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**Method and device for loading and unloading
elements into a carrier element**

The invention relates to a method for loading and unloading
5 disc-shaped elements into a carrier element provided
therefore.

In many production processes, it is necessary to load a
plurality of identical elements into or onto a carrier
10 element provided for transporting these elements, for the
purpose of further processing, and to unload these elements
from the carrier element again. Since these elements may
also be sensitive components, this operation is generally
performed by a person. The sensitivity of the elements can
15 be attributed, for example, to their geometry, material
property, or thickness. Disc-shaped elements, in
particular, are critical in respect of their handling.
Disc-shaped is understood here to mean elements which do
not expressly have to be round, but are referred to as
20 disc-shaped because their thickness is normally
significantly smaller than their length and width
dimensions. In addition, especially in printed circuit
board, semiconductor and also photovoltaics fabrication, it
is undesirable to touch the surface of the elements, since
25 this may render them unusable for the further processing.
Moreover, manual handling of the elements by a person is
uneconomical, since it depends greatly on the performance
of the person, which, as experience shows, is subject to
great variations during a working day and this in turn may
30 adversely affect both the number of elements processed and
the reject rate of the elements.



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It is therefore the object of the invention to automate a method and a device for loading and unloading a carrier element with a plurality of elements, in which their handling is effected gently and with a high degree of economic efficiency.

The method according to the invention and the device according to the invention have the advantage that the loading and unloading is effected in an automated manner.

10 For this purpose, the device has a transporting head, by which a set of elements can be simultaneously moved. This set of elements is deposited in a carrier element situated in a defined position, or a set of elements is removed from the carrier element. In this case, the throughput rates are

15 high owing to the simultaneous loading and unloading of a plurality of elements. Moreover, by virtue of the additionally provided conveying elements, manual interventions are not required either during the preparation or following unloading.

20 According to the invention, a transporting journey of the transporting head is not undertaken for each set of elements which has to be taken, but rather firstly at least one set of new elements is picked up by the transporting

25 head. In this case, at least one further transporting strip remains free. This strip picks up a set of elements from the carrier element, the depositing locations of the carrier element which become free then being equipped with the new elements of the transporting head again. Not only

30 does an automated exchange of the elements of the carrier element take place, but it is also possible for the supplying and conveying-away by conveying elements to be effected automatically and hence in a time-saving manner.

The subclaims relate to advantageous developments of the method according to the invention.

5 A preferred exemplary embodiment of the device according to the invention is illustrated in the drawing and explained in more detail, together with the method according to the invention, in the following description. In the drawing:

10 Fig. 1 shows an exemplary embodiment of a device according to the invention in a side view, and

Fig. 2 shows a plan view of the device according to the invention.

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Fig. 1 shows an exemplary embodiment of a device according to the invention, with the aid of which the method according to the invention is also explained, in a first view. In the case of the method according to the invention, 20 first of all a carrier element 1 is brought into the loading and unloading region of the device according to the invention. The carrier element 1 is essentially considered to be an element which is suitable for receiving a certain number of disc-like elements. This may, for example, be 25 achieved by the geometries of the disc-shaped elements being mapped in a systematic arrangement onto the carrier element, so that further processing or transporting of the disc-like elements no longer has to take place individually, these elements being considered to be held 30 securely in the carrier element. A particularly practical systematic arrangement is constituted in this case by a plurality of mutually parallel rows with in each case a plurality of depositing locations. The number of depositing

locations within the individual rows is in this case preferably identical. In this case, the carrier element 1 of the device according to the invention can be supplied both coming from each side and from above or below. The carrier element 1 interacts not only with the device according to the invention, but is also available for further process steps in the processing of the elements. For this purpose, a plurality of such carrier elements 1, 1' circulate, it being possible for in each case one carrier element 1 to be in the loading and unloading region of the device according to the invention. A continuously running process can thus be achieved, in which the unloading and loading of the carrier element 1 does not lead to a delay or even the stoppage of the installation.

The carrier element 1 taken over from the further-processing process by the device is first of all brought by means of a transporting device 60 into a defined position, in which an automated loading and unloading of the carrier element 1 with elements by means of the device according to the invention is possible. In the exemplary embodiment illustrated, the carrier element 1 is first of all fed horizontally on a first level 61. As soon as an end position on the first level 61 is reached, the carrier element 1 is lifted to a second level 62 by a lifting device 14. This position is a position which is defined with regard to its spatial location and in which the loading and unloading is then carried out in an automated manner.

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The lifting device 14 is, for example, a component part of the transporting device 60 which, for example, has further conveying bands (not illustrated) or other conveyors. In

the defined position, the carrier element 1 is referenced in all spatial directions by a holding device (not illustrated) and is locked for the loading and unloading operation. The carrier element 1 is in this case, for example, already equipped with disc-shaped elements which are returning from the further fabrication process and are to be unloaded.

In the explained example of a preferred embodiment, the elements to be loaded are disc-shaped and are made available in cassettes 10-13 provided therefor. The, for example, rectangular disc-shaped elements with an edge length of, for example, 6 cm by 6 cm are situated in stacked form in these cassettes, one compartment being assigned to each element. The individual compartments of the cassettes 10 to 13 in which the disc-shaped elements are situated have a tolerance, so that a disc-shaped element situated in a compartment can be moved easily, without being damaged. In the exemplary embodiment illustrated, the disc-shaped elements are arranged one above the other in the vertical direction in individual compartments of the cassettes 10 to 13 and have play in particular in the vertical direction in the compartments. In this way, the elements illustrated schematically in the cassette 13 can be lifted within each compartment for removal from the cassettes 10 to 13. The cassettes 10 to 13 are fed in a manner not illustrated and are individually adjustable in their height relative to the defined position of the carrier element 1. For this purpose, the cassettes 10 to 13 are in each case positioned via a lifting and lowering device, it being possible for the positioning for the individual cassettes 10 to 13 to take place individually. The individual vertical positioning of the

cassettes 10 to 13 is indicated in Fig. 1 by the arrows on the cassettes 10 to 13.

Arranged opposite the first to fourth cassette 10 to 13 is
5 in each case a further cassette 10' to 13', as will be
explained in detail later with reference to Fig. 2. The
fifth to eighth cassette 10' to 13' serve to receive and
take away the elements returning from the process and
unloaded from the carrier element 1. The number of
10 cassettes may also be greater or smaller and thus adapted
to the capacity of the production installation. In this
case, the cassettes are preferably provided in pairs, so
that each cassette provided for supply has an empty
cassette arranged opposite. It is also possible for the
15 disc-shaped elements to be made available in some other way
or by coming directly from an upstream process.

It is assumed below that elements which are to be loaded
onto the carrier element 1 by the device according to the
20 invention are arranged in the cassettes 10 to 13. For
loading the carrier element 1, the disc-shaped elements
supplied by means of the cassettes 10 to 13 are transported
from the region of the cassettes 10 to 13 to their
respective position on the carrier element 1 with the aid
25 of a transfer beam 4, which is movable in the direction of
a longitudinal axis of the carrier element 1 arranged in
its defined position. For this purpose, the transfer beam 4
is fastened to a positioning device, for example a running
rail 63. The exact procedure, in particular the
30 simultaneous transporting of a plurality of disc-shaped
elements, will be explained below with reference to Fig. 2.

In order to be able to transport the disc-shaped elements, four transporting strips 6, 7, 8 and 9 are arranged on the transfer beam 4. The four transporting strips 6, 7, 8 and 9 can, for their part, in turn each pick up a plurality of elements. The transporting strips 6, 7, 8 and 9 are rotatable jointly about their common longitudinal axis. In each case one of the transporting strips 6, 7, 8 or 9 can thus be oriented that it is directed towards the carrier element 1 or receiving or depositing regions formed in the region of the cassettes 10 to 13. In Fig. 1, this is the case for the transporting strip denoted by 8. The transporting strips 6, 7, 8 and 9 jointly form a transporting head 5, which is rotatably fastened to the transfer beam 4 and can be moved jointly with the latter in the x-direction. The x-direction coincides with the longitudinal axis of the carrier element 1. To simplify the description, a Cartesian coordinate system is indicated in Figs. 1 and 2. It will be understood that the movement directions indicated refer, merely for simplicity, to the coordinate axes and that the relative movement, resulting therefrom, of the individual components with respect to one another is crucial for carrying out the method according to the invention.

In Fig. 2, the device according to the invention for loading and unloading carrier elements 1 is shown in a plan view which corresponds, in the coordinate system indicated, to a view in the negative z-direction.

Arranged opposite the first to fourth cassette 10-13 is in each case a corresponding, initially empty, fifth to eighth cassette 10'-13' which serve to receive disc-shaped elements unloaded from the carrier element 1. As already

explained, the first to fourth cassette 10 to 13 serve to supply the unprocessed elements, while in the fifth to eighth cassette 10' to 13' the elements which have already been processed are taken away. The elements originally
5 situated in or on the carrier element 1 are replaced by new ones with the aid of the method described below.

The fifth to eighth cassette 10' to 13' are, like the first to fourth cassette 10 to 13, also situated on lifting and
10 lowering devices working independently of one another. Formed between the cassettes 10 and 10', 11 and 11', 12 and 12' and 13 and 13' are respectively a first to fourth conveying element 15-18 which are to be operated independently of one another and the longitudinal extents
15 of which in the direction of the y-axis extend in each case into the regions of the cassette cross-sections. In the present preferred embodiment, in each case two individual bands 15a, 15b, 16a, 16b, 17a, 17b, 18a and 18b form respectively one conveying element 15, 16, 17 and 18. The
20 use of conveying elements of another design is also possible. At least in the region of their compartment bottoms, the cassettes 10 to 13 and 10' to 13' have recesses on their open side facing the conveying elements 15 to 18, so that a collision with the conveying elements
25 15 to 18 is precluded, even when the cassettes 10 to 13 and 10' to 13' are lowered by the respective lifting and lowering device.

It is also conceivable for the conveying elements 15 to 18
30 not to reach into the region of the cassette cross-sections. In this case, cassettes having a closed bottom, for example, may also be used. To deposit the elements, carriers enabling the elements to be conveyed into and out

of the compartments of the cassettes could then be formed on the conveying elements.

The conveying elements 15-18 working independently of one another are driven in such a way that they can perform a band movement both in the positive and negative y-direction. Elements deposited on the conveying elements 15 to 18 can thus be conveyed both in the direction towards the cassettes 10 to 13 and in the opposite direction towards the cassettes 10' to 13'. The first and fifth cassette 10 and 10', the second and sixth cassette 11 and 11', the third and seventh cassette 12 and 12' and the fourth and eighth cassette 13 and 13' can thus, in principle, each be used for supplying disc-shaped elements and also taking the elements away. In the preferred embodiment, illustrated in the drawing, of the invention, the cassettes 10, 11, 12 and 13 are used merely for loading the carrier element 1 and thus for supplying the elements, while the cassettes 10', 11', 12' and 13' are used merely for unloading the carrier element 1, i.e. for taking the processed elements away.

First of all, the individual lifting and lowering devices are equipped with cassettes 10 to 13 and 10' to 13', the cassettes 10, 11, 12 and 13 already being equipped with disc-shaped elements provided for loading the carrier element 1, with one element in each compartment. In contrast, the compartments of the cassettes 10', 11', 12' and 13' are empty. The cassettes 10', 11', 12' and 13' are detected as being present and empty, for example by a signal of a weight sensor, and at that moment are moved by the system independently downwards, i.e. in the negative z-direction, by the respective lifting and lowering device.

The movement in the negative z-direction is carried out until the centre, with respect to the height, of the uppermost compartment of the respective fifth to eighth cassette 10' to 13' is at the height of the upper edge of the respective conveying element 15 to 18. An element conveyed in the direction of the cassettes 10' to 13' by a conveying element 15 to 18 is thus conveyed into the respectively uppermost compartment of the corresponding cassette 10' to 13' until it is completely situated in the compartment. During this, the recess present in the individual compartment bottoms of the cassette ensures that the conveying elements 15 to 18 can convey the disc-shaped elements completely into the cassettes.

In contrast, the lifting and lowering devices which were equipped with the cassettes 10 to 13 already filled with disc-shaped elements are only lowered until the centre of the lowermost compartment of the respective cassette 10 to 13 corresponds to the respective height of the upper edge of the corresponding conveying element 15 to 18 and thus the disc-shaped element situated in this compartment is deposited on the conveying element 15 to 18 located therebelow. The deposition of the elements on the conveying element 15 to 18 is possible here as a result of the available play of the disc-shaped elements within the cassette compartments.

In the initial situation illustrated, the transfer beam 4 is in a starting position. The carrier element 1 comprises, for example, twelve rows 31 to 42 in each of which there are formed six depositing locations for receiving one disc-shaped element each. For the twelfth row 42, the six depositing locations are denoted by 42.a to 42.f for

illustration. Corresponding denotation of the remaining depositing locations is omitted for reasons of clarity. As already explained in the description of Fig. 1, the transfer beam 4 has a transporting head 5, on which the four transporting strips 6, 7, 8 and 9 are formed. The longitudinal axis 64 of the transporting head 5 and of the transporting strips 6 to 9 extends in the direction of the y-axis, so that a number of lifting elements, which in each case jointly form a transporting strip 6, 7, 8 and 9, extend parallel to the orientation of the n rows of the carrier element 1. The six lifting elements of a transporting strip 6 to 9 are each identified by the suffixes a to f added to the reference symbols of the transporting strips 6 to 9.

The transfer beam 4 may also be designed with more or fewer transporting strips. Preferably, an even number of transporting strips are provided on the transporting head 5. If the transfer beam 4 has a transporting head 5 with more than one transporting strip 6 to 9, the transporting head 5 is designed, as in the explained example, rotatably about its longitudinal axis 64.

To change the elements on the carrier element 1, first of all in each case a number of disc-shaped elements from the cassettes 10 to 13 are successively deposited on the corresponding conveying elements 15 to 18. For this purpose, the cassettes are lowered step-by-step, while the conveying elements 15 to 18 are conveying. As a result, after the removal of in each case one disc-shaped element from in each case one compartment of the cassettes 10 to 13, by lowering the cassettes 10 to 13 the disc-shaped elements situated in the compartment located above are

deposited on the conveying elements 15 to 18. This procedure is repeated until in each case six disc-shaped elements are deposited on the conveying elements 15 to 18. The conveying elements 15 to 18 are stopped and the disc-shaped elements are preferably aligned.

In each case six of such elements corresponding to a row of the depositing locations of the carrier element 1 are referred to below also as a set of elements.

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To align the disc-shaped elements, i.e. to set an exact spacing within each set of elements which corresponds to the spacing of the at the depositing locations of the carrier element 1 within the rows 31 to 42, an aligning device can be used. The aligning will be discussed in more detail later.

The total of twelve disc-shaped elements aligned on the conveying elements 15 and 16 are picked up successively by the first transporting strip 6 and the second transporting strip 7, respectively. The third and the fourth transporting strip 8 and 9 are still free and not loaded. In this procedure, preferably one of the free transporting strips 8 or 9 is, after the twelve elements have been picked up, already rotated downwards by rotation of the transporting head 5 about the y-axis and is thus oriented in the direction of the negative z-axis. At the same time, the transfer beam 4 is already positioned in the x-direction above the row of the carrier element 1 which is the first to be unloaded and reloaded. The system is thus in its initial position.

After the start of the method according to the invention, the rotatable transporting head 5 is lowered in the negative z-direction and the disc-shaped elements from, for example, the twelfth row 42 are picked up, for example, by means of the third transporting strip 8 with the aid of lifting elements 8.a to 8.f forming the transporting strip. Each of the lifting elements 8.a to 8.f is formed in, preferably, by a so-called Bernoulli sucker. The transporting strips 6, 7 and 9 correspond in their structure to the third transporting strip 8. With the aid of each Bernoulli sucker, in each case one element can be picked up and held virtually without contact.

The rotatable transporting head 5 is lifted in the positive z-direction again. Since an embodiment of the method with a plurality of transporting heads is also possible, the required lifting of the transporting head in the z-direction may be variable.

During the lifting, the rotatable transporting head 5 is rotated through 90° , 180° or 270° clockwise or anticlockwise about the y-axis, so that the last transporting strip still free is directed downwards again. In the description of the loading and unloading according to the invention, a rotation of the transporting head 5 anticlockwise through in each case 90° is assumed, unless stated otherwise, so that finally the fourth transporting strip 9 is directed in the direction of the carrier element 1.

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Simultaneously, the rotatable transporting head 5 is brought in the x-direction into a position above the neighbouring eleventh row 41 by movement of the transfer

beam 4 in the x-direction. The rotatable transporting head 5 is lowered in the z-direction again and the set of disc-shaped elements from the eleventh row 41 is picked up by means of the fourth transporting strip 9.

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Subsequently, the rotatable transporting head 5 is lifted in the z-direction again. Simultaneously, the rotatable transporting head 5 is rotated again, so that the first transporting strip 6, which is already equipped with a set
10 of new disc-shaped elements, are oriented towards the carrier element 1. The transporting head 5 is lowered in the z-direction and the disc-shaped elements are deposited in the depositing locations of the eleventh row 41 of the carrier element 1. After deposition of the elements, the
15 transporting head 5 is lifted in the z-direction again.

In the description, it is assumed that the transporting head 5 is moved relative to the level of the carrier element 1 by, for example, the transporting head 5 being
20 appropriately moved by a telescopic device of the transfer beam 4. It is, however, likewise conceivable, conversely, for the transfer beam 4 including the transporting head 5 to have a fixed position in the z-direction. For depositing and picking-up a set of elements in or from the depositing
25 locations of the carrier element 1, the carrier element 1 can then be altered in its z-position. All that is crucial is that the relative distance between the transporting head 5 or each of the Bernoulli suckers of a transporting strip 6 to 9 oriented respectively in the direction of the
30 carrier element 1 can be altered.

Simultaneously, the rotatable transporting head 5 is rotated through 90° , 180° or 270° about the y-axis again,

so that the second of the two transporting strips 7 equipped at the start of the process is situated opposite the carrier element 1. Simultaneously with the rotation, the transfer beam 4 is moved in the x-direction above the
5 twelfth row 42. The rotatable transporting head 5 is lowered in the z-direction and the disc-shaped elements are deposited in the twelfth row 42 of the carrier element 1 and subsequently the rotatable transporting head 5 is lifted in the z-direction again.

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The transporting head 5 is now equipped on its third and fourth transporting strip 8 and 9 with one set of unloaded elements each.

15 In the preferred embodiment, a linear movement of the transporting head 5 or of the transfer beam 4 is in each case carried out simultaneously with a rotary movement of the transporting head 5. As a result, the time required for assuming a new position is reduced. It is, however, also
20 conceivable for such a simultaneous movement to be prevented, for example in order to avoid a collision of picked-up elements with the carrier element 1 until a sufficient distance between the transporting head 5 and the carrier element 1 is reached. Another reason for carrying
25 out the individual movement steps is to reduce the acceleration forces acting on a picked-up element.

The transfer beam 4 is moved in the x-direction above the tenth row 40. The rotatable transporting head 5 is lowered
30 in the z-direction there and the set of disc-shaped elements is picked up from the tenth row 40 of the carrier element 1. Subsequently, the rotatable transporting head 5 is lifted in the z-direction again.

During the lifting, the rotatable transporting head 5 is simultaneously rotated this time through 90° clockwise about the y-axis, so that the first transporting strip 6, which is the last still to be loaded in this example, is oriented in the z-direction. The transfer beam 4 is preferably moved again simultaneously in the x-direction above the neighbouring matrix row 39, where the rotatable transporting head 5 is lowered in the z-direction again and the disc-shaped elements are picked up from the depositing locations of the matrix row 39 of the carrier element 1. The rotatable transporting head 5 is lifted in the z-direction again together with the picked-up elements.

Now, all of the transporting strips 6, 7, 8 and 9 from this example are loaded with in each case six disc-shaped elements, which in turn are to be conveyed away selectively into the cassettes 10', 11', 12' or 13'. In the explained example, the transporting head 5 is equipped at all 24 Bernoulli suckers with one element each. The number of Bernoulli suckers arranged in a transporting strip 6 to 9 is determined by the maximum number of elements in a carrier element 1. It is, however, also possible to use other carrier elements 1 in the same installation. In the case of these carrier elements, provision may be made for the deposition of, for example, only five elements in a row 31 to 42.

In this case, the sixth lifting element 6f, 7f, 8f and 9f of each transporting strip 6 to 9 is uncoupled from the remaining lifting elements 6a-e, 7a-e 8a-e and 9a-e and moved to one side of the transfer beam 4. If the centre distance of the depositing locations changes as a result of

- the different number of depositing locations within the rows 31 to 42 of the carrier element 1, the remaining lifting elements are adjusted to the new centre distance and fixed thereat to the transporting head 5 or the transfer beam 4. Consequently, optimal picking-up of the elements close to their centre of gravity for each configuration is ensured and the lifting elements are adapted to the carrier element 1.
- 10 Different distances between the centres of the elements in the x-direction with different carrier elements 1 is taken into account by correcting the movement travel of the transfer beam 4.
- 15 To deposit and convey away the elements, the transfer beam 4 is, in this example, moved in the negative x-direction until it is above the first conveying element 15. The conveying element 15 in this example comprises two conveying belts. The first conveying element 15 may, however, also be designed with more or fewer conveying belts. It is, furthermore, possible for the conveying elements not to be conveying belts, but conveying bands or other suitable conveying systems. This applies correspondingly to the second to fourth conveying element 16, 17 and 18.

When it has arrived above the first conveying element 15, the rotatable transporting head 5 is lowered in the z-direction and the disc-shaped elements on the first transporting strip 6, which is still oriented in the negative z-direction, are deposited on the conveying element 15. The rotatable transporting head 5 is then lifted in the z-direction again. Simultaneously, both the

rotatable transporting head 5 is rotated through 90° about the y-axis and the disc-shaped elements deposited on the conveying element 15 are conveyed away into the fifth cassette 10' situated on the lifting and lowering device.

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The disc-shaped elements are conveyed into the fifth cassette 10' by means of the conveying element 15. After each disc-shaped element has been conveyed in, the fifth cassette 10' is moved upwards by the compartment spacing.

10 Each disc-shaped element is thus lifted off the first conveying element 15 and the centre of the next-lower compartment is positioned at the height of the upper edge of the first conveying element 15. The movement is preferably effected in a timed manner, whereby the

15 individual elements of a set are successively deposited in the fifth cassette 10' by a continuously running first conveying element 15. As soon as the procedure of conveying away the elements deposited on the first conveying element 15 is completed or starting already in a manner overlapping

20 with the conveying-away procedure, new disc-shaped elements are conveyed from the cassette 10 situated on the lifting and lowering device onto the conveying element 15 again, positioned and aligned with an aligning device. The lifting and lowering device of the first cassette 10, in which the

25 new disc-shaped elements are situated, is lowered step-by-step. Each element is thereby lifted off its supporting surface, formed as a compartment bottom, of the first cassette 10 by means of the running first conveying element 15 and transported towards the opposite cassette 10'. When

30 this element has left its compartment completely, the first cassette 10 is lowered by the lifting and lowering device by one compartment spacing until the element of the next-higher compartment of the cassette 10 thereby comes to rest

on the first conveying element 15. The movement of the first cassette 10 is again preferably effected in a timed manner, until a set of six new elements lie adjacent to one another on the first conveying element 15. By depositing
5 and aligning new elements on the first conveying element 15, a new set of elements is prepared.

The disc-shaped elements deposited successively on the first conveying element 15 in this way are aligned by means
10 of a suitable template as aligning device, which may be designed in a wide variety of ways. This template is moved upwards for this purpose. It is, however, also possible for the disc-shaped elements to be aligned by means of another suitable device, for example by pushing elements, or nests
15 tapering pyramidally in the negative z-direction, which are lifted and thus align the elements of each set.

The transporting head 5 is rotated about the y-axis, so that the next, second transporting strip 7 loaded with
20 disc-shaped elements is directed in the direction of the first conveying element 15. Simultaneously, the transfer beam 4 is moved in the x-direction until it is above the second conveying element 16. The rotatable transporting head 5 is lowered there in the z-direction and the disc-
25 shaped elements on second transporting strip 7, lying at the bottom, are deposited on the second conveying element 16, before the rotatable transporting head is lifted in the z-direction again.

30 The disc-shaped elements deposited on the conveying element 16 are conveyed into the sixth cassette 11'. The procedure of conveying the elements away into the sixth cassette 11' and depositing and aligning new elements on the second

conveying element 16 takes place analogously to the procedure already described for the first conveying element 15.

- 5 The transfer beam 4 is moved in the x-direction above the third conveying element 17 without the transporting head 5 being rotated. The rotatable transporting head 5 is lowered in the z-direction above the third conveying element 17 and the set of disc-shaped elements of the third conveying
10 element 17 which is prepared there is picked up by the third transporting strip 8, now lying at the bottom. The rotatable transporting head 5 is lifted in the z-direction.

- The transporting head 5 is rotated clockwise about the
15 y-axis and new disc-shaped elements are conveyed from the third cassette 12 onto the third conveying element 17 and aligned. This takes place again in the manner already described.

- 20 Simultaneously, the transfer beam 4 is moved with a linear movement in the x-direction until it is above the fourth conveying element 18. The rotatable transporting head 5 is lowered in the z-direction there and the disc-shaped elements of the fourth conveying element 18 are picked up
25 by the first transporting strip 6, now lying at the bottom. The transporting head 5 is rotated further clockwise until the fourth transporting strip 9 is oriented in the direction of the fourth conveying element 18. The transporting head 5 is lowered and the set of elements of
30 the fourth transporting strip 9 is deposited. The procedure of conveying the deposited elements away and depositing and aligning the new elements takes place analogously to the procedure already described by movement of the fourth

conveying element and timed movement of the cassettes 13 and 13' in opposite z-directions. The transporting head 5 is lifted and rotated clockwise until the third transporting strip 8 is oriented downwards. After the movement of the transporting beam 4, the transporting head 5 is lowered and the last set of unloaded elements is deposited. Here, too, the unloaded elements are conveyed away and new elements are prepared on the conveying element. Without rotation of the transporting head 5, the latter is lifted and moved above the first conveying element 15. There, the transporting head 5 is lowered and picks up a set of elements, which in the meantime has been fully prepared there, by means of the third transporting strip 8. After a further quarter turn clockwise with simultaneous movement of the transporting beam 4 in the x-direction, the fourth transporting strip 9 now likewise picks up a set of elements from the second conveying element 16.

For alignment, a corresponding aligning device is provided under each of the conveying element 15 to 18. Such an aligning device is illustrated by way of example as a template at the second conveying element 16. The individual aligning devices can be used individually, so that wherever a set of new elements is present on one of the conveying elements 15 to 18, this set can be aligned. Simultaneously, the other conveying elements can, however, continue to convey new elements from the cassettes 10 to 13.

The picking-up and depositing of elements by the transporting strips 6 to 9 is effected by activating the corresponding lifting elements. The individual lifting elements can preferably be separately activated, so that in

the example with only five active lifting elements and one inactive lifting element per transporting strip, the inactive lifting element is not activated. In the case of the Bernoulli suckers, the amount of air required is
 5 thereby reduced.

The transfer beam 4 with the four loaded transporting strips 6, 7, 8 and 9 is now moved in the x-direction until it is above the tenth row 40. The transporting head 5 is
 10 lowered in the z-direction and a set of disc-shaped elements is deposited by the fourth transporting strip 9 in the depositing locations of the tenth row 40 of the carrier element 1. The rotatable transporting head is lifted in the z-direction again and rotated, so that the loaded first
 15 transporting strip 6 with disc-shaped elements is oriented in the direction of the carrier element 1. Simultaneously, the transfer beam 4 is displaced in the x-direction and thus moved above the ninth row 39, where the rotatable transporting head 5 is lowered in the z-direction and the
 20 disc-shaped elements are deposited in the depositing locations provided in the ninth row 39 of the carrier element 1. The rotatable transporting head 5 is lifted in the z-direction again.

25 Without further rotation of the transporting head 5, the transfer beam 4 is moved in the x-direction above the eighth row 38. The transporting head 5, which at this point in time is not equipped at the first transporting strip 6, is lowered in the z-direction and the disc-shaped elements
 30 from the eighth matrix row 38 are picked up by means of the first transporting strip 6. The rotatable transporting head 5 is subsequently lifted in the z-direction again and this time rotated clockwise through 90° . In so doing, the

fourth transporting strip 9, which has already become free beforehand, is directed downwards again and preferably moved again by a displacement of the transfer beam 4 until it is over the seventh row 37.

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The elements situated at the depositing locations there are picked up by the free fourth transporting strip 9, and the transporting head 5, which is now equipped with a mixture of elements which have already been processed and new ones, is lifted again. After a quarter turn clockwise, by which the third transporting strip 8 is rotated in the direction of the carrier element 1, without movement of the transfer beam 4 the transporting head 5 is lowered again and the new elements which are held on the third transporting strip 8 are deposited there in the seventh row 37. The rotatable transporting head 5 is then lifted in the z-direction again and rotated clockwise by a quarter turn further, so that the second transporting strip 7, on which new elements are still present, is oriented in the direction of the carrier element 1. The transfer beam 4 is now moved such that, by lowering the transporting head 5, these last new elements can be deposited in the depositing locations of the eighth row 38.

25 The transporting head 5 is lifted and moved above the sixth row 36. There, the second transporting strip 7 picks up a set of elements. Subsequently, the transporting head 5 is lifted again and rotated, so that the third transporting strip 8 is oriented in the direction of the carrier
30 element 1. After movement, a set of elements is picked up from the fifth row 35 by the third transporting strip 8.

The transporting head 5 is now equipped with 24 elements again on the four transporting strips 6 to 9, which are again intended for deposition on the four conveying elements.

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The method steps with regard to deposition and picking up, and also the subsequent unloading and loading of the carrier element 1, are now repeated until gradually all of the elements in rows 31 to 42 are replaced. The carrier
10 element 1 is subsequently unlocked and fed, via a transporting section (not illustrated), to the following process.

If carrier elements 1, 1' in the exemplary embodiment
15 described are carrier elements with k rows, where k is equal to an integral multiple of the number of transporting strips 6 to 9, half of the transporting strips 6 to 9 are still equipped with new elements after complete replacement of the elements of the carrier element 1. The system is
20 thus in the starting position again. The above-described first equipping of the first and the second transporting strip 6 and 7 is therefore required only once. It is obvious that the first equipping in the case of a transporting head 5 with, for example, six regularly
25 arranged transporting strips is preferably effected on three of the transporting strips.

In contrast, if the total number of rows of the carrier element is not an integral multiple of the number of
30 transporting strips on the transporting head 5, the installation can be brought into its initial situation again in a single method step when the change of elements of the carrier element 1 is complete.

For example, if the carrier element 1 of the exemplary embodiment described has only ten rows, then at the point in time of the complete change of the elements, two of the transporting strips out of the four transporting strips 6 to 9 are still occupied by elements which have just been unloaded, when the carrier element 1 is being exchanged. These two sets of elements are then deposited on two of the conveying elements 15 to 18 and new elements are picked up. The system is thus again in the initial state.

The procedure described uses in each case the nearest free or equipped transporting strip and orients the latter by the shortest possible rotary movement. In the exemplary embodiment described, it is therefore necessary for the transporting head 5 to be rotatable in both directions about its longitudinal axis. Provision may, however, also be made for a transporting head which is rotatable in one direction only. The simplest adaptation is then made by replacing a rotation in an opposite direction through, for example, 90° by a further rotation through 270° . For transporting heads with another number of transporting strips, corresponding angles result, given a regular arrangement of the transporting strips.

25

If the production installation has a low capacity, it may be sufficient to use merely a single fixed transporting strip. In this case, following each pick-up of elements to be unloaded, the transporting head must deposit the picked-up elements on a conveying element. Preferably two conveying elements are used, so that there are no waiting times caused by the conveying-away and preparation of a new set of elements. It is thus possible to prepare a set of

elements in the meantime on one of the conveying elements, while the other conveying element is empty. The conveying-away of the elements and the preparation is then effected in each case alternately, in that immediately after the
5 unloaded elements have been deposited, the next set is prepared on the same conveying element.

Instead of new elements being conveyed from cassettes, the elements may also be made available by another supply
10 device. This may, for example, be a singulating device for singulating and transporting stacked elements.

It is also advantageous to use cassettes 10 to 13 and 10' to 13' of the same size. Once the first to fourth cassette
15 10 to 13 is empty and, accordingly, the fifth to eighth cassette 10' and 13' are full as a result of the unloading and loading operation and the supplying of new elements and conveying-away of unloaded ones, only the fifth to eighth cassette 10' to 13' are exchanged for cassettes with new
20 elements. The conveying direction of the conveying elements 15 to 18 is reversed, so that now new elements are supplied from the cassettes 10' to 13' and conveyed away into the first to fourth cassette 10 to 13. It is thus sufficient to exchange only the first to fourth cassette 10 to 13 or the
25 fifth to eighth cassette 10' to 13', respectively.

The sequence described for the purposes of explanation, in particular the order in which movement to the individual rows and conveying elements takes place, is not compulsory.
30 The exact order is flexibly determined by an event controller.

Claims

1. Device for unloading and loading carrier elements
(1, 1'), in which carrier elements a plurality of sets of
5 elements can be deposited in a systematic arrangement,
comprising a transporting head (5) having at least one
transporting strip (6, 7, 8, 9) for simultaneously picking
up at least one set of elements, the transporting head (5)
being displaceable between at least one conveying element
10 (15, 16, 17, 18) and a carrier element (1, 1') situated in
a defined position, and it being possible for both a set of
unloaded elements to be conveyed away and a new set of
elements supplied by means of at least one conveying
element (15, 16, 17, 18).

15

2. Device according to Claim 1,
characterised
in that a plurality of transporting strips (6, 7, 8, 9),
each having a corresponding number of lifting elements
20 (6a-f, 78a-f, 8a-f, 9a-f), are formed on the transporting
head (5).

3. Device according to Claim 2,
characterised
25 in that the lifting elements (6a-f, 78a-f, 8a-f, 9a-f) of
the transporting strips (6, 7, 8, 9) can be activated
individually.

4. Device according to Claim 2 or 3,
30 **characterised**
in that the individual lifting elements (6a-f, 78a-f, 8a-f,
9a-f) can be adapted to an arrangement of depositing

locations of a carrier element (1, 1') to be unloaded and loaded.

5. Device according to one of Claims 2 to 4,
5 **characterised**
in that the lifting elements (6a-f, 78a-f, 8a-f, 9a-f) are Bernoulli suckers.

6. Device according to one of Claims 1 to 5,
10 **characterised**
in that the transporting head (5) is arranged on a transfer beam (4).

7. Device according to Claim 6,
15 **characterised**
in that a distance, relative to one another, between the transporting head (5) or a transporting strip (6, 7, 8, 9) and a carrier element (1) situated in a defined position can be altered.

20
8. Device according to one of Claims 1 to 7,
characterised
in that the transporting head (5) is rotatable about a common axis of the transporting strips (6, 7, 8, 9)
25 arranged thereon.

9. Device according to one of Claims 1 to 8,
characterised
in that a number of conveying elements (15, 16, 17, 18)
30 corresponding to the number of transporting strips (6, 7, 8, 9) is provided.

10. Device according to Claim 9,

characterised

in that the orientation of the conveying elements (15, 16, 17, 18) is approximately parallel to the orientation of the
5 common longitudinal axis of the transporting strips (6, 7, 8, 9).

11. Device according to Claim 9 or 10,

characterised

10 in that each conveying element (15, 16, 17, 18) can simultaneously convey away a set of elements into a cassette (10', 11', 12', 13') for receiving elements and supply a further set of elements.

15 12. Device according to one of Claims 9 to 11,

characterised

in that each conveying element (15, 16, 17, 18) is assigned an aligning device (45).

20 13. Device according to one of Claims 1 to 12,

characterised

in that the conveying direction of the conveying elements (15, 16, 17, 18) is reversible.

25 14. Method for unloading and loading carrier elements (1, 1') with elements, a plurality of elements which form a set in each case being simultaneously unloaded or loaded, having the following method steps:

- positioning a carrier element (1, 1') in a defined
30 position,
- picking up, from depositing locations (42a-f) of the carrier element (1) by a movable transporting head (5), at least one set of elements to be unloaded

- moving the transporting head (5) to a conveying element (15, 16, 17, 18)
- depositing at least one set of unloaded elements on the conveying element (15, 16, 17, 18)
- 5 - picking up at least one set of new elements by the movable transporting head (5)
- moving the transporting head (5) to the depositing locations (42a-f) and depositing the new elements.

10 15. Method according to Claim 14,

characterised

in that all of the transporting strips (6, 7, 8, 9) of a transporting head (5) comprising a plurality of transporting strips (6, 7, 8, 9) pick up from the carrier
15 element (1) one set each of elements to be unloaded and, before picking up new elements, deposit the elements of only some of the transporting strips (6, 7, 8, 9) on conveying elements (15, 16).

20 16. Method according to Claim 15,

characterised

in that a number of conveying elements (15, 16, 17, 18) corresponding to the number of transporting strips (6, 7, 8, 9) is provided, which conveying elements both convey
25 away deposited unloaded elements and in each case supply a new set of elements.

17. Method according to Claim 15 or 16,

characterised

30 in that, during the movement of the completely loaded transporting head (5) towards the conveying elements (15, 16, 17, 18), on some of the conveying elements (17, 18) a prepared set of elements is present in each case, and,

after the deposition of a corresponding number of unloaded sets of elements on the remaining conveying elements (17, 18), the prepared sets of elements are picked up by the transporting strips (6, 7, 8, 9) which have become free.

5

18. Method according to one of Claims 14 to 17,

characterised

in that, after the deposition of unloaded elements on a conveying element (15, 16, 17, 18), a new set of elements
10 is prepared on this conveying element (15, 16, 17, 18).

19. Method according to one of Claims 14 to 18,

characterised

in that, at the start of the unloading and loading of a
15 carrier element (1), the transporting head (5) is equipped with new elements on some of its plurality of transporting strips (6, 7, 8, 9).

20. Method according to Claim 19,

20 **characterised**

in that the remaining transporting strips (6, 7, 8 9) pick up elements to be unloaded and subsequently deposit the new elements of the equipped transporting strips (6, 7, 8, 9) in the depositing locations (42a-f) of the carrier element
25 (1) which have become free.

21. Method according to Claim 20,

characterised

in that further elements to be unloaded are picked up by
30 the transporting strips (6, 7, 8, 9) which have become free after deposition of the new elements.

22. Method according to one of Claims 14 to 21,
characterised

in that, for conveying away a set of elements by the
conveying element (15, 16, 17, 18), the individual elements
5 of the set are successively conveyed into individual
compartments of a cassette (10', 11', 12', 13').

23. Method according to Claim 22,
characterised

10 in that, for individual reception of the elements, the
cassettes (10', 11', 12', 13') are moved in a timed manner
relative to the conveying element (15, 16, 17, 18).

24. Method according to one of Claims 14 to 23,
15 **characterised**

in that, for preparation of a set of elements by a
conveying element (15, 16, 17, 18), a predetermined number
of elements are successively conveyed from a cassette (10,
11, 12, 13) or by a singulating device.

20

25. Method according to Claim 24,
characterised

in that, for removal of the elements to be prepared from a
cassette (10, 11, 12, 13), the cassette (10, 11, 12, 13) is
25 moved in a timed manner and thus the elements arranged
individually in the cassette (10, 11, 12, 13) are
successively brought into contact with the conveying
element (15, 16, 17, 18).

30 26. Method according to one of Claims 14 to 25,
characterised

in that a plurality of carrier elements (1, 1') are successively brought into the defined position by a transporting device (60).

- 5 27. Method according to one of Claims 14 to 26,
characterised

in that the elements of a prepared set are brought, with respect to one another, into an arrangement corresponding to a geometry of the depositing locations of the carrier
10 element (1, 1') by an aligning device (45).

28. Method according to one of Claims 14 to 27,
characterised

in that each conveying element (15, 16, 17, 18) firstly
15 empties a cassette (10, 11, 12, 13) and fills an opposite cassette (10', 11', 12', 13') and subsequently, after reversal of the conveying direction of the conveying element (15, 16, 17, 18), conveys away unloaded elements into the now empty cassette (10, 11, 12, 13).