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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*): **DIEGUEZ-CAMPO, Jose Manuel** [ES/DE]; Hergerswiesenweg 11, 63457 Hanau (DE). **BANGERT, Stefan** [DE/DE]; Seidenrötherstr. 6,

36396 Steinau (DE). **SCHÜSSLER, Uwe** [DE/DE]; Bahnhofstr. 22, 63743 Aschaffenburg (DE). **LANDGRAF, Heike** [DE/DE]; Bahnhofstr. 27i, 63486 Bruchköbel (DE). **LOPP, Andreas** [DE/DE]; Hanauerstr. 26, 63579 Freigericht (DE). **STAAB, Hans** [DE/DE]; Fliederweg 7, 36381 Schlüchtern (DE).

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

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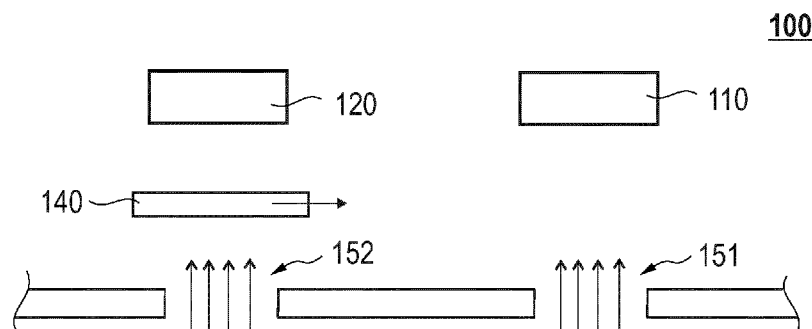


FIG. 1A

(57) Abstract: A measurement assembly (100) for measuring a deposition rate of an evaporated material is described. The measurement assembly (100) includes: a first oscillation crystal (110) for measuring the deposition rate; a second oscillation crystal (120) for measuring the deposition rate; and a movable shutter (140). The movable shutter (140) is configured for blocking the evaporated material provided from a first measurement outlet (151), the first measurement outlet directed for providing evaporated material to the first oscillation crystal (110). Further, the movable shutter (140) is configured for blocking the evaporated material provided from a second measurement outlet (152), the second measurement outlet directed for providing evaporated material to the second oscillation crystal (120).





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**MEASUREMENT ASSEMBLY FOR MEASURING A DEPOSITION RATE,
EVAPORATION SOURCE, DEPOSITION APPARATUS, AND METHOD
THEREFOR**

TECHNICAL FIELD

5 [0001] The present disclosure relates to a measurement assembly for measuring a deposition rate of an evaporated material, an evaporation source for evaporation of material, a deposition apparatus for applying material to a substrate and a method for measuring a deposition rate of an evaporated material. The present disclosure particularly relates to a measurement assembly for measuring a deposition rate of an
10 evaporated organic material and a method therefor. Further, the present disclosure particularly relates to devices including organic materials therein, e.g. an evaporation source and a deposition apparatus for organic material.

BACKGROUND

[0002] Organic evaporators are a tool for the production of organic light-emitting
15 diodes (OLED). OLEDs are a special type of light-emitting diode in which the emissive layer comprises a thin-film of certain organic compounds. Organic light emitting diodes (OLEDs) are used in the manufacture of television screens, computer monitors, mobile phones, other hand-held devices, etc., for displaying information. OLEDs can also be used for general space illumination. The range of colors,
20 brightness, and viewing angle possible with OLED displays is greater than that of traditional LCD displays because OLED pixels directly emit light and do not involve a back light. Therefore, the energy consumption of OLED displays is considerably less than that of traditional LCD displays. Further, the fact that OLEDs can be manufactured onto flexible substrates results in further applications.

25 [0003] The functionality of an OLED depends on the coating thickness of the organic material. This thickness has to be within a predetermined range. In the production of OLEDs, the deposition rate at which the coating with organic material is effected is controlled to lie within a predetermined tolerance range. In other words,

the deposition rate of an organic evaporator has to be controlled thoroughly in the production process.

[0004] Accordingly, for OLED applications, but also for other evaporation processes, a high accuracy of the deposition rate over a comparably long time is
5 needed. There is a plurality of measurement systems for measuring the deposition rate of evaporators available. However, these measurement systems suffer from either insufficient accuracy and/or insufficient stability over the desired time period.

[0005] Accordingly, there is a continuing demand for providing improved deposition rate measurement systems, deposition rate measurement methods,
10 evaporators and deposition apparatuses.

SUMMARY

[0006] In view of the above, a measurement assembly for measuring a deposition rate of an evaporated material, an evaporation source, a deposition apparatus and a method for measuring a deposition rate of an evaporated material according to the
15 independent claims are provided.

[0007] According to one aspect of the present disclosure, a measurement assembly for measuring a deposition rate of an evaporated material is provided. The measurement assembly includes a first oscillation crystal for measuring the deposition rate; a second oscillation crystal for measuring the deposition rate; and a
20 movable shutter. The movable shutter is configured for blocking the evaporated material provided from a first measurement outlet, the first measurement outlet directed for providing evaporated material to the first oscillation crystal. Further, the movable shutter is configured for blocking the evaporated material provided from a second measurement outlet, the second measurement outlet directed for providing
25 evaporated material to the second oscillation crystal.

[0008] According to another aspect of the present disclosure, an evaporation source for evaporation of material is provided. The evaporation source includes an evaporation crucible, wherein the evaporation crucible is configured to evaporate a

material; a distribution assembly with one or more outlets for providing evaporated material. The distribution assembly is in fluid communication with the evaporation crucible. Further, the evaporation source includes a measurement assembly according to any embodiment described herein.

- 5 [0009] According to a further aspect of the present disclosure, a deposition apparatus for applying material to a substrate in a vacuum chamber at a deposition rate is provided. The deposition apparatus includes at least one evaporation source according to any embodiment described herein.

- [0010] According to another aspect of the present disclosure, a method for
10 measuring a deposition rate of an evaporated material is provided. The method includes evaporating a material; applying a first portion of the evaporated material to a substrate; diverting a second portion of the evaporated material to a first oscillation crystal and/or a second oscillation crystal; and measuring the deposition rate by using the measurement assembly according to any embodiment described herein.

- 15 [0011] Further advantages, features, aspects and details are apparent from the dependent claims, the description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

- [0012] So that the manner in which the above recited features of the present disclosure can be understood in detail, a more particular description of the present
20 disclosure, briefly summarized above, may be had by reference to embodiments. The accompanying drawings relate to embodiments of the disclosure and are described in the following.

- FIGS. 1A to 1C show schematic views of a measurement assembly for measuring a deposition rate of an evaporated material according to embodiments described
25 herein in different states;

FIGS. 2A to 2D show schematic views of a measurement assembly for measuring a deposition rate of an evaporated material according to further embodiments described herein in different states;

FIG. 3 shows a schematic view of a portion of a measurement assembly according to further embodiments described herein;

FIGS. 4A and 4B show schematic side views of an evaporation source according to embodiments described herein;

- 5 FIG. 5 shows a schematic perspective view of an evaporation source according to embodiments described herein;

FIG. 6 shows a schematic top view of a deposition apparatus for applying material to a substrate in a vacuum chamber according to embodiments described herein; and

- 10 FIGS. 7A and 7B show block diagrams illustrating embodiments of a method for measuring a deposition rate of an evaporated material as described herein.

DETAILED DESCRIPTION OF EMBODIMENTS

- [0013] Reference will now be made in detail to the various embodiments of the disclosure, one or more examples of which are illustrated in the figures. Within the
15 following description of the drawings, the same reference numbers refer to same components. In the following, only the differences with respect to individual embodiments are described. Each example is provided by way of explanation of the disclosure and is not meant as a limitation of the disclosure. Further, features illustrated or described as part of one embodiment can be used on or in conjunction
20 with other embodiments to yield yet a further embodiment. It is intended that the description includes such modifications and variations.

[0014] Before various embodiments of the present disclosure are described in more detail, some aspects with respect to some terms used herein are explained.

- [0015] In the present disclosure, an “oscillation crystal for measuring a deposition
25 rate” may be understood as an oscillation crystal for measuring a mass variation of deposited material on the oscillation crystal per unit area by measuring the change in frequency of an oscillation crystal resonator. In particular, in the present disclosure

an oscillation crystal may be understood as a quartz crystal resonator. More particularly, an “oscillation crystal for measuring a deposition rate” may be understood as a quartz crystal microbalance (QCM).

[0016] In the present disclosure, a “movable shutter” may be understood as a
5 movable element which is arranged between a measurement assembly and a measurement outlet for providing evaporated material to the measurement assembly. In particular, a “movable shutter” may be understood as an element which is configured to be moved in a space between the measurement assembly and the measurement outlet. For instance, the movable shutter may be configured to be
10 movable along a transversal direction. According to another example, the movable shutter may be configured to be rotatable. Typically, the movable shutter is configured for blocking a flow of evaporated material provided through the measurement outlet in a first state of the movable shutter as well as for unblocking a flow of evaporated material provided through the measurement outlet in a second
15 state of the movable shutter. Accordingly, the movable shutter is configured for controlling an access of evaporated material to the measurement assembly.

[0017] In the present disclosure, an “evaporation source for evaporation of material” may be understood as an arrangement configured for providing a material to be deposited on a substrate. In particular, the evaporation source may be
20 configured for providing material to be deposited on a substrate in a vacuum chamber, such as a vacuum deposition chamber of a vacuum deposition apparatus. According to some embodiments, the evaporation source may include an evaporator or a crucible, which evaporates the material to be deposited on the substrate, and a distribution assembly, e.g. a distribution pipe or one or more point sources which can
25 be arranged along a vertical axis. For instance, the distribution assembly can be configured to release the evaporated material in a direction towards the substrate, e.g. through an outlet or a nozzle.

[0018] In the present disclosure, a “crucible” may be understood as a device or a reservoir providing or containing the material to be deposited. Typically, the crucible
30 may be heated for evaporating the material to be deposited on the substrate. The crucible may stand in fluid communication with a distribution assembly, to which the

material being evaporated by the crucible may be delivered. In one example, the crucible may be a crucible for evaporating organic materials, e.g. organic materials having an evaporation temperature of about 100°C to about 600°C.

[0019] In the present disclosure, the term “fluid communication” may be understood in that two elements being in fluid communication can exchange fluid via a connection, allowing fluid to flow between the two elements. In one example, the elements being in fluid communication may include a hollow structure, through which the fluid may flow. According to some embodiments, at least one of the elements being in fluid communication may be a pipe-like element.

[0020] In the present disclosure, a “distribution assembly” may be understood as a distribution pipe for guiding and distributing the evaporated material or as one or more point sources which can be arranged along a vertical axis. In particular, the distribution pipe or the one or more point sources may be configured for providing evaporated material from an evaporator to an outlet (such as nozzles or openings) in the distribution pipe or the one or more point sources. For instance, in the case of a distribution assembly in the form of a distribution pipe, the distribution pipe can be a linear distribution pipe extending in a longitudinal direction. For example, the distribution pipe may include a pipe having the shape of a cylinder, wherein the cylinder may have a circular, triangular or square-like bottom shape or any other suitable bottom shape.

[0021] With exemplary reference to FIGS. 1A to 1C, a measurement assembly 100 for measuring a deposition rate of an evaporated material according to embodiments described herein includes a first oscillation crystal 110 for measuring the deposition, a second oscillation crystal 120 for measuring the deposition rate, and a movable shutter 140. The movable shutter 140 is configured for blocking the evaporated material provided from a first measurement outlet 151 for providing evaporated material to the first oscillation crystal 110. In particular, the first measurement outlet 151 is directed for providing evaporated material to the first oscillation crystal 110. Further, the movable shutter 140 is configured for blocking the evaporated material provided from a second measurement outlet 152. In particular,

the second measurement outlet 152 is directed for providing evaporated material to the second oscillation crystal 120.

[0022] In particular, FIG. 1A shows the measurement assembly in a first state in which the second measurement outlet 152 is blocked by the movable shutter 140 such that an access of evaporated material provided through the second measurement outlet 152 to the second oscillation crystal 120 is blocked. Further, as exemplarily shown in FIG. 1A, the measurement assembly may be configured such that an access of evaporated material provided through the first measurement outlet 151 to the first oscillation crystal 110 is provided while the second measurement outlet 152 is blocked. Accordingly, a deposition rate may be measured by the first oscillation crystal 110 while the second oscillation crystal 120 may be cleaned. For instance, the second oscillation crystal 120 can be cleaned by heating, particularly by providing a heating temperature which corresponds to the evaporation temperature of evaporated material deposited on the second oscillation crystal 120. For example, the heating temperature can be provided by a heating element provided in the movable shutter 140 and/or a heating element provided in a holder for the second oscillation crystal 120.

[0023] FIG. 1B shows a second state of the measurement assembly in which the movable shutter 140 has been moved to a position in which the first measurement outlet 151 as well as the second measurement outlet 152 are open for providing an access of evaporated material to both the first oscillation crystal 110 and the second oscillation crystal 120. Accordingly, the first oscillation crystal 110 and the second oscillation crystal 120 may be employed for measuring a deposition rate, such that a redundant measurement can be carried out.

[0024] In FIG. 1C, a third state of the measurement assembly is shown in which the movable shutter 140 has been moved to a position in which an access of evaporated material provided through the first measurement outlet 151 to the first oscillation crystal 110 is blocked. Accordingly, as exemplarily shown in FIG. 1C, a deposition rate may be measured by the second oscillation crystal 120 while the first oscillation crystal 110 may be cleaned. For instance, the first oscillation crystal 110 can be cleaned by heating, particularly by providing a heating temperature which

corresponds to the evaporation temperature of evaporated material deposited on the first oscillation crystal 110. For example, the heating temperature can be provided by a heating element provided in the movable shutter 140 and/or a heating element provided in a holder for the first oscillation crystal 110.

5 [0025] According to embodiments which can be combined with any other embodiments described herein, the movable shutter may be connected to a drive, for instance a linear drive, which is configured for providing a translational movement of the movable shutter, which is exemplarily indicated by the arrow on the movable shutter 140 in FIGS. 1A and 1C. In particular, the drive may be configured for
10 moving the movable shutter between a state in which the first measurement outlet is blocked and a second state in which the second measurement outlet is blocked. Accordingly, with exemplary reference to FIGS. 1A to 1C, it is to be understood that the drive can be configured for a linear transversal alternating movement for blocking/unblocking the first measurement outlet and the second measurement
15 outlet.

[0026] Accordingly, a measurement assembly as described herein provides for the possibility to continuously measure a deposition rate of evaporated material. In particular, by providing a measurement assembly with which the deposition rate can be measured by a first oscillation crystal while a second oscillation crystal can be
20 cleaned, an improved measurement assembly is provided. For instance, a negative effect of deposited material on the accuracy of the deposition rate measurement can be reduced or even eliminated, since the first oscillation crystal and the second oscillation crystal may be cleaned in an alternating manner. Further, the measurement assembly as described herein provides for the possibility of conducting
25 a redundant deposition rate measurement. For instance, in a state of the measurement assembly in which the first measurement outlet and the second measurement outlet are open, i.e. an access of evaporated material provided through the first measurement outlet and the second measurement outlet is provided to the first oscillation crystal as well as the second oscillation crystal, both oscillation crystals
30 may be used for deposition rate measurement which is beneficial for increasing the measurement accuracy.

[0027] With exemplary reference to FIGS. 2A to 2D, a measurement assembly 100 for measuring a deposition rate of an evaporated material according to further embodiments is described. According to embodiments which can be combined with any other embodiments described herein, the movable shutter 140 may be a rotatable element having at least one aperture 160. The at least one aperture 160 can be configured for providing access for the evaporated material provided from the first measurement outlet to the first oscillation crystal 110 when the rotatable element is in a first state, as exemplarily shown in FIG. 2A. For instance, the rotatable element may be a rotatable disk having a substantially circular shape as exemplarily shown in FIGS. 2A to 2D. Alternatively, the rotatable element may be a rotatable plate having an elliptical, rectangular or any other suitable shape.

[0028] For example, the rotatable element may be connected to a drive which is configured for providing a rotational movement around a rotational axis of the rotatable element, as exemplarily shown FIGS. 2A to 2D.

[0029] According to embodiments which can be combined with any other embodiments described herein, the at least one aperture 160 is configured for providing access for the evaporated material provided from the second measurement outlet to the second oscillation crystal 120 when the rotatable element is in a second state. For instance, an access for the evaporated material provided from the second measurement outlet to the second oscillation crystal 120 can be provided when the rotatable element with the at least one aperture is turned by 180° from the first state, as exemplarily shown in FIG. 2A, to the second state.

[0030] With exemplary reference to FIGS. 2A to 2D, according to embodiments which can be combined with any other embodiment described herein, the at least one aperture 160 may include a first aperture 161 and a second aperture 162 which are arranged diametrically opposed to each other. Such a configuration is in particular beneficial for providing a simultaneous access of evaporated material to the first oscillation crystal and the second oscillation crystal such that a redundant to position measurement can be carried out.

[0031] Further, according to embodiments which can be combined with any other embodiment described herein, the at least one aperture 160 may include a third aperture 163 and a fourth aperture 164, which can be arranged on opposing sides of the first aperture 161, as exemplarily shown in FIGS. 2A to 2C. Additionally or
5 alternatively, the third aperture 163 and the fourth aperture 164 can be arranged on opposing sides of second aperture 162 (not explicitly shown). In particular, the third aperture 163 and the fourth aperture 164 can be arranged at a radial position which substantially corresponds to a radial position of the first aperture 161 and/or the radial position of the second aperture 162. The radial position of the at least one
10 aperture, e.g. the radial position of the first aperture 161, the second aperture 162, the third aperture 163, and the fourth aperture 164 is exemplarily indicated in FIGS. 2A to 2D by the arrow R and the dotted circle line.

[0032] For example, as exemplarily shown in FIG. 2C, the third aperture 163 and the fourth aperture 164 can be provided at an angle α of $\alpha=45^\circ$ relative to the position
15 of the first aperture 161. Although not explicitly shown, additionally or alternatively the third aperture 163 and the fourth aperture 164 can be provided at an angle α of $\alpha=45^\circ$ relative to the position of the second aperture 162. Accordingly, as can be seen from FIGS. 2A to 2D, a movable shutter can be provided with which four different states can be realized: a first state in which an access of evaporated material
20 provided through the first measurement outlet is provided to the first oscillation crystal 110, while an access of evaporated material provided through the second measurement outlet to the second oscillation crystal 120 is blocked, as exemplarily shown in FIG. 2A; a second state in which the first measurement outlet and the second measurement outlet are blocked, as exemplarily shown in FIG. 2B; a third
25 state in which an access of evaporated material provided through the second measurement outlet to the second oscillation crystal 120 is provided, while an access of evaporated material provided through the first measurement to the first oscillation crystal 110 outlet is blocked, as exemplarily shown in FIG. 2C; and a fourth state in
30 outlet to the second oscillation crystal 120 and an access of evaporated material provided through the first measurement outlet to the first oscillation crystal 110 is provided.

[0033] Accordingly, the movable shutter of the measurement assembly as described herein is configured for blocking/unblocking the evaporated material provided from the first measurement outlet to the first oscillation crystal as well as for blocking/unblocking the evaporated material provided from the second measurement outlet to the second oscillation crystal. As a result thereof, the first oscillation crystal can be cleaned, e.g. by heating, when the first measurement outlet is blocked while at the same time a deposition rate measurement can be carried out with the second oscillation crystal, and vice versa. Accordingly, an improved measurement assembly is provided with which a continuous deposition rate measurement can be carried out.

10 Further, the measurement assembly according to embodiments described herein provides for the possibility of in-situ cleaning of the oscillation crystal used for measuring.

[0034] As exemplarily shown in FIGS. 2A to 2D, according to embodiments which can be combined with other embodiments described herein, the first oscillation crystal 110 and the second oscillation crystal 120 can be fixed to a holder 150. With exemplary reference to FIG. 2C, according to some embodiments which can be combined with other embodiments described herein, the holder 150 may include at least one heating element 170 which is configured and arranged such that material deposited on the shutter, particularly material deposited on a side of the shutter which faces the holder, can be evaporated by applying heat. Accordingly, the shutter can be cleaned from material deposited on the shutter. For instance, as exemplarily shown in Fig. 2C, at least one heating element 170 may include a first heating element 171 and/or a second heating element 172 and/or a third heating element 173 and/or a fourth heating element 174 and/or a fifth heating element 175 and/or a sixth heating element 176. In particular, the heating elements may be arranged on the holder 150 in a circular manner, for example on a circle with a radius R which substantially corresponds to the radius R at which the at least one aperture 160 is provided in the movable shutter 140. According to an exemplary implementation, the heating elements are arranged equally spaced to each other, for example with an angle of 45° between neighboring heating elements, as exemplarily shown in FIG. 2C. Alternatively, as exemplarily shown in FIG. 2D, the at least one heating element 170 may be configured as a ring segment element having a width

corresponding to at least the opening of the at least one aperture 160, as exemplarily shown in FIG. 2D. For instance, a first ring segment heating element 177 and a second ring segment heating element 178 may be provided. Further, it is to be understood that the at least one heating element 170 may have any suitable shape or
5 configuration.

[0035] With exemplary reference to FIG. 3, according to embodiments which can be combined with any other embodiments described herein, the measurement assembly may include a heater 114 configured for applying heat to the first oscillation crystal 110 and/or the second oscillation crystal 120, such that material
10 deposited on the first oscillation crystal 110 and/or the second oscillation crystal 120 can be evaporated. For instance, the heater 114 may be provided in a holder 150 in which the first oscillation crystal 110 and/or the second oscillation crystal 120 may be arranged. The holder 150 may include a measurement opening 122, which can be configured and arranged such that evaporated material may be deposited on the first
15 oscillation crystal 110 and/or the second oscillation crystal 120 for measuring the deposition rate of the evaporated material. Additionally or alternatively, as exemplarily shown in FIG. 3, a further heater 115 may be provided in the movable shutter 140, e.g. in a movable shutter as described with reference to FIGS. 1A to 1C or a movable shutter as described with reference to FIGS 2A to 2D. In particular, the
20 further heater 115 provided in the movable shutter 140 is configured for applying heat to the movable shutter such that material deposited on the movable shutter can be evaporated. Typically, the heater 114 and/or the further heater 115 are configured for providing a heating temperature which corresponds to at least the evaporation temperature of the material deposited on the oscillation crystal and/or deposited on
25 the shutter. Accordingly, the oscillation crystal may be cleaned by heating as described herein. Further, also the shutter may be cleaned by heating the shutter.

[0036] With exemplary reference to FIG. 3, according to some embodiments which can be combined with other embodiments described herein, the movable shutter 140 may include a thermal protection shield 116. As exemplarily shown in FIG. 3, the
30 thermal protection shield 116 may be arranged on a side of the movable shutter 140 which faces the measurement outlet, e.g. the first measurement outlet 151 or the

second measurement outlet 152. In particular, the thermal protection shield 116 may be configured for reflecting heat energy provided by evaporated material provided through the measurement outlet. According to embodiments which can be combined with other embodiments described herein, the thermal protection shield 116 may be a
5 plate, for example a sheet metal. Alternatively, the thermal protection shield 116 may include two or more plates, e.g. sheet metals, which may be spaced with respect to each other, for example by a gap of 0.1 mm or more. For example the sheet metal may have a thickness of 0.1 mm to 3.0 mm. In particular, the thermal protection shield includes a ferrous or non-ferrous material, for example at least one material
10 selected from the group consisting of copper (Cu), aluminum (Al), copper alloy, aluminum alloy, brass, iron, titanium (Ti), ceramic and other suitable materials.

[0037] According to embodiments which can be combined with any other embodiment described herein, the further heater 115 of the movable shutter 140 may be provided on a side of the movable shutter 140 which faces the oscillation crystal,
15 e.g. the first oscillation crystal 110 or the second oscillation crystal 120. Accordingly, by providing a heater as described herein, for instance in the holder or a shutter, an oscillation crystal of a measurement assembly as described herein may be cleaned in situ by evaporating deposited material on the oscillation crystal by applying heat by the heater. This can be beneficial for the overall lifetime of the
20 oscillation crystal and the achievable measurement accuracy.

[0038] According to embodiments which can be combined with other embodiments described herein, the measurement assembly 100 may include a heat exchanger 132. In particular, the heat exchanger may be arranged in the holder, for example next to or adjacent to the oscillation crystal and/or next to or adjacent to the heater 114. The
25 heat exchanger 132 may be configured to exchange heat with the oscillation crystal and/or with the holder 150 and/or with the heater 114. For example, the heat exchanger may include tubes through which a cooling fluid may be provided. The cooling fluid may be a liquid, e.g. water, or a gas, e.g. air. Additionally or alternatively, the heat exchanger may include one or more Peltier element(s).
30 Typically, the heat exchanger is employed during a measurement of the oscillation crystal and switched off during a cleaning procedure conducted by heating the

oscillation crystal by the heater. Accordingly, by providing the measurement assembly with a heat exchanger 132, negative effects of high temperature on the quality, accuracy and stability of the deposition rate measurement may be reduced or even eliminated. In particular, providing the measurement assembly with a heat
5 exchanger may be beneficial for cooling the measurement device after the measurement device has been cleaned by heating in order to evaporate deposited material from the deposition rate measurement device.

[0039] With exemplary reference to FIG. 3, according to embodiments which can be combined with other embodiments described herein, the measurement
10 assembly 100 may include a temperature sensor 117 for measuring the temperature of the oscillation crystal and/or the holder 150. By providing the measurement assembly 100 with a temperature sensor 117, information about the temperature of the measurement assembly may be obtained such that a critical temperature at which the oscillation crystal tends to measure inaccurately may be detected. Accordingly, in
15 the case that a critical temperature of the oscillation crystal is detected by the temperature sensor, an adequate reaction may be initiated, for example a cooling by employing the heat exchanger.

[0040] According to embodiments which can be combined with other embodiments described herein, the measurement assembly 100, particularly for measuring a
20 deposition rate, may include a temperature control system for controlling the temperature of the oscillation crystal and/or the temperature of the holder. In particular, the temperature control system may include one or more of a temperature sensor 117, a heat exchanger 132, a heater 114 and a sensor controller 133. As exemplarily shown in FIG. 7B, the sensor controller 133 may be connected to the
25 temperature sensor 117 for receiving data measured by the temperature sensor 117. Further, the sensor controller 133 may be connected to the heat exchanger 132 for controlling the temperature of the holder 150 and/or oscillation crystal. Further, the sensor controller 133 may be connected to the heater 114 and or the further heater 115 in order to control the heating temperature of the holder 150 and/or the
30 oscillation crystal, e.g. during cleaning as described herein.

[0041] FIGS. 4A and 4B show schematic side views of an evaporation source 200 according to embodiments as described herein. According to embodiments, the evaporation source 200 includes an evaporation crucible 210, wherein the evaporation crucible is configured to evaporate a material, for example an organic
5 material. Further, the evaporation source 200 includes a distribution assembly, e.g. a distribution pipe 220, with one or more outlets 222 provided along the length of the distribution assembly for providing evaporated material, as exemplarily shown in FIG. 4B. According to embodiments, the distribution pipe 220 is in fluid communication with the evaporation crucible 210, for example via a vapor conduit.
10 The vapor conduit can be provided at the lower end of the distribution pipe. Further, the evaporation source 200 according to embodiments described herein includes a measurement assembly 100 according to embodiments described herein, as for example described with reference to FIGS. 1A through FIG. 3.

[0042] As exemplarily shown in FIGS. 4A and 4B, according to embodiments
15 which can be combined with other embodiments described herein, the evaporation source 200 may include a controller 250 connected to the measurement assembly 100 and to the evaporation source 200. As described herein, the controller 250 may provide a first control signal 251 to the evaporation source 200, particularly the evaporation crucible 210, for adjusting the deposition rate. Typically, the controller
20 250 is configured to receive and analyze the measurement data acquired by the measurement assembly 100. Further, the controller 250 may provide a second control signal 252 to the deposition rate measurement assembly, e.g. for controlling a position of the shutter of the deposition rate measurement assembly. For instance, the position of the shutter may be controlled such that a first measurement outlet for
25 providing evaporated material to the first oscillation crystal can be blocked by the shutter, and/or a second measurement outlet for providing evaporated material to the second oscillation crystal can be blocked by the shutter. Accordingly, one of the first oscillation crystal and the second oscillation crystal of the measurement assembly can be cleaned while the other oscillation crystal can be used for a deposition rate
30 measurement.

[0043] As exemplarily shown in FIG. 4A, according to embodiments which can be combined with other embodiments described herein, the distribution assembly may be an elongated cube, e.g. a distribution pipe 220, including a heating element 215. The evaporation crucible 210 can be a reservoir for material, e.g. organic material, to be evaporated with a crucible heating unit 225. For example, the crucible heating unit 225 may be provided within the enclosure of the evaporation crucible 210. According to embodiments which can be combined with other embodiments described herein, the distribution assembly, particularly the distribution pipe 220 may provide a line source. For example, as exemplarily shown in FIG. 4B, a plurality of outlets 222, such as nozzles, can be arranged along at least one line. According to an alternative embodiment (not shown), one elongated opening, e.g. a slit, extending along the at least one line may be provided. According to some embodiments which can be combined with other embodiments described herein, the line source may extend essentially vertically.

[0044] According to some embodiments which can be combined with other embodiments described herein, the length of the distribution pipe may correspond to a height of a substrate onto which material is to be deposited in a deposition apparatus. Alternatively, the length of the distribution pipe may be longer than the height of the substrate onto which material is to be deposited, for example at least by 10% or even 20%. Accordingly, a uniform deposition at the upper end of the substrate and/or the lower end of the substrate can be provided. For example, the length of the distribution pipe can be 1.3 m or above, for example 2.5 m or above.

[0045] According to embodiments which can be combined with other embodiments described herein, the evaporation crucible 210 may be provided at the lower end of the distribution pipe, as exemplarily shown in FIG. 4A. The material, e.g. organic material, can be evaporated in the evaporation crucible 210. The evaporated material may enter the distribution pipe at the bottom of the distribution pipe and may be guided essentially sideways through the plurality of outlets 222 in the distribution pipe 220, e.g. towards an essentially vertical substrate. With exemplary reference to FIG. 2B, the measurement assembly 100 according to embodiments described herein

may be provided at an upper portion of the distribution pipe 220, e.g. at the upper end of the distribution pipe 220.

[0046] With exemplary reference to FIG. 4B, according to embodiments which can be combined with other embodiments described herein, a first measurement outlet 151 and a second measurement outlet 152 may be provided in a wall of the distribution assembly, for example in a wall at the backside 224A of the distribution pipe, particularly at an upper portion of the wall at the backside 224A. Although not explicitly shown, it is to be understood that according to embodiments which can be combined with other embodiments described herein, the first measurement outlet 151 and the second measurement outlet 152 may be provided in a top wall 224C of the distribution assembly, particularly an upper horizontal top wall of the distribution assembly. As exemplarily indicated by the arrows in FIG. 4B, the evaporated material may be provided from the inside of the distribution pipe 220 through the first measurement outlet 151 and/or the second measurement outlet 152 to the measurement assembly 100. Accordingly, the first measurement outlet 151 and/or the second measurement outlet 152 are arranged and directed such that evaporated material can be provided to the first oscillation crystal and/or the second oscillation crystal. For example, the measurement assembly 100 can be arranged at the backside 224A of the distribution assembly, particularly at the backside 224A of an upper end portion of the distribution assembly, e.g. the distribution pipe 220. Typically, the backside of the end portion of the distribution assembly faces away from the deposition direction. According to some embodiments, the measurement assembly 100 can be mounted on the backside 224A of the upper end portion of the distribution assembly, particularly the distribution pipe 220.

[0047] According to embodiments which can be combined with other embodiments described herein, the first measurement outlet 151 and/or the second measurement outlet 152 may have an opening from 0.5 mm to 4 mm. Further, the first measurement outlet 151 and/or the second measurement outlet 152 may include a nozzle. For example, the nozzle may include an adjustable opening for adjusting the flow of evaporated material provided to the measurement assembly 100. In particular, the nozzle may be configured to provide a measurement flow selected

from a range between a lower limit of $1/70$ of the total flow provided by the evaporation source, particularly a lower limit of $1/60$ of the total flow provided by the evaporation source, more particularly a lower limit of $1/50$ of the total flow provided by the evaporation source and an upper limit of $1/40$ of the total flow provided by the evaporation source, particularly an upper limit of $1/30$ of the total flow provided by the evaporation source, more particularly an upper limit of $1/25$ of the total flow provided by the evaporation source. For example, the nozzle may be configured to provide a measurement flow of $1/54$ of the total flow provided by the evaporation source.

10 [0048] FIG. 5 shows a perspective view of an evaporation source 200 according to embodiments described herein. As exemplarily shown in FIG. 5, the distribution pipe 220 may be designed in a triangular shape. As described above, a triangular shape of the distribution pipe 220 may be beneficial in the case where two or more distribution pipes are arranged next to each other. In particular, a triangular shape of the distribution pipe 220 makes it possible to bring the outlets of neighboring distribution pipes as close as possible to each other. This allows for achieving an improved mixture of different materials from different distribution pipes, e.g. for the case of the co-evaporation of two, three or even more different materials. Further, the embodiment shown in FIG. 5 illustrates that typically a first measurement outlet 151 for providing evaporated material to a first oscillation crystal of the measurement assembly 100, and a second measurement outlet 152 for providing evaporated material to a second oscillation crystal of the measurement assembly 100 are provided, for instance at an upper end of the distribution pipe as exemplarily described with reference to FIGS. 4A and 4B.

25 [0049] With exemplary reference to FIG. 5, the distribution pipe 220 may include walls, e.g. side walls 224B and a wall at the backside 224A of the distribution pipe. As exemplarily shown in FIG. 5, the first measurement outlet 151 and the second measurement outlet 152 may be provided in the wall at the backside 224A of the distribution pipe 220. Further, the side walls 224B and the wall at the backside 224A can be heated by a heating element 215. For instance, the heating element 215 may be mounted or attached to the walls of the distribution pipe 220, as exemplarily

shown in FIG. 5. According to some embodiments, which can be combined with other embodiment described herein, the evaporation source 200 may include a shield 204. The shield 204 may reduce the heat radiation towards the deposition area. Further, the shield 204 may be cooled by a cooling element 216. For example, the
5 cooling element 216 may be mounted to the shield 204 and may include a conduit for cooling fluid.

[0050] FIG. 6 shows a schematic top view of a deposition apparatus 300 for applying material to a substrate 333 in a vacuum chamber 310 according to embodiments described herein. According to embodiments which can be combined
10 with other embodiments described herein, the deposition apparatus 300 includes an evaporation source 200 as described herein. In particular, the evaporation source 200 may be provided in a vacuum chamber 310 of the deposition apparatus 300, for example on a track, e.g. a linear guide 320 or a looped track. The track or the linear guide 320 may be configured for a translational movement of the evaporation source
15 200. Accordingly, a drive for the translational movement can be provided for the evaporation source 200, at the track and/or the linear guide 320, within the vacuum chamber 310. According to embodiments which can be combined with other embodiments described herein, a first valve 305, for example a gate valve, may be provided which allows for a vacuum seal to an adjacent vacuum chamber (not shown
20 in FIG. 6). The first valve can be opened for transport of a substrate 333 or a mask 332 into the vacuum chamber 310 or out of the vacuum chamber 310.

[0051] According to some embodiments which can be combined with other embodiments described herein, a further vacuum chamber, such as maintenance vacuum chamber 311 may be provided adjacent to the vacuum chamber 310, as
25 exemplarily shown in FIG. 6. Accordingly, the vacuum chamber 310 and the maintenance vacuum chamber 311 may be connected with a second valve 307. The second valve 307 may be configured for opening and closing a vacuum seal between the vacuum chamber 310 and the maintenance vacuum chamber 311. The evaporation source 200 can be transferred to the maintenance vacuum chamber 311
30 while the second valve 307 is in an open state. Thereafter, the second valve 307 can be closed to provide a vacuum seal between the vacuum chamber 310 and the

maintenance vacuum chamber 311. If the second valve 307 is closed, the maintenance vacuum chamber 311 can be vented and opened for maintenance of the evaporation source 200 without breaking the vacuum in the vacuum chamber 310.

[0052] As exemplarily shown in FIG. 6, two substrates may be supported on
5 respective transportation tracks within the vacuum chamber 310. Further, two tracks for providing masks thereon can be provided. Accordingly, during coating, the substrate 333 can be masked by respective masks. For example, the mask may be provided in a mask frame 331 to hold the mask 332 in a predetermined position.

[0053] According to some embodiments which can be combined with other
10 embodiments described herein, the substrate 333 may be supported by a substrate support 326, which can be connected to an alignment unit 312. The alignment unit 312 may adjust the position of the substrate 333 with respect to the mask 332. As exemplarily shown in FIG. 6, the substrate support 326 may be connected to the alignment unit 312. Accordingly, the substrate may be moved relative to the mask
15 332 in order to provide for a proper alignment between the substrate and the mask during deposition of the material, which may be beneficial for high quality display manufacturing. Alternatively or additionally, the mask 332 and/or the mask frame 331 holding the mask 332 can be connected to the alignment unit 312. Accordingly, either the mask 332 can be positioned relative to the substrate 333 or the mask 332
20 and the substrate 333 can both be positioned relative to each other.

[0054] As shown in FIG. 6, the linear guide 320 may provide a direction of the translational movement of the evaporation source 200. On both sides of the evaporation source 200, a mask 332 may be provided. The masks may extend essentially parallel to the direction of the translational movement. Further, the
25 substrates at the opposing sides of the evaporation source 200 can also extend essentially parallel to the direction of the translational movement. As exemplarily shown in FIG. 6, the evaporation source 200 provided in the vacuum chamber 310 of the deposition apparatus 300 may include a support 202 which may be configured for the translational movement along the linear guide 320. For example, the support 202
30 may support two evaporation crucibles and two distribution pipes 220 provided over the respective evaporation crucible. According to some embodiments, the support

202 may support three evaporation crucibles and three distribution pipes 220 provided over the respective evaporation crucible. Accordingly, the vapor generated in the evaporation crucible can move upwardly and out of the one or more outlets of the distribution pipe. The distribution pipes of the evaporation source may have a
5 substantially triangular cross-section. A triangular shape of the distribution pipe makes it possible to bring the outlets for depositing the evaporated material on a substrate, e.g. nozzles, of neighboring distribution pipes as close as possible to each other. This allows for achieving an improved mixture of different materials from different distribution pipes, e.g. for the case of the co-evaporation of two, three or
10 even more different materials.

[0055] Accordingly, embodiments of the deposition apparatus as described herein provide for improved quality display manufacturing, particularly OLED manufacturing.

[0056] With exemplary reference to the block diagrams shown in FIGS. 7A and
15 7B, embodiments of a method for measuring a deposition rate of an evaporated material are described. According to embodiments which can be combined with any other embodiments described herein, the method 400 for measuring a deposition rate of an evaporated material includes evaporating 410 an material, for example an organic material, applying 420 a first portion of the evaporated material to a
20 substrate, diverting 430 a second portion of the evaporated material to a first oscillation crystal and/or a second oscillation crystal, and measuring 440 the deposition rate by using a measurement assembly 100 according to any embodiments described herein.

[0057] Accordingly, by employing the method for measuring a deposition rate of
25 an evaporated material according to embodiments described herein, the deposition rate may be measured very accurately. In particular, by employing the method for measuring a deposition rate of an evaporated material as described herein, thermal effects on the oscillation crystal which can decrease the measurement accuracy may be reduced. Particularly, negative effects of high temperature on the quality,
30 accuracy and stability of the deposition rate measurement may be reduced or even eliminated. Further, the method for measuring a deposition rate of an evaporated

material according to embodiments described herein provides for measuring the deposition rate redundantly, which may further improve the quality and accuracy of the measurement result. Moreover, the method for measuring a deposition rate of an evaporated material as described herein provides for the possibility to clean one of
5 the first oscillation crystal and the second oscillation crystal while the other oscillation crystal can be used for a deposition rate measurement.

[0058] According to embodiments which can be combined with other embodiments described herein, evaporating 410 material includes using an evaporation crucible 210 as described herein. Further, applying 420 a first portion of the evaporated material
10 to a substrate may include using an evaporation source 200 according to embodiments described herein. According to embodiments which can be combined with other embodiments described herein, diverting 430 a second portion of the evaporated material to a first oscillation crystal and/or a second oscillation crystal may include using a first measurement outlet 151 and/or a second measurement
15 outlet 152, as described herein. In particular, diverting 430 a second portion of the evaporated material to the first measurement outlet 151 and/or a second measurement outlet 152 may include providing a measurement flow selected from a range between a lower limit of $1/70$ of the total flow provided by the evaporation source, particularly a lower limit of $1/60$ of the total flow provided by the evaporation
20 source, more particularly a lower limit of $1/50$ of the total flow provided by the evaporation source and an upper limit of $1/40$ of the total flow provided by the evaporation source, particularly an upper limit of $1/30$ of the total flow provided by the evaporation source, more particularly an upper limit of $1/25$ of the total flow provided by the evaporation source. For example, diverting 430 a second portion of
25 the evaporated material to the first measurement outlet 151 and/or a second measurement outlet 152 may include providing a measurement flow of $1/54$ of the total flow provided by the evaporation source.

[0059] According to embodiments which can be combined with other embodiments described herein, measuring 440 the deposition rate may include exchanging heat
30 with the measurement assembly 100, particularly with the first oscillation crystal and/or the second oscillation crystal, by a temperature control system as described

herein. Accordingly, by exchanging heat with the measurement assembly as described herein, particularly with the first oscillation crystal and/or the second oscillation crystal, negative effects of high temperature on the quality, accuracy and stability of the deposition rate measurement may be reduced or even eliminated. In particular, by exchanging heat with the measurement assembly as described herein, thermal fluctuations of the first oscillation crystal and/or the second oscillation crystal may be reduced or even eliminated, which may be beneficial for the deposition rate measurement accuracy. Accordingly, employing the method for measuring a deposition rate as described herein may be beneficial for high quality display manufacturing, particularly OLED manufacturing.

[0060] With exemplary reference to FIG. 7B, according to embodiments which can be combined with other embodiments described herein, the method 400 for measuring a deposition rate of an evaporated material may further include cleaning the first oscillation crystal by applying heat to the first oscillation crystal, when an access of the evaporated material to the first oscillation crystal is blocked by a movable shutter according to embodiments described herein. Accordingly, the method 400 for measuring a deposition rate of an evaporated material, the method may include cleaning the second oscillation crystal by applying heat to the second oscillation crystal, when an access of the evaporated material to the second oscillation crystal is blocked by a movable shutter according to embodiments described herein.

[0061] In view of the above, the embodiments of the measurement assembly for measuring a deposition rate of an evaporated material, the embodiments of the evaporation source, the embodiments of the deposition apparatus and the embodiments of the method for measuring a deposition rate as described herein provide for the possibility of measuring the deposition rate redundantly as well as for the possibility to clean one of the first oscillation crystal and the second oscillation crystal while the other oscillation crystal is being used for a deposition rate measurement. Accordingly, an improved deposition rate measurement for high quality display manufacturing, for example high quality OLED manufacturing, can be provided.

CLAIMS

1. A measurement assembly (100) for measuring a deposition rate of an evaporated material, comprising:
 - a first oscillation crystal (110) for measuring the deposition rate,
 - 5 - a second oscillation crystal (120) for measuring the deposition rate, and
 - a movable shutter (140), wherein the movable shutter (140) is configured for blocking the evaporated material provided from a first measurement outlet (151), the first measurement outlet (151) directed for providing evaporated material to the first oscillation crystal (110), and
 - 10 wherein the movable shutter (140) is configured for blocking the evaporated material provided from a second measurement outlet (152), the second measurement outlet (152) directed for providing evaporated material to the second oscillation crystal (120).
2. The measurement assembly (100) according to claim 1, wherein the
- 15 movable shutter is a rotatable element, particularly a rotatable disk, having at least one aperture (160), wherein the at least one aperture (160) is configured for providing access for the evaporated material provided from the first measurement outlet (151) to the first oscillation crystal (110) when the rotatable element is in a first state.
- 20 3. The measurement assembly (100) according to claim 2, wherein the at least one aperture (160) is configured for providing access for the evaporated material provided from the second measurement outlet (152) to the second oscillation crystal (120) when the rotatable element is in a second state.
4. The measurement assembly (100) according to claim 2 or 3, wherein the
- 25 at least one aperture (160) includes a first aperture (161) and a second aperture (162) which are arranged diametrically opposed to each other.

5. The measurement assembly (100) according to claim 4, wherein the at least one aperture (160) includes a third aperture (163) and a fourth aperture (164), which are arranged on opposing sides of the first aperture (161) and/or the second aperture (162), wherein the third aperture (163) and the fourth aperture (164) are arranged at a radial position substantially corresponding to a radial position of the first aperture (161) and/or a radial position of the second aperture (162).
6. The measurement assembly (100) according any of claims 1 to 5, further comprising a heater (114) configured for applying heat to the first oscillation crystal (110) and/or the second oscillation crystal (120), such that material deposited on the first oscillation crystal (110) and/or the second oscillation crystal (120) can be evaporated.
7. The measurement assembly (100) according to any of claims 1 to 6, further comprising a further heater (115) provided in the movable shutter (140) configured for applying heat to the movable shutter such that material deposited on the movable shutter can be evaporated.
8. The measurement assembly (100) according to claim 6, wherein the heater is provided in a first holder for the first oscillation crystal (110) and a second holder of the second oscillation crystal (120).
9. An evaporation source (200) for evaporation of material, comprising:
- an evaporation crucible (210), wherein the evaporation crucible is configured to evaporate a material;
 - a distribution assembly with one or more outlets (222) for providing evaporated material in a deposition direction, wherein the distribution assembly is in fluid communication with the evaporation crucible; and
 - a measurement assembly according to any of claims 1 to 8.

10. The evaporation source (200) according to claim 9, further comprising a first measurement outlet (151) for providing the evaporated material to the first oscillation crystal (110) of the measurement assembly (100) and a second measurement outlet (152) for providing the evaporated material to the second
5 oscillation crystal (120) of the measurement assembly (100).

11. The evaporation source (200) according to claim 10, wherein the first measurement outlet (151) and/or the second measurement outlet (152) are configured for providing a measurement flow from 1/70 of the total flow provided by the evaporation source to 1/25 of the total flow provided by the
10 evaporation source.

12. The evaporation source (200) according to claim 11, wherein the first measurement outlet (151) and the second measurement outlet (152) are provided at a backside of an end portion of the distribution assembly, wherein the measurement assembly (100) is arranged at the backside of the end portion
15 of the distribution assembly, and wherein the backside of the end portion of the distribution assembly faces away from the deposition direction.

13. A deposition apparatus (300) for applying material to a substrate in a vacuum chamber (310) at a deposition rate, comprising at least one evaporation source (200) according to any of claims 9 to 12.

20 14. A method (400) for measuring a deposition rate of an evaporated material, comprising:

- evaporating (410) a material;
- applying (420) a first portion of the evaporated material to a substrate;
- diverting (430) a second portion of the evaporated material to a first
25 oscillation crystal and/or a second oscillation crystal; and
- measuring (440) the deposition rate by using the measurement assembly according to any of claim 1 to 9.

15. The method (400) according to claim 14, further comprising cleaning (450) the first oscillation crystal and/or the second oscillation crystal by applying heat to the first oscillation crystal and/or the second oscillation crystal, when an access of the evaporated material to the first oscillation
5 crystal and/or the second oscillation crystal is blocked by the movable shutter.

100

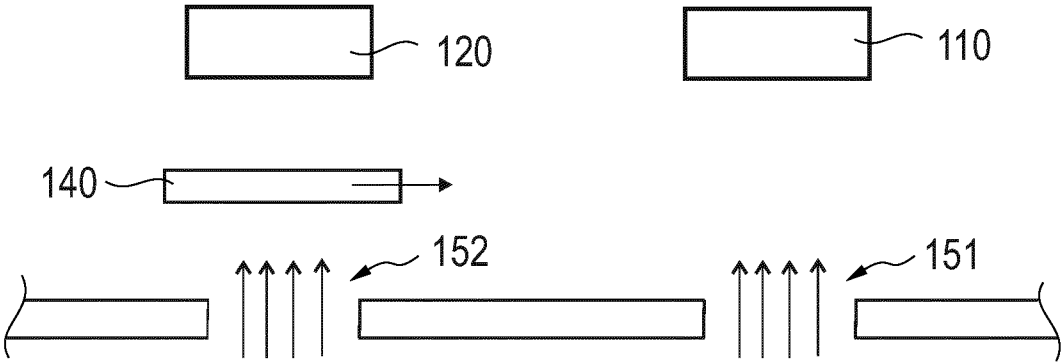


FIG. 1A

100

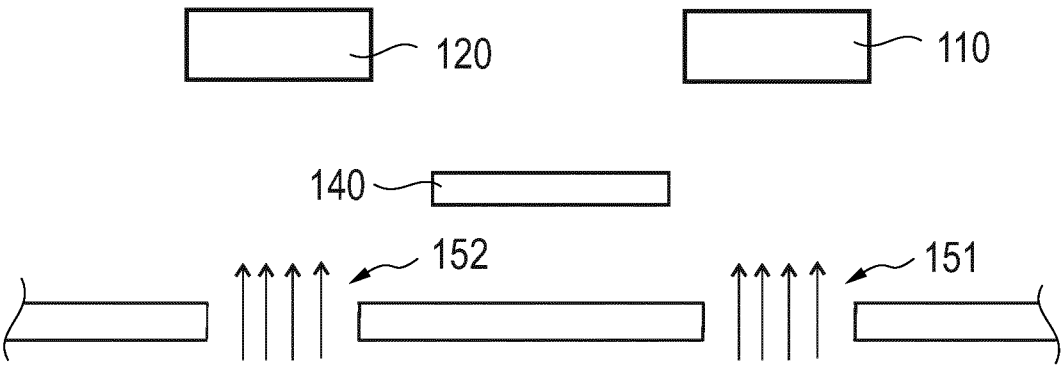


FIG. 1B

100

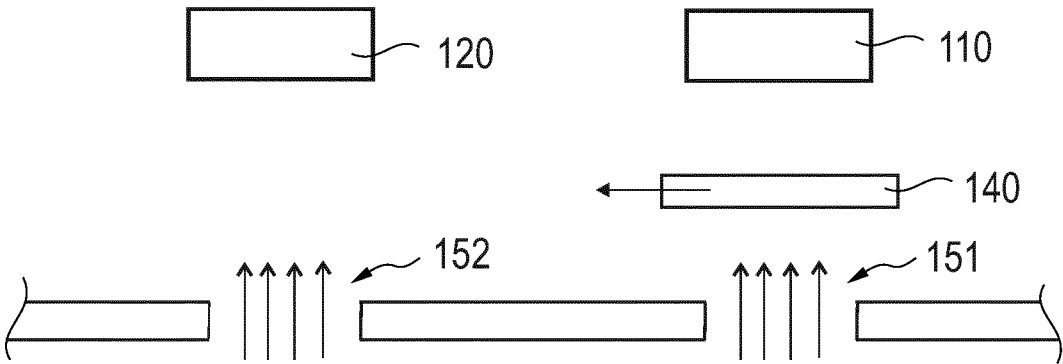


FIG. 1C

2 / 7

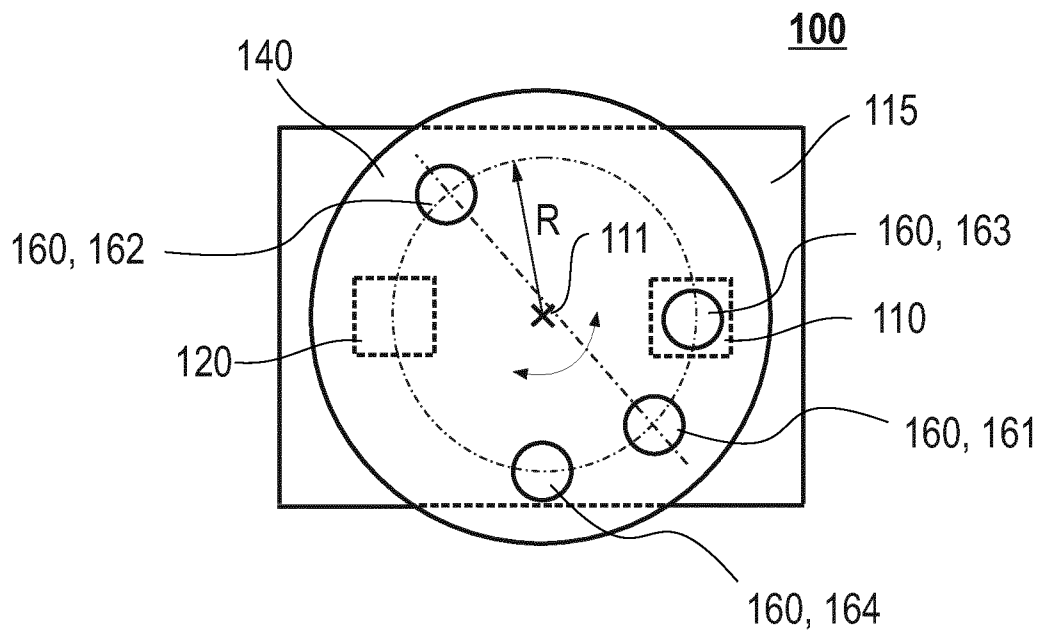


FIG. 2A

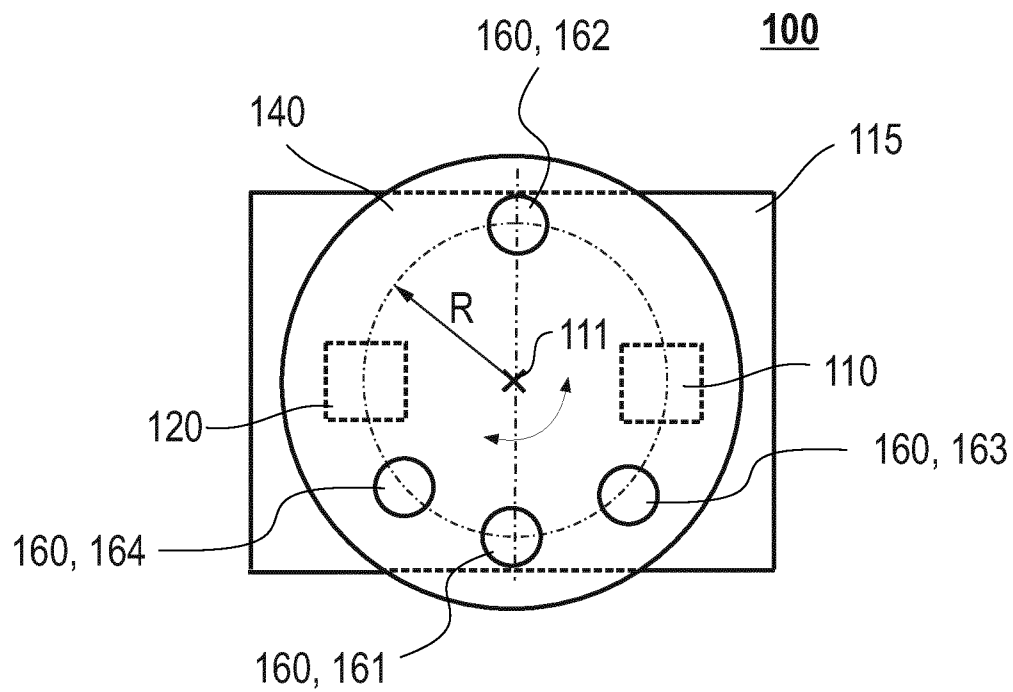


FIG. 2B

3 / 7

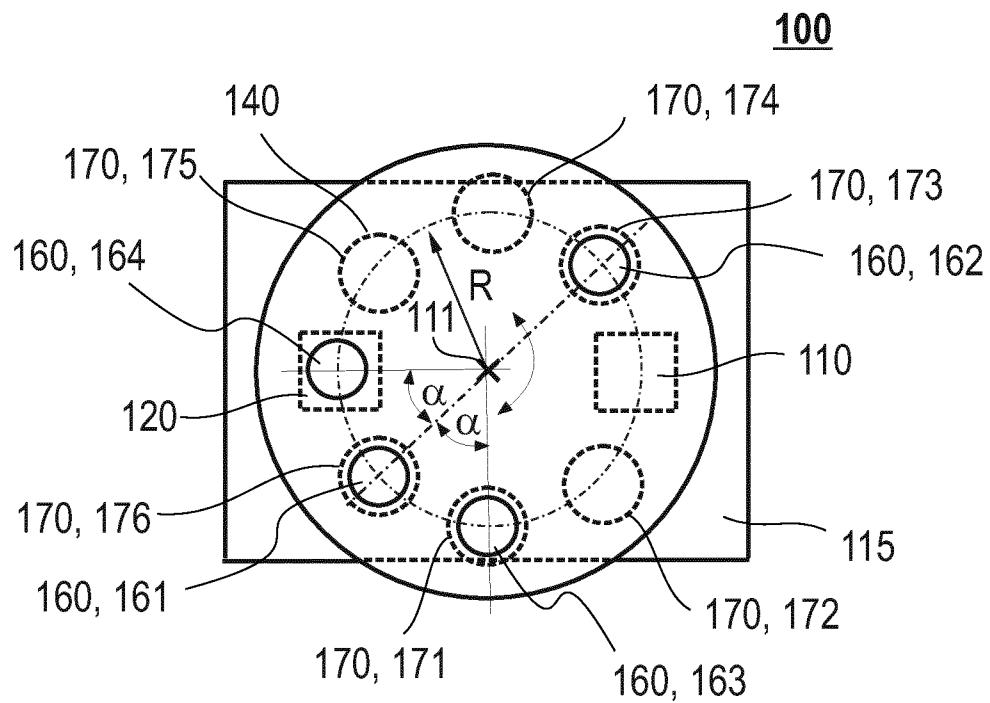


FIG. 2C

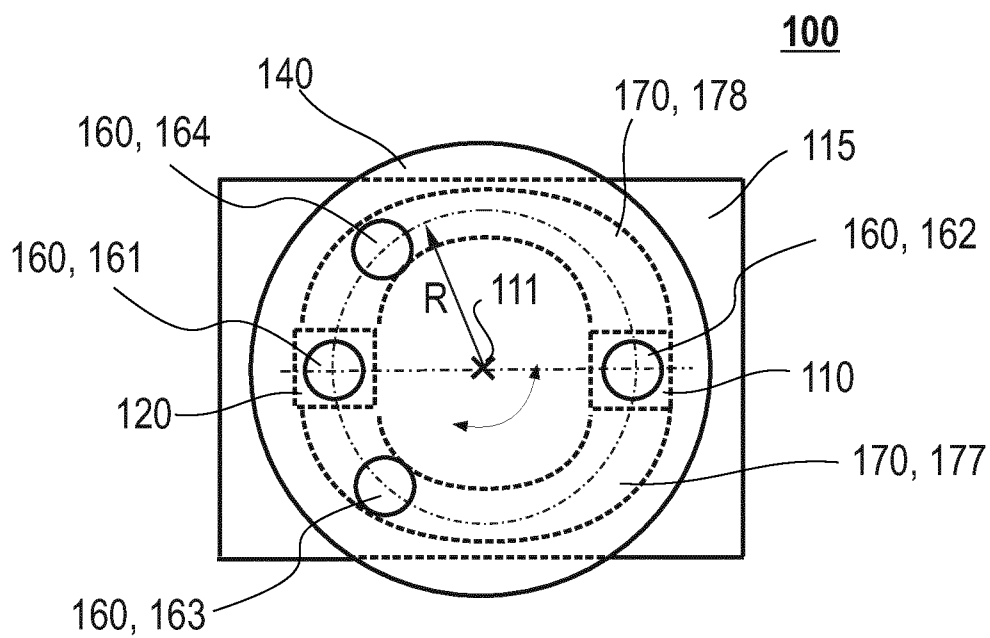


FIG. 2D

4 / 7

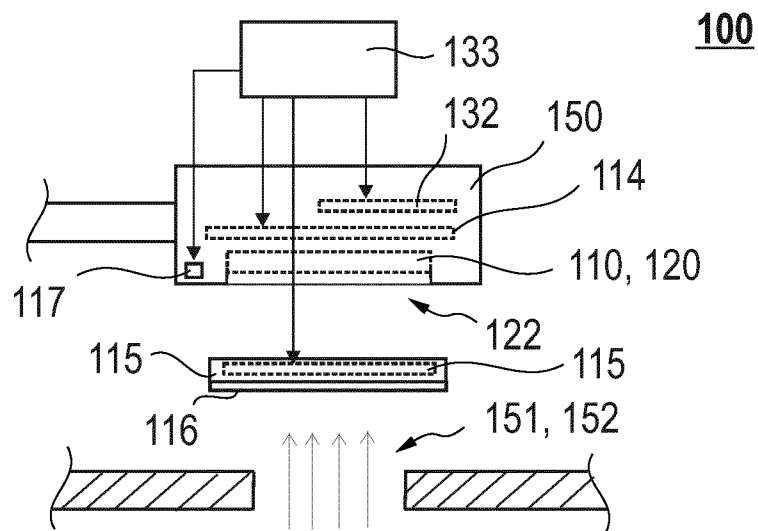


FIG. 3

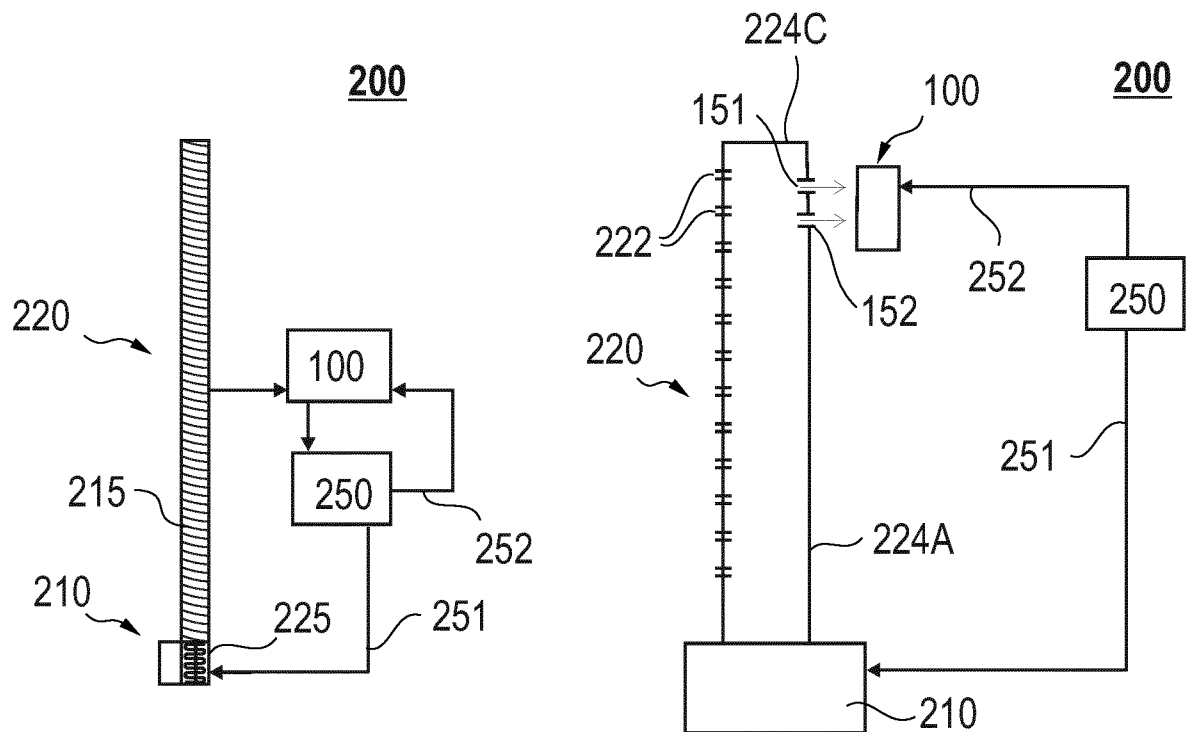


FIG. 4A

FIG. 4B

5 / 7

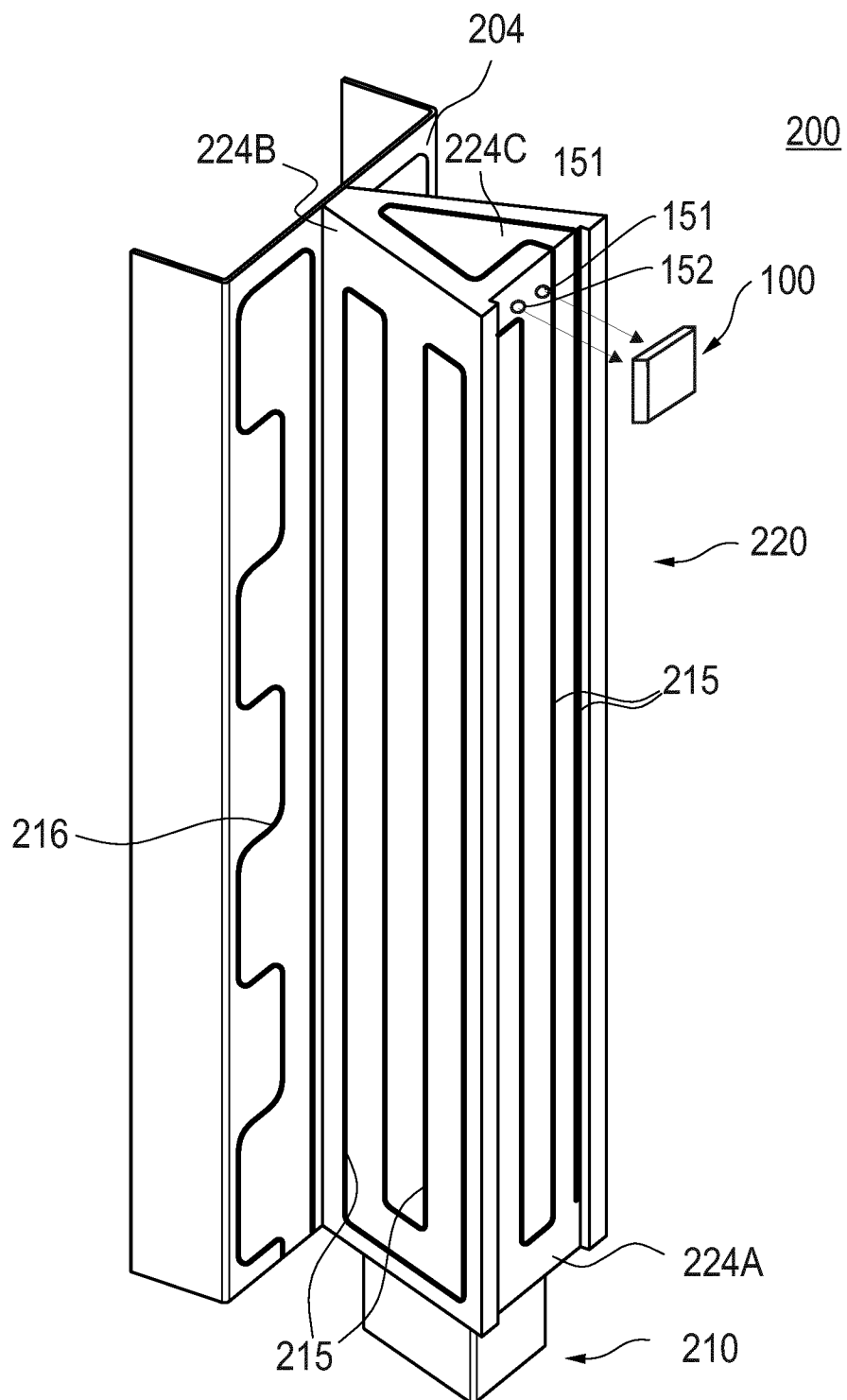


FIG. 5

6 / 7

300

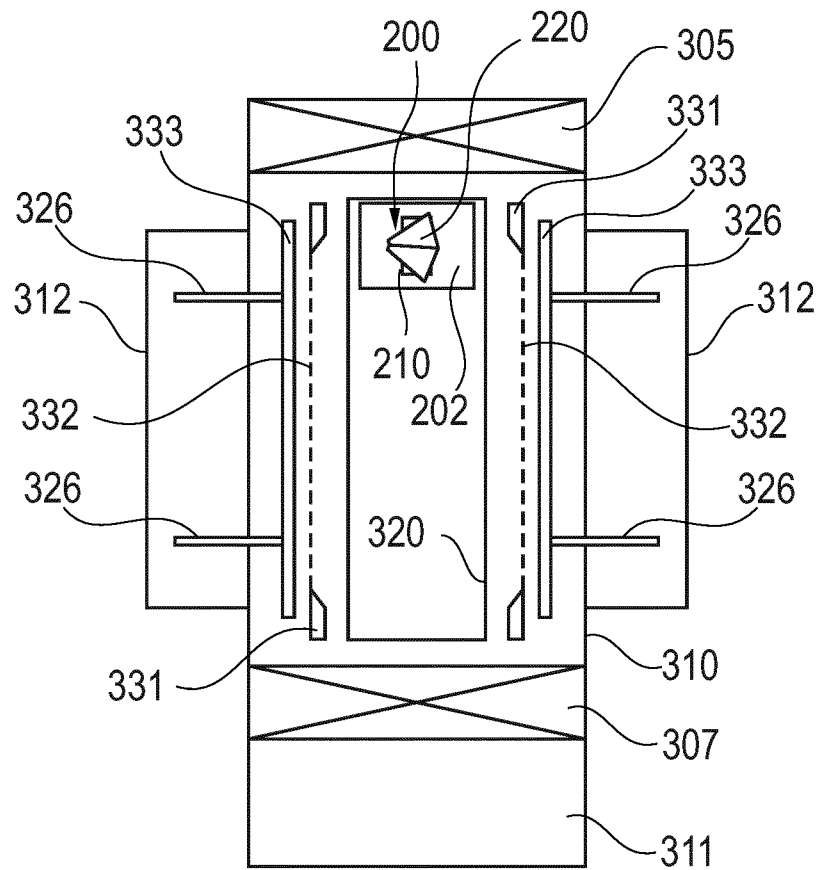


FIG. 6

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400

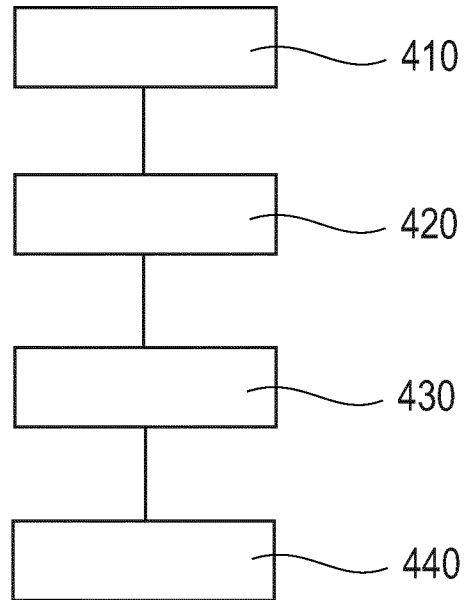


FIG. 7A

400

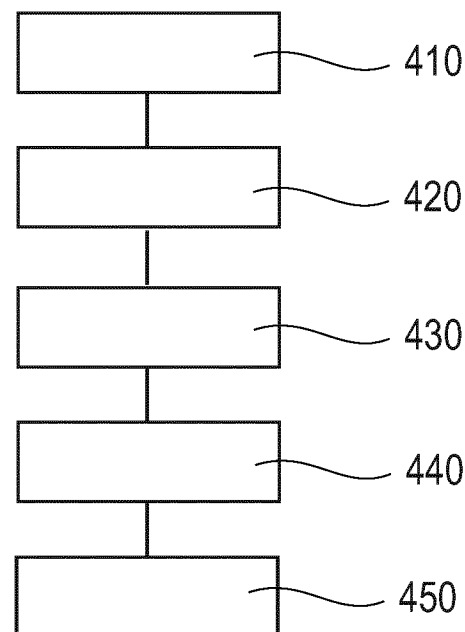


FIG. 7B

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/075681

A. CLASSIFICATION OF SUBJECT MATTER
INV. C23C14/04 C23C14/12 C23C14/24 C23C14/54 G01B7/06
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 G01B G01N

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, IBM-TDB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2008/241366 A1 (PETERSEN CARL [US] ET AL) 2 October 2008 (2008-10-02)	1-3,9-14
Y	paragraphs [0019] - [0028]; figure 1 -----	4-8,15
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	paragraphs [0015], [0036]; figure 1 -----	
A	GB 1 315 647 A (BALZERS PATENT BETEILIG AG) 2 May 1973 (1973-05-02)	1-5,9-14
	page 2, l. 28-45; figures 1,2 -----	
Y	US 2002/187253 A1 (MARCUS MICHAEL A [US] ET AL) 12 December 2002 (2002-12-12)	6-8,15
	paragraphs [0002], [0018], [0049], [0053] - [0055] ----- -/--	



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

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

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

1 August 2017

Date of mailing of the international search report

11/08/2017

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

Peijzel, Paul

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2016/075681

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 10 2014 102484 A1 (AIXTRON SE [DE]) 27 August 2015 (2015-08-27) paragraphs [0009], [0026], [0027] -----	6-8,15
Y	JP H07 257994 A (MATSUSHITA ELECTRIC IND CO LTD) 9 October 1995 (1995-10-09) paragraphs [0031] - [0036] -----	6-8,15

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2016/075681

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

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

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

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

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

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

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

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-5(completely); 9-14(partially)

Assembly and method for measuring the deposition rate of an evaporated material, having a first and a second oscillation crystal and a movable shutter for blocking the first and/or second oscillation crystal

2. claims: 6-8, 15(completely); 9-14(partially)

Assembly and method for measuring the deposition rate of an evaporated material, having a first and a second oscillation crystal and a heater configuration for removing material that has been deposited on the first or second oscillation crystal.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2016/075681

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
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			SG	146591	A1	30-10-2008
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			US	2016216099	A1	28-07-2016
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