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(54) Title: SOLAR CELL SORTING CONVEYOR AND METHODOLOGY THEREOF

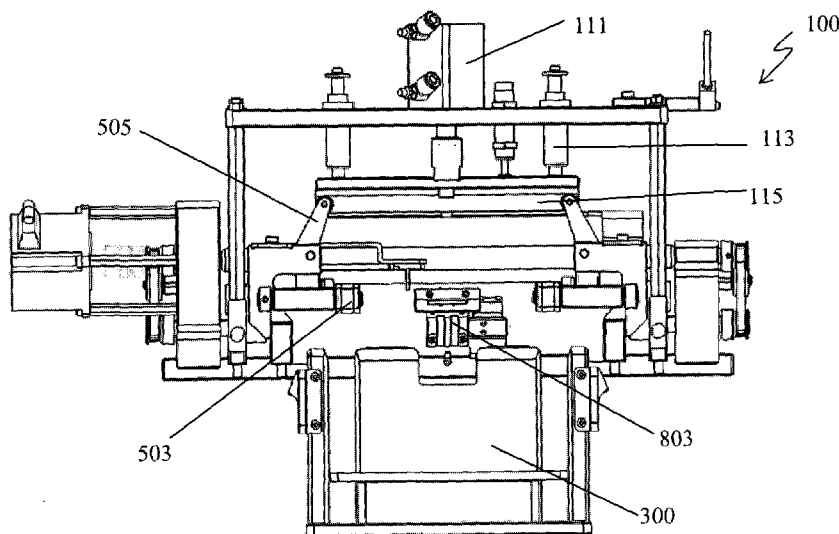


FIG. 1

(57) Abstract: The present invention relates generally to a solar cell sorting conveyor (100) comprises of a plurality of sub-assemblies which can be categorized as electrical motor drive assembly (400) with mechanical drive coupling (405, 406), conveyor belt assembly (500) with mechanical drive coupling (405, 406), stopper assembly (800) and linkage actuator assembly (110). All the said sub-assemblies are arranged in such that solar cell is able to be transported and to be unloaded into receiving bin (300) which are being positioned beneath the said solar cell sorting conveyor (100) with minimal cell to cell contact.

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SOLAR CELL SORTING CONVEYOR AND METHODOLOGY THEREOF

1. TECHNICAL FIELD OF THE INVENTION

The present invention relates generally to a solar cell sorting
5 conveyor comprises of a plurality of sub-assemblies which can be
categorized as electrical motor drive assembly with friction drive
coupling, conveyor belt assembly with friction drive coupling, stopper
assembly and linkage actuator assembly. All the said sub-assemblies
are arranged in such that solar cell is able to be transported and to be
10 unloaded into receiving bin which are being positioned beneath the
said solar cell sorting conveyor with minimal cell to cell contact.

2. BACKGROUND OF THE INVENTION

Study on manufacturing of solar cell has been made for many
years. With increase of interest in solar cell, much attention has been
15 placed on improving the process of manufacturing the solar cells. One
of the sub-processes in manufacturing the solar cell is the sorting of

solar cell, whereby solar cell can be sorted into categories of different qualities.

Currently solar cells produced in automated production line are transported from front-of-line to end-of-line using conveyor. The
5 output of solar cells from end-of-line are then inspected by using of some automated inspection equipment, which are then sorted into appropriate bins at designated location, categorized based on different qualities or classes.

There are a few types of equipment used for inspecting and
10 sorting of solar cells. For example, solar cells can be transported from one station to another station by using of pick and place robotic arm or conveyor. However, using of conveyor as transportation method is preferred due to lesser stress induced on the solar cells, as said stress induced on the solar cells may impact greatly on the breakage rate.

15 One of the examples of using conveyor in solar cell production line is the sorter with cross-lift conveyor. Said cross-lift conveyor sorter is used to sort the incoming solar cell from the middle conveyor to the receiving bin positioned at the left or right side of said conveyor by using an individual control conveyor which is arranged in a cross

manner. The solar cell that carries corresponding ID to respective receiving bin will be lifted up from the middle conveyor and then be transported either left or right into the receiving bin. The sorter with cross-lift conveyor is a simple and straightforward design. However, solar cell may rub each other when sliding down to the receiving bin which may induce scratches towards solar cell. In addition, solar cell may also halt when sliding down to receiving bin and thus causing breakage towards solar cell.

Another type of sorting equipment is sorter by using of delta robot technology. At this sorting equipment, receiving bins are placed at the left or right side to the middle conveyor that transports inspected cell from the upstream machine. The robot is usually assisted by a vision camera to locate the position of the cell before picking up on-the-fly while the conveyor is running continuously. This sorting equipment is flexible to have pickup position and able to operate at high speed. Nonetheless, it is not only costly but with low payload and also low accuracy.

In addition to this, there is also a solar cell sorter that is able to pick and place solar cell twice, whereby one is being carried out by turret and another one is by vertical robot arm before being sorted to

receiving bins. This sorter has a vertical bin which provides multiple bins in small footprint area and utilizes two lanes conveyor for high speed sorting. This sorting equipment is able to perform for high number of sorting categories at small footprint, but more pick and
5 place actions are involved and thereby may increase breakage rate.

On the other hand, the above explained sorting equipment are typically suitable for solar wafer sorting than solar cell sorting due to the rough texture inherited in solar cell ARC coating and bus bar or finger printing. As a result, it may cause unwanted result such as cell
10 breakage or scratches.

It would hence be extremely advantageous if the above shortcoming is alleviated by having a solar cell sorting conveyor comprising sub-assemblies such as electrical motor drive assembly with friction drive coupling, conveyor belt assembly with friction
15 drive coupling, stop assembly and linkage actuator assembly to transport the solar cell and to unload the solar cell into receiving bin by dropping said solar cell vertically after the conveyor belt is opened and thus minimal cell to cell contact is achieved.

3. SUMMARY OF THE INVENTION

Accordingly, it is the primary aim of the present invention to provide a solar cell sorting conveyor which is able to minimize rubbing among solar cells.

5 It is yet another object of the present invention to provide a solar cell sorting conveyor whereby no pick up stress is induced on solar cells.

It is yet another object of the present invention to provide a solar cell sorting conveyor which is able to reduce breakage rate.

10 It is yet another object of the present invention to provide a solar cell sorting conveyor which is able to reduce the incident of scratches to the solar cells after sorting process.

Other and further objects of the invention will become apparent with an understanding of the following detailed description
15 of the invention or upon employment of the invention in practice.

These and other objects are achieved by the present invention,
which in its preferred embodiment provides,

A solar cell sorting conveyor, comprising of:

5 a conveyor belt assembly (500) which comprises of at least a
pair of drive rollers (503) and at least a pair of belt (501) which
are entrained around said pair of drive rollers (503);

a drive assembly (400) for moving said conveyor belt (501);

at least one control unit for triggering the function at said
solar cell sorting conveyor (100);

10 characterized in that

at least a pair of mechanical drive (405, 406) is used to couple
and decouple said drive assembly (400) and said belt assembly
(500).

In another embodiment, it provides:

15 A methodology of sorting solar cell using sorting conveyor,
comprising the following steps:

- (i) transferring of solar cells by using conveyor belt (501);
- (ii) retaining of solar cell from being conveyed to next conveyor (100) if the solar cell is to be retained;
- (iii) conveying of solar cell to next conveyor if the solar cell is not to be retained.

5

characterized in that said step of retaining of solar cell is achieved by performing the following sub-steps:

- (a) retaining of solar cell by extending the stopper (803) and decelerating the conveyor belt (501);
- (b) activating the actuator (111) to effect the linear bearing (113) and the horizontal groove cam (115) to move down vertically;
- (c) triggering the pair of drive rollers (503) to decouple from said mechanical drive (406) so that said belt assembly (500) is opened;

10

15

- (d) unloading of solar cell by falling vertically into said receiving bin (300) which is positioned underneath the said sorting conveyor (100).

4. BRIEF DESCRIPTION OF THE DRAWINGS

5 Other aspect of the present invention and their advantages will be discerned after studying the Detailed Description in conjunction with the accompanying drawings in which:

FIG. 1 shows a front view of solar cell sorting conveyor.

FIG. 2 shows a back perspective view of the solar cell sorting conveyor.

10 FIG. 3 shows a receiving bin used in solar cell sorting conveyor of the present invention.

FIG. 4 shows a perspective view of the electrical motor drive assembly with friction drive.

15 FIG. 5 shows a perspective view of conveyor belt assembly with friction drive.

FIG. 6 shows a front view of said conveyor belt assembly.

FIG. 7 shows a back perspective view of said conveyor belt assembly.

FIG. 8 shows a perspective view of the stopper assembly.

FIG. 9 shows a diagram of which motor drive assembly, conveyor belt
5 assembly and stopper assembly are being assembled together at said
sorting conveyor.

FIG. 10 shows a perspective view of linkage actuator assembly.

FIG. 11 shows a diagram of belt assembly is in opened position to
unload the solar cell.

10 FIG. 12 shows the position of said mechanical drive for coupling and
decoupling of said motor drive assembly with said with said belt
assembly.

FIG. 13 shows the different width adjustment of said belt assembly.

5. DETAILED DESCRIPTION OF THE DRAWINGS

In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the invention. However, it will be understood by those of ordinary skill in the art that the invention may be practiced without these specific details. In other instances, well known methods, procedures and/or components have not been described in detail so as not to obscure the invention.

The invention will be more clearly understood from the following description of the embodiments thereof, given by way of example only with reference to the accompanying drawings which are not drawn to scale.

Referring now to FIG. 1, there is shown a front view of solar cell sorting conveyor (100), further substantiated by FIG. 2, showing a back perspective view of the solar cell sorting conveyor (100) of the present invention. Said solar cell sorting conveyor (100) comprises of a plurality of sub-assemblies which can be categorized as electrical motor drive assembly (400) with mechanical drive coupling (405, 406), conveyor belt assembly (500) with mechanical drive coupling (405, 406), stopper assembly (800) and linkage actuator assembly (110). All

the said sub-assemblies are arranged in such that solar cell is able to be transported and to be unloaded into receiving bin (300) (receiving bin as shown in FIG. 3) which are being positioned beneath the said solar cell sorting conveyor (100).

5 Referring now to FIG. 4, there is shown a perspective view of the electrical motor drive assembly (400). Said electrical motor drive assembly (400) comprises of at least an electrical motor (401), at least one driveshaft (403) and at least a pair of friction drive (405, 406). Said electrical motor drive assembly (400) can be any other actuating
10 device assembly as long as it is able to transform a circular motion to linear motion at said conveyor (100). At the first pair of friction drive (405), there is at least a pair of drive rollers (503) being connected to said first pair of friction drive (405), whereby said first pair of friction drive (405) can be engaged with a second pair of friction drive (406).
15 When said electrical motor (401) is activated, and when said first pair of friction drive (405) and said second pair of friction drive (406) are engaged, said driveshaft (403) will drive said second pair of friction drive (406), which will drive said first pair of friction drive (405) to cause the rotating motion of said pair of drive rollers (503). Said first
20 pair of friction drive (405) and said second pair of friction drive (406)

can be in the form of a roller with a rubber like material, which is able to create friction and motion to another roller upon touching said roller. Alternatively, other mechanical drive (405, 406) such as magnetic drive can also be used to replace said friction drive (405, 406) as long as it is able to provide the same rotational motion to said drive rollers (503).

Referring now to FIG. 5, there is shown a perspective view of conveyor belt assembly (500), further substantiated by FIG. 6 and FIG. 7, showing a front view and back perspective view of said conveyor belt assembly (500). Said conveyor belt assembly (500) comprises of at least one pair of conveyor belt component (507), said conveyor belt component (507) comprises of a belt (501) which are entrained around said pair of drive rollers (503) at said first pair of friction drive (405) in a taut condition to form a loop. When said electrical motor drive assembly (400) is activated, the rotary motion of said drive rollers (503) is transmitted to linear motion through said conveyor belt assembly (500). In addition, said friction drive (405, 406) is able to couple and decouple said motor drive assembly (400) and said belt assembly (500) easily, by engaging and disengaging of said first mechanical drive (405) with said second mechanical drive (406). If said

motor drive assembly (400) is to be coupled with said belt assembly (500), said first mechanical drive (405) is engaged with said second mechanical drive (406). If said motor drive assembly (400) is to be decoupled with said belt assembly (500), said first mechanical drive
5 (405) is disengaged with said second mechanical drive (406). FIG. 12 shown the position of said mechanical drive (405, 406) for coupling and decoupling of said motor drive assembly (400) with said belt assembly (500). By having such an arrangement, after the solar cells have been inspected or tested at the upstream process, the solar cells
10 are able to be transported at said sorting conveyor (100) through said conveyor belt assembly (500) and eventually to be unloaded into designated receiving bins (300) accordingly.

Referring now to FIG. 8, there is shown a perspective view of the stopper assembly (800) which comprises of at least one stop sensor
15 (801) and at least one stopper (803) which are mounted on or supported by a frame of the sorting conveyor (100). FIG. 9 shows a diagram of which motor drive assembly (400), conveyor belt assembly (500) and stopper assembly (800) are being assembled together at said sorting conveyor (100). Said sorting conveyor (100) is attached to a
20 control unit (not shown), which may include a programmable logic

controller (PLC) system to trigger all the function of the actuators and sensors at said sorting conveyor (100). Said stop sensor (801) is used for sensing the passage of the solar cell when the solar cell is being conveyed on the belt assembly (500) from the entrance (as shown in
5 direction A in FIG. 9) until the position where said stop sensor (801) is located. The said stop sensor (801) may sense the solar cell according to a predetermined physical characteristic or qualities of the solar cell and transmit this information to control unit for identification. If the said solar cell is to be stopped, the said conveyor (100) will then be
10 decelerated and said stopper (803) which is actuated by air cylinder or any other types of actuators is extended to stop said solar cell from being conveyed at said sorting conveyor (100). Said stopper assembly (800) also ensures that the solar cell is being positioned accurately before being dropped to receiving bin (300). If the said solar cell is not
15 to be stopped, said solar cell will be conveyed at said sorting conveyor (100) continuously without the action of extending said stopper (803) by the actuator. Therefore, said stopper (803) can be controlled by either extended or retracted to allow if the cell shall be conveyed to the next conveyor (100). The solar cells which are not stopped by the
20 said stopper (803) will be conveyed to the next conveyor (100).

Referring now to FIG. 10, there is shown a perspective view of linkage actuator assembly (110) comprises of at least one actuator (111), at least one linear bearing (113) connected to at least one horizontal groove cam (115). Said linkage actuator assembly (110) is used to actuate the opening and closing of said belt assembly (500) in order to sort the solar cells by dropping into designated receiving bins (300). When the solar cell is stopped by the said stopper (803) and rested on the belt assembly (500), it can be sorted into said receiving bin (300) which are positioned underneath by opening the belt assembly (500). The opening or closing of said belt assembly (500) is controlled by the said control unit which triggers the said actuator (111) to be activated and to effect the movement of said horizontal groove cam (115). When the actuator (111) is activated, said horizontal groove cam (115) which is driven by said actuator (111) through said linear bearing (113) is reciprocated to move up and down vertically at a predetermined period of time. At said horizontal groove cam (115), there is at least a pair of follower (not shown) and at least a pair of linkage arm (505) which is restrained by the groove on the said horizontal groove cam (115), whereby the arrangement is in such that the motion of said horizontal groove cam (115) imparts on the said followers and the said linkage arms (505). As the said drive rollers

(503) is connected to said linkage actuator assembly (110), if the said horizontal groove cam (115) is moved down vertically, the said pair of drive rollers (503) is triggered to decouple from said mechanical drive (405). Thus, said belt assembly (500) is opened and the solar cell is
5 unloaded by falling into the receiving bin (300) vertically. FIG. 11 shows the said belt assembly (500) is in opened position to unload the solar cell by dropping into receiving bin (300). After said solar cell fallen into the said receiving bin (300), the said belt assembly (500) is closed by the action of said horizontal groove cam (115) moves up
10 vertically to cause said pair of followers and said pair of linkage arm (505) to drive said pair of drive rollers (503) so that said belt assembly (500) is coupled with said second mechanical drive (406) and in closed position. The opening and closing action of said belt assembly (500) can be achieved in a predetermined of time so that said sorting
15 conveyor (100) is operated smoothly.

In addition to this, the width adjustment of said belt assembly (500) can be achieved easily by adjusting the distance between the conveyor belt component (507) of the corresponding pair, depending on the application. By having such width adjustment, said sorting
20 conveyor (100) can be used for sorting solar cells with different

dimensions and sizes. Upon completion of adjusting said belt component (507) of belt assembly to a predetermined position, the operation of said sorting conveyor (100) is commenced as explained above. FIG. 13 shows the different width adjustment of said belt
5 assembly (500) which is represented by the symbol of B and the symbol of C.

While the preferred embodiment of the present invention and their advantages have been disclosed in the above Detailed Description, the invention is not limited thereto but only by the scope
10 of the appended claim.

WHAT IS CLAIM IS:

1. A solar cell sorting conveyor (100), comprising of:

a conveyor belt assembly (500) which comprises of at least a
pair of drive rollers (503) and at least a pair of belt (501) which
5 are entrained around said pair of drive rollers (503);

a drive assembly (400) for moving said conveyor belt (501);

at least one control unit for triggering the function at said
solar cell sorting conveyor (100);

characterized in that

10 at least a pair of mechanical drive (405, 406) is used to couple
and decouple said drive assembly (400) and said belt
assembly (500).

2. A solar cell sorting conveyor (100) as claimed in Claim 1,
further comprises of a stopper assembly (800) to ensure the
15 solar cell to be positioned accurately before it is to be
transferred to receiving bin (300).

3. A solar cell sorting conveyor (100) as claimed in Claim 2, wherein said stopper assembly (800) comprises of at least one stop sensor (801) and at least one stopper (803) for sensing the passage of the solar cell.
- 5 4. A solar cell sorting conveyor (100) as claimed in Claim 3, wherein said solar cell is retained from being conveyed to next conveyor (100) by having said stopper (803) is extended and said conveyor belt (501) is decelerated.
5. A solar cell sorting conveyor (100) as claimed in Claim 3,
10 wherein said stopper (803) is retracted and said conveyor belt (501) is accelerated so that solar cell is allowed to be conveyed to next conveyor (100).
6. A solar cell sorting conveyor (100) as claimed in Claim 1, further comprises of a linkage actuator assembly (110) to drive
15 said belt assembly (500) either in opened or closed position.
7. A solar cell sorting conveyor (100) as claimed in Claim 6, wherein said linkage actuator assembly (110) comprises of at least one actuator (111), at least one linear bearing (113)

connected to at least one horizontal groove cam (115) so that said horizontal groove cam (15) is reciprocated to move up and down vertically when said actuator (111) is activated.

8. A solar cell sorting conveyor (100) as claimed in Claim 7,
5 wherein said linkage actuator assembly (110) further comprises of at least a pair of follower and at least a pair of linkage arm (505) which is retrained by the groove on said horizontal groove cam (115) so that said linkage actuator assembly (110) is able to drive said belt assembly (500) either in opened or closed
10 position through said drive rollers (503).
9. A solar cell sorting conveyor (100) as claimed in Claim 1, wherein said drive assembly (400) comprises of at least one electrical motor (401) and at least one driveshaft (403) to transform circular motion to linear motion at said conveyor belt
15 assembly (500).
10. A solar cell sorting conveyor (100) as claimed in Claim 1, wherein said mechanical drive (405, 406) includes a pair of friction drive or magnetic drive.

11. A solar cell sorting conveyor (100) as claimed in Claim 10,
wherein said friction drive (405, 406) can be in the form of a
roller with a rubber like material, which is able to create friction
and motion to another roller upon touching said roller.
- 5 12. A solar cell sorting conveyor (100) as claimed in Claim 1,
wherein at least one receiving bin (300) is positioned
underneath said solar cell sorting conveyor (100) so that when
said conveyor belt (501) is opened, said solar cell is unloaded
into said receiving bin (300).
- 10 13. A solar cell sorting conveyor (100) as claimed in Claim 1,
wherein said control unit is a programmable logic controller
(PLC) system.
14. A solar cell sorting conveyor (100) as claimed in Claim 1,
wherein the width adjustment of said belt assembly (500) is
15 achieved by adjusting the distance between the conveyor belt
component (507) of corresponding pair, depending on the
application or the dimensions or sizes of the solar cells to be
sorted.

15. A methodology of sorting solar cell using sorting conveyor (100), comprising the following steps:

- (i) transferring of solar cells by using conveyor belt (501);
- (ii) retaining of solar cell from being conveyed to next conveyor (100) if the solar cell is to be retained;
- (iii) conveying of solar cell to next conveyor if the solar cell is not to be retained.

characterized in that said step of retaining of solar cell is achieved by performing the following sub-steps:

- (a) retaining of solar cell by extending the stopper (803) and decelerating the conveyor belt (501);
- (b) activating the actuator (111) to effect the linear bearing (113) and the horizontal groove cam (115) to move down vertically; ;
- (c) triggering the pair of drive rollers (503) to decouple from said mechanical drive (406) so that said belt assembly (500) is opened;.

- (d) unloading of solar cell by falling vertically into said receiving bin (300) which is positioned underneath the said sorting conveyor (100).

16. A methodology of sorting solar cell using sorting conveyor (100), as claimed in Claim 15, wherein after said step of unloading of solar cell, the closing of conveyor belt (501) is achieved by performing the following sub-steps:
- (i) activating the actuator (111) to effect the horizontal groove cam (115) to move up vertically;
 - 10 (ii) triggering the pair of drive rollers (503) to couple from said mechanical drive (406) so that said belt assembly (500) is closed;
 - (iii) retracting the stopper (803) and accelerating the conveyor belt (501) to convey subsequent solar cells
15 continuously.

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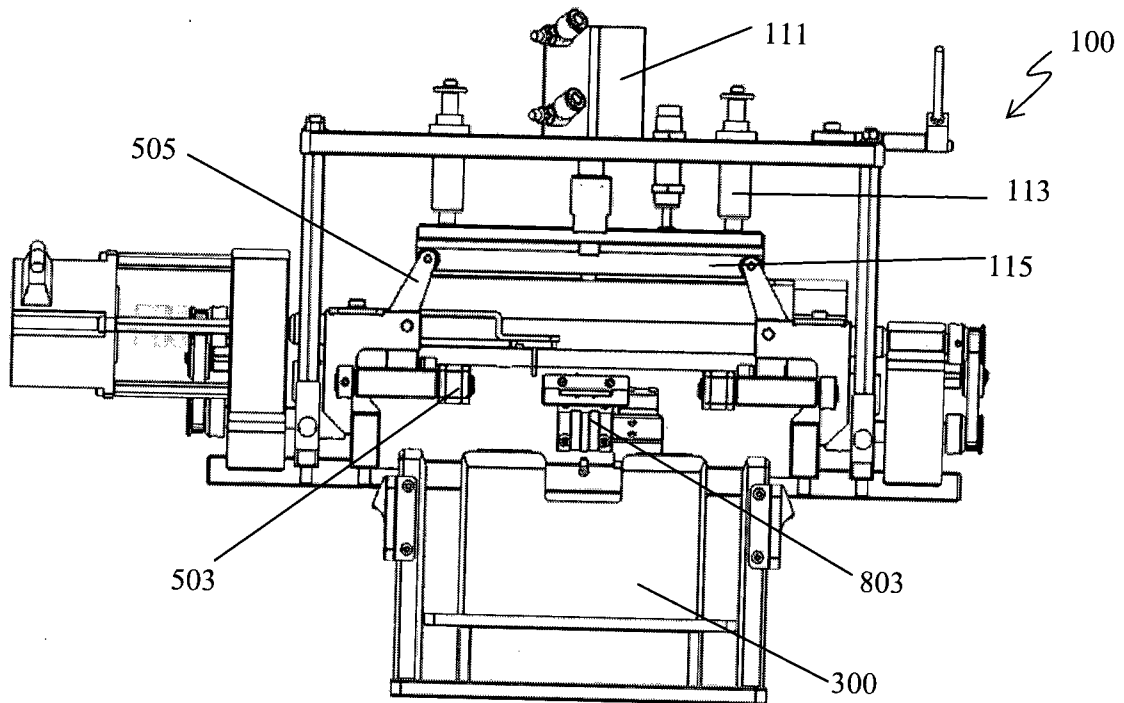


FIG. 1

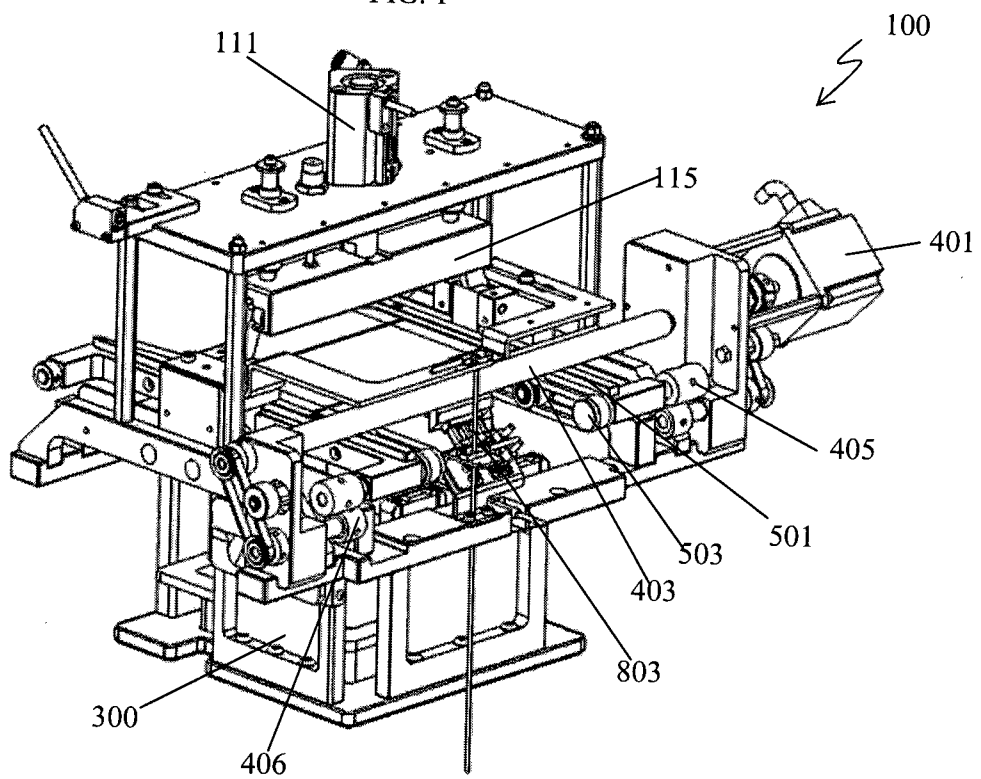


FIG. 2

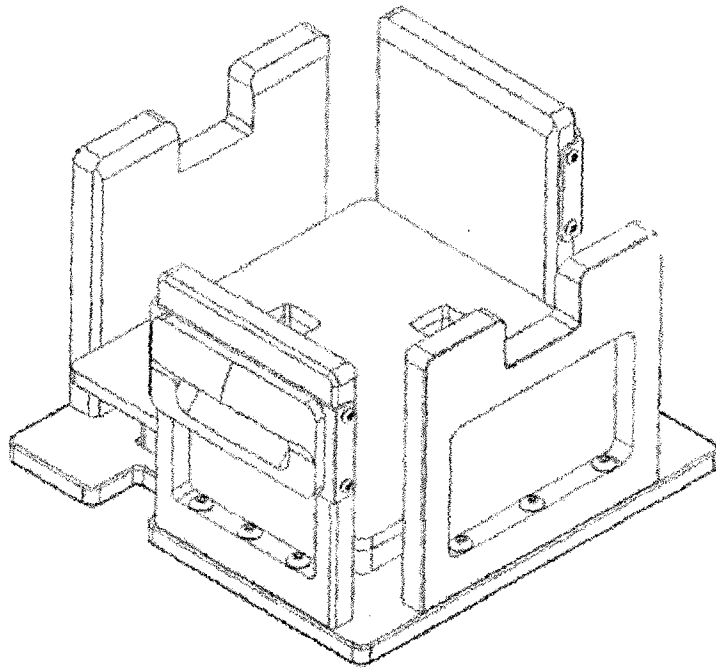
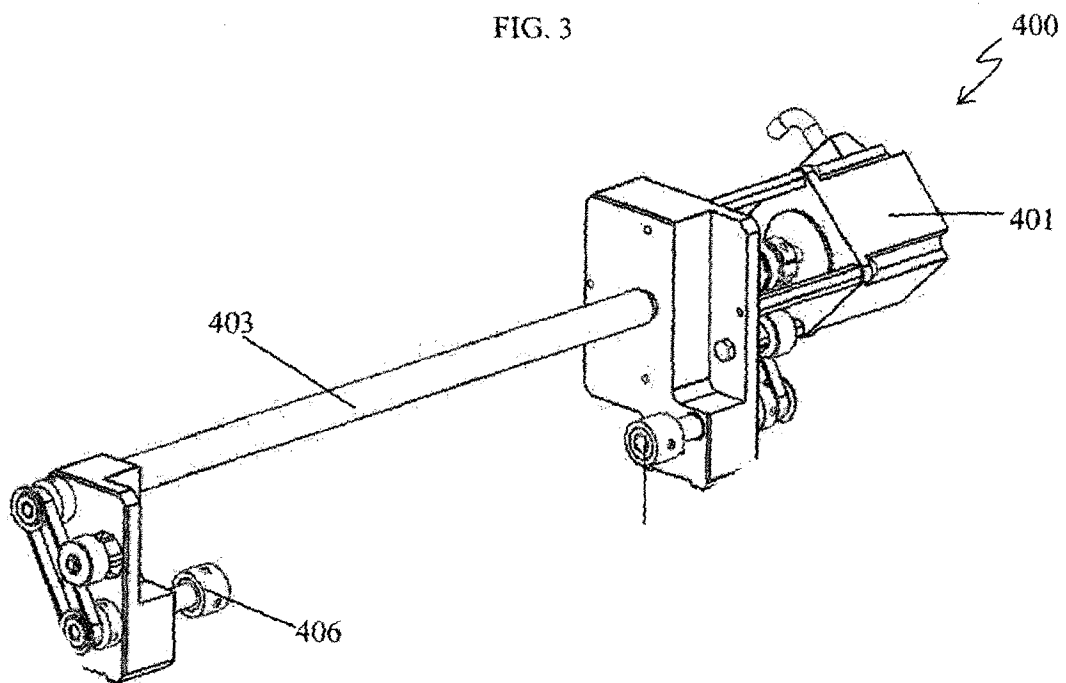


FIG. 3



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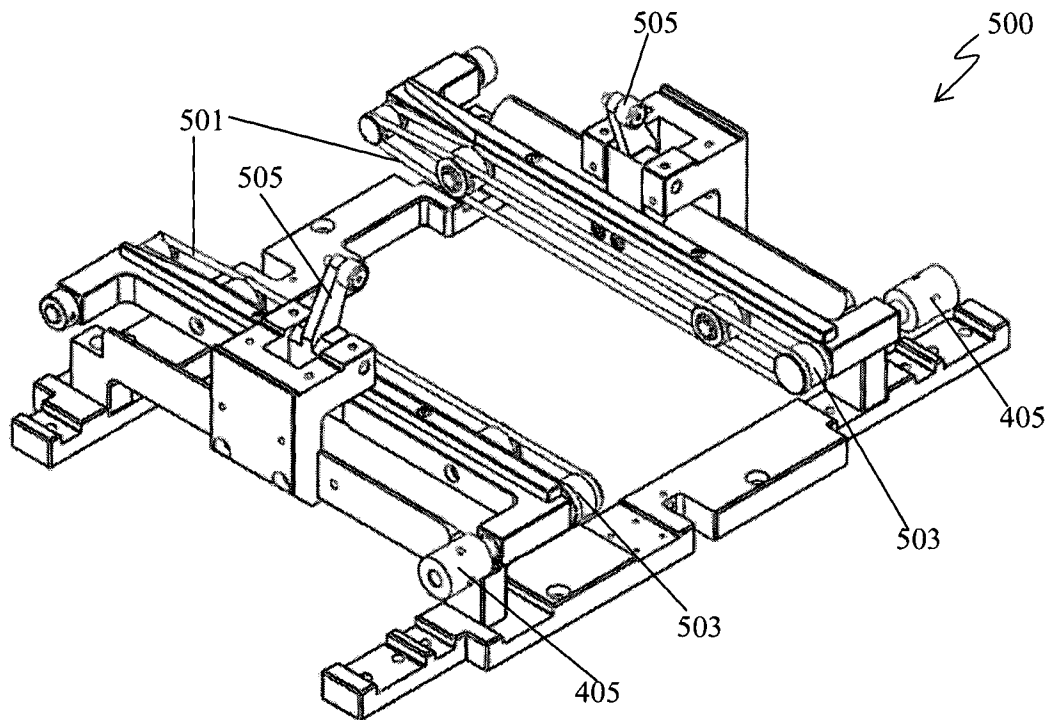


FIG. 5

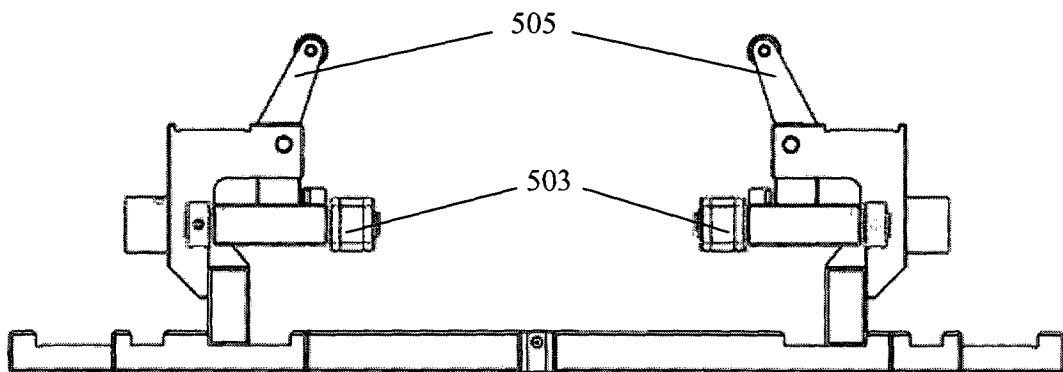


FIG. 6

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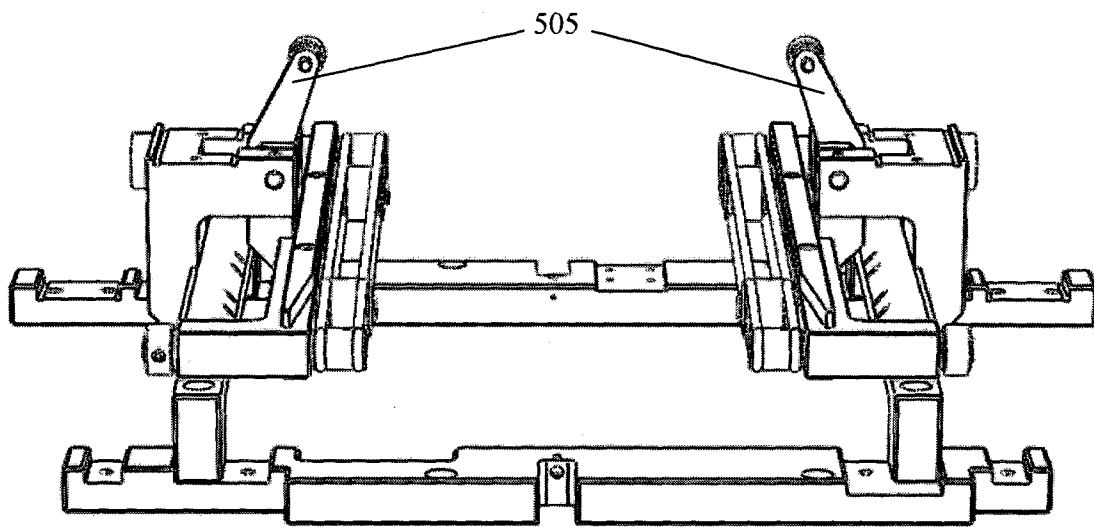


FIG. 7

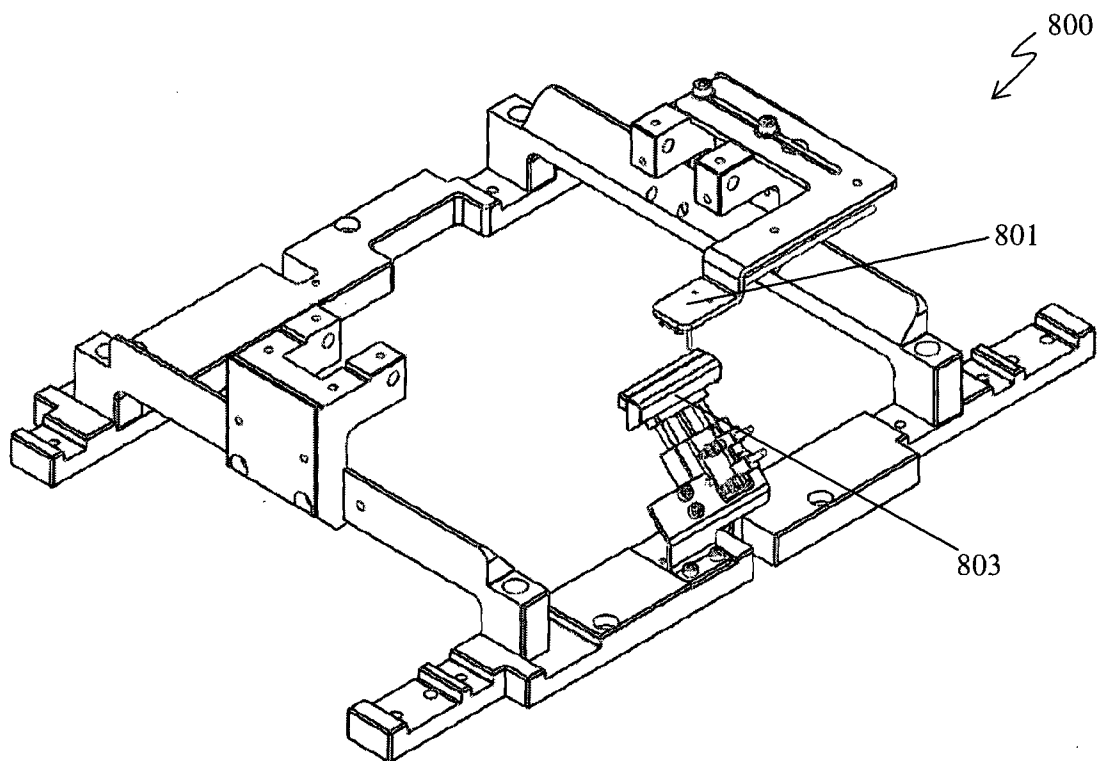


FIG. 8

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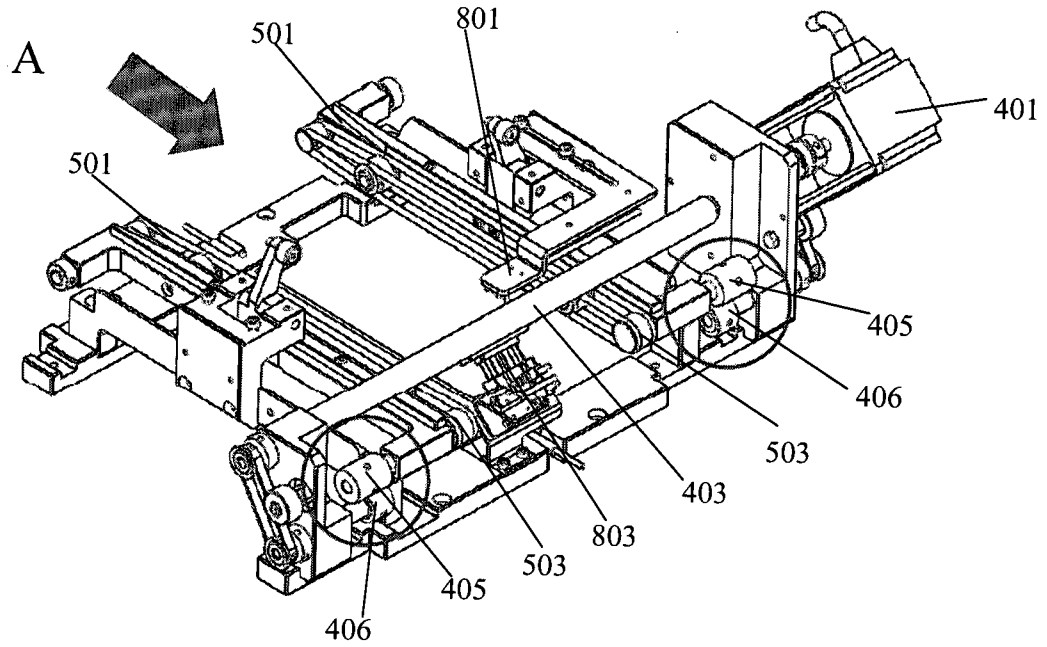


FIG. 9

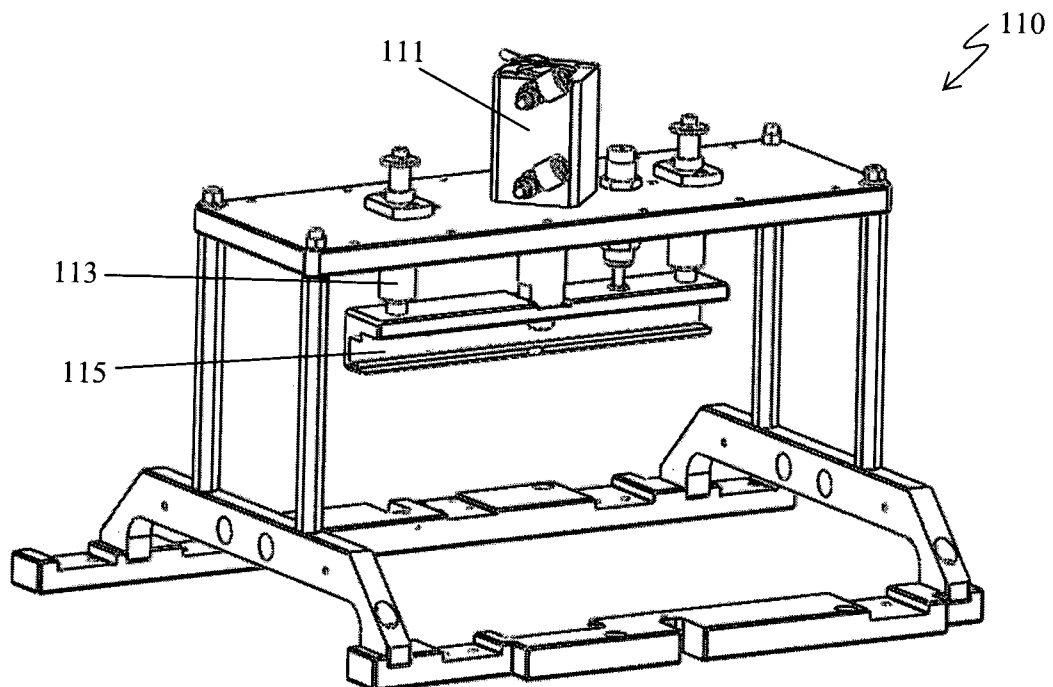


FIG. 10

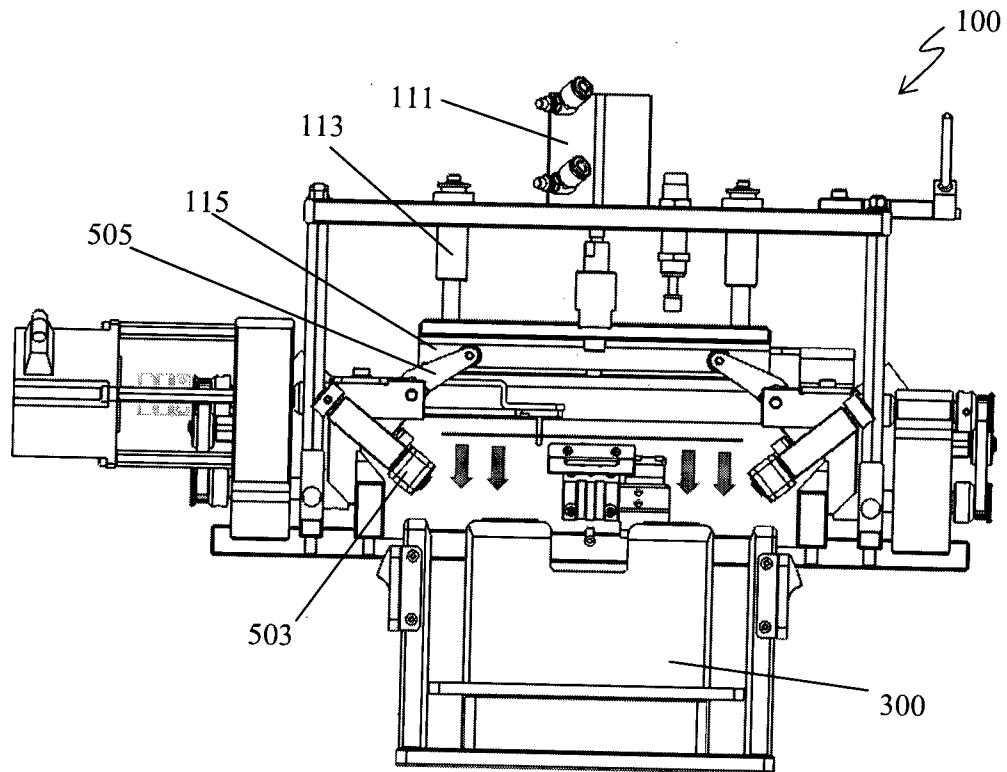


FIG. 11

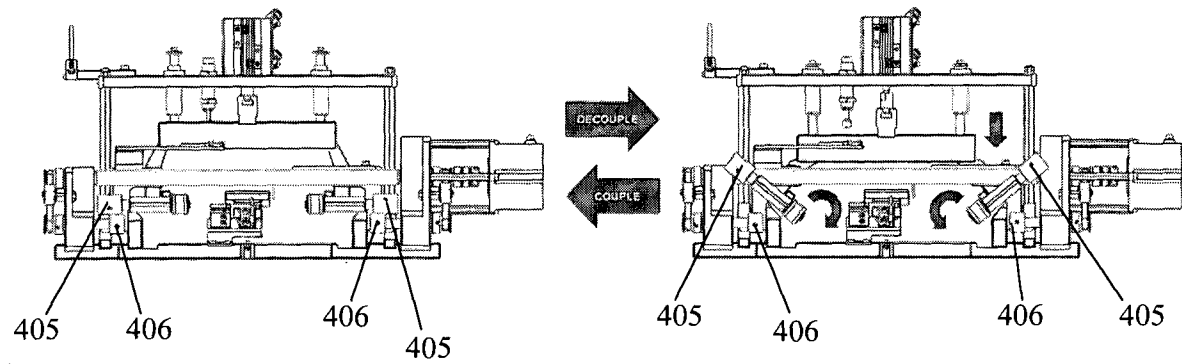


FIG. 12

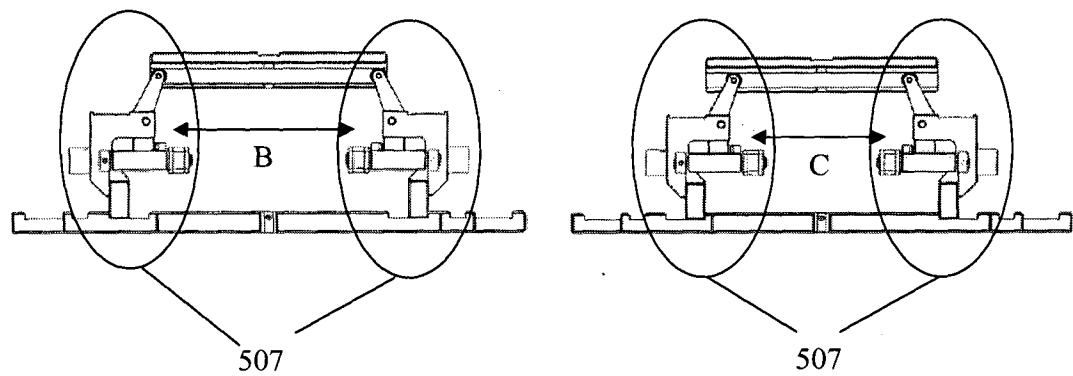


FIG. 13