(19) Europäisches Patentamt
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(11) **EP 4 400 258 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
17.07.2024 Bulletin 2024/29

(21) Application number: **22866477.7**

(22) Date of filing: **30.08.2022**

(51) International Patent Classification (IPC):
B24B 29/02 *(2006.01)* ***B24B 37/00*** *(2012.01)*
B24B 27/00 *(2006.01)*

(86) International application number:
PCT/CN2022/115771

(87) International publication number:
WO 2023/036011 (16.03.2023 Gazette 2023/11)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **07.09.2021 CN 202122142759 U**
30.11.2021 CN 202111445239

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(54) **WAFER POLISHING SYSTEM**

(57) Disclosed in the present invention is a wafer polishing system, at least comprising a polishing unit, which comprises a fixed working station and two polishing modules, wherein the polishing modules are located on two sides of the fixed working station; each polishing module comprises a polishing platform and a polishing arm, which can drive a wafer to move relative to the polishing platform, so as to implement a polishing process; the polishing arms of the polishing modules on the two sides are located in a diagonal direction of the fixed working station; and the polishing arms can respectively swing between the fixed working station and the polishing platforms to transfer the wafer, and movement regions of the polishing arms having an overlapping portion. By means of the present invention, the polishing arm of each polishing module is independently controlled, so as to achieve better stability and flexibility; and only one fixed working station is needed to achieve the cooperation of multiple polishing modules to implement the polishing process of single or multiple wafers, so that the movement path in the polishing process is greatly shortened, which minimizes the time of the transfer process and improves the polishing efficiency.

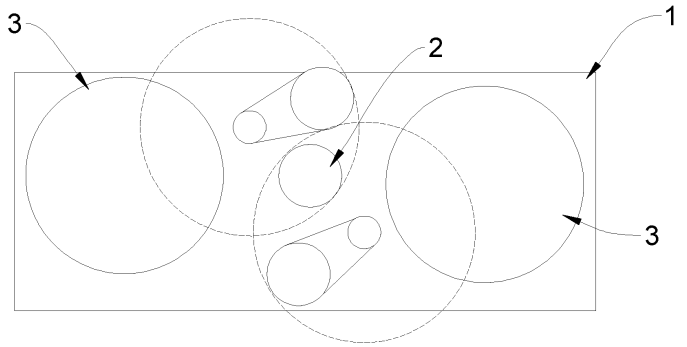

FIG. 2

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Description

Technical Field

[0001] The invention belongs to the technical field of semiconductor integrated circuit chip fabrication, and particularly relates to a wafer polishing system.

Description of Related Art

[0002] A chemical mechanical planarization (CMP) device is one of the seven key devices in the field of integrated circuit fabrication.

[0003] At present, the chemical mechanical polishing technique has evolved to integrate online measurement, online end-point detection, cleaning and other processes together, thanks to the development of integrated circuits towards miniaturization, multi-layer, thinness, and planarization, and is also a necessary process for increasing the diameter of wafers from 200 mm to 300 mm or above, increasing productivity, reducing fabrication costs, and realizing global planarization of substrates.

[0004] A chemical mechanical polishing and planarization device typically comprises an EFEM (Equipment Front End Module), a cleaning unit and a polishing unit. The EFEM mainly comprises a wafer box for storing wafers, a wafer transfer manipulator and an air purification system; the cleaning unit mainly comprises different numbers of megasonic cleaning components, brush cleaning components, drying components, and devices for transferring wafers between the components; the polishing unit typically comprises a workbench, a polishing disk, a polishing head, a polishing arm, a trimmer and a polishing solution arm, and all the components are arranged on the workbench according to their process positions. It is found from the actual wafer processing practices that the spatial arrangement of the polishing units, the cleaning and wafer transfer modules, etc. has a great influence on the polishing output of the whole chemical mechanical polishing and planarization device; and wafers are generally transferred between the polishing units and the outside as well as between the polishing units by means of a loading and unloading platform.

[0005] As for the spatial arrangement of the loading and unloading platform and the polishing units, a square arrangement of the loading and unloading platform and three polishing units has been adopted by most chemical mechanical polishing and planarization devices on the market as shown in FIG. 1. Four polishing heads are fixed on a cross-shaped rotary workbench, which means that each wafer entering the polishing area corresponds to one polishing head, one loading and unloading platform provides loading and unloading service for three polishing units, the number of the polishing heads and the number of polishing platforms cannot be adjusted, and the polishing time of each polishing head cannot be separately controlled, leading to poor timeliness and low flexibility; and liquids on different polishing platforms are easy to splash to result in a cross influence, compromising the polishing effect and leading to a complex process.

SUMMARY

[0006] To overcome the defects in the prior art, the invention provides a wafer polishing system, in which each polishing module of the wafer polishing system can be controlled separately, so the control flexibility is high; all polishing modules share one fixed working position, so the spatial arrangement of devices is compact; and the movement trajectory of wafers is designed to guarantee high wafer transfer efficiency, so the polishing efficiency is improved.

[0007] The technical solution adopted by the invention to settle the technical problems is as follows: a wafer polishing system comprises at least one polishing unit;

the polishing unit comprises a fixed working position and two polishing modules located on two sides of the fixed working position;

each of the polishing modules comprises a polishing platform and a polishing arm capable of driving a wafer to rotate with respect to the polishing platform to implement a polishing process;

the polishing arms of the polishing modules on the two sides are located in a diagonal direction of the fixed working position and are able to swing between the fixed working position and the polishing platforms to transfer the wafer respectively, and movement areas of the polishing arms have an overlap.

[0008] Further, after the polishing arm of one polishing module obtains the wafer from the fixed working position, the polishing process is completed, and the wafer is placed back to the fixed working position along a first trajectory; after the polishing arm of the other polishing module obtains the wafer from the fixed working position, the polishing process is completed, and the wafer is placed back to the fixed working position along a second trajectory; and the first trajectory and the second trajectory are approximately S-shaped.

[0009] Further, the overlap of the movement areas is in a shape of human eye, and a central axis of the fixed working position passes through a centre of the overlap.

[0010] Further, the first trajectory and the second trajectory are movement trajectories of the centre of the wafer and have only one point of tangency.

[0011] Further, a swing angle of the polishing arm is less than 180°.

[0012] Further, the fixed working position is configured as a height-adjustable structure, and when the fixed working position does not interact with the polishing arm for wafer loading or unloading, the fixed working position is located below a plane where the polishing platform is located.

[0013] Further, the polishing unit comprises two polishing modules; after a first polishing arm obtains the

wafer from the fixed working position, the wafer is polished on a first polishing platform; after the polishing module completes the polishing process, the first polishing arm places the wafer back to the fixed working position and rotates away from the fixed working position, a second polishing arm obtains the wafer from the fixed working position, and the wafer is polished on a second polishing platform; and at the same time, another wafer is placed on the fixed working position.

[0014] Further, after placing the polished wafer back to the fixed working position, the first polishing arm further rotates to a cleaning position to be cleaned; and after placing the polished wafer back to the fixed working position, the second polishing arm further rotates to the cleaning position to be cleaned.

[0015] Further, the polishing unit comprises at least two polishing modules; after the first polishing arm obtains the wafer from the fixed working position, the wafer is polished on the first polishing platform; and at the same time, another wafer is placed on the fixed working position, the second polishing arm obtains the wafer from the fixed working position, and the wafer is polished on the second polishing platform.

[0016] Further, a number of the polishing unit is three, the three polishing units are adjacently arranged in a vertical direction, and each polishing unit is provided with two polishing modules.

[0017] Further, a connecting line between centres of the polishing platforms of the two polishing modules in each polishing unit intersects with a central axis of the fixed working position.

[0018] The invention has the following beneficial effects: (1) the polishing arm of each polishing module is controlled separately, so the stability is better, and the flexibility is higher; (2) the working time of each polishing module can be controlled separately to satisfy different polishing requirements; (3) the cross influence of polishing liquids of different polishing modules is avoided, so the polishing effect is better; (4) trajectories in the whole working process are simple and smooth, and the movement distance in the whole polishing process is short, so the polishing efficiency is high; (5) by adjacently arranging multiple polishing units in the vertical direction, any number of polishing units or polishing modules can be selected as required to implement the whole polishing process to satisfy different process requirements; (6) the overall arrangement is more compact, and more space is reserved for the arrangement of cleaning positions; (7) one or more wafers can be polished through the cooperation of multiple polishing modules by means of only one fixed working position, so the movement path in the polishing process is greatly shortened, the transfer process and time are minimized, and the polishing efficiency is higher; the fixed working position is simple in structure, easy to maintain, lowest in cost and closer to the polishing modules, so the entire wafer polishing system has a smaller size; movement paths of wafers in the whole process are S-shaped trajectories to minimize the movement distance, so volatilization of liquids on surfaces of the wafers can be effectively reduced, and impurities are less likely to fall onto the wafers; because the two polishing arms share an area only at the fixed working position, before a wafer is placed to the fixed working position, a robot arm can approach a non-shared area of the fixed working position to wait for the wafer so as to grab the wafer within the shortest time, thus maximizing the overall polishing efficiency; and (8) wafer loading and unloading of the polishing modules on two sides can be realized by means of one fixed working position, and the working position does not need to be moved close to the polishing module on the left side or the right side, so control is more accurate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

FIG. 1 is a simplified schematic diagram of a wafer polishing system in the prior art.

FIG. 2 is a schematic diagram of a polishing unit according to Embodiment 1 of the invention.

FIG. 3 is a schematic diagram of a polishing module on the left side, with a movement area and trajectory of a first polishing arm according to Embodiment 1 of the invention.

FIG. 4 is a schematic diagram of the polishing module on the left side, with a first trajectory according to Embodiment 1 of the invention.

FIG. 5 is a schematic diagram of polishing modules on two sides, with movement areas and trajectories of the first polishing arm and the second polishing arm according to Embodiment 1 of the invention.

FIG. 6 is a schematic diagram of a polishing module on the right side, with the second trajectory according to Embodiment 1 of the invention.

FIG. 7 is a schematic diagram according to Embodiment 1 of the invention.

FIG. 8 is a schematic diagram of the arrangement of three polishing units according to the invention.

FIG. 9 is a first process diagram according to Embodiment 2 of the invention.

FIG. 10 is a second process diagram according to Embodiment 2 of the invention.

FIG. 11 is a third process diagram according to Embodiment 2 of the invention.

FIG. 12 is a process diagram according to Embodiment 3 of the invention.

[0020] Wherein: 1, polishing unit; 2, fixed working position; 3, polishing module; 311, first polishing platform; 312, second polishing platform; 321, first polishing arm; 322, second polishing arm; 41, first trajectory; 42, second trajectory; 5, overlap of movement areas; 51, centre of overlap.

DESCRIPTION OF THE EMBODIMENTS

[0021] To allow those skilled in the art to have a better understanding of the solutions of the invention, the technical solutions in the embodiments of the invention will be clearly and completely described below in conjunction with accompanying drawings in the embodiments of the invention. Obviously, the embodiments in the following description are merely illustrative ones, and are not all possible ones of the invention. All other embodiments obtained by those ordinarily skilled in the art according to the following ones without creative labor should also fall within the protection scope of the invention.

Embodiment 1

[0022] A wafer polishing system comprises at least one polishing unit 1.

[0023] As shown in FIG. 2, the polishing unit 1 comprises a fixed working position 2 and at least two polishing modules 3 located on two sides of the fixed working position 2.

[0024] Each polishing module 3 comprises a polishing platform and a polishing arm capable of driving a wafer to move with respect to the polishing platform to implement a polishing process; here, "move" means that the wafer moves synchronously with the polishing arm or the wafer and the polishing arm move relatively;

[0025] The polishing arms of the polishing modules 3 on the two sides are located in a diagonal direction of the fixed working position 2 and are able to swing between the fixed working position and the polishing platforms to transfer wafers respectively, and movement areas of the polishing arms have an overlap. Here, the polishing arm comprises a rotating arm and a polishing head for adsorbing wafers. Because the polishing head can move with respect to the rotating arm, more specifically, the polishing arms of the polishing modules 3 are located in the diagonal direction of the fixed working position 2 when the polishing modules 3 are used for polishing wafers, or the rotating arms are always located in the diagonal direction of the fixed working position 2.

[0026] In this embodiment, the polishing unit 1 comprises two polishing modules 3, that is to say, one polishing module 3 is arranged on each of the two sides of the fixed working position. For example, based on the direction shown in FIG. 2, a first polishing module located on the left side of the fixed working position 2 comprises the first polishing platform 311 and the first polishing arm 321, and the second polishing module located on the right side of the fixed working position 2 comprises the second polishing platform 312 and the second polishing arm 322.

[0027] As shown in FIG. 3 and FIG. 4, after obtaining a wafer from the fixed working position 2, the first polishing arm 321 of the first polishing module anticlockwise rotates onto the first polishing platform 311; after the first polishing module completes the polishing process, the first polishing arm 321 clockwise rotates to place the wafer back to the fixed working position 2 along a first trajectory 41, and the swing angle of the first polishing arm 321 is less than 180°.

[0028] Of course, in other embodiments, the first polishing arm 321 may clockwise rotate onto the first polishing platform 311 and anticlockwise rotate to place the wafer back to the fixed working position 2 after the first polishing module completes the polishing process.

[0029] As shown in FIG. 5 and FIG. 6, after obtaining a wafer from the fixed working position 2, the second polishing arm 322 of the second polishing module clockwise rotates onto the second polishing platform 321; after the second polishing module completes the polishing process, the second polishing arm 322 anticlockwise rotates to place the wafer back to the fixed working position 2 along a second trajectory 42, and the swing angle of the second polishing arm 322 is less than 180°.

[0030] Of course, in other embodiments, the second polishing arm 322 may anticlockwise rotate onto the second polishing platform 321 and clockwise rotate to place the wafer back to the fixed working position 2 after the second polishing module completes the polishing process.

[0031] The first trajectory 41 and the second trajectory 42 are approximately S-shaped, and to be exact, the middle of the S-shaped first trajectory 41 and the middle of the S-shaped second trajectory 42 are located on the fixed working position 2. In addition, as shown in FIG. 5, the overlap 5 of the movement areas is eye-shaped, and a central axis of the fixed working position 2 passes through a centre 51 of the overlap. The first trajectory 41 and the second trajectory 42 are broad movement trajectories, which not only comprise movement trajectories of outer edges of the polishing arms, and may also be movement trajectories of any one point of the wafer, including movement trajectories of the centre of the wafer. Here, the first trajectory 41 and the second trajectory 42 refer to the movement trajectories of the centre of the wafer and have only one point of tangency, as shown in FIG. 7.

[0032] To prevent the fixed working position 2 from interfering with the movement of the first polishing arm 321 and the second polishing arm 322, the fixed working position 2 is designed into a height-adjustable structure. When the fixed working position 2 does not interact with the first polishing arm 321 for wafer loading or unloading, the fixed working position 2 is located below a plane where the first polishing platform 311 is located. When the fixed working position 2 does not interact with the second polishing arm 322 for wafer loading or unloading, the fixed working position 2 is located below a plane where the second polishing platform 321 is located. The specific height-adjustable structure of the fixed working position 2 can be implemented through existing techniques and will not be repeated here.

[0033] As shown in FIG. 8, in this embodiment, a number of the polishing unit is three, the three polishing

units 3 are adjacently arranged in a vertical direction, and each polishing unit 1 is provided with two polishing modules 3.

[0034] A connecting line between centres of the polishing platforms of the two polishing modules 3 in each polishing unit 1 intersects with the central axis of the fixed working position 2. That is to way, a connecting line between the centre of the first polishing platform 311 and the centre of the second polishing platform 321 passes through an extended line of the central axis of the fixed working position 2.

Embodiment 2

[0035] In this embodiment, under the condition that the polishing unit 1 comprises two polishing modules 3, after the first polishing arm 321 of the first polishing module obtains a wafer from the fixed working position 2, the wafer is polished on the first polishing platform 311, as shown in FIG. 9; and after the first polishing module completes the polishing process, the first polishing arm 321 places the wafer back to the fixed working position 2 along the first trajectory 41 and further rotates from the fixed working position 2 in the same direction to a cleaning position to be cleaned, as shown in FIG. 10.

[0036] After the second polishing arm 322 of the second polishing module obtains the same wafer from the fixed working position 2, the wafer is polished on the second polishing platform 321; and after the second polishing module completes the polishing process, the second polishing arm 322 places the wafer back to the fixed working position 2 along the second trajectory 42 and further rotates from the fixed working position 2 in the same position to a cleaning position to be cleaned, as shown in FIG. 11.

Embodiment 3

[0037] The same wafer is processed in Embodiment 1 and Embodiment 2, while in this embodiment, different wafers are processed.

[0038] In this embodiment, under the condition that the polishing unit 1 comprises two polishing modules 3, after the first polishing arm 321 of the first polishing module obtains a first wafer from the fixed working position 2, the first wafer is polished on the first polishing platform 311, such that the polishing process is completed by the first polishing module.

[0039] At the same time, a second wafer is placed on the fixed working position 2 by means of a robot arm.

[0040] As shown in FIG. 12, after the second polishing arm 322 of the second polishing module obtains the second wafer form the fixed working position 2, the second wafer is polished on the second polishing platform 321, such that the polishing process is completed by the second polishing module.

[0041] The above specific embodiments are merely used for explaining the invention, and are not intended to limit the invention. Any modifications and variations made to the invention within the spirit of the invention and the protection scope of the claims should also fall within the protection scope of the invention.

Claims

1. A wafer polishing system, **characterized in that**, comprising:

   at least one polishing unit;
   wherein, the polishing unit comprises a fixed working position and two polishing modules located on two sides of the fixed working position;
   each of the polishing modules comprises a polishing platform and a polishing arm capable of driving a wafer to rotate with respect to the polishing platform to implement a polishing process;
   the polishing arms of the polishing modules on the two sides are located in a diagonal direction of the fixed working position and are able to swing between the fixed working position and the polishing platforms to transfer the wafer respectively, and movement areas of the polishing arms have an overlap.

2. The wafer polishing system according to claim 1, **characterized in that**, after the polishing arm of one polishing module obtains the wafer from the fixed working position, the polishing process is completed, and the wafer is placed back to the fixed working position along a first trajectory; after the polishing arm of the other polishing module obtains the wafer from the fixed working position, the polishing process is completed, and the wafer is placed back to the fixed working position along a second trajectory; and the first trajectory and the second trajectory are approximately S-shaped.

3. The wafer polishing system according to claim 1, **characterized in that**, an overlap of the movement areas is eye-shaped, and a central axis of the fixed working position passes through a centre of the overlap.

4. The wafer polishing system according to claim 2, **characterized in that**, the first trajectory and the second trajectory are movement trajectories of a centre of the wafer and have only one point of tangency.

5. The wafer polishing system according to claim 1, **characterized in that**, a swing angle of the polishing arm is less than 180°.

6. The wafer polishing system according to claim 1,

characterized in that, the fixed working position is configured as a height-adjustable structure, and when the fixed working position does not interact with the polishing arm for wafer loading or unloading, the fixed working position is located below a plane where the polishing platform is located.

7. The wafer polishing system according to claim 1, **characterized in that**, the polishing unit comprises two polishing modules; after a first polishing arm obtains the wafer from the fixed working position, the wafer is polished on a first polishing platform; after one polishing module completes the polishing process, the first polishing arm places the wafer back to the fixed working position and rotates away from the fixed working position, a second polishing arm obtains the wafer from the fixed working position, and the wafer is polished on a second polishing platform; and at the same time, another wafer is placed on the fixed working position.

8. The wafer polishing system according to claim 7, **characterized in that**, after placing the polished wafer back to the fixed working position, the first polishing arm further rotates to a cleaning position to be cleaned; and after placing the polished wafer back to the fixed working position, the second polishing arm further rotates to a cleaning position to be cleaned.

9. The wafer polishing system according to claim 1, **characterized in that**, the polishing unit comprises at least two said polishing modules; after a first polishing arm obtains the wafer from the fixed working position, the wafer is polished on a first polishing platform; and at the same time, another wafer is placed on the fixed working position, a second polishing arm obtains the wafer from the fixed working position, and the wafer is polished on a second polishing platform.

10. The wafer polishing system according to claim 1, **characterized in that**, a number of the polishing unit is three, the three polishing units are adjacently arranged in a vertical direction, and each polishing unit is provided with two polishing modules.

11. The wafer polishing system according to claim 10, **characterized in that**, a connecting line between centres of the polishing platforms of the two polishing modules in each polishing unit intersects with a central axis of the fixed working position.

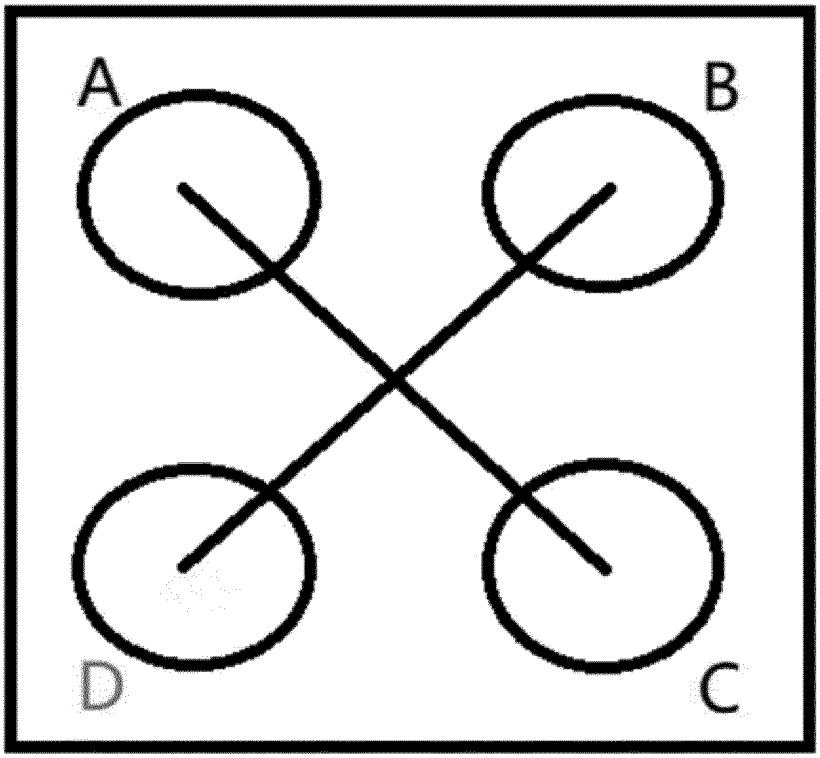

FIG. 1

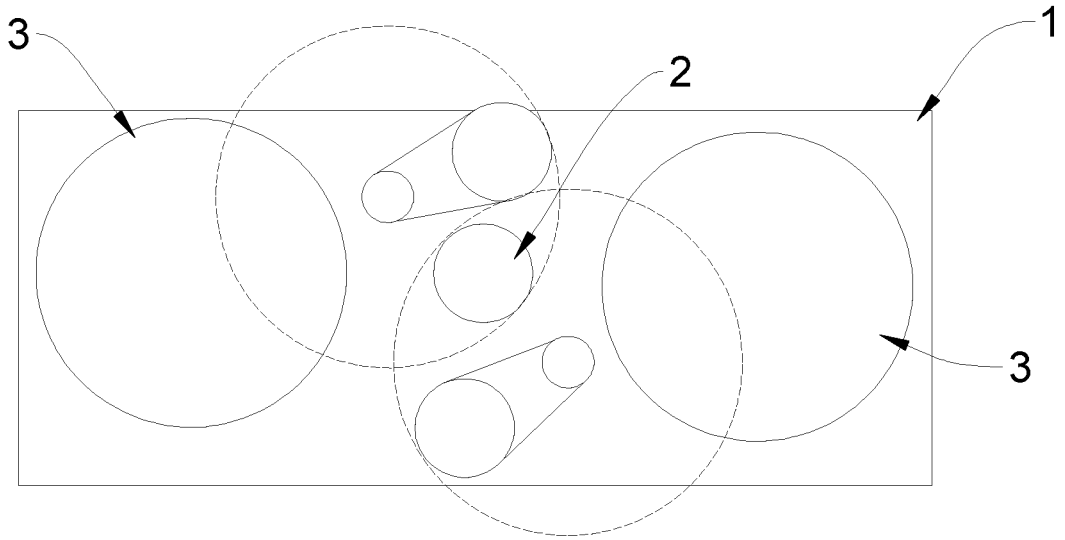

FIG. 2

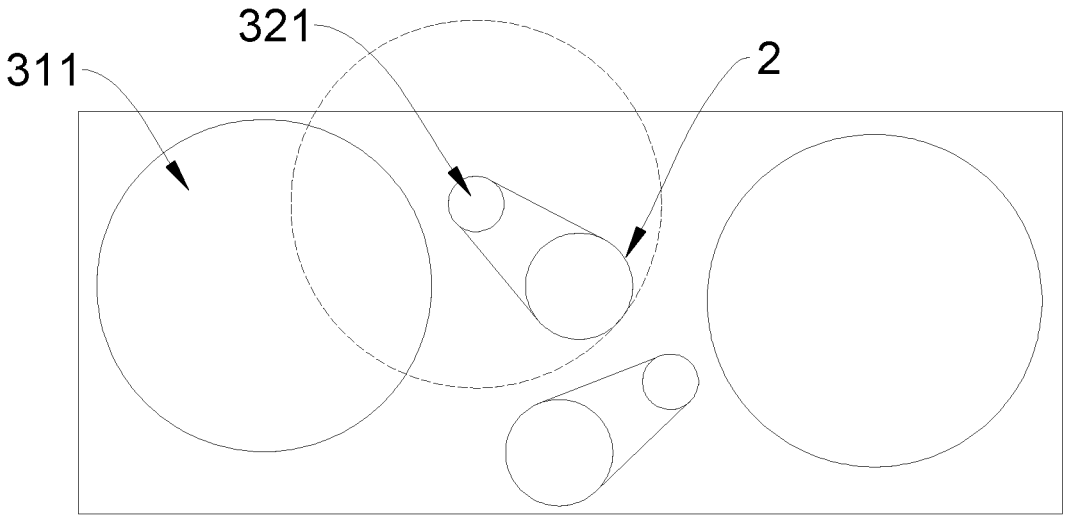

FIG. 3

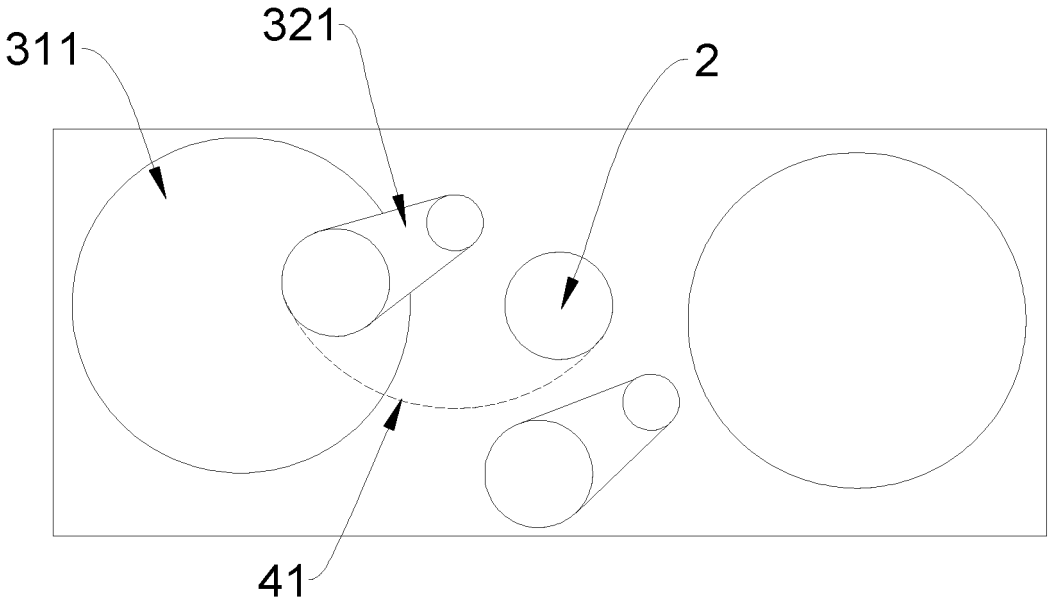

FIG. 4

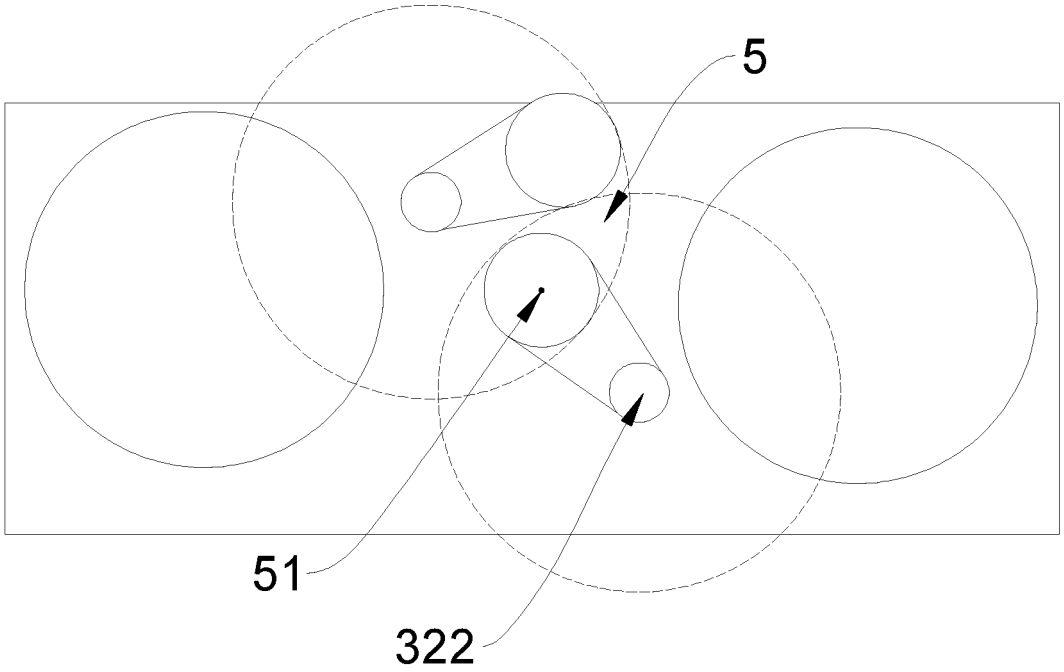

FIG. 5

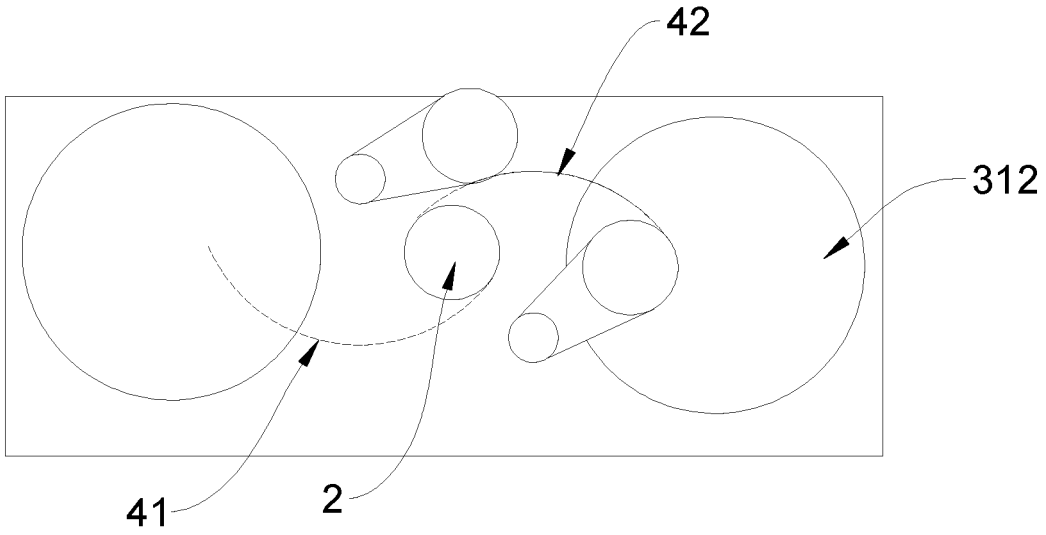

FIG. 6

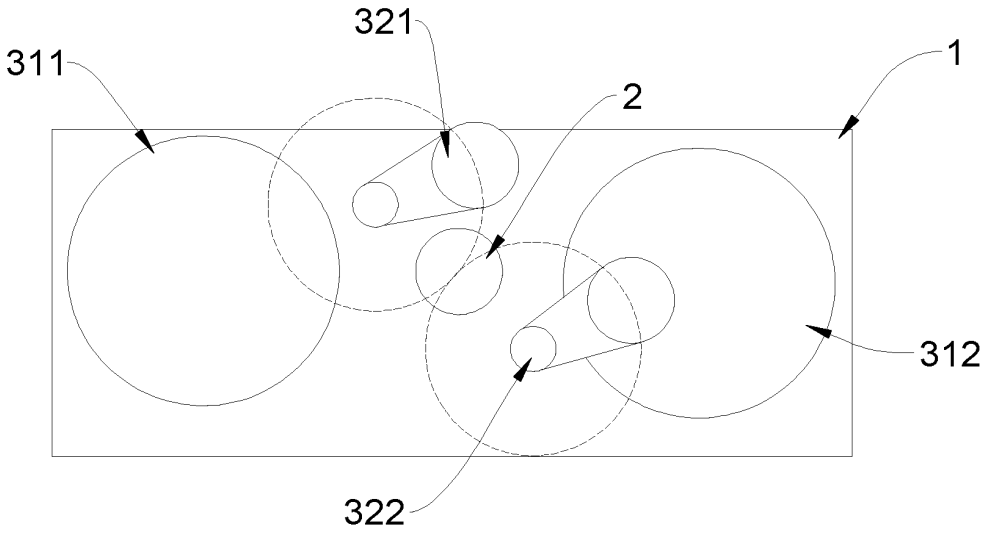

FIG. 7

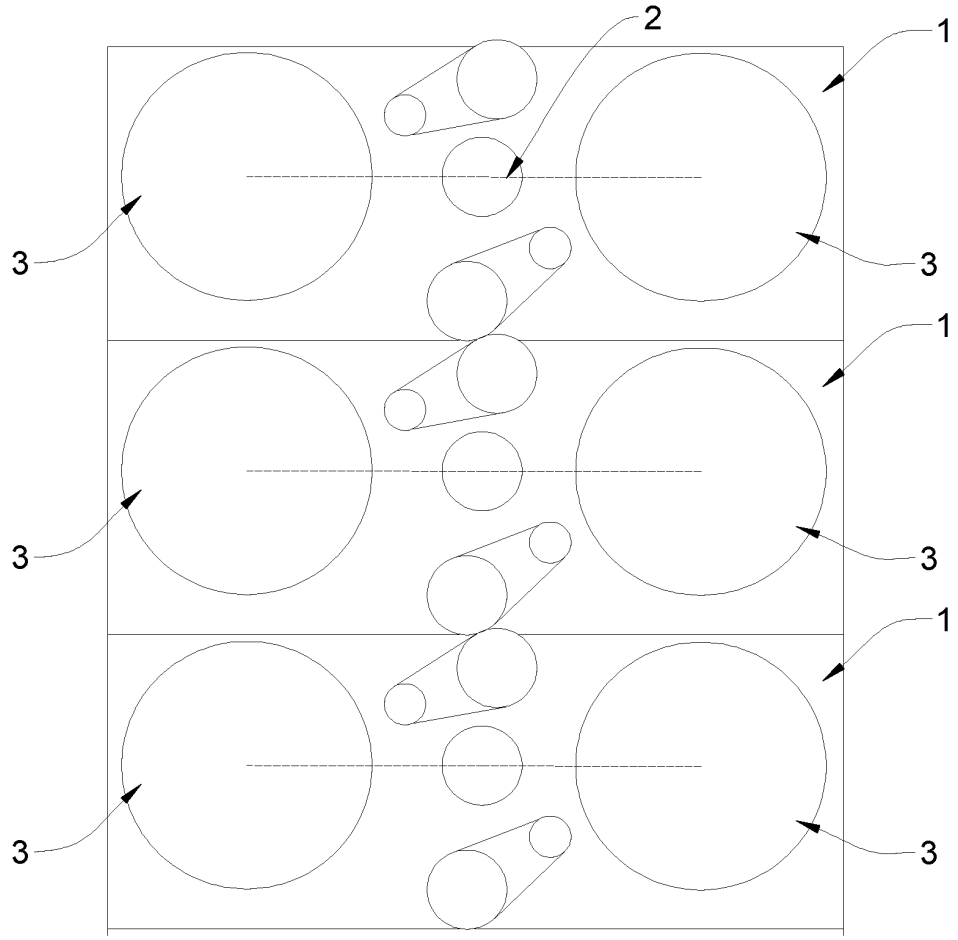

FIG. 8

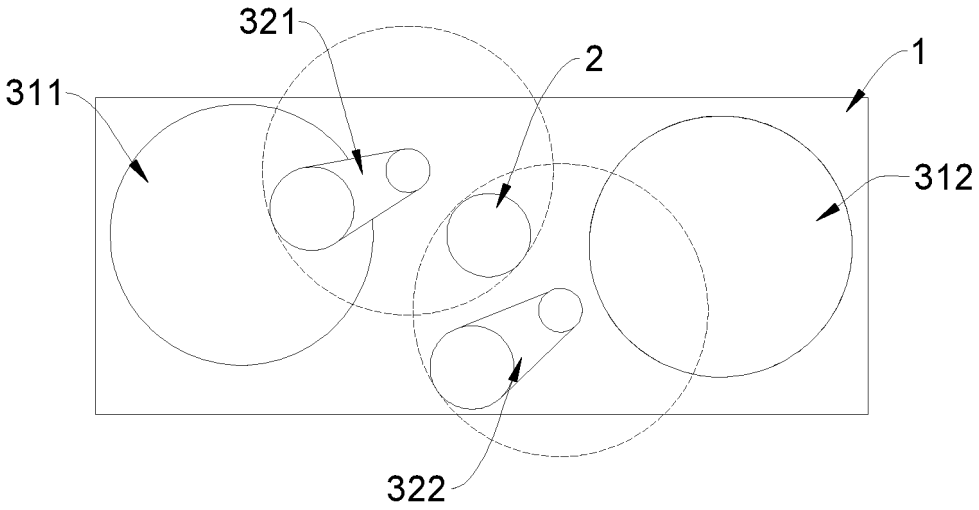

FIG. 9

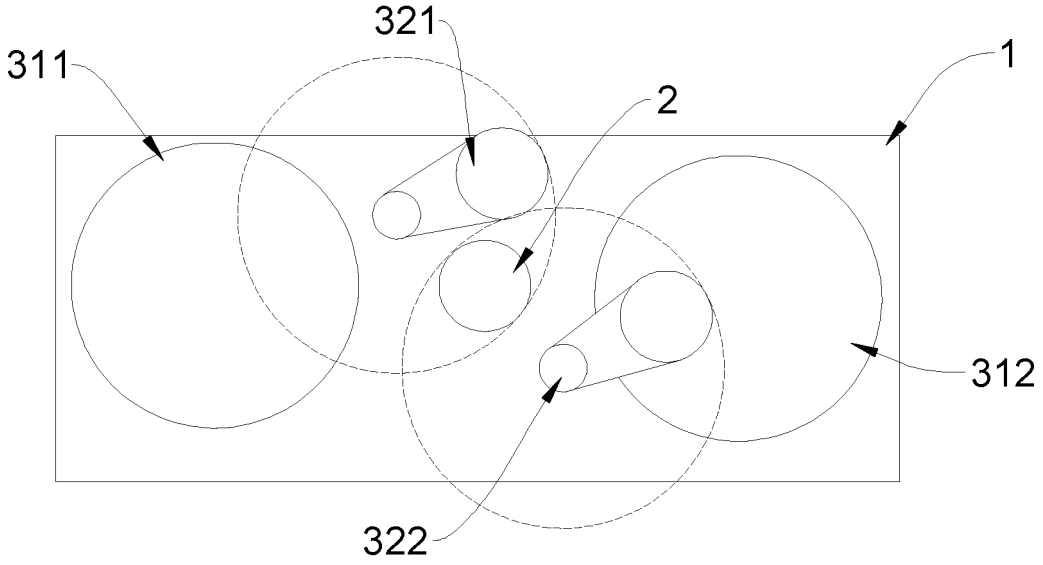

FIG. 10

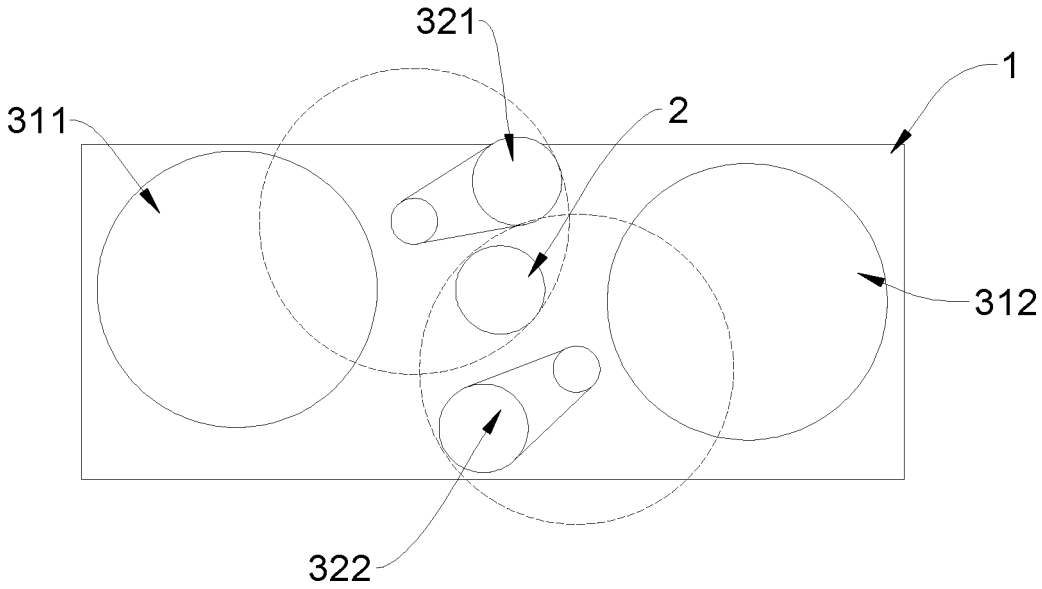

FIG. 11

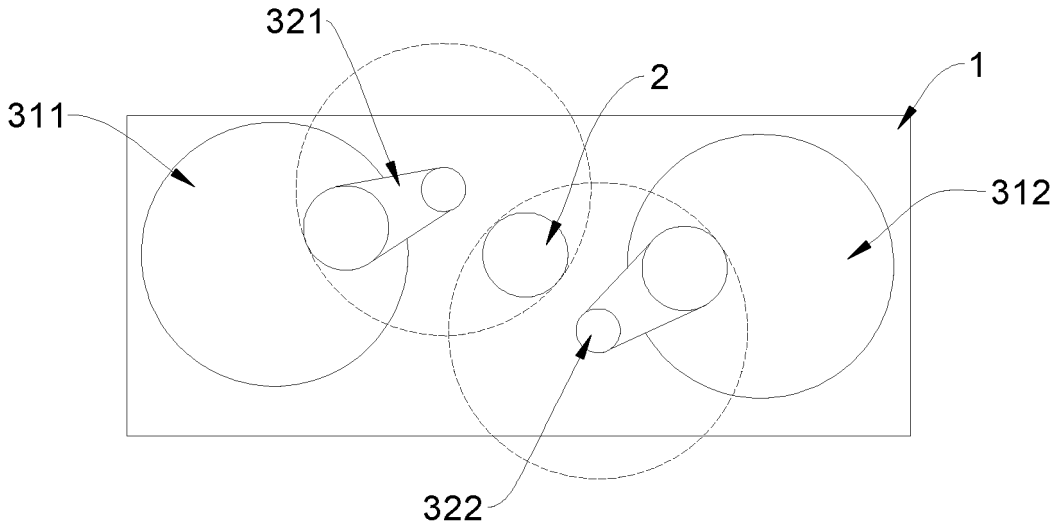

FIG. 12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2022/115771

A. CLASSIFICATION OF SUBJECT MATTER

B24B 29/02(2006.01)i; B24B 37/00(2012.01)i; B24B 27/00(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)

B24B

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)

CNTXT, ENTXTC, CNKI: 晶圆, 晶片, 硅片, 抛光, 磨, 机械臂, 机械手, 工位; ENTXT, VEN: wafer, plate, grind, polish, manipulator, arm, position.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 114147611 A (HANGZHOU SIZONE ELECTRONIC TECHNOLOGY INC.) 08 March 2022 (2022-03-08) claims 1-11	1-11
X	CN 108541334 A (SUMCO CORPORATION) 14 September 2018 (2018-09-14) description, paragraphs 43-54, and figure 4	1-11
X	CN 109015314 A (HANGZHOU SIZONE ELECTRONIC TECHNOLOGY INC.) 18 December 2018 (2018-12-18) description, paragraphs 37-53, and figures 1-6	1-11
X	CN 109304670 A (HANGZHOU SIZONE ELECTRONIC TECHNOLOGY INC.) 05 February 2019 (2019-02-05) description, paragraphs 30-38, and figures 1-2	1-11
X	CN 109514421 A (HANGZHOU SIZONE ELECTRONIC TECHNOLOGY INC.) 26 March 2019 (2019-03-26) description, paragraphs 23-32, and figure 1	1-11
A	JP 2000061833 A (SPEEDFAM IPEC CO., LTD.) 29 February 2000 (2000-02-29) entire document	1-11

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"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
01 November 2022	**18 November 2022**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration (ISA/CN)** **No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088, China** Facsimile No. **(86-10)62019451**	Authorized officer Telephone No.

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International application No.
PCT/CN2022/115771

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