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(54) SUBSTRATE SUPPORT, SUBSTRATE TABLE AND METHOD

(57) A substrate support for supporting a substrate in a lithographic apparatus, the substrate support comprising: a first support body configured to support the substrate; a main body separate from the first support body and configured to support the first support body, the main body comprising a thermal conditioner configured to thermally condition the main body, and/or the support body and/or the substrate; and an extractor body surrounding the main body and the support body, wherein the extractor body comprises a first extraction channel configured to extract fluid from near a peripheral part of the substrate.

SUBSTRATE SUPPORT, SUBSTRATE TABLE AND METHOD

FIELD

[0001] The present invention relates to a substrate support for supporting a substrate in a lithographic apparatus, a substrate table, a method for supporting a substrate and a device manufacturing method.

BACKGROUND

[0002] A lithographic apparatus is a machine constructed to apply a desired pattern onto a substrate. A lithographic apparatus can be used, for example, in the manufacture of integrated circuits (ICs). A lithographic apparatus may, for example, project a pattern (also often referred to as "design layout" or "design") of a patterning device (e.g., a mask) onto a layer of radiation-sensitive material (resist) provided on a substrate (e.g., a wafer). Known lithographic apparatus include so-called steppers, in which each target portion is irradiated by exposing an entire pattern onto the target portion at one time, and so-called scanners, in which each target portion is irradiated by scanning the pattern through a radiation beam in a given direction (the "scanning"-direction) while synchronously scanning the substrate parallel or anti-parallel to this direction.

[0003] As semiconductor manufacturing processes continue to advance, the dimensions of circuit elements have continually been reduced while the amount of functional elements, such as transistors, per device has been steadily increasing over decades, following a trend commonly referred to as 'Moore's law'. To keep up with Moore's law the semiconductor industry is chasing technologies that enable to create increasingly smaller features. To project a pattern on a substrate a lithographic apparatus may use electromagnetic radiation. The wavelength of this radiation determines the minimum size of features which are patterned on the substrate. Typical wavelengths currently in use are 365 nm (i-line), 248 nm, 193 nm and 13.5 nm.

[0004] Further improvements in the resolution of smaller features may be achieved by providing an immersion fluid having a relatively high refractive index, such as water, on the substrate during exposure. The effect of the immersion fluid is to enable imaging of smaller features since the exposure radiation will have a shorter wavelength in the fluid than in gas. The effect of the immersion fluid may also be regarded as increasing the effective numerical aperture (NA) of the system and also increasing the depth of focus.

[0005] The immersion fluid may be confined to a localized area between the projection system of the lithographic apparatus and the substrate by a fluid handling structure. Fast relative movement between the substrate and the confined immersion liquid may cause leaking of the immersion fluid from the localized area. Such leaking is undesirable and may lead to defects on the substrate. The speed at which the substrate is stepped or scanned with respect to the projection system is thus limited. This limits the throughput of the lithographic apparatus.

SUMMARY

[0006] During a semiconductor manufacturing process, the substrate is supported on a substrate support. Over time, the substrate support wears out and needs to be replaced. It is an object of the present invention to provide a substrate support that is cheaper to maintain and that reduces the length of downtime required to service it when it is worn.

[0007] According to the present invention, there is provided substrate support for supporting a substrate in a lithographic apparatus, the substrate support comprising:

a first support body configured to support the substrate;

a main body separate from the first support body and configured to support the first support body, the main body comprising a thermal conditioner configured to thermally condition the main body, and/or the support body and/or the substrate; and

an extractor body surrounding the main body and the support body, wherein the extractor body comprises a first extraction channel configured to extract fluid from near a peripheral part of the substrate.

[0008] According to the present invention, there is also provided a substrate table comprising: a substrate stage; and the substrate support.

[0009] According to the present invention, there is also provided a method for supporting a substrate in a lithographic apparatus on a substrate support comprising:

supporting the substrate on a first support body of the substrate support;

supporting the first support body on a main body separate from the first support body;

thermally conditioning the main body, and/or the support body and/or the substrate with a thermal conditioner of the main body; and

extracting fluid from near a peripheral part of the substrate through a first extraction channel of an extractor body surrounding the main body and the support body.

[0010] According to the present invention, there is also provided a device manufacturing method using a lithographic apparatus, the method comprising:

projecting a beam patterned by a patterning device onto a substrate while supporting the substrate with a substrate support; and

performing the method for supporting the substrate in the lithographic apparatus.

[0011] Further embodiments, features and advantages of the present invention, as well as the structure and operation of the various embodiments, features and advantages of the present invention, are described in detail below with reference to the accompanying drawings.

DRESCRIPTION OF THE DRAWINGS

[0012] Embodiments of the invention will now be described, by way of example only, with reference to the accompanying schematic drawings, in which corresponding reference symbols indicate corresponding parts, and in which:

Figure 1 depicts a schematic overview of the lithographic apparatus;

Figures 2 and 3 depict, in cross section, two different versions of a fluid handling system for use in a lithographic projection apparatus;

Figure 4 depicts part of a lithographic apparatus;

Figure 5 depicts a substrate support according to an embodiment of the invention;

Figure 6 depicts a substrate support according to a comparative example;

Figures 7 to 11 depict different versions of a substrate support according to the invention; and

Figures 12 and 13 depicts different versions of a height adjustment mechanism for an embodiment of the invention.

[0013] The features shown in the Figures are not necessarily to scale, and the size and/or arrangement depicted is not limiting. It will be understood that the Figures include optional features which may not be essential to the invention. Furthermore, not all of the features of the apparatus are depicted in each of the figures, and the Figures may only show some of the components relevant for describing a particular feature.

DETAILED DESCRIPTION

[0014] In the present document, the terms "radiation" and "beam" are used to encompass all types of electromagnetic radiation, including ultraviolet radiation (e.g. with a wavelength of 365, 248, 193, 157 or 126 nm).

[0015] The term "reticle", "mask" or "patterning device" as employed in this text may be broadly interpreted as referring to a generic patterning device that can be used to endow an incoming radiation beam with a patterned cross-section, corresponding to a pattern that is to be created in a target portion of the substrate. The term "light valve" can also be used in this context. Besides the classic mask (transmissive or reflective, binary, phase-shifting, hybrid, etc.), examples of other such patterning devices include a programmable mirror array and a programmable LCD array.

[0016] Figure 1 schematically depicts a lithographic apparatus. The lithographic apparatus includes an illumination system (also referred to as illuminator) IL configured to condition a radiation beam B (e.g., UV radiation or DUV radiation), a mask support (e.g., a mask table) MT constructed to support a patterning device (e.g., a mask) MA and connected to a first positioner PM configured to accurately position the patterning device MA in accordance with certain parameters, a substrate support (e.g., a substrate table) WT constructed to hold a substrate (e.g., a resist coated wafer) W and connected to a second positioner PW configured to accurately position the substrate support WT in accordance with certain parameters, and a projection system (e.g., a refractive projection lens system) PS configured to project a pattern imparted to the radiation beam B by patterning device MA onto a target portion C (e.g., comprising one or more dies) of the substrate W.

[0017] In operation, the illumination system IL receives the radiation beam B from a radiation source SO, e.g. via a beam delivery system BD. The illumination system IL may include various types of optical components, such as refractive, reflective, magnetic, electromagnetic, electrostatic, and/or other types of optical components, or any combination thereof, for directing, shaping, and/or controlling radiation. The illuminator IL may be used to condition the radiation beam B to have a desired spatial and angular intensity distribution in its cross section at a plane of the patterning device MA.

[0018] The term "projection system" PS used herein should be broadly interpreted as encompassing various types of projection system, including refractive, reflective, catadioptric, anamorphic, magnetic, electromagnetic and/or electrostatic optical systems, or any combination thereof, as appropriate for the exposure radiation being used, and/or for other factors such as the use of an immersion liquid or the use of a vacuum. Any use of the term "projection lens" herein may be considered as synonymous with the more general term "projection system" PS.

[0019] The lithographic apparatus is of a type wherein at least a portion of the substrate W may be covered by an immersion liquid having a relatively high refractive index, e.g., water, so as to fill an immersion space 11 between the projection system PS and the substrate W – which is also referred to as immersion lithography. More information on immersion techniques is given in US 6,952,253, which is incorporated herein by reference.

[0020] The lithographic apparatus may be of a type having two or more substrate supports WT (also named "dual stage"). In such "multiple stage" machine, the substrate supports WT may be used in parallel, and/or steps in preparation of a subsequent exposure of the substrate W may be carried out on the substrate W located on one of the substrate support WT while another substrate W on the other substrate support WT is being used for exposing a pattern on the other substrate W.

[0021] In addition to the substrate support WT, the lithographic apparatus may comprise a measurement stage (not depicted in figures). The measurement stage is arranged to hold a sensor and/or a cleaning device. The sensor may be arranged to measure a property of the projection system PS or a property of the radiation beam B. The measurement stage may hold multiple sensors. The cleaning device may be arranged to clean part of the lithographic apparatus, for example a part of the projection system PS or a part of a system that provides the immersion liquid. The measurement stage may move beneath the projection system PS when the substrate support WT is away from the projection system PS.

[0022] In operation, the radiation beam B is incident on the patterning device, e.g. mask, MA which is held on the mask support MT, and is patterned by the pattern (design layout) present on patterning device MA. Having traversed the mask MA, the radiation beam B passes through the projection system PS, which focuses the beam onto a target portion C of the substrate W. With the aid of the second positioner PW and a position measurement system IF, the substrate support WT can be moved accurately, e.g., so as to position different target portions C in the path of the radiation beam B at a focused and aligned position. Similarly, the first positioner PM and possibly another position sensor (which is not explicitly depicted in Figure 1) may be used to accurately position the patterning device MA with respect to the path of the radiation beam B. Patterning device MA and substrate W may be aligned using mask alignment marks M_1, M_2 and substrate alignment marks P_1, P_2. Although the substrate alignment marks P_1, P_2 as illustrated occupy dedicated target portions, they may be located in spaces between target portions. Substrate alignment marks P_1, P_2 are known as scribe-lane alignment marks when these are located between the target portions C.

[0023] To clarify the invention, a Cartesian coordinate system is used. The Cartesian coordinate system has three axis, i.e., an x-axis, a y-axis and a z-axis. Each of the three axis is orthogonal to the other two axis. A rotation around the x-axis is referred to as an Rx-rotation. A rotation around the y-axis is referred to as an Ry-rotation. A rotation around about the z-axis is referred to as an Rz-rotation. The x-axis and the y-axis define a horizontal plane, whereas the z-axis is in a vertical direction. The Cartesian coordinate system is not limiting the invention and is used for clarification only. Instead, another coordinate system, such as a cylindrical coordinate system, may be used to clarify the invention. The orientation of the Cartesian coordinate system may be different, for example, such that the z-axis has a component along the horizontal plane.

[0024] Immersion techniques have been introduced into lithographic systems to enable improved resolution of smaller features. In an immersion lithographic apparatus, a liquid layer of immersion liquid having a relatively high refractive index is interposed in the immersion space 11 between a projection system PS of the apparatus (through which the patterned beam is projected towards the substrate W) and the substrate W. The immersion liquid covers at least the part of the substrate W under a final element of the projection system PS. Thus, at least the portion of the substrate W undergoing exposure is immersed in the immersion liquid.

[0025] In commercial immersion lithography, the immersion liquid is water. Typically the water is distilled water of high purity, such as Ultra-Pure Water (UPW) which is commonly used in semiconductor fabrication plants. In an immersion system, the UPW is often purified and it may undergo additional treatment steps before supply to the immersion space 11 as immersion liquid. Other liquids with a high refractive index can be used besides water as the immersion liquid, for example: a hydrocarbon, such as a fluorohydrocarbon; and/or an aqueous solution. Further, other fluids besides liquid have been envisaged for use in immersion lithography.

[0026] In this specification, reference will be made in the description to localized immersion in which the immersion liquid is confined, in use, to the immersion space 11 between the final element and a surface facing the final element. The facing surface is a surface of substrate W or a surface of the supporting stage (or substrate support WT) that is co-planar with the surface of the substrate W. (Please note that reference in the following text to surface of the substrate W also refers in addition or in the alternative to the surface of the substrate support WT, unless expressly stated otherwise; and vice versa). A fluid handling structure IH present between the projection system PS and the substrate support WT is used to confine the immersion liquid to the immersion space 11. The immersion space 11 filled by the immersion liquid is smaller in plan than the top surface of the substrate W and the immersion space 11 remains substantially stationary relative to the projection system PS while the substrate W and substrate support WT move underneath.

[0027] Other immersion systems have been envisaged such as an unconfined immersion system (a so-called 'All Wet' immersion system) and a bath immersion system. In an unconfined immersion system, the immersion liquid covers more than the surface under the final element. The liquid outside the immersion space 11 is present as a thin liquid film. The liquid may cover the whole surface of the substrate W or even the substrate W and the substrate support WT co-planar with the substrate W. In a bath type system, the substrate W is fully immersed in a bath of immersion liquid.

[0028] The fluid handling structure IH is a structure which supplies the immersion liquid to the immersion space 11, removes the immersion liquid from the immersion space 11 and thereby confines the immersion liquid to the immersion space 11. It includes features which are a part of a fluid supply system. The arrangement disclosed in PCT patent application publication no. WO 99/49504 is an early fluid handling structure comprising pipes which either supply or recover the immersion liquid from the immersion space 11 and which operate depending on the relative motion of the stage beneath the projection system PS. In more recent designs, the fluid handling structure extends along at least a part of a boundary of the immersion space 11 between the final element of the projection system PS and the substrate support WT or substrate W, so as to in part define the immersion space 11.

[0029] The fluid handing structure IH may have a selection of different functions. Each function may be derived from a corresponding feature that enables the fluid handling structure IH to achieve that function. The fluid handling structure IH may be referred to by a number of different terms, each referring to a function, such as barrier member, seal member, fluid supply system, fluid removal system, liquid confinement structure, etc..

[0030] As a barrier member, the fluid handling structure IH is a barrier to the flow of the immersion liquid from the immersion space 11. As a liquid confinement structure, the structure confines the immersion liquid to the immersion space 11. As a seal member, sealing features of the fluid handling structure IH form a seal to confine the immersion liquid to the immersion space 11. The sealing features may include an additional gas flow from an opening in the surface of the seal member, such as a gas knife.

[0031] In an embodiment the fluid handling structure IH may supply immersion fluid and therefore be a fluid supply system.

[0032] In an embodiment the fluid handling structure IH may at least partly confine immersion fluid and thereby be a fluid confinement system.

[0033] In an embodiment the fluid handling structure IH may provide a barrier to immersion fluid and thereby be a barrier member, such as a fluid confinement structure.

[0034] In an embodiment the fluid handling structure IH may create or use a flow of gas, for example to help in controlling the flow and/or the position of the immersion fluid.

[0035] The flow of gas may form a seal to confine the immersion fluid so the fluid handling structure IH may be referred to as a seal member; such a seal member may be a fluid confinement structure.

[0036] In an embodiment, immersion liquid is used as the immersion fluid. In that case the fluid handling structure IH may be a liquid handling system. In reference to the aforementioned description, reference in this paragraph to a feature defined with respect to fluid may be understood to include a feature defined with respect to liquid.

[0037] A lithographic apparatus has a projection system PS. During exposure of a substrate W, the projection system PS projects a beam of patterned radiation onto the substrate W. To reach the substrate W, the path of the radiation beam B passes from the projection system PS through the immersion liquid confined by the fluid handling structure IH between the projection system PS and the substrate W. The projection system PS has a lens element, the last in the path of the beam, which is in contact with the immersion liquid. This lens element which is in contact with the immersion liquid may be referred to as 'the last lens element' or "the final element". The final element is at least partly surrounded by the fluid handling structure IH. The fluid handling structure IH may confine the immersion liquid under the final element and above the facing surface.

[0038] As depicted in Figure 1, in an embodiment the lithographic apparatus comprises a controller 500. The controller 500 is configured to control the substrate table WT.

[0039] Figure 2 schematically depicts a localized liquid supply system or fluid handling system. The liquid supply system is provided with a fluid handling structure IH (or liquid confinement structure), which extends along at least a part of a boundary of the space 11 between the final element of the projection system PS and the support table WT or substrate W. The fluid handling structure IH is substantially stationary relative to the projection system PS in the XY plane though there may be some relative movement in the Z direction (in the direction of the optical axis). In an example, a seal is formed between the fluid handling structure IH and the surface of the substrate W and may be a contactless seal such as a gas seal (such a system with a gas seal is disclosed in EP1,420,298) or liquid seal.

[0040] The fluid handling structure IH at least partly confines the immersion liquid in the space 11 between the final element of the projection system PS and the substrate W. The space 11 is at least partly formed by the fluid handling structure IH positioned below and surrounding the final element of the projection system PS. Immersion liquid is brought into the space 11 below the projection system PS and within the fluid handling structure IH by one of liquid openings 13. The immersion liquid may be removed by another of liquid openings 13. The immersion liquid may be brought into the space 11 through at least two liquid openings 13. Which of liquid openings 13 is used to supply the immersion liquid and optionally which is used to remove the immersion liquid may depend on the direction of motion of the support table WT.

[0041] The immersion liquid may be confined in the space 11 by a contactless seal such as a gas seal 16 formed by a gas which, during use, is formed between the bottom of the fluid handling structure IH and the surface of the substrate W. The gas in the gas seal 16 is provided under pressure via inlet 15 to the gap between the fluid handling structure IH and substrate W. The gas is extracted via outlet 14. The overpressure on the gas inlet 15, vacuum level on the outlet 14 and geometry of the gap are arranged so that there is a high-velocity gas flow inwardly that confines the immersion liquid. Such a system is disclosed in US 2004/0207824, which is hereby incorporated by reference in its entirety. In an example, the fluid handling structure IH does not have the gas seal 16.

[0042] Figure 3 is a side cross sectional view that depicts a further liquid supply system or fluid handling system according to an embodiment. The arrangement illustrated in Figure 3 and described below may be applied to the lithographic apparatus described above and illustrated in Figure 1. The liquid supply system is provided with a fluid handling structure IH (or a liquid confinement structure), which extends along at least a part of a boundary of the space 11 between the final element of the projection system PS and the support table WT or substrate W.

[0043] The fluid handling structure IH at least partly confines the immersion liquid in the space 11 between the final element of the projection system PS and the substrate W. The space 11 is at least partly formed by the fluid handling structure IH positioned below and surrounding the final element of the projection system PS. In an example, the fluid handling structure IH comprises a main body member 53 and a porous member 33. The porous member 33 is plate shaped and has a plurality of holes (i.e., openings or pores). In an embodiment, the porous member 33 is a mesh plate wherein numerous small holes 84 are formed in a mesh. Such a system is disclosed in US 2010/0045949 A1, which is hereby incorporated by reference in its entirety.

[0044] The main body member 53 comprises supply ports 72, which are capable of supplying the immersion liquid to the space 11, and a recovery port 73, which is capable of recovering the immersion liquid from the space 11. The supply ports 72 are connected to a liquid supply apparatus 75 via passageways 74. The liquid supply apparatus 75 is capable of supplying the immersion liquid to the supply ports 72 through the corresponding passageway 74. The recovery port 73 is capable of recovering the immersion liquid from the space 11. The recovery port 73 is connected to a liquid recovery apparatus 80 via a passageway 79. The liquid recovery apparatus 80 recovers the immersion liquid recovered via the recovery port 73 through the passageway 29. The porous member 33 is disposed in the recovery port 73. Performing the liquid supply operation using the supply ports 72 and the liquid recovery operation using the porous member 33 forms the space 11 between the projection system PS and the fluid handling structure IH on one side and the substrate W on the other side.

[0045] Figure 4 illustrates part of a lithographic apparatus useful for an understanding of an embodiment of the present invention. The arrangement illustrated in Figure 4 and described below may be applied to the lithographic apparatus described above and illustrated in Figure 1. Figure 4 is a cross-section through a substrate support 20 and a substrate W. In an embodiment, the substrate support 20 comprises one or more conditioning channels 61 of a thermal conditioner 60, which is described in more detail below. A gap 5 exists between an edge of the substrate W and an edge of the substrate support 20. When the edge of the substrate W is being imaged or at other times such as when the substrate W first moves under the projection system PS (as described above), the immersion space 11 filled with liquid by the fluid handling structure IH (for example) will pass at least partly over the gap 5 between the edge of the substrate W and the edge of the substrate support 20. This can result in liquid from the immersion space 11 entering the gap 5.

[0046] The substrate W is held by a first support body 21 (e.g. a pimple or burl table) comprising one or more projections 41 (i.e., burls). The first support body 21 is an example of an object holder. Another example of an object holder is a mask holder. An under-pressure applied between the substrate W and the substrate support 20 helps ensure that the substrate W is held firmly in place. However, if immersion liquid gets between the substrate W and the first support body 21 this can lead to difficulties, particularly when unloading the substrate W.

[0047] In order to deal with the immersion liquid entering that gap 5 at least one drain 10, 12 is provided at the edge of the substrate W to remove immersion liquid which enters the gap 5. In the embodiment of Figure 4 two drains 10, 12 are illustrated though there may only be one drain or there could be more than two drains. In an embodiment, each of the drains 10, 12 is annular so that the whole periphery of the substrate W is surrounded.

[0048] A primary function of the first drain 10 (which is radially outward of the edge of the substrate W/first support body 21) is to help prevent bubbles of gas from entering the immersion space 11 where the liquid of the fluid handling structure IH is present. Such bubbles may deleteriously affect the imaging of the substrate W. The first drain 10 is present to help avoid gas in the gap 5 escaping into the immersion space 11 in the fluid handling structure IH. If gas does escape into the immersion space 11, this can lead to a bubble which floats within the immersion space 11. Such a bubble, if in the path of the projection beam, may lead to an imaging error. The first drain 10 is configured to remove gas from the gap 5 between the edge of the substrate W and the edge of the recess in the substrate support 20 in which the substrate W is placed. The edge of the recess in the substrate support 20 may be defined by a cover ring 101 which is optionally separate from the first support body 21 of the substrate support 20. The cover ring 101 may be shaped, in plan, as a ring and surrounds the outer edge of the substrate W. The first drain 10 extracts mostly gas and only a small amount of immersion liquid.

[0049] The second drain 12 (which is radially inward of the edge of the substrate W/first support body 21) is provided to help prevent liquid which finds its way from the gap 5 to underneath the substrate W from preventing efficient release of the substrate W from the substrate table WT after imaging. The provision of the second drain 12 reduces or eliminates any problems which may occur due to liquid finding its way underneath the substrate W.

[0050] As depicted in Figure 4, in an embodiment the lithographic apparatus comprises a first extraction channel 102 for the passage therethrough of a two phase flow. The first extraction channel 102 is formed within a block. The first and second drains 10, 12 are each provided with a respective opening 107, 117 and a respective extraction channel 102, 113. The extraction channel 102, 113 is in fluid communication with the respective opening 107, 117 through a respective passageway 103, 114.

[0051] As depicted in Figure 4, the cover ring 101 has an upper surface. The upper surface extends circumferentially around the substrate W on the first support body 21. In use of the lithographic apparatus, the fluid handling structure IH moves relative to the substrate support 20. During this relative movement, the fluid handling structure IH moves across the gap 5 between the cover ring 101 and the substrate W. In an embodiment the relative movement is caused by the substrate support 20 moving under the fluid handling structure IH. In an alternative embodiment the relative movement is caused by the fluid handling structure IH moving over the substrate support 20. In a further alternative embodiment the relative movement is provided by movement of both the substrate support 20 under the fluid handling structure IH and movement of the fluid handling structure IH over the substrate support 20. In the following description, movements of the fluid handling structure IH will be used to mean the relative movement of the fluid handling structure IH relative to the substrate support 20.

[0052] Figure 5 is a schematic diagram of a substrate support 20 according to an embodiment of the invention. The substrate support 20 is for supporting a substrate W in the lithographic apparatus (such as the lithographic apparatus shown in Figure 1). During an exposure process, the substrate W is supported on the substrate support 20. Between exposure processes, the substrate W on the substrate support 20 may be replaced. During this time, the substrate support 20 may not have any substrate W supported on it.

[0053] As shown in Figure 5, in an embodiment the substrate support 20 comprises a first support body 21. The first support body 21 is configured to support the substrate W. When the substrate W is supported by the substrate support 20, the substrate W comes into direct contact with the first support body 21. The first support body 21 is the part of the substrate support 20 that physically supports the underside of the substrate W. As shown in Figure 5, in an embodiment the first support body 21 comprises a plurality of burls 41. The distal ends of the burls 41 form a plane at which the underside of the substrate W is supported. The underside of the substrate W comes into contact with the distal ends of the burls 41. The burls 41 are at the upper side of the first support body 21.

[0054] As shown in Figure 5, in an embodiment there is a space 42 between the underside of the substrate W and the base surface (between the burls 41) at the upper side of the first support body 21. In an embodiment, the substrate support 20 comprises a clamp configured to hold the substrate W onto the first support body 21. For example, as shown in Figure 5, in an embodiment the substrate support 20 comprises a clamp comprising a clamp channel 43. The clamp channel 43 is configured to extract gas from the space 42 between the substrate W and the first support body 21. The clamp channel 43 is in fluid communication with the space 42. As shown in Figure 5, in an embodiment the clamp channel 43 is in fluid communication with the space 42 via one of more clamp passageways 44. In an embodiment, the clamp channel 43 has an annular shape around the center of the substrate support 20. The clamp channel 43 extends circumferentially. In an embodiment, a plurality of clamp passageways 44 extend vertically to connect the clamp channel 43 to the space 42.

[0055] As shown in Figure 5, in an embodiment the substrate support 20 comprises a main body 22. The main body 22 is separate from the first support body 21. The first support body 21 can be separated from the main body 22 without substantially damaging the main body 22. The first support body 21 can be removed from, and placed back onto, the main body 22. The main body 22 is configured to support the first support body 21.

[0056] During use of the substrate support 20, the substrate support 20 undergoes wear and tear. For example, the distal ends of the burls 41 wear over time. When the burls 41 are worn, the first support body 21 can be replaced without having to replace the entirety of the substrate support 20. For example, the first support body 21 may be replaced without replacing the main body 22. In an embodiment, the first support body 21 is removed from the main body 22. A replacement first support body 21 is then positioned on the main body 22. Exposure processes are then continued using the replacement first support body 21. An embodiment of the invention is expected to reduce the cost of maintaining usability of the substrate support 20.

[0057] It may be quicker to replace the first support body 21 compared to replacing the entirety of the substrate support 20. An embodiment of the invention is expected to reduce the downtime of the lithographic apparatus required in order to maintain the substrate support 20.

[0058] As shown in Figure 5, in an embodiment, the main body 22 comprises a thermal conditioner 60. In an embodiment the thermal conditioner 60 is configured to thermally condition the main body 22. Additionally, or alternatively, the thermal conditioner 60 is configured to thermally condition the first support body 21. Additionally or alternatively, the thermal conditioner 60 is configured to thermally condition the substrate W. By thermally conditioning the main body 22 and/or the first support body 21 and/or the substrate W, the temperature profile can be controlled. In particular, deformations caused by thermal fluctuations can be reduced. By reducing deformations, the accuracy of the exposure processes can be improved.

[0059] The way in which the thermal conditioner 60 thermally conditions is not particularly limited. Merely as an example, as shown in Figure 5 in an embodiment the thermal conditioner 60 comprises one or more conditioning channels 61. The conditioning channels 61 may extend through the main body 22. In an embodiment, the conditioning channels 61 contain a fluid (e.g. a gas and/or a liquid).

[0060] As shown in Figure 1, in an embodiment, the lithographic apparatus comprises a controller 500. In an embodiment the controller 500 is configures to control a flow or fluid through the one of more conditioning channels 61. In an embodiment, the controller 500 is configured to control the flow of fluid through the conditioning channels 61 so as to control the temperature profile of a target body (e.g. the main body 22, the first support body 21 and/or the substrate W).

[0061] As shown in Figure 5, in an embodiment the thermal conditioner 60 comprises one or more sensors 62. In an embodiment, the sensor 62 is attached to the main body 22 or embedded in the main body 22. In an embodiment, the sensor 62 is a temperature sensor. In an embodiment, the sensor 62 may be configured to sense the temperature of fluid flowing in the conditioning channels 61. In an embodiment, a plurality of sensors 62 are provided at different positions along the conditioning channels 61 so as to detect the temperature profile throughout the conditioning channels 61.

[0062] As shown in Figure 5, in an embodiment the thermal conditioner 60 comprises one or more heaters 63. As shown in Figure 5, in an embodiment the heaters 63 are attached at the underside of the main body 22. However, heaters 63 may be positioned at other surfaces of the main body 22 or the first support body 21. Additionally or alternatively, sensors may be provided at the surfaces of the main body 22 and/or the first support body 21. In an embodiment, the controller 500 is configured to receive signals from the sensors 62 and subsequently control the heaters 63 and/or a flow of fluid through the conditioning channels 61.

[0063] In the substrate support 20, the function of physical supporting (and clamping) the substrate W is performed by the first support body 21. Meanwhile, the function of thermally conditioning is performed by the main body 22. The first support body 21 is separate from the main body 22. The functions of supporting the substrate W and thermal stabilization are separated into different components. When one function fails (or is no longer performed to the required standard), then the corresponding component can be replaced without having the replace the other component. An embodiment of the invention is expected to make it easier to maintain the substrate support 20 so that the functions performed by it are performed to the required standard.

[0064] As shown in Figure 5, in an embodiment the substrate support 20 comprises an extractor body 100. The extractor body 100 surrounds the main body 22 and the first support body 21. The extractor body 100 is radially outwards of the main body 22 and the first support body 21. As shown in Figure 5, in an embodiment the extractor body 100 is provided in a component which is separate from the main body 22. However, it is not essential for the extractor body 100 to be separate from the main body 22 and the first support body 21. As will be described in more detail below, the extractor body 100 may be part of the same component as the main body 22. In such an embodiment, the extractor body 100 cannot be replaced without also replacing the main body 22 (and vice versa). In an embodiment, for example, as shown in Figures 7 to 10, the extractor body 100 is part of the same component as the main body 22. The extractor body 100 may be integrally formed with the main body 22. In an alternative embodiment, the extractor body 100 is integrally formed with the substrate stage 26.

[0065] As shown in Figure 5, in an embodiment the extractor body 100 comprises a first extraction channel 102. In an embodiment, an extractor body 100 comprises the first drain 10 described above. The first extraction channel 102 is configured to extract fluid from near a peripheral part of the substrate W. As shown in Figure 5, in an embodiment the first extraction channel 102 is configured to extract fluid from radially outwards of the peripheral edge of the substrate W. The first extraction channel 102 is configured to remove bubbles that may otherwise be present in the immersion liquid used in the lithographic apparatus. The first extraction channel 102 helps to reduce image defects by reducing bubbles and/or by reducing the generation of watermarks for example.

[0066] As explained above, the extractor body 100 is configured to reduce defectivity issues. The function performed by the extractor body 100 may be different from the function performed by the first support body 21 and the main body 22. When one of the functions fails, or is no longer performed to the required standard, the corresponding component (e.g. the extractor body 100 or the first support body 21 or the main body 22) can be replaced without replacing the other components of the substrate support 20.

[0067] Figure 6 schematically depicts a substrate support 20 according to a comparative example. In the comparative example shown in Figure 6, both the function of supporting (and clamping) the substrate W and thermally conditioning the substrate W are performed in the same component. Accordingly, when the tips of the burls 41 wear out, the entire main body 22 including both of the thermal conditioner 60 and the burls 41 that support the substrate W has to be replaced. This is necessary even if, for example, the thermal conditioner 60 is still in good order and does not need to be replaced.

[0068] As shown in Figure 5, in an embodiment a seal member 27 is provided to seal a gap between the substrate support 20 and the substrate stage 26 that supports the substrate support 20. In the comparative example shown in Figure 6, when the substrate support 20 is replaced, it is also necessary to remove and replace the seal member 27. In contrast, in the embodiment shown in Figure 5, the extractor body 100 and the seal member 27 may remain in place while the first support body 21 and/or main body 22 is replaced. Similarly, the embodiments in which the extractor body 100 is part of the same component as the main body 22, the extractor body 100 and the seal member 27 can remain in place while the first support body 21 is replaced. An embodiment of the invention is expected to reduce the time required to maintain the substrate support 20.

[0069] As shown in Figure 5, in an embodiment the substrate support 20 comprises a second support body 23. The second support body 23 is separate from the main body 22. The second support body 23 is configured to support the main body 22 on the substrate stage 26. In an embodiment, the main body 22 comes into physical contact with the second support body 23. For example, in an embodiment the underside of the main body 22 is supported on top of the second support body 23. The second support body 23 is supported on the substrate stage 26.

[0070] As shown in Figure 5, in an embodiment the second support body 23 comprises a plurality of burls 91. In an embodiment, the burls 91 of the second support body 23 are longer than the burls 41 of the first support body 21. The burls 91 protrude at the underside of the second support body 23. These burls 91 extend towards the substrate stage 26 and are supported by the substrate stage 26. In an embodiment, the second support body 23 is configured to reduce relative movement between the substrate support 20 and the substrate stage 26. The second support body 23 is configured to reduce slipping between the substrate support 20 and the substrate stage 26. During use of the lithographic apparatus, the substrate stage 20 may undergo high accelerations. If the substrate support 20 slips relative to the substrate stage 26, then this can lead to undesirable overlay errors. The burls 91 are configured to grip relative to the substrate stage 26 so as to reduce slipping of the substrate support 20 relative to the substrate stage 26.

[0071] The second support body 23 can be physically separated from the main body 22 without damaging the main body 22 or the second support body 23. It is possible to replace one or the other of the main body 22 and the second support body 23 without replacing the other. For example, if the anti-slip function of the second support body 23 is no longer being performed to the required standard, then the second support body 23 can be replaced without replacing the main body 22. An embodiment of the invention is expected to reduce the cost for maintaining the substrate support 20.

[0072] In another example, the main body 22 may be replaced if, for example, the thermal conditioner 60 needs to be replaced. The main body 22 can be replaced without replacing (or even substantially moving) the second support body 23. An embodiment of the invention is expected to reduce the cost of maintaining the substrate support 20.

[0073] However, it is not essential for the substrate support 20 to comprise such a second support body 23. For example, as shown in Figures 7 to 12, the function of reducing slipping of the substrate support 20 relative to the substrate stage 26 may be performed by the main body 22. The burls 91 may be provided at the bottom of the main body 22.

[0074] As shown in Figures 5 and 7, for example, in an embodiment the main body 22 comprises at its upper side a plurality of burls 65. The burls 65 have distal ends in a plane. The burls 65 are configured to support the first support body 21. By providing the burls 65 of the upper side of the main body 22, the structure of the first support body 21 is kept simple. The underside of the first support body 21 can be flat and substantially featureless. The upper side of the first support body comprises the burls 41 for supporting the substrate W. An embodiment of the invention is expected to make it cheaper to manufacture the component that clamps the substrate W.

[0075] Additionally, as shown in Figures 5 and 8 to 10, for example, in an embodiment the first support body 21 comprises a plurality of seal protrusions 46. The seal protrusions 46 protrude at the upper side of the first support body 21. The seal protrusions 46 are shorter than the burls 41. The seal protrusions 46 do not come into contact with the substrate W. A small gap is present between the top of the seal protrusions 46 and the underside of the substrate W. In an embodiment, the seal protrusions 46 extend circumferentially around the first support body 21, i.e., the seal protrusions 46 form respective rings. The seal protrusions 46 are configured to reduce the amount of fluid passing across the seal protrusions 46.

[0076] However, it is not essential for the main body 22 to be provided with the burls 65. For example, in an alternative embodiment shown in Figure 8, the first support body 21 comprises at its lowest side a plurality of burls 47. The burls 47 have distal ends in a plane. The burls 47 are configured to contact the upper side of the main body 22. As shown in Figure 8, instead of the burls 65 being provided on the main body 22, a different set of burls 47 may be provided at the bottom side of the first support body 21. During use, it may be that the burls 41, 47 wear out before other parts of the substrate support 20 wear out. By providing both sets of burls 41, 47 on the first support body 21, the burls can be replaced simply by replacing the first support body 21 without needing to replace the main body 22. An embodiment of the invention is expected to reduce the cost of maintaining the substrate support 20.

[0077] As shown in Figure 5, in an embodiment the extractor body 100 comprises a second extraction channel 113. This is also shown in other Figures. The second extraction channel 113 is part of the second drain 12. In an embodiment, the second extraction channel 113 is configured to extract fluid from radially inward of the first extraction channel 102. In an embodiment, the second extraction channel 113 is provided to keep liquid from flowing under the substrate W. However, it is not essential for such a second extraction channel 113 to be provided. For example, Figure 10 shows an embodiment that does not have the second extraction channel 113.

[0078] In an embodiment, the second extraction channel 113 is configured to extract fluid from below the peripheral part of the substrate W so as to prevent liquid from reaching the space 42 between the central part of the substrate W and the first support body 21. As shown in Figure 4, in an embodiment the second extraction channel 113 is connected to the space below the peripheral part of the substrate W via one or more second passageways 114. In an embodiment, the second extraction channel 113 extends circumferentially around the substrate support 20. In an embodiment, a plurality of second passageways 114 are provided. The second passageways 114 extend vertically between the second extraction channel 113 and just below the peripheral part of the substrate W.

[0079] As shown in Figure 5, in an embodiment the second extraction channel 113 is spaced apart from the first extraction channel 102 by an open gap. The first extraction channel 102 and the second extraction channel 113 may be provided in separate bodies 24, 25. The separate bodies 24, 25 can be separated from each other without destroying either of the bodies 24, 25. The functions of reducing defectivity issues (performed by the first extraction channel 102) and keeping liquid from flowing under the substrate W (performed by the second extraction channel 113) may be performed by separate bodies 24, 25. It is possible to replace one of the bodies 24, 25 without replacing the other.

An embodiment of the invention is expected to reduce the cost of maintaining the substrate support 20.

[0080] As shown in Figure 7 (and also visible in Figures 5 and 8, for example), in an embodiment the substrate support 20 comprises an inner seal 112 and an outer seal 111. The inner seal 112 is positioned radially inward of the openings through which the second extraction channel 113 extracts fluid. The outer seal 111 is positioned radially outward of the openings through which the second extraction channel 113 extracts fluid. The inner seal 112 and the outer seal 111 protrude towards the underside of the substrate W. The inner seal 112 and the outer seal 111 do not protrude far enough to come into contact with the substrate W in use with the substrate support 20. Instead, a small gap is present between the tops of the inner seal 112 and the substrate W as well as between the top of the outer seal 111 and the substrate W. The inner seal 112 and the outer seal 11 are configured such that in use liquid may be present between the seal 111, 112 and the substrate W. This helps to prevent liquid from reaching below the substrate W in a central part of the substrate W.

[0081] As shown in Figure 9, in an embodiment the function of the inner seal 112 is performed by a seal protrusion 46 at the upper side of the first support body 21. This is an alternative to the arrangement shown in Figure 7, for example, where the inner seal 112 is provided as a protrusion at the upper side of the main body 22. As shown in Figure 9, in an embodiment an upper passageway 49 is provided through the first support body 21. The upper passageway 49 connects with the second passage way 114 so that fluid can be extracted from below the peripheral substrate W into the second extraction channel 113.

[0082] As shown in Figure 9, for example, in an embodiment the main body 22 comprises a seal protrusions 66. The seal protrusions 66 are configured to reduce the possibility of moisture reaching the upper surface of the main body 22. This reduces oxidation of the main body 22.

[0083] As shown in Figure 10, in an embodiment the substrate support 20 is not provided with the second extraction channel 113 shown in Figures 5 to 9 for example. As shown in Figure 10, in an embodiment an open gap or a flow passage 115 is formed between the extractor body 100 and main body 22 and the first support body 21. In an embodiment, the open gap or the flow passage 115 is in fluid communication with ambient pressure or a pressure source. In an embodiment, a plurality of flow passages 115 extend mainly vertically through the main body 22 (which may be part of the same component as the extractor body 100). In an alternative embodiment, an open gap may extend circumferentially around the main body 22, with the extractor body 100 provided as a separate component from the main body 22. In an embodiment, a flow of gas passes through the open gap or flow passage 115. The flow of gas passes over the seal protrusion 46 of the upper peripheral edge of the first support body 21. By providing the gas flow, the possibility of liquid reaching the underside of the substrate W over the seal protrusion 46 may be reduced. It may not be necessary to provide the second extraction channel 113. An embodiment of the invention is expected to reduce the complexity of the substrate support 20. An embodiment of the invention is expected to make it easier to manufacture the substrate support 20.

[0084] As described above and shown in Figures 5 and 7 to 10, the substrate support 20 can be modularized in various ways. As shown in Figure 11, in an embodiment an extractor body 100 is provided with both the first extraction channel 102 and the second extraction channel 113. The extractor body 100 is separate from both the first support body 21 and the main body 22. The main body 22 is supported directly on the substrate stage 26 (i.e. without the second support body 23). As shown in Figure 11, the inner seal 112 and the outer seal 111 are provided as part of the extractor body 100. This reduces the radial dimension of the first support body 21 (because the first support body 21 does not require an additional seal protrusion 46 to perform the function of the inner seal 112). This reduces the amount of the substrate support 20 that is replaced when it is necessary to replace worn out burls 41.

[0085] As shown in Figure 11, in an embodiment the main body 22 extends below the extractor body 100. The lower side of the extractor body 100 is coupled to the main body 22. This makes it easier to control the height of the extractor body 100 relative to the first support body 21. By controlling the height of the extractor body 100 more precisely, the sealing function provided by the inner seal 112 and the outer seal 111 is more reliable.

[0086] As shown in Figure 11, in an embodiment one or more holes 119 are provided in the main body 22. The holes 119 are configured to be in fluid communication with the gap between the radially inner part of the extractor body 100 and the main body 22. The holes 119 may connect to other holes extending through the substrate stage 26. The holes 119 are configured to provide ambient or pressurized gas. By providing a gas flow up through the holes 119, the possibility of liquid reaching below the central part of the substrate W is reduced. By providing the gas flow through the holes 119, humidity transfer to the first support body 21 is reduced. By reducing humidity transfer to the first support body 21, oxidation of the first support body 21 is reduced.

[0087] In an embodiment, the holes 119 are configured to provide pressurized gas. By providing a pressurized flow of gas, it is possible to control lifting of the edge of the substrate W. By controlling lifting of the outer edge of substrate W, wear on the outermost burl 41 of the first support body 21 can be reduced. An embodiment of the invention is expected to reduce wear of the substrate support 20.

[0088] As shown in Figure 11, in an embodiment an adhesive layer 104 is provided between the extractor body 100 and the main body 22. The adhesive layer 104 fixes the extractor body 100 to the main body 22. This makes it easier to control the gap from the substrate W to the inner seal 112 and the outer seal 111 of the extractor body 100.

[0089] In an embodiment, beads are dispersed in the adhesive layer 104. For example, glass beads may be dispersed in a glue. The beads can be chosen in size so as to provide the required height step between the tops of the inner/outer seals 111, 112 and the top of the seal protrusion 66 at the radially outward part of the top surface of the main body 22. In an embodiment, the beads have a diameter of, for example, 45 microns, 50 microns or 55 microns.

[0090] As shown in Figure 11, in an embodiment fluid connection is maintained from the first/second extraction channels 102, 113 through the main body 22 (on which the extractor body 100 is attached) and subsequently through the substrate stage 26. The fluid connection may be maintained by dog bone connectors 105 and rings 106. However, the connection between the extractor body 100 and the main body 22 for the purposes of the first/second extraction channels 102, 113 is not particularly limited.

[0091] It is not essential for the main body 22 to extend below the extractor body 100. In an alternative embodiment, the lower side of the extractor body 100 is attached to the substrate stage 26. In an embodiment, the substrate table WT (which comprises the substrate stage 26 and the substrate support 20) comprises a height adjustment mechanism 130. Alternative versions of a height adjustment mechanism 130 are shown in Figures 12 and 13, for example. The height adjustment mechanism 130 is configured to provide for fine-tunable height adjustment so as to obtain the right seal gap between the extractor body 100 and the substrate W. The height adjustment mechanism 130 is configured to control the height of at least part of the extractor body 100 below the substrate W such that the extractor body 100 is configured to prevent liquid from reaching between the central part of the substrate W and the first support body 21.

[0092] As shown in Figure 12, in an embodiment the height adjustment mechanism 130 comprises an insert member 131. The insert member 131 is a block of material. The insert member 131 is provided between the lower side for the extractor body 100 and the substrate stage 26. The insert member 131 is separate from the main body 22. The insert member 131 is the component through which the extractor body 100 is attached to the substrate stage 26.

[0093] As shown in Figure 12, in an embodiment the height adjustment mechanism 130 comprises a fastener 132. For example, in an embodiment the fastener 132 is a bolt. As shown in Figure 12, in an embodiment the fastener 132 does not reach through to the substrate stage 26. The fastener 132 connects the extractor body 100 to the insert member 131.

[0094] As shown in Figure 12, in an embodiment the extractor body 100 comprises protrusions 134 configured to engage with the insert member 131. As shown in Figure 12, in an embodiment the insert member 131 is glued onto the substrate stage 26.

[0095] As shown in Figure 12, in an embodiment the insert member 131 is structured with cut-out sections 133 such that the insert member 131 compresses when the fastener 132 fastens the extractor body 100 to the insert member 131. The compression of the insert member 131 can be controlled so as to control the height of the top of the extractor body 100 below the substrate W. In particular, the force supplied by the fastener 132 can be controlled so as to control compression of the insert member 131.

[0096] Figure 12 shows the force line 135 of reaction forces that pass through the fastener 132 and through solid parts (i.e. between cut-out sections 133) of the insert member 131. As shown in Figure 12, the cut-out sections 133 may be arranged so that the force line 135 extends through a relatively narrow section of the insert member 131. The narrow section of the insert member 131 may be relatively flexible, thereby making it easier for the insert member 131 to be compressed in a controlled way. This helps to control the height of the extractor body 100 below the substrate W. In particular, narrow sections of the insert member 131 between cut-out sections 133 may function as leaf springs (or other flexures).

[0097] The height adjustment mechanism 130 shown in Figure 12 is only one example. As another example, an alternative height adjustment mechanism 130 is shown in Figure 13. As shown in Figure 13, in an embodiment the extractor body 100 comprises a leaf spring 141. The leaf spring 141 comprises a lower part 142 fixed to the rest of the extractor body 100. The leaf spring 141 further comprises an upper part 143 that extends between the extractor body 100 and the first support body 21. In an embodiment, a plurality of such leaf springs 141 are provided circumferentially around the substrate support 20. In an alternative embodiment, a single leaf spring 141 extends circumferentially around the substrate support 20.

[0098] As shown in Figure 13, in an embodiment the height adjustment mechanism 130 is configured to control the height of the upper part 143 below the substrate W such that the upper part 143 is configured to prevent liquid from reaching between a central part of the substrate W and the first support body 21. In an embodiment, a set screw 144 is provided to allow for fine adjustment of the leaf spring 141. The set screw 141 can protrude a controlled distance below the extractor body 100. As the set screw 144 protrudes further from the bottom of the extractor body 100, the set screw 144 forces the leaf spring 141 to bend, thereby lowering the height of the upper part 144 of the leaf spring 141.

[0099] As shown in Figure 13, in an embodiment the first extraction channel 102 may be connected with the second extraction channel 113 via a connecting channel 140.

[00100] The way in which the thermal conditioner 60 is arranged in the main body 22 is not particularly limited. In an embodiment, the thermal conditioner 60 is attached at an under surface of the main body 22. For example, one of more Peltier elements and/or heaters may be provided at the lower surface of the main body 22 and/or the extractor body 100. Additionally or alternatively, the channels 61, one of more Peltier elements and/or heaters 63 may be provided externally around the bottom of the main body 22. The external channels 61 and/or one of more Peltier elements and/or heaters 63 may be attached (e.g. glued onto the main body 22). In an embodiment, the channels 61, heaters 63 and/or sensor 62 are arranged in the substrate stage 26. At least part of the thermal conditioning function is performed by the substrate stage 26. This helps to simplify the design of the main body 22. In an embodiment, the burls 91 are provided as part of the substrate stage 26. The main body 22 is not required to comprise the burls 91. The underside of the main body 22 may be substantially flat. In an embodiment, at least one sensor 62 is provided in a respective burl 91 of the substrate stage 26. The sensor 62 is configured to sense a temperature of the main body 22. The sensor 62 is positioned close to the main body 22. In an embodiment, at least one heater 63 is provided at a surface of the substrate stage 26 facing the main body 22. In an embodiment, the heater 63 is paired with a respective sensor 62. The heater 63 is positioned adjacent to the respective sensor 62. In an embodiment, the heater 63 is controlled based on output from the paired sensor 62.

[00101] As shown in Figure 5, in an embodiment the clamping channel 43 is in fluid communication with the space 42 via another space 45 between the main body 22 and the first support body 21.

[00102] As shown in Figure 5, in an embodiment the substrate support 20 is locked relative to the substrate stage 26 by at least one locking bolt 29. In an embodiment, the locking bolt 29 is configured to function as a safety lock that prevents the substrate support 20 from falling out from the substrate stage 26. However, the burls 91 perform the function of preventing slipping of the substrate support 20 relative to the substrate stage 26.

[00103] As shown in Figure 5, in an embodiment one of more pins 28 may be used to lower the substrate W onto the first support body 21. The pins 28 extend through respective holes in the substrate support 20 and support the substrate W so as to control the height of the substrate W above the first support body 21 during loading and unloading sequences.

[00104] As shown in Figure 7, in an embodiment the main body 22 is formed in two parts that are attached together at a bonding line 64. For example, a bonding material may be used.

[00105] Features shown in the different embodiments illustrated in the Figures can be combined with each other unless it is apparent that they are incompatible. Merely as an example, the feature of providing burls 47 at the underside of the first support body 21 (shown in Figure 8) may be applied to the arrangement shown in Figure 5, 9, 10 or 11. In particular, the arrangement shown in Figure 9 could be modified by replacing the burls 65 which are at the upper side of the main body 22 with burls 47 being provided at the underside of the first support body 21. Other combinations of features shown in the Figures are equally possible. Other aspects of the invention are set out as in the following numbered clauses:

1. A substrate support for supporting a substrate in a lithographic apparatus, the substrate support comprising:

    a first support body configured to support the substrate;

    a main body separate from the first support body and configured to support the first support body, the main body comprising a thermal conditioner configured to thermally condition the main body, and/or the first support body and/or the substrate; and

    an extractor body surrounding the main body and the first support body, wherein the extractor body comprises a first extraction channel configured to extract fluid from near a peripheral part of the substrate.

2. The substrate support of clause 1, comprising:

   a second support body separate from the main body and configured to support the main body on a substrate stage, the second support body configured to reduce relative movement between the substrate support and the substrate stage.

3. The substrate support of clause 1 or 2, wherein the main body comprises at its upper side a plurality of burls having distal ends in a plane configured to support the first support body.

4. The substrate support of clause 1 or 2, wherein the first support body comprises at its lower side a plurality of burls having distal ends in a plane configured to contact an upper side of the main body.

5. The substrate support of any of clauses 1 to 4, wherein the extractor body comprises:

   a second extraction channel configured to extract fluid from radially inward of the first extraction channel.

6. The substrate support of clause 5, wherein the second extraction channel is configured to extract fluid from below the peripheral part of the substrate so as to prevent liquid from reaching a space between a central part of the substrate and the first support body.

7. The substrate support of clause 5 or 6, wherein the second extraction channel is spaced apart from the first extraction channel by an open gap.

8. The substrate support of any of clauses 1 to 7, wherein an open gap or a flow passage is formed between the extractor body and the main body and the first support body.

9. The substrate support of clause 8, wherein the open gap or the flow passage is in fluid communication with ambient pressure or a pressure source.

10. The substrate support of any of clauses 1 to 7, wherein the extractor body forms an integral part of the main body.

11. The substrate support of clause 8 or 9, wherein the main body extends below the extractor body and a lower side of the extractor body is coupled to the main body.

12. The substrate support of clause 11, wherein an adhesive layer is provided between the extractor body and the main body.

13. The substrate support of any of clauses 1 to 12, wherein thermal conditioner is attached at an under surface of the main body.

14. A substrate table comprising:

a substrate stage; and

the substrate support of clause 8 or 9, wherein a lower side of the extractor body is attached to the substrate stage.

15. The substrate table of clause 14, comprising:

a height adjustment mechanism configured to control a height of at least part of the extractor body below the substrate such that the extractor body is configured to prevent liquid from reaching between a central part of the substrate and the first support body.

16. The substrate table of clause 15, wherein the height adjustment mechanism comprises:

an insert member between the lower side of the extractor body and the substrate stage; and

a fastener configured to fasten the extractor body to the insert member,

wherein the insert member is structured with cut-out sections such that the insert member compresses when the fastener fastens the extractor body to the insert member so as to control the height of the extractor body below the substrate.

17. The substrate table of clause 15, wherein:

the extractor body comprises a leaf spring comprising:

a lower part fixed to the rest of the extractor body; and

an upper part that extends between the extractor body and the first support body; and

the height adjustment mechanism is configured to control the height of the upper part below the substrate such that the upper part is configured to prevent liquid from reaching between a central part of the substrate and the first support body.

18. A substrate table comprising:

a substrate stage; and

the substrate support of any of clauses 1 to 7, wherein the extractor body is provided in the substrate stage.

19. A method for supporting a substrate in a lithographic apparatus on a substrate support comprising:

supporting the substrate on a first support body of the substrate support;

supporting the first support body on a main body separate from the first support body;

thermally conditioning the main body, and/or the first support body and/or the substrate with a thermal conditioner of the main body; and

extracting fluid from near a peripheral part of the substrate through a first extraction channel of an extractor body surrounding the main body and the first support body.

20. A device manufacturing method using a lithographic apparatus, the method comprising:

projecting a beam patterned by a patterning device onto a substrate while supporting the substrate with a substrate support; and

performing the method of clause 19.

CONCLUSIE

1. Een inrichting ingericht voor het belichten van een substraat.

Fig. 1

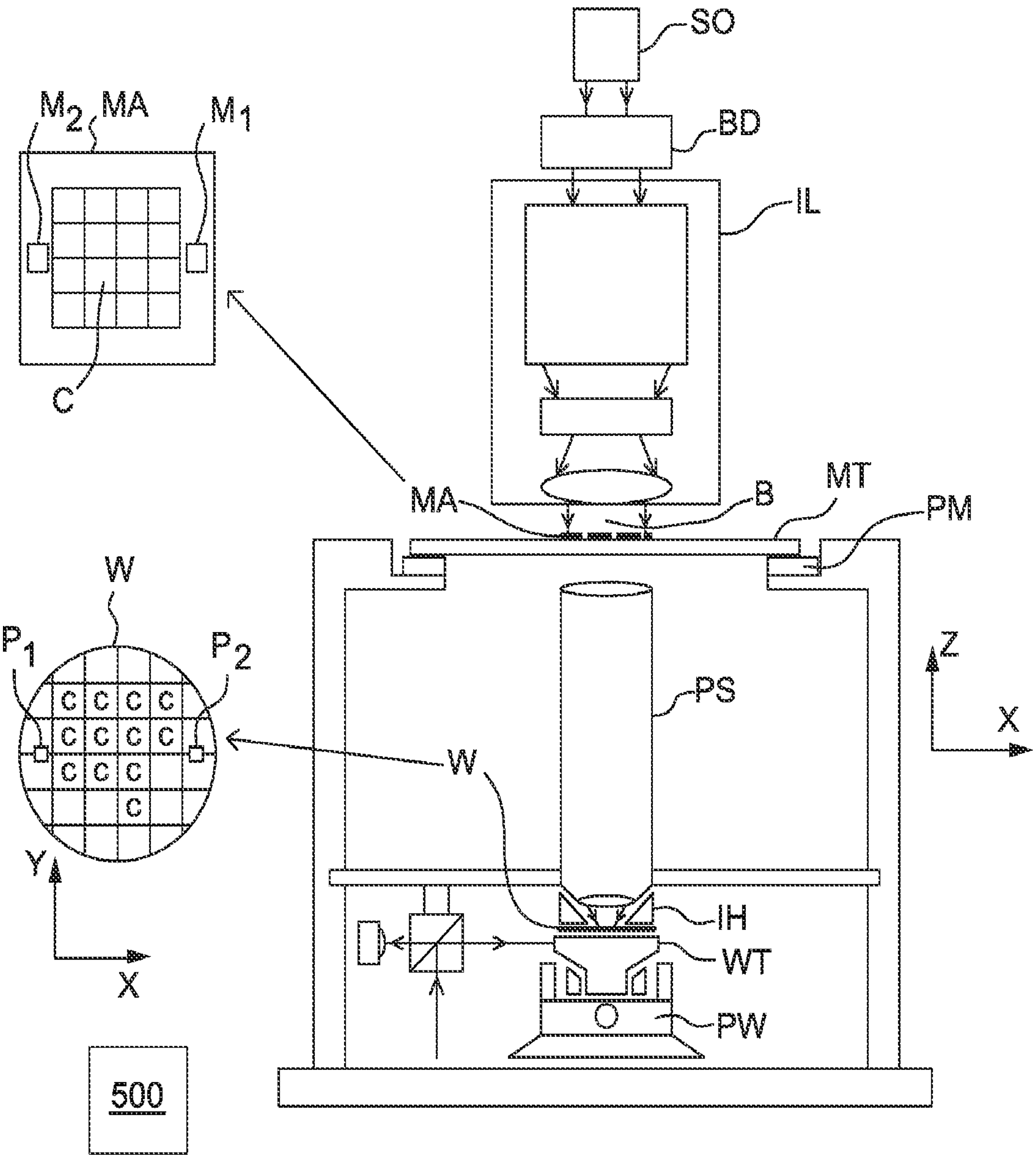


Fig. 2

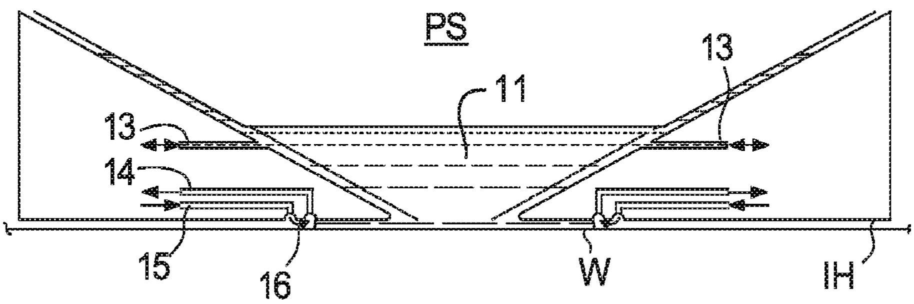


Fig. 3

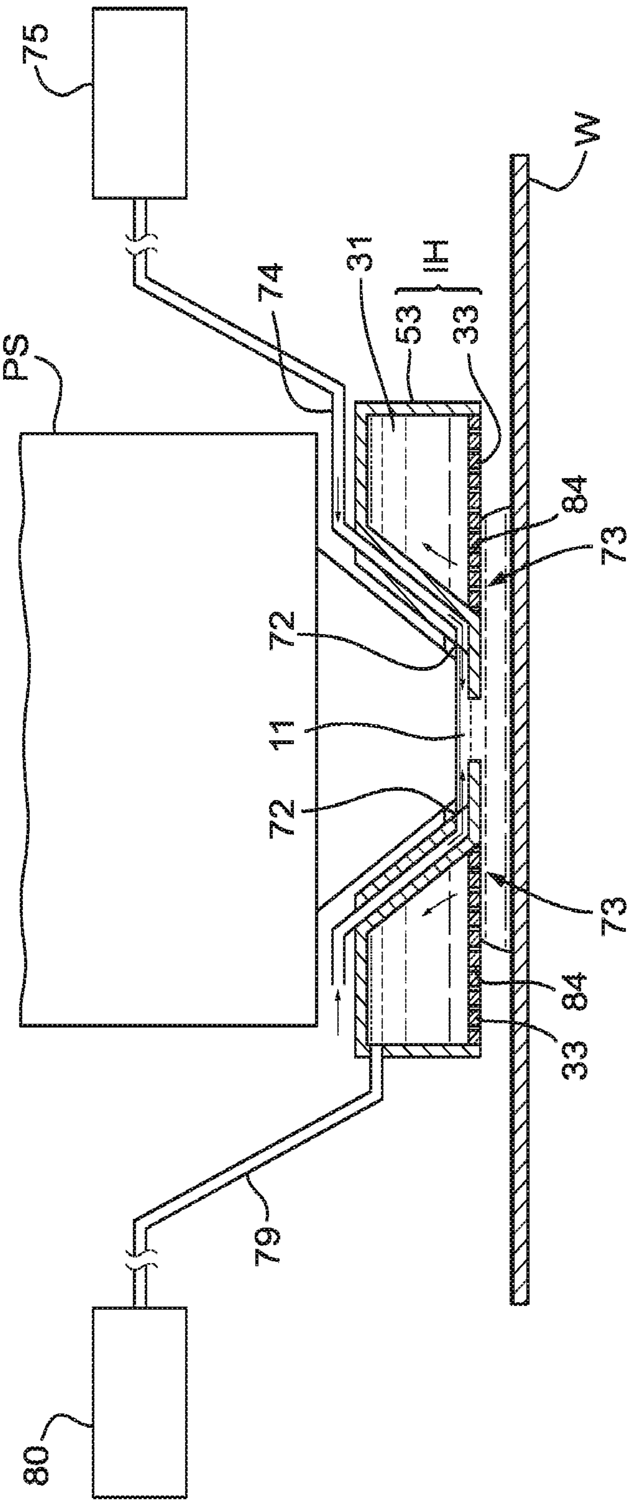
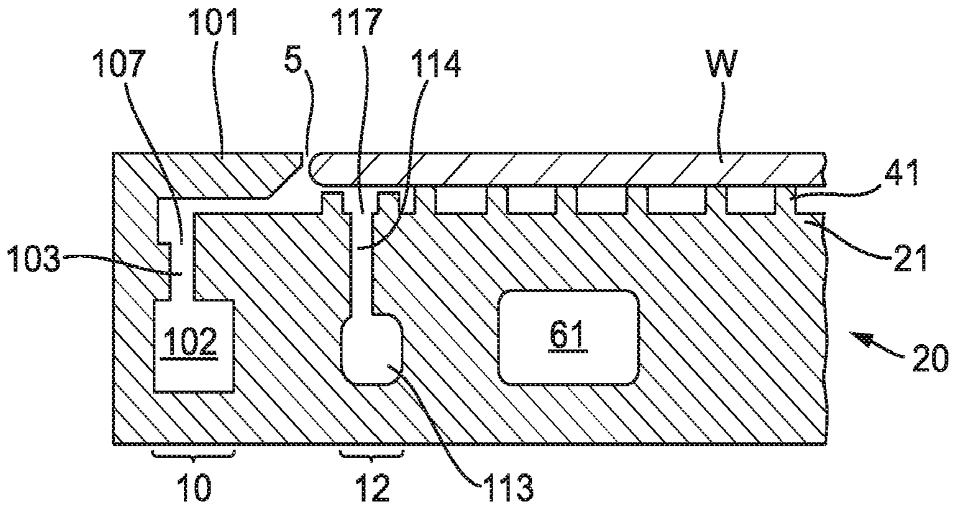


Fig. 4



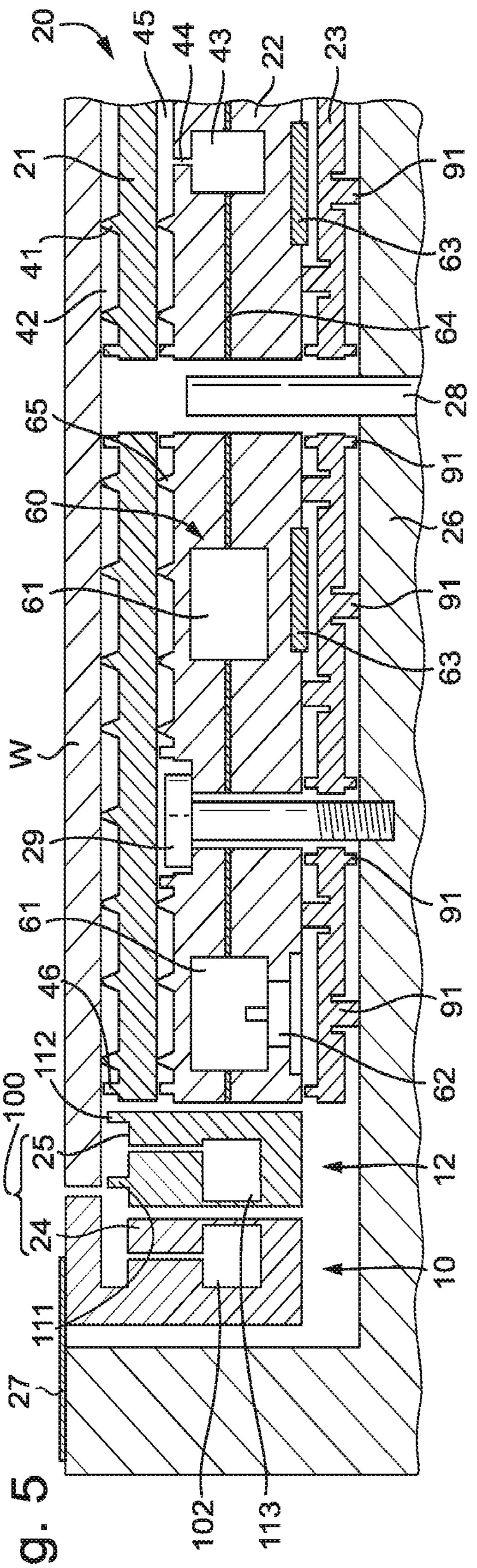

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Fig. 5

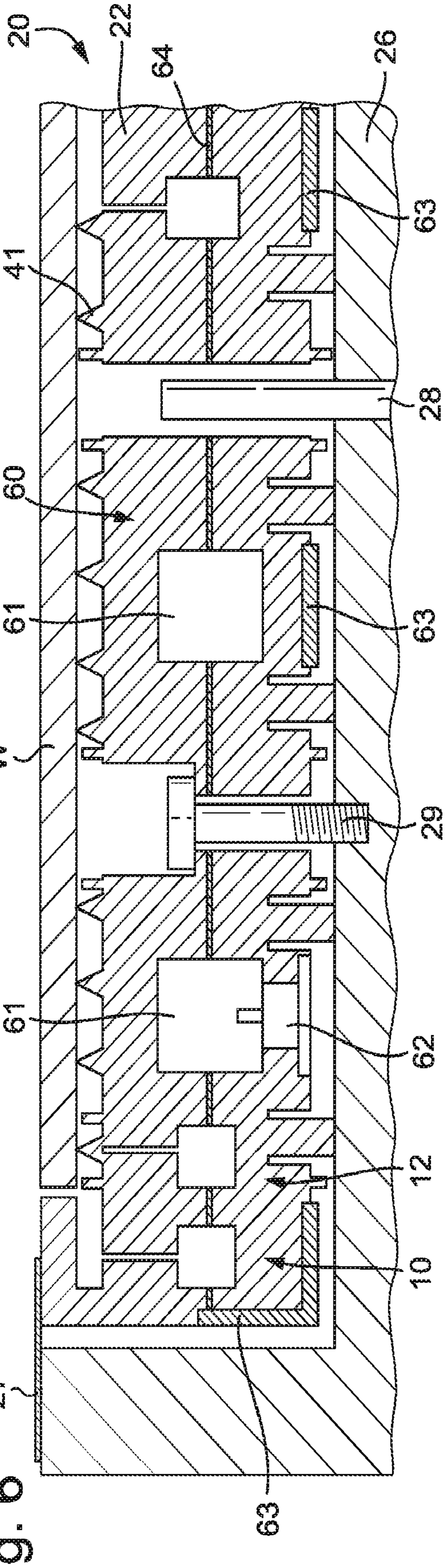
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Fig. 6

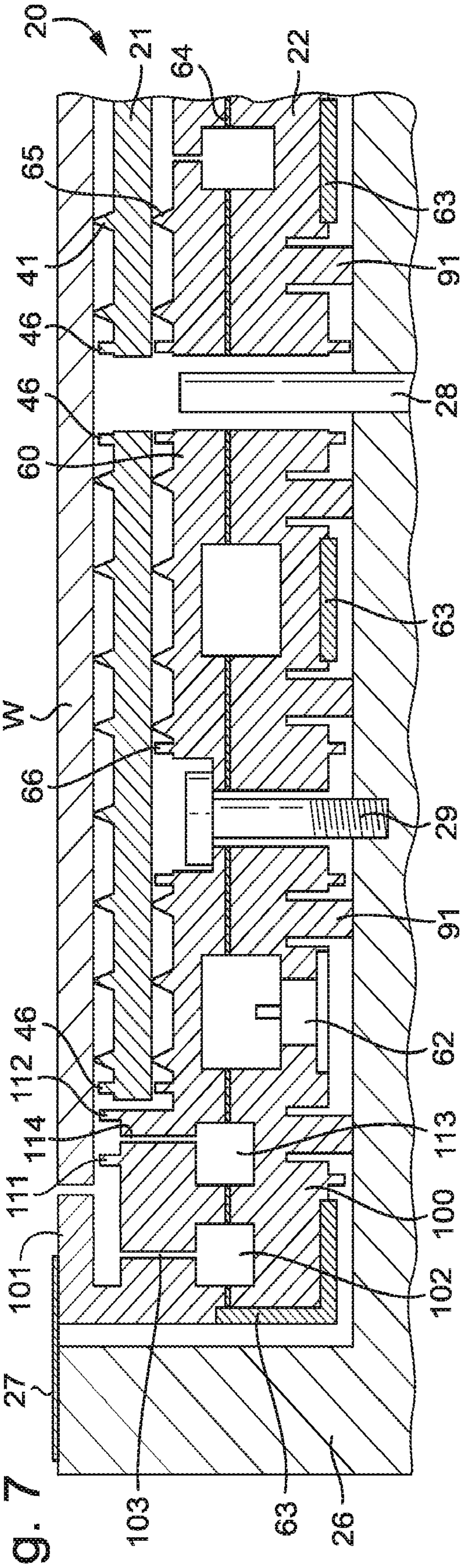
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Fig. 7

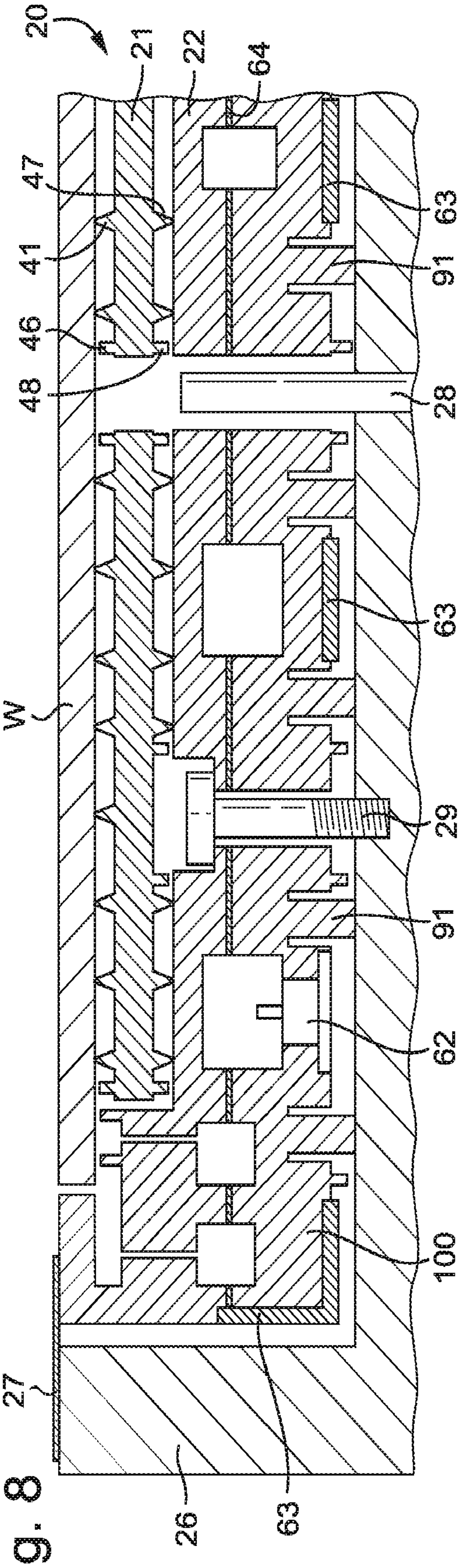
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Fig. 8

Fig. 9

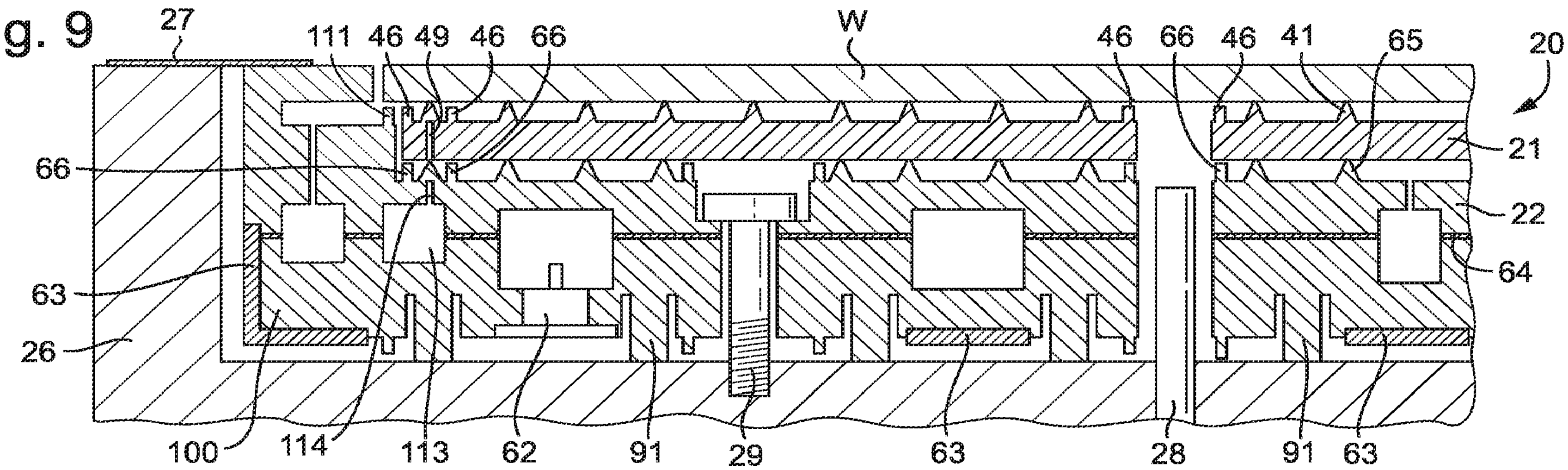
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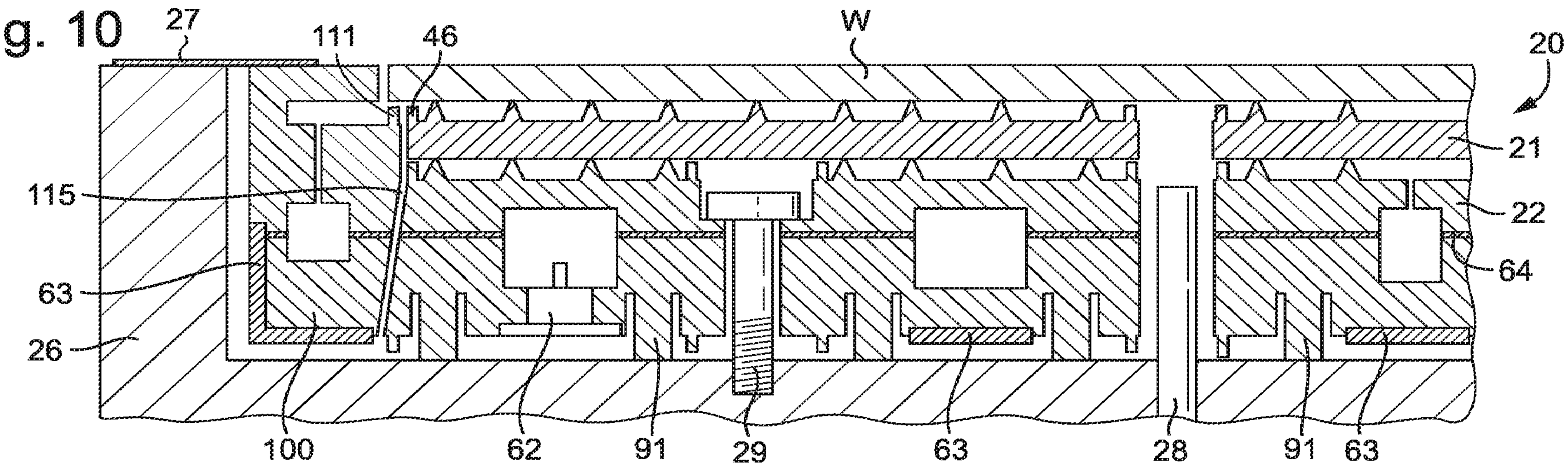
Fig. 10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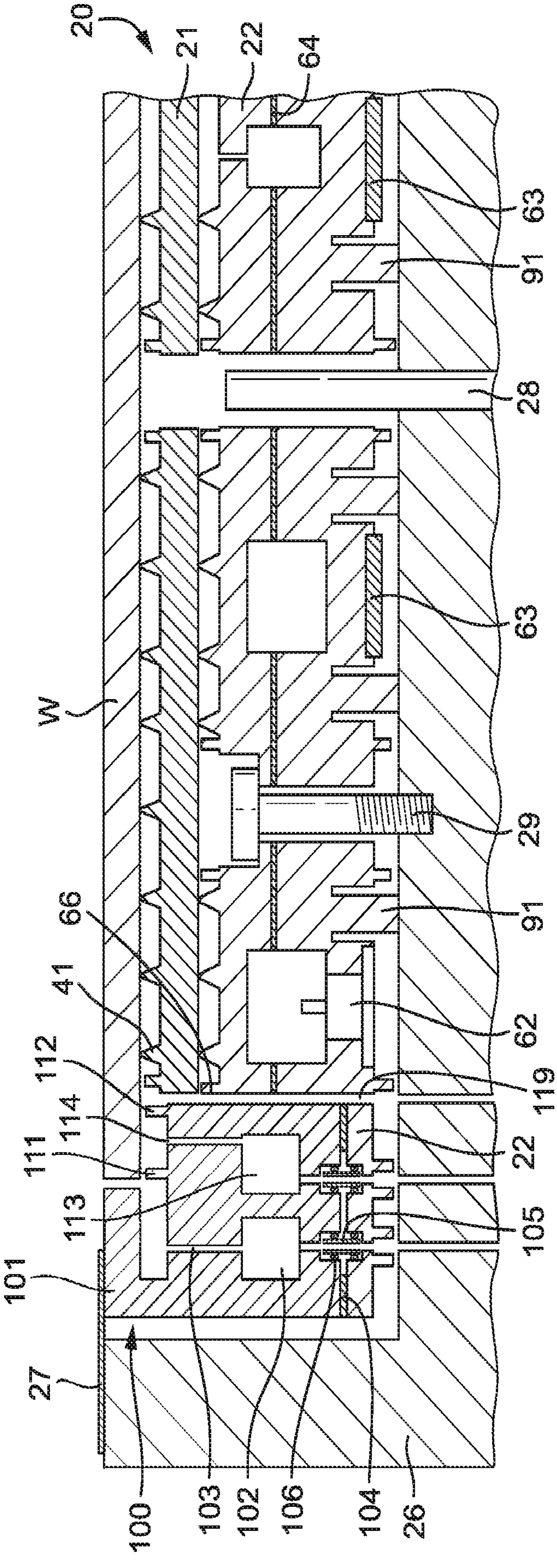
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Fig. 11

Fig. 12

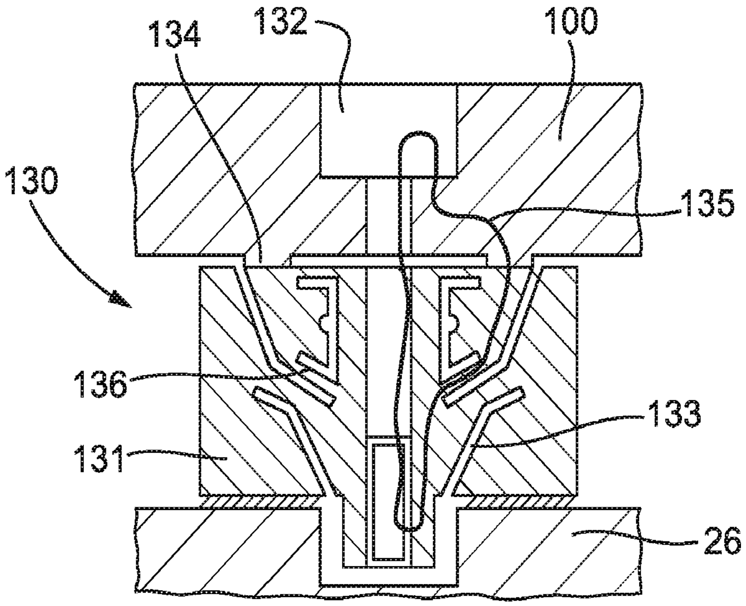
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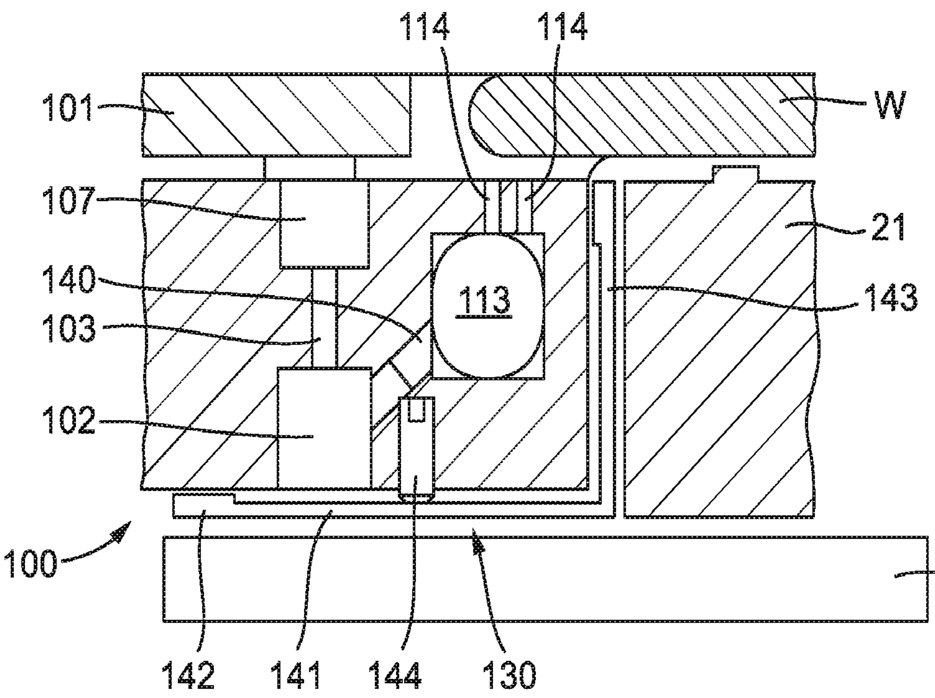
Fig. 13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