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(54) **MICRO DEVICE TRANSFER EQUIPMENT AND RELATED METHOD**

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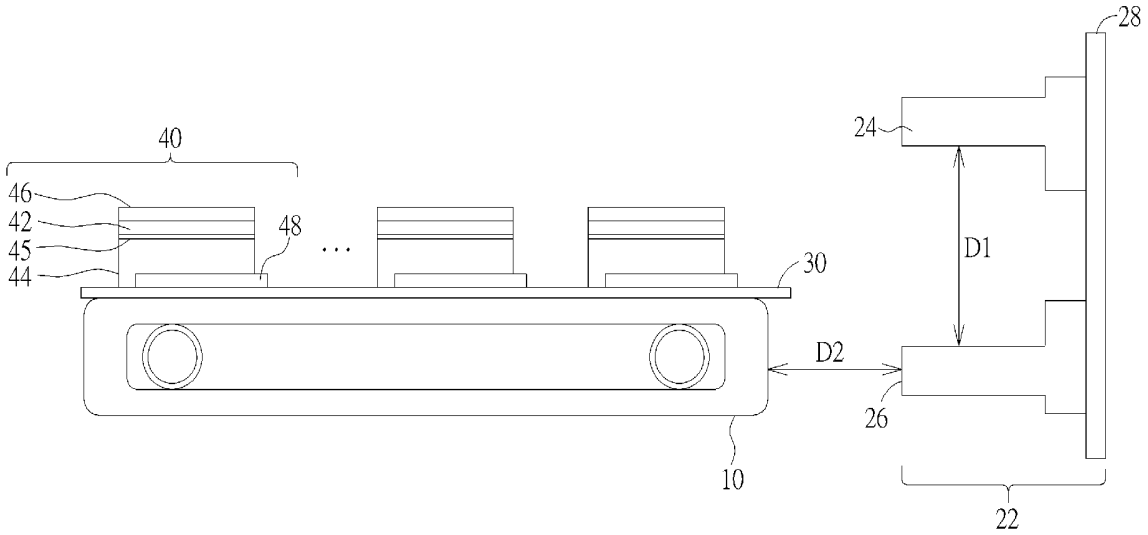
(57) **ABSTRACT**

A micro device transfer equipment includes a convey platform and a transfer device. The convey platform is configured to carry a wafer and move the wafer towards a specific direction, wherein a plurality of micro devices are fabricated on the wafer. The transfer device includes a plurality of transfer heads each including a base arm, a first side arm and a second side arm. The first side arm and the second side arm are disposed on the base arm in a movable manner for clamping a corresponding micro device among the plurality of micro devices.



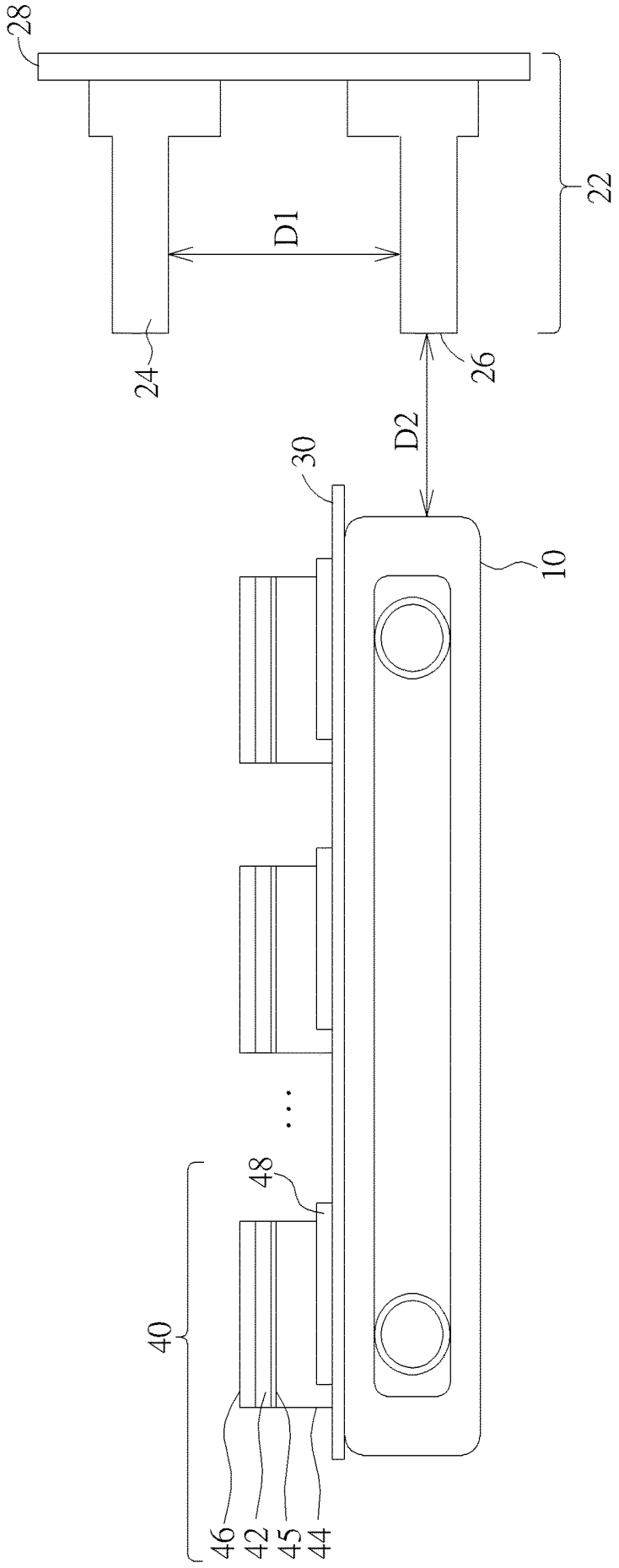


FIG. 1A

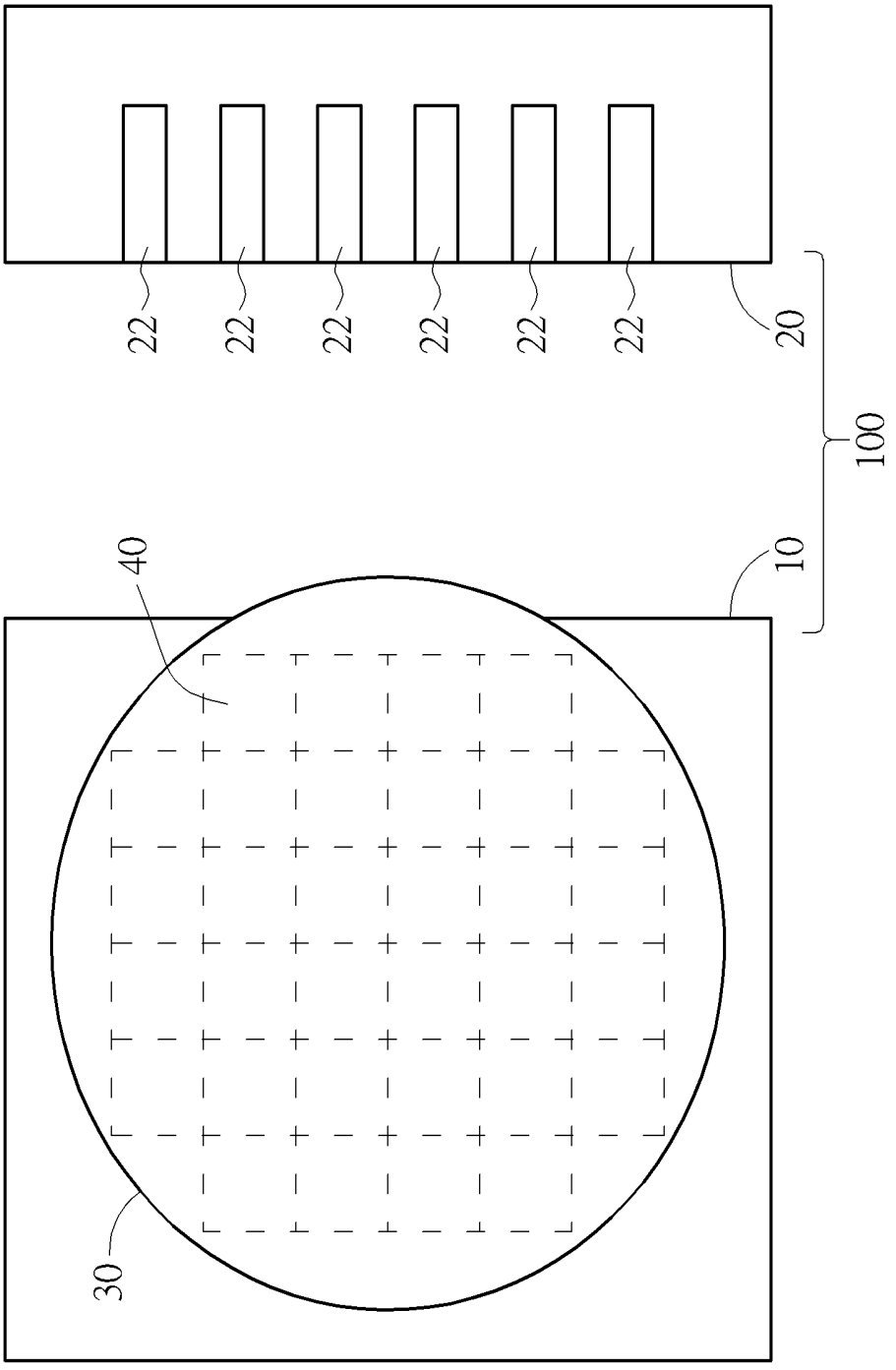


FIG. 1B

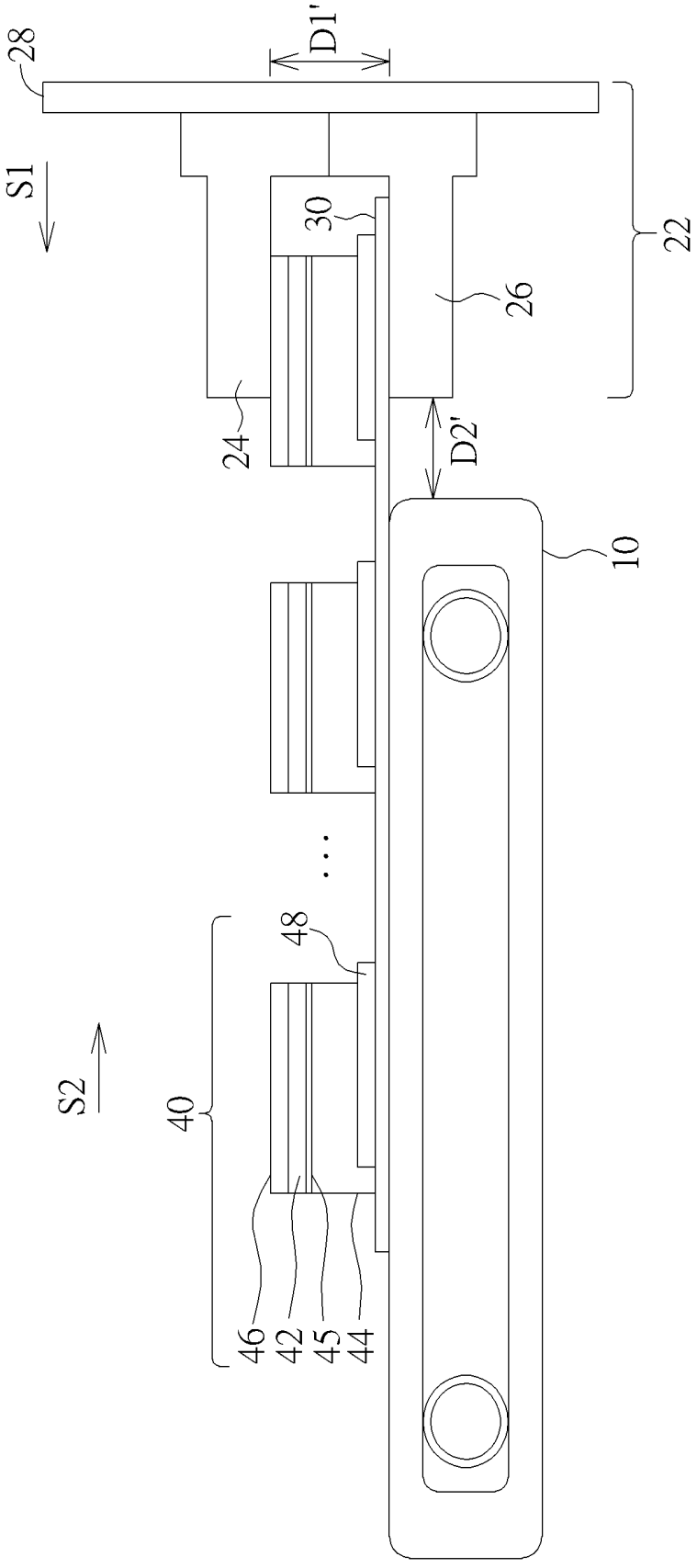


FIG. 2A

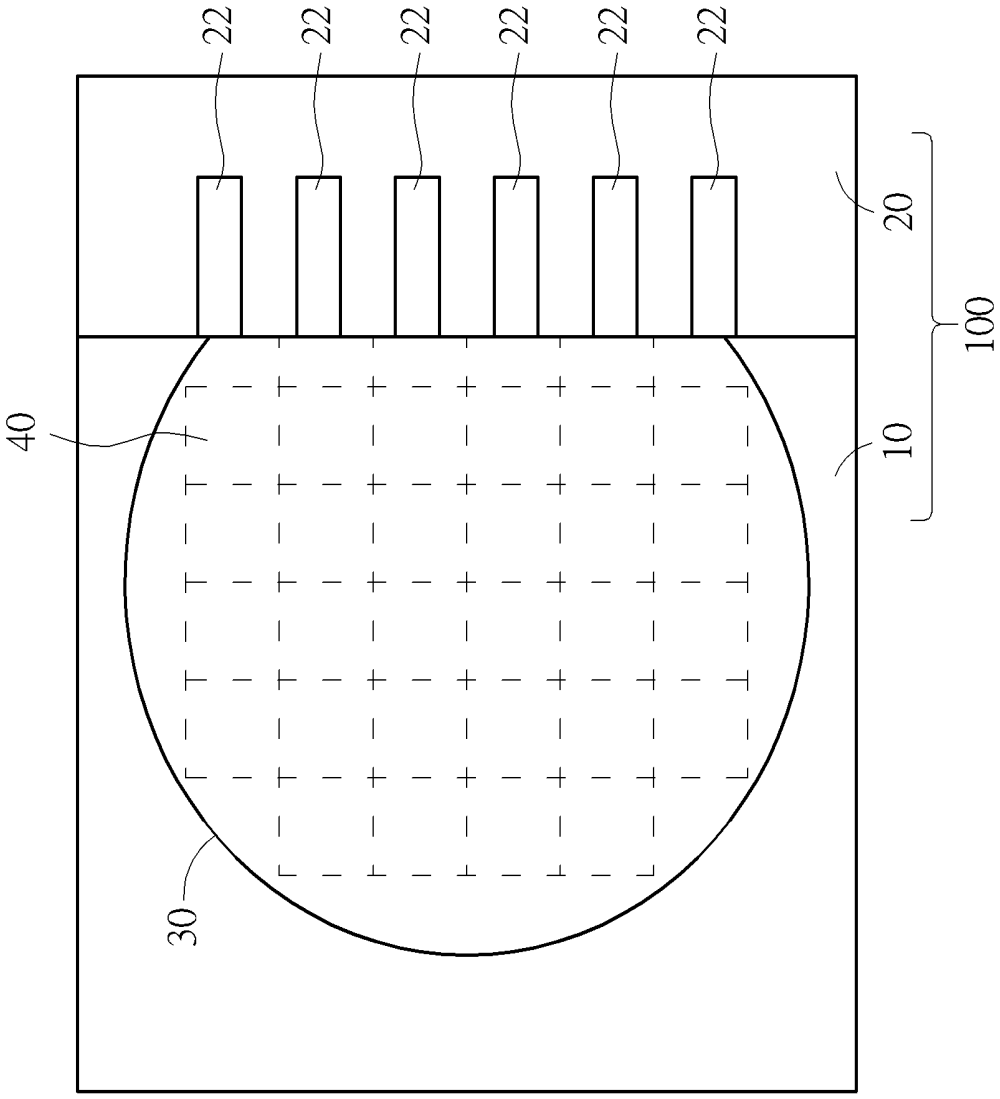


FIG. 2B

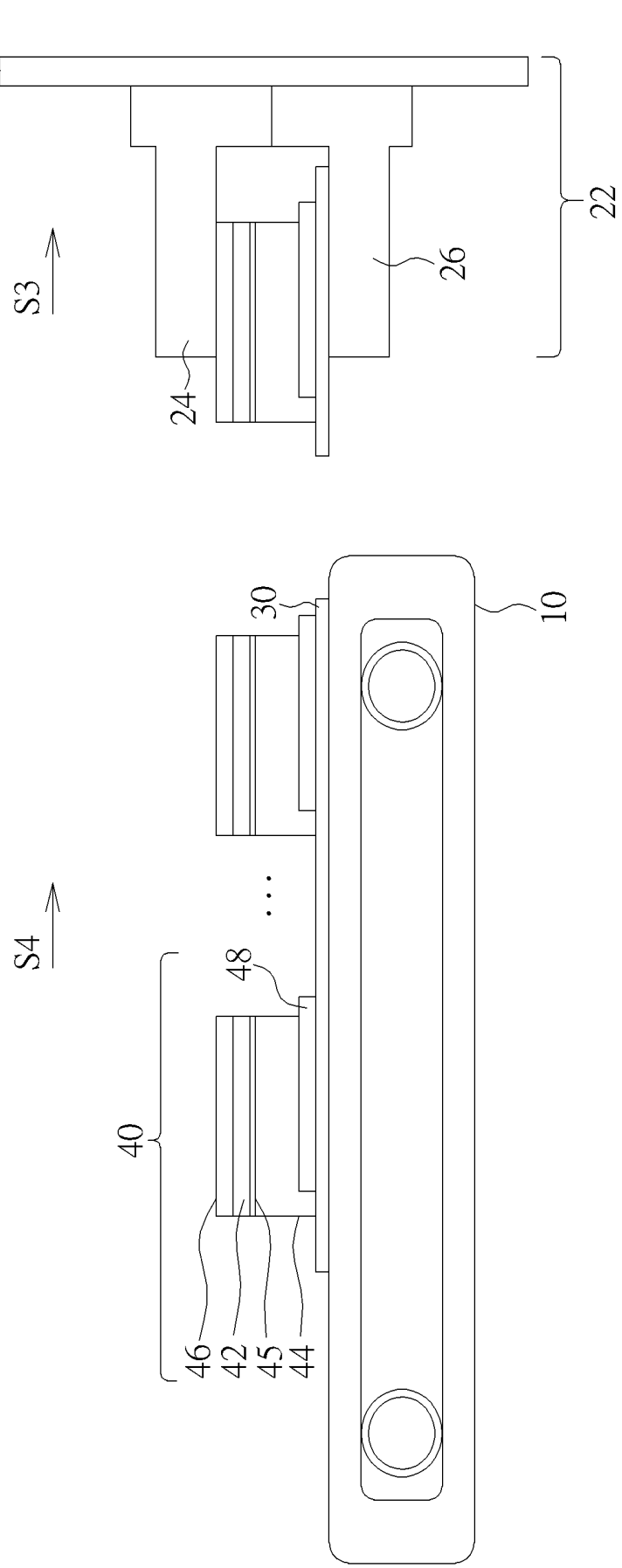


FIG. 3A

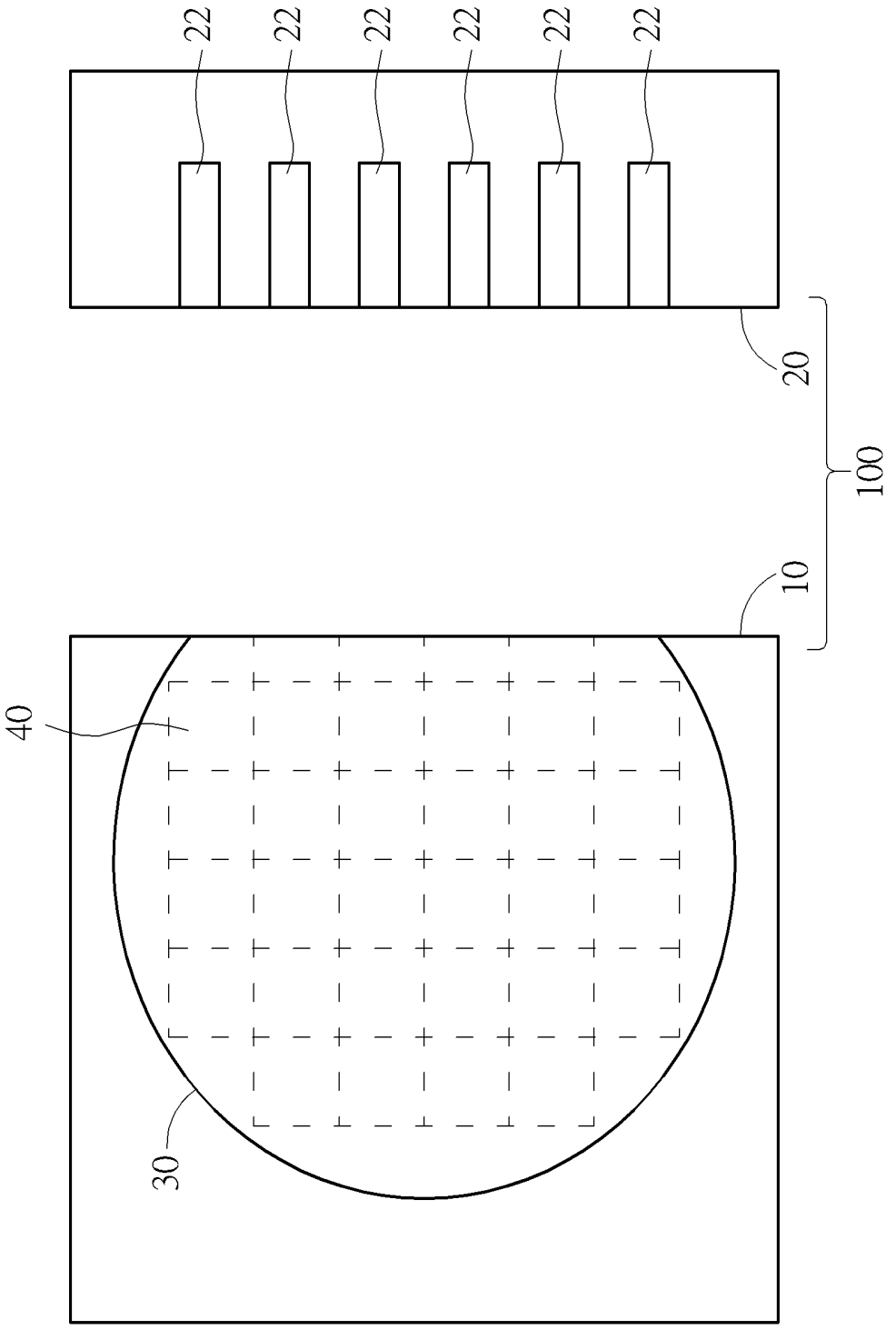


FIG. 3B

MICRO DEVICE TRANSFER EQUIPMENT AND RELATED METHOD

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims priority of Taiwan Application No. 107100811 filed Jan. 9, 2018.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present invention is related to a micro device transfer equipment and related method, and more particularly, to a micro device transfer equipment and related method capable of mass-transferring micro LEDs rapidly and efficiently.

2. Description of the Prior Art

[0003] Compared to traditional incandescent bulbs, light-emitting diodes (LEDs) are advantageous in low power consumption, long lifetime, small size, no warm-up time, fast reaction speed, and the ability to be manufactured as small or array devices. In addition to outdoor displays, traffic signs, and liquid crystal display (LCD) backlight for various electronic devices such as mobile phones, notebook computers or personal digital assistants (PDAs), LEDs are also widely used as indoor/outdoor lighting devices in place of fluorescent of incandescent lamps.

[0004] The size of traditional LED arrays is the dimension of millimeters (mm). The size of micro LED arrays may be reduced to the dimension of micrometers (μm) while inheriting the same good performances regarding power consumption, brightness, resolution, color saturation, reaction speed, life time and efficiency. In a micro LED manufacturing process, a thin-film, miniaturized and array design is adopted so that multiple micro LEDs are fabricated in the dimension of merely 1-250 μm. Next, these micro LEDs are mass transferred to be disposed on another circuit board. Protection layers and upper electrodes may be formed in a physical deposition process before packaging the upper substrate.

[0005] Therefore, there is a need for a micro device transfer equipment capable of mass-transferring micro LEDs rapidly and efficiently.

SUMMARY OF THE INVENTION

[0006] The present invention provides a micro device transfer equipment including a convey platform and a transfer device. The convey platform is configured to carry a wafer and move the wafer towards a specific direction, wherein a plurality of micro devices are fabricated on the wafer. The transfer device includes a plurality of transfer heads each having a base arm, a first side arm and a second side arm, wherein the first side arm and the second side arm are disposed on the base arm in a movable manner for clamping a corresponding micro device among the plurality of micro devices.

[0007] The present invention also provides method of transferring micro devices including using a convey platform to carry a wafer on which a plurality of micro devices are fabricated; arranging a plurality of transfer heads in a transfer device to be respectively aligned with a first column of micro devices among the plurality of micro devices fabricated on the wafer, or arranging the plurality of transfer heads in the transfer device to be respectively aligned with a first row of micro devices among the plurality of micro devices fabricated on the wafer; adjusting a distance between a first side arm and a second side arm in each transfer head to a first value; the transfer device moving towards the convey platform and the convey platform moving the wafer towards the transfer device until the first column of micro devices or the first row of micro devices are moved into a space between the first side arm and the second side arm of a corresponding transfer head; and adjusting the distance between the first side arm and the second side arm in each transfer head to a second value for clamping each micro device of the first column of micro devices or the first row of micro devices. The first value is larger than a sum of a height of each micro device and a height of the wafer. The second value is smaller than the first value. The first column of micro devices or the first row of micro devices are nearest to the transfer device among the plurality of micro devices fabricated on the wafer.

[0008] These and other objectives of the present invention will no doubt become obvious to those of ordinary skill in the art after reading the following detailed description of the preferred embodiment that is illustrated in the various figures and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIGS. **1A-3A** and **1B-3B** are diagrams illustrating a micro device transfer equipment according to an embodiment of the present invention.

DETAILED DESCRIPTION

[0010] FIGS. **1A-3A** and **1B-3B** are diagrams illustrating a micro device transfer equipment **100** according to an embodiment of the present invention. FIGS. **1A-3A** depict the side-view of the micro device transfer equipment **100** during each operational stage. FIGS. **1B-3B** depict the top-view of the micro device transfer equipment **100** during each operational stage.

[0011] The micro device transfer equipment **100** includes a convey platform **10** and a transfer device **20** for mass transferring micro devices **40** fabricated on a wafer **30** to another substrate (not shown). In an embodiment of the present invention, the wafer **30** may include an array of micro devices consisting of M columns and N rows (M and N are integers larger than 1). Each micro device **40** may be a micro LED device which includes a P-type semiconductor layer **42**, an N-type semiconductor layer **44**, a P-electrode **46**, an N-electrode **48**, and a luminescent layer **45**. When a positive voltage is applied to the P-electrode **46** and a negative voltage is applied to the N-electrode **48**, electrons flow from the N-region towards the P-region and holes flow from the P-region towards the N-region due to the forward-bias voltage. These electrons and holes then combine in the PN junction of the luminescent layer **45**, thereby emitting photons of light. However, the structure of the micro devices **40** does not limit the scope of the present invention.

[0012] The convey platform **10** is configured to carry the wafer **30**, and the transfer device **20** includes a plurality of transfer heads **22**. The amount of the transfer heads **22** is related to the amount of micro devices **40** fabricated on the wafer **30**. In an embodiment, the transfer device **20** may include at least N transfer heads **22** for clamping a column

of micro devices **40** at each operation. In another embodiment, the transfer device **20** may include at least M transfer heads **22** for clamping a row of micro devices **40** at each operation. However, the amount of transfer heads **50** does not limit the scope of the present invention.

[0013] Each transfer head **22** includes an upper side arm **24**, a lower side arm **26**, and a base arm **28**. The upper side arm **24** and the lower side arm **26** are disposed on the base arm **28** in a movable manner, wherein the distance between the upper side arm **24** and the lower side arm **26** may be adjusted according to different operational stages. The convey platform **10** may be a transport belt which can move an item towards a specific direction.

[0014] In the initial first stage depicted in FIGS. **1**A and **1**B, a cutting procedure is first performed on the wafer **40** for defining the range of each micro device **40** (indicated by the dotted line in FIG. **1**B). Next, the wafer **30** is disposed on the convey platform **10** in a way that each transfer head **22** is aligned with a corresponding micro device in the first column of micro devices or a corresponding micro device in the first row of micro devices, wherein the first column of micro devices or the first row of micro devices are nearest to the transfer device **40** among the plurality of micro devices **40** fabricated on the wafer **30**. In the first stage, the distance between the upper side arm **24** and the lower side arm **26** is D**1** and the distance between the convey platform **10** and the transfer device **20** is D**2**, wherein the value of D**1** is larger than the sum of the height of the micro device **40** and the height of the wafer **30**.

[0015] In the second stage depicted in FIGS. **2**A and **2**B, the transfer device **20** is moved towards the convey platform **10** (indicated by an arrow S**1**) and the convey platform **10** moves the wafer **30** towards the transfer device **20** (indicated by an arrow S**2**). The distance between the convey platform **10** and the transfer device **20** now becomes D**2'** (D**2'**<D**2**). Once the first column or the first row of micro devices **40** are moved into the space between the upper side arm **24** and the lower side arm **26** of corresponding transfer heads **22**, the transfer device **20** is configured to adjust the distance between the upper side arm **24** and the lower side arm **26** for steadily clamping each micro device **40** of the first column of micro devices **40** or the first row of micro devices **40**. The distance between the upper side arm **24** and the lower side arm **26** now becomes D**1'** (D**1'**<D**1**).

[0016] In the third stage depicted in FIGS. **3**A and **3**B, the transfer device **20** is moved away from the convey platform **10** (indicated by an arrow S**3**) and the convey platform **10** moves the wafer **30** towards the transfer device **20** (indicated by an arrow S**4**). Once the transfer device **20** relocates the clamped first column or the first row of micro devices **40** to other locations, the second column or the second row of micro devices **40** may be moved to the edge of the convey platform **10** near the transfer device **20**. Therefore, the step illustrated in FIGS. **2**A and **2**B may be re-executed until all micro devices **40** on the wafer **30** are relocated.

[0017] In conclusion, the present invention provides micro device transfer equipment and a related transfer method capable of mass-transferring micro LEDs rapidly and efficiently.

[0018] Those skilled in the art will readily observe that numerous modifications and alterations of the device and method may be made while retaining the teachings of the invention. Accordingly, the above disclosure should be construed as limited only by the metes and bounds of the appended claims.

What is claimed is:

1. A micro device transfer equipment, comprising:
- a convey platform configured to carry a wafer and move the wafer towards a specific direction, wherein a plurality of micro devices are fabricated on the wafer; and
- a transfer device including a plurality of transfer heads each comprising:
  - a base arm; and
  - a first side arm and a second side arm disposed on the base arm in a movable manner for clamping a corresponding micro device among the plurality of micro devices.

2. The micro device transfer equipment of claim **1**, wherein the convey platform is a transport belt.

3. The micro device transfer equipment of claim **1**, wherein the plurality of transfer heads are arranged to be respectively aligned with a first column of micro devices among the plurality of micro devices fabricated on the wafer, or arranged to be respectively aligned with a first row of micro devices among the plurality of micro devices fabricated on the wafer.

4. The micro device transfer equipment of claim **1**, wherein each micro device is a micro light emitting diode (LED).

5. A method of transferring micro devices, comprising:
- using a convey platform to carry a wafer on which a plurality of micro devices are fabricated;
- arranging a plurality of transfer heads in a transfer device to be respectively aligned with a first column of micro devices among the plurality of micro devices fabricated on the wafer, or arranging the plurality of transfer heads in the transfer device to be respectively aligned with a first row of micro devices among the plurality of micro devices fabricated on the wafer;
- adjusting a distance between a first side arm and a second side arm in each transfer head to a first value;
- the transfer device moving towards the convey platform and the convey platform moving the wafer towards the transfer device until the first column of micro devices or the first row of micro devices are moved into a space between the first side arm and the second side arm of a corresponding transfer head; and
- adjusting the distance between the first side arm and the second side arm in each transfer head to a second value for clamping each micro device of the first column of micro devices or the first row of micro devices, wherein:
  - the first value is larger than a sum of a height of each micro device and a height of the wafer;
  - the second value is smaller than the first value; and
  - the first column of micro devices or the first row of micro devices are nearest to the transfer device among the plurality of micro devices fabricated on the wafer.

6. The method of claim **5**, further comprising:
- the transfer device moving away from the convey platform for separating the first column of micro devices or the first row of micro devices from other micro devices fabricated on the wafer after clamping each micro device of the first column of micro devices or the first row of micro devices using each transfer head.

7. The method of claim 6, further comprising:

the transfer device moving a second column of micro devices or a second row of micro devices fabricated on the wafer towards the transfer device after separating the first column of micro devices or the first row of micro devices from other micro devices fabricated on the wafer, wherein the second column of micro devices or the second row of micro devices are nearest to the transfer device among the plurality of micro devices fabricated on the wafer except the first column of micro devices or the first row of micro devices.

8. The method of claim 5, further comprising:

performing a cutting procedure on the wafer for defining a range of each micro device before using the convey platform to carry the wafer.

9. The method of claim 5, wherein each micro device is a micro light emitting diode.

* * * * *

专利名称(译)	微器件传输设备及相关方法		
公开(公告)号	US20190214522A1	公开(公告)日	2019-07-11
申请号	US15/947881	申请日	2018-04-09
[标]申请(专利权)人(译)	宏碁股份有限公司		
申请(专利权)人(译)	宏碁股份有限公司		
当前申请(专利权)人(译)	宏碁股份有限公司		
[标]发明人	HSIANG JUI CHIEH CHEN CHIH CHIANG		
发明人	HSIANG, JUI-CHIEH CHEN, CHIH-CHIANG		
IPC分类号	H01L33/00 B25J18/00		
CPC分类号	B25J18/00 H01L2933/0033 H01L2933/0066 H01L33/005 H01L21/67144 H01L25/0753		
优先权	107100811 2018-01-09 TW		
其他公开文献	US10505070		
外部链接	Espacenet USPTO		

摘要(译)

微器件传输设备包括传输平台和传输设备。传送平台被配置为承载晶片并朝向特定方向移动晶片，其中在晶片上制造多个微器件。转移装置包括多个转移头，每个转移头包括基臂，第一侧臂和第二侧臂。第一侧臂和第二侧臂以可移动的方式设置在基臂上，用于将相应的微器件夹持在多个微器件中。