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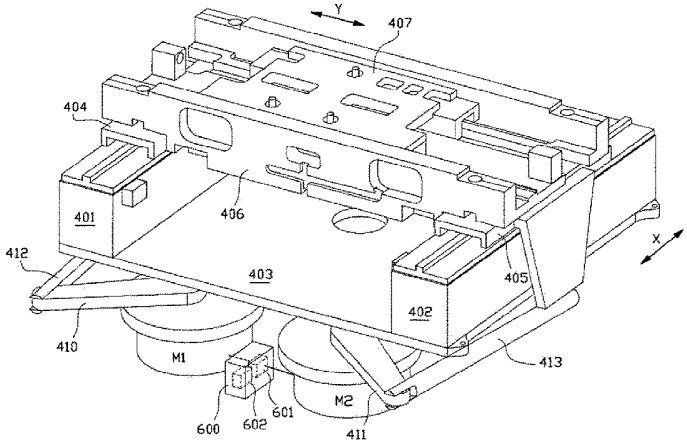
(54) **Target positioning device, method for driving a target positioning device, and a lithography system comprising such a target positioning device.**

(57) A target positioning device, in particular for a lithography system, comprising a carrier for carrying a target, and a stage for carrying and moving the carrier along a first direction (X). The stage comprising two X-stage bases, both arranged on top of a common base plate, each X-stage base carries an x-stage carriage, and a Y-beam comprising a Y-stage for carrying said carrier and moving the carrier said carrier in a second direction (Y). The Y-beam bridges the space between the X-stage carriages and is connected to the X-stage carriages via a flexible coupling. The device further comprises two motors each for driving a corresponding X-stage carriage along its corresponding X-stage base. The two motors are arranged at least substantially below the stage. Each motor of said two motors is coupled to an eccentric cam or crank which is connected to the corresponding X-stage carriage via a crank shaft.



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Target positioning device, method for driving a target positioning device, and a lithography system comprising such a target positioning device

BACKGROUND

The invention relates to a target positioning device, in particular for a lithography system, comprising a carrier for carrying a target, and a stage for carrying and moving the carrier along a first direction. The invention furthermore relates to a method for driving a target positioning device, in particular for a lithography system.

In particular for lithography systems which are designed for providing a sub-micron pattern on a wafer, any manipulation device for moving the wafer is designed to control the position of said wafer with high precision. Consequently the stages for use in lithography systems are designed to provide an extremely rigid and mechanically stiff construction. Usually highly accurate, rigid and robust stages are used, which take up a large amount of space.

Lithography systems are usually arranged in a clean room. Since floor space in a clean room is expensive it is disadvantageous when an apparatus has a large

footprint. This drawback usually is accepted in order to obtain the required high precision.

In addition, electromagnetic dispersion fields as commonly present at the actuators of the stages, in particular from electro-magnetic actuators, are not desired a charged particle beam lithography system as for example disclosed in WO 2010/021543, because any variation in electric or magnetic fields may affect the position of the charged particle beam. In order to reduce the effect of the actuators of the stages, the actuators which are used to drive the target in a first direction during the projection of a charged particle beam onto the target is arranged remote from the stage. According to WO 2010/02153, the actuator is arranged in a direct line of the first direction and at a distance from the stage. The actuator comprises a push-pull rod which connects to the stage. Due to this set-up, the footprint of known target positioning device is large, in particular in the first direction.

It is an object of the present invention to provide an alternative target positioning device of high accuracy, which has a reduced footprint and thus requires less space in a clean room.

SUMMARY OF THE INVENTION

According to a first aspect, the invention provides a target positioning device, in particular for a lithography system, comprising

a carrier for carrying a target,

a stage for carrying and moving the carrier along a first direction (X), wherein said stage comprising two X-stage bases, both arranged on top of a common base plate, wherein each X-stage base carries an X-stage carriage, and a Y-beam comprising a Y stage for carrying said carrier and moving the carrier said carrier in a second direction (Y), wherein said Y-beam bridges the space between the X-stage

carriages and is connected to the X-stage carriages via a flexible coupling,

wherein the target positioning device further comprises two motors each for driving a corresponding X-stage carriage along its corresponding X-stage base, wherein the two motors are arranged at least substantially below the stage and each motor of said two motors is coupled to an eccentric cam or crank which is connected to the corresponding X-stage carriage via a crank shaft.

By arranging the motors at least substantially below the stage and using a crank shaft and an eccentric cam or crank, the required footprint of the target positioning device of the invention is reduced, which provides a more compact target positioning device, at least when compared with the x-actuators with a push-pull rod as disclosed in WO 2010/021543. In an embodiment the motors are arranged substantially below the common base plate of the stage.

The footprint of the target positioning device is even further reduced in an embodiment, wherein said at least one of said two motors is arranged in an area between the two X-stage bases.

In the target positioning device of the invention, the two motors each comprises a rotary actuator, the rotary drive thereof is converted in a linear drive of the corresponding X-stage carriage by using the crank shaft and the eccentric cam or crank. In an embodiment, each of said motors has a motor shaft which extends in a direction at least substantially transverse to the first direction. In an embodiment the first direction is substantially horizontal and the motor shaft is arranged substantially vertical.

It is observed that driving the X-stage carriage by using the crank shaft and the eccentric cam or crank requires a more complex regulation of the rotary actuators, at least when compared with linear actuators with a push-pull rod. In spite of this disadvantage, the inventor found

that the use of rotary actuators can provide a reduction the footprint of the target positioning device of the invention. The use of rotary actuators can provide additional advantages as described in more detail below.

In an embodiment, said stage for carrying and moving the carrier is arranged on a wall part, which wall part, in use, is arranged as a wall of a vacuum chamber, and wherein the motor is arranged at least partially in or against the wall part. When the wall part is arranged as part of a vacuum chamber, said stage for carrying and moving the carrier is arranged inside a vacuum chamber, and said motor is at least partially arranged outside said vacuum chamber. Thus the part of the motor which is outside the vacuum chamber does not need to be vacuum compatible, and the target position device according to this embodiment does not require special vacuum compatible motors.

In an embodiment, the stage is arranged on a surface of the wall part which, in use, faces to the inside of the vacuum chamber. In an embodiment, motor is at least partially arranged on a side of the wall part which, in use, faces to the outside of the vacuum chamber.

In an embodiment, the wall part is arranged to form a bottom wall of the vacuum chamber, wherein the motor is arranged at least partially in or under the bottom wall. The bottom wall of the vacuum chamber is used for mounting the motor. In a further embodiment, the stage is arranged on this bottom wall, in particular on a surface of the bottom wall which faces to the inside of the vacuum chamber.

In an embodiment, the motor or the wall part is provided with a rotary feed through, at least at or near a position where the motor shaft traverses said wall part. In use, such a rotary feed through at least substantially maintains the pressure difference between the vacuum inside the vacuum chamber and the atmospheric pressure outside the vacuum chamber, and at the same time provides a passage for a rotatable member. Using this rotatable member a

rotational movement of the motor is transferred to a rotational movement of the rotatable member inside the vacuum chamber for driving the stage.

In an embodiment, the rotary feed through comprises a ferro fluid rotary feed through. Such a ferro fluid rotary feed through provides a passage for the motor shaft. In use, the motor is arranged outside the vacuum chamber and only the motor shaft extends into the vacuum of the vacuum chamber and is connected to the eccentric cam or crank. Thus the motor is arranged outside the vacuum chamber and does not need to be vacuum compatible and also non-vacuum-compatible motors can be used in the target positioning device according to this embodiment of the invention.

In a further embodiment, said motor is provided with an encoder, wherein the encoder is arranged on a side of the wall part which, in use, faces to the outside of the vacuum chamber. In use, the encoder is arranged outside the vacuum chamber. Thus the encoder does not need to be vacuum compatible and also non-vacuum-compatible encoders can be used in the target positioning device according to this embodiment of the invention. In addition, when using rotary actuators, rotary encoders can be used.

In an embodiment, the motor shaft is provided with a shielding member which extends at least partially in a radial direction with respect to the motor shaft. When build-in in a charged particle lithography system which is provided with a shielding as described for example in WO 2010/021543, the shielding member is arranged to at least partially overlap with the shielding of the system. Using such a shielding member on the motor shaft which overlaps the shielding of the system, effectively shields the charged particle lithography system from fluctuation in electromagnetic fields of the motors. Special motors provided with a multiple shield in the electromagnetic actuator are not necessary in the target positioning device according to this embodiment of the invention.

In order increase the shielding effect one or more of the following measures may be used: Preferably at the overlapping region, the shield member is arranged at a distance from the shielding of the system. Preferably at the overlapping region, a surface of the shielding member which faces the shielding of the system is arranged substantially parallel to shielding of the system.

In an embodiment, the shielding member is rigidly attached to the motor shaft, preferably at substantially the complete circumference of the motor shaft. Thus the shielding member rotates together with the motor shaft, and the shielding member is preferably circle symmetric with respect to a centre line of the motor shaft. But more important no stray electromagnetic field can pass between the shielding member and the motor shaft.

In particular for lithography systems the target must be driven with a high accuracy, preferably any deviation from the desired path must be smaller than the resolution of the lithography system. Usually highly accurate, rigid and robust stages are used, in which any play is mechanically minimized. As described above, the stages for use in lithography systems are designed to provide an extremely rigid and mechanically stiff construction, which makes such stages heavy and very expensive.

In an embodiment, the Y-beam is connected to the X-stage carriage via the flexible coupling which comprises one or more flexible struts, which flexible struts are at least substantially rigid in an axial direction of said struts and are flexible in a direction substantially transverse to the axial direction of said struts. It is counter intuitive to connect the Y-beam to the X-stage carriage via flexible struts, because such connection is not in itself accurate, is not rigid or robust. However, due to the flexible struts, the Y-beam is not only movable in the X-direction, but also movable with respect to the X-stage carriages in a direction at least transverse to the

axial direction of the struts. Thus this embodiment of the invention provides an additional freedom of movement which can be used to correct a deviation from the desired path by accurately and properly driving the X-stage carriages, as described in more detail below. Due to the flexible coupling a deviation from the desired path can actively be compensated which results in a controlled accuracy, rigidity and robustness of the target positioning device.

In an embodiment, each X-stage carriages is connected to the Y-beam via a first and a second flexible strut which extend at least substantially parallel to each other in a direction which is at least substantially transverse to the first direction, and wherein the first and second flexible strut are spaced apart in said first direction. In an embodiment, the first direction extends in an at least substantially horizontal direction, and wherein the first and second flexible strut extends in an at least substantially vertical direction. With this setup a rotational deviation of the Y-beam, at least substantially around the vertical direction Rz, for example due to a small deviation in the straightness of the X stages, can be compensated.

Due to the flexible coupling and the controlled accuracy, rigidity and robustness, the actual stages themselves do not need to be as highly accurate, rigid and robust as the stages usually applied in lithography systems. The target positioning device of the present invention provides more functionality in driving and controlling the movement of the target, allows the use of less accurate, rigid and robust stages yielding less a expensive target positioning device, and provides more freedom in the design and construction of target positioning devices.

In an embodiment, said motors are torque motors. Thus the force exerted by the motors to drive the X-stage carriages can be controlled.

In an embodiment, said target positioning device

further comprises a controller for controlling the motors, wherein the controller is arranged for controlling each of the motors individually.

In an embodiment, the controller is arranged for controlling each of said motors in dependence of a position of the carrier on the Y-beam. The position of the carrier on the Y-beam affects the centre of mass of the target position device. Preferably the controller is arranged for controlling each of said motors in dependence of the position of the centre of mass along the Y-beam. This position of the centre of mass is calculated from the position of the carrier on the Y-beam.

In an embodiment, the controller is arranged for controlling the force which each of said motors exerts on its corresponding X-stage carrier in dependence of the position of the centre of mass along the Y-beam. Preferably the force which a motor exerts on its corresponding X-stage carrier in inversely dependent on the distance between the x-stage carrier and the centre of mass along the Y-beam, in particular on the distance between the flexible coupling of the corresponding X-stage carrier and the centre of mass along the Y-beam.

According to a second aspect, the invention provides a lithography system comprising a target positioning device as described above.

According to a third aspect, the invention provides a method for driving a target positioning device within a system, in particular within a lithography system, said target positioning device comprising

a carrier for carrying a target,

a stage for carrying and moving the carrier within said system, wherein said stage comprises a first X-stage base and a second X-stage base, both arranged on top of a common base plate, wherein said first X-stage base carries a first X-stage carriage, and wherein said second X-stage base carries a second X-stage carriage, a Y-beam comprising a Y-stage for carrying said carrier and moving

said carrier in a second direction (Y), wherein said Y-beam bridges the space between the X-stage carriages and is connected to the first X-stage carriage via a first flexible coupling and to the second X-stage carriage via a second flexible coupling,

two motors, each for driving a corresponding X-stage carriage along its corresponding X-stage base along a first direction (X), and

a controller for controlling the motors, wherein the controller is arranged for controlling each of the motors individually,

wherein said method comprises a step of individually controlling the motors for at least substantially preventing a deviation in orientation of the Y-beam relative to said x-stage bases due to the flexible coupling. The flexible mount is adapted for compensating for some misalignment of the first x-stage carriage relative to the second x-stage carriage, for instance due to thermal expansion of the y-beam and/or of the x-stage bases. The flexibility of the mount however also allows for some deviation in orientation of the y-beam due to displacement of center of mass of the carrier, in particular due to displacement of the y-stage along the y-beam. By preventing such a deviation in orientation, an improved positioning accuracy is achieved, in which considerably less correction of a position of a target is required.

The first and second directions are preferably orthogonal to each other.

In an embodiment said motors are torque motors, and wherein said method comprises a step of individually controlling the torque of the motors. Torque motors can be precisely controlled.

In an embodiment the controller is arranged for controlling the motors such that a resulting torque on the carriage is substantially equal to zero. Driving of the motors may thus translate the carrier and target thereon

along the first direction X, without substantially rotating the target, in particular without substantially rotating the target around an axis substantially perpendicular to the first direction.

In an embodiment said motors are controlled in dependence on the positions of the carrier on the Y-beam relative to the first X-stage base and relative to said second X-stage base. The present invention thus takes into account the fact the either the first or the second motor has to perform more work than the other motor for displacing the y-beam along the first direction X when the position of the carrier on the Y-beam is changed.

In an embodiment the method further comprises a step of determining the relative position of a centre of mass of said Y-beam, said Y-stage, said carrier and/or said target, with respect to said first x-stage base and said second x-stage base, wherein said motors are further controlled in dependence on said determined relative position of said center of mass. The relative position is preferably a relative position projected on a plane spanned by said first and second directions. The amount of work each motor has to perform can be estimated based on said relative position of the center of mass.

In an embodiment said method further comprises a step of determining the relative position of a center of mass of said Y-beam, said Y-stage, said carrier and target, with respect to said first flexible coupling and said second flexible coupling, wherein said motors are controlled in dependence on said relative position of the said center of mass. By measuring the relative position of the center of mass with respect to the flexible couplings, a more accurate estimate can be determined for the amount of work each motor has to do to drive movement of the y-beam along the first direction X.

In an embodiment said method further comprises the step of determining a mass of said Y-beam, said Y-stage, said carrier and/or said target, wherein said motors

are further controlled in dependence on said mass. The mass is of the y-beam, y-stage and carrier is typically predetermined.

In an embodiment the method further comprises the step of determining a momentum of said Y-beam, said Y-stage, said carrier and/or said target, wherein the motors are further controlled in dependence on said momentum.

In an embodiment said motors are controlled for substantially preventing a rotation of the Y-beam around an axis normal to said first and second directions. Rotation around said axis, typically the z-axis in a system, is thus prevented, providing higher positioning accuracy which is in particular of importance for lithographic processes such as stitching and overlay.

In an embodiment said first and said second flexible coupling substantially support said Y-beam.

In an embodiment the first and second motors are controlled to provide an angular momentum of the y-beam in a plane parallel to said first and second direction, substantially equal to zero during movement of the x-stage carriages over the respective x-stage bases.

In an embodiment said system is a lithography system comprising an optical column, wherein said motors are controlled for substantially preventing a rotation of said target around an axis normal to said first and second directions, improving among others stitching and overlay in such a lithography system.

In an embodiment said system further comprises two sensors for respectively measuring the power used by said first motor and by said second motor, wherein said motors are controlled based on said measured powers.

In an embodiment the flexible coupling of each x-stage with the y-beam comprises two flexible struts which are spaced apart and arranged in parallel and normal to said first and second direction. The struts thus substantially limit translational movement of the y-beam relative to the x-stage carriers in a direction

perpendicular to the first and second directions, while allowing at least some translational movement of the y-beam relative to the x-stage carriers along the second direction Y.

According to a fourth aspect, the invention provides a method for driving a target positioning device within a system, in particular within a lithography system, said target positioning device comprising

a carrier for carrying a target,

a stage for carrying and moving the carrier within said system, wherein said stage comprises a first X-stage base and a second X-stage base, both arranged on top of a common base plate, wherein said first X-stage base carries a first X-stage carriage, and wherein said second X-stage base carries a second X-stage carriage, a Y-beam comprising a Y-stage for carrying said carrier and moving said carrier in a second direction (Y), wherein said Y-beam bridges the space between the X-stage carriages and is connected to the first X-stage carriage via a first flexible coupling and to the second X-stage carriage via a second flexible coupling,

two motors, each for driving a corresponding X-stage carriage along its corresponding X-stage base along a first direction (X), and

a controller for controlling the motors, wherein the controller is arranged for controlling a force which each of said motors applies to its corresponding x-stage carriage individually. By controlling the force applied by each of said motors in this manner, rotation of the y-beam can be substantially prevented.

In an embodiment the method comprises any one of the features of the method according to the third aspect as described herein.

The various aspects and features described and shown in the specification can be applied, individually, wherever possible. These individual aspects, in particular the aspects and features described in the attached

dependent claims, can be made subject of divisional patent applications.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be elucidated on the basis of an exemplary embodiment shown in the attached drawings, in which:

Figure 1 shows a simplified block diagram illustrating the principal elements of a modular lithography system,

Figure 2 shows a schematic cross section of the lower part of the lithography system,

Figure 3 shows a schematic view of a long stroke stage according to the invention,

Figure 4 shows a detailed view of a motor with a vacuum feed through for use in the lithography system of the invention, and

Figures 5A and 5B show a detailed view of the motor of figure 4 which is additionally provided with a shielding arrangement.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 shows a simplified block diagram illustrating the principal elements of a modular lithography system. The lithography system is preferably designed in a modular fashion to permit ease of maintenance. Major subsystems are preferably constructed in self- contained and removable modules, so that they can be removed from the lithography machine with as little disturbance to other subsystems as possible. This is particularly advantageous for a lithography machine enclosed in a vacuum chamber, where access to the machine is limited. Thus, a faulty subsystem can be removed and

replaced quickly, without unnecessarily disconnecting or disturbing other systems. In the embodiment shown in figure 1, these modular subsystems include:

an illumination optics module 201 including the charged particle beam source 101 and beam collimating system 102,

an aperture array and condenser lens module 202 including aperture array 103 and condenser lens array 104,

a beam switching module 203 including beamlet blanker array 105, and

projection optics module 204 including beam stop array 108, beam deflector array 109, and projection lens arrays 110.

In the embodiment shown in Figure 1, the alignment frame comprises an alignment inner sub-frame 205 and an alignment outer sub frame 206. A frame 208 supports the alignment sub-frames 205 and 206 via vibration damping mounts 207. The wafer 130 rests on wafer table 209, which is in turn mounted on chuck 210. Chuck 210 sits on the short stroke stage 211 which is arranged for driving said chuck 210 over a small distance along all six degrees freedom. The short stroke stage 211 is mounted on top of a long stroke stage 212 which is arranged for driving said short stroke stage 211 and the chuck 210 along two orthogonal directions (X and Y) in an at least substantially horizontal plane. The lithography machine 200 is enclosed in vacuum chamber 400, which includes a mu metal (μ metal) shielding layer or layers 215. The machine rests on base plate 220 supported by frame members 221.

In an embodiment the frame 208 and the frame member 211 are formed as one unit. For example the frame 208 and the frame member 211 are machined from a single monolithic block of material.

The frame 208 can also be a separate wall part, which in use forms the bottom wall of the vacuum chamber as shown in figure 2. The target positioning device of the invention can be mounted on or in the frame (or wall part)

208 before the frame 208 is arranged on the base plate 220 and/or before the other part of the vacuum chamber 400 is arranged onto the frame 208.

The position of the wafer and wafer table with respect to the optical column 201, 202, 203, 204 is measured with a measuring device 250 which is attached to the alignment sub-frame 205 which monitors the position of the chuck 210 with respect to the measuring device 250. The measuring device 250 comprises, for example, an interferometer system and the chuck 210 is then provided with a mirror 251 for reflecting the light beams 252 from the interferometer system. A measuring signal from the measuring device 250 is provided to a control unit 600 (see for example figures 2 and 3) which control unit is arranged for driving the short stroke stage 211 and/or the long stroke stage 212.

Figure 2 shows the long stroke stage 212 for carrying and moving the carrier 300 along a first direction (X) and a second direction (Y). The carrier 300 may comprise the wafer table 209, the chuck 2010 and the short stroke stage 211.

The long stroke stage 212 comprises two X-stage bases 401, 402, both arranged on top of a common base plate 403, wherein each X-stage base carries an X-stage carriage. Underneath said base plate 403, two motors M1, M2 are arranged, each for driving a corresponding X-stage carriage 404, 405 along its corresponding X-stage base 401, 402. The Y-beam 406 comprising a Y stage 407 for carrying said carrier 300 and moving said carrier 300 in a second direction (Y), wherein said Y-beam bridges the space between the X-stage carriages 404, 405 and is connected to the X-stage carriages via a flexible coupling 408, 409. Each motor M1, M2 is coupled to an eccentric cam or crank 410, 411 which is connected to the corresponding X-stage carriage 404, 405 via a crank shaft 412, 413.

As shown in figure 2, each of said motors M1, M2 has a motor shaft 414, 415 which extends in a direction at

least substantially transverse to the first (X) direction and the second (Y) direction. In addition, said two motors M1, M2 are arranged in an area between the two X-stage bases 401, 402.

As also shown in figure 2, said stage 212 for carrying and moving the carrier 300 is arranged inside a vacuum chamber 400, and wherein said motors M1, M2 is at least partially arranged outside said vacuum chamber 400.

The motor, at least at or near a position wherein the motor shaft traverses a wall of said vacuum chamber 400, is provided with a rotary feed through. As shown in figure 4, motor M1, M2 comprises a housing 506, which can be mounted in an opening in the wall of the vacuum chamber 400. The motor comprises a rotating shaft 500 which is mounted in the housing via two bearings 502, 503. Between these bearings 502, 503, the torque motor 504 for driving the rotating shaft, is arranged.

The motor is provided with a ferro fluid rotary feed through 501 which enable the rotating shaft 500 of the motor to get into the vacuum chamber 400. Due to the ferro fluid rotary feed through, every part of the motor below this feed through 501 can be at substantially atmospheric pressure.

Furthermore said motor M1, M2 is provided with an encoder 505, wherein the encoder is arranged outside the vacuum chamber at the lower end of the rotating shaft 500.

As clearly shown in figures 2 and 3, the motors M1, M2 are arranged substantially below the stage 212 and between the X-stage bases 401, 402. In order to shield the optical charged particle column 201, 202, 203, 204 and the target 130, shielding layer or layers 215 are provided. In order to provide a proper shielding at the rotary feed through 501, the motor shaft 500 is provided with a shielding member 602, 604 which extends at least partially in a radial direction with respect to the motor shaft 500, as shown in the examples of figures 5A and 5B. When build-in in a charged particle lithography system which is

provided with a shielding layer 601 or layers 603, 605, the shielding member 602, 604 is arranged to at least partially overlap with the shielding layer 601 or layers 603, 605 of the system. Using a shielding member 602 or 604 on the motor shaft which overlaps the shielding layer 601 or layers 603, 605 of the system, effectively shields the charged particle lithography system from fluctuation in electromagnetic fields of the motors M1, M2.

The shielding member 602, 604 is rigidly attached to the motor shaft 500 at substantially the complete circumference of the motor shaft 500. Thus the shielding member 602, 604 rotates together with the motor shaft 500, and the shielding member 602, 604 is preferably circle symmetric with respect to a centre line 507 of the motor shaft 500. At the overlapping region, the shield member 602, 604 is arranged at a short distance from the shielding layer 601 or layers 603, 605 of the system. In addition, at the overlapping region, a surface of the shielding member 602, 604 which faces the shielding layer 601 or layers 603, 605 of the system is arranged substantially parallel to a surface of the shielding layer 601 or layers 603, 605 of the system which faced the shielding member 602, 604.

In the example as shown in figure 5A, the overlapping region between the shielding member 602 and the shielding layer 601 of the system extends substantially parallel to the motor shaft 500.

In the example as shown in figure 5B, the shielding member 604 extends perpendicular to the motor shaft 500 and is arranged to extend in between the shielding layers 603, 605 of the system.

As shown in figure 2 the Y-beam 406 is connected to the X-stage carriages 404, 405 via one or more flexible struts 408, 409, which flexible struts are at least substantially rigid in an axial direction of said struts 408, 409 and are flexible in a direction substantially transverse to the axial direction of said struts 408, 409. In particular, each X-stage carriages 408, 409 is connected

to the Y-beam via a first and a second flexible strut which extend at least substantially parallel to each other in a direction which is at least substantially transverse to the first (X) direction, and wherein the first and second flexible strut are spaced apart in said first (x) direction.

The lithography system 200 is usually arranged such that the first (X) direction extends in an at least substantially horizontal direction, and the first and second flexible strut extends in an at least substantially vertical direction.

The lithography system 200 may further comprise a controller 600 for controlling the motors M1, M2, wherein the controller 600 is arranged for controlling each of the motors individually. The controller 600 comprises a processor 601 which drives the motors M1, M2 in accordance to a computer program which is stored in a memory 602, which computer program comprises instructions for carrying out one or more of the method steps described above or as described in the method claims as attached. Although the controller 600 in figures 2 and 3 is schematically arranged close to the motors M1, M2, in particular in between the motors M1, M2, said controller 600 may also be arranged at a position remote from the motors or even remote from the lithography system.

The controller is arranged for controlling each of said motors in dependence of a position of said carrier on the Y-beam. In particular in dependence of the position of the centre of mass CoM with respect to the flexible struts 408, 409, which position is defined by the distances r1, r2 as shown in figure 2. Essentially the torque of the motors M1, M2 is controlled such that the force of motor M1 on the first carriage 404 multiplied with the distance r1 is at least substantially equal to the force of motor M2 on the second carriage 405 multiplied with the distance r2.

In summary, the invention provides a target positioning device, in particular for a lithography system,

comprising a carrier for carrying a target, and a stage for carrying and moving the carrier along a first direction (X). The stage comprising two X-stage bases, both arranged on top of a common base plate, each X-stage base carries an X-stage carriage, and a Y-beam comprising a Y-stage for carrying said carrier and moving the carrier said carrier in a second direction (Y). The Y-beam bridges the space between the X-stage carriages and is connected to the X-stage carriages via a flexible coupling. The device further comprises two motors each for driving a corresponding X-stage carriage along its corresponding X-stage base. The two motors are arranged at least substantially below the stage. Each motor of said two motors is coupled to an eccentric cam or crank which is connected to the corresponding X-stage carriage via a crank shaft.

It is to be understood that the above description is included to illustrate the operation of the preferred embodiments and is not meant to limit the scope of the invention. From the above discussion, many variations will be apparent to one skilled in the art that would yet be encompassed by the spirit and scope of the present invention.

CONCLUSIES

1. Doelpositioneringsinrichting, in het bijzonder voor een lithografie systeem, omvattend

een drager voor het dragen van een doel,

een platform voor het dragen en bewegen van de drager langs een eerste richting (X), waarbij het platform twee X-platform bases omvat, beide gerangschikt bovenop een gezamenlijke basisplaat, waarbij elke X-platform basis een X-platform slede draagt, en een Y-balk omvattende een Y-platform voor het dragen van de drager en het bewegen van de drager in een tweede richting (Y), waarbij de Y-balk de ruimte tussen de X-platform sledes overbrugt en is verbonden met de X-platform sledes via een flexibele koppeling, en

twee motoren elk voor aandrijving een overeenkomstige X-platform slede langs zijn overeenkomstige X-platform basis, waarbij de twee motoren zijn gerangschikt ten minste in hoofdzaak onder het platform en elke motor van de twee motoren gekoppeld is aan een excenter kruk of crank die is verbonden met overeenkomstige X-platform slede via een krukas.

2. Doelpositioneringsinrichting volgens conclusie 1, waarbij ten minste een van de twee motoren is gerangschikt in een gebied tussen de twee X-platform bases.

3. Doelpositioneringsinrichting volgens conclusie 1 of 2, waarbij elk van de motoren een motor-as heeft die zich uitstrekt in een richting ten minste in hoofdzaak dwars op de eerste richting.

4. Doelpositioneringsinrichting volgens conclusie 3, waarbij de eerste richting in hoofdzaak horizontaal is en de motors-as in hoofdzaak verticaal is gerangschikt.

5. Doelpositioneringsinrichting volgens een der voorgaande conclusies, waarbij het platform voor het dragen en bewegen van de slede is gerangschikt op een wanddeel, welk wanddeel in gebruik is gerangschikt als een wanddeel van een vacuümkamer, en waarbij de motor ten minste ten dele in of tegen het wanddeel is gerangschikt.

6. Doelpositioneringsinrichting volgens conclusie 5, waarbij het platform is gerangschikt op een oppervlak van het wanddeel dat, in gebruik, naar de binnenkant van de vacuümkamer is gericht.

7. Doelpositioneringsinrichting volgens conclusie 6, waarbij de motor ten minste ten dele is gerangschikt aan een zijde van het wanddeel dat, in gebruik, naar de buitenkant van de vacuümkamer is gericht.

8. Doelpositioneringsinrichting volgens conclusie 7, waarbij de motor of het wanddeel is voorzien van een draai-doorvoer.

9. Doelpositioneringsinrichting volgens conclusie 8, waarbij de draai-doorvoer een ferro-vloeistof draai-doorvoer omvat.

10. Doelpositioneringsinrichting volgens conclusie 7, 8 of 9, waarbij de motor is voorzien van een encoder, waarbij de encoder is gerangschikt aan een zijde van het wanddeel dat, in gebruik, naar de buitenkant van de vacuümkamer is gericht.

11. Doelpositioneringsinrichting volgens een der voorgaande conclusies, waarbij de motor-as is voorzien van een afschermingselement dat zich ten minste ten dele in een radiale richting ten opzichte van de motor-as uitstrekt.

12. Doelpositioneringsinrichting volgens conclusie 11, waarbij het afschermelement stijf is verbonden met de motor-as, bij voorkeur aan in hoofdzaak de volledige omtrek van de motor-as.

13. Doelpositioneringsinrichting volgens een der voorgaande conclusies, waarbij de Y-balk is verbonden met de X-platform sledes via een of meer flexibele kolommen, welke flexibele kolommen ten minste in hoofdzaak stijf zijn in een axiale richting van de kolommen en flexibel zijn in een richting in hoofdzaak dwars op de axiale richting van de kolommen.

14. Doelpositioneringsinrichting volgens conclusie 13, waarbij elke X-platform sledes zijn verbonden met de Y-balk via een eerste en tweede flexibele kolom die zich ten minste in hoofdzaak parallel aan elkaar uitstrekken in een richting die ten minste in hoofdzaak dwars is op de eerste richting, en waarbij de eerste en tweede flexibele kolom op afstand van elkaar zijn geplaatst in de eerste richting.

15. Doelpositioneringsinrichting volgens conclusie 14, waarbij de eerste richting zich uitstrekt in een ten minste in hoofdzaak horizontale richting, en waarbij de eerste en tweede flexibele kolom zich uitstrekt in een ten minste in hoofdzaak verticale richting.

16. Doelpositioneringsinrichting volgens een der voorgaande conclusies, waarbij de motoren torsie-motoren zijn.

17. Doelpositioneringsinrichting volgens een der voorgaande conclusies, verder omvattend een aanstuurinrichting voor het aansturen van de motoren, waarbij de aanstuurinrichting is ingericht om elk van de motoren individueel aan te sturen.

18. Doelpositioneringsinrichting volgens conclusie 17, waarbij de aanstuurinrichting is ingericht om elk van de motoren afhankelijk van een positie van de drager op de Y-balk aan te sturen.

19. Lithografiesysteem omvattend een doelpositioneringsinrichting volgens een der voorgaande conclusies.

20. Werkwijze voor het aandrijven van een doelpositioneringsinrichting binnen een systeem, in het bijzonder binnen een lithografiesysteem, waarbij de doelpositioneringsinrichting omvat

een drager voor het dragen van een doel,

een platform voor het dragen en bewegen van de drager binnen het systeem, waarbij het platform een eerste X-platform basis en een tweede X-platform basis omvat, beide gerangschikt bovenop een gezamenlijke basisplaat, waarbij de eerste X-platform basis een eerste X-platform slede draagt, en waarbij de tweede X-platform basis een tweede X-platform slede draagt, en een Y-balk omvattend een Y-platform voor het dragen van de drager en het bewegen van de drager in een tweede richting (Y), waarbij de Y-balk de ruimte tussen de X-platform sledes overbrugt en is verbonden met de eerste X-platform slede via een eerste flexibele koppeling en met de tweede X-platform slede via een tweede flexibele koppeling,

twee motoren, elk voor het aandrijven van een overeenkomstige X-platform slede langs zijn

overeenkomstige X-platform basis langs een eerste richting (X), en

een aanstuurinrichting voor het aansturen van de motoren, waarbij de aanstuurinrichting is ingericht om elk van de motoren individueel aan te sturen,

waarbij de werkwijze een stap omvat van het individueel aansturen van de motoren om een afwijking in een oriëntatie van de Y-balk ten opzichte van de X-platform bases wegens de flexibele koppeling ten minste in hoofdzaak te voorkomen.

21. Werkwijze voor het aandrijven van een doelpositioneringsinrichting binnen een systeem, in het bijzonder binnen een lithografiesysteem, waarbij de doelpositioneringsinrichting omvat

een drager voor het drager van een doel,

een platform voor het dragen en bewegen van de drager binnen het systeem, waarbij het platform een eerste X-platform basis en een tweede X-platform basis omvat, beide gerangschikt bovenop een gezamenlijke basisplaat, waarbij de eerste X-platform basis een eerste X-platform slede draagt, en waarbij de tweede X-platform basis een tweede X-platform slede draagt, en een Y-balk omvattend een Y-platform voor het dragen van de drager en het bewegen van de drager in een tweede richting (Y), waarbij de Y-balk de ruimte tussen de X-platform sledes overbrugt en is verbonden met de eerste X-platform slede via een eerste flexibele koppeling en met de tweede X-platform slede via een tweede flexibele koppeling,

twee motoren, elk voor het aandrijven van een overeenkomstige X-platform slede langs zijn overeenkomstige X-platform basis langs een eerste richting (X), en

een aanstuurinrichting voor het aansturen van de motoren, waarbij de aanstuurinrichting is ingericht voor het individueel aansturen van een kracht die elk van de motoren toepast op zijn overeenkomstige X-platform slede.

22. Werkwijze volgens conclusie 20 of 21, waarbij de motoren torsie-motoren zijn, en waarbij de werkwijze een stap omvat van het individueel aansturen van de torsie van de motoren.

23. Werkwijze volgens een der conclusies 20-22, waarbij de aanstuurinrichting is ingericht voor het aansturen van de motoren zodanig dat een resulterende torsie op de slede in hoofdzaak gelijk is aan nul.

24. Werkwijze volgens een der conclusies 20-23, waarbij de motoren worden aangestuurd in afhankelijkheid van de posities van de drager op de Y-balk ten opzichte van de eerste X-platform basis en ten opzichte van de tweede X-platform basis.

25. Werkwijze volgens een der conclusies 20-24, verder omvattend een stap van het bepalen van de relatieve positie van een zwaartepunt van de Y-balk, het Y-platform, de drager en/of het doel, ten opzichte van de eerste X-platform basis en de tweede X-platform basis, waarbij de motoren verder worden aangestuurd in een afhankelijkheid op de bepaalde relatieve positie van het zwaartepunt.

26. Werkwijze volgens een der conclusies 20-25, verder omvattend een stap van het bepalen van de relatieve positie van een zwaartepunt van de Y-balk, het Y-platform, de drager en het doel, ten opzichte van de eerste flexibele koppeling en de tweede flexibele koppeling, waarbij de motoren worden aangestuurd in afhankelijkheid van de relatieve positie van het zwaartepunt.

27. Werkwijze volgens conclusie 25 of 26, verder omvattend de stap het bepalen van een massa van de Y-balk, het Y-platform, de drager en/of het doel, waarbij de

motoren verder worden aangestuurd in afhankelijkheid van de massa.

28. Werkwijze volgens een der conclusies 20-27, verder omvattend de stap van het bepalen van een moment van de Y-balk, het Y-platform, de drager en/of het doel, waarbij de motoren verder worden aangestuurd in afhankelijkheid van het moment.

29. Werkwijze volgens een der conclusies 20-28, waarbij de motoren worden aangestuurd voor het in hoofdzaak voorkomen van een draaiing van de Y-balk rond een as normaal aan de eerste en tweede richtingen.

30. Werkwijze volgens een der conclusies 20-29, waarbij de eerste en tweede flexibele koppeling in hoofdzaak de Y-balk ondersteunen.

31. Werkwijze volgens een der conclusies 20-30, waarbij de eerste en tweede motoren worden aangestuurd om een hoekmoment van de Y-balk te verschaffen in een vlak parallel de eerste en tweede richting, in hoofdzaak gelijk aan nul gedurende beweging van de X-platform sledes over de respectievelijke X-platform bases.

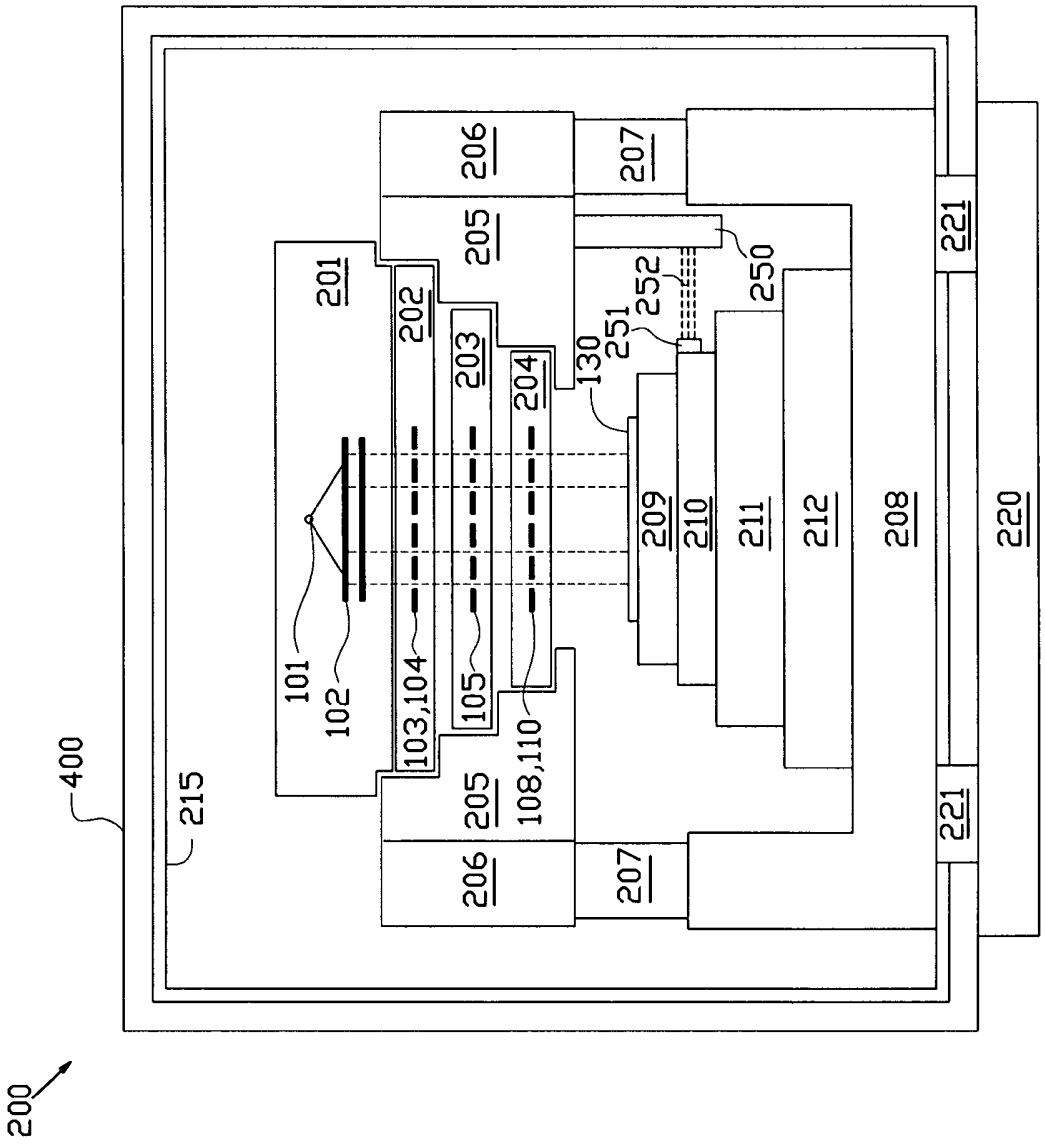
32. Werkwijze volgens een der conclusies 20-31, waarbij het systeem een lithografiesysteem is dat een optische kolom omvat, en waarbij de motoren worden aangestuurd voor het in hoofdzaak voorkomen van een draaiing van het doel rond een as normaal een de eerste en tweede richtingen.

33. Werkwijze volgens een der conclusies 20-32, verder omvattend twee sensoren voor het meten van het vermogen gebruikt door de eerste motor en door de tweede motor, waarbij de motoren worden aangestuurd op bases van de gemeten vermogens.

34. Werkwijze volgens een der conclusies 20-33, waarbij de flexibele koppeling van elk X-platform met de Y-balk twee flexibele kolommen omvat die op afstand van elkaar zijn geplaatst en in parallel en normaal aan de eerste en tweede richting zijn gerangschikt.

-o-o-o-o-o-

FIG. 1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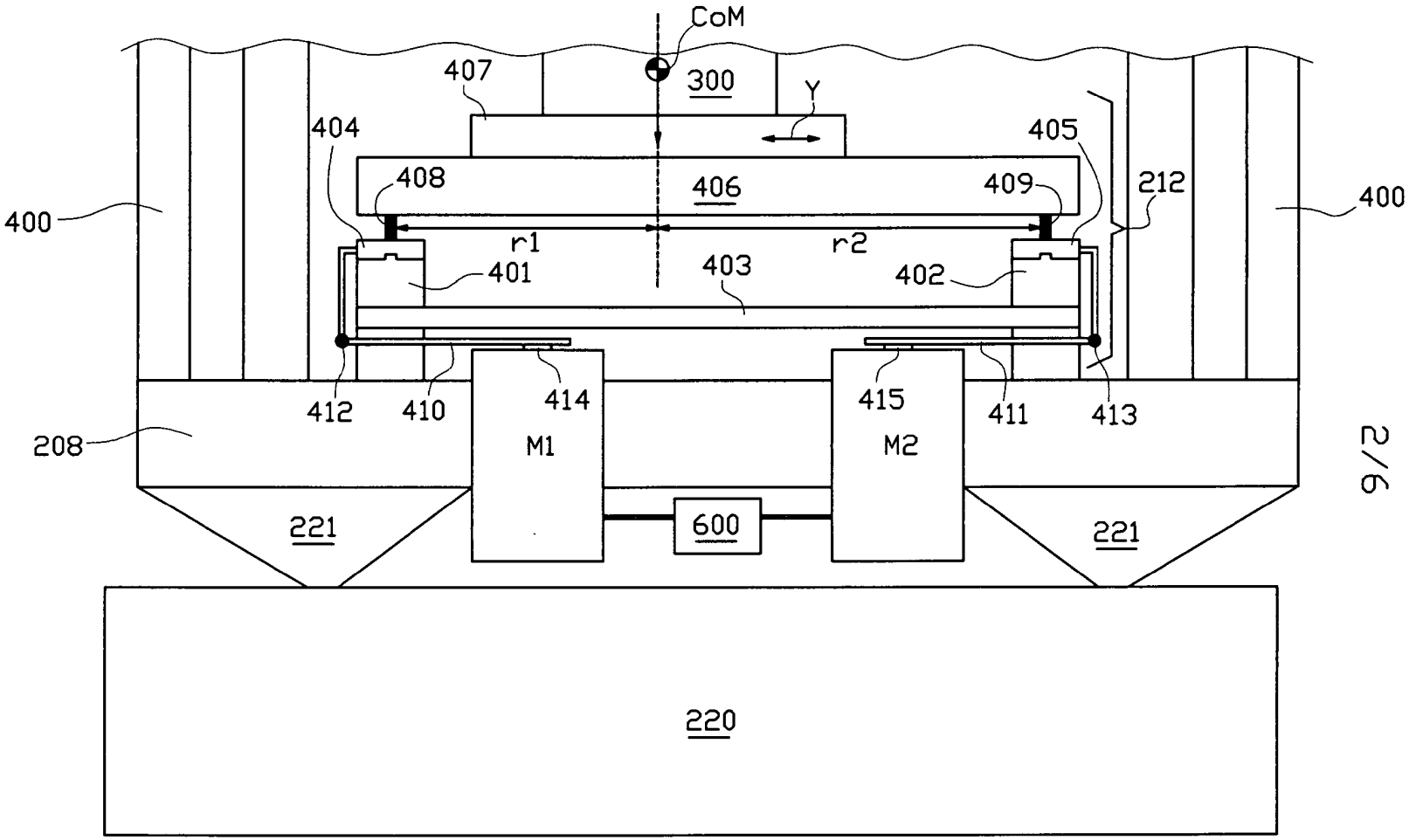
CoM
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208
M1
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FIG. 2

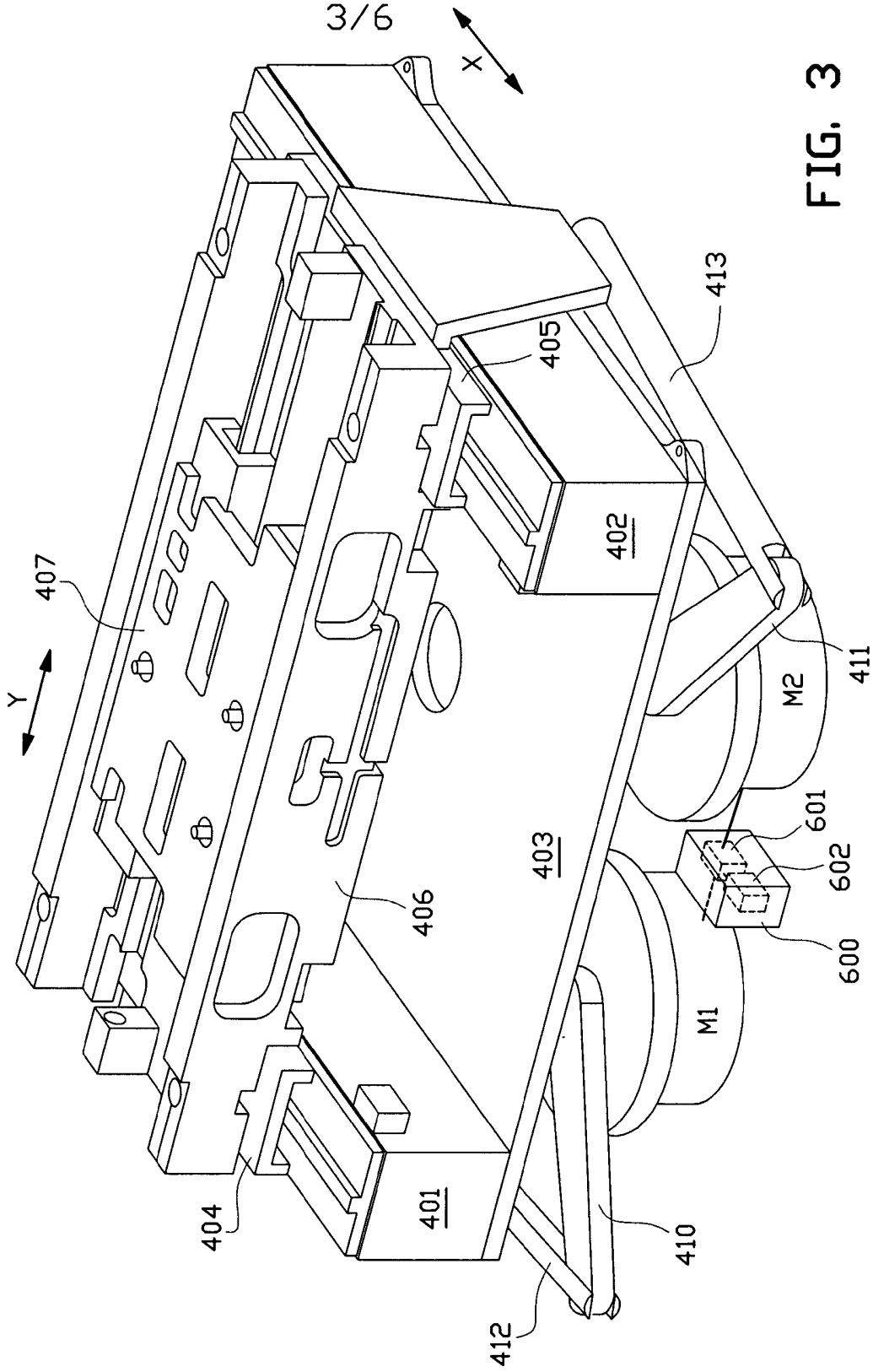


FIG. 3

FIG. 4

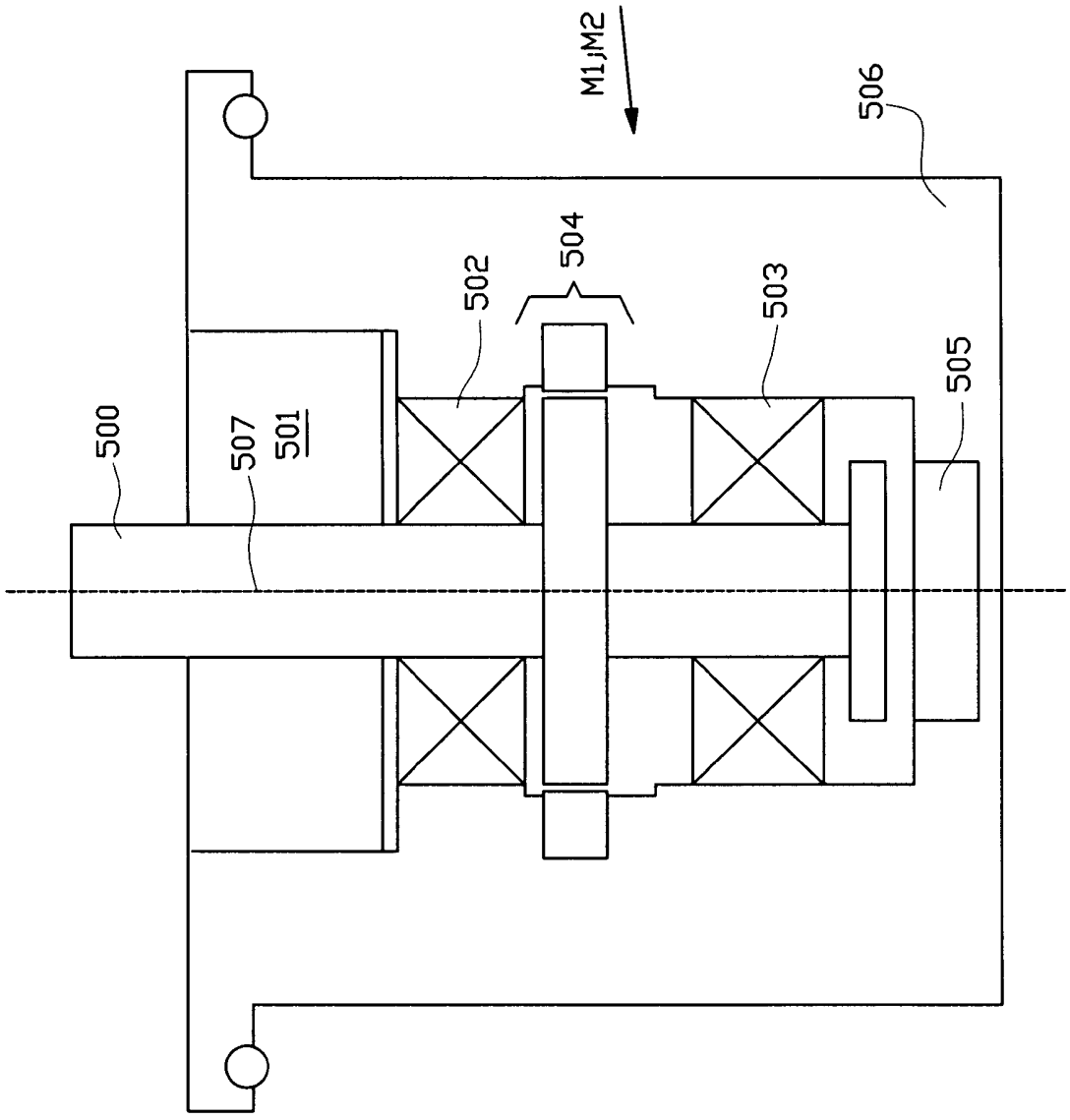


FIG. 5A

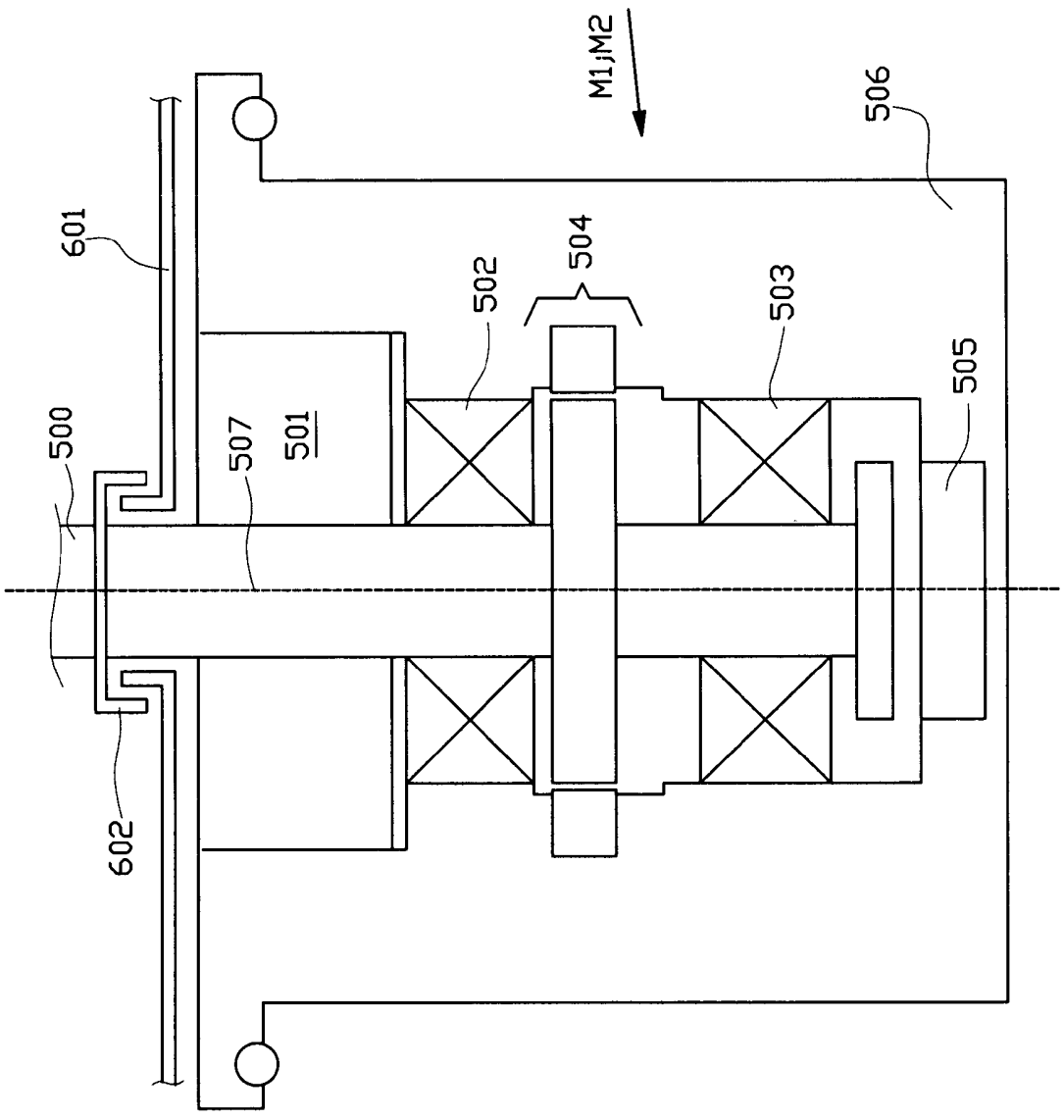
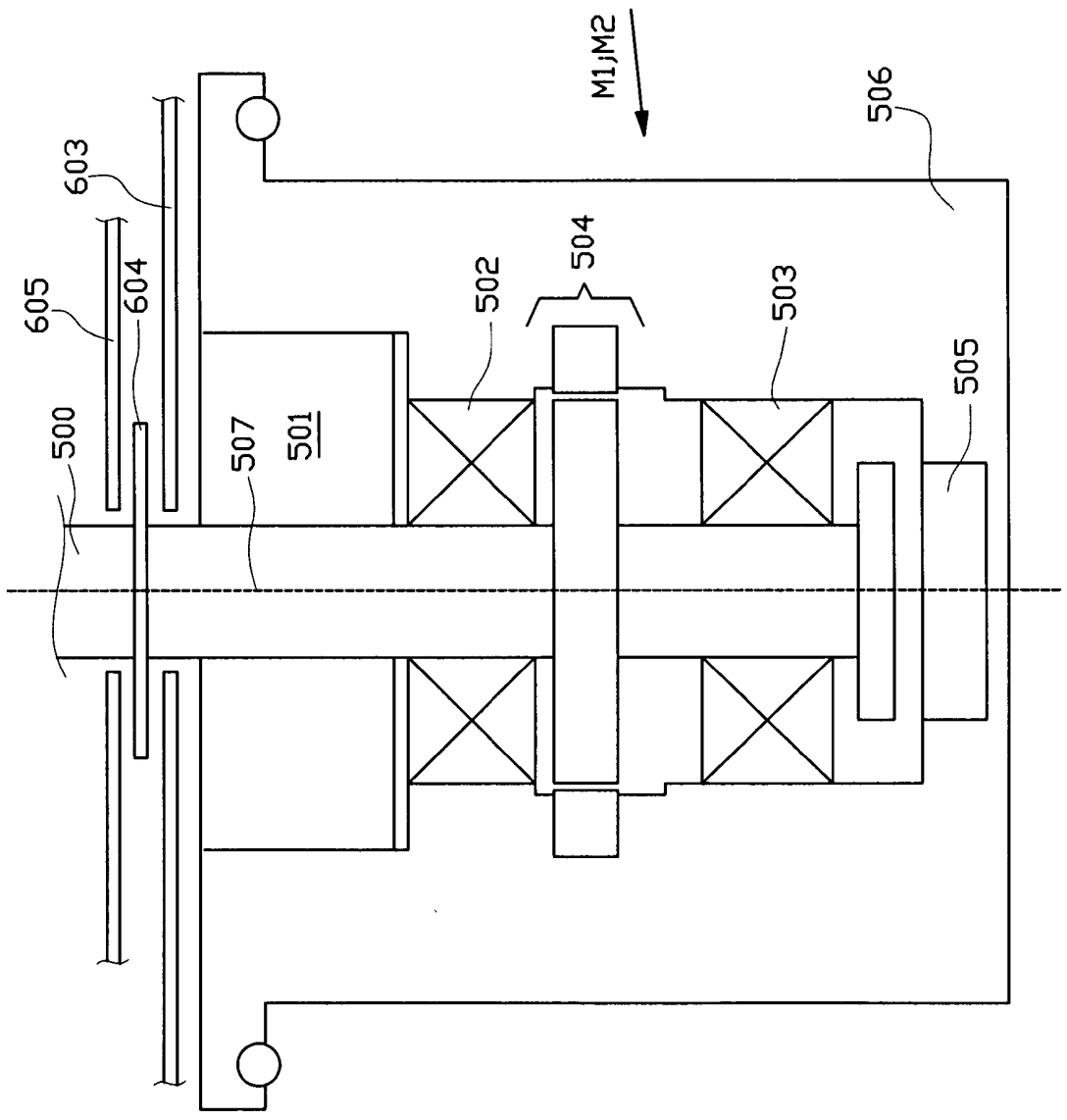


FIG. 5B



Agentschap NL
Ministerie van Economische Zaken

OCTROOIAANVRAAG NR.:
NO 138476
NL 1039797

ONDERZOEKSRAPPORT

BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK

RELEVANTE LITERATUUR

Categorie[1]	Literatuur met, voor zover nodig, aanduiding van speciaal van belang zijnde tekstgedeelten of figuren.	Van belang voor conclusie(s) nr:	Classificatie (IPC)
	EENHEID VAN UITVINDING ONTBREEKT zie aanvullingsblad B -----		INV. G03F7/20
A	WO 2010/021543 A1 (MAPPER LITHOGRAPHY IP BV [NL]; PEIJSTER JERRY [NL]; DE BOER GUIDO [NL]) 25 februari 2010 (2010-02-25) * samenvatting * * figuren 1,8-11 * * bladzijde 1, regels 3-6 * * bladzijde 17, regel 24 - bladzijde 19, regel 5 * -----	1-19	
A	US 2010/155560 A1 (MAKINO FUMINORI [JP]) 24 juni 2010 (2010-06-24) * samenvatting * * figuur 1 * * alineas [0001] - [0008] * -----	1-19	
A	EP 0 366 420 A2 (MAMIYA DENSHI CO LTD [JP]; SEIKA SANGYO CO LTD [JP]) 2 mei 1990 (1990-05-02) * samenvatting * * figuren 1-3 * * kolom 1, regels 6-10 * * kolom 3, regel 39 - kolom 4, regel 52 * -----	1-19	
			Onderzochte gebieden van de techniek
			H01L G03F B23Q H01J

Indien gewijzigde conclusies zijn ingediend, heeft dit rapport betrekking op de conclusies ingediend op:

Plaats van onderzoek:	Datum waarop het onderzoek werd voltooid:	Bevoegd ambtenaar:
München	4 november 2014	Andersen, Ole

[1] CATEGORIE VAN DE VERMELDE LITERATUUR

X: de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur
Y: de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht
A: niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft
O: niet-schriftelijke stand van de techniek
P: tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur
T: na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding
E: eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven
D: in de octrooiaanvrage vermeld
L: om andere redenen vermelde literatuur
&: lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

EOB FORM 02.83 (P0414B)

GEBREK AAN EENHEID VAN UITVINDING

Octrooiaanvrage Nr.:
NO 138476
NL 1039797

AANVULLINGSBLAD B

De Instantie belast met het uitvoeren van het onderzoek naar de stand van de techniek heeft vastgesteld dat deze aanvrage meerdere uitvindingen bevat, te weten:

1. conclusies: 1-19

Closest prior art: target positioning device known from WO 2010/021543 A.
Special technical feature, taking due account of the description and drawings: motors arranged substantially below the stage and each motor being coupled to an eccentric cam or crank which is connected to the corresponding X-stage carriage via a crank shaft.
Technical effect of this special technical feature: footprint of the target positioning device is reduced (see page 1, line 19 - page 2, line 2 and page 2, lines 19 - 22 of the application as filed).
Problem solved by this special technical feature: decreased operation costs of systems incorporating the target positioning device (see page 1, line 19 - page 2, line 2 and page 2, lines 19 - 22 of the application as filed).

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2. conclusies: 20-34

Closest prior art: Method for driving the target positioning device known from WO 2010/021543 A .
Special technical feature, taking due account of the description and drawings: step of controlling the motors such that resulting torque on the carriage is substantially zero.
Technical effect of this special technical feature: deviation in orientation of the Y-beam relative to the X-stage bases can be prevented.
Problem solved by this special technical feature: improved positioning accuracy and higher throughput (see page 9, lines 24 - 27 of the application as filed).

Het vooronderzoek werd tot het eerste onderwerp beperkt.

AANHANGSEL BEHORENDE BIJ HET RAPPORT BETREFFENDE HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK, UITGEVOERD IN DE OCTROOIAANVRAGE NR.

NO 138476
NL 1039797

Het aanhangsel bevat een opgave van elders gepubliceerde octrooiaanvragen of octrooien (zogenaamde leden van dezelfde octrooifamilie), die overeenkomen met octrooischriften genoemd in het rapport.
De opgave is samengesteld aan de hand van gegevens uit het computerbestand van het Europees Octrooibureau per
De juistheid en volledigheid van deze opgave wordt noch door het Europees Octrooibureau, noch door het Bureau voor de Industriële eigendom gegarandeerd; de gegevens worden verstrekt voor informatiedoeleinden.

04-11-2014

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
WO 2010021543 A1	25-02-2010	CN 102187424 A	14-09-2011
		CN 102522300 A	27-06-2012
		EP 2313908 A1	27-04-2011
		JP 5539468 B2	02-07-2014
		JP 2012500492 A	05-01-2012
		JP 2013038426 A	21-02-2013
		KR 20110055678 A	25-05-2011
		TW 201009519 A	01-03-2010
		TW 201250411 A	16-12-2012
		WO 2010021543 A1	25-02-2010
US 2010155560 A1	24-06-2010	GEEN	
EP 0366420 A2	02-05-1990	GEEN	

Algemene informatie over dit aanhangsel is gepubliceerd in de 'Official Journal' van het Europees Octrooibureau nr 12/82 blz 448 ev

SCHRIFTELIJKE OPINIE

DOSSIER NUMMER	INDIENINGSDATUM	VOORRANGSDATUM	AANVRAAGNUMMER
NO138476	12.09.2012	12.09.2011	NL1039797

CLASSIFICATIE
INV. G03F7/20

AANVRAGER
Mapper Lithography IP B.V.

Deze schriftelijke opinie bevat een toelichting op de volgende onderdelen:

- ☒ Onderdeel I Basis van de schriftelijke opinie
- ☐ Onderdeel II Voorrang
- ☒ Onderdeel III Vaststelling nieuwheid, inventiviteit en industriële toepasbaarheid niet mogelijk
- ☒ Onderdeel IV De aanvraag heeft betrekking op meer dan één uitvinding
- ☒ Onderdeel V Gemotiveerde verklaring ten aanzien van nieuwheid, inventiviteit en industriële toepasbaarheid
- ☐ Onderdeel VI Andere geciteerde documenten
- ☐ Onderdeel VII Overige gebreken
- ☐ Onderdeel VIII Overige opmerkingen

	DE BEVOEGDE AMBTENAAR

Aanvraag nr.:

SCHRIFTELIJKE OPINIE

NL1039797

Onderdeel I Basis van de Schriftelijke Opinie

1. Deze schriftelijke opinie is opgesteld op basis van de meest recente conclusies ingediend voor aanvang van het onderzoek.

2. Met betrekking tot **nucleotide en/of aminozuur sequenties** die genoemd worden in de aanvraag en relevant zijn voor de uitvinding zoals beschreven in de conclusies, is dit onderzoek gedaan op basis van:

   a. type materiaal:

   ☐ sequentie opsomming

   ☐ tabel met betrekking tot de sequentie lijst

   b. vorm van het materiaal:

   ☐ op papier

   ☐ in elektronische vorm

   c. moment van indiening/aanlevering:

   ☐ opgenomen in de aanvraag zoals ingediend

   ☐ samen met de aanvraag elektronisch ingediend

   ☐ later aangeleverd voor het onderzoek

3. ☐ In geval er meer dan één versie of kopie van een sequentie opsomming of tabel met betrekking op een sequentie is ingediend of aangeleverd, zijn de benodigde verklaringen ingediend dat de informatie in de latere of additionele kopieën identiek is aan de aanvraag zoals ingediend of niet meer informatie bevatten dan de aanvraag zoals oorspronkelijk werd ingediend.

4. Overige opmerkingen:

Aanvraag nr.:

SCHRIFTELIJKE OPINIE

NL1039797

Onderdeel III Vaststelling nieuwheid, inventiviteit en industriële toepasbaarheid niet mogelijk

De vraag of de uitvinding in de aanvraag nieuw, inventief en industrieel toepasbaar is, wordt niet behandeld in deze schriftelijke opinie met betrekking tot:

☐ de gehele aanvraag

☒ conclusies 20-34

omdat:

☐ deze aanvraag of deze conclusies , betrekking hebben op materie waarvoor het niet zinvol is een schriftelijke opinie op te stellen.

☐ de beschrijving, figuren of deze conclusies , , zo onduidelijk zijn dat het niet zinvol is een schriftelijke opinie op te stellen.

☐ deze conclusies , onvoldoende steun vinden in de beschrijving waardoor het niet zinvol is een schriftelijke opinie op te stellen.

☒ geen onderzoek naar de stand van de techniek is uitgevoerd voor deze conclusies 20-34.

☐ een zinvolle schriftelijke opinie niet opgesteld kon worden omdat de sequentie opsomming niet beschikbaar was in het juiste formaat, of in het geheel niet beschikbaar was (WIPO ST25).

☐ een zinvolle schriftelijke opinie niet opgesteld kon worden zonder de tabellen met betrekking tot de sequentie opsommingen; of deze tabellen waren niet beschikbaar in elektronische vorm.

☐ Zie aparte bladzijde

Onderdeel IV De aanvraag heeft betrekking op meer dan één uitvinding

1. Vastgesteld is dat de octrooiaanvraag betrekking heeft op meer dan één uitvinding.

   Zie aparte bladzijde

2. Het onderzoek naar de stand van de techniek is beperkt tot de eerstgenoemde uitvinding in de conclusies en betreft:

   ☐ alle conclusies

   ☒ conclusies: (zie nieuwheidsrapport)

Aanvraag nr.:

SCHRIFTELIJKE OPINIE

NL1039797

Onderdeel V Gemotiveerde verklaring ten aanzien van nieuwheid, inventiviteit en industriële toepasbaarheid

1. Verklaring

Nieuwheid	Ja:	Conclusies 1-19
	Nee:	Conclusies
Inventiviteit	Ja:	Conclusies 1-19
	Nee:	Conclusies
Industriële toepasbaarheid	Ja:	Conclusies 1-19
	Nee:	Conclusies

2. Citaties en toelichting:

Zie aparte bladzijde

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1 **Claims 1 - 19**

1.1 Reference is made to the following documents:

D1: WO 2010/021543 A (cited in the application)

D2: US 2010/155560 A

D3: EP 0 366 420 A

1.2 **D1** is regarded as being the prior art closest to the subject-matter of **claim 1**, and discloses an XY-stage for a target positioning device, the XY stage comprising two X-stage bases 86 arranged on top of a common base plate 85, an X-stage carriage 861 associated with each X-stage base, a Y-beam 84 comprising a Y stage 844, the Y-beam being connected to the X-stage carriages via flexible couplings 862, and two motors each for driving an X-stage carriage (implicitly).

1.2.1 The subject-matter of claim 1 therefore differs from this known target positioning device in that the two motors are arranged at least substantially below the stage and each motor of said two motors is coupled to an eccentric cam or crank which is connected to the corresponding X-stage carriage via a crank shaft.

1.2.2 The subject-matter of **claim 1** is therefore **new**.

1.2.3 The problem to be solved by the present invention may be regarded as providing a target positioning device having a small footprint and hence allowing for decreased operation costs of systems incorporating the device (see page 1, line 19 - page 2, line 2 and page 2, lines 19 - 22 of the application as filed).

1.2.4 The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step for the following reasons: none of the available prior art documents discloses the above difference or anything within an obvious modification of the above difference. **D2** merely discloses reducing the footprint of a positioning device by substituting linear motors with motors comprising coils surrounding magnets provided inside a guide shaft (paragraphs 1 - 8 and figure 1). **D3** merely discloses a target positioning device comprising direct drive motors provided with eccentrically mounted driving arms 16 (abstract; figure 1).

1.2.5 **Claims 2 - 19** are dependent on claim 1 and as such also meet the requirements of novelty and inventive step.

Re Item IV

Lack of unity of invention

2 It is considered that there are two inventions covered by the claims indicated as follows:

2.1 Invention 1: claims 1 - 19

2.1.1 Closest prior art: target positioning device known from **D1** (WO 2010/021543 A).

2.1.2 Special technical feature, taking due account of the description and drawings: motors arranged substantially below the stage and each motor being coupled to an eccentric cam or crank which is connected to the corresponding X-stage carriage via a crank shaft.

2.1.3 Technical effect of this special technical feature: footprint of the target positioning device is reduced (see page 1, line 19 - page 2, line 2 and page 2, lines 19 - 22 of the application as filed).

2.1.4 Problem solved by this special technical feature: decreased operation costs of systems incorporating the target positioning device (see page 1, line 19 - page 2, line 2 and page 2, lines 19 - 22 of the application as filed).

2.2 Invention 2: claims 20 - 34

2.2.1 Closest prior art: Method for driving the target positioning device known from **D1**.

2.2.2 Special technical feature, taking due account of the description and drawings: step of controlling the motors such that resulting torque on the carriage is substantially zero.

2.2.3 Technical effect of this special technical feature: deviation in orientation of the Y-beam relative to the X-stage bases can be prevented.

2.2.4 Problem solved by this special technical feature: improved positioning accuracy and higher throughput (see page 9, lines 24 - 27 of the application as filed).

2.3 The reasons for which the inventions are not so linked as to form a single general inventive concept, are as follows: the inventions mentioned above do not have a common special technical feature. Moreover, the different special technical features do not correspond by defining analogous or cooperating contributions to the prior art, e.g. by producing the same technical effect or by producing analogous or cooperating technical effects.

2.4 Therefore, the two inventions cannot be regarded as unitary.