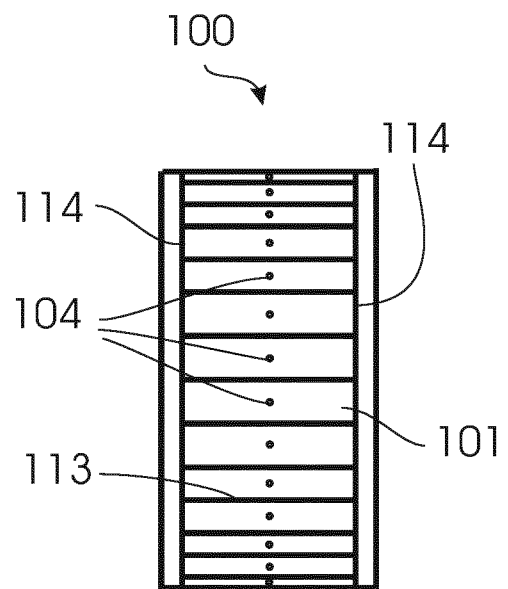


Fig. 5

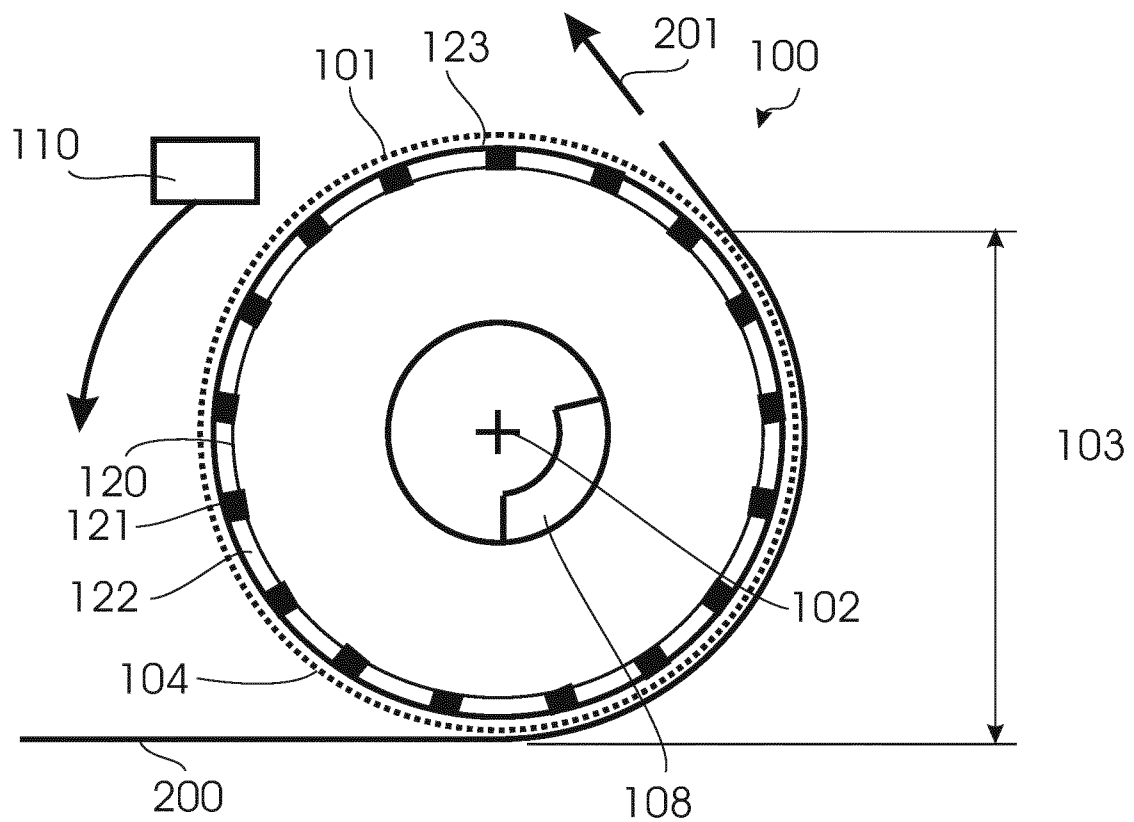


Fig. 7

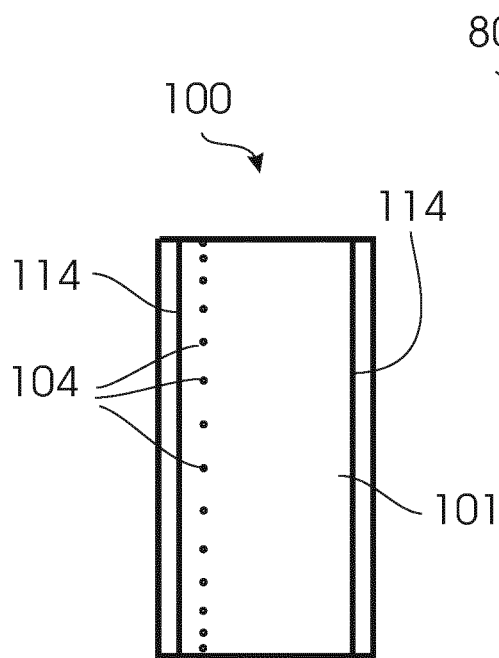


Fig. 6

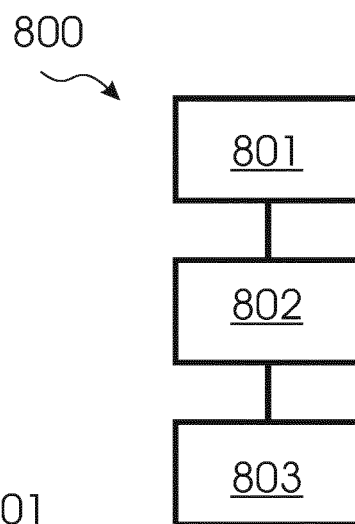


Fig. 8

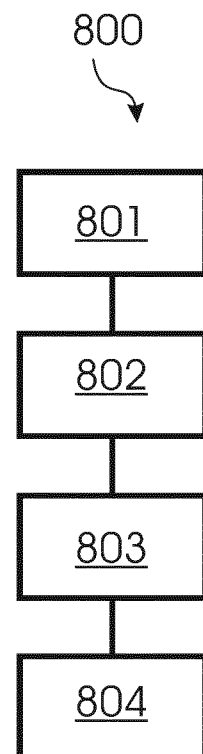


Fig. 9

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2016/062539

A. CLASSIFICATION OF SUBJECT MATTER

INV. C23C14/56 B65H23/00
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)

C23C B65H

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.
X	US 2012/006520 A1 (SFERLAZZO PIERO [US] ET AL) 12 January 2012 (2012-01-12)	1-4,6-8, 10-15
Y	the whole document	5,9
Y	DE 10 2014 113047 A1 (ARDENNE GMBH VON [DE]) 19 March 2015 (2015-03-19) paragraphs [0056] - [0062]	5
Y	WO 2010/122030 A2 (APPLIED MATERIALS INC [US]; HEIN STEFAN [DE]; HERZOG ANDRE [DE]; SKUK) 28 October 2010 (2010-10-28) paragraph [0024]	9



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

25 January 2017

Date of mailing of the international search report

31/01/2017

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Ekhuft, Hans

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2016/062539

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2012006520 A1	12-01-2012	US 2012006520 A1	12-01-2012
		WO 2012006045 A2	12-01-2012
DE 102014113047 A1	19-03-2015	NONE	
WO 2010122030 A2	28-10-2010	TW 201103853 A	01-02-2011
		WO 2010122030 A2	28-10-2010