Transport robot for a processing or treatment line for lead frames

The invention relates to a transport robot for transporting an essentially cuboidal magazine for lead frames fitted with electronic chips in a line of machines or devices for the automatic processing or treatment of these electronic chips, the magazine essentially comprising two walls kept parallel to each other and at a distance from each other and being fitted with at least one lead frame inserted in compartments or grooves of its walls, and the transport robot being provided with a gripping device for the automatic grasping and releasing of the magazine.

In the processing of individual electronic chips, cut out from semiconductor wafers, into a ready-to-use state which allows their industrial use in electronic circuits, there has long been a requirement for increasing quality and optimizing the process. This requirement lead to entire lines of machines or devices being set up and used for the automatic processing or handling of these electronic chips. This involves the electronic chips initially fitted on lead frames being further processed on these lead frames.

In such lines, the lead frames are transported from station to station. For example, one or more devices (so-called die bonders) for fastening the electronic chips on the lead frame, one or more devices for curing adhesives (so-called curing ovens) and one or more devices for wire bonding (so-called wire bonders) are arranged in a line, the transporting of the lead frames being performed in magazines of the type specified at the beginning. In such magazines, the lead frames are laterally pushed-in, but are not fastened in this pushing-in direction.

Depending on the lead frames being processed, it must be possible to handle in such a line magazines of a wide variety of widths, lengths and heights. The automatic transport of the magazines is accomplished by a transport robot, which transports the magazines from station to station.

Previous transport robots have a gripping device, by which a magazine is grasped above and below by corresponding grippers. This has the considerable disadvantage that the lead frames slide laterally out of the magazine as soon as the transport robot executes a horizontal movement parallel to the pushing-in direction of the lead frames with impetus or appreciable acceleration.

A further disadvantage is that the magazines have to be raised for grasping and gripping or else are located over recesses in order that the lower gripper can grip underneath the magazine.

Furthermore, it is not the same edges of a magazine which act at the processing or handling stations as a reference edge for the transport robot in the loading position and unloading position of the magazine, so that the grippers of previous transport robots engage the magazine at a different point during renewed picking up than during unloading. As a result, the positioning errors of the transport robot accumulate and the magazine is shifted at the next processing or handling station to a displaced position, so that finally the transport of the magazine is put at risk, in particular in the case of the system used today of belt transport of the magazine to or in the processing or handling stations themselves.

The object of the present invention is to improve a processing line of the abovementioned type in such a way that secured transporting of the magazines or of the lead frames

in the magazines is possible, that positioning errors of transport robots do not accumulate, and that allowance can be made for a wide variety of magazines.

To achieve this object, a transport robot of the type specified at the beginning is characterized in that the gripping device has two clamping jaws which bear against one side edge each of a wall of the magazine and together clamp this wall when the magazine is grasped by the gripping device, a width of the clamping jaws in a direction orthogonal to this clamped-in wall being greater than a width of this wall.

This means that the clamping jaws on both sides protrude into the clear widths of the magazine, so that the lead frames can no longer slide out laterally from the magazine.

This also means that the magazine is no longer grasped from above and below, but from the side. This dispenses with the raising of the magazine in order to move a gripper underneath the magazine. The magazine can now be conveyed on a corresponding transporting surface of the processing or handling station by means of the belt transport and, for example, be brought again into an unloading position which corresponds approximately to the loading position.

In this case, the mutually facing sides of the two clamping jaws preferably lie essentially in planes parallel to each other, which for their part lie orthogonally to the clamped-in wall. This arrangement is adapted optimally to the essentially cuboidal design of the magazine.

In the case of the already mentioned system of belt transport of the magazine in the processing or handling stations, the magazine in its loading or unloading position is pressed by the belt or belts, or rather by the friction of the magazine

against the running belt or belts, against a step which lies higher than the bottom plane of the magazine, and, as a result, acts as a stop for the magazine. Consequently, the position of the magazine is well defined by the bearing of the magazine against the step. In this case, however, the gripping device of the transport robot can get to the magazine only over the step, which means that the gripping device has to move up to the magazine at a relatively high level, with the consequence that, under these circumstances, the lowermost lead frames in the magazine are not prevented from lateral sliding out.

Moreover, even without this step, the gripping device of the transport robot would have to move up to the magazine at a relatively high level in order to avoid scraping of the mechanism of the gripping device on the transporting surface of the processing or handling station, again with the consequence that, under these circumstances, the lowermost lead frames in the magazine are not prevented from lateral sliding out.

To remedy this, there is preferably formed on a lower rim of each clamping jaw a lug, whose side facing the other lug lies in the same plane as the corresponding plane of the clamping jaw itself, while preferably there is formed in a transporting surface, intended for supporting a magazine, of a processing or handling station of the line of machines or devices a recess, if appropriate designed as a step, for receiving the lug. The lugs then in any event engage over even the lowermost lead frames, so that these too can be transported securely in the magazine. For example, for setting down at a loading position, the magazine is first of all moved up above the step and then set down onto the transport surface or the transporting belt, the lug engaging behind the step. Corresponding operations take place in the opposite sequence and direction at an unloading position.

Due to the engagement of the magazine from the side, the said magazine can have any width, height or length. The length of the magazine is limited merely by the maximum distance of the clamping jaws from each other.

For the greatest possible weight reduction, the clamping jaw should be designed to be as slender as possible, but execute as uniform a clamping action as possible over the entire height of the magazine. This can be ensured by the clamping jaws being divided into a lower bar and an upper bar strip, a rest shoulder being formed between bar and bar strip. This rest shoulder rests in place in the position for use of the upper edge of the abovementioned supporting bar of the gripping adapter, so that the upper bar strip, which in contrast to the lower bar has no abutment, can support itself by means of this rest shoulder against the supporting bar.

For this purpose, therefore, the gripping device is preferably provided with two gripping adapters, which are each assigned to a clamping jaw and are provided with a supporting bar each for supporting and fastening the corresponding clamping jaw. In this case, the clamping jaw preferably has a clamping jaw bar, supported and fastened on the supporting bar of the gripping adapter, and also a rest shoulder, engaging over the supporting bar and supported thereon, of a side strip rising above the supporting bar, while the supporting bar is preferably designed as a projection rising out from a bearing surface of the gripping adapter.

In a preferred exemplary embodiment of the invention, the clamping jaw is mounted resiliently on the supporting bar. By this resilient mounting, allowance is made for any changing of the dimensions of the magazine, for example during cooling of it after treatment in an oven. This also allows for any inaccuracy of the magazine, for example if a magazine edge

has a bevel.

In order nevertheless to ensure any desired contact pressure of the clamping jaws on the side edges of the wall of the magazine grasped by the gripping device, it may preferably be provided that a bolt arranged fixedly on the supporting bar between two spring elements engages in a cutout provided in the clamping jaw and can be moved therein against spring forces of the spring elements, a base of the cutout being positioned at the clamping jaw and the bolt being positioned at the supporting bar in such a way that there is a distance between the clamping jaw and the supporting bar even when the bolt is pressed against the spring forces of the spring elements up to the base of the cutout. By this measure, the bolt forms a pivot point for a rocking movement of the clamping jaw on the supporting bar. During pressing of the clamping jaws onto the side edges of the wall of the magazine, first of all the clamping jaws rock against the spring forces of the spring elements, until they bear flush against the side edges, then the bolt in the cutout of the clamping jaw is moved against the spring forces during compressing of the spring elements until it bears against the base of the cutout, after which however the contact of the bolt with the base of the cutout prevents any further yielding of the clamping jaws, i.e. the full force of the gripping device can then act for grasping of the magazine.

Moreover, the gripping device preferably has a front surface of a covering plate and the two gripping adapters each have a bearing surface, while the front surface and the two bearing surfaces lie essentially in one plane, and the front surface and also essentially the bearing surfaces bear against the clamped-in wall in a direction orthogonal to it when the magazine is grasped by the gripping device.

This covering plate protects a gear mechanism, mentioned

further below, and serves at the same time as a stop of the gripping device on the wall of the magazine, so that this front surface of the covering plate forms a reference surface during seizing of the transport robot and, if necessary, also serves for correcting the position of the magazine.

The two gripping adapters on both sides of the covering plate are preferably guided on oppositely rotatable spindle drives, which for their part are preferably connected to a gear mechanism which for its part is assigned a drive.

This has the advantage that, if for example the magazine is to come into an unloading position which differs from the loading position, a correction of the position of the magazine can then be performed by means of the front surface of the covering plate as a reference surface and by means of the laterally guided gripping adapters. As a result, positioning errors of the transport robot cannot accumulate in the individual processing or treatment station.

A further advantage of the combination of spindle drives and gear mechanism is that the clamping force is not cut out even in the event of a power failure and therefore the magazine cannot fall out of the gripping device even in the event of a power failure. Furthermore, the clamping of the magazine is performed with a defined clamping force without tilting of the clamping jaws.

For the drive, for example a symmetrical force-controlled direct-current motor is chosen.

The gripping device is preferably supported by means of a bearing arm with a threaded sleeve integrated therein on a spindle arranged perpendicularly in a column profile of the transport robot. This arrangement permits a lifting movement of the gripping device, which is necessary in particular in

order to compensate for different heights of the relevant machines or devices for the automatic processing or treatment of electronic chips, for example in order to be able to operate horizontally curing ovens arranged at different heights.

Altogether, the transport robot according to the invention can be used to advantage for the transporting of a magazine with lead frames inserted therein for electronic chips in a line of machines or devices for the automatic processing or treatment of these electronic chips.

Such a use is inexpensive, the conversion of existing transport robots having to be performed mechanically just with respect to the gripping device, otherwise only in terms of software.

Further advantages, features and details of the invention emerge from the following description of preferred exemplary embodiments and also with reference to the drawing, in which:

Fig. 1 shows a perspective view of a line of machines or devices for the automatic processing or treatment of electronic chips;

Fig. 2 shows a schematized plan view of a transport robot according to the invention;

Fig. 3 shows a side view of the transport robot according to Fig. 2;

Fig. 4 shows a side view of part of a processing or treatment station and part of the transport robot according to Fig. 2 during setting down of a magazine;

Fig. 5 shows a side view of part of a further exemplary embodiment of a transport robot;

Fig. 6 shows a front view of the part of the transport robot in the case of the exemplary embodiment according to Fig. 5;

Fig. 7 shows a plan view of a clamping jaw according to the invention;

Fig. 8 shows a further plan view of the clamping jaw according to Fig. 5, but turned through 90 .

A line R of machines or devices for the automatic processing or treatment of electronic chips has, connected in series one behind the other, a plurality of processing or treatment stations (cf. Fig. 1). In the line R, lead frames are transported from station to station in order to be processed or treated there. For example, a device 5 (so-called die bonder) for fastening the electronic chips on the lead frame, four identical devices 4 for curing adhesives (so-called curing ovens) and three identical devices 1, 2, 3 for wire bonding (so-called wire bonders) are arranged in the line R, connected in series one behind the other.

By means of a transport robot 6, which can be moved on a rail 7, magazines 8, which are fitted with lead frames, are removed from a buffer 9 and transported to the corresponding processing or treatment stations. Unlike in the case of the previous known prior art, in this case the rail 7 with the transport robot 6 is positioned behind the respective processing or treatment station, so that a processing of the corresponding lead frames can take place from the front without difficulties.

The transport robot 6 sets down a magazine 8 onto a transporting surface 10 of a processing or treatment station, there being located in the transporting surface 10 corresponding transport belts 11, which loop around a possibly driven deflecting roller 46. In Fig. 4 it can be seen that in the transporting surface 10 there is formed a step 45, over which the magazine 8 is set down onto the transport belts 11. By means of the transport belts 11, the magazine 8 is transported to the front side of the processing

or treatment station. There, the lead frames 35 are removed from the magazine 8, processed or treated and then returned again into the magazine 8. Thereafter, a return transport of the magazine 8 is performed by means of the transport belts 11, until it is pressed by friction on the running transport belts 11 against the step 45, which as a result acts as a stop for the magazine 8. In this position of the magazine 8, it can be seized by the transport robot 6 and passed on to another processing or treatment station, in order for example to run successively through the device 5 (so-called die bonder) for fastening the electronic chips on the lead frame, a device 4 for curing adhesives (a so-called curing oven) and a device 1, 2 or 3 for wire bonding (a so-called wired bonder).

The transport robot 6 rests with a housing 12 on a carriage 13, the carriage 13 being arranged movably on the rail 7. A telescopic frame 14 can be extended out of the housing 12 in direction X, so that a column profile 15 with a gripping device 16, shown in particular in Figs. 2 and 3, can be brought closely up to a magazine 8.

In this case, the gripping device 16 has a bearing arm 17, which is guided in the column profile 15 on a spindle 18. Fitted on the spindle 18 is a threaded sleeve 19, the internal thread of which interacts with the external thread of the spindle 18. As a result, a raising or lowering of the bearing arm 17, and consequently of the gripping device 16, is performed in the direction of the double-headed arrow Z.

Flanged onto the bearing arm 17 is a rail strip 20, on which there is fixed a gear mechanism 21 for the turning of two mirror-invertedly arranged spindle rods 22 and 23. Towards the front, the gear mechanism 21 is covered by a covering plate 24. Assigned to the gear mechanism 21, moreover, is a drive 25, which is indicated in Fig. 2 underneath the gear

mechanism 21, corresponding gear elements transmitting a rotation of a drive shaft onto the gear mechanism and the gear mechanism 21 converting this rotation into a rotation of the spindle rods 22 and 23. It goes without saying that the spindle 18 is also assigned a corresponding drive 26, by means of which the spindle 18 is turned, the threaded sleeve 19, and with it the bearing arm 17 or the gripping device 16, then moving in the direction of the double-headed arrow Z.

On each spindle rod 22 and 23 there is located a gripping adapter 26, which is guided both on the spindle rods 22 and 23 and on the rail strip 20. During rotation of the spindle rods 22 and 23, which is performed in opposite directions, each gripping adapter 26 is moved in the direction of the double-headed arrow Y. The spindle rods 22 and 23 thus form with the gripping adapters 26 two oppositely running spindle drives. An outer end position of the gripping adapter 26 is indicated by dashed lines and dot-dashed lines respectively.

A front surface 27 of the gripping adapter 26 lies in a plane of a front surface 28 of the covering plate 24. Protruding beyond this front surface 27, supporting bars 29, which hold clamping jaws 30, are respectively formed laterally on the adapters 26. The clamping jaws 30 are in this case connected to the supporting bars 29 by means of corresponding screws 31.

In Fig. 4 the function of the gripping device 16 is clearly shown. The magazines 8 generally comprise a front wall 32 and a rear wall 33. The two walls 32 and 33 are held parallel to each other and at a distance from each other by means of threaded bolts 34, it being possible for there to be fitted on the threaded bolts 34 for example spacing sleeves between the two walls 32 and 33. Arranged between the front wall 32 and the rear wall 33 are lead frames 35, which may be accommodated, for example, in corresponding compartments or

grooves.

For transporting, the magazine 8 is engaged and grasped by the gripping device 16 in such a way that the clamping jaws 30 take the rear wall 33 between them from both sides and hold it in the clamping manner.

In this case, each clamping jaw 30 has, according to Figs. 5 and 8 a width $\underline{b}$ which is slightly greater than the width $\underline{b}_1$ of the rear wall 33. This ensures that the clamping jaw 30 protrudes with part of its width $\underline{b}$ into the clear width between the front wall 32 and the rear wall 33, so that falling-out of the lead frames 35 from the magazine 8 during transporting is avoided. Serving this very purpose is also a lug 36, which is formed on a lower rim 37 of the clamping jaw 30. This lug 36 serves for compensation if, for example, the gripping device 16 is set against the magazine 8 at too high a level. If the lug 36 were not present, there would be the risk that, if the clamping jaws 30 were set against the side edges of the rear wall 33 at too high a level, the lowermost lead frames would be free and could slide out of the magazine 8. This is prevented by the lug 36, which with its width likewise protrudes at least partially into the clear width between the front wall 32 and the rear wall 33.

In order that, however, proper engagement of the gripping device 16 with the magazine 8 on the transporting surface 10 is possible in the first place, there is formed in this transporting surface 10 respectively on both sides a recess which is designed, for example, as a step 45 and is engaged behind by the lug 36 both when the magazine 8 is set down and when it is picked up.

The lug 36 is adjoined upwards by a bar 39, which serves for bearing against the supporting bar 29. Provided in this bar 39 are also bores 40 for the screws 31.

Adjoining the strip 39, the clamping jaw is widened, forming a rest shoulder 41, into a free bar strip 42, the latter tapering conically upwards. In the position for use, the rest shoulder 41 strikes against the upper edge of the supporting bar 29, whereby the bar strip 42 is supported. Therefore, when there is clamping bearing of the clamping jaw 30 against the magazine 8, the said bar strip cannot escape outwards. As a result, the magazine 8 is held in a secured manner.

In an exemplary embodiment of the invention represented in more detail in Figs. 5 and 6, the clamping jaws are of a resilient design. A corresponding clamping jaw 30a in this case assumes a variable distance e from a corresponding supporting bar 29a against the spring force of two spring elements 47a and 47b. The spring elements 47a and 47b comprise, for example, assemblies of disc springs, i.e. so-called spring assemblies. As a result, allowance can be made for changes and inaccuracies of the dimensions of the magazine by springing of the clamping jaw 30a.

A bolt 49 is arranged fixedly on the supporting bar 29a between the two spring elements 47a and 47b, while on the clamping jaw 30a there is provided a cutout 50, in which the bolt 49 engages, it being movable therein against spring forces of the spring elements. The cutout 50 has a base 51, up to which the bolt 49 can be pressed against the spring force of the two spring elements 47a and 47b. The base 51 of the cutout 50 is positioned on the clamping jaw 30a and the bolt 49 is positioned on the supporting bar 29a in such a way that an average distance e, drawn in in Fig. 6, is maintained between the clamping jaw 30a and the supporting bar 29a even when the bolt 49 is pressed against the spring force of the two spring elements 47a and 47b up to the base 51 of the cutout 50. As a result, the bolt 49 forms a pivot point for a rocking movement of the clamping jaw 30a on the supporting

bar 29a, which contributes to making allowance for the changes and inaccuracies of the dimensions of the magazine. During pressing of the two clamping jaws 30a on both sides onto the side edges of the wall of the magazine, first of all the clamping jaws 30a rock against the spring forces of the spring elements 47a and 47b, until they bear flush against the side edges of the magazine. Subsequently, the bolt in the cutout 50 is moved against the spring forces during further compressing of the spring elements 47a and 47b, until it bears against the base 51 of the cutout 50. Thereafter, however, the contact of the bolt 49 with the base 51 of the cutout 50 prevents any further yielding of the clamping jaws 30a, so that the full force of the gripping device is transmitted to the clamping jaws 30a and acts for grasping of the magazine.

A major advantage of this measure is that, for example when picking up the magazine 8 from an oven, allowance is made for contacting of the magazine 8. For this reason, in the position of rest, the bolt 49 does not in fact lie on the base 51 of the cutout 50, but at a distance of, for example, two millimetres from it. When picking up the magazine 8, this position-of-rest distance is first of all reduced to zero. When the magazine 8 cools, it does not drop down between the two clamping jaws 30a, because they follow the changes of the dimensions of the magazine 8 thanks to the springing back of the spring elements 47a and 47b.

Patent Claims

1. Transport robot for transporting an essentially cuboidal magazine (8) for lead frames (35) fitted with electronic chips in a line of machines or devices for the automatic processing or treatment of these electronic chips, the magazine essentially comprising two walls (32, 33) kept parallel to each other and at a distance from each other and being fitted with at least one lead frame (35) inserted in compartments or grooves of its walls (32, 33), and the transport robot being provided with a gripping device (16) for the automatic grasping and releasing of the magazine (8), characterized in that the gripping device (16) has two clamping jaws (30; 30a) which bear against one side edge each of a wall (33) of the magazine (8) and together clamp this wall (33) when the magazine (8) is grasped by the gripping device (16), a width (b) of the clamping jaws (30; 30a) in a direction orthogonal to this clamped-in wall (33) being greater than a width (b_1) of this wall (33).

2. Transport robot according to Claim 1, characterized in that mutually facing sides of the two clamping jaws (30; 30a) lie essentially in planes parallel to each other, which for their part lie orthogonally to the clamped-in wall (33).

3. Transport robot according to Claim 2, characterized in that the gripping device (16) is provided with two gripping adapters (26), which are each assigned to a clamping jaw (30; 30a) and are provided with a supporting bar (29) each for supporting and fastening the corresponding clamping jaw (30; 30a).

4. Transport robot according to Claim 3, characterized in that the clamping jaw (30a) is mounted resiliently on the supporting bar (29a).

5. Transport robot according to Claim 4, characterized in that a bolt (49) arranged fixedly on the supporting bar (29a) between two spring elements (47a, 47b) engages in a cutout (50) provided in the clamping jaw (30a) and can be moved

therein against spring forces of the spring elements (47a, 47b), a base (51) of the cutout (50) being positioned at the clamping jaw (30a) and the bolt (49) being positioned at the supporting bar (29a) in such a way that there is a distance (e) between the clamping jaw (30a) and the supporting bar (29a) even when the bolt (49) is pressed against the spring forces of the spring elements (47a, 47b) up to the base (51) of the cutout (50).

6. Transport robot according to Claim 2, characterized in that there is formed on a lower rim (37) of each clamping jaw (30; 30a) a lug (36), whose side facing the other lug (36) lies in the same plane as the corresponding plane of the clamping jaw (30; 30a) itself.

7. Transport robot according to Claim 3, characterized in that the gripping device (16) has a front surface (28) of a covering plate (24) and the two gripping adapters (26) each have a bearing surface (27), the front surface (28) and the two bearing surfaces (27) lie essentially in one plane, and the front surface (28) and also essentially the bearing surfaces (27) bear against the clamped-in wall (33) in a direction orthogonal to this wall (33) when the magazine (8) is grasped by the gripping device (16).

8. Transport robot according to Claim 3, characterized in that the clamping jaw (30) has a clamping jaw bar (39), supported and fastened on the supporting bar (29) of the gripping adapter (26), and also a rest shoulder (41), engaging over the supporting bar (29) and supported thereon, of a side strip (42) rising above the supporting bar (29).

9. Transport robot according to Claim 3, characterized in that the supporting bar (29) is designed as a projection rising out from a bearing surface (27) of the gripping adapter (26).

10. Transport robot according to Claim 3, characterized in that the two gripping adapters (26) on both sides of the covering plate (24) are guided on oppositely rotatable spindle drives (22, 23).

11. Transport robot according to Claim 8, characterized in that the spindle drives (22, 23) are connected to a gear mechanism (21), which for its part is assigned a drive (25).

12. Transport robot according to Claim 1, characterized in that the gripping device (16) is supported by means of a bearing arm (17) with a threaded sleeve (19) integrated therein on a spindle (18) arranged perpendicularly in a column profile (15) of the transport robot (6).