

Method and apparatus for the placement of electronic components, in particular semiconductor chips, on a substrate

The invention relates to a method for the placement of electronic components, in particular semiconductor chips, in accordance with the preamble of claim 1. By means of a method of this type, for example during the production of semiconductor components, in automatic chip mounting machines (die bonders), the unpackaged chip is picked from the already subdivided silicon wafer and then placed or bonded onto corresponding substrates. The bonding process is followed by further process steps such as e.g. curing, wire bonding, melting of soldering connections, encapsulation, singulation, etc.

For positioning the chips on the substrate there are a multiplicity of different processes such as e.g. adhesive bonding, soldering or lamination. The type of connecting process also determines whether the chip does have to be turned (flip-chip applications) or does not have to be turned (non-flip applications) prior to positioning. Turning of the chip is understood hereinafter expressly not to mean a relative movement with respect to a spatial axis or spatial plane, but rather turning with regard to the original bearing side. In the case of non-flip applications, the chip is not turned, and after the pick-up it is transported from the wafer film to the substrate directly in one step, the pick-up tool also simultaneously being used as a bonding tool. The bearing side by which the chip was adhesively bonded on the wafer film is then also the side by which the chip is adhesively bonded onto the substrate. A known apparatus of this type has been mentioned for example in EP 1 049 140 B1 or disclosed by the applicant's company magazine "Newsline 1/2002" (machine type "Easyline"). In the case of flip-chip applications, the chip is deposited onto the substrate by its structure side after turning, that is to say that the bearing side by which the chip was adhesively bonded on the wafer film is, after positioning, then the side remote from the substrate. Ever greater requirements are made of modern diebonder systems with regard to production costs,

throughput, accuracy and process flexibility. The machines should nevertheless not exceed existing apparatuses with regard to structural height, machine layout plan, weight, etc. This leads to an ever greater complexity of the machines with regard to mechanics, movement sequences and control.

US 2005/0132567 has disclosed an apparatus in which semiconductor chips are picked up by a rotatable pick tool and are transported from there to a higher plane and are accepted by a further tool, which carries the chips in a linear movement over the substrate and deposits them there. Pick plane and substrate plane run parallel, but at different levels. It thereby becomes possible for the wafer table to be able to be driven under the substrate table, which is evidently advantageous particularly in the case of large wafers because this means that the total basic area of the machine can be kept small. However, in this case the chip is evidently turned by the transfer operation, so that it is deposited onto the substrate by its structure side rather than by its bearing side (flip-chip applications).

Therefore, it is an object of the invention to provide a method of the type mentioned in the introduction in which components can also be deposited onto the substrate again by the same bearing side (non-flip application), with the possibility of obtaining a highest possible throughput with an improved depositing accuracy. Moreover, the intention is to afford the possibility of picking at room temperature, but of also being able to effect hot positioning under certain circumstances. Moreover, the intention is for it to be possible to use the same apparatus to conduct both flip-chip and non-flip applications, in order to considerably broaden the range of use with low extra costs. Finally, the apparatus is intended to be constructed as compactly as possible and to have a smallest possible machine layout plan. This object is achieved from a method standpoint by means of a method having the features in claim 1. From an apparatus standpoint, the object is achieved by means of an apparatus having the features in claim 6.

The use of the turning apparatus in the provision plane makes it possible, in a simple manner, to reverse again the turning process that otherwise takes place during the transfer of the component from the primary tool to the secondary tool. The turning apparatus evidently simultaneously fulfills the function of a type of intermediate station which enables greater flexibility for the different movement sequences and process parameters.

Further advantages can be achieved if the actual position (position and angle) of the component on the supply station prior to the pick-up is determined by means of a first monitoring device, and/or if the actual position of the component in the provision plane prior to the transport to the substrate is determined by means of a second monitoring device, and/or if the actual position of the substrate is determined by means of a third monitoring device, deviations between the actual values determined and a predetermined desired position of the component being corrected preferably during transport. In this case, the monitoring devices may be image recognition devices, that is to say CCD cameras for example. With a total of only three cameras of this type it is possible here to achieve a very high precision or the possibility of optimal correction. Depending on the application, however, it would also be conceivable to measure for example only the actual position of the component in the provision plane or at the turning apparatus.

The actual position is advantageously determined whenever the primary tool or the secondary tool clears the image field of the actual position to be determined. Transport movement and image recognition thus run in parallel alongside one another without impeding one another.

A particularly high component throughput is achieved if two primary tools are actuated in such a way that a first primary tool picks up a component at the supply station, while a second primary tool delivers a component to the turning appara-

tus. In this case, the two primary tools may move synchronously or asynchronously with regard to picking up and delivering the components.

Finally, a particularly high process flexibility of the apparatus can be achieved if in a first operating mode the turning apparatus works in an operating position, and in that for a second operating mode the turning apparatus is brought to a rest position, in which the secondary tool accepts the components directly from the primary tool, said components being deposited onto the substrate by the structure side remote from the bearing side (flip-chip application). It is evidently possible for a component thus to be deposited onto the substrate after having been turned or without having been turned by means of one and the same apparatus whilst maintaining all the advantages.

If the image recognition device for identifying the actual position of the substrate is mounted on a displaceable slide, the image recognition device can be driven into an observation position independently of the respective position of the secondary tool. This simplifies the construction of the substrate feeding. This is because in the case of substrates with a matrix like arrangement of depositing positions, the substrates only have to be displaced in one direction (X), while the other direction (Y) can be attained by the image recognition device that can be moved in this spatial direction and the secondary tool that can likewise be moved in this spatial direction. In addition, this evidently increases the flexibility of the sequences and thus improves the throughput since the measurement can be effected in a manner decoupled from the position of the secondary tool and processes can thus be parallelized.

Further advantages can be achieved if the first and second image recognition devices are arranged in such a way that the image fields assigned to them are captured from within the rotational circle of the primary tool. In this way, an image

recognition device can simultaneously be directed towards the supply station from above, while a further image recognition device is directed from below towards the component held either by the secondary tool or by the turning apparatus.

This type of observation of the image fields is fostered by virtue of the fact that a first and a second primary tool are arranged diametrically opposite one another relative to the axis of rotation preferably on a U-shaped rotary arm.

The turning apparatus itself may also be a rotatable double arm tool, in which case with each arm it is possible for a component to be accepted from the primary tool in the provision plane and to be transferred to the secondary tool, respectively.

The secondary tool is advantageously arranged on a linearly displaceable slide. Curved movements or likewise a rotational movement would also be conceivable, however.

A particularly space-saving and kinematically advantageous arrangement results if the primary tool rotates on a rotational plane which runs approximately parallel to the displacement direction of the secondary tool. This is because with this arrangement the housings for drive and camera installations extend within the rotational circle transversely with respect to the displacement direction of the secondary tool, which has an advantageous effect on the machine layout plan.

Further advantages can be achieved if the placement station is embodied as a transport station for the preferably linear passage of a plurality of substrates. In this case, clamping devices, conveyor belts or the like that are known per se may be used as transport means.

A discontinuous feeding of components at the supply station can be achieved in a particularly advantageous manner by virtue of the fact that the turning apparatus is embodied as a

buffer station for temporarily receiving a plurality of components. It would thus be conceivable, for example, for the turning apparatus to be embodied as a carousel having a plurality of turning locations, so that a specific supply of components is always received at the buffer station. As a result it is possible, for example for feeding a new wafer frame at the supply station, to temporarily shut down the primary tool. During this shut down time, the secondary tool takes the components from the buffer station.

A wafer cassette may be arranged alongside the supply station and can be moved, for the purpose of loading wafer frames onto the supply station, into different loading positions in which the supply station and the wafer cassette are at least partly arranged on the same plane, and in that the wafer cassette can be moved into a rest position in which the supply station, for processing a loaded wafer frame, can be displaced at least partly in the horizontal working plane over the wafer cassette. The wafer cassette can thus evidently be arranged in a highly space-saving manner without its function being impaired during the loading of the working station.

Finally, further advantages may additionally be achieved if one or a plurality of intermediate placement stations at which a component can be placed temporarily prior to the transfer to the turning apparatus or prior to the transfer to the secondary tool are arranged in the region of the rotational circle of the primary tool. It is evidently thus possible for individual components to be temporarily removed from the working process and stored intermediately in order to be processed further again at a later point in time. Specifically, with regard to present-day quality requirements in manufacturing, it is necessary in some instances for example to differentiate chips in terms of quality. In order to obtain a highest possible yield, it may be necessary for only high-quality chips to be deposited onto high-quality substrate positions, with poorer-quality chips being able to be used on poorer-quality substrate positions. The intermediate placement station also

enables qualitative control of the placement process in a particularly simple manner.

Further individual features and advantages of the invention emerge from the following description of an exemplary embodiment and from the drawings, in which:

figure 1 shows a simplified illustration of a subdivided wafer with a semiconductor chip illustrated in enlarged fashion,

figure 2 shows a highly schematic illustration of an apparatus according to the invention as seen from the side,

figure 2a shows a highly simplified side illustration of an apparatus with a wafer cassette in the bottommost feed position,

figure 2b shows the apparatus in accordance with figure 2a with the wafer cassette in the topmost feed position,

figure 2c shows the apparatus in accordance with figure 2a with the wafer cassette in the rest position,

figure 2d shows the side illustration of an alternative apparatus with an additional intermediate placement station in the region of the primary tool,

figure 3 shows a perspective illustration of a first and second primary tool, a turning apparatus and a secondary tool,

figure 4 shows a cross section through a first and second primary tool and a secondary tool,

figure 5 shows the schematic illustration of a first and second primary tool and a turning apparatus as seen from the side,

figure 6a shows a cross section through a first and second primary tool with the associated separate image recognition devices, for a view toward the bottom and a view toward the top,

figure 6b shows a cross section through a first and second primary tool with an associated common image recognition device for a view toward the bottom and a view toward the top,

figures 7a
to 7e show different sequences of a working procedure with turning of the component,

figures 8a
to 8e show different sequences of a working procedure without turning of the component, and

figure 9 shows an overall perspective illustration of an apparatus.

Figure 1 illustrates an arrangement known per se in a highly simplified manner, in which arrangement an already subdivided semiconductor wafer 18 is adhesively bonded onto a wafer film 19, which, for its part, is clamped in a wafer frame 20. The semiconductor chips 1 have already been singulated by means of the sawing lines, which is indicated by the intercepting lines. Each chip 1 has a bearing side 4, by which it adheres on the wafer film 19 prior to detachment. A semiconductor structure is applied on the opposite side to the bearing side 4, for which reason it is referred to hereinafter as the structure side 17. The singulation of the chips by sawing and the detachment procedure from the wafer film with the aid of

needles and other auxiliary means are sufficiently known to the person skilled in the art.

The most important machine components will firstly be described with reference to figure 2. A supply station 5 is arranged on a machine frame 26, said supply station being embodied in the present case as a wafer table for receiving prepared wafer frames in accordance with figure 1. Further wafer frames can be subsequently provided as required from a wafer cassette 27. Two primary tools 6a, 6b are mounted above the supply station 5 such that they can be rotated about an axis of rotation, which will be described in more detail below. With the aid of the two primary tools, the semiconductor chips can be transported from the plane of the supply station 5 to a provision plane 7 located higher.

A turning apparatus 9 is arranged in the region of said provision plane 7, and is able to accept a semiconductor chip from a primary tool, turn it through 180° and transfer it to a secondary tool 8. The secondary tool 8 is arranged on a slide 15, which can be displaced along a guide rail 21.

A placement station 3 is arranged in a region below the guide rail 21 and in a manner laterally offset with respect to the supply station 5, said placement station being embodied in the present case as feed systems for the passage of individual substrates 2 or a continuous substrate.

Various cameras are arranged on the apparatus for monitoring and correction of various actual positions. A first camera 10 determines the actual position of a chip 1 at the supply station 5 prior to lift-off. A second camera 11 identifies the actual position of a semiconductor chip at the turning apparatus 9 after transfer from a primary tool 6a or 6b. Finally, a third camera 12 can identify the actual position of the substrate 2 on the placement station 3. Said third camera 1 is arranged on a slide 16, which can be displaced along a guide

rail 22. Further details concerning these components will also emerge from figures 3 and 4.

Since the placement station 3 and the supply station 5 lie on different planes, the supply station 5, that is to say the wafer table, can evidently move under the placement station, that is to say under the feed system, with regard to its range of movement, whereby the layout plan of the machine frame 26 can be kept very small. The supply station 5 must be horizontally displaceable in two spatial axes since each individual chip to be lifted off is in each case to be moved exactly under the lifting-off primary tool. Controls of this type are already known to the person skilled in the art.

Figures 2a to 2c reveal further details concerning the displaceability of the supply station 5, to be precise also in combination with the wafer cassette 27. The wafer cassette 27 has various insertion compartments in a manner known per se, each compartment containing a prepared wafer frame with a subdivided wafer (in accordance with figure 1). The wafer cassette can be moved vertically and a removal mechanism (not specifically illustrated here) can remove a wafer frame from each tier and transfer it to the supply station 5. In accordance with figure 2a, the wafer cassette 27 is in the bottommost unloading position, in which a wafer frame can be removed from the topmost tier.

Subsequently, each time a wafer frame has been emptied by picking, said wafer frame is pushed back into the corresponding empty tier and a new wafer frame is removed from the next tier until the last tier is reached. In this case, the wafer cassette 27 is situated in the topmost removal position, which is illustrated in figure 2b. As is apparent particularly clearly from this figure, the left-hand end face of the wafer cassette in the illustration runs approximately tangentially with respect to the turning circle of the two primary tools 6a and 6b. It would be conceivable, under certain circumstances, to shift the wafer cassette even closer to the axis 13 or ro-

tation of the two primary tools, so that the wafer cassette could be raised up only in the illustrated vertical position of the two primary tools.

When picking up a wafer frame on the supply station 5, the wafer cassette 27 is lowered below the level of the supply station, which is illustrated in figure 2c. In this position, the supply station 5, which can be displaced in two spatial axes, can be shifted both under the placement station 3 and over the wafer cassette 27, by which means the machine layout plan can evidently be kept very small.

Figure 2d shows an alternative embodiment of an apparatus in accordance with figure 2 with an additional intermediate placement station 40 in the region of the rotational circle 14 of the two primary tools 6a, 6b. A plurality of such intermediate placement stations could be arranged in angularly distributed fashion in the region of the turning circle 14. The intermediate placement station has a buffer function and serves for intermediately storing a picked-up chip. At a later point in time, said chip can be reintegrated into the working process or else be completely excluded.

Figure 3 shows further details of the primary tool and the secondary tool. The two primary tools 6a and 6b are arranged diametrically opposite one another at the end and on the outer side of a U-shaped rotary arm 23. The rotary arm rotates about a horizontal axis 13 and can be driven rotationally by means of a motor 25. The two tools 6a and 6b describe a rotational circle 14 in this case. A camera housing 24 with objective outputs, which will be described below, is arranged within the rotational circle 14.

The provision plane 7 practically forms a horizontal tangent with respect to the rotational circle 14. The turning apparatus 9 with the two turning arms 30a and 30b is arranged in said provision plane. Its axis 28 of rotation is laterally offset somewhat with respect to the axis 13 of rotation of the

rotary arm 23. An apparatus for fixedly holding a semiconductor chip, for example a suction needle, is arranged at each end of a turning arm 30a, 30b, analogously to the two primary tools 6a, 6b.

The guide rail 21 for the slide 15 of the secondary tool 8 extends above the provision plane 7. In the position illustrated in figure 3, the secondary tool 8 has just accepted a semiconductor chip from the turning arm 30b of the turning apparatus 9 and is transporting said chip toward the placement station. The turning arm 30b is already ready again for accepting a new chip from the primary tool 6b.

In accordance with figure 4, the rotary arm 23 with the two primary tools 6a, 6b is arranged in a shaft 31. The primary tools comprise a suction needle 32, for example, which can suck up a semiconductor chip 1. For taking the latter from the wafer film, a small lifting movement must evidently be able to be implemented. This lifting movement is effected here by virtue of the suction needle 32 being arranged at the end of a pivotable double lever arm 33. The other end is connected to a pneumatic piston 34, upon the actuation of which the suction needle 32 is also displaced. Instead of the pneumatic piston, an electromagnetic drive apparatus could also be used, by way of example. It goes without saying that the realization of the lifting movement could also be achieved by other means.

It is also evident from figure 4 that the turning apparatus 9 has its own drive motor 35.

Figures 5 and 6a schematically show the arrangement of the two cameras 10 and 11 with the associated illumination unit within the rotational circle 14 for the two primary tools 6a, 6b. The two cameras 10 and 11 are arranged one above another in separate camera housings 24, 24', to be precise on a vertical plane running in a manner offset by 90° with respect to the vertical plane of the rotational circle 14. The image regions 37, 37' of the actual positions to be captured are viewed via

deflection mirrors 36a, 36b. The deflection mirror 36a is assigned to the first camera 10 and captures the image region 37 on the supply station 5, while the second deflection mirror 36b is assigned to the second camera 11 and thus views from below the image region 37 of a semiconductor chip fixedly held by the turning apparatus 9 or, if appropriate, by the secondary tool. It goes without saying that corresponding light sources which illuminate the image regions to be viewed are also provided.

In contrast to this, figure 6b shows an alternative embodiment, in which the two image regions 37, 37' are viewed by means of a single camera 11 accommodated in a camera housing 24. In this case, the camera housing extends in the longitudinal direction of the axis 13 of rotation of the rotary arm 23. The image splitting that is required in the case of this solution is effected by means of a mirror 38, by way of example.

The placement procedure for a semiconductor chip is described below with reference to figures 7a to 7e, in the course of which the chip is placed onto the substrate by the same placement side by which it previously adhered on the wafer film (non-flip application). In accordance with figure 7a, the rotary arm 23 is in a vertical position in which the primary tool 6a acquires a semiconductor chip from the supply station 5 and the primary tool 6b transfers a semiconductor chip already picked up previously to the turning apparatus 9.

In accordance with figure 7b, the rotary arm 23 rotates in arrow direction a and the slide with the secondary tool 8 moves in arrow direction b. In this case, the secondary tool has accepted a semiconductor chip from the turning apparatus, while the semiconductor chip previously delivered to the turning apparatus still remains in the same position. The primary tool 6b now moves downward without load, while the primary tool 6a moves upward with a picked-up semiconductor chip. In the position illustrated, the imager regions for the actual position to be captured are no longer concealed by the two primary

tools 6a and 6b, so that it is now possible, as illustrated in figure 6a, to effect the capture of the actual position of a new semiconductor chip on the supply station and also that of the semiconductor chip still fixedly held at the turning apparatus. Approximately at the same time, the third camera captures the actual position of the substrate at the placement station 3.

In accordance with figure 7c, the rotary arm 23 has reached an approximately horizontal position. The secondary tool 8 deposits its semiconductor chip onto the substrate at the placement station. At the same time, the turning apparatus 9 has also begun to rotate in arrow direction c in order to turn the previously received chip 1 through 180°.

In accordance with figure 7d, the secondary tool 8 is already being moved back again in arrow direction d. The turning apparatus 9 has not yet completely finished the turning operation and the rotary arm 23 has likewise not yet reached its vertical pick-up or delivery position again. Incidentally, the directions of rotation of the rotary arm and of the turning apparatuses always run in opposite senses, but always in the same direction, so that the two rotary bodies always intermesh without colliding with one another. Consequently, two chips are always transported by means of a rotational movement of 360° in each case.

In the position in accordance with figure 7e, the turning apparatus 9 has attained a complete rotation through 180°. So has the rotary arm 23, which is now once again in a vertical position. The primary tool 6a is now ready to transfer its previously picked-up chip to the turning apparatus 9, while the primary tool 6b is ready to pick up a new chip from the supply station 5. The secondary tool 8 is likewise ready to accept the now turned chip from the turning apparatus.

If it is desired to place the chip onto the substrate by its structure side (flip-chip application), the apparatus can be

driven in a second operating mode. In this case, the turning apparatus 9 is brought from an operating position to a rest position. This is done by drawing it back to a plane lying behind the plane of movement of the secondary tool 8. For the sake of better clarity, the turning apparatus has been completely omitted in figures 8a to 8e although it does, of course, remain visible in the rest position, too.

The sequences illustrated in figures 8a to 8e largely correspond to those as also illustrated in figures 7a to 7e. In accordance with figure 8a, a semiconductor chip is picked up from the supply station 5 by the primary tool 6a, while the primary tool 6b transfers a semiconductor chip directly to the secondary tool 8. It is evident that the secondary tool 8 now no longer acquires the semiconductor chip on the structure side, as was the case after the turning of the chip in the operating mode described previously, but rather on the bearing side on which the chip previously adhered from the wafer film.

In accordance with figure 8b, the rotary arm 23 begins to rotate in arrow direction a, while the secondary tool 8 is still stationary. In this position, the three cameras can once again capture the respective actual position. In detail, this means that the camera 11, which captures the position of the chip on the turning apparatus in the non-flip application (figure 5), is now used for capturing the position on the secondary tool 8. This is evidently a further advantage of the bifunctional apparatus.

In accordance with figure 8c, the secondary tool 8 has started to move in the direction of the placement station 3. The empty primary tool 6b and the loaded primary tool 6a have covered a path of 90°.

In accordance with figure 8d, the secondary tool has already deposited its chip onto the substrate and is on the way back again to the pick-up position. The rotary arm 23 has not yet completely finished its 180° rotation.

In accordance with figure 8e, the primary tools 6a, 6b and the secondary tool 8 are situated exactly on the same vertical plane. The secondary tool 8 is ready to pick up a new chip that is provided in the provision plane by the primary tool 6a. At the same time, the primary tool 6b is ready to pick up a new chip from the supply station or from the wafer table. The placement procedure now begins again from the start.

Figure 9 shows again an overall perspective illustration of the apparatus described with the machine frame 26 and the wafer cassette 27 lowered into the rest position here. The placement station 3 is embodied here as a feed system 39, on which substrates can be fed cyclically in arrow direction x. The turning apparatus 9, the rotary arm 23 and the guide rail 21 for the slide with the secondary tool can likewise be seen.

Patent Claims

1. A method for the placement of electronic components (1), in particular semiconductor chips, on a substrate (2) at a placement station (3), in which case the component bearing by a bearing side (4) at a supply station (5) is picked up by means of a primary tool (6) and is transported to a provision plane (7) lying above the plane of the supply station by means of a rotational movement of the primary tool, and the component is accepted by a secondary tool (8) in the provision plane, transported over the substrate (2) and deposited there, characterized in that the component (1) is taken from the primary tool (6) in the provision plane (7) by means of a turning apparatus (9) and is turned and transferred to the secondary tool (8) in such a way that it is deposited onto the substrate once again by the same bearing side (4).
2. The method as claimed in claim 1, characterized in that the actual position of the component on the supply station prior to the pick-up is determined by means of a first monitoring device (10), and/or in that the actual position of the component in the provision plane prior to the transport to the substrate is determined by means of a second monitoring device (11), and/or in that the actual position of the substrate is determined by means of a third monitoring device (12), deviations between the actual values determined and a predetermined desired position of the component being corrected.
3. The method as claimed in claim 2, characterized in that the actual position is determined by means of a respective image recognition device whenever the primary tool or the secondary tool clears the image field of the actual position to be determined.
4. The method as claimed in one of claims 1 to 3, characterized in that at least two primary tools (6a, 6b) are actu-

ated in such a way that a first primary tool (6a) picks up a component, and a second primary tool (6b) delivers a component to the turning apparatus (9).

5. The method as claimed in one of claims 1 to 4, characterized in that in a first operating mode the turning apparatus (9) works in an operating position, and in that for a second operating mode the turning apparatus is brought to a rest position, in which the secondary tool (8) accepts the components directly from the primary tool (6a, 6b), said components being deposited onto the substrate by the structure side (17) remote from the bearing side (4).
6. An apparatus for the placement of electronic components (1) in particular semiconductor chips, on a substrate (2) at a placement station (3), in which case the component bearing at a supply station (5) by a bearing side (4) can be picked up by means of a primary tool (6a, 6b), which is mounted such that it can be rotated about an axis (13) and by means of which the component can be transported to a provision plane (7) lying above the plane of the supply station, and the component can be accepted from the provision plane by a displaceable secondary tool (8), can be transported over the substrate (2) and can be deposited there, characterized in that a turning apparatus (9) is arranged in the region of the provision plane (7), by means of which turning apparatus the component can be taken from the primary tool (6a, 6b) at the bearing side (4) and can be turned and can be transferred to the secondary tool (8) in such a way that it can be deposited onto the substrate once again by the same bearing side (4).
7. The apparatus as claimed in claim 6, characterized in that a first monitoring device (10) is provided for determining the actual position of the component on the supply station prior to the pick-up, and/or in that a second monitoring device (11) is provided for determining the actual position of the component in the provision plane (7) prior to

- the transport to the substrate, and/or in that a third monitoring device (12) is provided for determining the actual position of the substrate, it being possible to correct deviations between the actual values determined and a predetermined desired position of the component.
8. The apparatus as claimed in claim 7, characterized in that the monitoring devices are image recognition devices which are positioned in such a way that the image field of the actual position to be determined can be completely captured in at least one operating position of the primary tool or of the secondary tool.
 9. The apparatus as claimed in claim 7 or 8, characterized in that the third image recognition device is mounted on a slide that can be displaced at least in one spatial axis.
 10. The apparatus as claimed in claim 8 or 9, characterized in that the first and second image recognition devices are arranged in such a way that the image fields assigned to them are captured from within the rotational circle of the primary tool.
 11. The apparatus as claimed in one of claims 6 to 10, characterized in that two primary tools (6a, 6b) are coupled to one another in such a way that a component can be picked up by means of a first primary tool (6a), and a component can be delivered to the turning apparatus by means of a second primary tool (6b).
 12. The apparatus as claimed in claim 11, characterized in that the first and second primary tools (6a, 6b) are arranged diametrically opposite one another relative to the axis of rotation preferably on a U-shaped rotary arm.
 13. The apparatus as claimed in one of claims 6 to 12, characterized in that the turning apparatus (9) can be displaced from an operating position into a rest position, in which

case, in the rest position, the components can be transferred to the secondary tool from the primary tool directly in the provision plane and can be deposited onto the substrate by the structure side (17) remote from the bearing side (4).

14. The apparatus as claimed in claim 13, characterized in that the turning apparatus (9) is a rotatable double arm tool, in which case with each arm it is possible for a component to be accepted from the primary tool in the provision plane and to be transferred to the secondary tool, respectively.
15. The apparatus as claimed in one of claims 6 to 14, characterized in that the secondary tool (8) is arranged on a linearly displaceable slide (15).
16. The apparatus as claimed in one of claims 6 to 15, characterized in that the primary tool rotates on a rotational plane which runs approximately parallel to the displacement direction of the secondary tool.
17. The apparatus as claimed in one of claims 6 to 16, characterized in that the placement station is embodied as a feed station for the preferably linear passage of a plurality of substrates.
18. The apparatus as claimed in one of claims 6 to 17, characterized in that the turning apparatus is embodied as a buffer station for temporarily receiving a plurality of components.
19. The apparatus as claimed in one of claims 6 to 18, characterized in that a wafer cassette (27) is arranged alongside the supply station (5) and can be moved, for the purpose of loading wafer frames onto the supply station, into different loading positions in which the supply station and the wafer cassette are at least partly arranged on the

same plane, and in that the wafer cassette can be moved into a rest position in which the supply station, for processing a loaded wafer frame, can be displaced at least partly in the horizontal working plane over the wafer cassette.

20. The apparatus as claimed in one of claims 6 to 19, characterized in that one or a plurality of intermediate placement stations (40) at which a component can be placed temporarily in particular prior to the transfer to the turning apparatus or prior to the transfer to the secondary tool are arranged in the region of the rotational circle of the primary tool.