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(71) Applicant: VKR HOLDING A/S [DK/DK]; Breettevej 18,
2970 Hørsholm (DK).

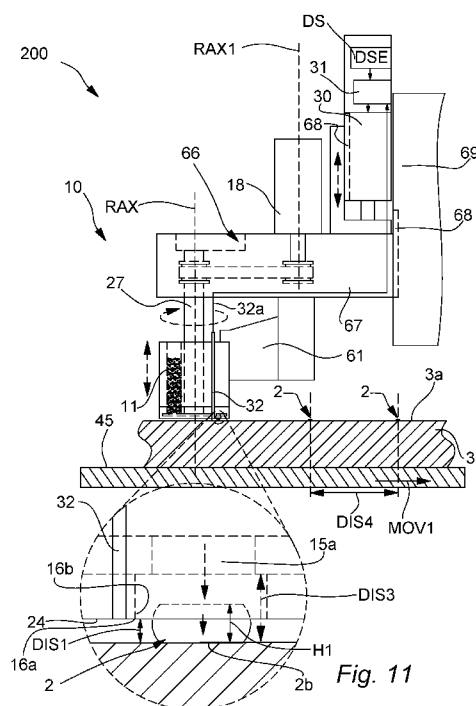
(72) Inventors: JENSEN, Henrik Aslak; c/o VKR Holding A/
S, Breettevej 18, 2970 Hørsholm (DK). JOHNSEN, Si-
mon; c/o VKR Holding A/S, Breettevej 18, 2970 Hørsholm
(DK).

(74) Agent: HØIBERG P/S; Adelgade 12, 1304 Copenhagen K
(DK).

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(57) Abstract: The present disclosure relates to a method of manufacturing a vacuum insulating glass unit (VIG). The method comprises providing a first glass sheet (3) comprising a major surface (3a), and dispensing a plurality of spacers (2) on the major surface (3a) by means of one or more spacer dispensing systems (200). The spacer dispensing system (200) comprises a spacer storage (11) comprising a plurality of spacers (2), a dispenser (10) comprising a spacer outlet (16) for dispensing spacers (2) collected from the spacer storage (11), and a distance adjustment motor (30) configured to move the spacer outlet (16) towards and/or away from the glass sheet surface (3a). The dispensing of a plurality of spacers (2) comprises providing a spacer placement sequence to place a plurality of spacers at the major glass sheet surface (3a) by means of the dispenser (10), wherein the spacer placement sequence comprises providing a relative first movement (MOV1) between the glass sheet surface (3a) and the spacer outlet (16) in a direction along the glass sheet surface by means of a displacement motor (80), and distributing a plurality of spacers (2) from the spacer storage (11) with a mutual spacer distance (DIS4) on the glass sheet surface (3a) by means of the dispenser (10) through the spacer outlet (16). A distance controller (31) controls the distance adjustment motor (30) to move the spacer outlet (16) towards and/or away from the glass sheet surface (3a) during the spacer placement sequence based on output (32a) from a sensor (32).

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SPACER OUTLET DISTANCE CONTROL DURING VIG UNIT MANUFACTURING BY MEANS OF A DISTANCE CONTROLLER

The present disclosure relates to a method of manufacturing a vacuum insulating glass unit.

5

Background

Vacuum insulating glass (VIG) units are generally known to provide an insulating glass unit with desirable features such as a space saving unit with good heat insulating capabilities.

Such VIG units may comprise spacers distributed in an evacuated gap between two glass
10 sheets of the VIG unit. These spacers may be very small, such as below 0.5 mm in height. This may result in issues when providing automation equipment such as a spacer dispensing solution, since a spacer dispensing solution for use in larger scale VIG unit manufacturing should preferably deliver a consistent, desired result.

15 Different spacer dispensing solutions in VIG unit manufacturing have been disclosed. For example, WO2019218901 discloses a dispenser solution for spacers for VIG units where a vibration arrangement may line up and convey the spacers. WO21208628 discloses a solution for separating spacers for VIG units. A vibrator is used and a separation chamber component is arranged obliquely to the horizontal plane. Other types of spacer dispensing
20 solutions comprises a radial drum solution as disclosed in CN 205258287U, where a radial drum having a horizontal rotation axis collects spacers from a spacer storage and the drum is rotated around the horizontal axis so the collected spacers are delivered. US11396477 discloses a solution where spacers are arranged stacked in a spacer column of a magazine, and pushed horizontally to leave the magazine from the bottom of the magazine to the glass
25 sheet surface. CN106045286 discloses a further VIG unit spacer dispensing solution comprising a reciprocating collection member, or a rotating collection member with a collection opening for receiving a spacer.

The above solutions may suffer from different drawbacks such as risking inaccurate spacer
30 placement, may be space consuming and/or the like.

The present disclose provides a solution that may e.g. help to reduce or avoid one or more of the above mentioned drawbacks.

Summary

The present disclosure relates to a method of manufacturing a vacuum insulating glass unit. The method comprises providing a first glass sheet comprising a major surface, and dispensing a plurality of spacers on the major surface by means of one or more spacer
5 dispensing systems.

The spacer dispensing system comprises:

- a spacer storage comprising/containing a plurality of spacers,
- a dispenser comprising a spacer outlet for dispensing spacers collected from the spacer storage, and
- 10 a distance adjustment motor configured to move the spacer outlet towards and/or away from the glass sheet surface.

The dispensing of a plurality of spacers comprises providing a spacer placement sequence to place a plurality of spacers at the major glass sheet surface by means of the dispenser. The spacer placement sequence comprises providing a relative first movement between the glass
15 sheet surface and the spacer outlet in a direction along the glass sheet surface by means of a displacement motor, and distributing a plurality of spacers from the spacer storage with a mutual spacer distance on the glass sheet surface by means of the dispenser through the spacer outlet. A distance controller controls the distance adjustment motor to move the spacer outlet towards and/or away from the glass sheet surface during the spacer placement
20 sequence based on output from a sensor. The method further comprises providing a second glass sheet, and sealing together the first glass sheet and the provided second glass sheet at the periphery of the glass sheets with the plurality of dispensed spacers arranged between major surfaces of the glass sheets so that a gap is provided between the first and second glass sheets. The method also comprises evacuating the gap.

25 This provides a solution where improved spacer placement precision and/or consistency of spacer placement may be obtained.

The adjustment of the distance between the spacer outlet and the glass sheet surface based on
30 the output from the sensor during the spacer placement sequence may provide that the distance between the spacer outlet and the part of the glass sheet surface arranged opposite to the outlet is individually adapted for each individual glass sheet one or a plurality of times during the spacer placement sequence. This may e.g. reduce the risk of (or magnitude of) the dispensed spacers bouncing on the glass sheet surface and/or rolling on the glass sheet

surface when dispensed by the dispenser to drop onto the glass sheet surface, and hence reduce the risk of spacer misplacement.

5 Hence, when the dispenser is used for consecutively dispensing a group of spacers one at a time at the same glass sheet surface during the spacer placement sequence, individual distance adaption when placing/dispensing each spacer may be provided according to the individual surface topology of the glass sheet surface at the location of the glass sheet surface to receive the spacer.

10 The spacers may be placed one by one, consecutively, at the glass sheet surface by means of the dispenser. A relative movement between the glass sheet surface and the spacer outlet in a direction along the glass sheet surface by means of a displacement motor may be provided between each consecutive placement of a spacer by means of the dispenser.

15 The distance controller may in some embodiments comprise one or more hardware processors, such as one or more microcontrollers, Field-Programmable Gate Arrays (FPGA), Programmable Logic controllers (PLC), microprocessors and/or the like. For example, the hardware processor may comprise one or more general-purpose hardware processors.

20 Generally, according to one or more embodiments of the present disclosure, a system controller comprising one or more hardware processors (such as one or more of the above mentioned types) may, based on a computer implemented software program and control circuitry, control the movement and/or movement speed of the displacement motor and the dispensing of spacers, e.g. in order to time the spacer dispensing and start/stop and/or
25 movement speed of the displacement motor.

In some embodiments of the present disclosure, the distance controller and the system controller may be the same controller or may be provided by means of different hardware controllers, such as distributed hardware controllers.

30

For example, in some embodiments, the distance adjustment motor, such as an electric motor, such as a servo motor, may comprise a hardware controller and regulation circuitry, and may handle the distance control based on direct sensor input or sensor input supplied

from another hardware controller. Such a controller may e.g. receive distance setting input supplied from e.g. a separate hardware controller.

5 The evacuation of the gap may in embodiments of the present disclosure be provided by means of one or more one or more of: a vacuum chamber, such as a vacuum chamber containing the entire VIG unit assembly therein, one or more vacuum pumps in communication with the gap, for example by means of a suction cup, a getter arranged in the gap and/or the like.

10 The sealing together of the first and second glass sheets may comprise use of an edge seal material such as a solder glass edge seal or a solder metal edge seal, or it may comprise fusing the glass sheets directly together. In some embodiments, the sealing may comprise heating at least the edge seal, or the entire VIG unit assembly to a desired temperature.

15 In one or more embodiments of the present disclosure, the distance controller may control the distance adjustment motor so as to reduce the distance between the outlet and the glass sheet surface during the spacer placement sequence so that a surface facing the glass sheet surface touches the glass sheet surface. Hence, the distance controller may be configured to stop the distance adjustment motor when output from the sensor indicates that the surface
20 touches the glass sheet surface.

This may e.g. provide a cost efficient solution and/or enable a more simple solution, and/or a solution where spacer misplacement may be reduced or avoided.

25 Additionally or alternatively, it may help to provide that the distance between the individual spacer outlet and the glass sheet surface is adapted to the local surface topology of the major glass sheet surface opposite to the spacer outlet one or more times, such as continuously, during the spacer placement sequence.

30 In one or more embodiments of the present disclosure, said surface facing the glass sheet and which is configured to touch the glass sheet surface may be a surface of the spacer outlet. This may e.g. provide a simple solution where contact between glass sheet surface and outlet is assured. This may e.g. reduce the risk of spacer misplacement and adaption to local glass sheet surface topology.

In some embodiments of the present disclosure, the surface facing the glass surface and which is configured to touch the glass sheet surface may be a surface of a nozzle wall of an outlet nozzle comprising the spacer outlet. For example, the surface may be an end surface of a nozzle wall enclosing the outlet.

In other embodiments of the present disclosure, said surface facing the glass sheet and which is configured to touch the glass sheet surface may be a surface of a touching body that is not a part of the spacer outlet, such as not a part of a spacer outlet body.

In some embodiments of the present disclosure, the outlet may be integrated in, or be attached to, a housing of the dispenser.

In some embodiments of the present disclosure, the outlet is enclosed by an outlet nozzle wall, such as a nozzle wall providing or comprising a free end surface of a nozzle.

In one or more embodiments of the present disclosure, the sensor may be a distance sensor. Such a sensor may enable advantageous distance control and/or improved distance regulation options.

In one or more embodiments of the present disclosure, the distance controller may be configured to control the distance adjustment motor so as to reduce the distance between the respective outlet and the glass sheet surface, and the distance controller may stop the distance adjustment motor prior to a surface, such as an outlet surface, facing the sheet glass surface, touches the glass sheet surface.

In one or more embodiments of the present disclosure, the sensor may comprise at least one of:

- at least one current measuring circuitry. In some embodiments hereof, the current measuring circuitry may measure a current that reflects the consumption of electric current used in order to move the spacer outlet towards the glass sheet surface. In some embodiments, the current measuring circuitry may be connected to or integrated in the distance adjustment motor,
- at least one force sensor, such as a strain gauge sensor or a piezo electric sensor,

- at least one switch, such as a MEMS switch or an electromechanical switch,
- at least one proximity sensor,
- at least one optical sensor, such as a fibre-optic sensor.

- 5 In one or more embodiments of the present disclosure, the sensor may comprise an optical sensor, such as a fibre optic sensor, or an ultrasonic sensor.

In one or more embodiments of the present disclosure, the sensor may comprise or be a distance sensor.

10

In some embodiments of the present disclosure, the surface facing the glass surface and which is configured to touch the glass sheet may be part of and/or may be comprised in a touch probe sensor.

- 15 In one or more embodiments of the present disclosure, the distance controller may control the distance between the glass sheet surface and the spacer outlet to be less than a spacer height of the spacers. This may be provided at least while the spacers are delivered to, such as dropped onto, the glass sheet surface by the dispenser. This may enable reducing the risk of too large spacer misplacing during spacer dispensing. A surface, such as a wall surface or
- 20 an edge/corner, of the dispenser enclosing the dispenser outlet may hence prevent the spacer from rolling, bouncing or the like beyond the outer periphery/outer boundary described by the dispenser opening. Hence it may be assured that the spacer outlet opening size and/or shape may define the maximum limit for a possible spacer movement and displacement of the spacer during dispensing the spacer and until the spacer rests as desired on the glass sheet
- 25 surface.

- The spacer outlet may comprise an outermost outlet surface facing the glass and being proximate the glass (e.g. provided by a dispenser bottom or by a spacer nozzle outlet having an outer diameter that is less than the diameter of a housing of the dispenser), and the
- 30 distance between the spacer outlet and the glass sheet surface may be defined between that outermost outlet surface and the glass sheet.

In one or more embodiments of the present disclosure, the spacers may have a spacer height of less than 0.5 mm such as less than 0.3 mm, such as less than 0.25 mm.

A VIG unit comprises an evacuated gap placed between opposing, major surfaces of two glass sheets. The spacers are distributed in the evacuated gap so as to maintain a certain distance between the glass sheet surfaces. This distance may be desired to be less than 0.5 mm such as less than 0.3 mm, such as less than 0.25 mm, for example a distance of 0.2 mm. Hence, the spacers may have a height that enables maintaining the desired distance between the glass sheets.

In one or more embodiments of the present disclosure, the distance controller may maintain a maximum distance between the spacer outlet and the glass sheet surface of less than 0.6 mm, such as less than 0.3 mm, such as less than 0.2 mm based on the output from the sensor, at least when the spacers are delivered, such as dropped, onto the glass sheet surface.

In one or more embodiments of the present disclosure, the distance controller maintains a minimum distance between the spacer outlet and the glass sheet surface, such as a minimum distance of at least 0.05 mm, such as at least 0.1 mm during the spacer placement sequence.

In one or more embodiments of the present disclosure, the distance controller may monitor a distance representative of a distance between the glass sheet surface and the spacer outlet based on the output from the sensor and a distance setting during the spacer placement sequence, and controls the distance adjustment motor based thereon during the spacer placement sequence.

The sensor, such as a distance sensor, may in embodiments of the present disclosure monitor the distance between the glass sheet surface and the spacer outlet directly or indirectly.

The distance controller may in embodiments of the present disclosure monitor the distance between the glass sheet surface and the spacer outlet, e.g. by means of the sensor output.

In one or more embodiments of the present disclosure, the distance controller may comprise distance regulation circuitry.

In one or more embodiments of the present disclosure, the distance controller provides closed loop distance control, such as by means of one or more of Proportional, Integral and/or derivative control.

- 5 This may e.g. provide improved precision and/or distance control during the spacer placement sequence.

In one or more embodiments of the present disclosure, the distance setting comprises one or more distance set points such as a distance target setting or a distance range setting.

10

In one or more embodiments of the present disclosure, the sensor may be attached to, such as arranged in, a housing of the dispenser.

- 15 This may help to provide one or more of enhanced distance control, mechanical simplicity and/or advantages with respect to maintenance.

- 20 In one or more embodiments of the present disclosure, the spacers may comprises opposing, pre-shaped, predefined contact surfaces, and the spacers may have a spacer height extending between the contact surfaces. The pre-shaped contact surfaces may in further embodiments of the present disclosure be flat, such as substantially plane.

- 25 In one or more embodiments of the present disclosure, the maximum width, such as the maximum diameter, of the spacers may be at least 2 times larger, such as at least 2.5 times larger than the height of the spacers.

25

In embodiments of the present disclosure, the maximum width, such as the maximum diameter, of the spacer may be between 1.3 and 6 times, such as between 1.5 and 6 times, for example between 2 times and 4 times larger than the height of the spacer.

- 30 In one or more embodiments of the present disclosure, each of said spacers may have a maximum spacer width defined by a curved outer side surface, such as wherein said curved outer side surface describes a convex surface shape between the contact surfaces.

Dispensing spacers comprising opposing, Predefined, such as flat/plane contact surfaces may e.g. ease maintaining the spacers at the desired position on the glass sheet surface after dispensing as the spacers can hence rest on the glass sheet surface on one of the contact surfaces. The plane contact surfaces are preferably oppositely directed. Additionally or
5 alternatively, using spacers having predefined plane contact surfaces may help to provide improved control of the contact surface area between the glass sheet surface and the spacer.

The spacers to be dispensed may in embodiments of the present disclosure have a shape different from spherical. In other embodiments, the spacers may be spherical.

10

In some embodiments of the present disclosure, the curved outer side surface may describe a convex surface shape between the contact surfaces. This may help to enable that the spacer moves to a resting position on a contact surfaces. In other embodiments of the present disclosure, the curved outer side surface may describe a concave surface shape between the
15 contact surfaces. In still further embodiments of the present disclosure, the spacer may have the shape of a cylinder and the curved outer side surface may extend substantially straight between the contact surfaces.

The curved outer side surface may in some embodiments extend around the spacer and be
20 curved in the sense that it enables the spacer rolling on the side surface.

In embodiments of the present disclosure, the maximum spacer width may be larger, such as at least 1.5 times larger, such as at least 2 times larger, than the spacer height.

25 In one or more embodiments of the present disclosure, the glass sheet is a thermally tempered glass sheet, for example a thermally tempered glass sheet. In further embodiments of the present disclosure, the thermally tempered glass sheet may comprise a glass sheet surface unevenness of at least 0.1 mm, such as at least 0.2 mm, for example at least 0.3 mm.

30 Thermally tempered glass sheets may suffer from surface unevenness originating from the thermally tempering process to obtain the tempered glass sheet. Such surface unevenness, also called distortion, may e.g. comprise unevenness originating from one or more of roller waves, glass sheet bowing, glass sheet warp, glass sheet edge lift and/or the like.

Tempered glass sheets however provides advantages with regard to increased strength that enables using thinner glass sheets and/or providing larger distances between adjacent spacer, compared to if using annealed glass sheets in VIG units. It may however also provide challenges when providing a precise placement of spacers, as the surface unevenness may provide difficulties in getting close to the glass sheet surface to reduce the risk of the dispensed spacers relocating/misplacing, such as e.g. by rolling and/or bouncing. The distance controller help to provide that the dispenser outlet can get close enough to the glass sheet surface to reduce the risk of spacer misplacement during the spacer placement sequence when arranging a plurality of distributed spacers on the glass sheet surface.

10

For example, a distance setting may be set to e.g. 0.1 mm, and hence, the distance controller may provide adjustment/adaption of the spacer outlet to glass surface distance during the spacer placement sequence so that the outlet is maintained substantially at 0.1 mm from the glass sheet surface during spacer dispensing in spite of the glass sheet surface being uneven. Hence, individual adaption to the surface unevenness during the spacer placement sequence, preferably to place a full set of spacers, is provided by means of the distance controller and distance adjustment motor.

In other embodiments, a surface, such as an outlet surface, facing the glass sheet surface may be moved to touch the glass sheet surface. Hence, the distance controller may be configured to stop the distance adjustment motor when output from the sensor indicates that the surface touches the glass sheet surface. Hence, individual adaption to the surface unevenness during the spacer placement sequence, preferably to place a full set of spacers, is provided by means of the distance controller and distance adjustment motor.

25

In one or more embodiments of the present disclosure, the distance controller may control the distance adjustment motor to move the spacer outlet towards and/or away from the glass sheet surface during the spacer placement sequence based on a distance setting and output from a sensor.

30

In one or more embodiments of the present disclosure, the glass sheet surface unevenness may be equal to or larger than the spacer height.

In one or more embodiments of the present disclosure, the dispenser comprises a housing, wherein the housing comprises

- the spacer outlet,
- a spacer storage storing a plurality of spacers to be dispensed,
- 5 - a collection sheet, such as a disc shaped collection sheet, wherein the collection sheet comprises a collection hole which during the spacer placement sequence collects spacers one at a time in the collection hole from the spacer storage by means of a relative movement between the housing and the collection sheet provided by means of a drive motor,
- 10 wherein the collected spacers are dispensed consecutively through the spacer outlet, wherein the distance controller provides the control of the distance adjustment motor to move the spacer outlet towards and/or away from the glass sheet surface by moving the housing towards and/or away from the glass sheet surface.
- 15 Such a dispenser may e.g. enable a space saving and/or more mechanically simple solution. The collection sheet may in embodiments of the present disclosure be of the reciprocating type, or of a disc shaped rotating type. In embodiments of the present disclosure, if the collection sheet is a disc shaped collection sheet, the relative movement between the housing and the collection sheet may be a rotating movement around a rotation axis. In embodiments
- 20 of the present disclosure, if the collection sheet is of the reciprocating type, the relative movement may be or comprise a linear movement.

In one or more embodiments of the present disclosure, the distance between adjacent spacer outlets in the spacer dispensing array is between 20 mm and 70 mm, such as between 25 mm

25 and 45 mm,

In one or more embodiments of the present disclosure, the distance between adjacent spacer outlets of more than 50% or more than 60% of the spacer outlets of the spacer dispensing array may be between 20 mm and 70 mm, such as between 25 mm and 45 mm,

30 In one or more embodiments of the present disclosure, the distance between adjacent dispensed spacers on the glass sheet surface, such as between more than 50% or more than 60%, such as more than 90% of the dispensed spacers may be between 20 mm and 70 mm, such as between 25 mm and 45 mm.

In one or more embodiments of the present disclosure, the dispenser housing has a maximum outer width, such as a maximum outer diameter, that is 60 mm or less such as 50 mm or less, such as 40 mm or less, for example 30 mm or less.

5

In one or more embodiments of the present disclosure, a plurality of spacers are consecutively delivered to the glass sheet surface by the dispenser through the spacer outlet with a predetermined, mutual distance on the glass sheet surface, wherein the displacement motor provides the relative movement between the glass sheet surface and the spacer outlet in the direction along the glass sheet surface to obtain the predetermined distance.

10

The relative movement between the glass sheet surface and the spacer outlet in the direction along the glass sheet surface may in embodiments of the present disclosure be continuous during the spacer placement sequence and the dispensing of the spacers at the glass sheet surface may hence be timed dependent on the displacement motor speed to obtain the predetermined distance. In other embodiments of the present disclosure, the relative movement between the glass sheet surface and the spacer outlet in the direction along the glass sheet surface may comprise a plurality of intermittent movements and between each movement, a spacer may be provided through the spacer outlet.

15

20

In one or more embodiments of the present disclosure, each of the plurality of spacers in the spacer storage compartment has a spacer height extending between contact surfaces of the spacer, and wherein each of said spacers has a spacer width, wherein the collection sheet is arranged in a guidance space of the housing, and wherein the guidance space has a height which is less than 1.4 times the spacer height, and wherein the height of the guidance space is smaller than the spacer width.

25

In one or more embodiments of the present disclosure, the distance between the glass sheet surface and a major surface of the collection sheet facing the glass sheet surface is less than 10 mm, such as less than 3 mm, such as less than 1 mm, at least while the spacer is dropped towards the glass sheet surface.

30

In one or more embodiments of the present disclosure, a spacer dispensing array comprises a plurality of said spacer dispensing system, wherein a distance controller provides an

adjustment, such as an individual adjustment, of the spacer outlet of the respective spacer dispensing system of the dispensing array in a direction towards and/or away from the glass sheet surface based on output from a plurality of sensors during the spacer placement sequence.

5

This may e.g. enable a faster manufacturing of glass sheets comprising a desired, full set of distributed spacers arranged at desired spacer positions at the glass sheet surface. The individual distance adaption provides precise spacer placement across the glass sheet surface, such as in a row, despite possible glass surface variation.

10

The dispensing array may e.g. enable that a row of spacers at a time may be arranged at the glass sheet surface, and the relative movement between the glass sheet surface and the spacer outlet in a direction along the glass sheet surface by means of a displacement motor is provided in order to provide a plurality of spaced apart rows of spacers. Hence, each distance controller may provide distance adjustment during and/or after a relative movement between the glass sheet surface and the spacer outlet in a direction along the glass sheet surface by means of a displacement motor.

15

In one or more embodiments of the present disclosure, the plurality of spacer dispensing systems of the array, such as all spacer dispensing systems of the array, each comprises an individual distance controller.

20

In further embodiments, the individual distance controller may individually monitor the distance between the glass sheet surface and the spacer outlet of the dispenser of the respective individual spacer dispensing system based on output from a sensor, such as a distance sensor, and each individual distance controller may individually control the distance adjustment motor to move the spacer outlet of the dispenser of that spacer dispensing system towards and/or away from the glass sheet surface during the spacer placement sequence.

25

This may enable individual adaption of the individual spacer dispensing across the glass sheet surface.

30

In one or more embodiments of the present disclosure, the individual adjustment may be based on sensor output from an individual sensor, such as distance sensor, assigned each spacer dispensing system.

In one or more embodiments of the present disclosure, the spacer outlets of the dispensing systems are distributed transverse to, such as arranged in a line extending transverse to, such as perpendicular to, direction of the relative movement between the glass sheet surface and the spacer outlet along the glass sheet surface provided by means of a displacement motor.

In one or more embodiments of the present disclosure, one or more dispensers of the array are displaced horizontally relative to one or more adjacent dispenser(s) of the array by means of a displacer, such as in a direction transverse to the direction of the first movement.

10

This may e.g. enable adaption of spacer distance on the glass sheet surface, and hence help to e.g. adapt spacer distances to different glass sheets sizes. Hence, it may e.g. help to adapt the compressive loads acting on the respective spacer.

15 In one or more embodiments of the present disclosure, the distance controller may be configured to control the distance adjustment motor to move the spacer outlet within a distance adjustment range based on the output from the sensor during the spacer placement sequence, wherein the distance adjustment range is at least 0.5 mm, such as at least 1.5 mm, such as at least 10 mm,

20 In one or more embodiments of the present disclosure, the distance adjustment motor may be configured to be controlled by the distance controller to move the spacer outlet with a distance adjustment resolution of less than 0.1 mm such as less than 0.08 mm, such as less than 0.05 mm.

25 Hence, the minimum distance adjustment that may be enabled by the distance adjustment motor may be less than 0.1 mm such as less than 0.08 mm, such as less than 0.05 mm. This may enable more precise distance adjustment to adjust the distance between the spacer outlet and the glass sheet surface based on the information of the sensor input/output, such as distance sensor input/output, during the spacer placement sequence.

30

In one or more embodiments of the present disclosure, the dispenser may comprise a vacuum path, such as one or more vacuum channels, connected to a vacuum pump, wherein vacuum pump provides suction in the vacuum path so as to help a spacer of the spacer storage compartment to enter into the collection hole. Additionally or alternatively, the dispenser

comprises a fluid outlet for pressurized gas, and wherein pressurized gas is provided through said fluid outlet to provide a blowing force onto the collected spacer in the collection hole to help the collected spacer leave the collection hole.

- 5 This may e.g. help to improve dispenser reliability.

In one or more embodiments of the present disclosure, a charge modulation system reduces and/or maintains a difference in electrostatic charge potential between the glass sheet and the dispensing system, such as between the between the glass sheet and the dispenser, to be
10 below 10 kV, such as below 5kV, such below 2 kV, such as wherein the charge modulation system comprises one or more of:

- a grounding connection
- one or more ionizer devices providing a flow of ions with controlled polarity towards the dispensing system,
- 15 • a humidity control system maintaining the relative humidity of the ambient air surrounding the dispenser above 40%, such as above 50%, for example between 40% and 70%.

Such charge modulation system(s) may help the ensure reliability of the dispensing system.

20

The inventor has tested an (ungrounded) metal dispenser comprising a disc shaped collection sheet made from a metal, and a housing made from a metal, where the collection sheet was rotated relative to the housing in the guidance space by means of a shaft connected to a motor. The result was that sometimes a spacer was not successfully loaded into the collection
25 hole or unloaded at the spacer outlet. The inventor then provided a grounding connection by galvanic connection to the housing to reduce static electricity, and this increased the spacer dispensing success rate significantly.

Hence, the charge modulation system, such as a grounding connection and/or other charge
30 modulation systems, such as one or more ionizer bars and/or humidity control, may increase the spacer dispensing success rate thereby reducing the number of times where topping up with spacers at the glass surface is necessary due to an uncollected or un-dispensed spacer from the dispenser and/or it may enable increasing the manufacturing speed of glass sheets with a full set of spacers.

In one or more embodiments of the present disclosure, the dispenser comprises:

- a spacer storage compartment, comprising a plurality of said spacers,
- a housing comprising a guidance space placed between a first housing surface of an upper part of the housing and a second housing surface of a bottom part of the housing,
- a spacer outlet arranged at the bottom part of the housing,
- a disc shaped collection sheet providing a bottom part of the spacer storage compartment, wherein the disc shaped collection sheet comprises at least one collection hole extending between opposing major surfaces of the collection sheet, wherein the collection hole is a through hole and wherein the disc shaped collection sheet is arranged in the guidance space.

The dispensing of spacers may here comprise:

- providing a relative, rotational movement between the disc shaped collection sheet and the housing around a rotation axis by means of a drive motor so that the collection hole is arranged at the bottom of the spacer storage compartment and thereby collects a spacer from the bottom of the spacer storage compartment, and
- providing a further, relative rotational movement between the collection sheet and the housing around the rotation axis to align the collected spacer in the collection hole opposite to the spacer outlet to deliver the collected spacer to the spacer outlet and towards the major surface of the glass sheet.

- In one or more embodiments of the present disclosure, the length of the traveling path of the collection hole at the bottom of the spacer storage compartment may be at least 0.9 times, such as at least 1.2 times, such as at least 1.8 times, the distance between the rotation axis and the outer periphery of the dispenser housing.

- In one or more embodiments of the present disclosure, the spacer storage compartment is elongated and extends partly around the rotation axis, such as wherein the spacer storage compartment is arc shaped.

In one or more embodiments of the present disclosure, the dispenser housing and the collection sheet may be made from metal, wherein the dispenser, such as the housing and/or collection sheet, is/are connected to ground by means of a grounding connection.

In one or more embodiments of the present disclosure, the dispenser comprises a fluid outlet for pressurized gas, such as an outlet arranged opposite to the spacer outlet, wherein the pressurized gas is provided in order to provide a blowing force onto the collected spacer in the collection hole to help the collected spacer leave the collection hole.

In one or more embodiments of the present disclosure, the dispenser comprises a vacuum path, such as one or more vacuum channels, connected to a vacuum pump, wherein vacuum the pump provides suction in the vacuum path so as to help a spacer of the spacer storage compartment to enter into the collection hole.

In one or more embodiments of the present disclosure, the housing comprises a part of the vacuum path, such as a recessed channel, such as an elongated, curving channel, arranged to abut the guidance space to provide a fluid communication between the collection hole of the collection sheet and a suction outlet of the housing connected to the vacuum pump when the collection hole is arranged at the bottom of the spacer storage compartment to collect a spacer from the bottom of the spacer storage compartment.

In one or more embodiments of the present disclosure, one or more magnets may attract a spacer into the collection hole from the spacer storage compartment. In certain further embodiments, the dispenser may comprise the one or more magnets, and the collection sheet may be placed between the one or more magnets and the spacer storage compartment.

In one or more embodiments of the present disclosure, a spacer maintaining arrangement comprising one or more magnets maintains the dispensed spacer in position at the glass sheet surface. In further embodiments, the one or more magnets of the spacer maintaining arrangement may be arranged opposite to the major surface of the glass sheet facing away from the dispenser so that the glass sheet is placed between the spacer outlet and the magnet.

In one or more embodiments of the present disclosure the distance between the glass sheet surface for receiving a collected spacer from the dispenser and the spacer outlet may be less than 0.6 mm, such as less than 0.3 mm, such as less than 0.2 mm, at least while the spacer is dispensed towards the glass sheet surface.

In one or more embodiments of the present disclosure, the sensor may detect when a surface, such as a movable surface, facing the glass sheet surface touches the glass sheet surface. This may e.g. provide a cost efficient solution, a more safe solution and/or enable a more simple regulation solution.

5

In one or more embodiments of the present disclosure, the distance controller may stop the distance adjustment motor when the sensor detects that the surface facing the glass sheet surface touches the glass sheet surface. This may provide a cost efficient solution.

- 10 In one or more embodiments of the present disclosure, the surface facing the glass sheet surface is a surface of an outlet nozzle. This may e.g. provide a cost efficient solution, a space saving solution and/or a solution where the risk of spacer misplacement is reduced.

- 15 In one or more embodiments of the present disclosure, a spacer is dispensed by the dispenser while the surface facing the glass sheet surface touches the glass sheet surface. This may e.g. help to provide a cost efficient and/or more simple distance control and/or a solution where spacer misplacement is reduced.

- 20 In one or more embodiments of the present disclosure, a spacer is dispensed, such as dropped onto, the glass sheet surface by the dispenser while a surface of an outlet nozzle comprising the spacer outlet touches the glass sheet surface. This may e.g. enable a more cost efficient regulation solution and/or reduce the risk of spacer misplacement.

- 25 In one or more embodiments of the present disclosure, a spacer is dispensed, such as dropped onto, the glass sheet surface by the dispenser while an end surface enclosing the outlet touches the glass sheet surface. This may e.g. enable a more cost efficient regulation solution and/or reduce the risk of spacer misplacement.

- 30 In one or more embodiments of the present disclosure, the distance adjustment motor may provide that the surface of the nozzle wall touches the glass sheet surface. This may e.g. provide a cost efficient solution and/or a control solution that may be easily adapted.

In one or more embodiments of the present disclosure, the distance controller may move the outlet away from the glass sheet surface after a spacer has been dispensed towards the glass

sheet surface. The distance controller may then move the outlet towards the glass sheet surface again prior to dispensing a further spacer, such as a further consecutive spacer, at the glass sheet surface through the outlet at another location of the glass sheet surface.

5 Additionally or alternatively, the distance controller may in one or more embodiments of the present disclosure control the distance adjustment motor so as to move the outlet away from the glass sheet surface after a spacer has been dispensed at the glass sheet surface and prior to the relative first movement between the glass sheet surface and the spacer outlet along the glass sheet surface.

This may e.g. help to reduce the risk of spacer misplacement.

10

In some embodiments of the present disclosure, the distance between the outlet and the glass sheet surface may be controlled so as to be larger than zero when the spacer is dispensed. In other embodiments, the distance between the outlet and the glass sheet surface 3a may be controlled so as to be omitted/be zero when the spacer is dispensed.

15

The present disclosure moreover relates, in a second aspect, to a method of manufacturing a vacuum insulating glass unit, the method comprising:

providing a first glass sheet comprising a major surface,

20 dispensing a plurality of spacers on the major surface by means of one or more spacer dispensing systems, wherein the spacer dispensing system comprises:

a spacer storage comprising a plurality of spacers,

a dispenser comprising a spacer outlet for dispensing spacers collected from the spacer storage, and

25 a distance adjustment motor configured to move the spacer outlet towards and/or away from the glass sheet surface,

wherein a distance controller controls the distance adjustment motor to move the spacer outlet towards and/or away from the glass sheet surface based on output from a sensor, such as a distance sensor,

30 the method further comprising providing a second glass sheet,

sealing together the first glass sheet and the provided second glass sheet at the periphery of the glass sheets with the plurality of dispensed spacers arranged between major surfaces of the glass sheets so that a gap is provided between the first and second glass sheets, and evacuating the gap.

It is understood that in embodiments of the second aspect, the method may comprise one or more of the previously mentioned embodiments.

- 5 In one or more embodiments of the second aspect, the dispensing of a plurality of spacers comprises providing a spacer placement sequence to place a plurality of spacers at the major glass sheet surface by means of the dispenser, wherein the spacer placement sequence comprises providing a relative first movement between the glass sheet surface and the spacer outlet in a direction along the glass sheet surface by means of a displacement motor,
10 and distributing a plurality of spacers from the spacer storage with a mutual spacer distance on the glass sheet surface by means of the dispenser through the spacer outlet

- In one or more embodiments of the second aspect, the distance controller controls the distance adjustment motor to move the spacer outlet towards and/or away from the glass
15 sheet surface during the spacer placement sequence.

- The present disclosure moreover relates, in a third aspect, to a spacer dispensing station for dispensing spacers on a surface of a glass sheet during manufacturing of a vacuum insulated glass unit,
20 wherein spacer dispensing station comprises a plurality of spacer dispensing systems wherein each spacer dispensing system comprises:
a spacer storage comprising a plurality of spacers,
a dispenser comprising a spacer outlet for dispensing spacers from the spacer storage,
and
25 a distance adjustment motor configured to move the spacer outlet towards and/or away from the glass sheet surface,
wherein the spacer dispensing station moreover comprises:
a glass sheet support,
a displacement motor configured to provide a relative movement between a major glass sheet
30 surface of a glass sheet on the glass sheet support and the spacer outlets in a direction along the major glass sheet surface,
a plurality of sensors, such as distance sensors, and
one or more distance controllers,

wherein the spacer dispensing systems and the displacement motor are configured to be controlled to provide a spacer placement sequence comprising providing relative movement between the glass sheet surface and the spacer outlet in a direction along the major glass sheet surface by means of the displacement motor, and distributing a plurality of spacers
5 from the spacer storage with a mutual spacer distance on the glass sheet surface by means of the dispensers through the spacer outlets,

wherein the one or more distance controllers is/are configured to control the distance adjustment motors individually so as to individually move the respective spacer outlet towards and/or away from the glass sheet surface during the spacer placement sequence
10 based on output from the sensors. This may in some embodiments be provided so that the distance between the individual spacer outlet and the glass sheet surface is adapted to the local surface topology of the major glass sheet surface opposite to the spacer outlet one or more times, such as continuously, during the spacer placement sequence.

15 In one or more embodiments of the third aspect, said distance controllers are configured to control the distance adjustment motor so as to reduce the distance between the outlet and the glass sheet surface so that a surface facing the sheet glass surface touches the glass sheet surface, and wherein the distance controller is configured to stop the distance adjustment motor when output from the sensor indicates that the surface touches the glass sheet surface.

20 In one or more embodiments of the third aspect, the one or more distance controllers are configured to control the distance adjustment motor so as to reduce the distance between the respective outlet and the glass sheet surface, wherein the distance controller is configured to stop the distance adjustment motor prior to a surface, such as an outlet surface, facing the
25 sheet glass surface, touches the glass sheet surface.

In one or more embodiments of the third aspect, said surface facing the glass sheet surface may be a surface of the spacer outlet.

30 In one or more embodiments of the third aspect, the surface facing the glass surface may be a surface of a nozzle wall of an outlet nozzle comprising the spacer outlet, such as an end surface of a nozzle wall enclosing the outlet.

In one or more embodiments of the third aspect, the outlet may be integrated in, or is attached to, a housing of the dispenser.

In one or more embodiments of the third aspect, the sensor comprises at least one of:

- 5 • at least one current measuring circuitry, such as wherein the measured current reflects the consumption of electric current used in order to move the spacer outlet (16) towards the glass sheet surface (3a),
- at least one force sensor, such as a strain gauge sensor or a piezoelectric sensor
- at least one switch, such as a MEMS switch or an electromechanical switch,
- 10 • at least one proximity sensor
- at least one optical sensor such as a fibre-optical sensor

In one or more embodiments of the third aspect, the sensor is a distance sensor.

- 15 In some embodiments, the spacer outlets in the dispenser array may be configured to be displaced horizontally relative to the adjacent outlet of the array. This may e.g. enable adjustment of the mutual spacer distance between adjacent spacers at the surface.

- 20 In one or more embodiments of the third aspect one or more dispensers of the array are configured to be displaced horizontally relative to one or more adjacent dispenser(s) of the array by means of a displacer, such as in a direction transverse to the direction of the first movement.

- 25 In one or more embodiments of the third aspect, the distance controller is configured to move the outlet away from the glass sheet surface after a spacer has been dispensed towards the glass sheet surface, and wherein the distance controller is configured to move the outlet towards the glass sheet surface again prior to dispensing a further spacer, such as a further consecutive spacer, at the glass sheet surface through the outlet at another location of the glass sheet surface.

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In one or more embodiments of the third aspect, the distance controller may be configured to control the distance adjustment motor so as to move the outlet away from the glass sheet surface after a spacer has been dispensed at the glass sheet surface and prior to the relative

movement between the glass sheet surface and the spacer outlet in the direction along the glass sheet surface. For example during the spacer placement sequence.

5 In one or more embodiments of the third aspect, said individual movement of the respective spacer outlet towards and/or away from the glass sheet surface during the spacer placement sequence may be configured to be provided so that the individual spacer outlet is adapted to the local surface topology of the major glass sheet surface opposite to the spacer outlet one or more times, such as continuously, during the spacer placement sequence. In some situations, glass sheets, such as thermally tempered glass sheets, may have a varying surface
10 topology. The sensor may help to provide that the distance controller may provide adaption according to the local glass surface conditions opposite the outlet.

In one or more embodiments of the third aspect, the distance controller may be configured to control the distance between the glass sheet surface and the spacer outlet to be less than a
15 spacer height of the spacers. This may at least be provided while the spacers are delivered to, such as dropped onto, the glass sheet surface by the dispenser.

In one or more embodiments of the third aspect, the spacer dispensing station is used in the method according to one or more of the above or below mentioned aspects and/or
20 embodiments.

In one or more embodiments of the third aspect, the spacer dispensing station is used during the spacer placement sequence according to one or more of the above mentioned methods or
25 embodiments.

In one or more embodiments of the third aspect, the spacer dispensing station provides the method according to one or more of the above described embodiments or is used in the method according to one or more of the above described embodiments.

30

The present disclosure relates, in a fourth aspect, to a method of manufacturing a vacuum insulating glass unit. The method comprises providing a first glass sheet comprising a major surface, and dispensing a plurality of spacers on the major surface by means of one or more spacer dispensing systems. The spacer dispensing system comprises:

- a spacer storage comprising a plurality of spacers,
a dispenser arrangement comprising a spacer outlet for dispensing spacers from the
spacer storage, and
a distance adjustment motor configured to move the spacer outlet towards and/or away
5 from the glass sheet surface.

- The dispensing of a plurality of spacers comprises providing a spacer placement sequence to
place a plurality of spacers at the major glass sheet surface by means of the dispenser
arrangement. The spacer placement sequence comprises providing a relative first movement
between the glass sheet surface and the spacer outlet in a direction along the glass sheet
10 surface by means of a displacement motor, and distributing a plurality of spacers from the
spacer storage with a mutual spacer distance on the glass sheet surface by means of the
dispenser arrangement through the spacer outlet. A distance controller controls the distance
adjustment motor to increase or decrease the distance between the spacer outlet and the glass
sheet surface during the spacer placement sequence based on output from a sensor. The
15 method further comprises providing a second glass sheet, sealing together the first glass
sheet and the provided second glass sheet at the periphery of the glass sheets with the
plurality of dispensed spacers arranged between major surfaces of the glass sheets so that a
gap is provided between the first and second glass sheets, and evacuating the gap.
- 20 In one or more embodiments of the fourth aspect, the method may comprise one or more of
the features of one or more of the embodiments described above, such as in relation to the
first, second or third aspect.

Figures

- 25 Aspects of the present disclosure will be described in the following with reference to the
figures in which:
- figs 1a-2a : illustrates a dispenser for dispensing spacers according to embodiments of the
present disclosure,
figs. 2a-2b : illustrates a spacer comprising predefined, pre-shaped contact surfaces
30 according to embodiments of the present disclosure,
figs. 3a-3c : illustrates a spacer collection and dispensing process according to various
embodiments of the present disclosure,

- figs. 4a-4b : illustrates a dispenser comprising a vacuum path according to various embodiments of the present disclosure,
- fig. 5 : illustrates a dispenser comprising a sensor system according to embodiments of the present disclosure,
- 5 fig. 6 : illustrates a repeated travel path of a collection hole of a dispenser according to embodiments of the present disclosure,
- fig. 7 : illustrates a curved traveling path of a collection hole at the bottom of a spacer storage compartment according to embodiments of the present disclosure,
- figs. 8-9 : illustrates side wall surfaces enclosing a spacer storage compartment which narrows towards a collection sheet, according to embodiments of the present disclosure,
- 10 fig. 10 : illustrates a dispenser array according to embodiments of the present disclosure,
- fig. 11 : illustrates a dispenser system according to embodiments of the present disclosure,
- 15 fig. 12 : illustrates a distance controller configured to control a distance adjustment motor according to embodiments of the present disclosure,
- fig. 13 : illustrates a quick release locking system according to embodiments of the present disclosure,
- 20 fig. 14 : illustrates a dispenser comprising an outlet nozzle,
- fig. 15 : illustrates an embodiment of the present disclosure wherein holes are chamfered, according to embodiments of the present disclosure,
- fig. 16 : illustrates a spacer dispenser comprising a vibrator,
- fig. 17 : illustrates a Vacuum Insulating Glass (VIG) unit according to embodiments of the present disclosure,
- 25 fig. 18 : illustrates a manufacturing line for manufacturing VIG units according to embodiments of the present disclosure,
- fig. 19 : illustrates a glass sheet having a major glass sheet surface that has been subjected to a spacer placement sequence provided by means of one or more dispensers, according to embodiments of the present disclosure,
- 30 fig. 20 : illustrates one or more dispensers in a dispenser array configured to be displaced horizontally relative to an adjacent dispenser,
- fig. 21 : illustrates static charge reduction, according to embodiments of the present disclosure,

- fig. 22 : illustrates schematically a dispensing array comprising a plurality of dispensing systems according to further embodiments of the present disclosure,
- figs. 23a-23b : illustrates a quick release locking system according to further embodiments of the present disclosure,
- 5 fig. 24 : illustrates a microscopic image of a spacer according to embodiments of the present disclosure,
- fig. 25 : illustrates a collection sheet comprising a chickened centre part according to embodiments of the present disclosure,
- 10 figs. 26-27 : illustrate various embodiments of predefined, pre-shaped, flat, such as plane, contact surfaces of a spacer, according to further embodiments of the present disclosure,
- fig. 28 : illustrates a spacer maintaining arrangement configured to maintain a spacer in position at a glass sheet surface according to embodiments of the present disclosure,
- 15 fig. 29 : illustrates a magnet configured to attract a spacer from a spacer storage and into a collection hole, according to embodiments of the present disclosure, and
- figs. 30a-32b : illustrates adjustment of a distance between an outlet and a glass sheet surface based on output from a sensor, according to various embodiments of the present disclosure where a surface touches a glass sheet surface.
- 20

Detailed description

- 25 Figs. 1a and 1b illustrates schematically and in perspective a dispenser 10 according to embodiments of the present disclosure for dispensing spacers 2 onto a glass sheet for use in a Vacuum insulating glass unit, also referred to as a VIG unit.

Fig. 1a illustrates an exploded, unassembled view of the dispenser 10, so that the different parts of the dispenser according to various embodiments can be seen. Both in fig. 1a and 1b, a bottom part of the housing 12b comprises a cut-out in a wall 19 for viewing purpose only, so that the structure of the lower part of the dispenser 10 is more visible, also after assembling. Hence, it is understood that the wall 19 may be annular and substantially complete.

30

As can be seen, the dispenser comprises a housing 12. The housing 12 comprises an upper part 12a such as a body part 12a and a bottom part 12b. The upper body part 12a is configured to be attached to the lower body part 12b by mechanical fastening means 26, such as releasable fastening means such as one or more threaded bolts, screws, clips or the like. The fastening means in fig. 1a and 1b comprises bolts, and the upper body part 12a comprises through going holes 26a through which the bolts extends, and the bottom part 12b comprises threaded holes 26b in the outer wall 19 for receiving and engaging with the bolts 12a. Thereby, the upper body part 12a can be attach to the bottom part 12b to form the dispenser housing 12 as seen in fig. 1b.

The upper body part 12a comprises a spacer storage compartment. This storage compartment is configured to store a plurality of spacers 2 therein. The spacers for VIG units are small (ad explained in more details below), such as having a spacer height H1 less than 0.4 mm, such as less than 0.25 mm, for example 0.2 mm or less. More than 10.000, such as more than 20.000, for example more than 40.000 spacers may be stored in the storage at the same time.

A guidance space 13 is placed between the upper body part 12a of the housing 12 and the bottom part (12b) of the housing. In the embodiments of figs. 1 and 1a, the guidance space 13 is placed between a first housing surface 17a of the upper body part 12a of the housing 12 and a second housing surface 17b of the bottom part 12b of the housing 12. Hence, when the upper body part 12a and the bottom part are assembled, the guidance space is defined/provided.

As can be seen, the annular wall 19 of the bottom part 12b may extend around and encircle/enclose the guidance space when the dispenser is assembled.

The dispenser also comprises a disc shaped collection sheet 15. In this embodiment, the collection sheet comprises/describes a circular outer periphery 15d, and comprises a first major surface 15b facing the upper body part 12a and a downwardly facing, oppositely directed, major surface (not visible in fig. 1a and 1b) facing the bottom part 12b. The major surfaces of the collection disc are preferably parallel.

The size such as the diameter and thickness TH1 of the collection sheet 15 is adapted so that the collection sheet 15 can be rotated around its centre CDC in the guidance space 13, around a rotation axis RAX. Hence, the major surfaces of the collection sheet 15 comprises/defines a plane that are substantially perpendicular to the rotation axis RAX. The rotation axis RAX is preferably arranged to extend through the collection sheet centre CDC.

A shaft extends through the upper body part 12a and may be connected/attached to the upper body part by means of a bearing 27a such as roller bearing or another suitable type of bearing that enables relative rotation between the housing 12 and the shaft 27 around the rotation axis RAX. The rotation axis is in fig. 1a and 1b coincident with a centre axis of the housing, but in other embodiments, the rotation axis may be displaced relative to a centre axis of the housing.

The collection sheet 15a may as illustrated e.g. have hole or the like at the centre CDC, to enable fastening of e.g. a shaft or the like to the collection sheet 15. As can be seen, the bottom wall 24 of the bottom part 12b may be provided with a recess or a hole (the latter being illustrated in fig. 1a) at the centre, so as to e.g. enable space for a fastening part (not illustrated) for fastening the collection sheet 15 to a shaft 27a at the centre CDC. The hole 12b1 may hence be arranged at the centre of the bottom wall 24a. It is understood that the bottom wall 24a in fig. 1a comprises the major surface 17b for facing the guidance space 13 upon housing part 12a, 12b assembly.

As can be seen, the outer periphery of the housing 12 is circular and has an outer diameter D2, and the housing 12 may as illustrated be substantially cylindrical. Here, the outer sidewall 12c of the dispenser extending between top 12to and bottom 12bo of the dispenser housing is curved to provide the cylinder shape. However, in other embodiments, the outer side wall 12c of the housing 12 may have another shape (not illustrated in figs 1a and 1b), e.g. rectangular, for example square shaped or the like and have a width that may also be referred to as D2.

The housing 12 may in embodiments of the present disclosure have a maximum width D2, such as a maximum outer diameter, that is 50 mm or less, such as 40 mm or less, for example 30 mm or less. The housing 12 may in embodiments of the present disclosure have

a maximum width D2 that is between 20 mm and 70 mm, , such as between 20 mm and 50 mm. such as between 25 mm and 45 mm for example 30 mm.

5 The width D2 may in an embodiment of the present disclosure be determined/defined along a plane extending in a direction transverse to, such as perpendicular to, the rotation axis RAX1.

The maximum width D2 may in an embodiment of the present disclosure be determined/defined in a direction transverse to, such as perpendicular to, the rotation axis RAX1, such as in a direction extending transverse to, such as perpendicular to, the rotation axis RAX1.

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The bottom part 12b comprises a spacer outlet 16 for dispensing spacers one at a time towards a glass sheet surface. The spacer outlet is arranged in the major surface 17b facing towards the upper body part 12a and the collection sheet 15.

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The as can be seen from fig. 1b, the collection sheet 15 is arranged in the guidance space between 13 between the surfaces 17a, 17b. The collection sheet 15 comprises a collection hole 15a extending between the opposing major surfaces 15b, 15c (15 c not illustrated in figs 1a and 1b) of the collection sheet 15. The collection hole 15a is a through hole allowing a spacer to enter through the collection hole 16. In fig. 1, the collection sheet comprises a single collection hole 15a. In other embodiments, the collection sheet 15 may comprise a plurality of collection holes 15a, e.g. distributed with a mutual distance of e.g. π (pi), $\frac{1}{2}\pi$ or less. For example, the collection sheet may comprise 3 collection holes arranged with 120° there between, four collection holes arranged with 90° there between or the like. The collection sheet 15 may comprise between one and ten collection holes 15a, such as between one and six collection holes, such as between two and six collection holes (not illustrated). However, it is understood that the collection sheet 15 may also comprise just one collection hole 15a as illustrated.

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It is understood that in embodiments of the present disclosure, one or both surfaces 17a, 17b may be uncoated or coated. If the surface(s) 17a, 17b is/are coated, they may be coated e.g. by an electrically conducting layer or an electrically substantially electrically un-conducting layer. In additional or alternative embodiments, if the surface(s) 17a, 17b is/are coated, the

coating may comprise a friction-reducing layer such as a polymer, such as Polytetrafluoroethylene (PTFE) or other suitable materials. It is understood that in embodiments of the present disclosure, one or both surfaces 15b, 15c of the collection sheet may be coated or uncoated. If these/this surface(s) 17a, 17b is/are coated, the coating may e.g. comprise a friction-reducing layer such as a polymer, such as Polytetrafluoroethylene (PTFE) or other suitable materials. In embodiments the coating may comprise a magnetic material.

The collection sheet 15 provides a bottom part of the spacer storage compartment 11, and hence a plurality of the spacers 2 in the storage compartment are configured to be in touch with and support on the major surface 15b of the collection sheet, such as due to gravity. Hence, the size and/or shape of the spacer storage compartment 11 proximate the collection sheet 15 provides that a plurality of spacers are in touch with the surface 15b. Hence, e.g. more than 50, such as more than 200, such as more than 500 or more than 1000 spacers may be in touch with the collection sheet surface 15b.

In fig. 1b a relative rotational movement between the collection sheet 15 and the housing 12 is provided by keeping the housing 12 un-rotating/stationary (with respect to at least rotation). The disc shaped collection sheet 15 is rotated inside the guidance space 13 by means of the shaft 27 and a driver motor 18 such as an electrical motor 18, such as a servo motor, stepper motor or the like. In other embodiments of the present disclosure, the relative rotational movement between the collection sheet 15 and the housing 12 may be provided by keeping the collection sheet un-rotating/stationary (with respect to at least rotation) and instead rotate the housing and hence the spacer outlet 16 by means of a driver motor 18.

The relative rotation around the rotation axis RAX provides that the collection hole 15a enters into the bottom of the spacer storage compartment 11 with the spacers in the storage compartment resting on the surface 15b. Hence, a relative movement between the spacers 2 at the bottom of the compartment 11, which supports on the surface 15b of the collection sheet in the compartment 11, and the collection sheet surface 15b, is provided. Hence, a spacer 2 is collected in the collection hole 15a during the rotational movement when the collection hole 15a “moves through”/swipes the compartment 11 bottom. The collection hole 15a then leaves the spacer storage bottom (with a collected spacer therein) and enters the

guidance space 13 again at a guidance space entrance 13a due to a further rotation around the rotation axis RAX.

The dispenser hence dispenses collected spacers consecutively through the spacer outlet 16.

5

One or more of the housing top part 12a, bottom part 12b and/or the collection sheet 15 may in embodiments of the present disclosure be made from metal such as steel, such as stainless steel, brass or aluminium. In some embodiments, the entire housing 12 and the collection disc 15 may be made from the same metal material or from different metal materials.

10

Figs. 2a and 2b illustrates schematically a spacer 2 to be dispensed by the dispenser 10, according to embodiments of the present disclosure. Reference is also made to fig. 24 where a microscopic picture of a spacer embodiment is illustrated.

15 The spacer 2 comprises opposing predefined, pre-shaped contact surfaces 2a, 2b which are the contact surfaces for contacting and separating glass sheet surfaces facing the evacuated gap of a VIG unit. In fig. 2a and 2b, the contact surfaces 2a, 2b are flat.

The spacer 2 has a spacer height H1 extending between the predefined contact surfaces 2a, 20 2b. This height H1 may in embodiments of the present disclosure be less than 0.4 mm, such as less than 0.25 mm, for example 0.2 mm or less.

As can be seen, the spacer have a width W1. As the spacer 2 in embodiments of the present disclosure may have an outer circular side periphery (see fig. 2b) described by the side 25 surface/side edge surface 2c extending between the contact surfaces 2a, 2b, the width W1 may be a diameter.

In embodiments of the present disclosure, the maximum width W1, such as the maximum diameter, of the spacer 2 may be larger than the height H1 of the spacer 2, such as at least 30 1.3, times, such as at least 1.5 times or at least 1.8 times larger than the height H1 of the spacer 2.

The spacer side surface 2c as illustrated extends between the contact surfaces 2a, 2b, and may as illustrated, in embodiments of the present disclosure, be curved and convexly

extending, such as bulging, between the contact surfaces 2a, 2b. Hence, the width W2 (such as diameter) of the contact surfaces 2a, 2b may be less than the maximum width W1 (such as diameter) of the spacer 2. For example, the width (such as diameter) W2 of the contact surfaces 2a, 2b may be less than 0.95 times, such as less than 0.8 times, for example less than 0.6 times the maximum width W1 (such as diameter) of the spacer 2.

In some embodiments, the width W2 (such as diameter) of the contact surfaces 2a, 2b may be larger than 0.4 times, such as larger than 0.5 times, for example larger than 0.6 times the maximum width W1 (such as diameter) of the spacer 2.

In some embodiments, the width W2 (such as diameter) of the contact surfaces 2a, 2b may be less than 0.7 times, such as less than 0.6 times, for example less than 0.5 times the maximum width W1 (such as diameter) of the spacer 2.

The thickness TH1 of the collection sheet 15 may in embodiments of the present disclosure be within $\pm 15\%$, such as within $\pm 10\%$, such as within $\pm 5\%$ or within $\pm 3\%$ of the spacer height H1.

The thickness TH1 of the collection sheet 15 may in embodiments of the present disclosure be 1.4 times or less of the spacer height H1.

The thickness TH1 of the collection sheet 15 may in embodiments of the present disclosure be less than the spacer height H1. The thickness TH1 of the collection sheet 15 may in embodiments of the present disclosure be between 1 and 1.4 times the spacer height H1, such as between 1 and 1.3 times the spacer height H1, for example between 1 and 1.15 times the spacer height H1.

The spacer 2 may be made from a metal, such as steel, such as stainless steel, or iron, or a polymer material. The spacer may be made from a material that provides no or low outgassing in the evacuated gap of the VIG unit, in order to maintain the desired vacuum integrity of the VIG unit.

As can be seen, the collection sheet 15 comprises an upwardly facing first major surface 15b and a downwardly facing, oppositely directed second major surface 15c.

5 The second housing surface 17b facing towards the top 12to of the housing may in embodiments of the present disclosure cover a major part of the major surface of the collection disc. For example, the surface 17b may in embodiments of the present disclosure cover at least 85% or at least 90%, such as at least 98% of the surface area of the second major surface 15c of the collection sheet.

10 The first housing surface 17a facing the bottom part with the spacer outlet 16 may in embodiments of the present disclosure cover at least 40%, such as at least 60%, such as at least 75% of the surface area of the first major surface 15b of the disc shaped collection sheet 15.

15 One or more of the spacer storage compartment 11 and optional holes for sensors, pressurized air and/or the like may cause a reduced covering of the surface 15b by the surface 17a compared to the covering of the surface 15c by the housing surface 17b.

20 The collection sheet 15 has an outer maximum disc diameter (D1) and the housing 12 has a width D2, such as a diameter, which is larger than the collection sheet diameter D1.

25 The housing 12 encloses at least 80% such as at least 95 %, such as e.g. more than 99% of the outer periphery 15d of the disc shaped collection sheet 15. The housing may in embodiments of the present disclosure fully enclose the outer periphery 15d of the collection sheet 15. This may be provided by means of the wall 19 part, such as an annular wall part, that is arranged opposite to the outer periphery 15d of the disc shaped collection sheet 15. The wall part 19 may be part of, such as unitary with the bottom part 12b as illustrated, or May be unitary with the upper body part 12a.

30 The guidance space 13 may be obtained upon assembly of the upper housing part 12a and the lower bottom part 12b.

Figs. 3a-3c illustrates schematically a spacer collection and dispensing process according to various embodiments of the present disclosure. Here, a spacer collection is provided when

the collection hole 15a moves through/swipes the storage 11 bottom to collect a spacer 2, see fig. 3a. The collected spacer 2 enters the guidance space (see fig. 3b) at an entrance 13a, and the collected spacer 2 is dispensed through the spacer outlet 16 at the dispenser bottom 12bo (se fig 3c), according to various embodiments of the present disclosure.

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In fig. 3a, the collection sheet 15 is rotated which provides that the collection hole 15 moves into the spacer storage compartment 11 at the bottom and moves relative to the plurality of spacers 2 in the storage compartment 11. This movement provides that a spacer 3 enters into the collection hole 15a. The collection hole has a width that enables only one spacer to move into the collection hole 15a, and a height that is 1.4 times the spacer height H1 or less, such as substantially corresponding the spacer height.

The diameter/width of the collection hole (It may be a circular hole) is fitted to be larger than the spacer width W1 such as spacer diameter. However, not larger than preventing two spacers 2 from entering into the collection hole at once. For example, the collection hole 15a may have a width, such as a diameter that is between 1.01 and 1.6 times, such as between 1.1 and 1.5 times, for example between 1.2 and 1.4 times the spacer width W1.

In some embodiments of the present disclosure, the collection hole 15a may have a maximum width such as diameter that is between 0.01–mm - 0.3 mm larger, such as between 0.05–mm - 0.2 mm larger, for example between 0.08–mm - 0.13 mm larger than the spacer width W1 such as spacer diameter. For example, for spacers with a diameter of 0.5 mm, the collection hole diameter may be 0.6 mm, i.e. 0.1 mm larger than the spacer diameter.

The spacers 2 in the spacer storage compartment 11 may in embodiments of the present disclosure be randomly intermixed and randomly orientated (e.g. as illustrated). This may be provided by loading, pouring or the like the spacers into the storage compartment. When the collection hole 15a enter through the bottom of the spacer storage 11, this movement may help to provide that one of the randomly intermixed and randomly orientated spacers 2 enters into/is collected by the collection hole.

The collection sheet 15 (and the collection hole 15a) moves due to the rotation around the rotation axis RAX (see fig. 1b) further through the compartment 11 bottom, now with the collected spacer 2 preventing further spacers of the storage 11 from entering into the

collection hole. A predefined, pre-shaped, such as flat, contact surface 2a or 2b of the collected spacer 2 supports on the bottom part surface 17b facing the collected spacer and being arranged opposite the major surface 15c of the collection sheet 15 and slides over the surface 17b.

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In fig. 3b, the spacer enters the guidance space 13 at a guidance space entrance 13a. The spacers 2 in the storage 11 has the maximum spacer width W1 and spacer height H1. The guidance space 13 has a height H2 that is less than 1.4 times the spacer height H1. Also, the height H2 of the guidance space 13 may be smaller than the spacer width W1, at least at the edge 28 at the entrance 13a.

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In embodiments of the present disclosure, the guidance space 13 has a height H2 at the collection hole entrance 13a to the guidance space 13 from the spacer storage compartment 11 which is less than 1.4 times the spacer height H1, the height H2 of the guidance space 13 at the entrance is smaller than the spacer width W1. This height may be substantially constant for the entire guidance space 13 between the surfaces 17a, 17b, or may at least be the case/present for/at the collection hole entrance 13a to assure that only one spacer enters the guidance space. In some embodiments, the height H2 may be larger at other locations than at the entrance 13a.

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The edge 28 of the housing 12 proximate the guidance space 13 (and the surface of the housing above the entrance 13a) at the entrance 13a will, due to the said guidance space 13 height H2, retain/detain spacers 2 in the spacer storage compartment 11. This helps to provide that only one spacer 2 at the time is allowed to enter into the guidance space, and that spacer 2 is the spacer collected in the collection hole 15a.

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Hence, the distance between the surface 15b of the collection sheet 15 and the housing surface 17a is less than the spacer height H1, such as less than half of the spacer height.

30 In embodiments of the present disclosure, guidance space 13 has a height H2 that is between 1.05 and 1.4 times, such as between 1.1 and 1.3 times the spacer height H1.

It is understood that in embodiments of the present disclosure, the spacers 2 may have a spacer height H1 of less than 0.5 mm such as less than 0.3 mm, such as less than 0.25 mm. For example, the spacer height H1 may be 0.2 mm or less.

- 5 The surfaces 17a and 17b may help to maintain guidance of the collection sheet 15 and the collected spacer 2, and/or help to maintain collection sheet integrity and/or shape over time.

In embodiments of the present disclosure, the height H2 of the guidance space 13 is less than 0.5 mm, such as less than 0.3 mm, such as less than 0.25 mm

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In embodiments of the present disclosure, the height H2 of the guidance space 13 is less than 1.5 times, such as less than 1.3 times the thickness TH1 of the disc shaped collection sheet 15.

- 15 In fig. 3c, the spacer has been moved to be aligned with/opposite to the spacer outlet 16 at the bottom part 12b in the bottom 12bo of the housing 12. This provides that the collected spacer 2 is dropped into the spacer outlet 16 from the collection hole 15a, and from there out of the spacer outlet. The spacer outlet 16 may in embodiments of the present disclosure be larger than the collection hole, which may increase the chance of the spacer 2 dropping into
20 the outlet 16 from the collection hole 15a. The collection hole hence both provides a collection sheet inlet for a spacer at the spacer storage, and a collection sheet outlet at the spacer outlet 16.

- Gravity may induce the dropping of the collected spacer into the spacer outlet, but one or
25 more of applied vibrations, pressurized air and/or the like may in further embodiments of the present disclosure help the spacer 2 to drop into the outlet.

- As can be seen, the spacer 2 is designed with the predefined, pre-shaped contact surfaces 2a, 2b. These 2a, 2b are shaped so that when the dispenser 10 dispenses the spacer 2, the spacer 2 will generally land on the glass sheet surface 3a and support on one of the first and second
30 contact surface 2a, 2b.

In some embodiments, if the side edge surface (see e.g. figs. 2a and 2b and other figures described further below) are convexly shaped and extending between the contact surfaces,

this may increase the chance of the spacer not staying at the side surface 2c when it is dispensed.

5 Figs. 4a-4b illustrates schematically and in perspective the dispenser 10 comprising a vacuum path according to embodiments of the present disclosure.

The vacuum path 21a, 21b, 21c, such as one or more vacuum channels are connected to a vacuum pump 21d, and the vacuum pump provides suction in the vacuum path so as to help a spacer 2 of the spacer storage compartment 11 to enter into the collection hole 15a.

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As illustrated in fig. 4a, the collection sheet may comprise a part 21c of the vacuum path integrated therein, in the illustrated example a such as a channel, such as a recessed channel/slit extending from the collection hole 15a and towards the periphery 15d of the collection sheet. This channel may help to provide a suction in the collection hole when the hole is arranged to collect spacer from the spacer storage 11. In fig. 4a, the collection sheet is turned upside down, and the surface 15c is the surface that will face away from the spacer storage 11 during dispenser operation.

15 In other embodiments, the vacuum channel in the sheet 15 may extend from the collection hole towards the centre portion of the collection sheet, and the vacuum path may hence e.g. be arranged together with and/or inside a shaft for rotating the sheet, or a stationary part extending from the centre of the sheet 26 dependent on the constitution of the dispenser.

25 Fig 4b illustrates an additional or alternative embodiment of the present disclosure wherein the housing 12 comprises at least a part 21b of the vacuum path.

Here the housing bottom part 12b comprises a recessed channel 21b, in the illustrated example an elongated, curving channel, arranged to abut the guidance space 13. The channel 21b provides a fluid communication between the collection hole 15a of the collection sheet 15 and a suction outlet of the housing connected to the vacuum pump 21d when the collection hole 15a is arranged at the bottom of the spacer storage compartment 11 to collect a spacer 2 from the bottom of the spacer storage compartment 11. This channel 21b may additionally or alternatively be arranged at the upper part 12a.

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The housing 12 may additionally or alternatively comprise a vacuum space, such as a vacuum channel, arranged opposite to a major surface of the collection sheet, wherein the vacuum in the vacuum space provides a suction at the collection hole 15a when the collection hole is arranged at the bottom of the spacer storage compartment to collect a
5 spacer from the bottom of the spacer storage compartment.

It is understood that in embodiments of the present disclosure, the vacuum path may be designed so that when the collection hole is not arranged at the bottom of the spacer storage compartment, but e.g. is arranged in the guidance space opposite the spacer outlet or in the
10 guidance space between opposing surfaces of the bottom part of the housing and the upper body part, the vacuum/suction in the collection hole may be reduced or omitted/prevented.

The vacuum path may comprises an elongated, curved vacuum channel 21b extending around the rotation axis RAX, such as at least 45° around the rotation axis, for example at
15 least 80° around the rotation axis RAX.

The vacuum path may comprise comprises an elongated, curved vacuum channel (21b) extending less than 270° around the rotation axis RAX, such as less than 190° around the rotation axis RAX.

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Fig. 5 illustrates schematically an embodiment of the present disclosure, where the dispenser 10 comprises a part of a sensor system. The sensor system comprises one or more sensors. 22, 23. For example one or more optical sensors, ultrasonic sensor(s) and/or the like. The sensor(s) 22, 23 is/are configured to detect if a collected spacer 2 is present in the collection
25 hole 15a, and the sensor system provides one or more sensor outputs 22a, 23a comprising information of if a collected spacer 2 is present in the collection hole 15a.

In fig. 5, the spacer sensor 22 is configured to detect if a collected spacer 2 is present in the collection hole prior to the collection hole being arranged opposite to the spacer outlet 16.
30 This may e.g. be provided during the further rotational movement provided in order to move the collected spacer from the storage 11 to the spacer outlet. The spacer sensor 22 provides a sensor output comprising information of if a collected spacer is present in the collection hole 15a.

In fig. 5, the spacer sensor 23 is configured to detect if a collected spacer 2 is present in the collection hole 15a after the collection hole has been arranged opposite to the spacer outlet 16. The spacer sensor may also be considered/referred to as an unloading sensor. The unloading sensor 23 detects if a collected spacer 2 is present in the collection hole 15a subsequent to the collection hole 15a being arranged opposite to the spacer outlet 16.

The output 22a from the sensor 22 and/or the output 22a from the sensor 23 is received by a controller 22c, such as a hardware processor 22c, such as a micro controller, microprocessor, FPGA or the like. The controller 22c can hence, based on the sensor output 22, determine if a spacer should be dispensed dependent on if a spacer is present in the collection hole 15a or not.

If a spacer 22 was detected in the collection hole by sensor 22, but a spacer was not detected by sensor 23, it may be concluded that a spacer has been collected and dispensed.

If a spacer 22 was detected in the collection hole by sensor 22, but a spacer 2 is still detected by sensor 23, it may be concluded that a spacer has clogged the or the spacer outlet 16 (in the latter case a spacer or a foreign object may clog the spacer outlet 16).

If a spacer 22 was not detected in the collection hole by sensor 22, it may be concluded that the collection sheet did not succeed in collecting a spacer from the storage 11, and a further turn around the rotation axis may be needed to try to collect a new spacer.

Hence, the controller 12c may provide a warning, a control output and/or the like so that the glass sheet will not be moved further before a spacer 2 has been collected and dispensed, it may provide a warning that the glass sheet may not have received the desired number of spacers and/or the like.

In embodiments of the present disclosure, output from the sensor system 22, 23 may be used by a counter (e.g. a counter of the controller 22c) for counting the number of spacers 2 dispensed by the dispenser.

In fig. 5, the sensor or sensors 22, 23 of the sensor system is/are arranged in and/or supported in the upper body part 12a, such as in a bore or channel 22b, 23b arranged opposite to a

major surface 15b of the collection sheet 15 facing away from the spacer outlet 16. In other embodiments of the present disclosure, the sensor or sensors, or a part thereof, may be arranged in the bottom part 12b, such as in the bottom wall comprising the surface 17b (see e.g. fig. 1a).

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The sensor 22 and/or 23 may have a detection/monitoring zone and/or monitoring/detection direction. The sensor(s) 22, 23 may be arranged so that this detection/monitoring zone and/or monitoring/detection direction is placed opposite to the travel path of the collection hole 15a to be able to detect if a spacer is present in the hole 15a. Hence, when the hole 15a travels in its travel path (or the housing is rotated dependent on the rotation solution), the hole enters in and out of the detection/monitoring zone of the sensor or sensors 22, 23. Hence, when the housing or collection sheet has rotated 360 degrees around the rotation axis RAX, it will have entered the detection zone of the sensor(s) 23, 22.

15 In some embodiments of the present disclosure, the sensor output may be correlated with information of the rotational position of the housing and/or collection sheet, for in order to determine when the collection hole should be within the monitoring zone.

20 In embodiments of the present disclosure, the sensor/sensors 22, 23 and/or a controller 22c may be calibrated or in other ways adapted to be able to distinguish between detecting the major surface 15b of the collection sheet and the surface 17b of the housing. In some embodiments, the sensor or sensors 22, 23 may be a distance sensor.

25 In embodiments, the sensor or sensors 22, 23 may e.g. be sensor(s) configured to provide different sensor output 22a 23a dependent on the characteristics of the surface 15b, 17 and or contact surface 2a/2b. Here, at least two of these surfaces may provide/comprise different surface characteristics that will trigger the sensor(s) to provide different output 22a, 23a. For example based on difference in surface structure, surface colour, surface reflection properties and/or the like. For example one of the surfaces 2a/2b, 17b, 15b may be configured so that it will return an optical sensor signal, such as a changed polarization, when compared to the returned another of the surfaces.

Fig. 6 illustrates schematically a dispenser 10 according to embodiments of the present disclosure, seen towards the housing 12 top 12to. In fig. 6, the continuous/repeated travel

path CTP of the collection hole 15a is illustrated by a dashed circle. The circle continuous/repeated travel path/travelling path CTP has the center coinciding with the rotation axis RAX. In fig. 6, the collection hole 15 is illustrated at the position where the collection hole 15a with a collected spacer enters into the guidance space 13. See also fig. 3b. The rotational angle α_2 between the collection sheet 15 and the housing 12 around the rotation axis RAX from the storage 11 (may be measured from edge 28) to align the collected spacer 2 in the collection hole 15a opposite to the spacer outlet 16 may in embodiments of the present disclosure be at least 85° , such as at least 120° , for example at least 170° .

Fig. 7 illustrates schematically a dispenser 10 according to embodiments of the present disclosure, seen towards the housing 12 top 12to. In this embodiment, the length of the curved traveling path TPS of the collection hole 15a at the bottom of the spacer storage compartment 11 is illustrated.

The length of this travel path TPS is a subset of the continuous/repeated travel path CTP for the collection hole 15 illustrated in fig. 6.

The length of the travel path TPS in the storage 11 may in embodiments of the present disclosure be at least 0.7 times, such as 0.9 times, such as at least 1.2 times, such as at least 1.8 times, the distance DIS2 between the rotation axis RAX and the outer periphery of the dispenser housing 12. For example, in fig. 7, as the housing 12 is here depicted as having a circular outer periphery, the length of the collection hole 15b travel path TPS in the storage 11 may be at least 0.9 times, such as at least 1.2 times, such as at least 1.8 times, the housing 12 radius, i.e. $D_2/2$.

In embodiments of the of the present disclosure, the length of the travel path TPS of the collection hole 15a in/across the storage bottom 11 may be more than 90° such as more than 140° such as more than 170° .

It is generally understood that the spacer storage compartment 11 in embodiments of the present disclosure may be integrated in, such as milled into, the upper part, and the storage compartment 11 comprises a loading opening spacer inlet at the dispenser housing 12 top.

In figs. 6 and 7, side wall surfaces 11a, 11b of the upper body part 12a abuts and faces the spacer storage compartment 2. The spacer storage compartment 11 is defined between the opposing side wall surfaces 11a, 11b, and the side wall surface 11b facing and enclosing a part of the spacer storage compartment 2, and which is placed proximate the rotation axis RAX is convexly shaped. In the example of figs 6 and 7, a part of the convexly shaped side wall surface 11b is shaped to be coaxial with the rotation axis RAX, in other embodiments, a part of the convexly shaped side wall surface 11b may be shaped to be non-coaxial with the rotation axis RAX. The opposing surface 11a is concavely shaped, it 11a may be shaped to be coaxial with the rotation axis RAX (as illustrated), but in other embodiments it 11a may not be coaxial with the axis RAX.

As can be seen from among others figs. 6-7, the wherein the spacer storage compartment may in embodiments of the present disclosure be elongated and extend partly around the rotation axis RAX, and this may provide that the spacer storage compartment 11 is arc shaped, and may be longer (e.g. defined by length of the travel path TPS) than it is wide. The opposing side walls are connected at end parts of the storage 11.

In embodiments of the present disclosure, the storage 11 may as e.g. illustrated in figs. 6 and 7 be shaped and placed so that the collection hole 15a enters the compartment at one storage compartment 11 end E1. The hole 15a then leaves the storage at the other/another storage compartment 11 end E2 below/opposite to the edge 28 with a collected spacer therein.

Figs. 8 and 9 illustrates schematically embodiments of the dispenser according to embodiments of the present disclosure, where the side wall surfaces 11a, 11b enclosing the spacer storage compartment 11 narrows in a direction towards the disc shaped collection sheet 15 surface 17b. This may e.g. provide a funnel shaped storage compartment 11.

Fig. 8 illustrates the dispenser seen towards the dispenser housing top 12to, and fig. 9 illustrates schematically a cross sectional view A-A of a part of the housing 12 illustrated in fig.8, seen in a direction towards the storage 11 end E2 and towards the entrance 13a for the collection hole 15a to the guidance space.

The narrowing of the walls 11a, 11b in a direction towards the disc shaped collection sheet 15 surface 15b This provides, in figs. 8 and 9, that the compartment 11, proximate the

housing top 12to may be larger than at the compartment bottom proximate the sheet surface 15b as e.g. illustrated in fig. 9.

- 5 In embodiments of the present disclosure, the volume of the uppermost 25% of the storage compartment 11 proximate the housing 12 top 12to may be at least 10% such as at least 30% such as at least 50% larger than the volume of the lowermost 25% of the storage compartment 11 proximate the sheet 15 surface 15b at the storage bottom.

- 10 This provides that over time when spacers 2 are collected from the storage 11 by means of the hole 15a, the spacers in the storage 11 will be gradually guided towards the storage bottom at the sheet surface 15a, and the funnel shape may moreover provide that the spacers at the lower parts of the storage are guided towards the travel path of the collection opening as illustrated by dashed arrows in fig. 9.

- 15 Gravity acts on the spacers 2 in the storage 11 and provides that the weight of the spacers 2 in the storage acts towards the sheet surface 15a, which may help, e.g. together with the funnel shape (if present), to increase the chance of collecting a spacer by the collection hole 15a.

- 20 Fig. 10 illustrates schematically an embodiment of the present disclosure wherein a plurality of dispensers 10 of dispenser systems 200 are arranged in an array 500, in this case side by side, transverse to the movement direction of the glass sheet (or the array 500) in a direction along the glass sheet surface 3.

- 25 Hence, the dispensers 10 of the array may dispense a row of spacers, for example simultaneously, onto the glass sheet surface. This may e.g. increase manufacturing speed when compared to using only one or a few dispensers to place the spacers at the glass sheet surface 3a.

- 30 The dispensers are arranged e.g. side by side in a dispenser distribution direction DIR2 that may be transverse to the movement MOV1 (see e.g. fig. 11) direction with which a motor or the like provides a relative displacement between the array 15 and the glass sheet 3 along the glass sheet surface 3a.

The array 50 may in embodiments of the present disclosure comprise between 4 dispensers and 80 dispensers, such as between 4 dispensers and 50 dispensers, such as between 4 dispensers and 30 dispensers. Each dispenser may be part of/comprised in an individual spacer dispensing system 200.

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The spacer dispensing systems 200 may each comprise a spacer storage 11, for example a spacer storage arranged in the housing 12 as previously described, and the storage 11 comprises a plurality of spacers 2. Moreover, the spacer dispensing system 200 may comprise a dispenser 10, such as a dispenser of the type described above in accordance with various embodiments. Each dispensing system 200 comprises a spacer outlet 16 for dispensing spacers 2 collected from the spacer storage 11, In the illustrated embodiment a spacer outlet 16 provided in a dispenser housing 12.

In fig. 10, each dispensing system 200 also comprises a distance adjustment motor 30 configured to move the spacer outlet 16 of the respective system 200 towards and/or away from the glass sheet surface 3a. In other embodiments of the present disclosure, the motor 30 may be omitted, and the outlets may hence not be moved towards or away from the glass sheet surfaces, at least not individually. The distance adjustment motor may e.g., in some embodiments, comprise an electric motor such as a servo motor or a stepper motor. In other embodiments, other motor types may be used.

Distance controllers 31 are configured to control distance adjustment motors 30 to move the spacer outlet 16 towards and/or away from the glass sheet surface 3a during the spacer placement sequence based on output 32a from a sensor 32 such as a distance sensor 32. This distance control is configured so as to adapt the surface 3a to spacer outlet 16 distance DIS1 to the local surface topology of the major glass sheet surface 3 opposite to the spacer outlet 16 one or more times, such as continuously, during a spacer placement sequence.

It is generally understood that a spacer placement sequence comprises placing a plurality of spacers 2 at the major glass sheet surface 3a by means of the dispenser(s) 10. Here, the spacer placement sequence comprises providing relative movement between the glass sheet surface 3a and the spacer outlet 6 in a direction along the glass sheet surface by means of a displacement motor 80, such as an electrical motor, and distributing a plurality of spacers 2

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from the spacer storage 11 with a mutual spacer distance DIS4 (see fig. 11) on the glass sheet surface 3a by means of the dispenser 10 through the spacer outlet 16.

5 The glass sheet is placed on a support 45, such as conveying means, for example a movable table or plate, a conveyer band or chains, rollers and/or the like, e.g. so that the surface 3a extends horizontally, and the motor 80 moves the glass sheet relative to the systems 200. In other embodiments, the motor 80 may be configured to move the array 500/system(s) 200 instead.

10 In the example of fig. 10, the array 500 may place/dispense, such as drop, a row of spacers 2 onto the surface, then the glass sheet 3 (or array) is moved a predetermined distance, a new spacer 2 row is dispensed and so on until the desired amount of spacers are distributed at the surface 3a. Instead of stepwise, predefined movement of the glass sheet or array, a continuous movement may also be provided and the dispensing of spacers may be timed
15 according to the relative displacement speed along the surface 3a.

The distance control so as to control the outlet distance DIS1 may be provided to adapt to varying glass sheet topology.

20 For example, the glass sheet 3 may be a tempered glass sheet, for example a thermally tempered glass sheet. Such glass sheets may provide advantages with regards to strength, and tempered glass sheets may be cost efficient. However, for example thermally tempered glass may have a glass sheet surface 3a with an unevenness of at least 0.1 mm, such as at least 0.2 mm, for example at least 0.3 mm.

25 In some embodiments, the glass sheet 3, 4 surface 3a, 4a unevenness may even be equal to or larger than the spacer height H1.

The distance controller 31 help to provide that the dispenser outlet 16 can get close enough
30 to the glass sheet surface 3a to reduce the risk of spacer 2 misplacement during the spacer placement sequence when arranging spacers s on the glass sheet surface.

For example, the distance setting may be set to e.g. 0.1 mm, and hence, the distance controller provides adjustment/adaption of the spacer outlet 16 to glass surface 3a distance

during the spacer placement sequence so that the outlet is maintained substantially at 0.1 mm from the glass sheet surface during spacer dispensing in spite of the glass sheet surface being uneven.

- 5 In one or more embodiments of the present disclosure, the distance controller 21 controls the distance adjustment motor 30 to move the spacer outlet 16 towards and/or away from the glass sheet surface during the spacer placement sequence based on a distance setting DSE and output from a distance sensor.

- 10 In one or more embodiments of the present disclosure, distance sensor 32 may comprise an optical sensor, such as a fibre optic sensor, or an ultrasonic sensor or another suitable type of sensor.

- The spacers 2 are placed one by one, consecutively, at the glass sheet surface 3a by means of
15 the respective dispenser, see also fig. 11. A relative movement between the glass sheet surface 3a and the spacer outlet in a direction along the glass sheet surface by means of a displacement motor is provided between each consecutive placement of a spacer by means of the dispenser.

- 20 The distance controller may comprise one or more hardware processors, such as one or more microcontrollers, Field-Programmable Gate Arrays (FPGA), Programmable Logic controllers (PLC), microprocessors and/or the like. For example, the hardware processor may comprise one or more general-purpose hardware processors.

- 25 A system controller (not illustrated in fig. 10) comprising one or more hardware processors (such as one or more of the above mentioned types) may based on a computer implemented software program and control circuitry control the movement and/or movement speed of the displacement motor and the dispensing of spacers, e.g. in order to time the spacer dispensing and start/stop and/or movement speed of the displacement motor. In some embodiments of
30 the present disclosure, the distance controller 31 and the system controller may be the same controller or may be provided by means of different hardware controllers, such as distributed hardware controllers.

For example, in some embodiments, the distance adjustment motor, such as a servo motor, may comprise a hardware controller and regulation circuitry, and may handle the distance control based on direct sensor input or sensor input supplied from another hardware controller. Such a controller may e.g. receive distance-setting input supplied from e.g. a
5 separate hardware controller.

As can be seen in fig. 10, the dashed line L1 illustrates that the dispensers 10 have been adapted in height relative to the glass sheet surface, so that each outlet 16 has substantially the same distance DIS1 to the glass sheet surface 3a, and hence, the dispensers 10 are
10 displaced/height adjusted individually relative to a horizontal plane (not illustrated).

In embodiments of the present disclosure, the distance controller(s) 31 maintains/provides a maximum distance DIS1 between the spacer outlet 16 and the glass sheet surface 3a of less than 0.6 mm, such as less than 0.3 mm, such as less than 0.2 mm based on the output 32a
15 from the distance sensor 32, at least when the spacers 2 are delivered, such as dropped, onto the glass sheet surface 3a.

In one or more embodiments of the present disclosure, the distance controller(s) 31 may maintain a minimum distance between the spacer outlet and the glass sheet surface, such as a
20 minimum distance of at least 0.05 mm, such as at least 0.1 mm during the spacer placement sequence.

It is understood that the spacer outlet may comprise an outermost outlet surface 16a facing the glass surface 3a and being proximate the glass. In the embodiment of fig. 10, this outlet
25 surface 16a is provided by a major dispenser bottom part surface 24, but it may also be provided by a spacer nozzle outlet (see fig. 14) having an outer diameter that is less than the diameter of a housing of the dispenser.

In several of the figures described above, the disc shaped collection sheet 15 is arranged at
30 the lower fourth, such as the lower sixth, such as the lower eighth of the housing 12, proximate the bottom wall 24a of the housing.

In embodiments of the present disclosure, the distance DIS3 between the glass sheet surface 3a and the major surface 15c of the collection sheet 15 facing the glass sheet surface 3a may

be less than 10 mm, such as less than 5 mm or less than 3 mm, such as less than 1 mm, at least while the spacer 2 is dropped towards the glass sheet surface. This distance DIS3 will vary together with the distance DIS1 upon distance adjustment by the motor 30.

- 5 In fig. 10 (and fig. 11) the distance controller 31 provides the control of the distance adjustment motor 30 to move the spacer outlet 16 towards and away from the glass sheet surface 3a by moving the housing 12 towards and away from the glass sheet surface 3a.

In one or more embodiments of the present disclosure, the horizontal distance between
10 adjacent spacer outlets 16 in the spacer array 500 may be between 20 mm and 70 mm, such as between 25 mm and 45 mm. This In this case, the adjacent outlets 16 are aligned and abuts the same horizontal plane.

In one or more embodiments of the present disclosure, the horizontal distance between
15 adjacent spacer outlets of more than 50% or more than 60% of the spacer outlets of the spacer dispensing array 500 may be between 20 mm and 70 mm, such as between 25 mm and 45 mm.

Fig. 11 illustrates schematically a dispensing system 200 according to further, various
20 embodiments of the present disclosure.

The distance controller 31 comprises distance regulation circuitry. This may provide closed loop distance control, such as by means of one or more of Proportional, Integral and/or derivative (PID) control. This closed loop control is based on the output 32a from the
25 distance sensor 32 and at least a distance setting DSE stored in a data storage DS during the spacer placement sequence. Naturally, other regulation settings may be stored in the data storage that may be used by the controller 31. The controller 31 hence may control the distance adjustment motor 30 based on the setting DSE and the sensor output 32a during the spacer placement sequence.

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The distance controller 31 may monitor a distance representative of a distance DIS1 between the glass sheet surface 3a and the spacer outlet 16. For example, a predefined distance may be used for the monitoring, and this distance may e.g. be larger than the distance DIS1. This may e.g. be acceptable as long as a distance offset is known.

In one or more embodiments of the present disclosure, the distance setting DSE comprises one or more distance set points such as a distance target setting or a distance range setting representing a desired distance.

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The distance sensor 32 may in embodiments of the present disclosure monitor the distance DIS1 between the glass sheet surface 83a and the spacer outlet 16 directly or indirectly.

The dispenser housing 10 is attached to a dispenser holding part 61 of the dispenser system 200. The dispenser holding part 61 is attached to or integrated in a height adjustable movable frame part 67. This part 67 that can be displaced vertically by the motor 31 relative to a fixed frame part 69. The movable frame part 67 is connected to, such as attached to, the fixed frame part 69 by means of a displaceable connection such as a rail solution, an actuator and/or the like 68. The movable frame part 67 may thus hang directly or indirectly from the fixed frame part 69. The fixed frame part may in embodiments of the present disclosure comprise a plurality of dispensing systems 200, such as an array 500 as previously described.

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The drive motor 18 may as illustrated, in embodiments of the present disclosure, be attached to the movable frame part 67.

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Fig. 11 moreover discloses an embodiment of the present disclosure, wherein the rotation axis RAX1 of the drive motor 18 is displaced, in this embodiment displaced parallel, relative to the rotation axis RAX. Hence, the dispenser system 200 may comprise an interconnecting drive arrangement 66 comprising one or more of a chain drive, belt drive, a toothed wheel system such as a gearing system and/or the like which transfers the rotary motion of the motor 18 to the collection sheet 15 through the shaft 27. The dispenser 10 is in fig. 11 placed below a movable frame part 67.

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Fig. 11 illustrates a further embodiment of the present disclosure, wherein the distance controller 31 controls the distance DIS1 between the glass sheet surface 3a and the spacer outlet 16 to be less than the spacer height H1 of the spacers 2 ($H1 > DIS1$), at least while the spacers 2 are delivered to, such as dropped onto, the glass sheet surface 3a by the dispenser. A wall surface or an edge/corner 16b of the dispenser 10, which encloses the dispenser outlet 16, prevents the dispensed spacer 2 from rolling, bouncing or the like beyond the outer

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periphery described by the outlet opening 16. The spacer outlet opening size and/or shape may thus define the maximum limit for a possible spacer movement and displacement of the spacer during dispensing the spacer, for example until the spacer rests as desired on the glass sheet surface.

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During the spacer placement sequence, the distance controller 31 may hence lift the dispenser(s) away from the glass sheet surface 3a, the displacement motor may then provide a (e.g. predefined) relative displacement $MOV1$ between the spacer outlet(s) 16 and the glass sheet, The outlet(s) 16 may then be lowered again by the distance controller 31 so that the

10 $DIS1$ between the glass sheet surface 3a and the spacer outlet 16 is less than the spacer height $H1$ of the spacers 2 ($H1 > DIS1$) while the spacers 2 are delivered to, such as dropped onto, the glass sheet surface 3a by the dispenser. This may continue until all spacers 2 have been placed on the major glass sheet surface 3a in the spacer placement sequence.

15 It is to be understood the dispenser 10 used in the system(s) 200 according to various embodiments of the present disclosure where individual distance control is provided by one or more controllers 31 as e.g. described above in relation to figs. 10 and/or 11, may in embodiments of the present disclosure be of the rotary type as e.g. described according to various embodiments above and/or further below. However, in other embodiments of the

20 present disclosure, the dispensers 11 used in the system(s) 200 where for example distance control is provided may be of another type such as of the reciprocating collection member/sheet dispenser type or another type.

The distance sensor 32 may in embodiments of the present disclosure be attached to the

25 dispenser housing, and hence move together with the housing when the motor 30 displaces the housing towards and away from the glass sheet surface 3a.

In some embodiments, the sensor 32 may be arranged in the housing 12 of the dispenser 10. In other embodiments it may be attached to/at the outside of the dispenser 10 housing. In still

30 further embodiments of the present disclosure, the sensor 32 may be attached directly or indirectly to the height adjustable movable frame part 67 for example attached to the dispenser holding part 61.

In fig. 10, the spacer dispensing array 500 comprises a plurality of spacer dispensing systems 200, for example a plurality of systems 200 as illustrated in fig. 11. A distance controller 31 provides an individual adjustment of the spacer outlet 16 of the dispenser 10 of the respective spacer dispensing system 200 of the dispensing array in a direction towards and/or away from the glass sheet surface 3a. This is based on output 32 from a plurality of distance sensors 32 during the spacer placement sequence. For example,, each dispensing system 200 may comprise its own sensor assigned to provide sensor output for use as a regulation parameter for the dispenser comprised in that system.

As can be seen from figs. 10 the plurality of spacer dispensing systems 200 of the array 500, such as all spacer dispensing systems 200 of the array 500, may each comprises an individual distance controller 31 for providing distance regulation of the spacer output 16 of the respective system.

wherein the individual distance controller 31 may hence individually, directly or indirectly, monitor the distance DIS1 between the glass sheet surface 3a and the spacer outlet 16 of the dispenser 10 of the respective individual spacer dispensing system 200 based on output from a distance sensor 32a. Each individual distance controller 31 may hence in embodiments of the present disclosure individually control the/an individual distance adjustment motor 30 to move the spacer outlet 16 of the dispenser 10 of that spacer dispensing system 200 towards and/or away from the glass sheet surface 3a, for example during the spacer placement sequence.

The individual distance adjustment by means of a distance controller may be based on sensor output 32a from an individual distance sensor 32 assigned each spacer dispensing system 200. In other embodiments, sensor output from a single sensor 32 may be used as input for regulating spacer outlets 16 of two or more systems. For example, adjacent dispensers may be placed close enough so that a single sensor input may be suitable for providing spacer outlet 16 to glass sheet surface 3a distance control. The reason for this may be that the surface variation of the surface 3a may not vary so much per distance, and/or the outlet may not be arranged so close DIS1 to the surface 3a during dispensing, that the surface variation within the spacer distance DIS4 may be critical or become an issue. Hence, for example, in some embodiments, the sensor output 32a from a single sensor 32 may be used for, for example common, distance regulation of two or more adjacent dispenser outlets of the array

500, such as for example between two and six, such as between two and four, for example between 2 and 3, adjacent distance outlets (16). This regulation may be provided by e.g. providing a single motor 30 for regulating outlet 16 to glass sheet surface 3a distance of a plurality of spacer outlet 16 of adjacent dispensers 10 during the dispensing sequence. In such embodiments (not illustrated), these dispensers may be attached to and moved by means of a common movable frame part 67.

In one or more embodiments of the present disclosure, the spacer outlets 16 of the dispensing systems 200 are arranged in a line extending transverse to, such as perpendicular to, the direction of the relative movement MOV1 between the glass sheet surface and the spacer outlet along the glass sheet surface provided by means of a displacement motor 80. In other embodiments, the outlets may be e.g. arranged staggering transverse to, such as perpendicular to, the direction of the relative movement MOV1.

Generally, in one or more embodiments of the present disclosure, the distance DIS4 between adjacent dispensed spacers on the glass sheet surface 3a along the movement direction MOV, such as between more than 50% or more than 60%, such as more than 90% of the dispensed spacers 2 may be between 20 mm and 70 mm, such as between 25 mm and 45 mm.

Generally, in one or more embodiments of the present disclosure, the distance DIS4 between adjacent dispensed spacers on the glass sheet surface 3a transverse to the movement direction MOV, such as between more than 50% or more than 60%, such as more than 90% of the dispensed spacers 2 may be between 20 mm and 70 mm, such as between 25 mm and 45 mm.

Generally, the distance DIS4 between more than 60%, such as more than 90% or more than 95% of all the dispensed adjacent spacers 2 on the glass sheet surface 3a may in one or more embodiments of the present disclosure be between 20 mm and 70 mm, such as between 25 mm and 60 mm, such as between 25 mm and 45 mm.

It is to be understood that in other embodiments of the present disclosure, no distance adjustment may be provided by means of the distance controller during the spacer placement sequence. Hence, for example, the spacer outlet(s) 16 may be maintained a predefined

distance from the support 45 (at least corresponding to the glass sheet thickness + spacer height + a smaller distance for clearance). A distance controller may hence adapt the distance DIS1 to fit the glass sheet height and spacer height, but may not provide adjustment during the spacer placement sequence as such. The smaller distance for clearance may in
5 embodiments of the present disclosure be at least half the spacer height $H1$ ($H1/2$) or at least $H1 \times 2$. It may however in embodiments be less than $H1 \times 30$ such as less than $H1 \times 20$ or less than $H1 \times 10$ or less than $H1 \times 5$.

Fig. 12 illustrates schematically an embodiment of the present disclosure, wherein the
10 distance controller 31 is configured to control the distance adjustment motor 30 to move the spacer outlet 16 within a predefined distance DIS1 adjustment range DAR based on the output 32a from the distance sensor 32 during the spacer placement sequence. The distance adjustment range DAR may in embodiments of the present disclosure be at least 0.5 mm, such as at least 1.5 mm, such as at least 10 mm.

15 The distance adjustment range DAR may in embodiments of the present disclosure be between 0.3 mm and 100 mm, such as between 0.5 mm and 60 mm, such as between 1 mm and 10 mm.

20 The distance adjustment resolution enabled by the controller 31 and the mechanical and electrical setup (see e.g. 30, 68, 67 of fig. 11) for moving the outlet 16 towards and/or away from the glass sheet may be less than 0.15 mm such as 0.1 mm or less, such as less than 0.08 mm or less than .05 mm. Hence, for example for a distance adjustment resolution of 0.1 mm, the minimum movement the distance adjustment system and the outlet 16 can provide
25 towards and away from the glass sheet surface 3a is 0.1 mm. It may be preferred that the sensor 32 provides a measurement sensitivity that is adapted to the distance adjustment range.

The distance controller 31 may comprise analog and/or digital control circuitry. For
30 example, an analog circuitry may be used for the sensor 32 output 32a, and an analog-to-digital (ADC) converter may provide transformation of the measured information into a digital signal. The ADC may be adapted to fit the desired distance DIS1 adjustment range DAR and/or desired distance adjustment resolution or vice versa.

Figs. 11 and 13 illustrates schematically embodiments of the present disclosure wherein the housing 12 of the dispenser 10 is attached to a dispenser holding part 61 of the dispenser system 200. The holding part 61 holds/fixates the housing 12 in a fixed, un-rotational position and the shaft 27 hence rotates the collection disc 15 inside the housing. If the height adjustment 31 is provided in embodiments of the present disclosure as e.g. described above, the holding part 61 may be attached to or be integrated in adjustable movable frame part 67.

The dispenser holding part 61 is separate to a shaft 27 for rotating the disc shaped collection sheet 15 and/or the housing 12 around the rotation axis RAX.

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Generally, in one or more embodiments of the present disclosure, the distance DIS1 between the spacer outlet 16 and the glass sheet surface 3a may be less than 0.3 mm, such as less than 0.2 mm, for example 0.15 mm or less while the spacer is dispensed towards the glass sheet surface.

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Fig. 13 illustrates a further embodiment of the present disclosure, wherein a quick release locking system 60 is provided for enabling quick release of the housing 12 from the system 200. In fig. 13, the quick release locking system is a spring 65 loaded locking system where the quick release locking system 60 comprises an actuation member 64 to be operated to actuate the locking system 60.

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The spring-loaded locking system comprises one or more springs 65. In fig. 13 the system comprises a compression spring, but it is understood that it in other embodiments may be or comprise a torsion spring and/or extension spring. The spring (s) 65 may e.g. be a metal spring and/or a coil spring.

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The locking system 60 may be configured for tool-less mounting and dismounting of the dispenser. For example, releasing of one or more screws or bolts by means of a screwdriver or a spanner may not be necessary.

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the quick release locking system 60 comprises one or more movable locking parts such as locking bolts 63, that is/are spring loaded by the spring 65. The locking bolt(s) 63 is/are configured to be moved between a locking position/state LOP (as illustrated) and an unlocking position/state. In the locking position/state LOP, the locking bolt(s) 63 provides an

attachment of the housing 12 of the dispenser 22 to the dispenser holding part 61 by engaging an engagement member 62 such as a strike part 62 of the housing 12. In other embodiments, the dispenser, such as the housing 12, may comprise the spring loaded member 64.

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In the unlocking position, the one or more movable locking bolts 63 disengages the engagement member 62 and thereby provides a release of the housing 12 of the dispenser 22 so as to enable removing the dispenser 10 housing 12 from the dispenser holding part 61. In fig. 13, the engagement member 62 is integrated in the housing, but the housing may also in other embodiments comprise a separate part that is attached to the housing 12 which comprises the engagement member 62.

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The actuation member 64 is configured to be pushed by means of a force (F_p), such as by hand or a pushing tool, to move the one or more movable locking bolts 63, between the locking position LOP and the unlocking position. In fig. 12, this movement will be a linear movement, but in other embodiments it may additionally or alternatively comprise a rotational movement of the actuation member 54 to switch between the locking position LOP and the unlocking position/state.

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Fig. 14 illustrates schematically a spacer outlet of the dispenser 10 according to embodiments of the present disclosure, where the dispenser outlet comprises a dispenser outlet nozzle 16x with a nozzle wall 16y extending from the dispenser towards the surface 3a. The nozzle wall 16y may e.g. be annular. The nozzle 16x wall 16y has an outer width D_3 , such as diameter, that is less than the outer housing width D_2 (see e.g. fig. 1) of the dispenser 10. For example, the outer outlet width D_3 may be less than $1/10$, such as less than $1/20$, such as less than $1/30$ of the housing width D_2 .

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The distance $DIS1$ (see e.g. fig. 10) between the spacer outlet 16 and the glass sheet surface 3a may thus be defined between that outermost outlet surface 16a provided by the nozzle wall 16y that is proximate the glass sheet surface 3a, and the glass sheet surface 3a opposite the outlet 16. The distance $DIS3$ between the glass sheet surface 3a and the major surface 15c of the collection sheet 15 facing the glass sheet surface 3a may, in some embodiments of the present disclosure, despite the presence of the nozzle 16x be less than 10 mm, such as less than 5 mm, for example less than 3 mm, or less than 1 mm.

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It is generally understood that in some embodiments of the present disclosure, the spacer outlet 16 and/or the collection hole 15a may be un-chamfered at the edge transition between a major surface of the wall 24a and/or the sheet surface(s) 15c, 15b and the respective opening 15a, 16. This is e.g. illustrated in some of the figures described above.

Fig. 15 illustrates schematically an embodiment of the present disclosure wherein both the collection hole 15a and the outlet 16 are chamfered. The chamfering is, for the collection sheet 15, in fig. 15, provided at the edge transition between the major surface 15b and the surface enclosing the collection hole.

A chamfering may additionally or alternatively (not illustrated) be provided at the edge transition between the major surface 15c and the surface enclosing the collection hole.

In fig. 15, the chamfering is provided between the major surface of the bottom wall 24a facing the collection sheet 15, and the surface enclosing the spacer outlet 16 hole.

However, it is understood that in other embodiments, the spacer outlet 16 and/or the collection hole 15a may be chamfered, for example at the edge transition between a major surface of the wall 24a and/or the sheet surface(s) 15c, 15b and the respective opening 15a, 16. The outlet 16 may additionally or alternatively (not illustrated) be chamfered at the transition between surface 16a and the wall surface 24.

Fig. 15 illustrates a further embodiment of the present disclosure, wherein the dispenser comprises a fluid outlet 40 for pressurized air. This fluid outlet 40 is may e.g. be arranged opposite to the spacer outlet 16 as illustrated. Pressurized gas is provided through the fluid outlet 40 in the housing 12 in order to provide a blowing force onto the collected spacer 2 in the collection hole to help the collected spacer leave the collection hole 15a and the outlet 16. The housing may comprise an air inlet for the pressurized air, e.g. at the top part 12a of the housing 12 (see previous figures), and an air duct/path may lead towards the outlet 40, such as an outlet nozzle, for the pressurized air.

Fig. 16 illustrates schematically a spacer dispenser 10 comprising a vibrator 46 according to embodiments of the present disclosure. The vibrator 45 is controlled by a hardware

controller to vibrate (e.g. a central system controller or a distributed controller of at a dispensing station). This provides that at least a part of the dispenser 10, such as the dispenser housing and/or the collection sheet 15 vibrates. This may in embodiments of the present disclosure help to increase the chance of a spacer moving into the collection hole.

- 5 The vibrations may be provided by the vibrator 46 while the collection hole moves through/swipes the storage 11 bottom. Additionally or alternatively, the vibrations may provide that the spacers 2 are “shaken” and moves inside the storage to chance e.g. orientation. The vibrations provided by the vibrator 46 may in embodiments of the present disclosure be above 1 Hz, such as above 100 Hz, such as above 1000 Hz. The vibrations
10 provided by the vibrator 46 may in embodiments of the present disclosure be between 0.5 Hz and 10000 Hz, such as between 1 Hz and 1000 Hz, for example between 5 Hz and 500 Hz or between 50 Hz and 1000 Hz.

- The vibrator 46 may in embodiments of the present disclosure comprise a motor with an
15 unbalanced mass such as an unbalanced flywheel. In other embodiments of the present disclosure, the vibrator 46 may be of the Linear Resonant Actuator (LRA) vibrator type.

In fig. 16, the vibrator is illustrated as being attached to the housing. In other embodiments, it may e.g. be attached to the shaft 27.

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- Fig. 17 illustrates a further embodiment of the present disclosure, wherein the spacer storage compartment 11 has a circular shape as opposed to the previously described elongated shape. the spacer storage compartment 11 may in further embodiments of the present disclosure comprise another shape such as a polygonal shape, for example a rectangular shape, a
25 triangular shape, a hexa- or pentagonal shape or the like. In still further embodiments, the compartment 11 may have a tapering shape in a direction towards the spacer exit 13a.

Fig. 17 illustrates schematically a vacuum insulated glass (VIG) unit 1 according to embodiments of the present disclosure.

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The VIG unit 1 comprises the first glass sheet 3a having a first major surface 3a, and a second glass sheet 4 comprising a second major surface 4a. These major glass sheet surfaces 3a, 4a faces each other and the evacuated gap 5. The spacers 2 arranged on the surface 3a by

means of the dispensing system(s) 200 comprising the dispenser 10 according to various embodiments described above are placed in the gap 5.

5 The glass sheets 3, 4 are sealed together at the periphery of the glass sheets 3, 4 with the plurality of dispensed spacers arranged between the major surfaces 3a, 4a in the gap 5. The sealing together of the first and second glass sheets may comprise use of an edge seal material 7 such as a solder glass edge seal material or a solder metal edge seal, or it may comprise fusing the glass sheets directly together. In some embodiments, the sealing together may comprise locally heating at least at the edge seal location, or heating the entire VIG unit
10 assembly to a desired temperature in e.g. a furnace. The sealing together of the glass sheet 3, 4 edges may provide a fused, rigid edge seal. Other airtight edge seal solutions may alternatively be provided.

15 The glass sheets 3, 4 may be annealed glass sheets or tempered glass sheets, such as thermally tempered glass sheets. One or both glass sheets 3,4 may have a thickness between 1 mm and 6 mm, such as between 2 mm and 4 mm, for example between 2,5 mm and 3,5 mm including both end points. The glass sheets 3, 4 may be of the same or different thickness.

20 The gap 5 has been evacuated to a reduced pressure. In embodiments of the present disclosure, the pressure in the gap 5 may be below 0.05 mbar, such as below 0.005 mbar, such as 0.003 or 0.001 mbar or below. This may be obtained by means of an evacuation pump (not illustrated. For this evacuation of the gap, the pump may have been connected directly or indirectly to an evacuation outlet 6, and after the evacuation, the evacuation outlet
25 6 is sealed by a sealing 6a, such as at least partly by means of a solder material. In fig. 17, the evacuation outlet 6 is illustrated in a glass sheet, in other embodiments, the evacuation outlet may be provided in the edge seal material or between the edge seal material and one of the glass sheets 3, 4. In some embodiments, the evacuation of the gap 5 may be provided by means of a suction cup arranged to cover an evacuation opening 6. In other embodiments,
30 the evacuation may be provided inside an evacuation chamber, such as where the entire VIG unit assembly is placed inside the evacuation chamber. In some situations, the sealing of the gap and/or fusing at the edges by an edge seal may also be obtained in such a vacuum chamber.

The spacers 2 placed by means of the dispenser(s) 10 maintains a distance between the glass sheet surfaces 3a, 4a across the evacuated gap when the gap has been evacuated. The distance between the glass sheet surfaces 3a, 4a may in embodiments of the present disclosure be 0.5 mm or below, such as 0.3 mm or below, for example 0.2mm or below.

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The evacuation of the gap 5 may in embodiments of the present disclosure be provided by means of one or more one or more of: a vacuum chamber, such as a vacuum chamber containing the entire VIG unit assembly therein, one or more vacuum pumps in communication with the gap, for example by means of a suction cup. Additionally, one or more getters may be arranged in the gap to provide further pressure reduction in the gap and/or to maintain vacuum integrity.

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Fig. 18 illustrates schematically a manufacturing line for a VIG unit according to embodiments of the present disclosure. The first glass sheet 3 first enters a first station 180a where edge seal material 7 such as solder glass edge seal material or metal solder edge seal material is provided to the upwardly facing major surface 3a.

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Then the glass sheet 3a is moved to a spacer placement station 180b where one or more spacer dispensers 10, such as a dispenser system array 500 as previously described, dispenses spacers onto the major surface 3a. This is provided so that the spacers 2 are provided with a mutual distance DIS4 in rows and/or columns on the glass sheet surface 3a, or in another desired pattern. The relative movement MOV1 may be provided by means of a motor 80 as e.g. previously described. The previously described spacer placement sequence to place the spacers 2 at the surface 3a may be provided at the station 180b.

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At glass pairing station 180c, the glass sheets 4 and 3 are paired by placing the second glass sheet 4 on top of the first glass sheet 3 to cover the spacers 2. The glass sheet 4 may e.g. rest on the edge seal material 7. The glass pairing station may comprise automation systems such as one or more of a robotic arm, one or more linear displacement members, one or more rails and/or the like for transporting the glass sheet 4 to the position opposite the surface 3a and lowering the glass sheet towards the surface 3a.

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After this, the edge seal material 7 of the VIG unit assembly 150 may be heated and the gap is evacuated to a reduced pressure. It is understood that the edge seal material, if even

needed, may be placed/applied subsequent to placing the spacers at station 18a instead. It may even in some embodiments be provided in an evacuation chamber or be omitted if the glass sheets are fused directly together by an glass sheet 3, 4 edge melting operation.

- 5 Fig. 19 illustrates a glass sheet 3 having a major glass sheet surface 3a that has been subjected to a spacer placement sequence provided by means of one or more dispensers 10, 500 described according to various embodiments above. In this example, the glass sheet has been provided with a full set of spacers 2 compared to the glass sheet surface 3a area. In the example of fig. 19, 18x29 spacers 2 = 522 spacers have been placed to sufficiently cover the
10 glass sheet surface to provide load distribution between the spacers 2 when the gap evacuation is provided.

- In fig. 19, the spacers 2 are placed in a rectangular pattern in rows and columns. In the example of fig. 19, if an array (see e.g. fig. 10) of dispensers 10 is provided, the array may
15 comprise at least 18 dispenser systems 200. If smaller glass sheets than the illustrated is provided, then fewer dispensers may be used in the array. If larger glass sheets are to be used, the array may in embodiments of the present disclosure comprise even more dispensers, or the array may in embodiments of the present disclosure be moved to arrange further spacers along a row than the number of dispensers in the array allows. In some
20 embodiments, the array may comprise more than 19 dispensers, such as more than 30 dispensers or the like.

- It is understood that if smaller glass sheets 3 are then to be supplied with spacers in a spacer placement sequence, and hence the number of dispensers in the array is larger than the
25 number of spacers to be arranged in e.g. a row, the number of used dispensers 10 of the array may be reduced so that some of the dispensers are unused for that glass sheet.

- Fig. 20 illustrates an embodiment of the present disclosure, wherein one or more dispensers 10 in a dispenser array 500 may be configured to be displaced horizontally MOV2 relative to
30 the adjacent dispenser(s) 10 of the array 500.

In some embodiments, the spacer outlets 16 in the dispenser array may be configured to be displaced horizontally MOV2 relative to the adjacent outlet 16 of the array 500.

The dispensing systems 200 are attached to a fixed frame part 69, such as a beam or plate, by means of or through a displacement arrangement 91 such as a rail arrangement, a linear actuator such as a spindle, piston solution and/or the like. This displacement arrangement 91 is configured to support the system 200 during horizontal displacement MOV2 relative to the frame.

The displacement direction MOV2 allowed/enabled by the displacement arrangement 91 is a relative movement between the glass sheet surface 3a and the spacer outlet 6 of the respective dispenser 10 in a movement direction MOV2 along the glass sheet surface 3a, for example substantially horizontally. The movement direction MOV2 is transverse to, such as perpendicular to, the movement direction MOV1 (see e.g. fig 11 or fig 18) provided by means of the displacement motor 80, such as an electrical motor.

A displacement motor 92, such as an electrical motor, provides the movement MOV2 of the dispensing system 200 relative to the fixed frame part 69, which movement MOV2 is guided by the displacement arrangement 91.

This arrangement 91, 92 enables adaption of the distance between adjacent dispensers 10 of the array 500 and thereby adaption of the distance (may correspond to distance DIS4) between the adjacent spacer outlets 16 of two adjacent dispensers 10. This will adapt the distance DIS4 between dispensed spacers 2.

Hence, if a glass sheet 3 is to be supplied with spacers 2, the width of the glass sheet may in some embodiments of the present disclosure not fit fully with the desired spacer distance DIS4. As one example, the glass sheet width defined between parallel glass sheet edges 3b (or distance between parallel stripes/strips of edge seal material 7) may not be dividable by the desired spacer distance DIS4 to give a whole number. In that case, adaption of the horizontal distance between one or more adjacent outlets 16 may be provided by the arrangement 91, 92, to assure that there will not be a too large distance difference DIS4 between the adjacent spacers. E.g. to obtain improved load distribution on the spacers and/or to obtain less visual noticeability of distance (DIS4) variations from humans looking at the VIG unit with the plurality of dispensed spacers 2 laid/provided by means of the dispenser(s) 10. In fig. 3, three motors 92 provides individual adaption of the horizontal distance between

three dispensers 10. This may be provided for one or both sides of the array 50. In some embodiments, all of the dispensers in the array may be adjustable MOV2 horizontally and sideways relative to the frame part 69 by means of the arrangement of one or more displacement arrangements 91 and one or a plurality of displacement motors 92. In some
5 embodiments, less than half, such as less than 25% such as less than 10% or less than 5% of the dispensers 10 of the array 500 may be individually displaceable sideways relative to the frame arrangement 69a by means of an arrangement 91, 92. In certain embodiments, just one or two, e.g. the outermost dispensers 10 in the array 500 at one or both ends/sides of the array 500 may be displaceable sideways MOV2.

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In some embodiments of the present disclosure, the movement MOV2 transverse to movement MOV1 (see fig 11) may be provided by allowing the dispenser itself 10, or the outlet (by e.g. rotating the housing 12) to be displaced horizontally towards and/or away from the adjacent dispenser 10 to chance spacer outlet 16 distance between adjacent spacers. Thereby, the distance DIS4 between some of the spacers 2 may be reduced or increased. It is
15 generally understood that in some embodiments of the present disclosure, distance adjustment towards ad away from the glass sheet surface 3a by means of a distance controller as e.g. previously described may also be enabled or provides in an array as illustrated in fig. 20. In other embodiments, such distance adjustment by one or more
20 controllers 31 may be omitted.

Fig. 21 illustrates schematically static charge reduction according to various embodiments of the present disclosure. In fig. 21, the dispenser 10, such as the housing 12 and/or collection sheet 15, is/are connected directly or indirectly to ground by means of a grounding
25 connection 70, such as e.g. by means of a grounding wire 71 or the like. In additional or alternative embodiments, the grounding connection may be provided through conducting bearings and/or the like, and through the shaft 27. Hence, for example, the grounding may be provided by means of one or more electric wires 71 from a frame part of the dispensing system and to the grounding connection 70, such as from a frame part 69 and/or 67 as
30 previously described. In other embodiments, the housing 12 may comprise a grounding wire connection terminal at e.g. the upper 12a or lower 12b part of the housing (see e.g. fig. 1a and/or 1b) for fastening or soldering a ground connection wire.

Fig. 21 illustrates a further embodiment of the present disclosure, wherein the transportation support 45 is connected directly or indirectly to ground 70, such as by means of one or more wires 72, and/or by means of bearings, metal brushes and/or the like. The ground connection 70 may as illustrated in still further embodiments be a common ground connection for the dispenser/dispensing system 200 and the transportation/support equipment 45 in order to reduce static charge between the glass sheet 3 and the dispensing system 200, such as the dispenser 10. Such grounding connection(s) 70, 71 and/or 72 and thereby reduction in static charge may e.g. help to reduce spacer dispensing and/or placing issues.

Fig. 21 illustrates a further embodiment of the present disclosure where an ionizer device 400 (one or more may be provided) is provided at a spacer dispensing station 180b comprising one or more dispensers 10 such as an array 500 of spacer dispensers as previously described. The ionizer/ionizing device 400 provides ions of controlled polarity towards the dispensing system 200 such as towards the dispenser(s) 10, and/or towards the glass sheet 3. The ions of controlled polarity may additionally or alternatively be provided towards the glass sheet handling system 45. The ionizer(s) 400 may thereby change the electrostatic potential at/in the glass sheet/handling system 45 and/or dispensing system such as the dispenser 10. The ionizing device(s) 400 may provide a pressurized flow of ions. For example, the ionizing device(s) 400 may comprise one or more ionizing bars each comprising one or more flow outlet(s) arranged so as to provide at least one line of flow outlet extending towards one or more of the glass sheet 3, dispensing system, handling system/support and/or the like. The properties of the ion flow from the ionizer bar(s) 400, e.g. charge properties, flow direction, operating length and/or the like provided by the ionizing/ionizer bar(s) may be controlled individually by one or more settings of the ionizer bar. In one or more embodiments, the ionizer bar flow outlets comprises one or a plurality of nozzles 401.

Fig. 21 illustrates a further embodiment of the present disclosure, wherein, for example in addition or as an alternative to the grounding connection 70 and/or ionizer device(s) 400, the spacers 2 may be dispensed by the dispenser 10 while the relative humidity of the ambient air surrounding the dispenser 10 is above 40%, such as above 50%, for example between 40% and 90% or between 40% and 70%. In some embodiments, the relative humidity may be determined substantially at atmospheric pressure and/or at an ambient temperature between 15°C and 30°C, such as between 18°C and 23°C, such as at 20°C. This may be

obtained by means of a humidity control system 300 which provides/controls a relative humidity of the ambient air near the dispenser 10 and glass sheet 3. In some embodiments, the humidity control system 300 may be configured to introduce water into the ambient air surrounding the VIG unit assembly 1 through one or more discharge openings of one or
5 more water discharge arrangements of the humidity control system 300.

One or more of the ionizer device(s) 400, humidity control system 30 and/or the grounding connection 70 may together or alone reduce and/or maintain a difference in electrostatic charge potential between the glass sheet 3 and the dispensing system 200, such as between
10 the between the glass sheet 3 and the one or more dispensers (10) or array 500 to be below a maximum allowed voltage value. This maximum allowed voltage value may in embodiments of the present disclosure be 10 kV, such as 8kV, such as 5 kV or 2 kV or 1 kV.

One or more of the ionizer device(s) 400, humidity control system 30 and/or the grounding
15 connection 70 may together or alone reduce and/or maintain a difference in electrostatic charge potential between the glass sheet 3 and the dispensing system 200, such as between the between the glass sheet 3 and the one or more dispensers (10) or array 500 to be below 10 kV, such as below 5kV, such below 2 kV. In certain embodiments, the maximum voltage allowed between the glass sheet 3 and the dispensing system 200, such as between the
20 between the glass sheet 3 and the one or more dispensers (10) or array 500 may be below 1kV such as below 0.5 kV.

The one or more ionizing device(s) 400, one or more humidity control system(s) 300 and/or one or more grounding connections 70, 71, 72 may be considered a charge modulation
25 system, or considered comprised in a charge modulation system for controlling the electrostatic charge potential between the glass sheet 3 (and/or glass sheet handling system 45) and the dispensing system 200, such as between the glass sheet 3 (and/or glass sheet handling system 45) and the one or more dispensers (10) or array 500 to be below a maximum allowed voltage value as e.g. disclosed above.

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In one or more embodiments, for example the ionizer bar may be omitted, and e.g. only the grounding connection(s) 70 and/or humidity control may be used.

Fig. 22 illustrates schematically a dispensing array comprising a plurality of dispensing systems 200 according to embodiments of the present disclosure. In fig. 22, the array 500 comprises 16 dispensing systems 200, but fewer or more may be provided in the array 500.

- Fig. 22 is seen towards the bottom surfaces 24 of the dispenser 10. As can be seen, the
5 dispenser comprises a dispenser housings 12 (for figure clarity, not all features are assigned a reference number), such as housing 12 for providing e.g. dust protection and/or the like as e.g. previously disclosed in relation to one or more of the figures described above.

- The spacer outlet 16 may as illustrated, in embodiments of the present disclosure, be
10 arranged in the respective dispenser housing bottom surface 24. As can be seen from fig. figure, the outlets 16 may be aligned on a line, so that they 10 dispenses a row of spacers (see e.g. fig. 19) if dispensing simultaneously and/or if the glass sheet 3 (not illustrated in fig. 22) is kept stationary/still during spacer 2 dispensing.

- 15 Fig. 22 moreover illustrates an embodiment of the present disclosure (see also fig. 11), wherein the rotation axis RAX1 of the drive motor 18 is displaced, in the present example displaced parallel relative to the rotation axis RAX for providing a relative rotation between the housing 12 and the collection disc 15 (not illustrated in fig. 22).

- 20 Hence, the dispenser system 200 may comprise an interconnecting drive arrangement 66 comprising one or more of a chain drive, belt drive, a toothed wheel system such as a gearing system and/or the like which transfers the rotary motion of the motor 18 to the collection sheet 15 through the shaft 27 which rotates around the axis RAX. An interconnecting drive arrangement (see e.g. ref. 66 of fig. 11) may comprise one or more of a chain drive, belt
25 drive, a toothed wheel system such as a gearing system and/or the like which transfers the rotary motion of the motor 18 around the axis RAX1 to a shaft or the like for rotating the collection sheet 15 inside the housing 12 (or for rotating the housing 12) around an axis RAX. Axes RAX1 and RAX may be parallel as illustrated, or they may be non-parallel, or even perpendicular, dependent on the drive system 18, 66 setup. In certain other
30 embodiments (not illustrated in fig. 22, see e.g. fig 1b), the axes RAX and RAX1 may be coincident.

The drive arrangement comprising the drive motor 18, such as an electric motor, frame parts, such as height adjustable frame parts and/or the like if present (see e.g. figs. 10 and 11) may

- as illustrated in embodiments of the present disclosure be arranged staggered on opposing sides on the extension direction DIR2 line (see dashed double arrow line DIR2) of the dispenser array 500. One or more of the motor 18, frame arrangement and/or the like may in embodiments of the present disclosure be wider than the maximum width D2, such as the diameter (see e.g. fig. 1a) of the dispenser housing 12, But the staggering arrangement of these parts may provide more room/space for arranging such a drive arrangement 18 and/or the like in the spacer placement station. The staggering arrangement may additionally or alternatively enable that the dispensers 10 may be placed closer together.
- 10 Figs. 23a and 23b Illustrates schematically a further embodiment of the present disclosure wherein the housing of the dispenser 10 is releasably attached to a dispenser holding part 61 of the dispenser system 200 by means of a quick release locking system 60. Here, the system is not spring loaded, but it may be in further embodiments of the present disclosure.
- 15 One or more actuation members 64 (in fig. 23a and 23b there is a single member 64) is arranged at the dispenser holding part 61, and is operatable to actuate the locking system 60. The quick release locking system 60 comprises one or more movable locking bolts/parts 63 that may e.g. be attached to or integrated in the actuation member 64. The actuation member 64 is configured to be moved between a locking position LOP and an unlocking position. For example by rotation and/or pushing directly by hand or by means of a tool such as a screwdriver or another suitable mechanical tool. The one or more movable locking bolts 63 in the locking position LOP provides an attachment of the housing 12 of the dispenser 10 to the dispenser holding part 61 through the interfacing part 96 by engaging one or more engagement members 62, in this case two engagement members 62.
- 20
- 25 The engagement members 62 in figs. 23a and 23b comprises two rods 95 attached to or integrated in at the dispenser housing 12, and the rods 95 may be guided into a bore or recess in the holding part 61 to engage with the actuation member and/or the locking bolts 63.
- 30 In figs. 23a and 23b, The dispenser comprises an interfacing part 96 comprising the rods 95, each rod comprising an engagement member 62, such as a conical part, one or more recesses and/or protrusions or the like for enabling and fastening of the dispenser 10 to the dispenser holding part 61 through the interfacing part 96 by means of the quick release locking system 60. The interfacing part 96 may in embodiments of the present disclosure be attached to the

housing by means of one or more mechanical and/or chemical fasteners (not illustrated) or the interfacing part 96 may be unitary with the housing 12 of the dispenser, such as an upper housing part 12a (see e.g. fig 1a). The interfacing part 96 and/or the rods 95 may as illustrated, in embodiments of the present disclosure, extend from the housing. In other
5 embodiments of the present disclosure (not illustrated), the dispenser holding part 61 may comprise the one or more rods 95 or the like, and the one or more actuation members 64 may instead be placed at or in the interfacing part 96.

The movable locking bolts/parts 63 in the unlocking position ULP disengages the
10 engagement member 62 and thereby provides a release of the housing 12 of the dispenser 10. The actuation member 64 can be displaced, such as pushed and/or rotated, by means of a force, such as by hand or by means of a hand held tool or the like to move the one or more movable locking parts 63, between the locking position LOP (fig. 23b) and the unlocking position ULP (Fig. 23a).

15 It is generally understood that in one or more embodiments of the present disclosure, the rods 95 as illustrated in fig. 23b and the locking parts 63 as illustrated in fig 13 may be considered different types of fastening parts for fastening the dispenser housing 12. Other types of fastening parts may also be used in further embodiments of the present disclosure.
20 In one or more embodiments of the present disclosure, the quick release locking system comprises three or less fastening parts 63, 95, such as two or less fastening parts 63, 95 or just one fastening part 63, 95. This may enable faster housing release and/or replacement.

In embodiments of the present disclosure the actuation member 64 may require a rotation of
25 the actuation member 64 less than 360° , such as less than 180° , for example less than 90° degrees around a rotation axis in order to either lock the dispenser 10 housing 12 in place by means of the locking system 60, or release the dispenser 10 for e.g. dispenser maintenance, spacer storage 11 filling and/or dispenser replacement. The actuation member may hence assure that the fastening part(s) is/are engaged and/or disengaged within such a rotation. In
30 some embodiments of the present disclosure, a linear movement, such as a push or pull of the actuation member 64 may provide the engagement or disengagement of the fastening part(s). such a linear movement may in embodiments be an addition to or alternative to the mentioned rotation of the actuation member 64.

Fig. 24 is a microscopic picture of a spacer 2 made from a spherical precision steel ball that has been compressed in a press (not illustrated) or the like to shape the contact surface 2a, 2b by plastic deformation. This provides that the spacer width W1 (in the illustrated example 0.67 mm) is significantly larger than the spacer height H1 (0.2 mm). As can be seen, the
5 compression of the steel ball provides that the convex side edge surfaces (2c, 2d) (imagined if looking at a cross section of the spacer), describes circular 97 arcs having non-coinciding centres C1, C2.

In other embodiments (not illustrated), ceramic balls or balls from another material may be
10 processed, such as mechanically (for example by grinding) or chemically processed to have predefined and pre-shaped, such as flat, contact surfaces 2a, 2b. The convex side surfaces 2c, 2d may here describes minor circular arcs having a coinciding centre. In still further embodiments, the spacers 2 may e.g. be cylindrical in shape and extend substantially linear between the surfaces 2a, 2b, or may have another shape.

15 It is generally understood that the spacers may be made from any suitable materials such as be made from, such as comprise or consist of metal, polymer material and/or ceramic.

In embodiments of the present disclosure, the maximum width W1, such as the maximum
20 diameter, of the spacer 2 may be at least 2 times, such as at least 2.4 times or at least 2.8 times larger than the height H1 of the spacer 2. In fig. 24, the maximum width W1, such as the maximum diameter, of the spacer 2 is about $0.668/0.204 = 3.3$ times larger than the height H1 of the spacer 2.

25 In embodiments of the present disclosure, the maximum width W1, such as the maximum diameter, of the spacer 2 may be between 1.3 and 6 times, such as between 1.5 and 6 times, for example between 2 times and 4 times larger than the height H1 of the spacer 2.

In some embodiments of the present disclosure, the maximum width W1, such as the
30 maximum diameter of the spacer may be less than 0.8 mm, such as less than 0.6 mm, such as less than 0.4 mm. In certain embodiments of the present disclosure, the diameter of the spacer may be 0.3mm or less.

In fig. 24, the width W2 (such as diameter) of the contact surfaces 2a, 2b is 0.87 times the maximum width W1 (such as diameter) of the spacer 2.

The compressive load on each of at least 50%, such as at least 70% of the spacers 2 in a VIG unit (see e.g. fig. 17 and 19) for a cylindrical spacer 2 or a spacer with curved outer side edge surfaces 2c and plane contact surface 2a, 2b as described previously, in a “square spacer grid” of 40x40 mm² (i.e. distance of substantially 40mm between neighbouring/adjacent spacers), may amount to at least 0.5 GPa, such as at least 0.8 GPa, such as substantially 1 GPa. In some embodiments, the compressive load on at least 80% or 90%, such as substantially all spacers may be between 0.5 GPa and 2 GPa, such as between 0.6 and 1.3 GPa.

It is generally understood that the tolerances for the spacers 200 in the spacer storage 11 and/or the distributed spacers may in embodiments of the present disclosure may be ± 30 micron, such as ± 20 micron, or ± 10 micron or less. For example, spacer height H1 may be 0.2 mm with a ± 30 micron, such as ± 20 micron, or ± 10 micron tolerance.

For example, maximum spacer width W1 may be for example 0.44 mm or 0.66 mm with a ± 40 micron, such as ± 20 micron, or ± 10 micron tolerance. The tolerances of the spacer width W1 may in some embodiments of the present disclosure be less restrictive than the tolerance requirements to the spacer height H1.

It may be preferred that surfaces 2a, 2b and/of spacers are shaped/designed so as not allow to trap pockets of gasses between glass surface and pillar surface, and hence the contact surface 2a, 2b flatness may in embodiments of the present disclosure be substantially flat and/or comprise one or more grooves/furrows and/or the like to reduce the risk of trapping gasses in between the glass sheet surfaces 3a, 4a and the contact surfaces 2a, 2b.

Outgassing from the spacers 2 should be minimized. Particularly outgassing of non-getterable species should be avoided for example argon.

As can be seen from e.g. fig 1a, the collection sheet 15 in embodiments of the present disclosure may comprise a single sheet of material having a substantially

continuous/constant thickness TH1 between the collection sheet centre and towards the collection sheet centre CDC.

Fig. 25 illustrates a collection sheet 15 according to further embodiments of the present disclosure, comprising a thickened part 15e at the collection sheet centre. In fig. 25, the collection sheet 15 comprises a thickened part 15e placed with a distance DIS5 from the outer sheet periphery 15d, and the thickened part 15e has a centre that is coinciding with the centre CDC of the collection sheet 15 and the rotation axis RAX. The thickened part 15e may e.g. help to increase the structural integrity of the collection sheet 15. The thickness TH1 (see fig 1) may still be the same as disclosed previously at the area of the collection hole 15a, but the thickness of the entire collection sheet 15 may change/vary between the periphery 15d and the centre CDC. The thickened part 15e may in embodiments of the present disclosure be integrated/unitary with the part of the sheet 15 comprising the collection hole 15. In other embodiments, the thickened part 15e may be attached to the sheet 15 by mechanical and/or chemical fastening means. In some embodiments, the thickened part may additionally or alternatively provide the interface between the collection sheet and a shaft 27 (not illustrated in fig. 25).

In embodiments of the present disclosure, the surface 17a part of the upper housing part 12 facing the thickened part 15e may be adapted to the shape and size of the thickened part. Hence, for the embodiment of the present disclosure, the surface 17a may have a concavely extending surface (not illustrated). In certain embodiments of the present disclosure, a vacuum channel or the like may be provided in a part of the thickened part 15e, for example in order to provide a vacuum path/duct interface between a shaft and the collection hole 15a.

Figs. 26 and 27 illustrates schematically and in cross section different surface topologies of the contact surface(s) 2a, 2b of the spacers 2 according to embodiments of the present disclosure.

In fig. 26, the surface structure of the contact surface 2a, 2b is provided due to the manufacturing method of the spacer. This may e.g. be provided by one or more of compressing, plastically deforming, moulding and/or sintering or the like of a suitable spacer material into a spacer comprising predefined flat contact surfaces. Here, the surface topology is to be considered flat, but some degree of surface variation may still be accepted. In fig. 26,

the opposite flat contact surfaces 2a, 2b has a surface shape, such as a surface roughness, that varies relative to a mean line per plane P1. In some embodiments, this variation may be less than ± 30 micron, such as less than ± 10 micron of the spacer height H1, relative to the mean line or mean plane P1 defined by the respective contact surface 2a, 2b. The mean line or plane may be defined by the average surface roughness of the respective spacer contact surface 2a, 2b. The surface roughness may e.g. be determined according to ISO 4287:1997 standard, or similar, and the contact surface variation may e.g. be an average, or arithmetic average, of surface height deviation/variation from the mean line p1. For example, this may be defined by a Ra roughness parameter.

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Fig. 27 illustrates a contact surface 2a where a certain degree of surface variation of the surface 2a is intentionally provided by furrows in order to e.g. reduce capture of air/gas in between the glass sheet surface and contact surface of the spacer. However, this may still be considered a flat contact surface.

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Fig. 28 illustrates schematically an embodiment of the present disclosure, wherein a spacer 2 maintaining arrangement 85 is configured to maintain a spacer 2 at the glass sheet surface 3a at a desired position when the spacer has been dispensed by the dispenser 10. In fig. 28, the spacer position maintaining arrangement 85 comprises a magnet, and the spacer is designed to be magnetic enough to be maintained at the desired position by means of the dispenser. For example, the spacer 2 may comprise a ferromagnetic coating and/or the structural body of the spacer 2 may be made from or comprise a ferromagnetic material.

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In some embodiments of the present disclosure, the transportation support 45 may comprise the spacer position maintaining arrangement 85 such as one or more magnets. In some embodiments the magnet(s), such as a magnet array, may be movable by a motor or another type of glass moving unit to provide a relative movement MOV1 between the glass sheet 3a and the dispenser along the glass sheet surface 3a.

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In some embodiments, the spacer 2 maintaining arrangement 85 may be considered separate to the transportation support that may move the glass sheet into and away from the dispenser.

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It is to be understood that in some embodiments, the spacer position maintaining arrangement 85 may comprise a plurality of magnets spaced apart according to the desired

spacer distance (see e.g. fig. 19). In some embodiments, if a dispenser array 500 as described according to various embodiments above is provided, a row or the like of a plurality of magnets may be placed beneath the glass sheet along the array direction DIR2 (see fig. 22).

- 5 In some embodiments of the present disclosure, the glass sheet 3 may be placed above, such as on, magnets of the arrangement 85, and for example an array 500 of dispensers 10 may be moved relative to the glass sheet surface along the glass sheet surface to dispense a plurality of spacers 2, such as at positions opposite to magnets of the arrangement 85. In some
10 embodiments, the magnets may be placed according to the desired pattern, such as a grid pattern, of spacers 2 (see fig. 19).

In embodiments of the present disclosure, the device(s) comprising the magnet(s), such as the magnet(s) itself/ themselves, may provide support for the glass sheet 3 during spacer
15 dispensing.

- 15 In fig. 28, the magnet 85 is arranged opposite to the major surface of the glass sheet 3 that faces away from the dispenser 10 and the major surface 3a receiving the spacer(s) 2, and the magnet(s) hence provides a magnetic field through the glass sheet 3 in order to maintain the spacer 2 in position.

- 20 In other embodiments of the present disclosure, the spacer maintaining arrangement 85 may comprise a template comprising holes or the like for maintaining the spacers in position.

- It is understood that the spacer 2 maintaining arrangement 85 may be considered a temporary
25 maintaining arrangement that may e.g. only be used until the spacers 2 have been placed and rests as desired on the surface 3a, hence, the spacer 2 maintaining arrangement 85 may e.g. not follow the individual glass sheet 3 through the further manufacturing steps for the VIG unit assembly, but may e.g. be placed and maintained at a spacer placement station of a VIG unit assembly manufacturing line.

- 30 Fig. 28 moreover illustrates a further embodiment of the present disclosure, wherein the distance between the spacer outlet 16 of the dispenser and the glass sheet surface 3a is larger than the spacer height H1 (see e.g. spacer height H1 in fig. 2a). In embodiments of the present disclosure, the distance DIS1 may be at least 2 times the spacer height such as at

least 4 times the spacer height. In Certain embodiments, the distance DIS1 may be between 1.5 and 10 times the spacer height H1, such as between 2 times and 5 times the spacer height H1.

- 5 Fig. 29 illustrates schematically an embodiment of the present disclosure, wherein a magnet attracts spacers 3 from the spacer storage 11 into the collection hole 15a. The spacers 2 in the storage 11 are in this embodiment magnetic, and the magnet 89 is placed opposite to the storage bottom, so that the collection sheet 15 is placed between the magnet 89 and the storage 11. The collection sheet 15 may in embodiments of the present disclosure not be
10 magnetic, or may only comprise a limited amount of ferromagnetic material. When the collection hole 15a moves through the spacer storage 11 at the bottom of the spacer storage 11, the magnet 89 attracts spacers 2 from the storage 11 and into the collection hole 15a.

- In some embodiments of the present disclosure, one or more magnets 89 may be arranged
15 opposite to the storage 11 along at least 40%, such as at least 80% or at least 95% of the length of the collection hole's 15a traveling path (TPS – see fig. 7) at the bottom of the spacer storage compartment 11. The magnet(s) 89 is/are in some embodiments placed opposite the collection hole at the traveling path.

- 20 The dispenser 10 may as illustrated comprise the magnet(s) 89, for example embedded in the bottom wall 24a. In some embodiments, the magnet(s) 89 may provide at least a part of the surface 17b of the dispenser wall facing towards the sheet 15. In some other embodiments (not illustrated), the magnet(s) 89 may be placed external to the housing 12.

- 25 Figs. 30a-32b illustrates control of a distance DIS1 between an outlet 16 and a glass sheet surface 3a based on output from a sensor 32, according to various embodiments of the present disclosure.

- In figs. 30a-30b, the outlet 16 is moved towards the glass sheet 3 surface 3a (see fig. 30a) so
30 as to touch the glass sheet surface 3a (see fig. 30b). The distance controller 31 receives sensor information from the sensor 32 so as to determine when to stop the distance adjustment motor 30. Hence, when distance controller 31 reduces the distance between the outlet 16 and the glass sheet surface, and when the sensor output comprises information that

indicates that the outlet 16 touches the glass sheet surface 3a, the motor 30 is stopped and a spacer 2 may be dispensed.

5 In figs. 30a-30b, the surface 16a of the outlet 16 facing the glass surface 3a is the surface that faces and touches the glass sheet 3 surface 3a. The surface 16a is provided by a nozzle wall 16y of the outlet nozzle 16x comprising the spacer outlet 16. The surface 16a encloses the outlet 16 and provides an outermost end of the outlet nozzle.

10 In figs. 31a-31b, another touching body 16z than the outlet 16 nozzle comprises the surface 16a touches the glass sheet surface 3a. The touching body 16z and hence the surface 16zs may as illustrated extend beyond the free end of the nozzle body and face the major glass sheet surface 3a so as to touch the surface 3a instead of the surface 16a.

15 The touching body 16z with the surface 16zs may in embodiments of the present disclosure be part of or connected directly or indirectly to a frame part. The frame part may e.g. be moved by the distance adjustment motor 30, e.g. together with the outlet 16.

20 As can be seen from fig. 31b, the distance between the outlet 16 as well as the touching body 16z, and the glass sheet surface 13a may be reduced. This provides that the surface 16zs of the touching body 16z, which faces the glass sheet surface 3a, will get to touch the glass sheet surface. In this case, the outlet surface 16a may not touch the glass sheet surface 3a when the surface 16zs of the touching body 16z touches the glass sheet surface 3a.

25 The distance controller 31 receives sensor information 32a from the sensor 32 so as to determine when to stop the distance adjustment motor 30. Hence, when distance controller 31 reduces the distance between the outlet 16 and the glass sheet surface, and when the sensor output 32a comprises information that indicates that the outlet surface 16zs of the touching body touches the glass sheet surface 3a, the motor 30 is stopped and a spacer 2 may be dispensed.

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It is noted that the touching body 16z may be part of, such as integrated in, the outlet body 16x, or may be a part that is separate to the outlet body 16x.

Generally, in some embodiments of the present disclosure, the outlet 16 may be enclosed by an outlet nozzle wall, such as a nozzle 16x wall 16y providing or comprising a free end surface 16a of the spacer outlet nozzle.

- 5 In the figures 30a-32b, the sensor 32 may comprise a sensor that is configured to register/detect when a surface 16a, 16zs touches the glass sheet surface, and provide a sensor output indicating when this happens.

The surface 16a, 16zs faces the glass sheet 3 surface 3a and may be movable by means of the
10 distance adjustment motor 30 together with the outlet 16.

In some embodiments of the present disclosure, the surface 16a, 16zs facing the glass surface and which is configured to touch the glass sheet surface 3a may be part of and/or be comprised in a touch probe sensor providing the output 32a.

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In some embodiments of the present disclosure, the distance between the outlet 16 and the glass sheet surface 3a may be controlled so as to be larger than zero (see e.g. figs. 31a-31b, 32a-32b, fig. 15 and/or fig. 11) when the spacer 2 is dispensed. In other
20 embodiments, as e.g. illustrated in fig. 30a-30b, the distance between the outlet 16 and the glass sheet surface 3a may be omitted/be zero when the spacer 2 is dispensed.

In some embodiments of the present disclosure, the sensor 32 may comprises at least one current measuring circuitry. In embodiments hereof, the current measurement circuitry may be configured to measure an electric current which reflects the consumption of electric
25 current used in order to move the spacer outlet 16 towards the glass sheet surface 3a. For example a current consumed by the distance adjustment motor 30. Hence, when the current measurement value gets above a threshold, such as a predefined threshold, the distance controller 31 may stop the distance adjustment motor 30. In some embodiments, the current measuring circuitry may be integrated in the distance adjustment motor 30 or a controller
30 hereof.

In some embodiments of the present disclosure, the sensor 32 may comprise at least one force sensor, such as a strain gauge force sensor, or a piezoelectric force sensor. The force sensor may be configured to detect when the surface 16, 16zs touches the surface. For

example when the surface 16 or 16zs touch the surface 3a, the touch sensor output will indicate a change in the measured value, for example a relatively sudden change. In some embodiments, the motor may stop the motor 30 when a measured force value or a signal indicative of a force value, exceed a predefined threshold. The force sensor may be
5 connected directly or indirectly to a frame part, the nozzle, the part 16zs and/or the like in order to detect when the surface 16a or 16zs touches the glass sheet surface 3a. For example, the force sensor may be arranged to measure a strain change in or at a part, where the strain change is caused by a counter force provided by the glass sheet surface when the surface 16 or 16zs touches the glass sheet surface.

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In some embodiments of the present disclosure, the sensor 32 may comprise a proximity sensor. In some embodiments of the present disclosure, the sensor 32 may comprise an optic sensor such as a fibre optic sensor. In some embodiments of the present disclosure, the sensor 32 may comprise an ultrasonic sensor.

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In some embodiments of the present disclosure, the sensor 32 may comprise at least one switch, such as a MEMS switch or an electromechanical switch. The switch 32 is configured to be triggered, such as be (directly or indirectly) activated or deactivated, by the glass sheet surface 3a due to/when a surface 16a or 16zs touching the glass sheet surface 3a. Fig. 32a-
20 32b illustrates an embodiment of the present disclosure where the sensor 32 comprises a switch, such as an electromechanical switch or a MEMS switch. The sensor part 32, may in some embodiments be configured to move towards and away from the glass sheet surface together with the outlet 16. The glass sheet surface 3a may hence directly or indirectly trigger the switch (See fig. 32b) thereby indicating that the surface 16zs touches the glass
25 sheet surface and that the outlet 16, as a consequence thereof, either is arranged with a desired distance to the surface 3a or touches the surface 3a. The surface 16zs may be part of the switch 32 or be part of a body connected to the switch. The sensor output 32b may e.g. be dependent on the state of a galvanic connection between two sensor parts. In some embodiments, the sensor 16 may be a "normally open" or a "normally closed" switch when
30 the surface 16zs is not touching the glass sheet surface 3a. The switch, such as a contact of the switch, may then switch state when the surface 3a is touched by the part 16zs.

In some embodiments of the present disclosure, the sensor 32 is a distance sensor.

It is generally understood that if the distance DIS1 between the glass sheet surface 3a and the outlet is controlled to be less than the spacer height H1 (See e.g. fig. 11 or 14, 30b, 31b, 32b), or if a surface 16zs, 16a, such as an outlet surface 16a, is moved so as to touch the glass sheet surface 3a, the distance controller 31 may in embodiments of the present disclosure provide distance regulation between consecutively dispensing two adjacent spacers.

For example, the distance controller 31 may move the outlet 16 away from the glass sheet surface 3a after a spacer 4 has been dispensed towards the glass sheet surface 3. The distance controller 31 may then move the outlet towards the glass sheet surface 3a again prior to dispensing a further spacer 2, such as dispensing a further consecutive spacer 2, at the glass sheet surface through the outlet 16 at another location of the glass sheet surface 3a.

In some embodiments, the distance controller 31 may control the distance adjustment motor 30 so as to move the outlet 16 away from the glass sheet surface 3a after a spacer 4 has been dispensed, such as dropped at the glass sheet surface 3 and prior to the relative first movement MOV1 between the glass sheet surface 3a and the spacer outlet 16. This may be provided so that the spacer is not unintentionally moved/pushed by the outlet body wall 16y when the movement MOV1 between the glass sheet surface 3a and the spacer outlet 16 along the glass sheet surface is provided.

In some embodiments of the present disclosure, the outlet 16 may be integrated in a housing 12 of the dispenser 10. In some embodiments of the present disclosure, the outlet 16 may be attached to a housing 12 of the dispenser 10.

During the spacer placement sequence, the distance controller 31 may hence lift the dispenser(s) away from the glass sheet surface 3a, and the displacement motor 80 (see fig. 10) may then provide a (e.g. predefined) relative displacement MOV1 between the spacer outlet(s) 16 and the glass sheet along the glass sheet surface. The distance controller 31 may then control the distance adjustment motor 30 so as to lower the outlet(s) 16 again. This may be provided either:

- to obtain that a DIS1 between the glass sheet surface 3a and the spacer outlet 16 is less than the spacer height H1 of the spacers 2 ($H1 > DIS1$) while the spacer 2 is

delivered to, such as dropped onto, the glass sheet surface 3a by means of the dispenser, or

- to obtain that a surface 16zs, 16a (see e.g. figs. 31a-32b), such as an outlet surface 16a, touches the glass sheet while the spacer 2 is delivered to, such as dropped onto, the glass sheet surface 3a by means of the dispenser.

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This may continue until all spacers 2 have been placed on the major glass sheet surface 3a in the spacer placement sequence, e.g. to provide a glass sheet surface 3a with substantially evenly DIS4 spacers 2 (see e.g. fig. 19) thereon.

- 10 In some embodiments of the present disclosure, the movement of the outlet 16 by means of the distance adjustment motor 30 may comprise or be a reciprocating movement.

It is generally to be understood that the VIG unit may e.g. be transparent to at least visible light, such as light that is visible to the human eye.

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In embodiments of the present disclosure, the manufactured VIG unit may be for use in a building window. In some embodiments, the building window may be a roof window. In other embodiments, the building window may be a vertical window such as a façade window. In some embodiments, the VIG unit when used in a building window may be laminated at one or both sides of the VIG unit by means of an interlayer and a further glass sheet. In other embodiments of the present disclosure, the VIG unit may be used for e.g. cooling furniture such as in a door of a refrigerator or freezer and/or for heating furniture such as in a door of an oven. The VIG unit to enable a view through the VIG unit towards the goods stored in the interior of the cooling or heating furniture.

20

Items

The present disclosure is further described in the following items.

1. A method of manufacturing a vacuum insulating glass unit (VIG), the method comprising:
- 30 providing a first glass sheet (3) comprising a major surface (3a),
dispensing a plurality of spacers (2) on the major surface (3a) by means of one or more spacer dispensing systems (200), wherein the spacer dispensing system (200) comprises:
a spacer storage (11) comprising a plurality of spacers (2),

- a dispenser (10) comprising a spacer outlet (16) for dispensing spacers (2) collected from the spacer storage (11), and
- a distance adjustment motor (30) configured to adjust the distance between the spacer outlet (16) and the glass sheet surface (3a),
- 5 wherein a distance controller (31) controls the distance adjustment motor (30) so as to adjust the distance between the spacer outlet (16) and the glass sheet surface (3a) based on output (32a) from a sensor (32),
- the method further comprising providing a second glass sheet (4),
- sealing together the first glass sheet (3) and the provided second (4) glass sheet at the
- 10 periphery of the glass sheets (3, 4) with the plurality of dispensed spacers (2) arranged between major surfaces (3a, 4a) of the glass sheets so that a gap (5) is provided between the first and second glass sheets (3, 4), and
- evacuating the gap (5).
- 15 2. The method according to item 1, wherein the dispensing of a plurality of spacers (2) comprises providing a spacer placement sequence to place a plurality of spacers at the major glass sheet surface (3a) by means of the dispenser (10), wherein the spacer placement sequence comprises providing a relative first movement (MOV1) between the glass sheet surface (3a) and the spacer outlet (16) in a direction along the glass sheet surface by means
- 20 of a displacement motor (80), and distributing a plurality of spacers (2) from the spacer storage (11) with a mutual spacer distance (DIS4) on the glass sheet surface (3a) by means of the dispenser (10) through the spacer outlet (16).
3. The method according to item 2, wherein the distance controller (31) controls the distance adjustment motor (30) to move the spacer outlet (16) towards and/or away from the glass
- 25 sheet surface (3a) during the spacer placement sequence.
4. A method of manufacturing a vacuum insulating glass unit (VIG), the method comprising:
- providing a first glass sheet (3) comprising a major surface (3a),
- 30 dispensing a plurality of spacers (2) on the major surface (3a) by means of one or more spacer dispensing systems (200), wherein the spacer dispensing system (200) comprises:
- a spacer storage (11) comprising a plurality of spacers (2),
- a dispenser (10) comprising a spacer outlet (16) for dispensing spacers (2) collected from the spacer storage (11), and

a distance adjustment motor (30) configured to move the spacer outlet (16) towards and/or away from the glass sheet surface (3a),
wherein the dispensing of a plurality of spacers (2) comprises providing a spacer placement sequence to place a plurality of spacers at the major glass sheet surface (3a) by means of the dispenser (10), wherein the spacer placement sequence comprises providing a relative first movement (MOV1) between the glass sheet surface (3a) and the spacer outlet (16) in a direction along the glass sheet surface by means of a displacement motor (80), and distributing a plurality of spacers (2) from the spacer storage (11) with a mutual spacer distance (DIS4) on the glass sheet surface (3a) by means of the dispenser (10) through the spacer outlet (16),
wherein a distance controller (31) controls the distance adjustment motor (30) to move the spacer outlet (16) towards and/or away from the glass sheet surface (3a) during the spacer placement sequence based on output (32a) from a sensor (32),
the method further comprising providing a second glass sheet (4),
sealing together the first glass sheet (3) and the provided second (4) glass sheet at the periphery of the glass sheets (3, 4) with the plurality of dispensed spacers (2) arranged between major surfaces (3a, 4a) of the glass sheets so that a gap (5) is provided between the first and second glass sheets (3, 4), and
evacuating the gap (5).

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5. The method according to any of the preceding items, wherein the distance controller (31) controls the distance (DIS1) between the glass sheet surface (3a) and the spacer outlet (16) to be less than a spacer height (H1) of the spacers (2) at least while the spacers (2) are delivered to, such as dropped onto, the glass sheet surface (3a) by the dispenser.

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6. The method according to any of the preceding items, wherein the spacers (2) have a spacer height (H1) of less than 0.5 mm such as less than 0.3 mm, such as less than 0.25 mm.

7. The method according to any of the preceding items, wherein the distance controller (31) maintains a maximum distance between the spacer outlet (16) and the glass sheet surface (3a) of less than 0.6 mm, such as less than 0.3 mm, such as less than 0.2 mm based on the output (32a) from the distance sensor (32), at least when the spacers are delivered, such as dropped, onto the glass sheet surface (3a).

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8. The method according to any of the preceding items, wherein the distance controller (31) monitors a distance representative of a distance (DIS1) between the glass sheet surface (3a) and the spacer outlet (16) based on the output (32a) from the distance sensor (32) and a distance setting (DSE) during the spacer placement sequence, and controls the distance adjustment motor (30) based thereon during the spacer placement sequence.
9. The method according to any of the preceding items, wherein the distance controller (31) provides closed loop distance control, such as by means of one or more of Proportional, Integral and/or derivative (PID) control.
10. The method according to any of the preceding items, wherein the distance sensor (32) is attached to, such as arranged in, a housing (12) of the dispenser (10).
11. The method according to any of the preceding items, wherein the glass sheet (3) is a thermally tempered glass sheet, for example a thermally tempered glass sheet comprising a glass sheet surface (3a) unevenness of at least 0.1 mm, such as at least 0.2 mm, for example at least 0.3 mm.
12. The method according to any of the preceding items, wherein the dispenser (10) comprises a housing (12), wherein the housing (12) comprises
- a spacer storage (11) storing a plurality of spacers to be dispensed,
 - a collection sheet (15), such as a disc shaped collection sheet (15), wherein the collection sheet (15) comprises a collection hole (15a) which during the spacer placement sequence collects spacers (12) one at a time in the collection hole (15a) from the spacer storage (11) by means of a relative movement between the housing (12) and the collection sheet (15) provided by means of a drive motor (18),
- wherein the collected spacers are dispensed consecutively through the spacer outlet (16), wherein the distance controller (31) provides the control of the distance adjustment motor (30) to move the spacer outlet (16) towards and/or away from the glass sheet surface (3a) by moving the housing (12) towards and/or away from the glass sheet surface (3a).
- 12a. The method according to item 12, wherein the housing (12) comprises the spacer outlet (16).

13. The method according to item 12 or 12a, wherein each of the plurality of spacers (2) in the spacer storage compartment (11) has a spacer height (H1) extending between contact surfaces (2a, 2b) of the spacer, and wherein each of said spacers (2) has a spacer width (W1), wherein the collection sheet 15 is arranged in a guidance space (13) of the housing (12), and
5 wherein the guidance space (13) has a height (H2) which is less than 1.4 times the spacer height (H1), and wherein the height (H2) of the guidance space (13) is smaller than the spacer width (W1).
14. The method according to any of the preceding items, wherein the distance (DIS3)
10 between the glass sheet surface (3a) and a major surface (15c) of the collection sheet (15) facing the glass sheet surface (3a) is less than 10 mm, such as less than 3 mm, such as less than 1 mm, at least while the spacer (2) is dropped towards the glass sheet surface (3a).
15. The method according to any of the preceding items, wherein a spacer dispensing array
15 (500) comprises a plurality of said spacer dispensing system (200), wherein a distance controller (31) provides an adjustment, such as an individual adjustment, of the spacer outlet (16) of the respective spacer dispensing system (200) of the dispensing array (500) in a direction towards and/or away from the glass sheet surface (3a) based on output (32) from a plurality of distance sensors (32) during the spacer placement sequence.
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16. The method according to item 15, wherein the plurality of spacer dispensing systems (200) of the array (500), such as all spacer dispensing systems (200) of the array (500), each comprises an individual distance controller (31).
- 25 17. The method according to item 16, wherein the individual distance controller (31) individually monitors the distance (DIS1) between the glass sheet surface (3a) and the spacer outlet (16) of the dispenser (10) of the respective individual spacer dispensing system (200) based on output from a distance sensor (32a), and wherein each individual distance
30 controller (31) individually controls the distance adjustment motor (30) to move the spacer outlet (16) of the dispenser (10) of that spacer dispensing system (200) towards and/or away from the glass sheet surface (3a) during the spacer placement sequence.

18. The method according to item 16 or 17, wherein the individual adjustment is based on sensor output (32a) from an individual distance sensor (32) assigned each spacer dispensing system (200).

5 19. The method according to any of items 15-18, wherein one or more dispensers (10) of the array (500) are displaced horizontally (MOV2) relative to one or more adjacent dispenser(s) (10) of the array (500) by means of a displacer (91, 92), such as in a direction transverse to the direction of the first movement (MOV1).

10 20. The method according to any of the preceding items, wherein the distance controller (31) is configured to control the distance adjustment motor (30) to move the spacer outlet (16) within a distance (DIS1) adjustment range (DAR) based on the output (32a) from the distance sensor (32) during the spacer placement sequence, wherein the distance adjustment range (DAR) is at least 0.5 mm, such as at least 1.5 mm, such as at least 10 mm,
15 and/or

21. The method according to any of the preceding items, wherein the distance adjustment motor (30) is configured to be controlled by the distance controller (31) to move the spacer outlet (16) with a distance adjustment resolution of less than 0.1 mm such as less than 0.08
20 mm, such as less than 0.05 mm.

22. The method according to any of the preceding items, wherein a charge modulation system (400, 300, 70, 72, 73) reduces and/or maintains a difference in electrostatic charge potential between the glass sheet (3) and the dispensing system (200), such as between the
25 between the glass sheet (3) and the dispenser (10), to be below 10 kV, such as below 5kV, such below 2 kV, such as wherein the charge modulation system (400, 300, 70,72, 73) comprises one or more of:

- a grounding connection (70, 71, 72)
- one or more ionizer devices (400) providing a flow of ions with controlled polarity
30 towards the dispensing system (200),
- a humidity control system (300) maintaining the relative humidity of the ambient air surrounding the dispenser (10) above 40%, such as above 50%, for example between 40% and 70%.

23. The method according to any of items 12-22, wherein said housing (12) and the collection sheet (15) are made from metal, wherein the dispenser (10), such as the housing (12) and/or collection sheet (15), is/are connected to ground by means of a grounding connection (70).

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24. The method according to any of the preceding items, wherein the dispenser (10) comprises a fluid outlet (40) for pressurized gas, such as an outlet arranged opposite to the spacer outlet (16), wherein the pressurized gas is provided in order to provide a blowing force onto the collected spacer in the collection hole to help the collected spacer leave the collection hole.

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25. The method according to any of the preceding items, wherein the dispenser (10) comprises a vacuum path (21a, 21b, 21c), such as one or more vacuum channels, connected to a vacuum pump (21d), wherein vacuum pump provides suction in the vacuum path so as to help a spacer (2) of the spacer storage compartment (11) to enter into the collection hole (15a).

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26. The method according to item 25, wherein the housing (12) comprises a part of the vacuum path, such as a recessed channel, such as an elongated, curving channel, arranged to abut the guidance space to provide a fluid communication between the collection hole (15a) of the collection sheet (15) and a suction outlet of the housing connected to the vacuum pump (21d) when the collection hole (15a) is arranged at the bottom of the spacer storage compartment (11) to collect a spacer (2) from the bottom of the spacer storage compartment (11).

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27. The method according to any of the preceding items, wherein the dispenser (10) comprises:

- a spacer storage compartment (11), comprising a plurality of said spacers (2), a housing (12) comprising a guidance space (13) placed between a first housing surface (17a) of an upper part (12a) of the housing (12) and a second housing surface (17b) of a bottom part (12b) of the housing (12),
- a spacer outlet (16) arranged at the bottom part (12b) of the housing (12),
- a disc shaped collection sheet (15) providing a bottom part of the spacer storage compartment (11), wherein the disc shaped collection sheet (15) comprises at least

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one collection hole (15a) extending between opposing major surfaces (15b, 15c) of the collection sheet (15), wherein the collection hole (15a) is a through hole and wherein the disc shaped collection sheet (15) is arranged in the guidance space (13), wherein the dispensing of spacers (2) comprises:

- 5 providing a relative, rotational movement between the disc shaped collection sheet (15) and the housing (12) around a rotation axis (RAX) by means of a drive motor (18) so that the collection hole (15a) is arranged at the bottom of the spacer storage compartment (11) and thereby collects a spacer (2) from the bottom of the spacer storage compartment (11), and providing a further, relative rotational movement between the collection sheet (15) and the
- 10 housing (12) around the rotation axis (RAX) to align the collected spacer (2) in the collection hole (15a) opposite to the spacer outlet (16) to deliver the collected spacer (2) to the spacer outlet (16) and towards the major surface (3a) of the glass sheet (3).

28. The method according to item 27, wherein the dispenser (10) wherein the length of the
- 15 traveling path (TPS) of the collection hole (15a) at the bottom of the spacer storage compartment (11) is at least 0.9 times, such as at least 1.2 times, such as at least 1.8 times, the distance (DIS2) between the rotation axis (RAX) and the outer periphery of the dispenser housing (12).

- 20 29. The method according to any of the preceding items, wherein the spacer storage compartment (11) is elongated and extends partly around the rotation axis, such as wherein the spacer storage compartment (11) is arc shaped.

30. The method according to any of the preceding items, wherein the distance controller (31)
- 25 moves the outlet (16) away from the glass sheet surface (3a) after a spacer (2) has been dispensed towards the glass sheet surface (3), and wherein the distance controller (31) moves the outlet towards the glass sheet surface (3a) again prior to dispensing a further spacer (2), such as a further consecutive spacer (2), at the glass sheet surface through the outlet (16) at another location of the glass sheet surface.

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31. The method according to any of the preceding items, wherein the distance controller (31) controls the distance adjustment motor (30) so as to move the outlet (16) away from the glass sheet surface (3a) after a spacer (2) has been dispensed at the glass sheet surface (3) and

prior to the relative first movement (MOV1) between the glass sheet surface (3a) and the spacer outlet (16).

32. The method according to any of the preceding items, wherein the distance controller (31) controls the distance adjustment motor (30) so as to reduce the distance between the outlet (16) and the glass sheet surface (3a) so that a surface (16a, 16zs) facing the glass sheet surface (3a) touches the glass sheet surface (3a), wherein the distance controller (31) stops the distance adjustment motor when output from the sensor indicates that the surface (16a, 16zs) touches the glass sheet surface (3a).

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33. The method according to item 32, wherein said surface (16a, 16zs) facing the glass sheet surface (3a) is a surface (16a, 16zs) of the spacer outlet (16).

34. The method according to item 32 or 33, wherein the surface (16a) facing the glass surface (3a) is a surface of a nozzle wall (16y) of an outlet nozzle (16x) comprising the spacer outlet (16), such as an end surface (16a) of a nozzle wall (16y) enclosing the outlet (16).

35. The method according to any of the preceding items, wherein the outlet (16) is integrated in, or is attached to, a housing (12) of the dispenser (10).

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36. The method according to any of items 32-35, wherein a spacer (2) is delivered to, such as dropped onto, the glass sheet surface (3a) by the dispenser while the surface (16a, 16zs) facing the glass sheet surface (3a) touches the glass sheet surface (3a).

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37. The method according to any of the preceding items, wherein the sensor (32) comprises at least one of:

- at least one current measuring circuitry, such as wherein the measured current reflects the consumption of electric current used in order to move the spacer outlet (16) towards the glass sheet surface (3a),
- at least one force sensor, such as a strain gauge sensor
- at least one switch, such as a MEMS switch or an electromechanical switch,
- at least one proximity sensor
- at least one optical sensor

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38. The method according to any of the preceding items, wherein the sensor (32) is a distance sensor.

5 39. The method according to any of the preceding items, wherein the distance controller (31) is configured to control the distance adjustment motor (30) so as to reduce the distance between the respective outlet (16) and the glass sheet surface (3a), wherein the distance controller (31) stop the distance adjustment motor prior to a surface (16a, 16zs), such as an outlet surface (16a), facing the sheet glass surface (3a), touches the
10 glass sheet surface (3a).

40. The method according to any of the preceding items, wherein a spacer (2) is dispensed, such as dropped onto, the glass sheet surface (3a) by the dispenser while a surface (16a, 16zs) of an outlet nozzle (16x) comprising the spacer outlet (16) touches the glass sheet
15 surface (3a).

41. The method according to any of the preceding items, wherein a spacer (2) is dispensed, such as dropped onto, the glass sheet surface (3a) by the dispenser while an end surface (16a) enclosing the outlet (16) touches the glass sheet surface (3a).

20 42. The method according to any of the preceding items wherein the distance controller (31) controls the distance adjustment motor (30) to adjust the distance between the spacer outlet (16) and the glass sheet surface (3a) during the spacer placement sequence, such as in a direction with an angle to, such as in a direction perpendicular to, the glass sheet surface
25 (3a).

43. The method according to any of the preceding items, wherein the sensor (32) is a distance sensor.

30 44. A spacer dispensing station for dispensing spacers (2) on a surface (3a) of a glass sheet (3) during manufacturing of a vacuum insulated glass unit, wherein spacer dispensing station comprises a plurality (500) of spacer dispensing systems (200) wherein each spacer dispensing system (200) comprises:
a spacer storage (11) comprising a plurality of spacers (2),

- a dispenser (10) comprising a spacer outlet (16) for dispensing spacers (2) collected from the spacer storage (11), and
- a distance adjustment motor (30) configured to move the spacer outlet (16) towards and/or away from the glass sheet surface (3a),
- 5 wherein the spacer dispensing station moreover comprises:
- a glass sheet support (45),
- a displacement motor (80) configured to provide a relative movement between a major glass sheet surface (3a) of a glass sheet (3) on the glass sheet support and the spacer outlets (16) in a direction along the major glass sheet surface (3),
- 10 a plurality of sensors (32), and
- one or more distance controllers (31),
- wherein the spacer dispensing systems (200) and the displacement motor (80) are configured to be controlled to provide a spacer placement sequence comprising providing relative movement between the glass sheet surface (3a) and the spacer outlet (16) in a direction along
- 15 the major glass sheet surface (3a) by means of the displacement motor (80), and distributing a plurality of spacers (2) from the spacer storage (11) with a mutual spacer distance (DIS4) on the glass sheet surface (3a) by means of the dispensers (10) through the spacer outlets (16), and
- wherein the one or more distance controllers (31) is/are configured to control the distance
- 20 adjustment motors (30) individually so as to individually move the respective spacer outlet (16) towards and/or away from the glass sheet surface (3a) during the spacer placement sequence based on output (32a) from the sensors (32), such as so that the distance (DIS1) between the individual spacer outlet (16) and the glass sheet surface is adapted to the local surface topology of the major glass sheet surface opposite to the spacer outlet one or more
- 25 times, such as continuously, during the spacer placement sequence.
45. A spacer dispensing station according to item 44, wherein the sensors (32) are distance sensors.
- 30 46. A spacer dispensing station according to item 44 or 45, wherein the one or more distance controllers (31) are configured to control the distance adjustment motor (30) so as to reduce the distance between the outlet (16) and the glass sheet surface (3a) so that a surface (16a, 16zs) facing the sheet glass surface (3a) touches the glass sheet surface (3a), and

wherein the distance controller is configured to stop the distance adjustment motor when output from the sensor (32) indicates that the surface (16a, 16zs) touches the glass.

47. A spacer dispensing station according to any of items 44 to 46, wherein the one or more distance controllers (31) are configured to control the distance adjustment motor (30) so as to reduce the distance between the respective outlet (16) and the glass sheet surface (3a), wherein the distance controller is configured to stop the distance adjustment motor prior to a surface (16a, 16zs), such as an outlet surface (16a), facing the sheet glass surface (3a), touches the glass sheet surface (3a).
48. A spacer dispensing station according to any of items 44 to 47, wherein said surface (16a, 16zs) facing the glass sheet surface (3a) is a surface (16a, 16zs) of the spacer outlet (16).
49. A spacer dispensing station according to any of items 44 to 48, wherein the surface (16a) facing the glass surface (3a) is a surface of a nozzle wall (16y) of an outlet nozzle (16x) comprising the spacer outlet (16), such as an end surface (16a) of a nozzle wall (16y) enclosing the outlet (16).
50. A spacer dispensing station according to any of items 44 to 49, wherein the outlet (16) is integrated in, or is attached to, a housing (12) of the dispenser (10).
51. A spacer dispensing station according to any of items 44 to 50, wherein the sensor (32) comprises at least one of:
- at least one current measuring circuitry, such as wherein the measured current reflects the consumption of electric current used in order to move the spacer outlet (16) towards the glass sheet surface (3a),
 - at least one force sensor, such as a strain gauge sensor or a piezoelectric sensor
 - at least one switch, such as a MEMS switch or an electromechanical switch,
 - at least one proximity sensor
 - at least one optical sensor
52. A spacer dispensing station according to any of items 44 to 51, wherein the sensor (32) is a distance sensor.

53. A spacer dispensing station according to any of items 44 to 52, wherein the distance controller (31) is configured to move the outlet (16) away from the glass sheet surface (3a) after a spacer (2) has been dispensed towards the glass sheet surface (3), and wherein the distance controller (31) is configured to move the outlet towards the glass sheet surface (3a) again prior to dispensing a further spacer (2), such as a further consecutive spacer (2), at the glass sheet surface through the outlet (16) at another location of the glass sheet surface.

54. A spacer dispensing station according to any of items 44 to 53, wherein the distance controller (31) is configured to control the distance adjustment motor (30) so as to move the outlet (16) away from the glass sheet surface (3a) after a spacer (2) has been dispensed at the glass sheet surface (3) and prior to the relative movement (MOV1) between the glass sheet surface (3a) and the spacer outlet (16) in the direction along the major glass sheet surface (3a), such as during the spacer placement sequence.

55. A spacer dispensing station according to any of claims 44 to 54, wherein said individual movement of the respective spacer outlet (16) towards and/or away from the glass sheet surface (3a) during the spacer placement sequence is configured to be provided so that the individual spacer outlet (16) is adapted to the local surface topology of the major glass sheet surface (3a) opposite to the spacer outlet (16) one or more times, such as continuously, during the spacer placement sequence.

56. A spacer dispensing station according to any of claims 44 to 55, wherein the distance controller (31) is configured to control the distance (DIS1) between the glass sheet surface (3a) and the spacer outlet (16) to be less than a spacer height (H1) of the spacers (2), at least while the spacers (2) are delivered to, such as dropped onto, the glass sheet surface (3a) by the dispenser.

57. A spacer dispensing station according to any of items 44 to 56, wherein the spacer dispensing station provides the method according to any of the preceding items or is used in the method according to any of the preceding items.

58. A method of manufacturing a vacuum insulating glass unit, wherein the method comprises providing a first glass sheet (3) comprising a major glass sheet surface (3a), and

dispensing a plurality of spacers (2) on the major surface (3a) by means of one or more spacer dispensing systems (200). The spacer dispensing system comprises:

- a spacer storage comprising a plurality of spacers,
- a dispenser arrangement (10) comprising a spacer outlet (16) for dispensing spacers
- 5 from the spacer storage, and
- a distance adjustment motor (30),

wherein the dispensing of a plurality of spacers (2) comprises providing a spacer placement sequence to place a plurality of spacers (2) at the major glass sheet surface (3a) by means of the dispenser arrangement (10), wherein the spacer placement sequence comprises providing

10 a relative first movement between the glass sheet surface (3a) and the spacer outlet in a direction along the glass sheet surface by means of a displacement motor (80), and distributing a plurality of spacers (2) from the spacer storage with a mutual spacer distance (DIS4) on the glass sheet surface (3a) by means of the dispenser arrangement (10) through the spacer outlet, wherein a distance controller controls the distance adjustment motor to

15 increase or decrease the distance between the spacer outlet (16) and the glass sheet surface during the spacer placement sequence based on output (32a) from a sensor (32), the method further comprising providing a second glass sheet (4), sealing together the first glass sheet (3) and the provided second (4) glass sheet at the periphery of the glass sheets (3, 4) with the plurality of dispensed spacers (2) arranged

20 between major surfaces (3a, 4a) of the glass sheets so that a gap (5) is provided between the first and second glass sheets (3, 4), and evacuating the gap (5).

59. A method according to item 58, wherein the method comprises one or more of the

25 features of one or more of items 1-43, such as one or more of the features of one or more of items 5-43.

60. The method according to any of the preceding items, for example according to item 11, wherein the distance controller (31) control the distance adjustment motor (30) individually

30 so as to move the respective spacer outlet (16) towards and/or away from the glass sheet surface (3a) during the spacer placement sequence based on output (32a) from the sensor (32), so that the individual spacer outlet (16) is adapted to the local surface topology of the major glass sheet surface (3a) opposite to the spacer outlet (16) one or more times, such as continuously, during the spacer placement sequence.

In general, it is to be understood that the present disclosure is not limited to the particular examples described above but may be adapted in a multitude of varieties within the scope of the present disclosure as specified in e.g. the claims and/or items. Accordingly, for example,

5 one or more of the described and/or illustrated embodiments above may be combined to provide further embodiments of the disclosure.

Claims

1. A method of manufacturing a vacuum insulating glass unit (VIG), the method comprising:
providing a first glass sheet (3) comprising a major surface (3a),
dispensing a plurality of spacers (2) on the major surface (3a) by means of one or more
5 spacer dispensing systems (200), wherein the spacer dispensing system (200) comprises:
a spacer storage (11) comprising a plurality of spacers (2),
a dispenser (10) comprising a spacer outlet (16) for dispensing spacers (2) collected
from the spacer storage (11), and
a distance adjustment motor (30) configured to move the spacer outlet (16) towards
10 and/or away from the glass sheet surface (3a),
wherein the dispensing of a plurality of spacers (2) comprises providing a spacer placement
sequence to place a plurality of spacers at the major glass sheet surface (3a) by means of the
dispenser (10), wherein the spacer placement sequence comprises providing a relative first
movement (MOV1) between the glass sheet surface (3a) and the spacer outlet (16) in a
15 direction along the glass sheet surface by means of a displacement motor (80) , and
distributing a plurality of spacers (2) from the spacer storage (11) with a mutual spacer
distance (DIS4) on the glass sheet surface (3a) by means of the dispenser (10) through the
spacer outlet (16),
wherein a distance controller (31) controls the distance adjustment motor (30) to move the
20 spacer outlet (16) towards and/or away from the glass sheet surface (3a) during the spacer
placement sequence based on output (32a) from a sensor (32),
the method further comprising providing a second glass sheet (4),
sealing together the first glass sheet (3) and the provided second (4) glass sheet at the
periphery of the glass sheets (3, 4) with the plurality of dispensed spacers (2) arranged
25 between major surfaces (3a, 4a) of the glass sheets so that a gap (5) is provided between the
first and second glass sheets (3, 4), and
evacuating the gap (5).
2. The method according to claim 1, wherein the distance controller (31) controls the
30 distance (DIS1) between the glass sheet surface (3a) and the spacer outlet (16) to be less than
a spacer height (H1) of the spacers (2), at least while the spacers (2) are delivered to, such as
dropped onto, the glass sheet surface (3a) by the dispenser.

3. The method according to any of the preceding claims, wherein the distance controller (31) controls the distance adjustment motor (30) during the spacer placement sequence so as to reduce the distance between the outlet (16) and the glass sheet surface (3a) so that a surface (16a, 16zs) facing the glass sheet surface (3a) touches the glass sheet surface (3a),
- 5 wherein the distance controller (31) stops the distance adjustment motor when output from the sensor indicates that the surface (16a, 16zs) touches the glass sheet surface (3a).
4. The method according to claim 3, wherein said surface (16a, 16zs) facing the glass sheet surface (3a) is a surface (16a, 16zs) of the spacer outlet (16).
- 10
5. The method according to claim 3 or 4, wherein the surface (16a) facing the glass surface (3a) is a surface of a nozzle wall (16y) of an outlet nozzle (16x) comprising the spacer outlet (16), such as an end surface (16a) of a nozzle wall (16y) enclosing the outlet (16).
- 15
6. The method according to any of the preceding claims, wherein the outlet (16) is integrated in, or is attached to, a housing (12) of the dispenser (10).
7. The method according to any of claims 3-6, wherein a spacer (2) is delivered to, such as dropped onto, the glass sheet surface (3a) by the dispenser while the surface (16a, 16zs)
- 20 facing the glass sheet surface (3a) touches the glass sheet surface (3a).
8. The method according to any of the preceding claims, wherein the sensor (32) comprises at least one of:
- at least one current measuring circuitry, such as wherein the measured current
 - 25 reflects the consumption of electric current used in order to move the spacer outlet (16) towards the glass sheet surface (3a),
 - at least one force sensor, such as a strain gauge sensor
 - at least one switch, such as a MEMS switch or an electromechanical switch,
 - at least one proximity sensor
 - 30 • at least one optical sensor such as a fibre optical sensor
9. The method according to any of the preceding claims, wherein the sensor (32) is a distance sensor.

10. The method according to any of claims 1-2 or 8-9, wherein the distance controller (31) is configured to control the distance adjustment motor (30) so as to reduce the distance between the respective outlet (16) and the glass sheet surface (3a), wherein the distance controller (31) stop the distance adjustment motor prior to a surface (16a, 16zs), such as an outlet surface (16a), facing the sheet glass surface (3a), touches the glass sheet surface (3a).

11. The method according to any of the preceding claims, wherein the distance controller (31) maintains a maximum distance between the spacer outlet (16) and the glass sheet surface (3a) of less than 0.6 mm, such as less than 0.3 mm, such as less than 0.2 mm based on the output (32a) from the sensor (32), at least when the spacers are delivered, such as dropped, onto the glass sheet surface (3a).

12. The method according to any of the preceding claims, wherein the spacers (2) have a spacer height (H1) of less than 0.5 mm such as less than 0.3 mm, such as less than 0.25 mm.

13. The method according to any of the preceding claims, wherein the distance controller (31) monitors a distance representative of a distance (DIS1) between the glass sheet surface (3a) and the spacer outlet (16) based on the output (32a) from the sensor (32) and a distance setting (DSE) during the spacer placement sequence, and controls the distance adjustment motor (30) based thereon during the spacer placement sequence.

14. The method according to any of the preceding claims, wherein the sensor (32) is attached to, such as arranged in, a housing (12) of the dispenser (10).

15. The method according to any of the preceding claims, wherein the glass sheet (3) is a thermally tempered glass sheet, for example a thermally tempered glass sheet comprising a glass sheet surface (3a) unevenness of at least 0.1 mm, such as at least 0.2 mm, for example at least 0.3 mm.

16. The method according to any of the preceding claims, wherein the dispenser (10) comprises a housing (12), wherein the housing (12) comprises

- a spacer storage (11) storing a plurality of spacers (2) to be dispensed,

- a collection sheet (15), such as a disc shaped collection sheet (15), wherein the collection sheet (15) comprises a collection hole (15a) which during the spacer placement sequence collects spacers (12) one at a time in the collection hole (15a) from the spacer storage (11) by means of a relative movement, such as a rotation (RAX), between the housing (12) and the collection sheet (15) provided by means of a drive motor (18),

wherein the collected spacers are dispensed consecutively through the spacer outlet (16), wherein the distance controller (31) provides the control of the distance adjustment motor (30) to move the spacer outlet (16) towards and/or away from the glass sheet surface (3a), such as by means of moving the housing (12) towards and/or away from the glass sheet surface (3a).

17. The method according to any of the preceding claims, wherein a housing (12) of the dispenser comprises the spacer outlet (16) and/or wherein the spacer outlet (16) is integrated in, or is attached to, a housing (12) of the dispenser (10).

18. The method according to any of the preceding claims, wherein each of the plurality of spacers (2) in the spacer storage compartment (11) has a spacer height (H1) extending between contact surfaces (2a, 2b) of the spacer, and wherein each of said spacers (2) has a spacer width (W1).

19. The method according to claim 16 and 18 wherein the collection sheet (15) is arranged in a guidance space (13) of the housing (12), and wherein the guidance space (13) has a height (H2) which is less than 1.4 times the spacer height (H1), and wherein the height (H2) of the guidance space (13) is smaller than the spacer width (W1).

20. The method according to any of the preceding claims, wherein a spacer dispensing array (500) comprises a plurality of said spacer dispensing system (200), wherein a distance controller (31) provides an adjustment, of the outlets (16) of the spacer dispensing systems (200) of the dispensing array (500) in a direction towards and/or away from the glass sheet surface (3a) based on output (32) from a plurality of sensors (32), such as distance sensors, during the spacer placement sequence.

21. The method according to claim 20, wherein the provided adjustment is a an individual adjustment of the spacer outlets (16),

22. The method according to claim 20 or 21, wherein the plurality of spacer dispensing
5 systems (200) of the array (500), such as all spacer dispensing systems (200) of the array (500), each comprises an individual distance controller (31),
wherein each individual distance controller (31) individually controls the distance
adjustment motor (30) to move the spacer outlet (16) of the dispenser (10) of that spacer
dispensing system (200) towards and/or away from the glass sheet surface (3a) during the
10 spacer placement sequence.

23. The method according to claim 22, The method according to claim 22, wherein the
individual distance controller (31) individually monitors the distance (DIS1) between the
glass sheet surface (3a) and the spacer outlet (16) of the respective individual spacer
15 dispensing system (200) based on output from a sensor (32a).

24. The method according to any of claims 20-23, wherein the individual adjustment is based
on sensor output (32a) from an individual sensor (32), such as a distance sensor, assigned
each spacer dispensing system (200).
20

25. The method according to any of the preceding claims, wherein the distance controller
(31) moves the outlet (16) away from the glass sheet surface (3a) after a spacer (2) has been
dispensed towards the glass sheet surface (3), and wherein the distance controller (31) moves
the outlet towards the glass sheet surface (3a) again prior to dispensing a further consecutive
25 spacer (2), at the glass sheet surface through the outlet (16) at another location of the glass
sheet surface.

26. The method according to any of the preceding claims, wherein the distance controller
(31) controls the distance adjustment motor (30) so as to move the outlet (16) away from the
30 glass sheet surface (3a) after a spacer (2) has been dispensed at the glass sheet surface (3)
and prior to the relative first movement (MOV1) between the glass sheet surface (3a) and the
spacer outlet (16).

27. The method according to any of claims 18-26, wherein said spacers (2) have a maximum spacer width (W1) defined by a curved outer side surface (2c), such as wherein the spacer width (W1) is larger than the spacer height (H1).

5 28. The method according to claim 27, wherein said curved outer side surface (2c) describes a convex surface shape between the contact surfaces (2a, 2b).

29. The method according to any of the preceding claims, wherein the sensor (32) detects when a surface (16a, 16zs), such as a movable surface, facing the glass sheet surface (3a)
10 touches the glass sheet surface (3a).

30. The method according to claim 29, wherein said distance controller (31) stop the distance adjustment motor (30) when the sensor (32) detects that the surface (16a, 16zs) facing the glass sheet surface touches the glass sheet surface (3a).

15

31. The method according to claim 29 or 30, wherein the surface facing the glass sheet surface (16a, 16zs) is a surface of an outlet nozzle (16x).

32. The method according to any of claims 29 - 31, wherein a spacer (2) is delivered to, such as dropped onto, the glass sheet surface (3a) while the surface (16a, 16zs) facing the glass sheet surface (3a) touches the glass sheet surface (3a).
20

33. The method according to any of the preceding claims, wherein a spacer (2) is delivered to, such as dropped onto, the glass sheet surface (3a) by the dispenser while a surface (16a, 16zs) of an outlet nozzle (16x) comprising the spacer outlet (16) touches the glass sheet surface (3a).
25

34. The method according to any of the preceding claims, wherein a spacer (2) is dispensed, such as dropped onto, the glass sheet surface (3a) by the dispenser while an end surface (16a) enclosing the outlet (16) touches the glass sheet surface (3a).
30

35. The method according to any of the preceding claims, wherein the sensor (32) and/or the distance controller (31) monitors the distance between the glass sheet surface (3a) and the spacer outlet (16).

36. The method according to any of the preceding claims, wherein the distance controller (31) comprises distance regulation circuitry.

- 5 37. The method according to any of the preceding claims, wherein the distance controller (31) controls the distance adjustment motor (30) individually so as to move the respective spacer outlet (16) towards and/or away from the glass sheet surface (3a) during the spacer placement sequence based on output (32a) from the sensor (32), so that the individual spacer outlet (16) is adapted to the local surface topology of the major glass sheet surface (3a)
10 opposite to the spacer outlet (16) one or more times, such as continuously, during the spacer placement sequence.

38. The method according to claim 37, wherein the method is a method according to claim 15.

15

39. A spacer dispensing station for dispensing spacers (2) on a surface (3a) of a glass sheet (3) during manufacturing of a vacuum insulated glass unit, wherein spacer dispensing station comprises a plurality (500) of spacer dispensing systems (200) wherein each spacer dispensing system (200) comprises:

- 20 a spacer storage (11) comprising a plurality of spacers (2),
a dispenser (10) comprising a spacer outlet (16) for dispensing spacers (2) collected from the spacer storage (11), and
a distance adjustment motor (30) configured to move the spacer outlet (16) towards and/or away from the glass sheet surface (3a),
25 wherein the spacer dispensing station moreover comprises:
a glass sheet support (45),
a displacement motor (80) configured to provide a relative movement between a major glass sheet surface (3a) of a glass sheet (3) on the glass sheet support and the spacer outlets (16) in a direction along the major glass sheet surface (3),
30 a plurality of sensors (32), and
one or more distance controllers (31),
wherein the spacer dispensing systems (200) and the displacement motor (80) are configured to be controlled to provide a spacer placement sequence comprising providing relative movement (MOV1) between the glass sheet surface (3a) and the spacer outlet (16) in a

direction along the major glass sheet surface (3a) by means of the displacement motor (80), and distributing a plurality of spacers (2) from the spacer storage (11) with a mutual spacer distance (DIS4) on the glass sheet surface (3a) by means of the dispensers (10) through the spacer outlets (16), and

- 5 wherein the one or more distance controllers (31) is/are configured to control the distance adjustment motors (30) individually so as to individually move the respective spacer outlet (16) towards and/or away from the glass sheet surface (3a) during the spacer placement sequence based on output (32a) from the sensors (32).

- 10 40. A spacer dispensing station according to claim 39, wherein the one or more distance controllers (31) are configured to control the distance adjustment motor (30) so as to reduce the distance between the outlet (16) and the glass sheet surface (3a) so that a surface (16a, 16zs) facing the sheet glass surface (3a) touches the glass sheet surface (3a), and wherein the distance controller is configured to stop the distance adjustment motor when
15 output from the sensor (32) indicates that the surface (16a, 16zs) touches the glass.

41. A spacer dispensing station according to any of claims 39 or 40, wherein the one or more distance controllers (31) are configured to control the distance adjustment motor (30) so as to reduce the distance between the respective outlet (16) and the glass sheet surface (3a),
20 wherein the distance controller is configured to stop the distance adjustment motor prior to a surface (16a, 16zs), such as an outlet surface (16a), facing the sheet glass surface (3a), touches the glass sheet surface (3a).

42. A spacer dispensing station according to any of claims 39-41, wherein said surface (16a, 16zs) facing the glass sheet surface (3a) is a surface (16a, 16zs) of the spacer outlet (16).
25

43. A spacer dispensing station according to any of claims 39-42, wherein the surface (16a) facing the glass surface (3a) is a surface of a nozzle wall (16y) of an outlet nozzle (16x) comprising the spacer outlet (16), such as an end surface (16a) of a nozzle wall (16y)
30 enclosing the outlet (16).

44. A spacer dispensing station according to any of claims 39-43, wherein the outlet (16) is integrated in, or is attached to, a housing (12) of the dispenser (10).

45. A spacer dispensing station according to any of claims 39-44, wherein the sensor (32) comprises at least one of:

- at least one current measuring circuitry, such as wherein the measured current reflects the consumption of electric current used in order to move the spacer outlet (16) towards the glass sheet surface (3a),
- at least one force sensor, such as a strain gauge sensor or a piezoelectric sensor
- at least one switch, such as a MEMS switch or an electromechanical switch,
- at least one proximity sensor
- at least one optical sensor

46. A spacer dispensing station according to any of claims 39-45, wherein the sensor (32) is a distance sensor.

47. A spacer dispensing station according to any of claims 39-46, wherein one or more dispensers (10) of the array (500) are configured to be displaced horizontally (MOV2) relative to one or more adjacent dispenser(s) (10) of the array (500) by means of a displacer (91, 92), such as in a direction transverse to the direction of the first movement (MOV1).

48. A spacer dispensing station according to any of claims 39-47, wherein the distance controller (31) is configured to move the outlet (16) away from the glass sheet surface (3a) after a spacer (2) has been dispensed towards the glass sheet surface (3), and wherein the distance controller (31) is configured to move the outlet towards the glass sheet surface (3a) again prior to dispensing a further spacer (2), such as a further consecutive spacer (2), at the glass sheet surface through the outlet (16) at another location of the glass sheet surface.

49. A spacer dispensing station according to any of claims 39-48, wherein the distance controller (31) is configured to control the distance adjustment motor (30) so as to move the outlet (16) away from the glass sheet surface (3a) after a spacer (2) has been dispensed at the glass sheet surface (3) and prior to the relative movement (MOV1) between the glass sheet surface (3a) and the spacer outlet (16) in the direction along the major glass sheet surface (3a), such as during the spacer placement sequence.

50. A spacer dispensing station according to any of claims 39-49, wherein said individual movement of the respective spacer outlet (16) towards and/or away from the glass sheet

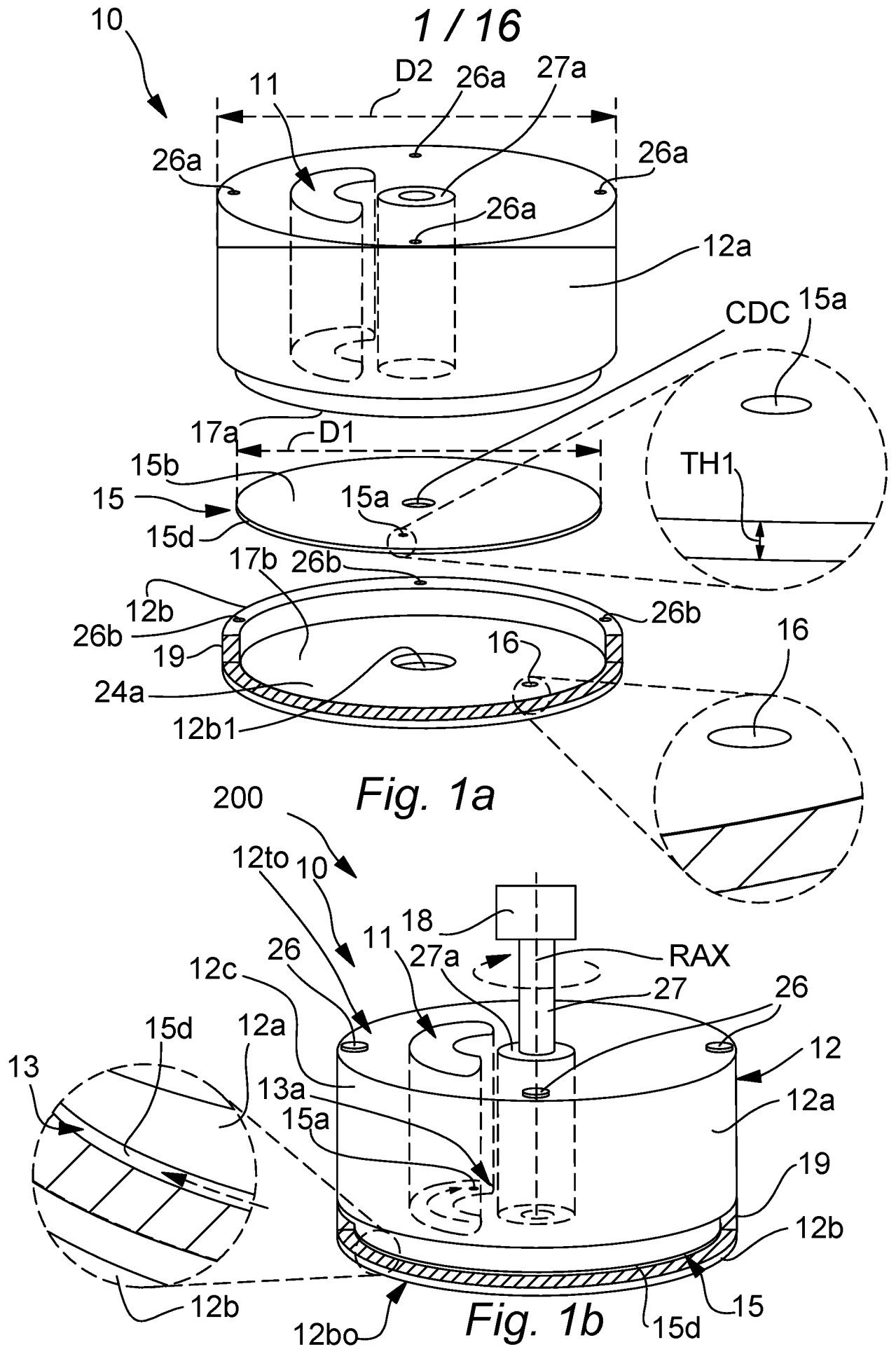
surface (3a) during the spacer placement sequence is configured to be provided so that the individual spacer outlet (16) is adapted to the local surface topology of the major glass sheet surface (3a) opposite to the spacer outlet (16) one or more times, such as continuously, during the spacer placement sequence.

5

51. A spacer dispensing station according to any of claims 39-50, wherein the distance controller (31) is configured to control the distance (DIS1) between the glass sheet surface (3a) and the spacer outlet (16) to be less than a spacer height (H1) of the spacers (2), at least while the spacers (2) are delivered to, such as dropped onto, the glass sheet surface (3a) by the dispenser.

10

52. A spacer dispensing station according to any of claims 39-51, wherein the spacer dispensing station is used in the method according to any of claims 1-38.



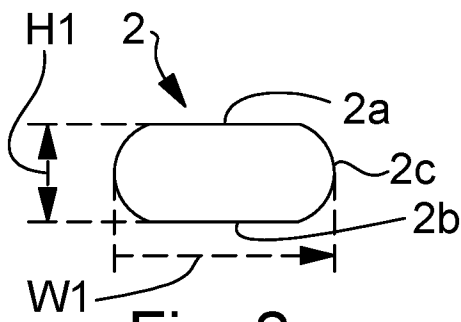


Fig. 2a

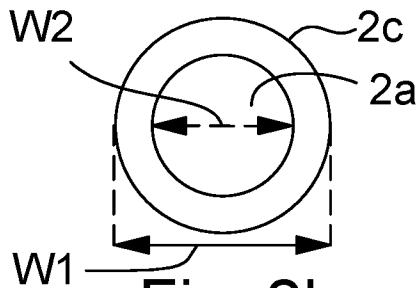


Fig. 2b

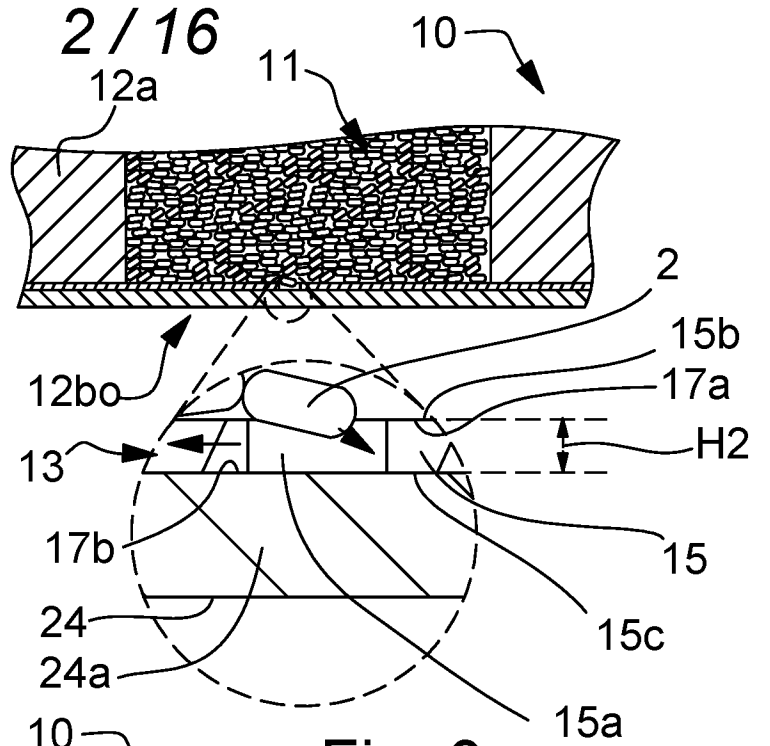


Fig. 3a

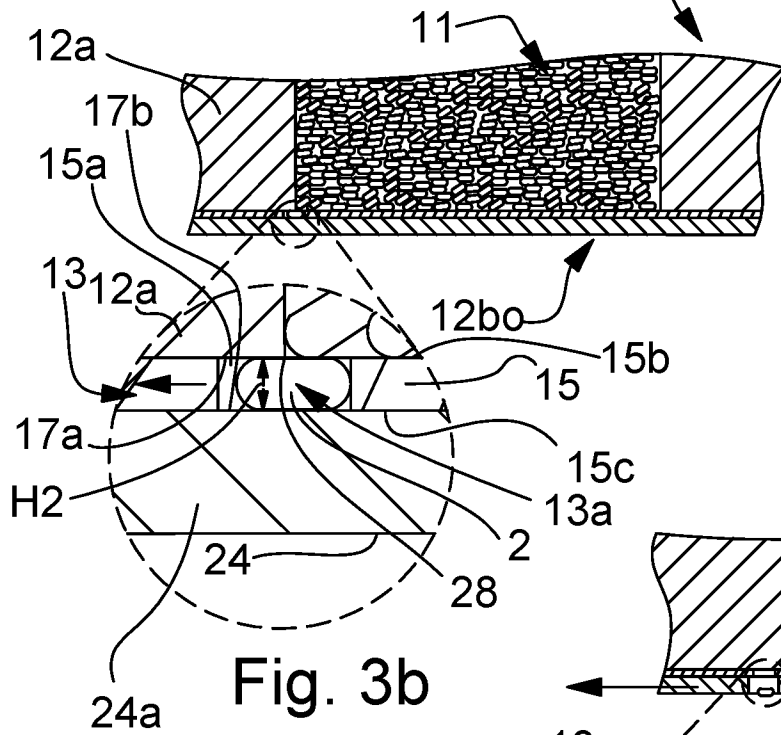


Fig. 3b

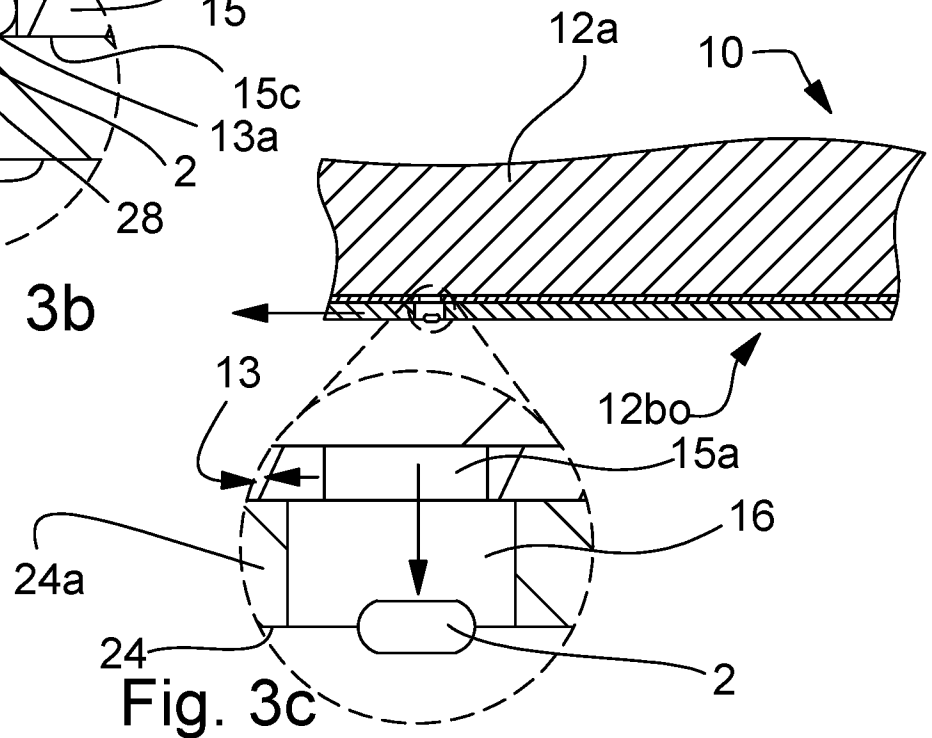


Fig. 3c

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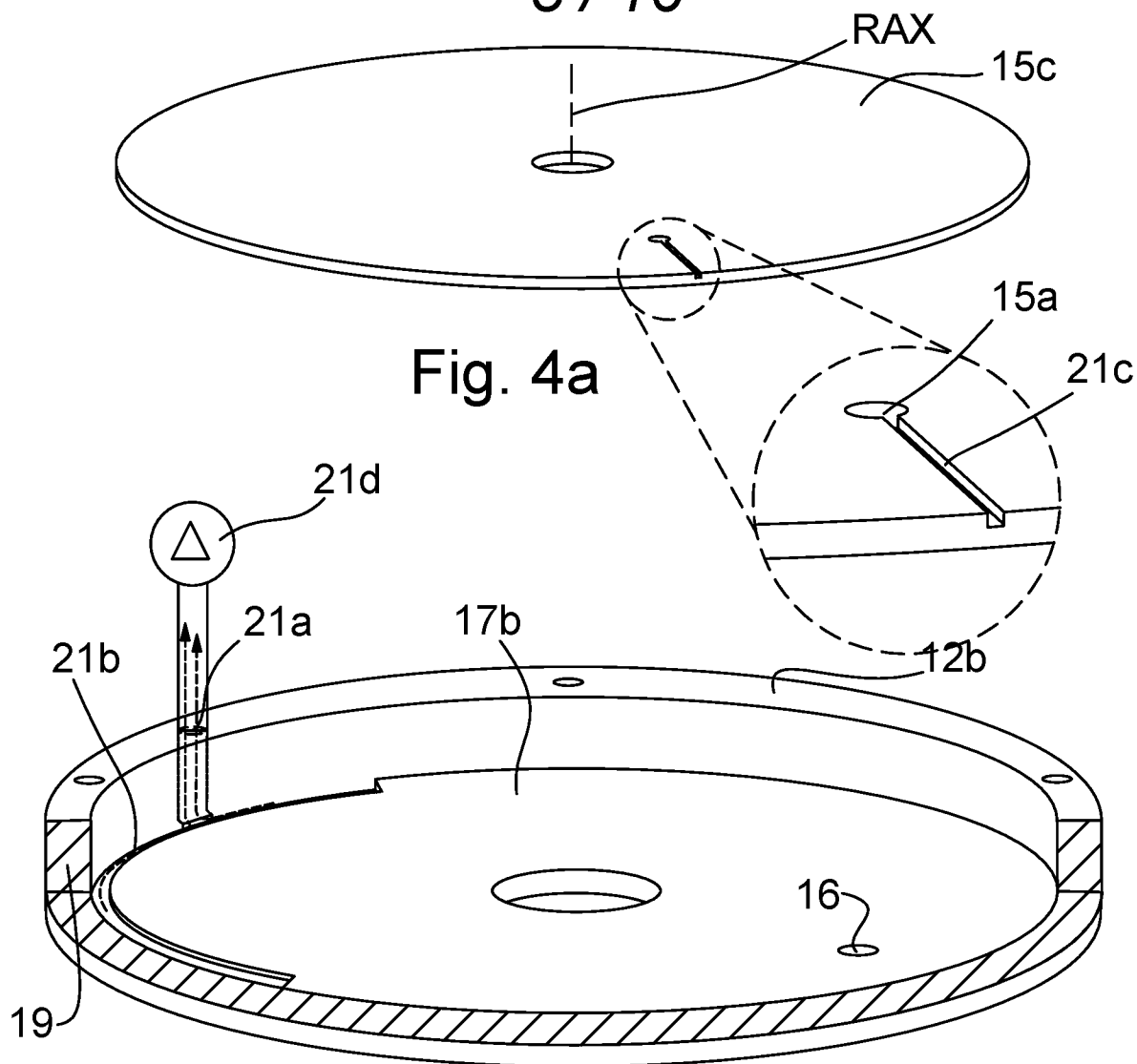


Fig. 4b

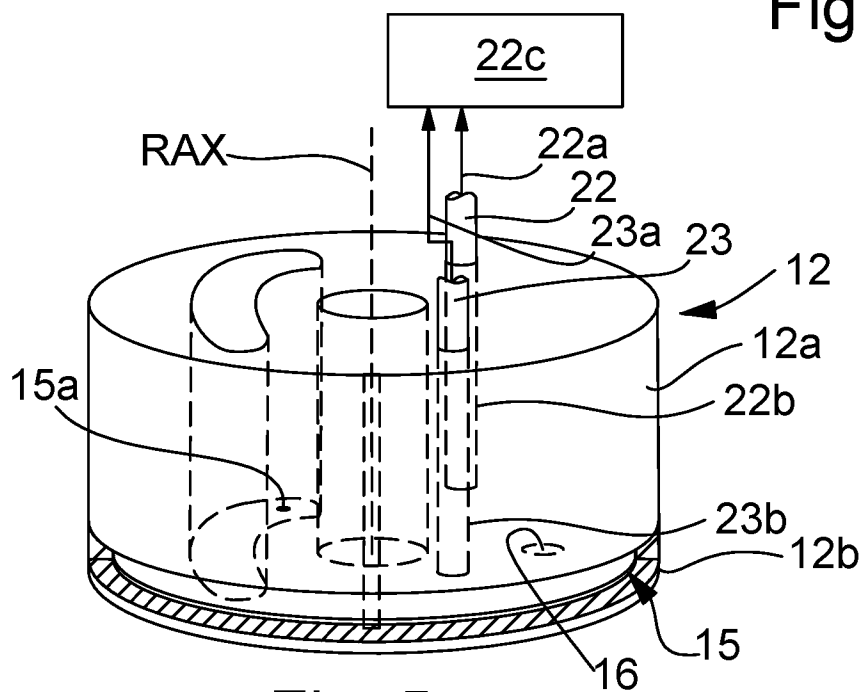


Fig. 5

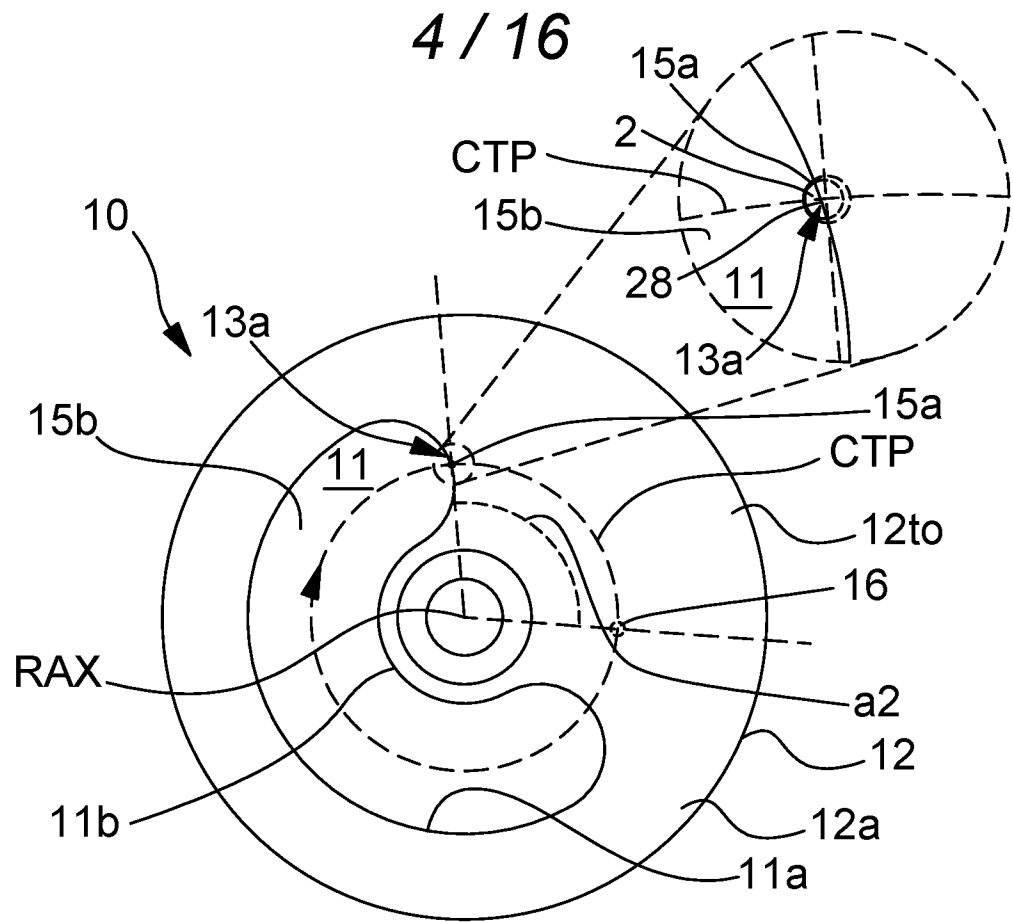


Fig. 6

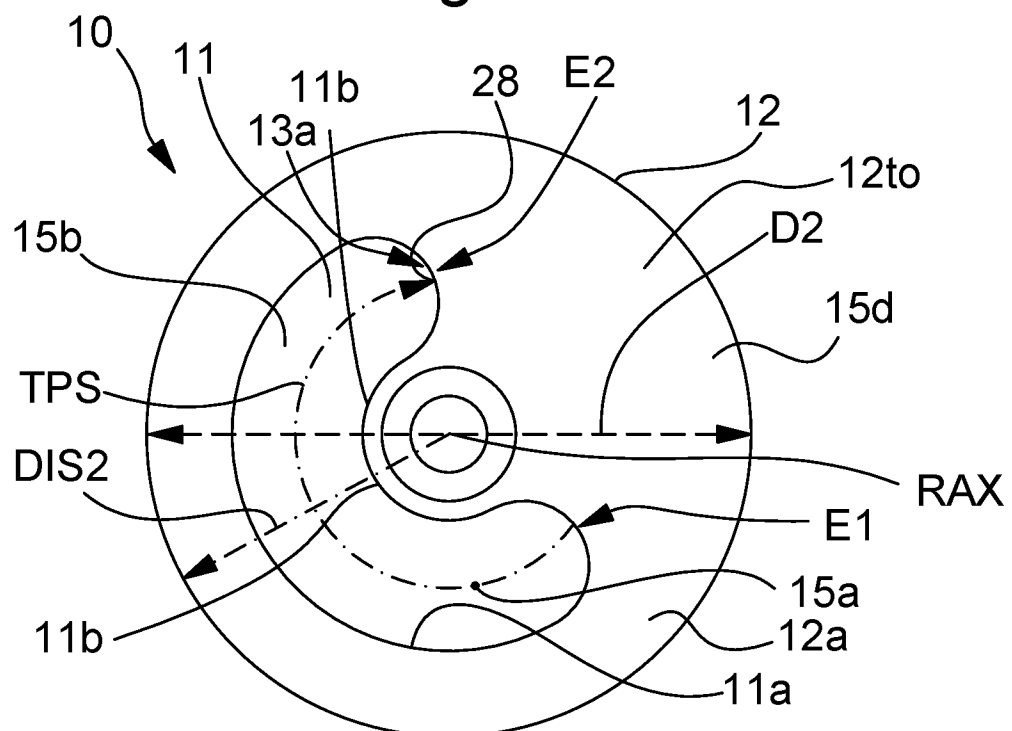


Fig. 7

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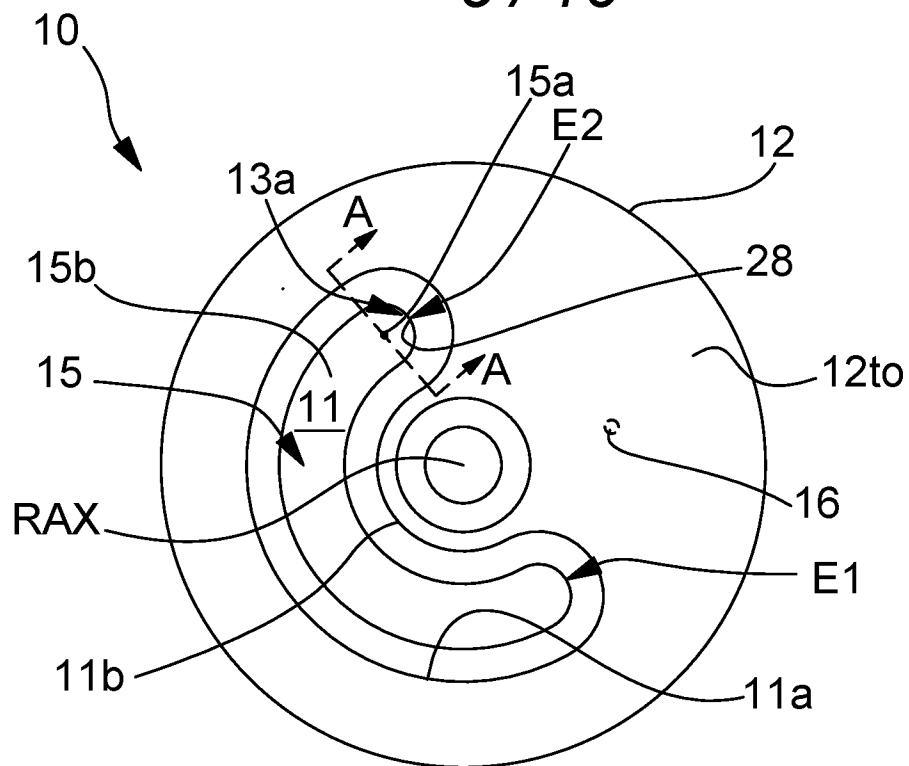


Fig. 8

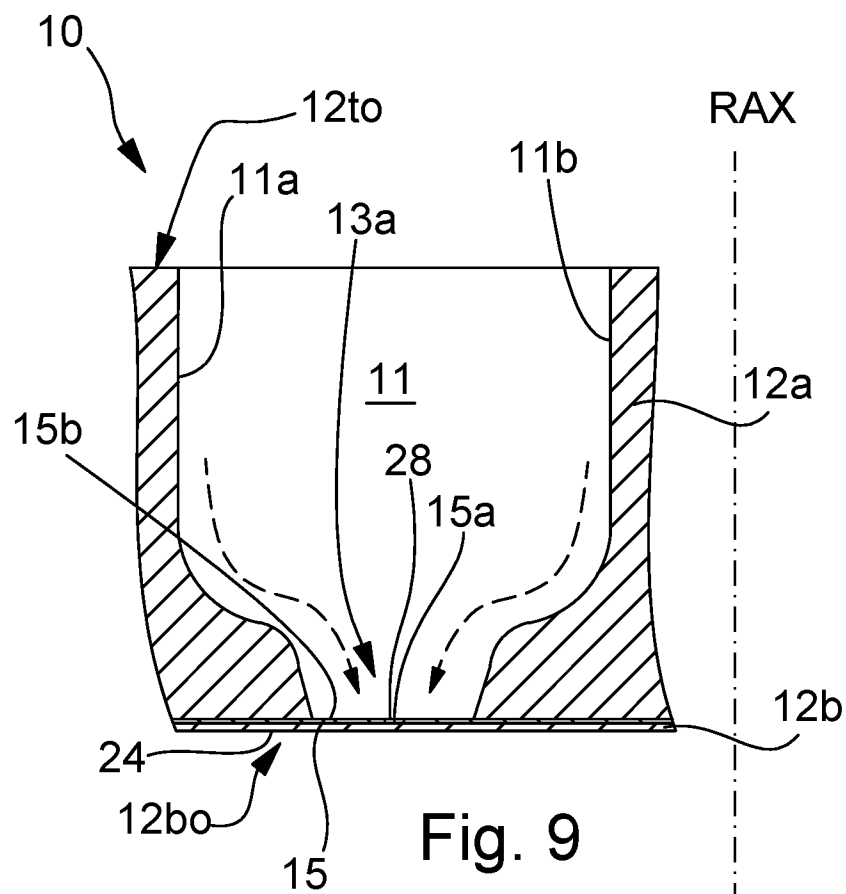


Fig. 9

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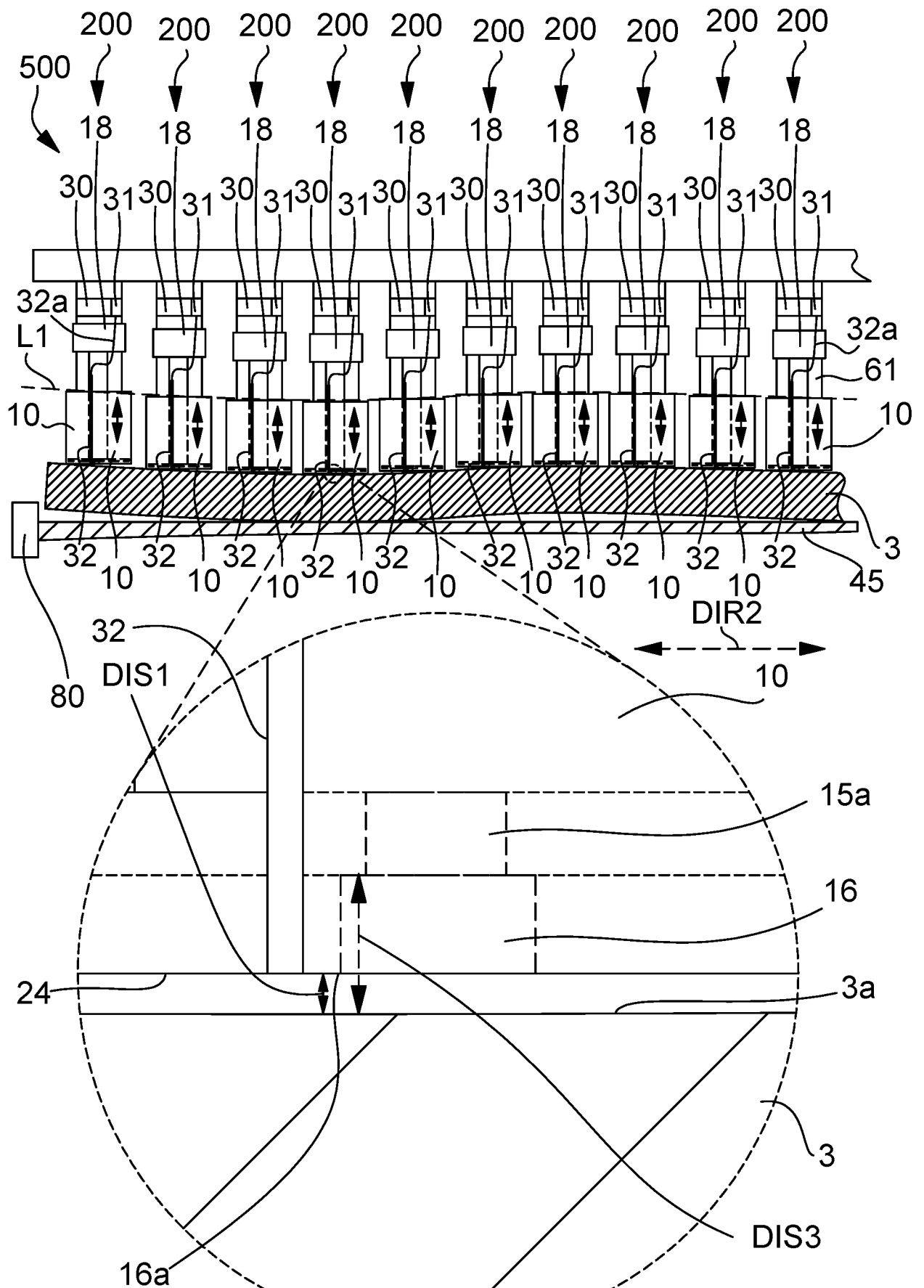
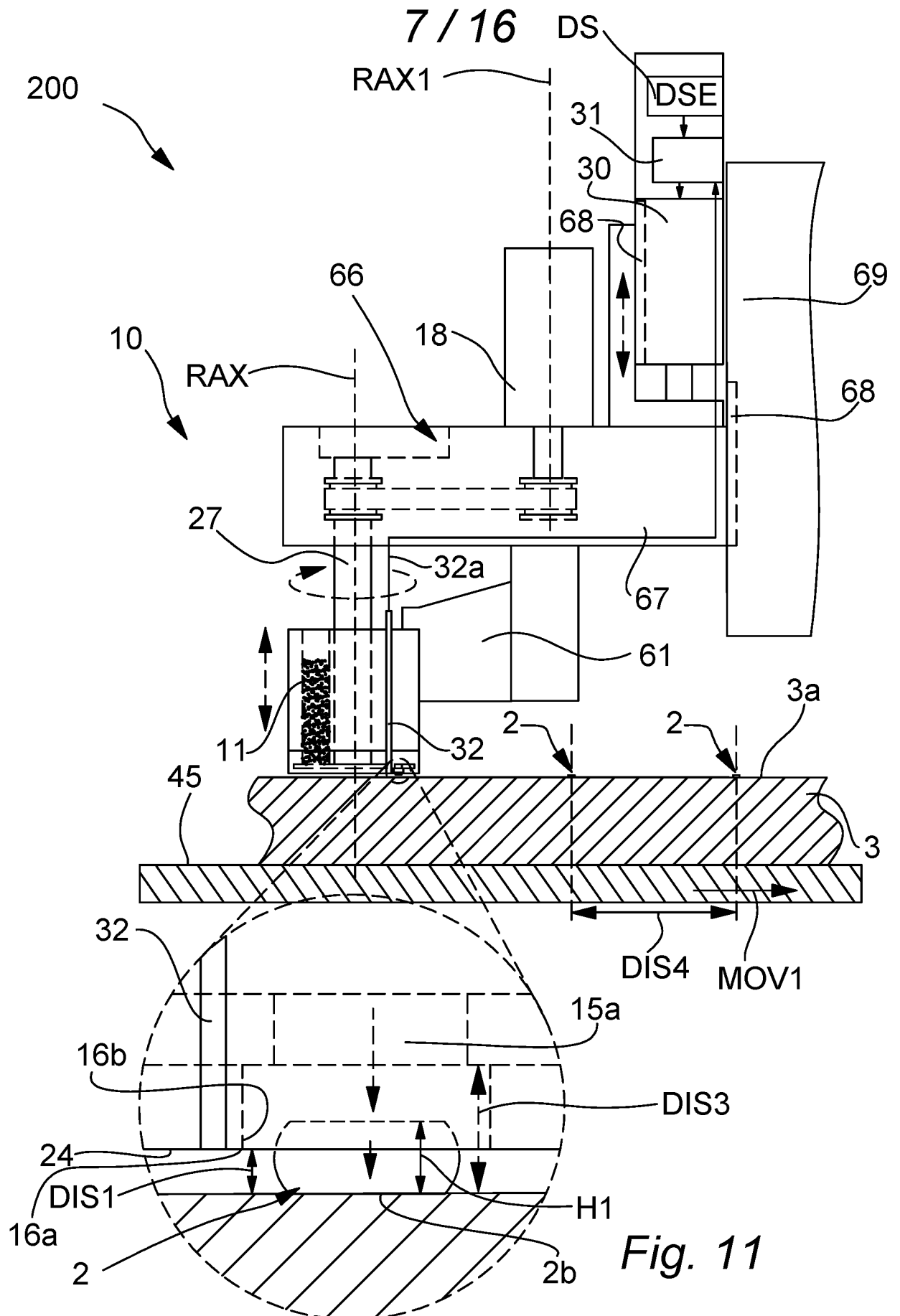


Fig. 10



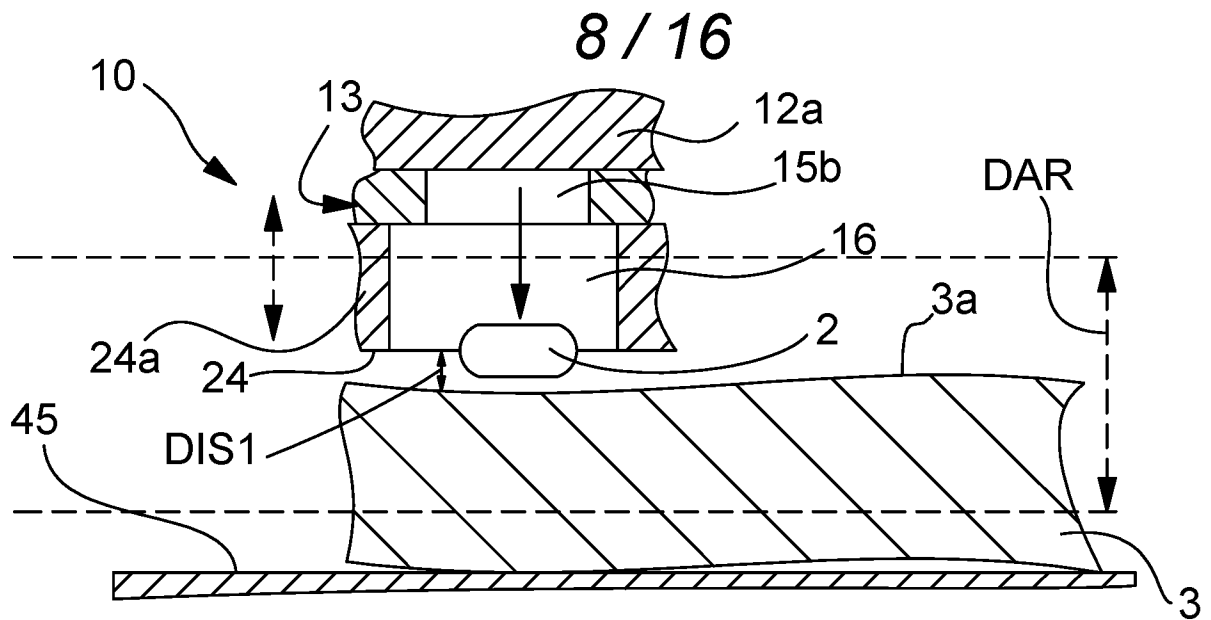


Fig. 12

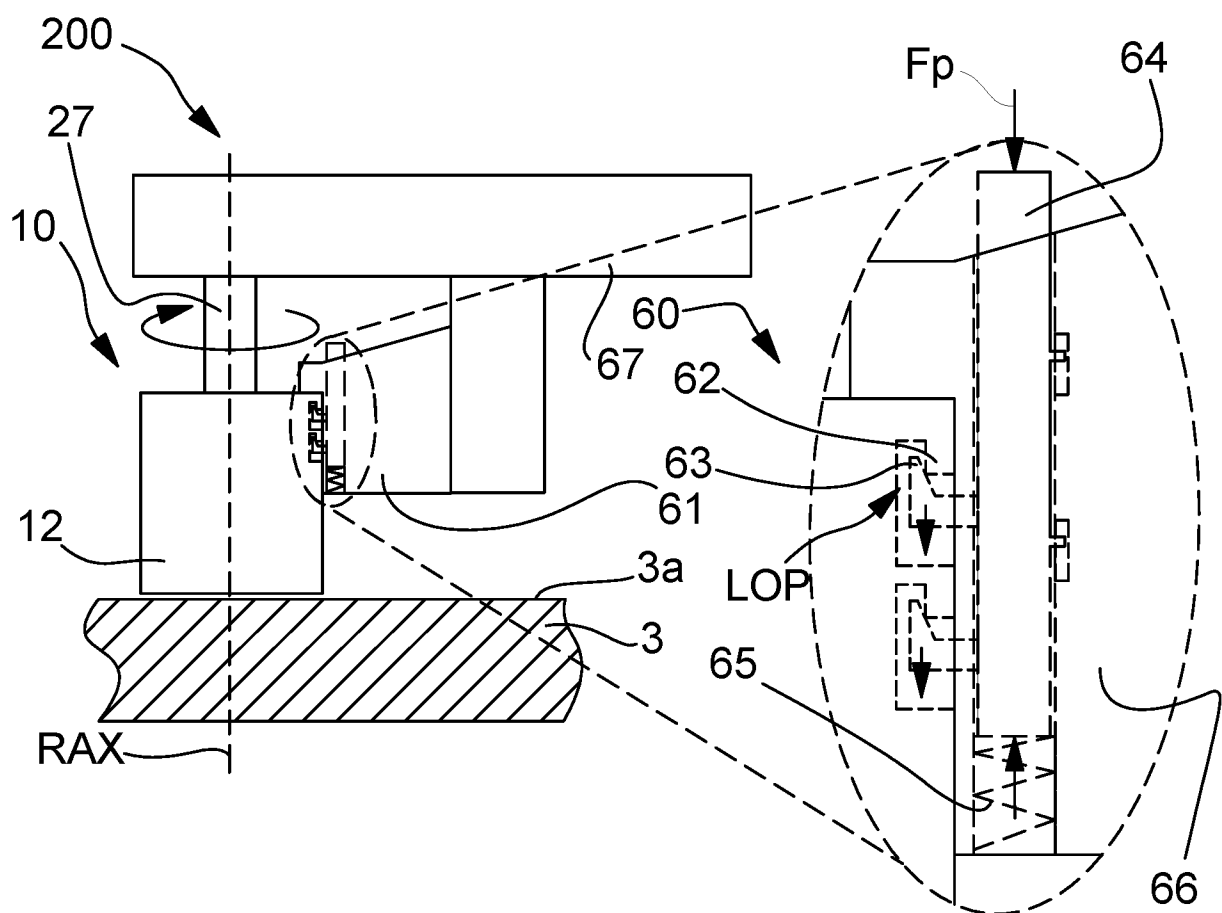
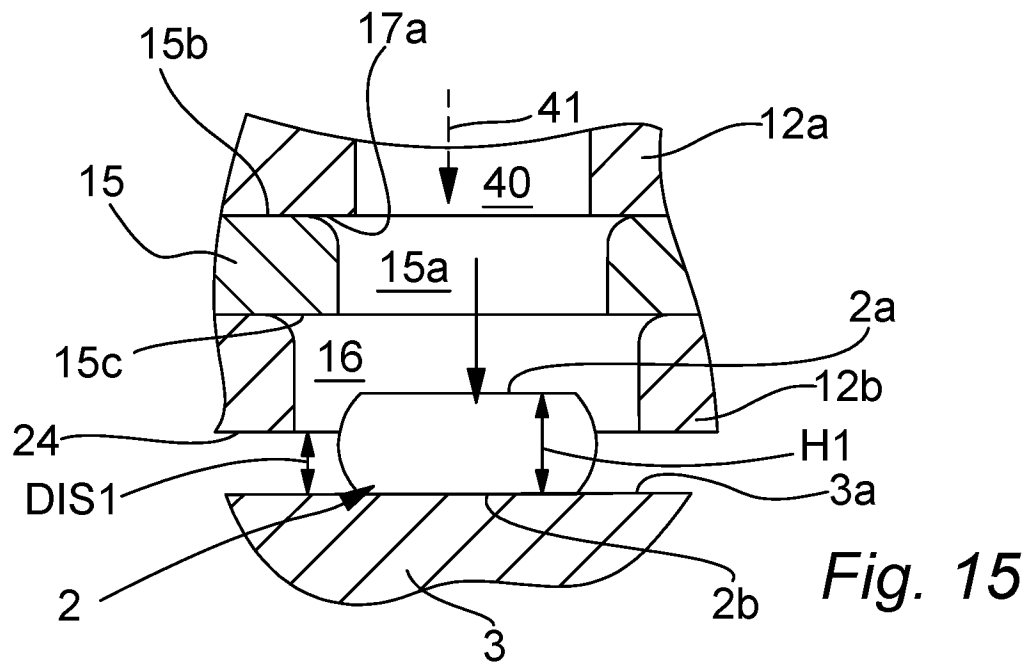
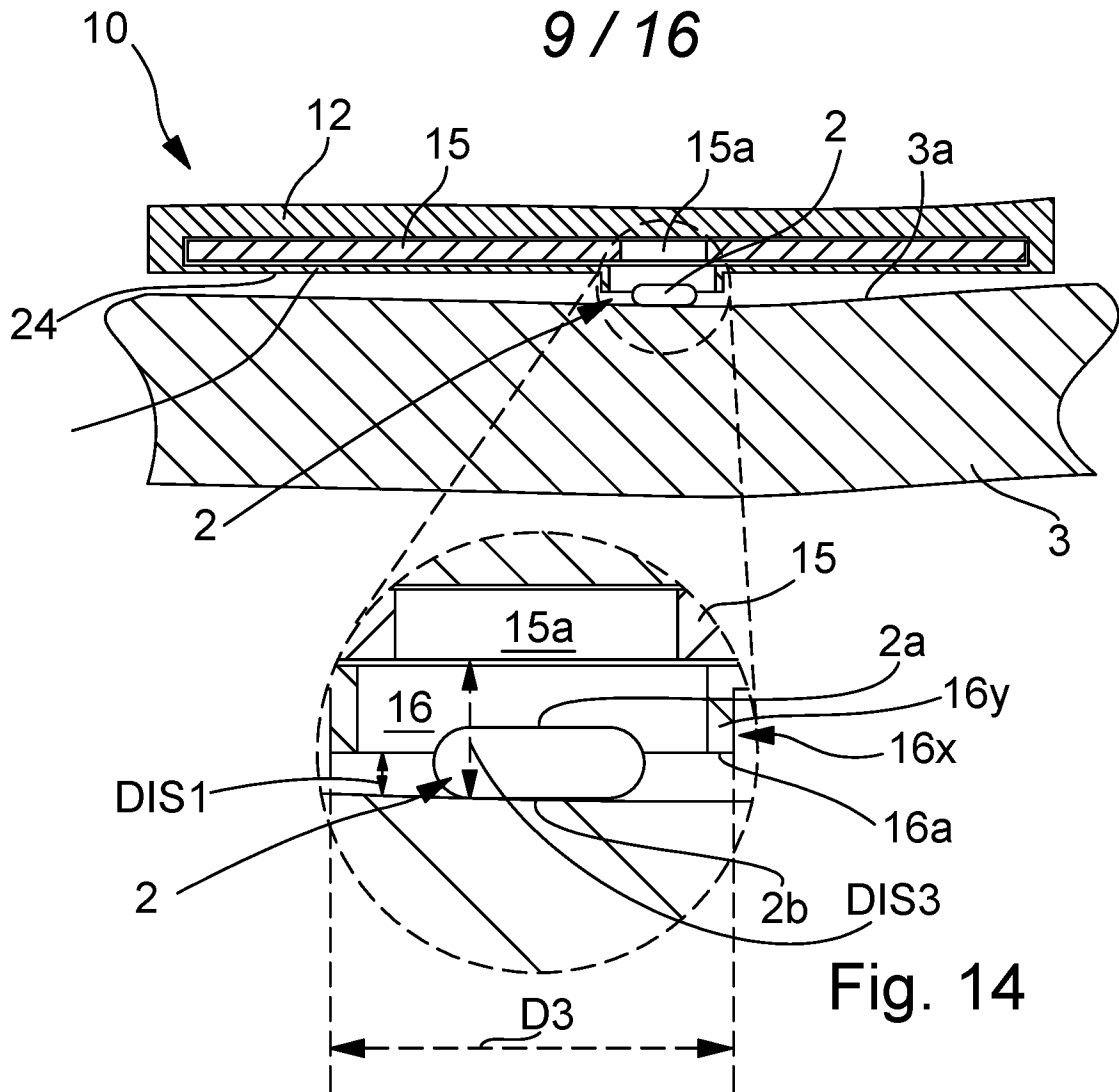
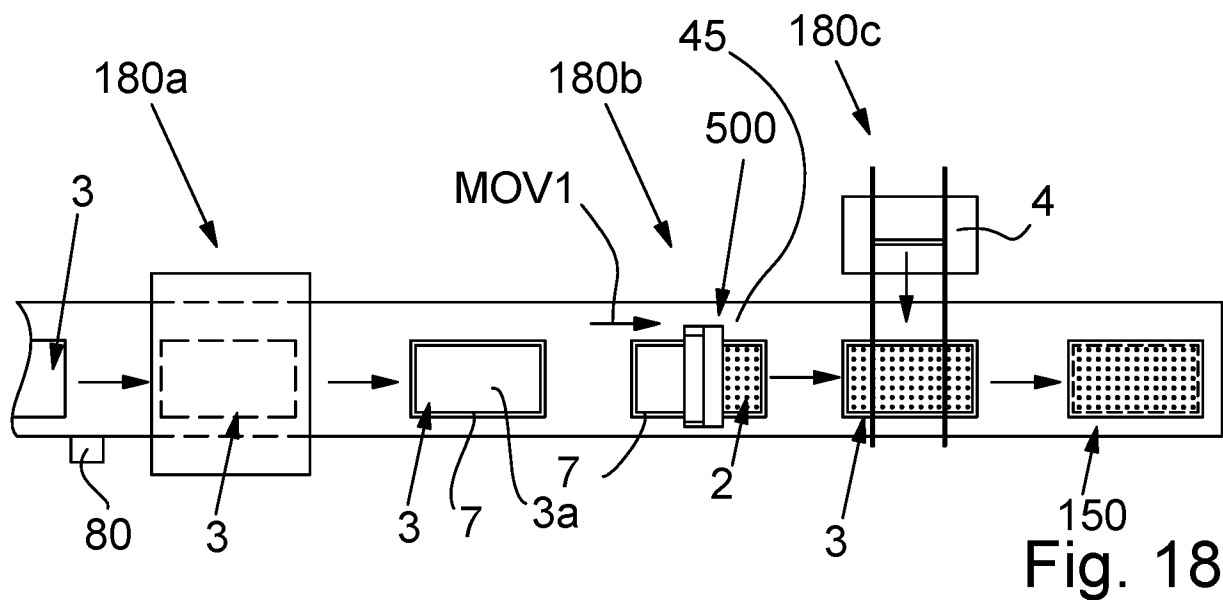
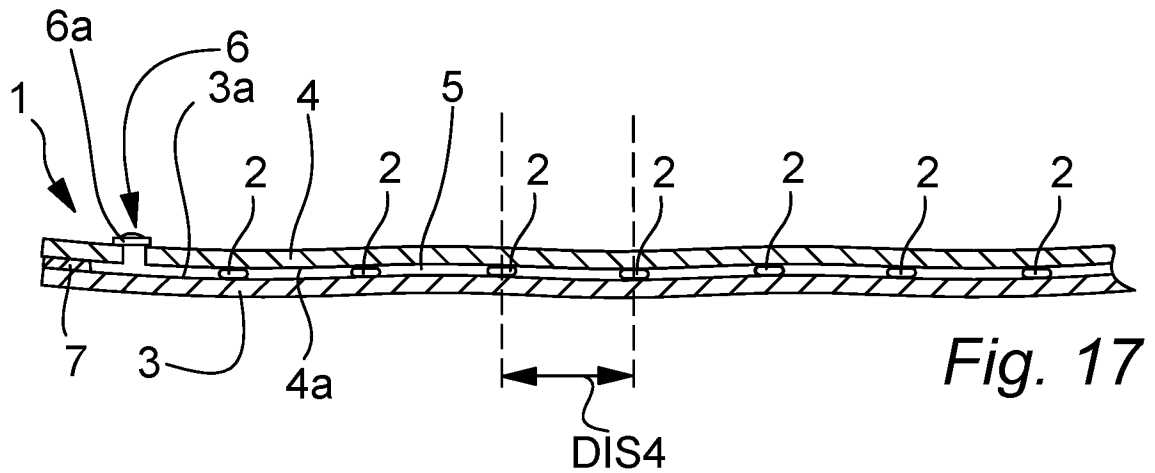
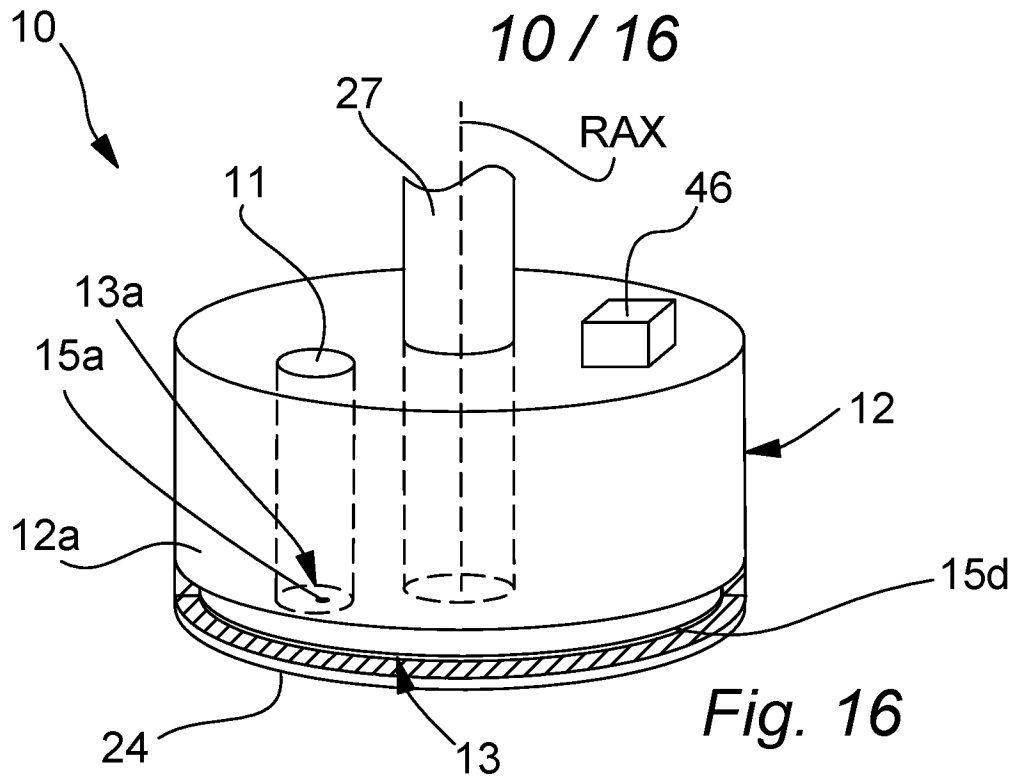


Fig. 13





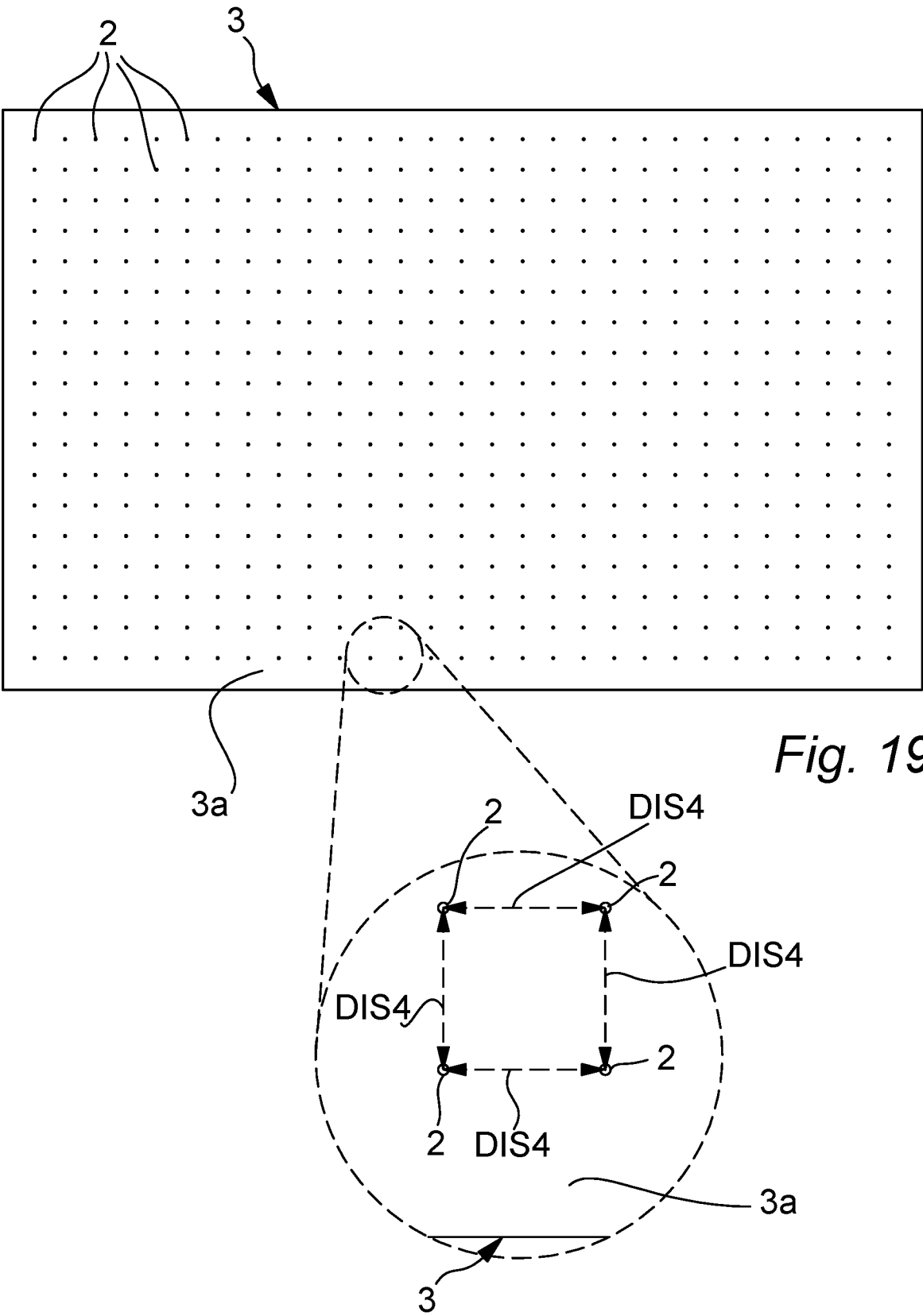
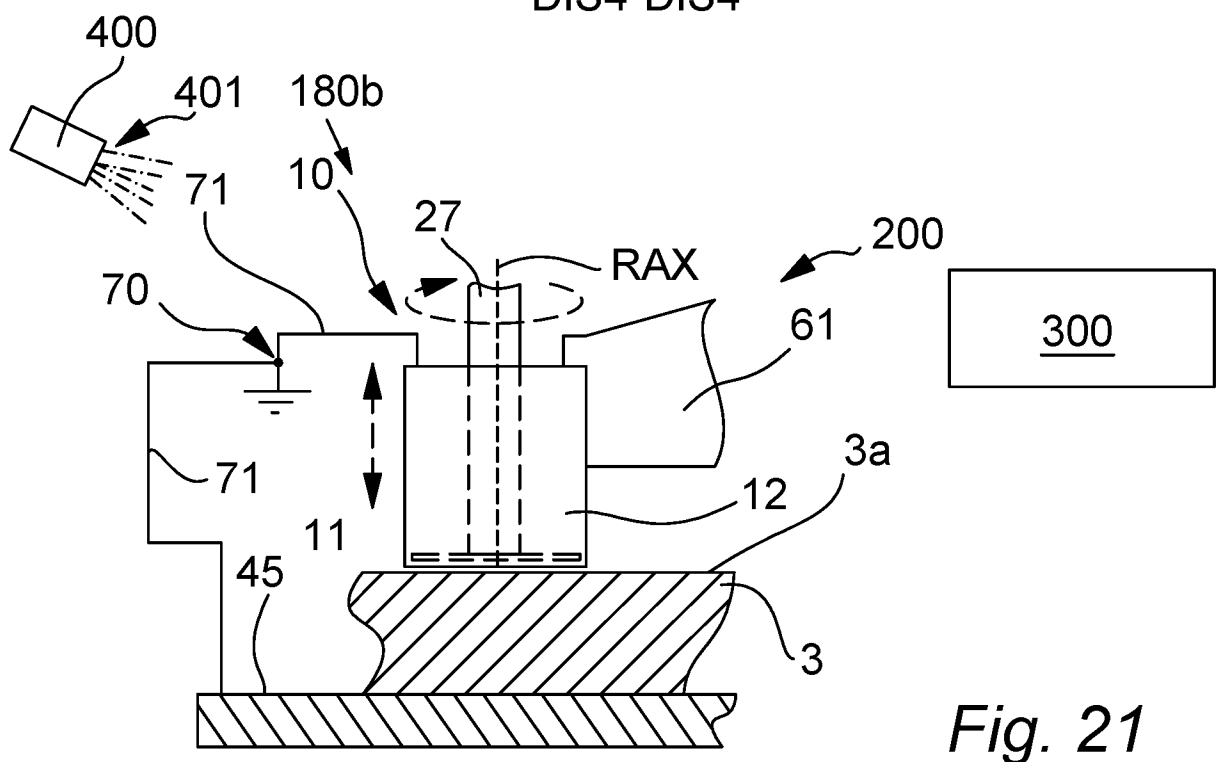
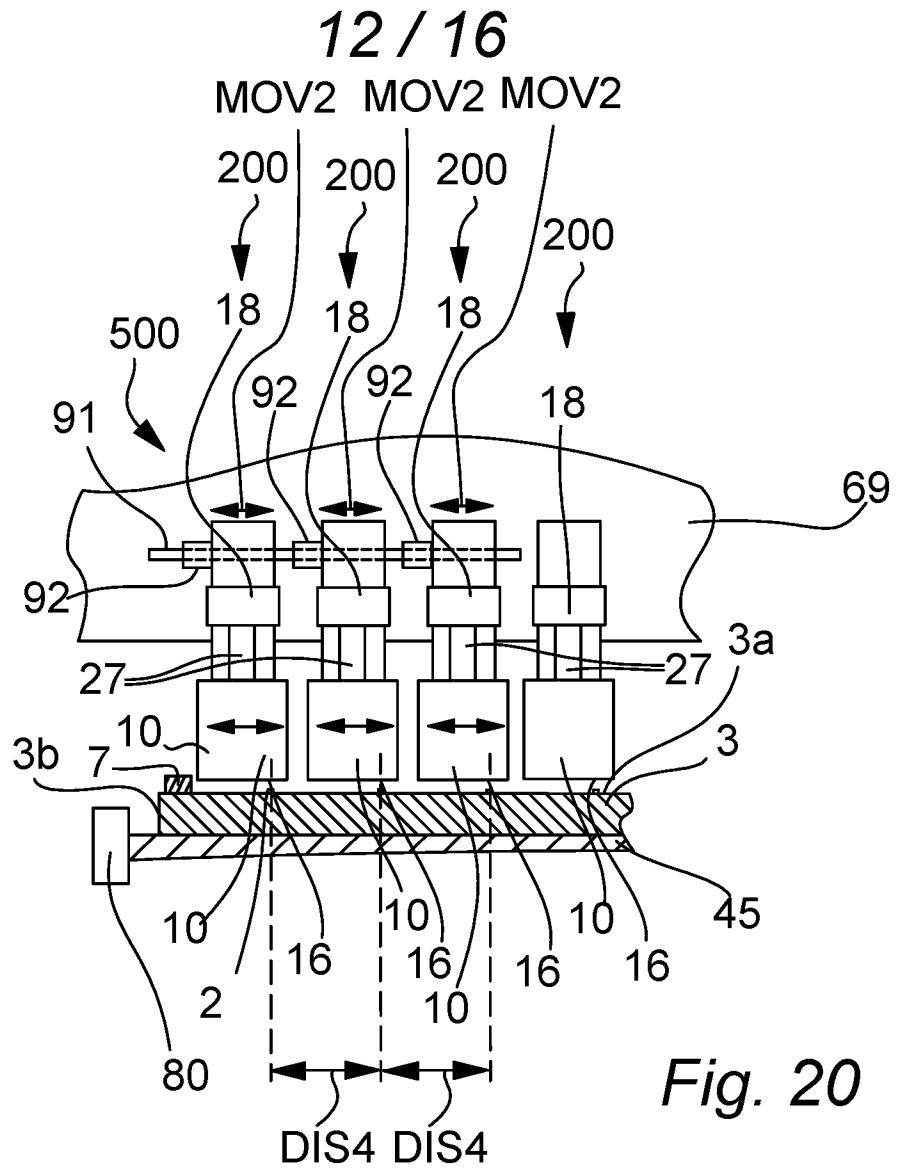


Fig. 19



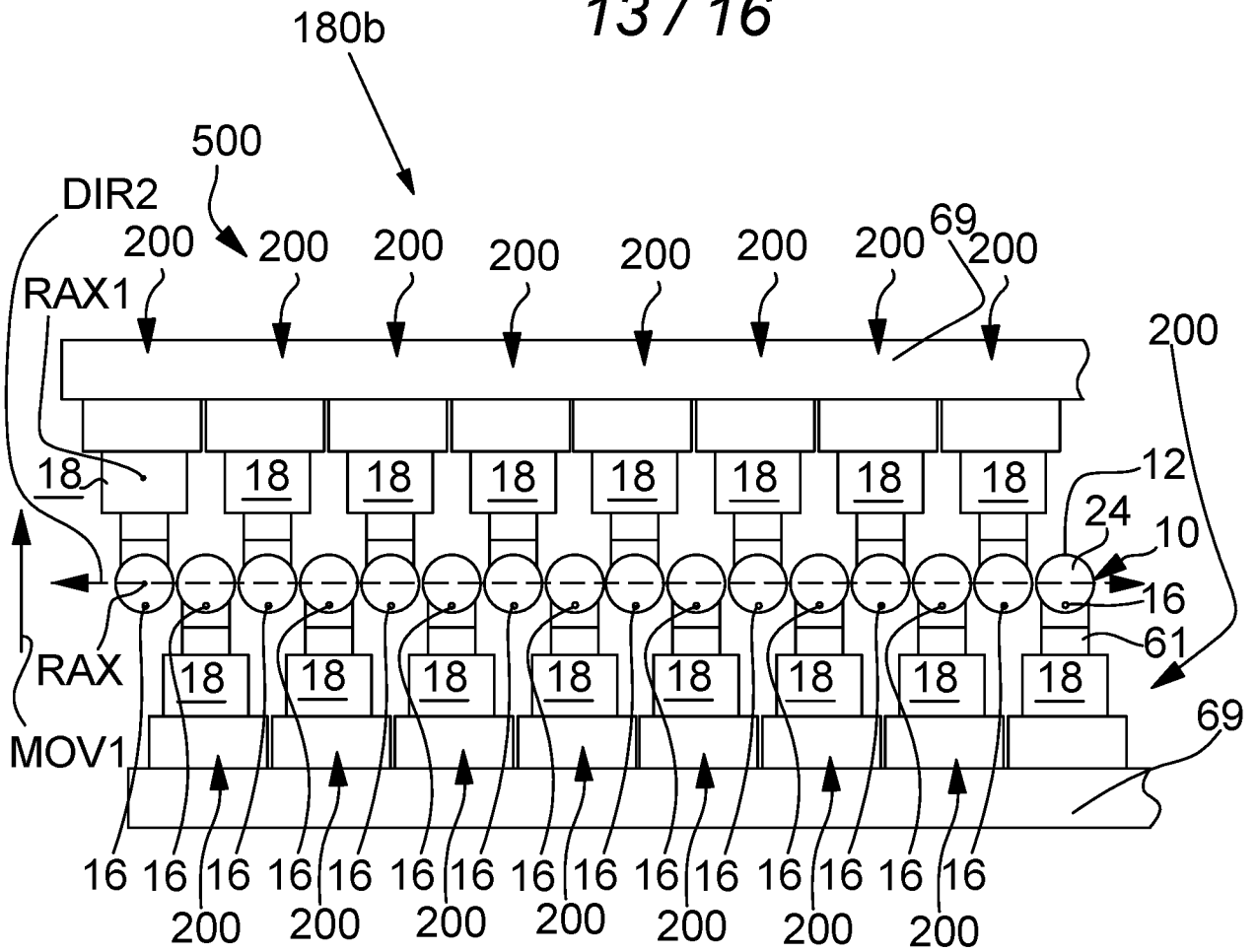


Fig. 22

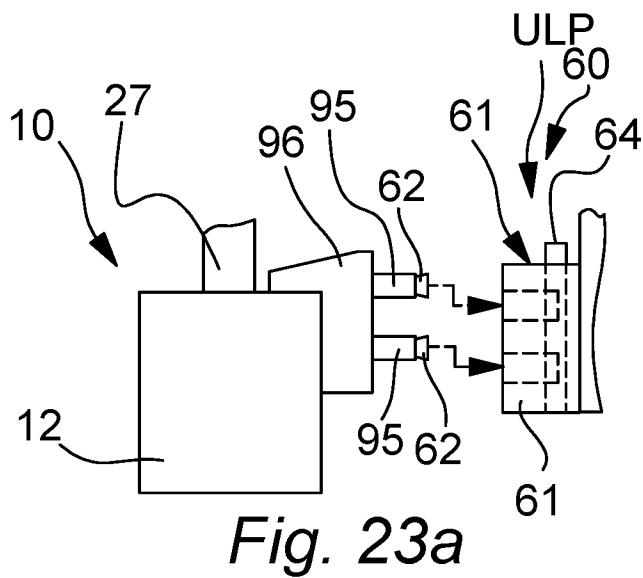


Fig. 23a

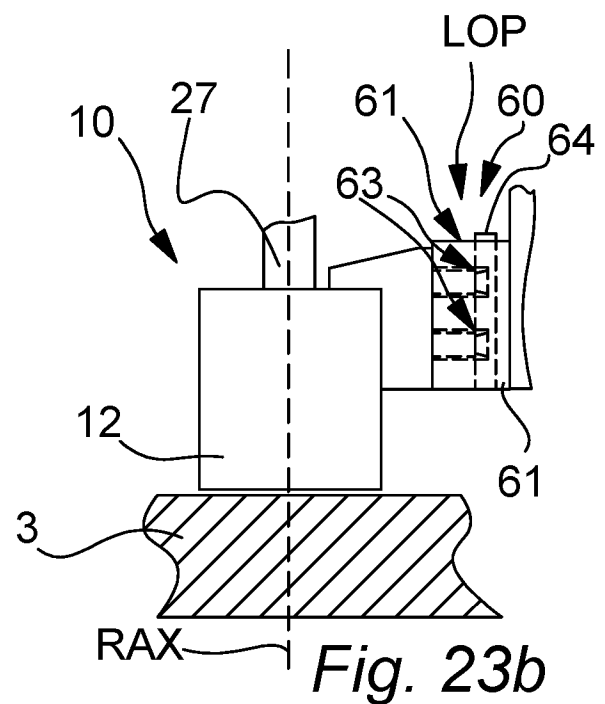
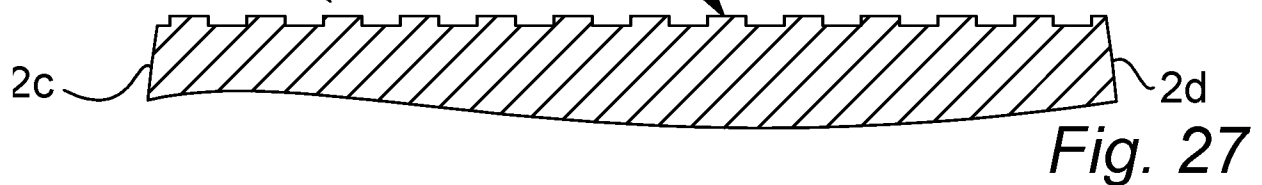
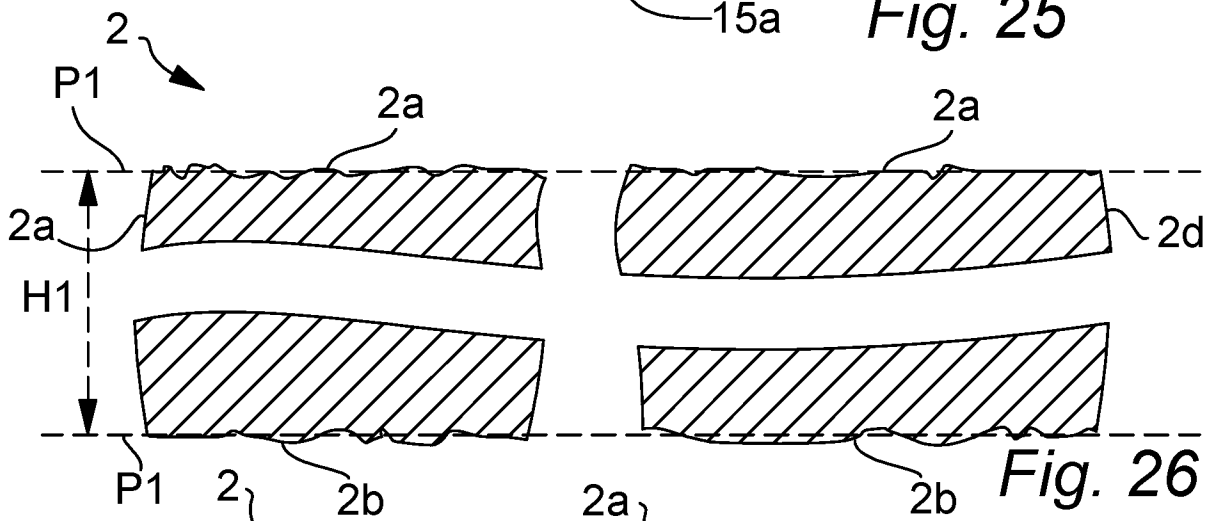
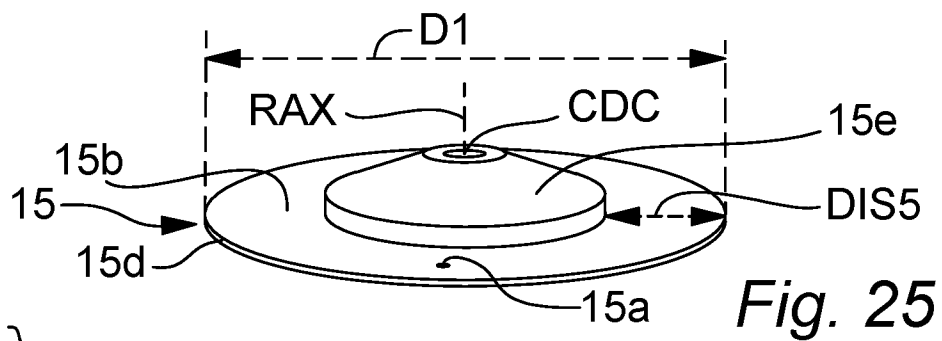
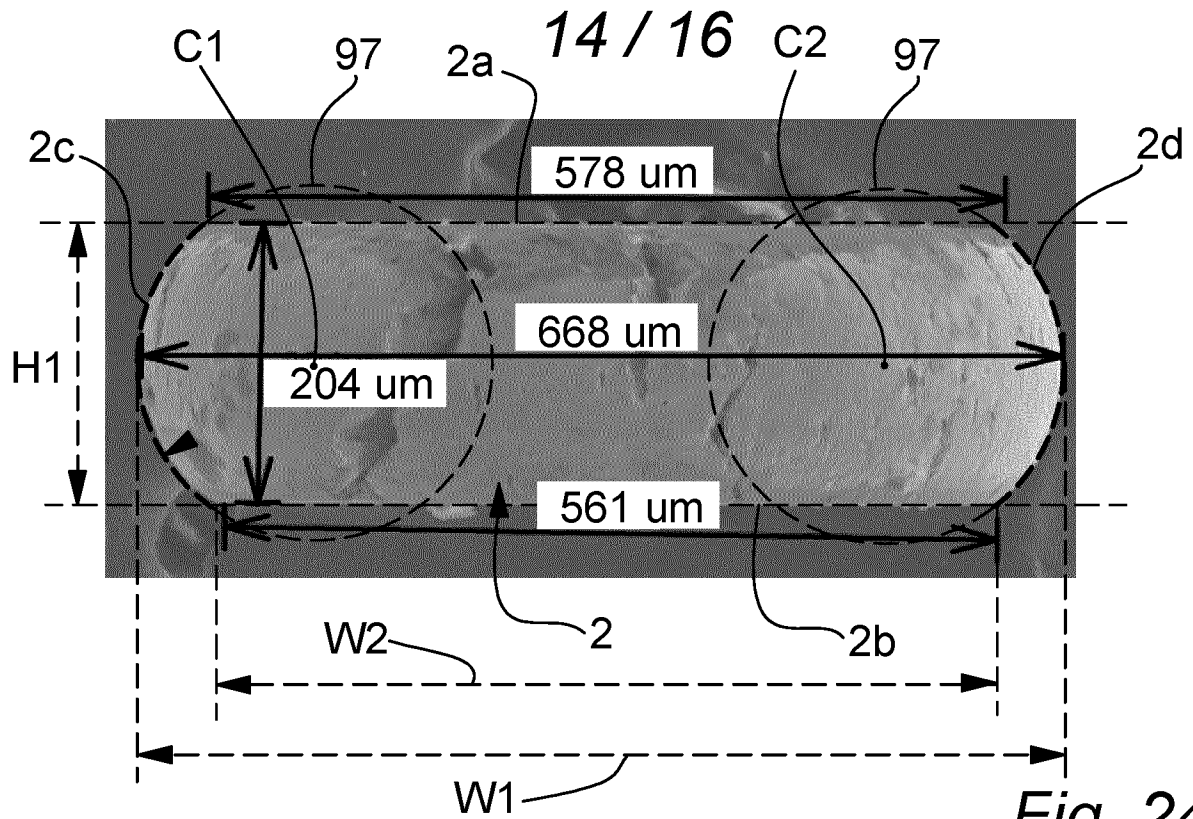


Fig. 23b



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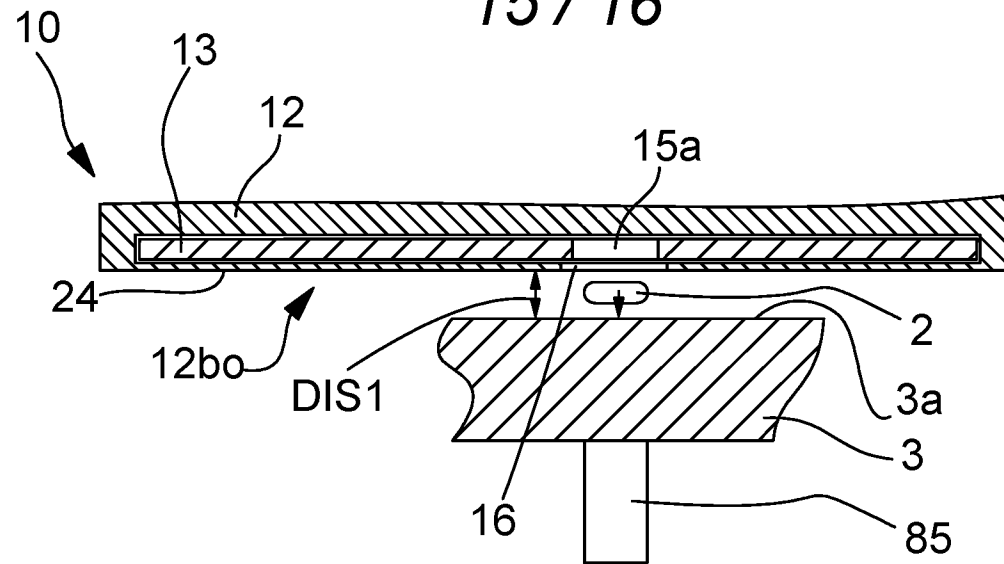


Fig. 28

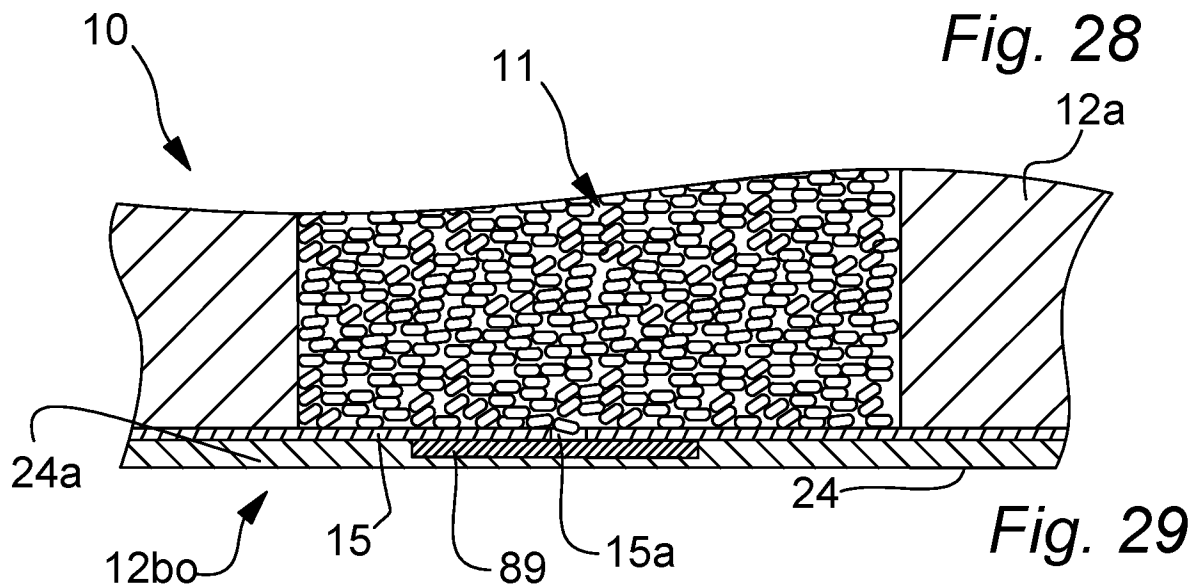


Fig. 29

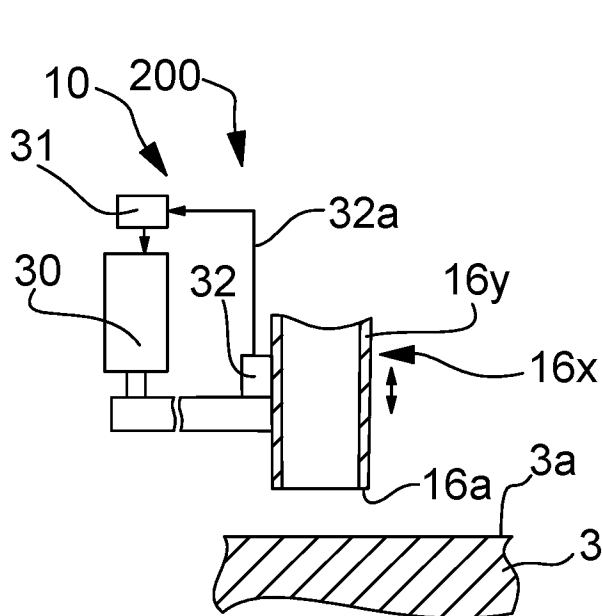


Fig. 30a

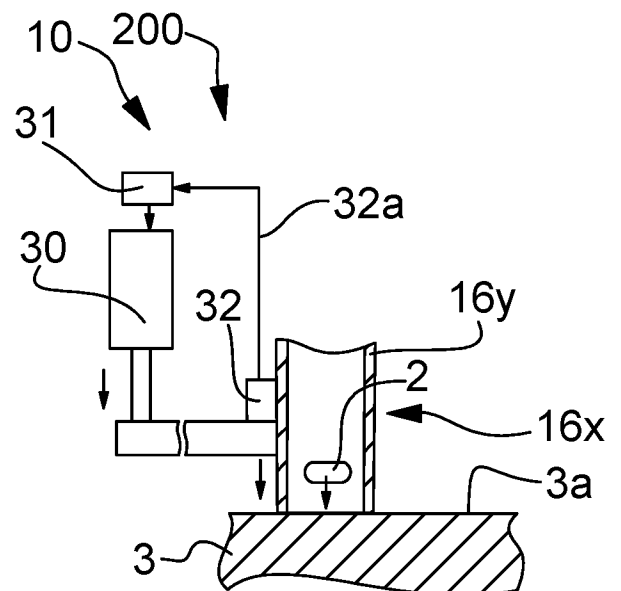


Fig. 30b

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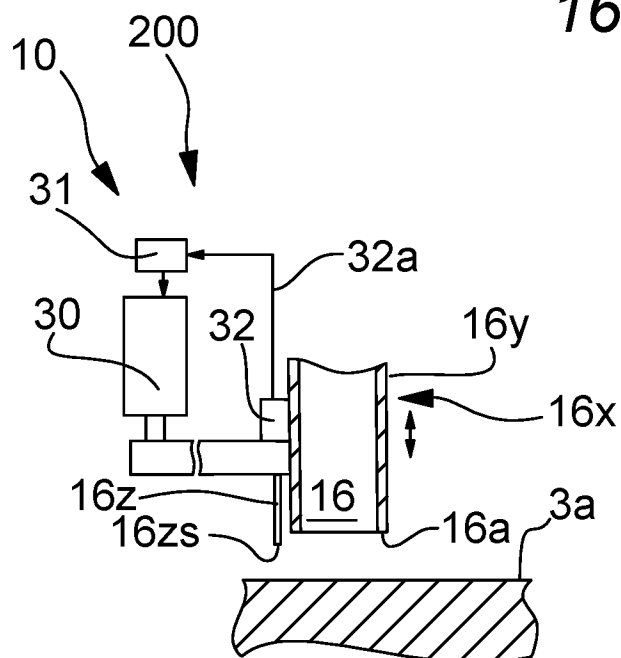


Fig. 31a

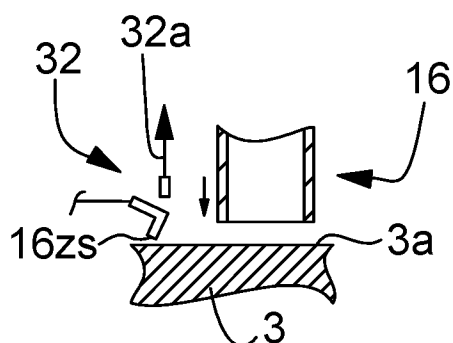


Fig. 32a

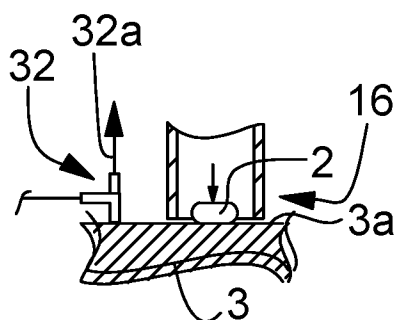


Fig. 32b

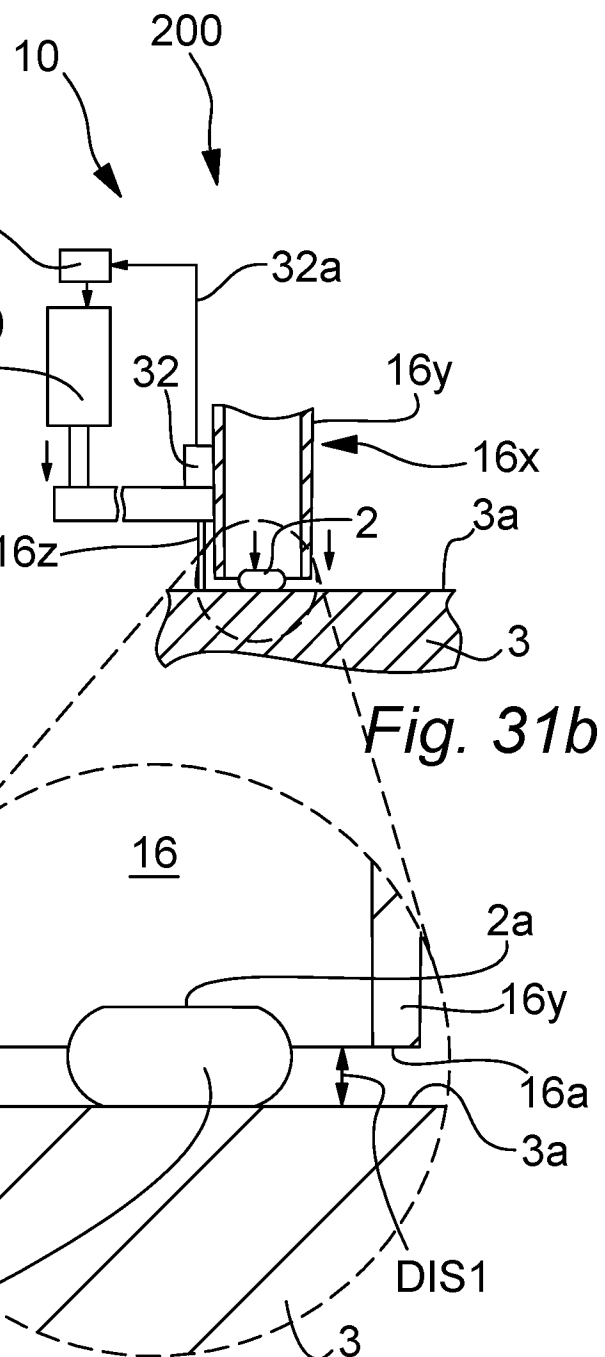


Fig. 31b

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2023/077733

A. CLASSIFICATION OF SUBJECT MATTER

INV. E06B3/663 E06B3/677 E06B3/673 E06B3/66

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)

E06B

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	CN 203 668 211 U (LUOYANG LANDGLASS TECH CO LTD) 25 June 2014 (2014-06-25) figures 1-7 -----	1, 2, 6, 8-18, 20, 25-28, 35, 36



Further documents are listed in the continuation of Box C.



See patent family annex.

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"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)

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"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

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Date of the actual completion of the international search

15 December 2023

Date of mailing of the international search report

03/01/2024

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Authorized officer

Crespo Vallejo, D

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2023/077733

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CN 203668211	U	25-06-2014	NONE
