The object of the invention is to create an improved printing apparatus, which guarantees easy, safe and fast transport of substrates from the conveyor to a printing device and back, without the need of a complex actuator.

Summary

According to an aspect, the present disclosure refers to a printing apparatus, in particular solar cells, wafers, circuit boards or the like, having at least one printing device, which is assigned at least one movable printing table, having a conveyor track, along which the substrates can be moved, and having a transport device for transporting the substrates from the conveyor track to the at least one printing device and back, and is characterized in that the transport device has at least one transport pendulum which can be pivoted or rotated about a pendulum axis and which has the printing table at at least one end at a distance from the pendulum axis, wherein the printing table can be pivoted by the transport pendulum into a first position assigned to the printing device for a printing operation and into a second position lying in the conveyor track, wherein the respective printing table has a conveying device which also forms the conveyor track in the second position of the printing table.

The object of the disclosure is achieved by a printing apparatus with the features of the above aspect. This printing apparatus has the advantage that the respective substrate is movable from the conveyor track to the printing device and back by a simple movement, which is achieved with particularly simple kinematics. At first, an actuator is sufficient to make the transport of the substrate possible. According to an example of the present disclosure, it is provided that the transport device has at least one transport pendulum which can be pivoted or rotated around a pendulum axis and which has a printing table at least one end at a distance from the pendulum axis, the printing table being pivotable by the transport pendulum into a first position assigned to the printing device for a printing operation and into a second position in the conveyor track, and the printing table having a conveying device in order to form the conveyor track in the second position as well. The transportation from the second position to the first position, or from the conveyor track to the printing device, thus takes place by means of a pivoting movement about the pendulum axis such that the printing table is moved along a circular path. Since the second position is in the conveyor track and the transport pendulum thus forms the conveyor track in the second position, a substrate is simply transported onto the

printing table by the conveyor track itself, whereby the conveying device of the printing table simplifies the transport of the respective substrate onto the printing table and from the printing table onto the conveyor track. The conveying device also ensures that the printing table itself forms the conveyor track, so that a substrate can easily be conveyed over the printing table in the second position, for example to transport it past the printing device to a processing device further back in the production line. The printing apparatus therefore also has the advantage that a kind of bypass for substrates is provided through which the substrates can easily be passed past the respective printing device. A further advantage resulting from the design of the printing apparatus according to the disclosure is that the transport pendulum can be designed to pivot, for example by only 180°, so that no rotary feed-through of matter is required, such as air, vacuum or electricity to be guided to the pressure table. As a result, a simple mechanism and connection technology can be used. This results in advantages both in terms of cost and in terms of endurance of the printing apparatus.

According to a preferred example of the disclosure, it is provided that in each case a printing table is arranged at at least two ends of the pendulum axis of the transport pendulum, whereby

the frequency or the throughput of the printing apparatus is increased. In doing so, the transport pendulum carries two printing tables, which can be transported from the first to the second position by pivoting the pendulum axis by means of the transport pendulum. The printing tables are preferably arranged such that when one of the printing tables is in the first position, the other printing table is in the second position.

In particular, the printing tables are arranged diametrically opposite each other with respect to the pendulum axis in order to allow an easy transport movement of the transport pendulum, in which whenever one of the printing tables is in the first position, the other is arranged in the second position. This makes it possible, for example, that a substrate resting on one of the printing tables can be printed, while another substrate is conveyed over the printing table positioned in the conveyor track. Thus, during the execution of a printing operation, the conveyor track is not interrupted and the conveyance of substrates is ensured, so that the overall throughput of substrates by the printing apparatus is increased in a simple manner. Due to the advantageous integration of the transport device into the conveyor track, a space-saving and constructively simple solution is also available.

Furthermore, according to an example, it is preferably provided that the respective conveying device has a drivable conveyor belt, in particular a vacuum belt, paper belt or the like, which forms a substrate support for the substrates on the respective printing table. By means of the conveyor belt, the substrates can be easily conveyed over the printing table by means of the conveying device. The respective conveyor belt forms the substrate support for the substrates on the printing table. This is optionally equipped with several suction openings, which can exert a suction effect on a substrate resting on the conveyor belt, in particular through the vacuum belt or an air-permeable paper belt, in order to keep it positioned on the printing table, in particular during the printing process. In addition, the vacuum fixation also ensures that the substrate remains securely on the printing table when the transport pendulum pivots. In contrast to the paper belt, the vacuum belt itself must have its own vacuum or suction openings and is otherwise preferably made of an air-impermeable material, in particular an elastically deformable material, which offers defined elastic support for the respective substrate, whereby the elasticity of the support is defined, for example, by its shore-hardness and can be adjusted by a suitable material selection. Preferably, the respective conveying device either has a conveyor belt which extends over at least substantially the entire printing table to provide a large support surface area for the respective

substrate, or at least two or more parallel conveyor belts on which the substrate can be placed and which together form the substrate supports.

The respective conveying device preferably has an exchangeable conveyor cartridge. Alternatively, the cconveying device is designed as a replaceable unit, for example in the form of a conveyor belt cartridge, with optional integrated drive direction. Thus, the conveyor belt is easily replaceable during maintenance or cleaning by replacing the conveyor cartridge. As a result, cost effective and fast maintenance and repair of the printing apparatus is possible.

Furthermore, according to an example, the disclosurepreferentially foresees that the conveyor track for each of the transport pendulums has an interrupted section, or an interruption, with the respective printing table filling or replacing the interrupted section in the second position in order to complete the conveyor track. The conveyor track thus has an interruption for the respective transport pendulum, which can be filled by one of the printing tables in order to continue the conveyor track. The printing table of the transport pendulum thus completes the conveyor track in the second position so that it forms a continuous conveyor track along which substrates can be conveyed past the one printing device to a further processing station, in particular a further printing device.

Furthermore, according to an example, it is preferred that the respective pendulum axis is aligned vertically so that the respective printing table is moved in a horizontal plane by the transport pendulum, and in particular pivoted. As a result, the transport pendulum is inexpensive and structurally easy to store. By pivoting around the vertical axis, the transport pendulum only requires sufficient space in the horizontal plane to avoid collision with other components of the printing apparatus. In order to form the conveyor track in the second position, the transport pendulum is pivotable, for example, such that the printing table assigned to the conveyor track comes to rest on the conveyor track and picks up substrates conveyed along the conveyor track and further conveys them by means of the conveying device. The printing table preferably has a feed slant and removal slant, which make it easier to lift and pick up the substrates from the conveyor track or to place the substrates on the conveyor track.

According to a preferred example of the disclosure, it is provided that at least the substrate support of each printing table is vertically displaceable. This ensures that the

respective substrate support is adjustable in height or can be raised or lowered. This ensures that the substrate support can be easily guided, especially into the conveyor track or into the vicinity of the print mask or

printing device. In particular, the transport pendulum is designed in such a way that the printing table is first moved below the conveyor track by the transport pendulum, which can be pivoted in the horizontal plane, and that the substrate support is lifted from below the conveyor track to complete the conveyor track, and inserted into the interruption of the conveyor track in order to fill or replace it. As a result, a simple completion of the conveyor track is ensured by the respective printing table or the transport pendulum in the second position of the printing table. In order to ensure easy insertion and positioning of the printing table in the first and/or second position, a centering apparatus, in particular a centering guide, is optionally assigned to the conveyor track, in particular to the printing table and/or the substrate support.

According to a preferred example of the disclosure, it is intended that the first and/or second position of the respective printing table and/or at each printing table of the respective substrate, the support is assigned a lifting device for the respective substrate support. If the lifting device is arranged on the respective printing table in order to be able to raise or lower the substrate support located there if necessary, an additional actuator is to be carried along with the printing table, which ensures the raising and lowering of the substrate support. Although this ensures individual operation of the substrate supports in terms of lifting, it does require appropriate installation space on the respective printing table for the respective lifting device. If the respective lifting device is assigned only to the first or second position of the respective printing table, i.e. as a stationary lifting device of a printing apparatus, then the respective printing table can be constructed to save space and the transport pendulum can be realized with little intrinsic mass. The stationary lifting devices are especially designed to lift the substrate support of one of the first or second positioned printing tables. For this purpose, the lifting device comprises, for example, one or more punches, rams or the like, which can be passed either past the respective printing table or through an opening of the respective printing table in order to lift the substrate support and/or substrates positioned on the printing table. For this purpose, for example, the lifting device, by means of the ram or puncher, cooperate with the conveying device to raise or lower the conveyor belt as a whole. As a result, a simple and inexpensive lifting device is realized. Alternatively, the respective lifting device is designed to lift the entire printing table or the entire transport pendulum in order to lift the substrate support as well. For this purpose, the respective lifting device is, for example, assigned to the first or second position in such a way that it is able to raise or lower the respective printing table as

required, i.e. to adjust its height (z-direction). In order to ensure safe interaction between the stationary lifting device and the movable printing table, it is in particular provided that centering aids are assigned to the lifting

device which ensure safe feeding of the ram and/or puncher to the substrate support in the first or second position of the printing table. According to a further example of the disclosure, it is preferably provided that the respective lifting device is moved along with the transport pendulum.

According to an alternative example of the disclosure, it is provided that in each case the entire transport pendulum can be raised and lowered by the lifting device or adjusted in height in order to ensure the previously described arrangement of the printing tables and supply to the printing device or conveyor track. As a result, the number of lifting devices for the respective transport pendulum is reduced to one.

In particular, the respective lifting device is thus configured to lift a substrate from a transport position to a printing position on the printing device or into a conveying position on the conveyor track. This results in the advantages already specified above.

Furthermore, according to an example, it is preferably provided that the transport device has at least one further transport pendulum which is designed as the other transport pendulum and is arranged next to it. Thus, the printing apparatus has at least two transport pendulums, which are arranged side by side. The conveyor track has interruptions corresponding to the number of transport pendulums, so that each transport pendulum is assigned a second position in or on the conveyor track in which a printing table of the respective transport pendulum can be arranged in order to form the conveyor track as described above.

According to an example, the transport pendulums are preferably arranged so close to each other that the movement paths of their printing tables overlap. As a result, the printing apparatus is designed particularly space-saving. Appropriately, the transport pendulums are driven in such a way that they do not collide with each other during operation. This results in an operation of the transport pendulums similar to that of a roots blower, for example. Therefore, the transport pendulums are formed in a roots arrangement.

According to an example, the transport pendulums are preferably mechanically or electrically coupled to each other in order to, in particular, implement the drive described above. Due to the mechanical coupling, a collision of adjacent transport pendulums can be reliably and

permanently avoided. In addition, an additional drive for the additional transport pendulum is not necessary. This results in a compact and energy-saving embodiment of the printing apparatus. As a result of the electrical

coupling, the actuators assigned to the transport pendulums are actuated independently of one another in order to achieve the pivoting of the respective transport pendulum. The electrical coupling allows an individual transport pendulum drive, which also allows, for example, that the transport pendulums are at least temporarily aligned parallel to each other. This results in further freedoms in the operation of the printing apparatus. Optionally, the conveying devices of the printing tables, in particular those of a transport pendulum, are driven together.

Furthermore, according to an example, it is preferably provided that the transport tables are assigned in their first position of a common printing device or in each case a separate printing device. Thus, the two transport pendulums can interact with a single printing device or with two different or at least separately formed printing devices that can be operated in particular independently. Depending on process requirements, combinations of filter adjustment mechanics, a common metering blade and/or flood movement axis or multiple filters can be formed together. Individual elements can also be provided in duplicate, i.e. not together, but separately.

According to a further example of the disclosure, it is preferably provided that the pendulum axis is aligned horizontally, so that the respective printing table is pivoted or rotated by the transport pendulum in a vertical plane. Thus, a printing table is raised by the transport pendulum and guided along a circular path to the printing device or the conveyor track. As a result, space can be saved in particular in the direction of the conveyor track, but space in the vertical plane of the transport pendulum movement is certainly required.

In the following, the invention will be explained in more detail with reference to the drawing. For this

Figure 1 shows an advantageous printing apparatus from its side view,

Figure 2 shows the printing apparatus from its top view,

Figure 3 shows a detailed illustration of the printing apparatus and

Figures 4A and 4B show the printing apparatus in different operating states to explain their functions.

Figure 1 shows a simplified side view of a printing apparatus 1, which is adapted to substrates such as solar cells, wafers, printed circuit boards or the like, to be printed by means of a

CLAIMS

1. Printing apparatus for printing substrates, in particular solar cells, wafers, circuit boards or the like, having at least one printing device, which is assigned at least one movable printing table, having a conveyor track, along which the substrates can be moved, and having a transport device for transporting the substrates from the conveyor track to the at least one printing device and back, and is **characterized in that** the transport device has at least one transport pendulum which can be pivoted or rotated about a pendulum axis and which has the printing table at at least one end at a distance from the pendulum axis, wherein the printing table can be pivoted by the transport pendulum into a first position assigned to the printing device for a printing operation and into a second position lying in the conveyor track, wherein the respective printing table has a conveying device which also forms the conveyor track in the second position of the printing table.

2. Printing apparatus according to claim 1 is **characterized** in that a respective printing table is arranged at at least two ends of the transport pendulum at a distance from the pendulum axis.

3. Printing apparatus according to any of the preceding claims, **characterized** in that the printing tables are arranged diametrically opposite each other to the pendulum axis.

4. Printing apparatus according to any of the preceding claims, **characterized** in that the respective conveying device has a drivable conveyor belt, in particular a vacuum belt, paper belt or the like, which forms a substrate support for the substrate on the upper side of the respective printing table.

5. Printing apparatus according to any of the preceding claims, **characterized** in that the respective conveying device has an exchangeable conveyor belt cartridge.

6. Printing apparatus according to any of the preceding claims, **characterized** in that the conveyor track has an interruption for each of the transport pendulums, which can be filled or replaced by a respective printing table in order to complete the conveyor track.

7. According to one of the preceding claims, the printing apparatus is **characterized** in that the pendulum axes are vertically aligned, so that the respective printing table is movable in a horizontal plane by the transport pendulum.

8. Printing apparatus according to any of the preceding claims, **characterized** in that at least the substrate support of each printing table is vertically displaceable.

9. Printing apparatus according to any of the preceding claims, **characterized** in that at the first and/or second position of the respective printing table and/or at each printing table a lifting device is arranged for the respective substrate support.

10. Printing apparatus according to any of the preceding claims, **characterized** in that the respective lifting device is designed to lift a substrate from a transport position to a printing position on the printing apparatus and/or into a conveying position on the conveyor track.

11. Printing apparatus according to any of the preceding claims, **characterized** in that the transport device has at least one further transport pendulum which, like the other transport pendulum, is arranged and assigned next to the one transport pendulum.

12. Printing apparatus according to any of the preceding claims, **characterized** in thatthe transport pendulums are arranged close to one another in such a way that the movement paths of the printing tables overlap.

13. Printing apparatus according to any of the preceding claims, **characterized** in that the transport pendulums are mechanically or electrically coupled to each other, so that colliding of the printing tables with each other is prevented.

14. Printing apparatus according to any of the preceding claims, **characterized** in thatthe transport pendulums are assigned in their first position to a common printing device or in each case to a separate printing device.

15. Printing apparatus according to any of the preceding claims, **characterized** in that the respective pendulum axis is oriented horizontally so that the respective printing table can be moved in a vertical plane by the transport pendulum.