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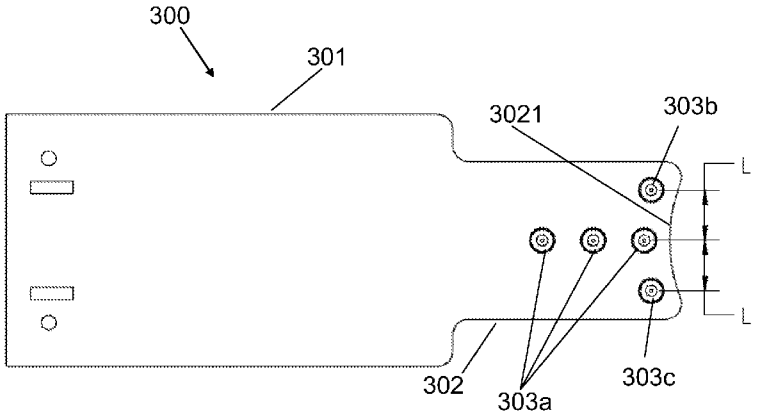

FIG 4

(57) Abstract: A robot arm (300, 400, 500, 600) for transporting semiconductor substrates (304, 404) comprises a body portion (301, 401, 501, 601), an end portion (302, 402, 502, 602) extending from the body portion (301, 401, 501, 601), a plurality of vacuum cups disposed on the end portion (302, 402, 502, 602), and a plurality of vacuum lines connecting to the plurality of vacuum cups respectively. The distance between any two adjacent vacuum cups satisfies the following condition: a vertical displacement of the semiconductor substrate (304, 404) produced by one of the two adjacent vacuum cups sucking down the semiconductor substrate is greater than a warpage of the semiconductor substrate (304, 404) in the range of the two adjacent vacuum cups, so that once the one of the two adjacent vacuum cups sucks the semiconductor substrate (304, 404), the other vacuum cup of the two adjacent vacuum cups is followed to suck the semiconductor substrate (304, 404).

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ROBOT ARM FOR TRANSPORTING SEMICONDUCTOR SUBSTRATES

FIELD OF THE INVENTION

[0001] The present invention generally relates to semiconductor manufacturing equipment, and more particularly relates to a robot arm for transporting semiconductor substrates.

BACKGROUND

[0002] It is well-known that in semiconductor manufacturing processes, robot arms are widely used for transporting semiconductor substrates. Generally, the robot arm takes out a semiconductor substrate from a cassette and then puts the semiconductor substrate on a chuck which is used to hold the semiconductor substrate and is disposed in a processing chamber. After the end of the process which is done in the processing chamber, the robot arm picks up the semiconductor substrate from the chuck and then transports the semiconductor substrate into another processing chamber or a cassette.

[0003] Referring to FIG. 1, a conventional robot arm is illustrated. The robot arm 100 has a fork-shaped end portion 101. The end portion 101 has a rectangular base portion 1011 and two finger portions 1012 extending in parallel from the base portion 1011. Three vacuum cups 102 are disposed respectively on the base portion 1011 and the two finger portions 1012 for sucking and holding a semiconductor substrate 103 thereon by vacuum absorption. The three vacuum cups 102 have the same height. When the robot arm 100 is used for picking up the semiconductor substrate 103 from a chuck 104, the end portion 101 is driven to close to the chuck 104 and the two finger portions 1012 locate at both sides of the chuck 104. Therefore, the space between the two finger portions 1012 limits the size of the chuck 104. If the size of the chuck 104 is large for holding a semiconductor substrate with a large size, for example, a 12-inch semiconductor substrate, the robot arm 100 cannot pick up the large semiconductor substrate from the chuck 104 because the space between the two finger portions 1012 is smaller than the size of the chuck 104. If the size of the chuck 104 is small, the robot arm 100 can pick up the semiconductor substrate 103 from the chuck 104.

However, if the semiconductor substrate 103 is thin or warped, the robot arm 100 has its limitation and even cannot be used to pick up the semiconductor substrate 103 from the chuck 104.

[0004] Please refer to FIG. 2a to FIG. 2c and FIG. 3. Ideally, the semiconductor substrate 103 should be flat as shown in FIG. 2a. Therefore, it is easy for the three vacuum cups 102 which have the same height to suck and hold the semiconductor substrate 103. But as the semiconductor substrate 103 becomes thinner and thinner, when the robot arm 100 holds the semiconductor substrate 103, the peripheral edge of the semiconductor substrate 103 hangs down, as shown in FIG. 3. Besides, as the semiconductor substrate 103 warps, it is difficult to ensure all of the vacuum cups 102 to suck the semiconductor substrate 103. As shown in FIG. 2b, the semiconductor substrate 103 is actually upwarping, which makes only the vacuum cup 102 disposed on the base portion 1011 contact the semiconductor substrate 103 and the two vacuum cups 102 disposed on the two finger portions 1012 fail to contact the semiconductor substrate 103. As shown in FIG. 2c, the semiconductor substrate 103 is actually downwarping, which makes the two vacuum cups 102 disposed on the two finger portions 1012 contact the semiconductor substrate 103 and the vacuum cup 102 disposed on the base portion 1011 fail to contact the semiconductor substrate 103. Because it is difficult to ensure all of the vacuum cups 102 to suck the semiconductor substrate 103 when the semiconductor substrate 103 warps, the robot arm 100 may not hold the semiconductor substrate 103 stably and the semiconductor substrate 103 may fall out of the robot arm 100, which reduces the reliability of the robot arm 100.

SUMMARY

[0005] The present invention provides a robot arm for transporting semiconductor substrates. The robot arm comprises a body portion, an end portion extending from the body portion, a plurality of vacuum cups disposed on the end portion, and a plurality of vacuum lines connecting to the plurality of vacuum cups respectively. The distance

between any two adjacent vacuum cups satisfies the following condition: a vertical displacement of the semiconductor substrate produced by one of the two adjacent vacuum cups sucking down the semiconductor substrate is greater than a warpage of the semiconductor substrate in the range of the two adjacent vacuum cups, so that once the one of the two adjacent vacuum cups sucks the semiconductor substrate, the other vacuum cup of the two adjacent vacuum cups is followed to suck the semiconductor substrate.

[0006] As described above, since the distance between any two adjacent vacuum cups of the robot arm satisfies the above-mentioned condition, therefore, once one of the two adjacent vacuum cups sucks the semiconductor substrate, the other vacuum cup of the two adjacent vacuum cups is followed to contact and suck the semiconductor substrate. By this way, all of the vacuum cups suck the semiconductor substrate no matter whether the semiconductor substrate warps or not. Besides, when all of the vacuum cups suck the semiconductor substrate, the semiconductor substrate is symmetrically upwarping or downwarping along a center line of the semiconductor substrate. Hence, the robot arm holds and transports the semiconductor substrate more reliably and stably compared with a conventional robot arm, solving a thin and/or warped semiconductor substrate transporting problem.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. 1 is a bottom view showing a conventional robot arm picking up a semiconductor substrate from a chuck.

[0008] FIGS. 2a to 2c show the conventional robot arm transporting the semiconductor substrate.

[0009] FIG. 3 shows the conventional robot arm transporting the semiconductor substrate.

[0010] FIG. 4 is a perspective view showing a robot arm for transporting a semiconductor substrate according to an embodiment of the present invention.

[0011] FIG. 5 is a bottom view showing the robot arm picking up the semiconductor substrate from a chuck.

[0012] FIG. 6 is a front view showing the robot arm transporting the semiconductor substrate.

[0013] FIG. 7 is a right view showing the robot arm transporting the semiconductor substrate.

[0014] FIG. 8 is a partial enlarged view of a portion A encircled in FIG. 7.

[0015] FIG. 9 is a perspective view showing a robot arm for transporting a semiconductor substrate according to another embodiment of the present invention.

[0016] FIG. 10 is a bottom view showing the robot arm picking up the semiconductor substrate from a chuck.

[0017] FIG. 11 is a front view showing the robot arm transporting the semiconductor substrate.

[0018] FIG. 12 is a right view showing the robot arm transporting the semiconductor substrate.

[0019] FIG. 13 is a partial enlarged view of a portion B encircled in FIG.12.

[0020] FIG. 14 is a perspective view showing a robot arm for transporting a semiconductor substrate according to another embodiment of the present invention.

[0021] FIG. 15 is a cross-sectional view taken along line C-C shown in FIG. 14.

[0022] FIG. 16 is a partial enlarged view of a portion D encircled in FIG. 15.

[0023] FIG. 17 is a sectional view showing an opening of a vacuum pump which is in communication with a main vacuum pipe of the robot arm.

[0024] FIG. 18 is a perspective view showing a robot arm for transporting a semiconductor substrate according to another embodiment of the present invention.

[0025] FIG. 19 shows the distance between any two adjacent vacuum cups of a robot arm, wherein the two adjacent vacuum cups are aligned with a center of a semiconductor substrate.

[0026] FIG. 20 is a partial enlarged view of a portion E encircled in FIG. 19.

[0027] FIG. 21 is a partial enlarged view of a portion F encircled in FIG. 19.

[0028] FIG. 22 shows the distance between any two adjacent vacuum cups of a robot arm, wherein one vacuum cup is aligned with a center of a semiconductor substrate, and the other vacuum cup is disposed at a side of the vacuum cup which is aligned with the center of the semiconductor substrate.

DETAILED DESCRIPTION

[0029] The present invention provides a robot arm for transporting semiconductor substrates. The robot arm comprises a body portion, an end portion extending from the body portion, a plurality of vacuum cups disposed on the end portion, and a plurality of vacuum lines connecting to the plurality of vacuum cups respectively, wherein the distance between any two adjacent vacuum cups satisfies the following condition: a vertical displacement of the semiconductor substrate produced by one of the two adjacent vacuum cups sucking down the semiconductor substrate is greater than a warpage of the semiconductor substrate in the range of the two adjacent vacuum cups, so that once the one of the two adjacent vacuum cups sucks the semiconductor substrate, the other vacuum cup of the two adjacent vacuum cups is followed to suck the semiconductor substrate.

[0030] Since the distance between any two adjacent vacuum cups of the robot arm satisfies the above-mentioned condition, therefore, once one of the two adjacent vacuum cups sucks the semiconductor substrate, the other vacuum cup of the two adjacent vacuum cups is followed to contact and suck the semiconductor substrate. By

this way, all of the vacuum cups disposed on the end portion of the robot arm contact and suck the semiconductor substrate no matter whether the semiconductor substrate warps or not. Besides, when all of the vacuum cups suck the semiconductor substrate, the semiconductor substrate is symmetrically upwarping or downwarping along a center line of the semiconductor substrate. Hence, the robot arm holds and transports the semiconductor substrate more reliably and stably compared with a conventional robot arm, solving a warped semiconductor substrate transporting problem, especially solving a thin semiconductor substrate transporting problem.

[0031] Referring to FIG. 4 to FIG. 8, a robot arm for transporting a semiconductor substrate according to an embodiment of the present invention is illustrated. As shown in FIG. 4, the robot arm 300 includes a body portion 301 and an end portion 302 extending from the body portion 301. The body portion 301 and the end portion 302 are substantially rectangular. An end edge 3021 of the end portion 302 is designed in an arc-shape for matching with a chuck 309. The chuck 309 holds and supports the semiconductor substrate 304. The robot arm 300 picks up the semiconductor substrate 304 from the chuck 309. It is recognized that the robot arm 300 is not only fit for transporting the semiconductor substrate 304 between two chucks 309, but also fit for transporting the semiconductor substrate 304 between the chuck 309 and a cassette. A plurality of vacuum cups is disposed on the end portion 302 for sucking and holding the semiconductor substrate 304 by vacuum absorption. The plurality of vacuum cups is divided into several groups. In an embodiment, the plurality of vacuum cups is divided into at least three groups and every group of the vacuum cups includes at least one vacuum cup. A first group of vacuum cups 303a is aligned with the center of the semiconductor substrate 304. A second group of vacuum cups 303b and a third group of vacuum cups 303c are symmetrically distributed at both sides of the first group of vacuum cups 303a. The distance between the first group of vacuum cups 303a and the second group of vacuum cups 303b is the same as the distance between the first group of vacuum cups 303a and the third group of vacuum cups 303c. The second group of vacuum cups 303b and the third group of vacuum cups 303c have the same height.

[0032] In the embodiment of the present invention, the height of the first group of vacuum cups 303a is lower than the height of the third group of vacuum cups 303c and the second group of vacuum cups 303b. As shown in FIG. 5 to FIG. 8, when the robot arm 300 is used for transporting the semiconductor substrate 304, the robot arm 300 is driven to close to the chuck 309 and the robot arm 300 locates at a side of the chuck 309. One vacuum cup sucks down the semiconductor substrate 304 by vacuum absorption, and another vacuum cup which is adjacent to the one vacuum cup is followed to suck the semiconductor substrate 304 by vacuum absorption. By this way, all of the vacuum cups disposed on the end portion 302 of the robot arm 300 suck the semiconductor substrate 304. Because the height of the first group of vacuum cups 303a is lower than the height of the third group of vacuum cups 303c and the second group of vacuum cups 303b, when all groups of vacuum cups 303a, 303b, 303c suck the semiconductor substrate 304, the semiconductor substrate 304 is symmetrically upwarping along a center line of the semiconductor substrate 304, which enhances the transporting stability of the semiconductor substrate 304. The warpage of the semiconductor substrate 304 will not affect the semiconductor substrate 304 loading and unloading.

[0033] Referring to FIG. 9 to FIG. 13, a robot arm for transporting a semiconductor substrate according to another embodiment of the present invention is illustrated. As shown in FIG. 9, the robot arm 400 includes a body portion 401 and an end portion 402 extending from the body portion 401. The body portion 401 and the end portion 402 are substantially rectangular. An end edge 4021 of the end portion 402 is designed in an arc-shape for matching with a chuck 409 which holds and supports a semiconductor substrate 404. A plurality of vacuum cups is disposed on the end portion 402 for sucking and holding the semiconductor substrate 404 by vacuum absorption. The plurality of vacuum cups is divided into several groups. In an embodiment, the plurality of vacuum cups is divided into at least three groups and every group of the vacuum cups includes at least one vacuum cup. A first group of vacuum cups 403a is aligned with the center of the semiconductor substrate 404. A

second group of vacuum cups 403b and a third group of vacuum cups 403c are symmetrically distributed at both sides of the first group of vacuum cups 403a. The distance between the first group of vacuum cups 403a and the second group of vacuum cups 403b is the same as the distance between the first group of vacuum cups 403a and the third group of vacuum cups 403c. The second group of vacuum cups 403b and the third group of vacuum cups 403c have the same height.

[0034] Comparing with the robot arm 300, the difference of the robot arm 400 is that the height of the first group of vacuum cups 403a is higher than the height of the third group of vacuum cups 403c and the second group of vacuum cups 403b. As shown in FIG. 10 to FIG. 13, when the robot arm 400 is used for transporting the semiconductor substrate 404, the robot arm 400 is driven to close to the chuck 409 and the robot arm 400 locates at a side of the chuck 409. One vacuum cup sucks down the semiconductor substrate 404 by vacuum absorption, and another vacuum cup which is adjacent to the one vacuum cup is followed to suck the semiconductor substrate 404 by vacuum absorption. By this way, all of the vacuum cups disposed on the end portion 402 of the robot arm 400 suck the semiconductor substrate 404. Because the height of the first group of vacuum cups 403a is higher than the height of the third group of vacuum cups 403c and the second group of vacuum cups 403b, when all groups of vacuum cups 403a, 403b, 403c suck the semiconductor substrate 404, the semiconductor substrate 404 is symmetrically downwarping along a center line of the semiconductor substrate 404, which enhances the transporting stability of the semiconductor substrate 404. The warpage of the semiconductor substrate 404 will not affect the semiconductor substrate 404 loading and unloading.

[0035] Please refer to FIGS. 14 to 17. A plurality of vacuum lines 505 is formed in a body portion 501 and an end portion 502 of a robot arm 500. A main vacuum pipe 506 is formed in the body portion 501. Every vacuum line 505 extends from the main vacuum pipe 506 to a corresponding vacuum cup. The plurality of vacuum lines 505 is respectively connected to the plurality of vacuum cups 503a, 503b, 503c and the main vacuum pipe 506. The main vacuum pipe 506 is connected to a vacuum pump. As

shown in FIG. 16 and FIG. 17, an opening 507 of every vacuum line 505 which is in communication with the main vacuum pipe 506 is square of which length is a. An opening 508 of the vacuum pump which is in communication with the main vacuum pipe 506 is circle of which diameter is d. The relationship between a and d satisfies the following formula: $d = a \cdot \sqrt[3]{\frac{15.45n}{12.1}}$, n is the number of the vacuum lines 505. Every vacuum line 505 is thin enough. Although all of the vacuum lines 505 are connected to the main vacuum pipe 506, as every vacuum line 505 is thin enough, even if there is a leak in one of the vacuum lines 505, the other vacuum lines 505 will not be affected and the vacuum cups which are in communication with these vacuum lines 505 still can suck and hold the semiconductor substrate by vacuum absorption.

[0036] Please refer to FIG. 18. In another embodiment of the present invention, a plurality of vacuum lines 605 is formed in a body portion 601 and an end portion 602 of a robot arm 600. The plurality of vacuum lines 605 is respectively connected to the plurality of vacuum cups 603a, 603b, 603c and a vacuum pump.

[0037] As shown in FIG. 19 to FIG. 21, the distance between any two adjacent vacuum cups satisfies the following condition: $x \prec R * \sqrt{1-(\frac{R-3H1}{R})^2}$, wherein x is the distance between any two adjacent vacuum cups, wherein the two adjacent vacuum cups belong to the first group of vacuum cups 703a, R is the radius of an arc formed by the warpage of the semiconductor substrate in the range of the two adjacent vacuum cups, H1 is the height of the two adjacent vacuum cups.

[0038] As shown in FIG. 22, the distance between any two adjacent vacuum cups satisfies the following condition: $L \prec \sqrt{R^2 * \left[1-\left(\frac{R-H2}{R}\right)^2\right] - x1^2}$, wherein L is the distance between any two adjacent vacuum cups, wherein one of the two adjacent vacuum cups belongs to the first group of vacuum cups 703a, the other vacuum cup of the two adjacent vacuum cups belongs to the second group of vacuum cups 703b or

the third group of vacuum cups 703c, R is the radius of an arc formed by the warpage of the semiconductor substrate in the range of the two adjacent vacuum cups, H2 is the height of the other vacuum cup which belongs to the second group of vacuum cups 703b or the third group of vacuum cups 703c, x1 is the vertical distance between the other vacuum cup which belongs to the second group of vacuum cups 703b or the third group of vacuum cups 703c and an axis passing through the center of the semiconductor substrate and perpendicular to the first group of vacuum cups 703a.

[0039] The foregoing description of the present invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed, and obviously many modifications and variations are possible in light of the above teaching. Such modifications and variations that may be apparent to those skilled in the art are intended to be included within the scope of this invention as defined by the accompanying claims.

What is claimed is:

1. A robot arm for transporting semiconductor substrates, comprising:

a body portion;

an end portion, extending from the body portion;

a plurality of vacuum cups, disposed on the end portion;

a plurality of vacuum lines, connecting to the vacuum cups respectively;

wherein distance between any two adjacent vacuum cups satisfies following condition: a vertical displacement of the semiconductor substrate produced by one of the two adjacent vacuum cups sucking down the semiconductor substrate is greater than a warpage of the semiconductor substrate in the range of the two adjacent vacuum cups, so that once the one of the two adjacent vacuum cups sucks the semiconductor substrate, the other vacuum cup of the two adjacent vacuum cups is followed to suck the semiconductor substrate.

2. The robot arm of claim 1, wherein the plurality of vacuum cups is divided into at least three groups, every group of vacuum cups includes at least one vacuum cup.

3. The robot arm of claim 2, wherein a first group of vacuum cups is aligned with center of the semiconductor substrate, a second group of vacuum cups and a third group of vacuum cups are symmetrically distributed at both sides of the first group of vacuum cups, the distance between the first group of vacuum cups and the second group of vacuum cups is the same as the distance between the first group of vacuum cups and the third group of vacuum cups, the second group of vacuum cups and the third group of vacuum cups have the same height.

4. The robot arm of claim 3, wherein the distance between any two adjacent vacuum cups satisfies the following condition: $x \prec R * \sqrt{1-(\frac{R-3H1}{R})^2}$, wherein x is distance between any two adjacent vacuum cups, wherein the two adjacent vacuum cups belong to the first group of vacuum cups, R is radius of an arc formed by the warpage of the semiconductor substrate in the range of the two adjacent vacuum cups, H1 is height of the two adjacent vacuum cups.

5. The robot arm of claim 3, wherein the distance between any two adjacent vacuum cups satisfies the following condition:

$$L \prec \sqrt{R^2 * \left[1-\left(\frac{R-H2}{R}\right)^2\right] - x1^2} ,$$

wherein L is distance between any two adjacent vacuum cups, wherein one of the two adjacent vacuum cups belongs to the first group of vacuum cups and the other vacuum cup of the two adjacent vacuum cups belongs to the second group of vacuum cups or the third group of vacuum cups, R is radius of an arc formed by the warpage of the semiconductor substrate in the range of the two adjacent vacuum cups, H2 is height of the other vacuum cup which belongs to the second group of vacuum cups or the third group of vacuum cups, x1 is vertical distance between the other vacuum cup which belongs to the second group of vacuum cups or the third group of vacuum cups and an axis passing through the center of the semiconductor substrate and perpendicular to the first group of vacuum cups.

6. The robot arm of claim 3, wherein the height of the first group of vacuum cups is lower than the height of the second group of vacuum cups and the third group of vacuum cups, when all groups of vacuum cups suck down the semiconductor substrate, the semiconductor substrate is symmetrically upwarping along a center line of the semiconductor substrate.

7. The robot arm of claim 3, wherein the height of the first group of vacuum cups is higher than the height of the second group of vacuum cups and the third group of vacuum cups, when all groups of vacuum cups suck down the semiconductor substrate, the semiconductor substrate is symmetrically downwarping along a center line of the semiconductor substrate.

8. The robot arm of claim 1, wherein the plurality of vacuum lines is connected to a main vacuum pipe, the main vacuum pipe is connected to a vacuum pump.

9. The robot arm of claim 8, wherein an end opening of every vacuum line which is in communication with the main vacuum pipe is square of which length is a, an end opening of the vacuum pump which is in communication with the main vacuum pipe is circle of which diameter is d, the relationship between a and d satisfies formula: $d = a \cdot \sqrt[3]{\frac{15.45n}{12.1}}$, n is number of the vacuum lines.

10. The robot arm of claim 8, wherein the main vacuum pipe is formed in the body portion, the plurality of vacuum lines are formed in the body portion and the end portion and extend from the main vacuum pipe to the corresponding vacuum cups.

11. The robot arm of claim 1, wherein the plurality of vacuum lines is connected to a vacuum pump.

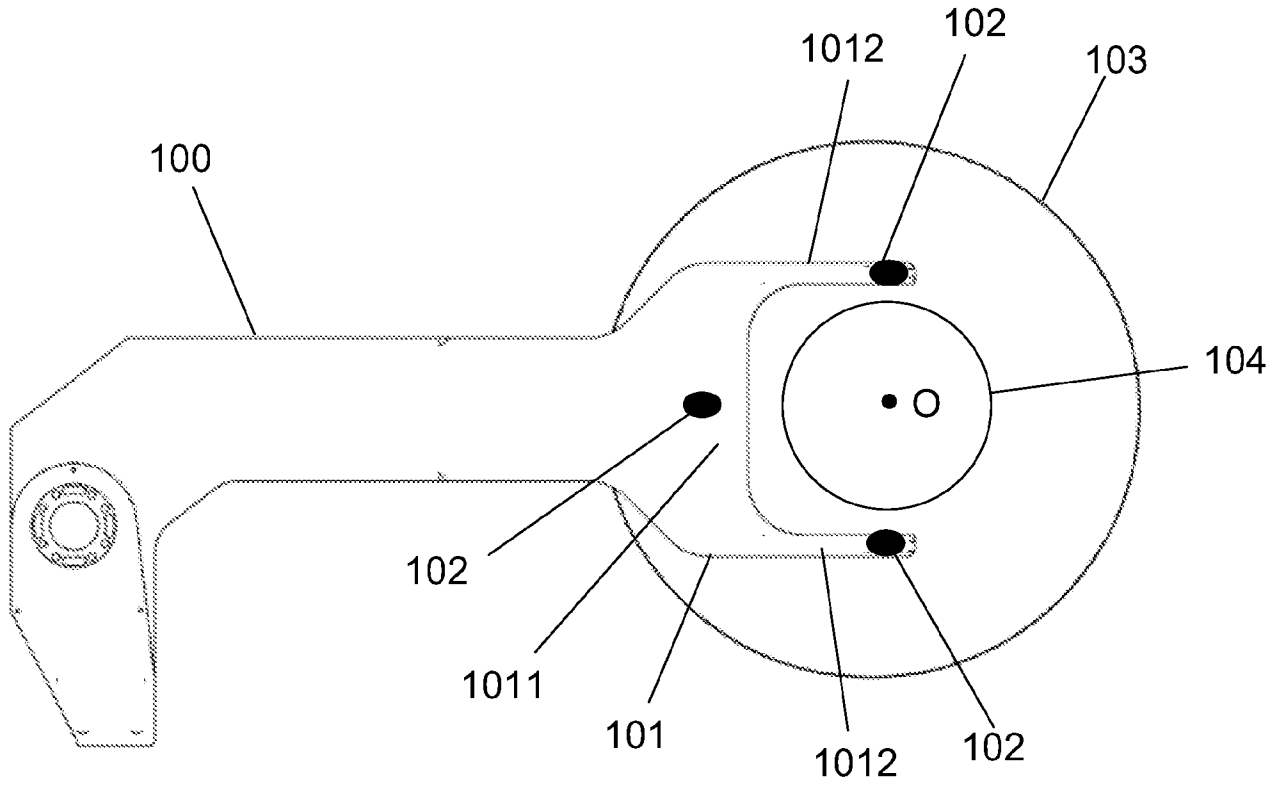

FIG 1

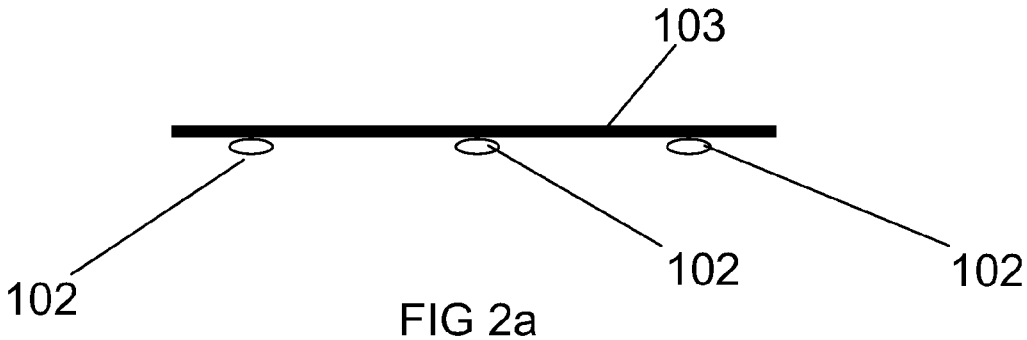

FIG 2a

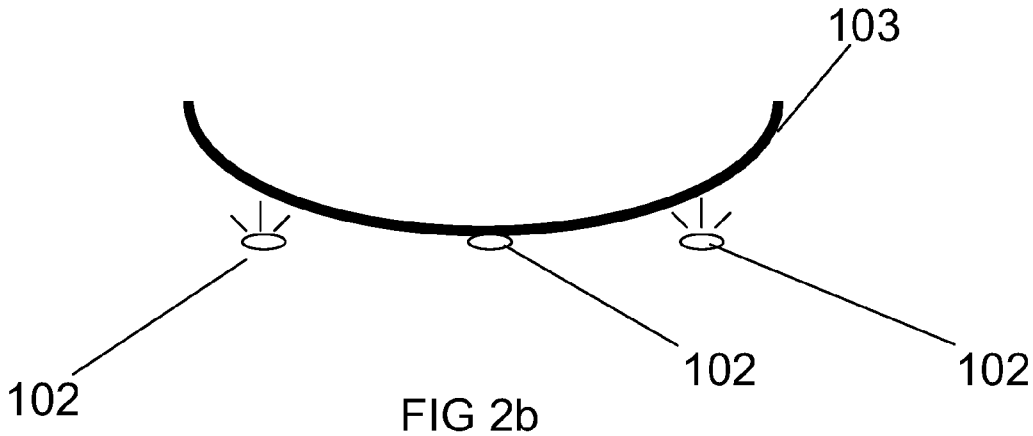

FIG 2b

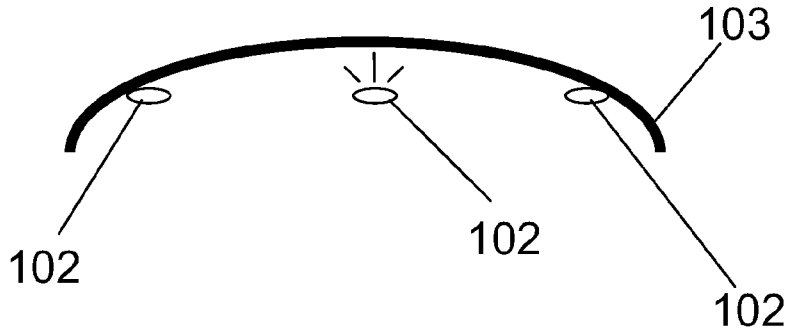

FIG 2c

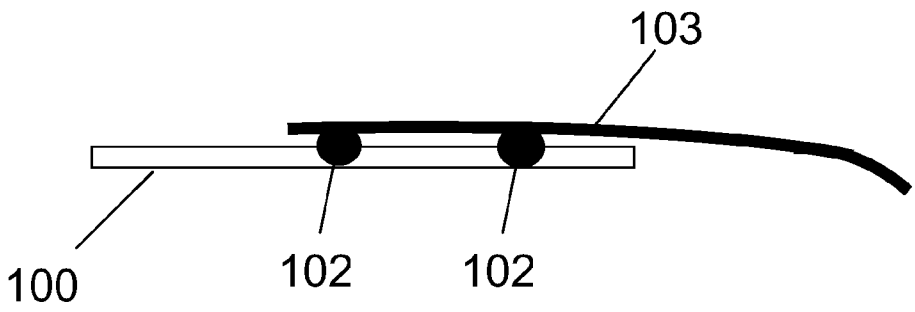

FIG 3

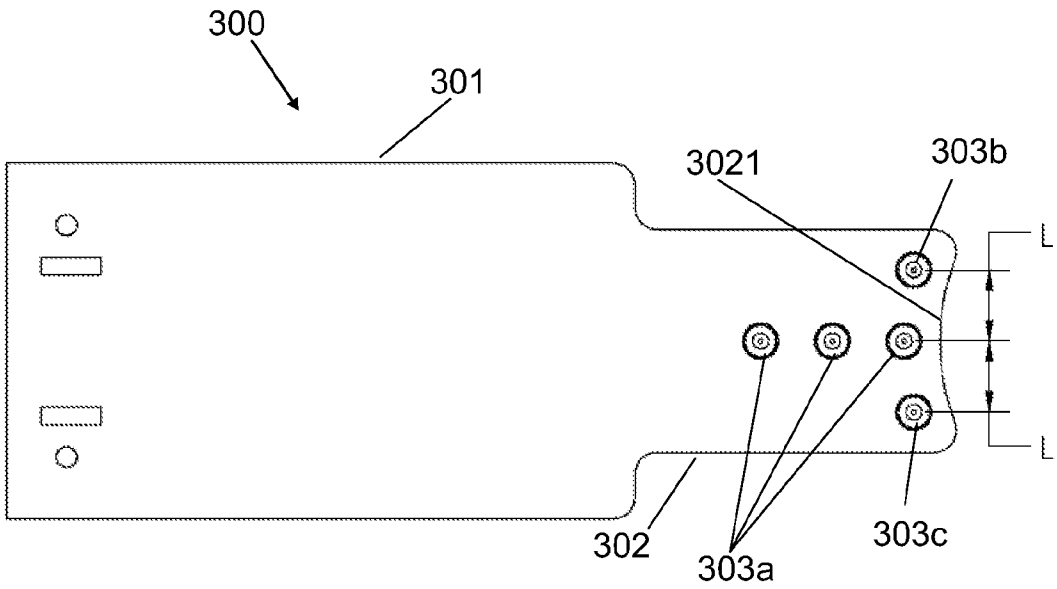

FIG 4

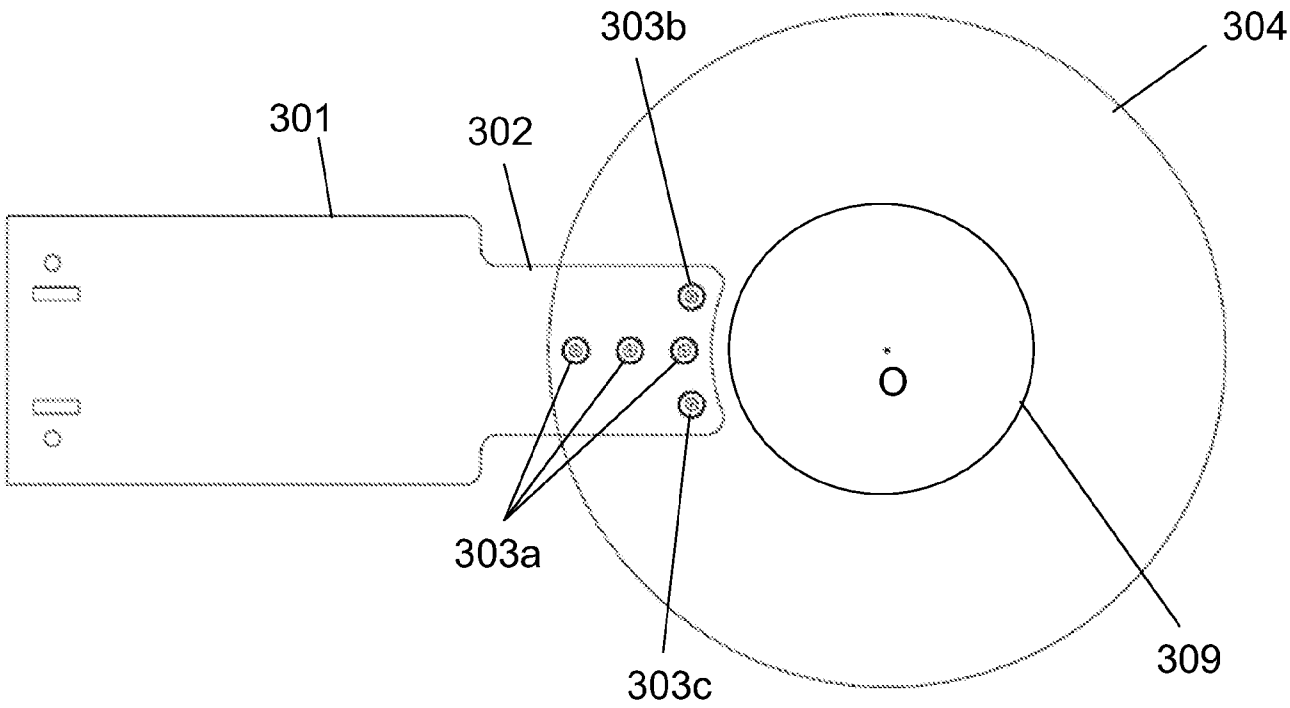

FIG 5

FIG 6

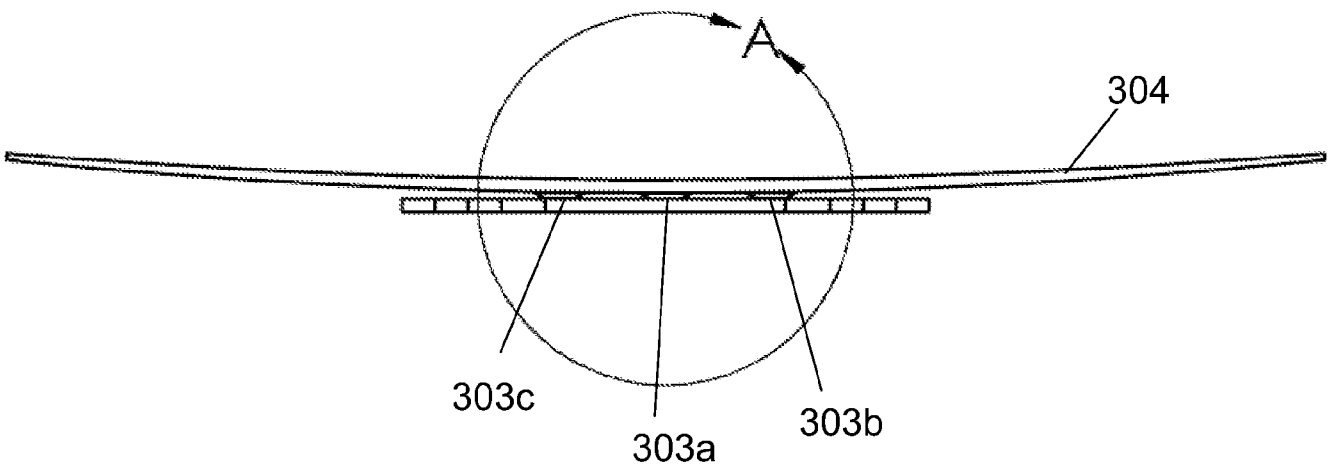

FIG 7

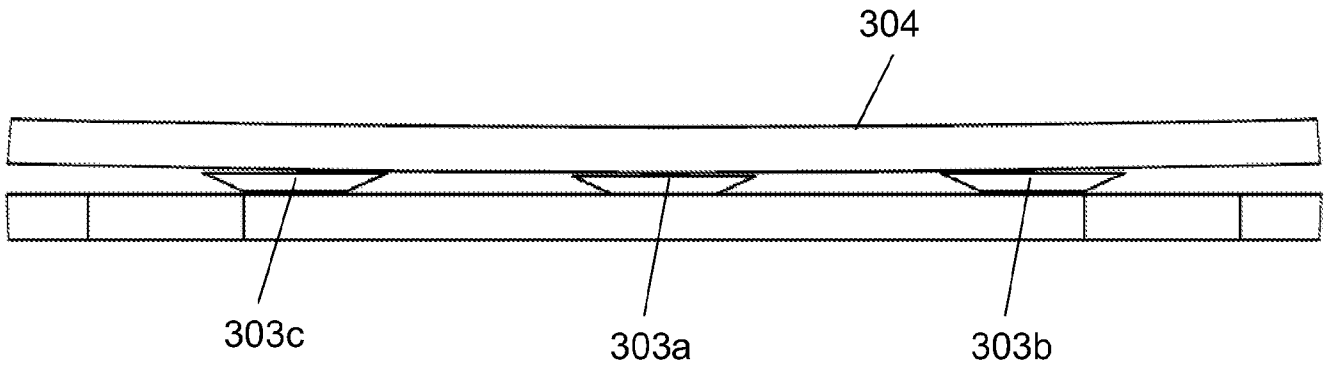

FIG 8

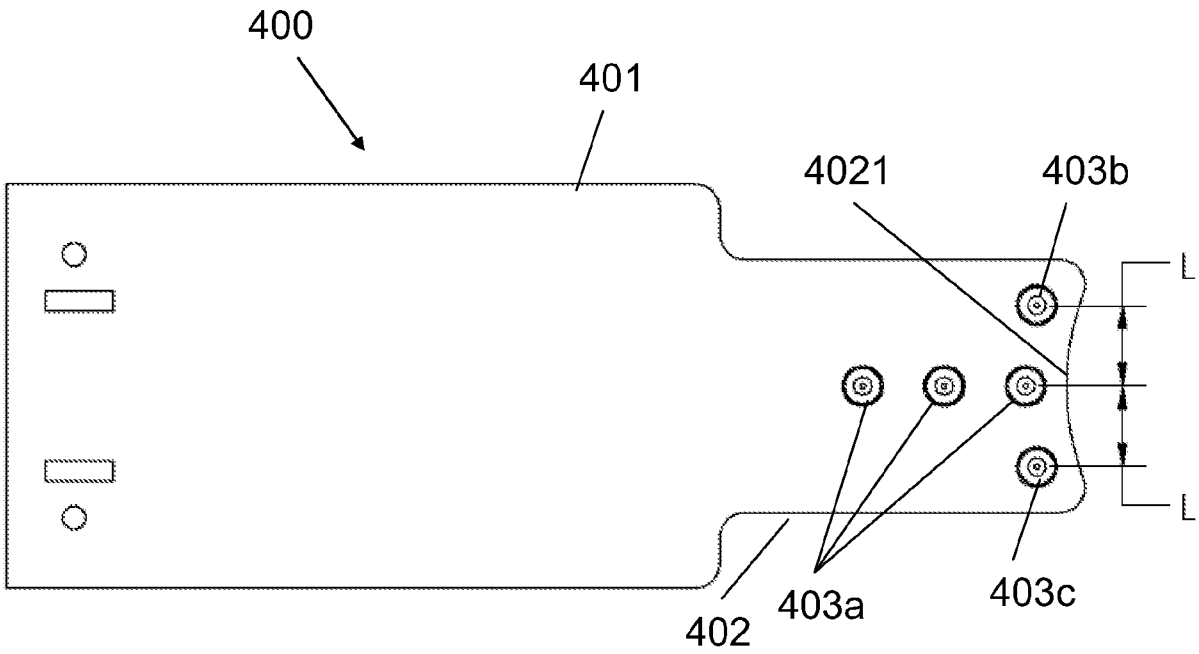

FIG 9

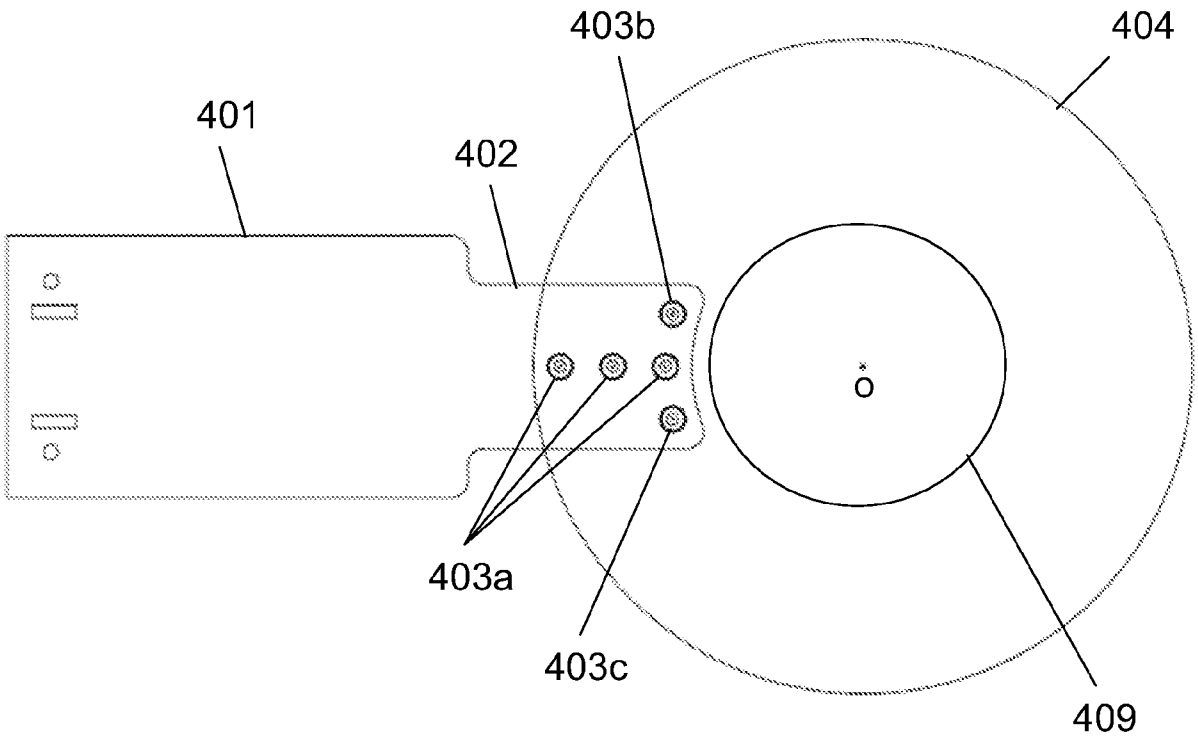

FIG 10

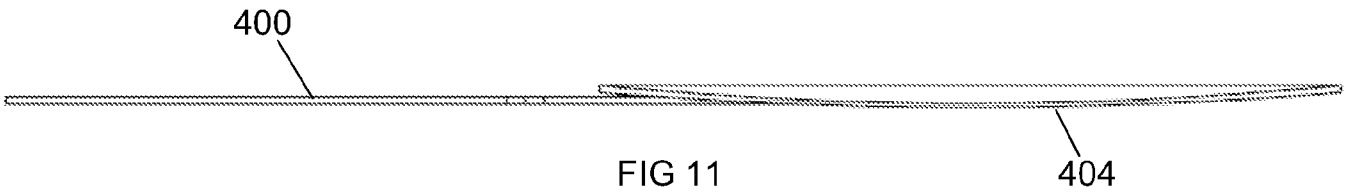

FIG 11

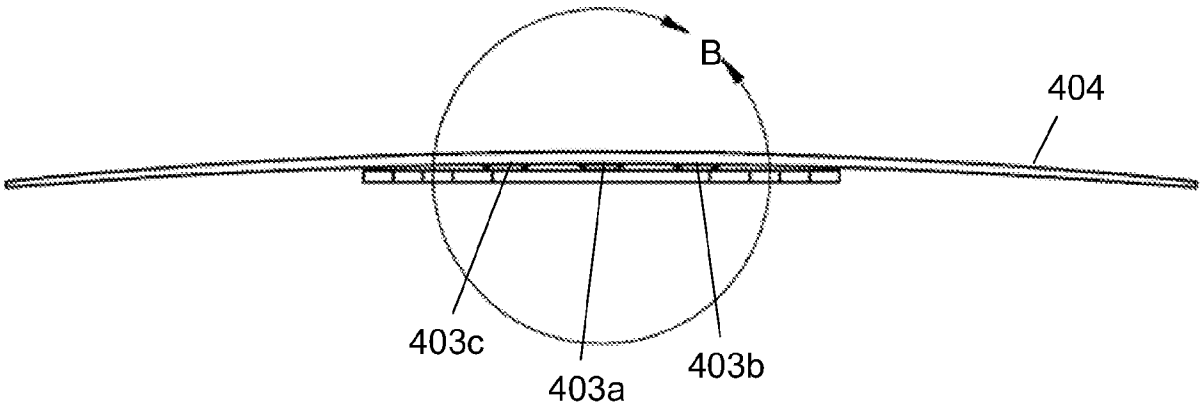

FIG 12

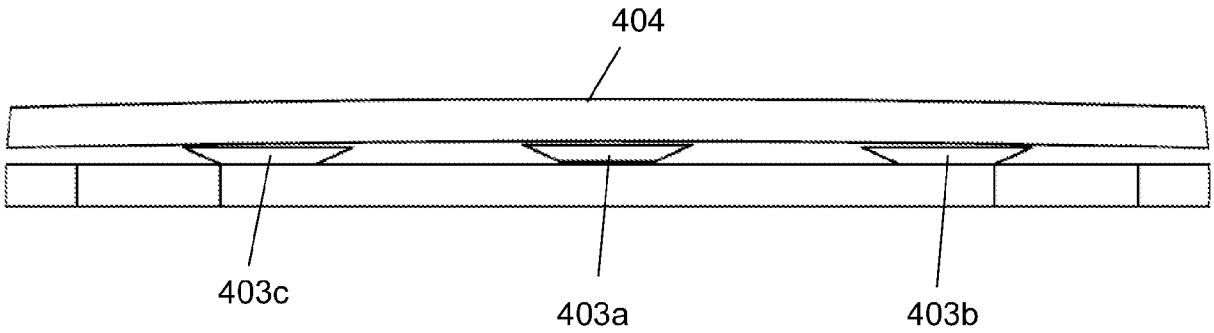

FIG 13

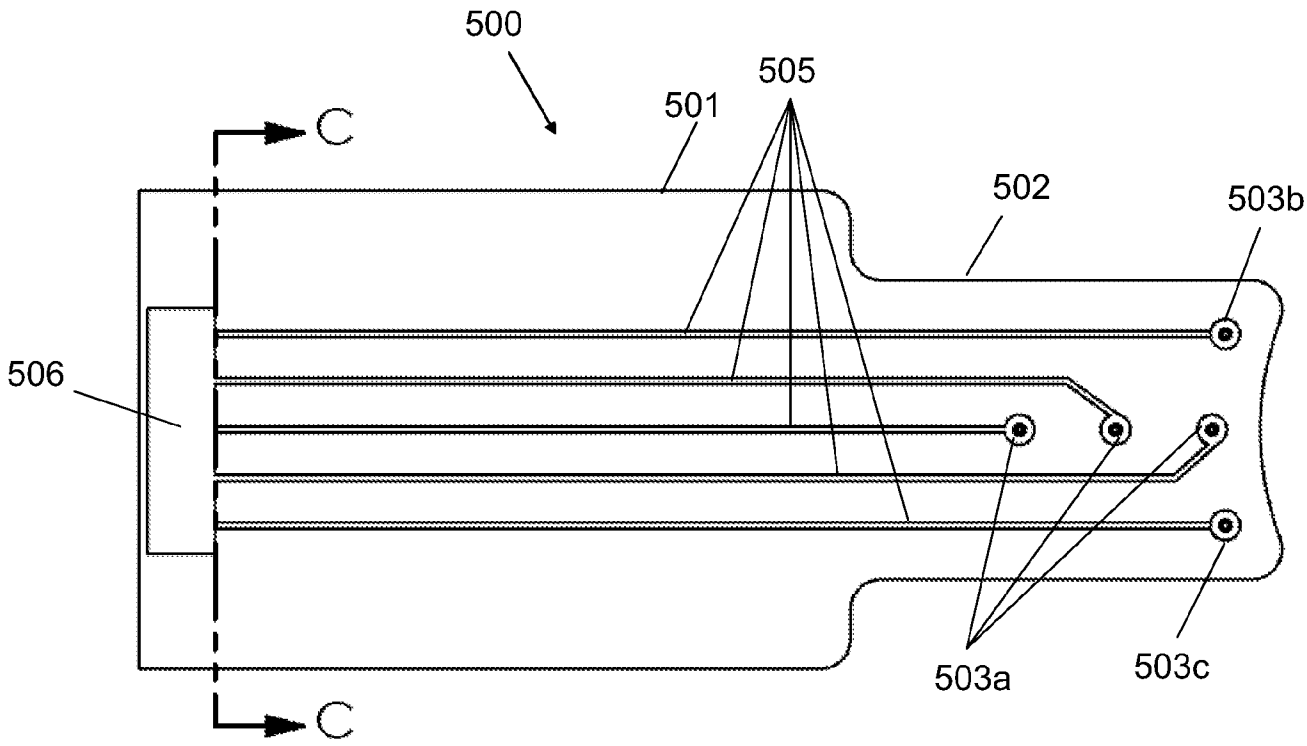

FIG 14

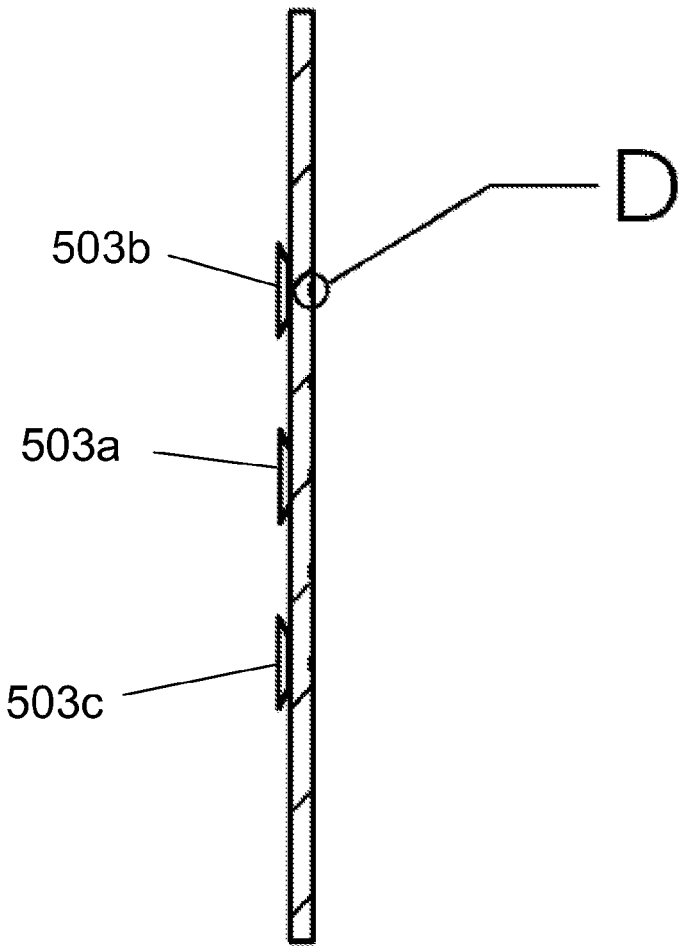

FIG 15

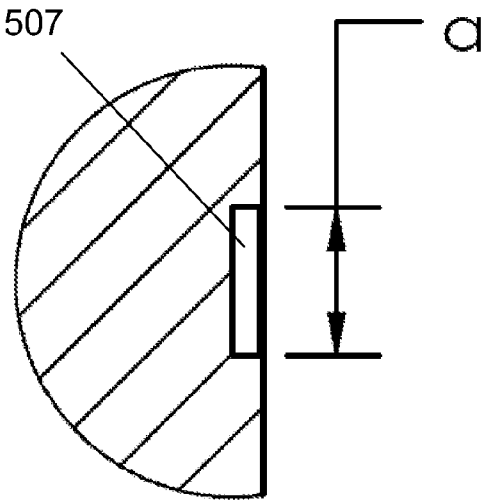

FIG 16

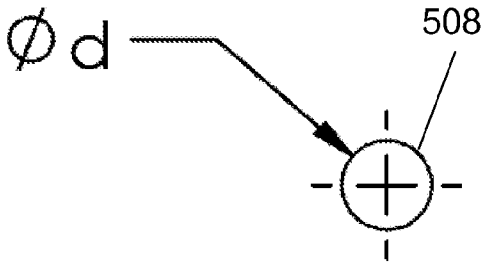

FIG 17

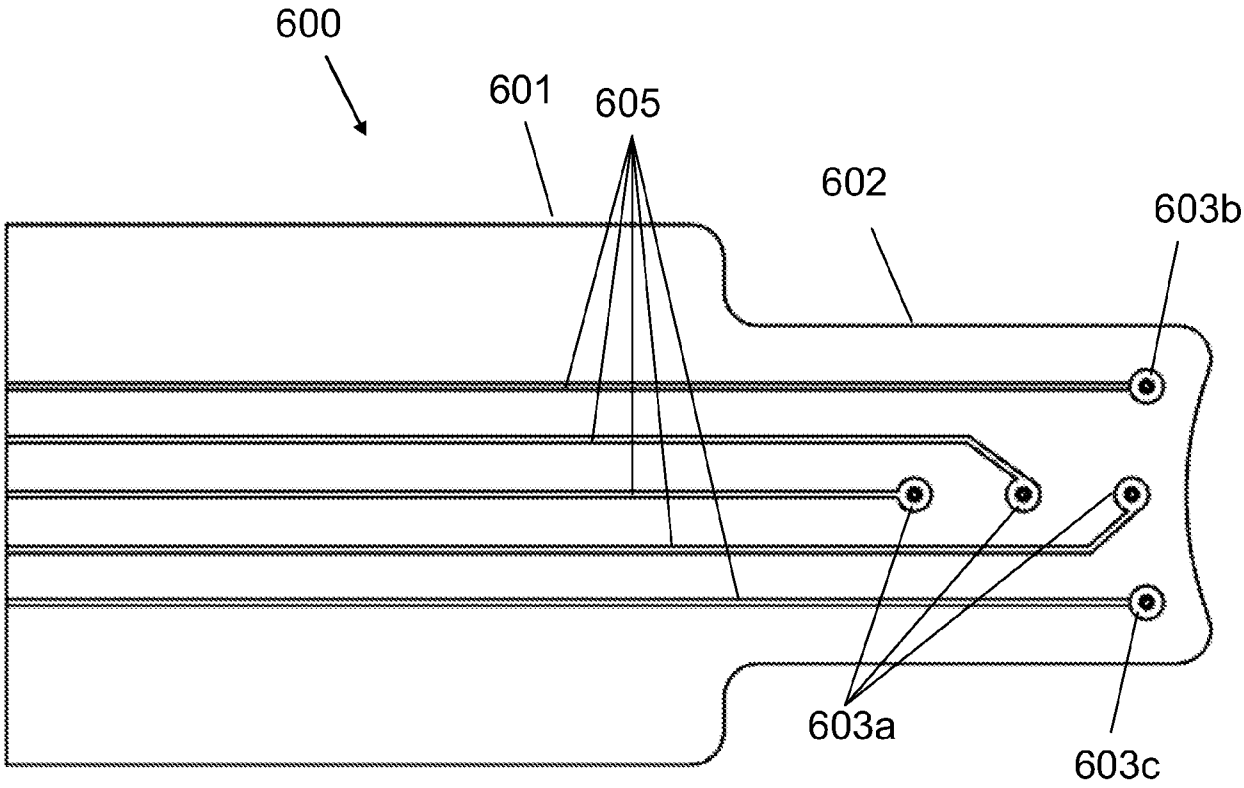

FIG 18

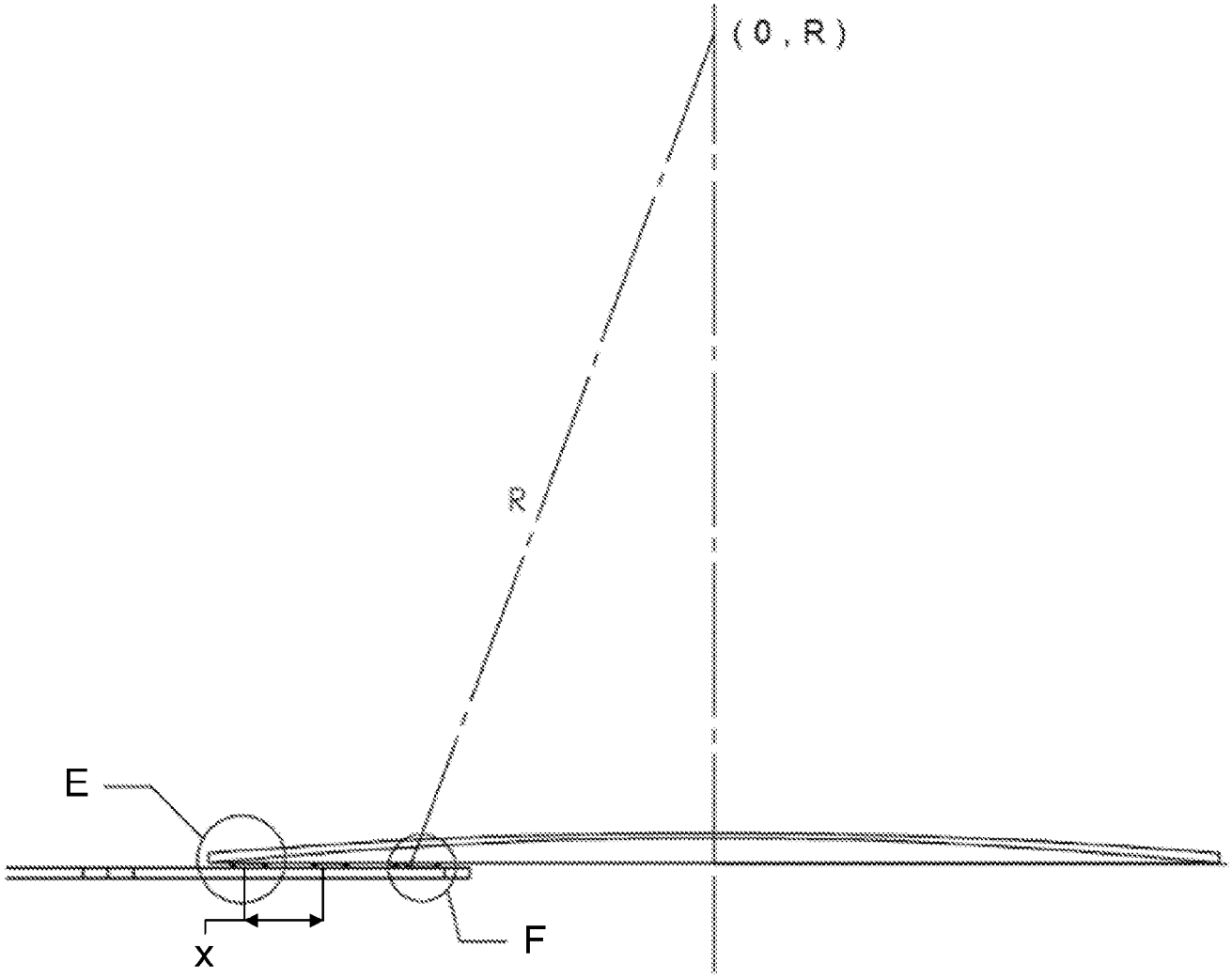

FIG 19

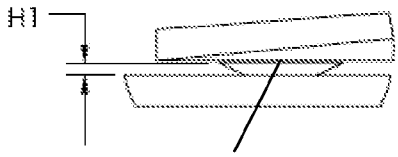

FIG 20

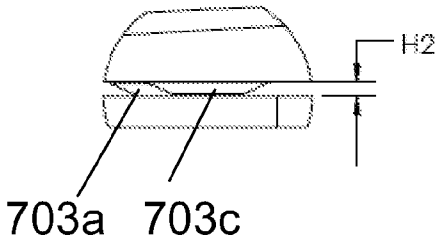

FIG 21

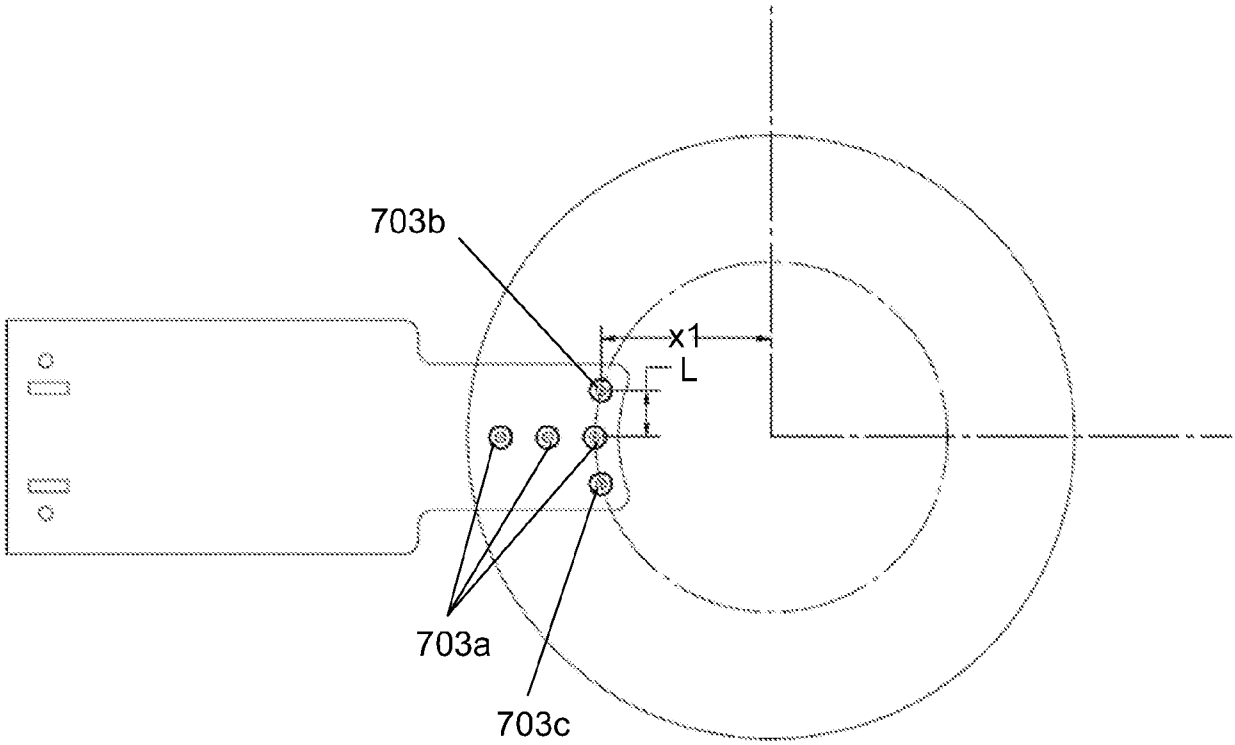

FIG 22

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2015/095089

A. CLASSIFICATION OF SUBJECT MATTER

H01L 21/677(2006.01)i; H01L 21/683(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01L21/-, B25J15/-

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT, WPI, EPODOC, CNKI:substrate, wafer, suck+, adsorp+, suction, adsorb+, vacuum, disk, cup, transfer, carry+, convey +, transport+, mov+, warp+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2015146187 A1 (TOKYO ELECTRON LTD.) 28 May 2015 (2015-05-28) the description, the embodiments and figures 1-4	1-11
A	US 2014169929 A1 (TOKYO OHKA KOGYO CO., LTD.) 19 June 2014 (2014-06-19) the whole document	1-11
A	US 2010201976 A1 (SUMCO CORP.) 12 August 2010 (2010-08-12) the whole document	1-11
A	WO 2012004002 A1 (CENTROTHERM THERMAL SOLUTIONS G.M.B.H. & CO. KG.) 12 January 2012 (2012-01-12) the whole document	1-11
A	KR 20110101808 A (LG SILTRON INC.) 16 September 2011 (2011-09-16) the whole document	1-11
A	US 2014227072 A1 (SAMSUNG ELECTRONICS CO., LTD.) 14 August 2014 (2014-08-14) the whole document	1-11
A	CN 101295661 A (TOKYO ELECTRON LTD.) 29 October 2008 (2008-10-29) the whole document	1-11

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 July 2016	**12 August 2016**
Name and mailing address of the ISA/CN **STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA** **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088, China** Facsimile No. **(86-10)62019451**	Authorized officer **YU,Hui** Telephone No. **(86-10)62413092**

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2015/095089

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 20100077523 A (YOON, JUM CHAE) 08 July 2010 (2010-07-08) the whole document	1-11

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2015/095089

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				KR	20150060533	A	03 June 2015
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				JP	2014118250	A	30 June 2014
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CN	101295661	A	29 October 2008	KR	20080095784	A	29 October 2008
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				JP	2008270626	A	06 November 2008
				TW	200849459	A	16 December 2008
KR	20100077523	A	08 July 2010	None			