

Title of invention: Equipping a conveying unit during the production of solar modules

The invention relates to a method for producing solar modules, wherein solar elements are combined to form lines, wherein each line comprises at least two solar elements and wherein the solar modules are constructed from electrically interconnected lines.

5 The solar elements which are combined to form lines may be solar cells, photovoltaic solar cells, photovoltaic cells or partially sectioned parts thereof, what is known as shingle, that is to say for example solar cell shingle or photovoltaic cell shingle.

10 In such a method, individual solar elements or basic elements of a solar cell may be passed in lines onto a transfer unit, the transfer unit may be displaced into an assembling region and in the assembling region the solar elements may be deposited in lines on a tray or another conveying unit, in particular a motorized conveying unit. The depositing of the solar element on the motorized conveying unit for provision of a solar module is also referred to as equipping the solar module. The assembling region is therefore also referred to as equipping, mounting or construction region.

15 For the equipping of the solar module, in particular of a one-piece solar module, the lines, that is to say the lines of solar elements or solar elements arranged in lines, may be arranged so as to overlap one another along a longitudinal axis of two lines arranged next to one another. In the region of overlap, an adhesive or another fastening means for connecting the lines arranged next to one another may be applied. The adhesive may be applied, for
20 example, to the solar elements or to the lines located on the transfer unit. For the application of the adhesive, delivery units may be used. By way of example, dispensers which can carry out linear applications of adhesive may be used. As an alternative, the adhesive may be applied by a printing apparatus. By way of example, the adhesive may be applied by means of a printing method, such as web-fed printing or screen printing. The lines provided with the adhesive may
25 be aligned with one another and connected to one another on the motorized conveying unit and thus be combined to form a solar module.

30 In such methods, the time required between the provision of an individual solar element and the equipping of a solar module with the individual solar element, also referred to as the cycle time, plays a decisive role. A shortened cycle time leads to a considerable shortening of the processing time for producing the entire solar module. The object on which the invention is based is therefore to increase the efficiency of a method for producing solar modules, in particular to accelerate such a method.

In the case of the method of the type mentioned in the introduction, this object is achieved in particular in that, for the equipping of the solar module, at least two lines are picked up in one operation and held ready at different heights above the solar module, and in that, for the equipping of the solar module, the lines are lowered together in each case only to the extent that only the respective line currently to be equipped contacts the solar module.

The invention is based on the realization that the cycle time can be shortened by simultaneously carrying out individual method steps for a plurality of solar cells. By way of example, in the method according to the invention, a plurality of lines, that is to say at least two lines, are picked up in one operation from the transfer unit by a pick-up apparatus, in order to deposit these on the motorized conveying unit in a subsequent step. The motorized conveying unit constitutes, for example, a tray or a conveyor belt. In this case, the method according to the invention furthermore allows at least two lines to be successively deposited, which overlap after the deposition. In this way, the number of pick-up processes and the travel of the pick-up apparatus within a production process of a solar module is reduced and the time required for the production method is shortened. The efficiency of the method mentioned in the introduction is thus increased.

In one refinement, provision is made for the remaining lines to remain vertically spaced apart from the solar module. By way of example, two or three lines are picked up simultaneously by the pick-up apparatus and provided above the solar module. In the method according to the invention, the pick-up apparatus is able to move toward the solar module in a vertical direction until a first line, or the line currently to be equipped, contacts the solar module, for example contacts it so as to overlap a previously deposited line, and a second and third line, or the remaining lines, continue to remain vertically spaced apart from the solar module by their vertical spacing when the solar module is contacted by the first line. In this way, the pick-up apparatus can equip the solar module with a line while simultaneously guiding a plurality of lines. In one or more further deposition steps, the solar module can be equipped with the further lines.

In one refinement, provision is made for the lines to be picked up by means of suckers which are preferably vertically adjustable counter to a restoring force. By way of example, the solar elements arranged in lines are each picked up by means of at least one sucker. In this case, the suckers may be arranged in such a way that the suckers for the first line protrude in the vertical direction beyond the suckers for the second line in the direction of the lines to be picked up. The suckers for the second line may in turn protrude vertically beyond suckers for a further, third line in the direction of the lines, etc. This enables selective pick-up or selective deposition

of an individual line, for example the deposition of the first line without depositing the second line. The suckers which are vertically adjustable for example counter to a restoring force allow a further, second line to be picked up and deposited after the first line has been picked up or deposited, in particular prior to one or more further, third lines being picked up or deposited. In
5 other words: this thus allows a plurality of lines to be jointly picked up, in particular with a subsequent selective deposition of the jointly picked-up lines.

As a further possibly independent aspect, in the case of the method of the type mentioned in the introduction, the object mentioned in the introduction is alternatively achieved in particular in that two successive lines cover different distances during the equipping process.
10 By way of example, the pick-up apparatus is moved perpendicularly with respect to the lines, i.e. perpendicularly with respect to a longitudinal direction of the lines, during the equipping process. By way of example, a first line and at least a second line are picked up by the pick-up apparatus. In this case, the pick-up apparatus is moved, e.g. displaced in a motorized or mechanical manner, perpendicularly with respect to and relative to the first line for example
15 after the first line has been deposited on the motorized conveying unit and prior to deposition of the second line on the motorized conveying unit. In this way, during the equipping, a movement of the motorized conveying unit is supplemented and/or replaced by a movement of the pick-up apparatus, which moves the lines from the transfer unit onto the conveying unit. This makes it possible for the individual lines to be arranged on the conveying unit in an
20 effective manner in terms of time and space.

In one embodiment of the method, provision is made for two successive lines to be picked up in one operation during an equipping process for equipping the solar module. It is also possible for the two successive lines to cover distances of differing length during the equipping process.

25 In one refinement, provision is made for the solar module to remain positionally fixed during the equipping process with the two successive lines. In other words: in this refinement, the conveying unit is not moved during the equipping. In this refinement, after the first line has been deposited, the pick-up apparatus may move perpendicularly with respect to the deposited first line, in order for the second line for equipping the solar module to be deposited on the
30 conveying unit so as to adjoin and overlap the first line. In this way, the relative arrangement of the lines is determinable or settable at least also by the movement of the pick-up apparatus. As an alternative, the conveying unit is moved during the equipping.

In one refinement, provision is made for the solar module to be moved in a clocked manner between two equipping processes. A clocked movement of the solar module or of the

conveying unit may be advantageous during the equipping of the conveying unit with the lines. During the equipping, the lines are aligned with one another and connected to one another on the conveying unit. A clocked forward movement makes it possible to provide space at the equipping location for new rows to be arranged on the conveying unit. It is thus conceivable
5 for the pick-up apparatus to move, in order to successively deposit all the picked-up lines, while the conveying unit moves when the pick-up apparatus is intended to pick up a new load.

In one refinement, provision is made for the solar module to be moved in a clocked manner between two equipping processes, namely between a deposition of the lines which are picked up in the one operation and a deposition of further lines which are picked up in a further
10 operation.

In this way, the relative arrangement of the lines during the equipping is determinable solely by the movement of the pick-up apparatus, while the movement of the conveying unit enables a smaller and thus shorter travel of the pick-up apparatus during the equipping. In this way, the equipping of the conveying unit can be carried out in a simplified, in particular more
15 rapid, manner and with increased precision.

In one refinement, provision is made for the solar module to be moved continuously during the equipping process. In particular, the solar module is moved perpendicularly with respect to the lines during the equipping process. In other words: the conveying unit is moved continuously during the equipping process. In this way, the production process of the solar
20 modules can be further accelerated. This is in particular because a line is moved further during and after the equipping of the module with this line and thus a subsequent method step is reached more rapidly.

In a subsequent method step, the solar modules may be moved, for example, for thermal treatment, i.e. for curing of the adhesive means in a region of thermal action, for example in a
25 furnace. In this case, the solar modules may still be located on the conveying unit. Here, the continuous movement of the conveying unit is advantageous. This is because a clocked movement produces regions of overlap of the thermal action, produced by a different dwell time of the rows of solar cells under thermal action, which results in thermal action which is too strong or too weak and thus a striped pattern. By contrast, in the case of a continuous
30 movement of the solar module or of the conveying unit, the solar module is moved uniformly through a region of thermal action, the adhesive applied to and between the lines curing in said region.

The movement of the conveying system may be compensated by a corresponding movement of the pick-up apparatus during the deposition of a line. In this way, a movement of

the conveying unit relative to the pick-up apparatus during the deposition of the line can be prevented. As an alternative, the duration of the deposition process may be selected such that, in particular may be selected to be so short that, the described relative movement during the depositing of the line is negligible.

5 As a further possibly independent aspect, the object mentioned in the introduction is achieved in particular by providing an apparatus for producing solar modules, wherein solar elements are combined to form lines, wherein each line comprises at least two solar elements and wherein the solar modules are constructed from electrically interconnected lines, wherein the apparatus comprises a pick-up apparatus which is designed, for the equipping of the solar
10 module, to pick up at least two lines in one operation and to hold them ready at different heights above the solar module and, for the equipping of the solar module, to lower the lines together in each case only to the extent that only the respective line currently to be equipped contacts the solar module.

In one refinement, provision is made for the pick-up apparatus to be designed to hold
15 the remaining lines vertically spaced apart from the solar module.

In one refinement, provision is made for the pick-up apparatus to comprise suckers which are preferably vertically adjustable counter to a restoring force and which are designed to pick up the lines, in particular to jointly pick up the lines in one working step.

As a further possibly independent aspect, the object mentioned in the introduction is
20 achieved in particular by providing an apparatus for producing solar modules, wherein solar elements are combined to form lines, wherein each line comprises at least two solar elements and wherein the solar modules are constructed from electrically interconnected lines, wherein the apparatus comprises a pick-up apparatus which is designed to cover different distances for at least two successive lines during the equipping process. To this end, the pick-up apparatus
25 may be displaced in a running direction of the conveying apparatus and/or in the vertical direction, for example in a direction along the lines.

In one refinement, provision is made for the apparatus, in particular its pick-up apparatus, to be configured to pick up two successive lines in one operation during an equipping process for equipping the solar module.

30 In one refinement, provision is made for the pick-up apparatus to be configured to cover distances of differing length for at least two successive lines during the equipping process.

In one refinement, provision is made for the pick-up apparatus to preferably be movable relative to the solar module during the equipping process, in particular to be movable in a direction transverse to the lines. As an alternative or in addition, the pick-up apparatus may

preferably be movable in a direction longitudinally with respect to the lines during the equipping process.

In one refinement, provision is made for the apparatus to comprise a conveying unit for accommodating the solar module and for the apparatus to be designed to hold the conveying unit positionally fixed during the equipping process with the two successive lines.

In one refinement, provision is made for the apparatus to be designed to move the conveying unit in a clocked manner between two equipping processes. In one refinement, provision is made for the apparatus to be designed to move the conveying unit in a clocked manner between two equipping processes, namely between a deposition of the lines which are picked up in the one operation and a deposition of further lines which are picked up in a further operation.

In one refinement, provision is made for the apparatus to be designed to move the conveying unit continuously, in particular during the equipping process.

The invention will be described in more detail below on the basis of a plurality of preferred exemplary embodiments.

In the figures:

figure 1A shows a three-dimensional view of a first apparatus for producing solar modules,

figure 1B shows a top view of the first apparatus,

figure 2A shows a three-dimensional view of a second apparatus for producing solar modules,

figure 2B shows a top view of the second apparatus,

figure 2C shows a side view of the second apparatus,

figure 3A shows a three-dimensional view of a third apparatus for producing solar modules,

figure 3B shows a top view of the third apparatus,

figure 3C shows a side view of the second apparatus,

figures 4A-H show a first pick-up apparatus, a transfer unit and a conveying unit of the first, second or third apparatus in side views and in different arrangements according to different method steps,

figure 5A shows a side view of a second pick-up apparatus of the first, second or third apparatus, and

figure 5B shows a three-dimensional view of the second pick-up apparatus above a conveying unit of the first, second or third apparatus, and also an exploded illustration of an

enlarged detail of the pick-up apparatus.

Figure 1A shows a three-dimensional view of a first apparatus 1 for producing solar modules 14. The apparatus 1 comprises a conveying unit 2, a transfer unit 3 and a pick-up apparatus 4. As illustrated in figure 1A, solar elements 15 are arranged on the transfer unit 3, which are combined to form lines. In the present example, the solar elements 15 are of elongate design in the form of what is known as shingle. Solar elements 15 which are strips of a wafer are also referred to as shingle. The lines arranged on the transfer unit 3 are picked up by the pick-up apparatus 4 and deposited onto the conveying unit 2. In one or more preceding steps, the solar elements 15 are provided on a providing unit 5 and placed on the transfer unit 3 by a handling unit 6. The preceding step or steps may be controlled by a monitoring system 13, for example a sensor and/or camera system.

The individual solar elements 15 of different rows may each be arranged on the transfer unit 3 next to one another spaced apart in a direction perpendicular to the rows (or perpendicular to a longitudinal direction of the rows). As an alternative, as illustrated in figure 1A, the individual solar elements 15 of different rows may be spaced apart in a transverse direction with respect to the rows and be offset relative to one another in a longitudinal direction with respect to the rows, in what is known as a wall pattern.

The transfer unit 3 may move parallel, that is to say in a direction along the lines, to the lines deposited on the conveying unit 4. The transfer unit 3 may move relative to the conveying device 4. In this way, the transfer unit 3 can move from a first position, in which the transfer unit 3 is equipped with the solar elements 15 by the handling unit 6, to a second position, in which the lines are picked up by the pick-up apparatus 4 and deposited onto the conveying unit 4. On the way from the first to the second position, the solar elements 15, or the lines, are provided with an adhesive means along at least a longitudinal axis of the lines. The adhesive means is applied by a plurality of delivery units, in the shown example by a plurality of dispensers 7, for example by one dispenser per line. As an alternative, the adhesive means may be applied by only one dispenser 7 (see figures 3A-3C). As an alternative, the adhesive means is applied by means of a printing method, for example screen printing or web-fed printing, by means of printing units, for example screen printing units or web-fed printing units.

After the adhesive means has been applied, the lines arranged on the transfer unit 3 can be connected, on the conveying unit 4, to lines which have already been deposited on said conveying unit. A newly deposited line is connected by virtue of the line to be newly deposited being deposited in a partially overlapping manner on a line which has already been deposited

previously, the adhesive means coming into contact both with the line which has already been deposited previously and with the new line to be deposited. In other words, the lines arranged on the conveying unit 4 partially overlap, in particular in a region of the applied adhesive means.

In a subsequent method step, the lines which are arranged on the conveying unit 2 and which are combined to form a solar module 14 can be moved on the conveying unit 2. The conveying unit 2 is, for example, a tray or a conveyor belt. The conveying unit 2 may be a motorized conveying unit. In the next method step, the equipped solar module 14 is guided for example into a region of thermal action, for example into a furnace, in order to cure the adhesive and to thus fixedly connect the lines within the solar module 14 to one another.

The conveying unit 2 may be moved continuously or in a clocked manner during and/or after the equipping process. In particular, the conveying unit 2 can be moved continuously during the equipping process and after the equipping process. As an alternative, the conveying unit 2 may be moved in a clocked manner during the equipping process and continuously after the equipping process.

Figure 1B shows a top view of the first apparatus 1 from figure 1A. Identical or similar features are provided with identical reference designations.

Figure 2A shows a three-dimensional view of a second apparatus 1A for producing solar modules 14. The second apparatus 1A is similar to the first apparatus 1 shown in figures 1A and 1B. Identical or similar features are provided with identical reference designations. Instead of the transfer unit 3 of the apparatus 1, the apparatus 1A comprises a transfer unit 3A. The transfer unit 3A is designed as a conveyor belt. The conveyor belt extends from the first position, described with reference to figure 1, of the transfer unit 3 to the second position of the transfer unit 3. The conveyor belt is movable parallel to the lines arranged thereon and parallel to the lines deposited on the conveying unit 2. In other words, the conveyor belt is movable in a longitudinal direction of the lines. In this way, the solar elements 15 deposited on the transfer unit 3A and arranged in lines can be moved by movement of the conveyor belt from the first position to the second position, from which they are deposited onto the conveying unit 2 by means of the receptacle 4.

Figure 2B shows a top view of the second apparatus 1A. Figure 2C shows a side view of the second apparatus 1A. Identical or similar features are provided in each case with identical reference designations.

Figure 3A shows a three-dimensional view of a third apparatus 1B for producing solar modules 14. The third apparatus 1B is similar to the first apparatuses 1 and second apparatus 1A illustrated in figures 1A-1B and 2A-2C. Identical or similar features are provided with

identical reference designations.

Instead of the conveying unit 2 of the first apparatus 1, the apparatus 1B comprises a conveying unit 2A which is designed as a conveyor belt. Instead of the transfer unit 3A of the second apparatus 1A, said transfer unit being shown in figures 2A-2B, the third apparatus 1B comprises a transfer unit 3B which is designed as a conveyor belt. The conveyor belt 3B is movable perpendicularly with respect to the lines which are arranged on the conveyor belt. Correspondingly, the conveying unit 2A, the transfer unit 3B, the handling unit 6 and the providing unit 5 are arranged in a row perpendicularly with respect to the lines on the conveying unit 2A and on the transfer unit 3B.

Similarly to the arrangement of the third apparatus 1B shown in figure 3A, it is conceivable for the transfer unit 3 of the first apparatus 1 shown in figures 1A and 1B to be arranged in series with the conveying unit 2, the handling unit 6 and the providing unit 5. In such an arrangement, the transfer unit 3, similarly to the transfer unit 3B, may be movable perpendicularly with respect to the lines arranged on the transfer unit 3 or on the conveying unit 2. As an alternative, in such an arrangement the first position of the transfer unit 3, in which the transfer unit 3 is equipped with the solar elements 15 by the handling unit 6, may correspond to the second position of the transfer unit 3, in which the solar elements 15 are picked up from the transfer unit 3 by the pick-up apparatus 4 and deposited on the conveying unit 2. In this way, the transfer unit would not have to be moved between the loading and unloading thereof. In this case, the arrangement shown in figure 3A has, inter alia, the advantage that the transfer unit 3B can simultaneously be unloaded by the pick-up apparatus 4 and loaded by the handling unit 6.

Figure 3B shows a top view of the third apparatus 1B. Figure 3C shows a side view of the third apparatus 1B. Identical or similar features are provided in each case with identical reference designations.

Figure 4A shows the pick-up apparatus 4, which is arranged above the transfer device 3. The transfer unit 3 is in turn arranged above the conveying unit 2. In other words, the transfer unit 3 is arranged in the second position of the transfer unit 3, said second position being described with reference to figure 1. As an alternative, the transfer unit 3 of the first apparatus 1 may be the transfer unit 3A of the second apparatus 1A or the transfer unit 3B of the third apparatus 1B. The conveying unit 2 of the first apparatus 1 may be the conveying unit 2A of the third apparatus 1B.

The pick-up apparatus 4 comprises one or more suckers. In the shown example, the pick-up apparatus comprises a plurality of suckers which are arranged in rows and by means of

which the lines can be picked up by the pick-up apparatus 4. In the shown example, the suckers are arranged in three rows. In the shown example, the respective rows of suckers extend perpendicularly with respect to the image plane. In this case, the suckers are arranged such that a first sucker or a plurality of suckers arranged in a first row (the left-hand row of suckers in figure 4) contacts, after a vertical movement of the pick-up apparatus 4 toward the transfer unit 3, a line or one or more solar elements 15 of a line, while one or more other suckers of a further row (the suckers of the middle and right-hand rows of suckers in figure 4) are vertically spaced apart from the lines or the solar elements 15.

If the vertical movement of the pick-up apparatus 4 in the direction of the transfer unit 3 is continued, the further suckers move toward further lines or further solar elements 15 of further lines. In the case of this further vertical movement, that is to say in the case of a vertical movement in the direction of the transfer unit 3 after the first sucker or the first row of suckers has already come into contact with a solar cell, this or these first suckers is/are adjusted vertically, for example counter to a restoring force. The vertical adjustment of the suckers enables a vertical movement of the pick-up apparatus 4 after the suckers have come into contact with the solar elements 15, without destroying or damaging the solar elements 15 in the process.

The vertical adjustment makes it possible for the suckers to be arranged at the same height relative to one another. The further vertical movement of the pick-up apparatus 4 in the direction of the transfer unit 3 has the result that eventually a number of second suckers, in the shown example the middle row of suckers, and eventually a number of third suckers, in the shown example the right-hand row of suckers, each come into contact with further solar elements 15, as illustrated in figure 4B.

A vertical movement of the pick-up apparatus 4 away from the transfer unit 3 has the result that the individual contacted solar elements 15 are picked up from the transfer unit 3 by means of the pick-up apparatus 4. The suckers are also moved to their original position by the restoring force, such that the suckers on different rows have different spacings to the transfer unit 3 and the conveying unit 2. This is illustrated in figure 4C. Due to the different vertical arrangement of the suckers or rows of suckers, the picked-up solar elements 15 or lines are arranged vertically spaced apart at different heights relative to the transfer unit 3 and the conveying unit 2.

The pick-up apparatus 4 is movable in translation in a direction perpendicular to the lines or toward the solar module 14, as illustrated in figure 4D. In this way, due to different vertical arrangement of the suckers or rows of suckers, the picked-up solar elements 15 or lines are arranged vertically spaced apart at different heights relative to the conveying unit 2.

The pick-up apparatus 4 may comprise suckers, for example a row of suckers, which are not vertically adjustable. By way of example, the row of suckers which has the greatest vertical spacing to the transfer unit 3 or to the conveying unit 2 may not be vertically adjustable. In the shown example, this is the right-hand row of suckers.

5 As shown in figure 4E, a first line is brought into contact with the conveying unit 2 or with a line which is already arranged on the conveying unit 2, while further lines, in the shown example a middle second and a right-hand third line, are arranged at a vertical spacing above the conveying unit 2 or the solar module 14. In other words: for the equipping of the solar module 14, the lines are lowered together in each case only to the extent that only the respective
10 line currently to be equipped contacts the solar module 14.

A movement of the pick-up apparatus 4 and/or of the conveying unit 2 perpendicularly with respect to the lines or to a longitudinal axis of the lines makes it possible for the further lines picked-up by the pick-up apparatus 4 to be deposited on the conveying unit 2, as illustrated in figures 4G and 4H. In other words: during the equipping process of the solar module 14, the
15 second line (in the shown example the middle line) covers a different, namely a longer, distance than the first line (in the shown example the left-hand line).

It is thus possible, as illustrated in figures 4E-4H, for a second line to be positioned vertically above a suitable deposition position, in order to move the pick-up apparatus 4 vertically in the direction of the conveying unit 2 until the solar elements 15 picked up by the
20 row of second suckers contact the conveying unit 2 or the previously deposited line.

In this process, the first row of suckers, as shown in figure 4H, is contacted by the conveying unit 2. The vertical movement of the pick-up apparatus 4 in the direction of the conveying unit 2, said movement being continued after the conveying unit 2 has come into contact with the first row of suckers, leads to a vertical adjustment of the first row of suckers.

25 During the equipping process shown in figures 4D-4H, the solar module 14 or the conveying unit 2 may, for example, remain positionally fixed or move continuously. Between two equipping processes, that is to say between the deposition of the picked-up three lines of solar elements 15 and the deposition of a further three picked-up solar elements 15, the solar module 14 or the conveying unit 2 may move for example continuously and/or in a clocked
30 manner, in order to free up further space on the conveying unit 2 for equipping purposes.

Figure 5A shows a second pick-up apparatus 4A similar to the first pick-up apparatus 4 shown in figures 1A-4H. The second pick-up apparatus 4A comprises a number of suckers 8, which are arranged in two rows in side view. The suckers 8 may correspond to the suckers of the first pick-up apparatus 4.

The suckers 8 arranged in the first row are arranged vertically spaced apart at a first spacing relative to a reference plane arranged under the pick-up apparatus 4A, for example relative to the transfer unit 3 or the conveying unit 2. The suckers 8 arranged in the second row are arranged spaced apart at a second spacing relative to the reference plane. The second spacing is greater than the first spacing. The first and the second spacing may be changed by the vertical movement of the pick-up apparatus 4A relative to the reference plane. If in so doing a sucker 8 which is arranged in the first row strikes the reference plane and the vertical movement of the pick-up apparatus 4A in the direction of the reference plane is continued, this sucker 8 is adjusted vertically, in particular moved relative to the pick-up apparatus 4A. In the shown example, the sucker 8 is moved relative to the pick-up apparatus 4A in a direction opposite to the movement direction of the pick-up apparatus 4A, that is to say away from the reference plane. The vertical adjustment is effected counter to a restoring force, which in the shown example is provided by a spring element 9.

The suckers 8 each comprise a vacuum sucker 10, for example a suction head. The vacuum sucker 10 can pick up a solar element 15 by generation of a negative pressure on the surface of the solar element 15 and can deposit it by re-establishment of the ambient pressure or by generation of a positive pressure. The respective pressure state may be provided, for example, by a pumping apparatus (not illustrated) connected to the suckers 8.

In a similar manner, the solar elements 15 on the conveying unit 2 or 2A and on the transfer unit 3, 3A or 3B may be held on the respective conveying or transfer unit by generation of a negative pressure on a side (for example facing away from the pick-up apparatus 4 and/or from the handling unit 6) of the solar elements 15. The negative pressure may be provided, for example, via openings in the respective conveying or transfer unit, which are connected to the or a pumping apparatus (not illustrated).

Figure 5A shows a three-dimensional view of a pick-up apparatus 4A which is arranged above the conveying unit 2. Identical or similar features are provided with identical or similar reference designations. In the shown example, the suckers 8 comprise, in addition to the spring element 9, a securing ring 11 and a spring plunger 12.

/ List of reference designations

List of reference designations

	1	First apparatus for producing solar modules
	1A	Second apparatus for producing solar modules
	1B	Third apparatus for producing solar modules
5	2	Conveying unit of the first and second apparatus
	2A	Conveying unit of the third apparatus
	3	Transfer unit of the first apparatus
	3A	Transfer unit of the second apparatus
	3B	Transfer unit of the third apparatus
10	4	First pick-up apparatus
	4B	Second pick-up apparatus
	5	Providing unit
	6	Handling unit
	7	Dispenser
15	8	Sucker
	9	Spring element
	10	Vacuum sucker
	11	Securing ring 11
	12	Spring plunger
20	13	Monitoring system

/ Claims

Claims

1. A method for producing solar modules (14), wherein solar elements (15) are combined to form lines, wherein each line comprises at least two solar elements (15) and wherein the solar modules (14) are constructed from electrically interconnected lines, **characterized in that**, for the equipping of the solar module (14), at least two lines are picked up in one operation and held ready at different heights above the solar module (14), and in that, for the equipping of the solar module (14), the lines are lowered together in each case only to the extent that only the respective line currently to be equipped contacts the solar module (14).

2. The method as claimed in claim 1, characterized in that the remaining lines remain vertically spaced apart from the solar module (14).

3. The method as claimed in either of the preceding claims, characterized in that the lines are picked up by means of suckers (8) which are preferably vertically adjustable counter to a restoring force.

4. A method for producing solar modules (14), in particular as claimed in one of the preceding claims, wherein solar elements (15) are combined to form lines, wherein each line comprises at least two solar elements (15) and wherein the solar modules (14) are constructed from electrically interconnected lines, **characterized in that** two successive lines cover different distances during the equipping process.

5. The method as claimed in one of the preceding claims, characterized in that the solar module (14) remains positionally fixed during the equipping process with the two successive lines.

6. The method as claimed in one of the preceding claims, characterized in that the solar module (14) is moved in a clocked manner between two equipping processes.

7. The method as claimed in one of the preceding claims, characterized in that the solar module (14) is moved continuously, in particular during the equipping process.

8. The method as claimed in one of the preceding claims, characterized in that strips

of a wafer are used as solar elements (15).

9. An apparatus for producing solar modules (14), wherein solar elements (15) are combined to form lines, wherein each line comprises at least two solar elements (15) and wherein the solar modules (14) are constructed from electrically interconnected lines, characterized in that the apparatus comprises a pick-up apparatus (4, 4A) which is designed, for the equipping of the solar module (14), to pick up at least two lines in one operation and to hold them ready at different heights above the solar module (14) and, for the equipping of the solar module (14), to lower the lines together in each case only to the extent that only the respective line currently to be equipped contacts the solar module (14).

10. The apparatus as claimed in claim 9, characterized in that the pick-up apparatus (4, 4A) is designed to hold the remaining lines vertically spaced apart from the solar module (14).

11. The apparatus as claimed in either of claims 9 and 10, characterized in that the pick-up apparatus (4, 4A) comprises suckers (8) which are preferably vertically adjustable counter to a restoring force and which are designed to pick up the lines, in particular to pick up the lines in one working step.

12. An apparatus, in particular as claimed in one of claims 9 to 11, for producing solar modules (14), wherein solar elements (15) are combined to form lines, wherein each line comprises at least two solar elements (15) and wherein the solar modules (14) are constructed from electrically interconnected lines, characterized in that the apparatus comprises a pick-up apparatus (4, 4A) which is designed to cover different distances for at least two successive lines during the equipping process.

13. The apparatus as claimed in one of claims 9 to 12, characterized in that the pick-up apparatus (4, 4A) is preferably movable relative to the solar module (14) during the equipping process, in particular is movable in a direction transverse to the lines.

14. The apparatus as claimed in one of claims 9 to 13, wherein the apparatus comprises a conveying unit (2, 2A) for accommodating the solar module (14), characterized in that the apparatus is designed to hold the conveying unit (2, 2A) positionally fixed during the

equipping process with the two successive lines.

15. The apparatus as claimed in one of claims 9 to 14, characterized in that the apparatus is designed to move the conveying unit (2, 2A) in a clocked manner between two
5 equipping processes.

16. The apparatus as claimed in one of claims 9 to 15, characterized in that the apparatus is designed to move the conveying unit (2, 2A) continuously, in particular during the equipping process .

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/ Abstract