Device for extracting electronic components

The present invention concerns a device for extracting electronic components, in particular for extracting electronic chips and/or for extracting other electronic components, for example Lead Less Package (LLP), from a semiconductor wafer and/or a cutout leadframe.

Electronic chips and LLP, for example, are electronic components of very small size. Electronic chips are formed in series on semiconductor wafers that are generally circular and about 10 to 30 centimeters in diameter. Other electronic components such as for example LLPs, for their part, are generally produced on rectangular wafers called leadframes. Each wafer can comprise up to several thousands components, for example chips or LLPs. After their manufacture, the electronic components are separated from one another and then extracted one by one from their wafer.

According to the principle adopted by most extracting devices, the wafers are glued on an elastic membrane and cut in order to single out the individual components, for example the chips or LLPs. During this operation, the membrane must remain intact for it to be able to be stretched afterwards on a rigid frame in order to move the electronic components apart from one another. The individual extracting of each component from the cutout wafer is generally carried out through the conjugated action of one or several extractors, for example one or several needles, pushing the electronic component to be extracted from below and an aspiration head removing it from above.

In the prior art extracting devices, the movements of the extractor or extractors are generally controlled by pneumatic actuators or by revolving cylinder engines connected to cam systems such as that described for example in patent US5755373. However, the acceleration of these systems is limited by their inertia due to the mass of the moving parts. Their speed is thus limited, in particular over short distances, thus restricting the maximal rate of the extracting devices. Because of the

moving masses, such systems are also subjected to fast aging of their mechanism, which affects their life expectancy.

Patent application EP0565781 describes an extracting device in which the extractor, namely a needle, is fixed whilst the support on which the membrane is placed is mobile. The designing of such a device is however considerably more complex than that of devices in which the support is fixed and the extractor is mobile. Furthermore, the disadvantages of the aforementioned devices are even more magnified because of the great mass of the support, of the wafer and of its frame.

Once extracted, the electronic components are generally tested electrically, controlled visually and/or conditioned in honeycombed bands, mini-wafers, or any other conditioning used for such components. All these operations are often performed on the individual components by automated processing lines working at high speed, considerably higher than the speeds of prior art extracting devices, thus requiring either the use of several extracting devices in parallel for each processing line (as for example on the "Die-bonding" lines of the prior art) or the reduction of the processing line's speed.

The integration of the prior art extracting devices into processing lines is generally more difficult because of their space requirement. The extracting devices must be able to remove all the components of the cutout wafer, including those close to the periphery. The point of extraction being generally fixed, the free space around this point of extraction corresponds practically to a perimeter whose largest dimension equals the double of the largest dimension of the frame holding the cutout wafer. Under these conditions, it is difficult, if not impossible, to integrate such devices into processing lines articulated around a conveyor, since the point of extraction cannot be brought sufficiently close to the conveyor for the chips or LLPs to be directly removed during their extraction by the conveyor's component-holders.

It is thus an aim of the present invention to propose a device for extracting electronic components from a cutout wafer capable of working at higher speeds than those of the prior art extracting devices.

It is another aim of the invention to propose a device for extracting electronic components from a cutout wafer capable of being integrated directly into a processing line.

It is another aim of the invention to propose a device for extracting electronic components from a cutout wafer having a greater life expectancy thanks to a low wear of its mechanical parts.

These aims are achieved by a device and a method having the characteristics of the corresponding independent claims, advantageous embodiments being furthermore given by the dependent claims.

These aims are achieved in particular by a device for extracting electronic components from a cutout wafer comprising at least one needle for extracting electronic components, the needle or needles being actuated by a linear electromagnetic transducer.

Use of a linear electromagnetic transducer, preferably a voice coil motor, for generating the movements of the extractor or extractors, for example of the extraction needle, allows the extracting device to achieve very high working speeds, equal or greater than those of most of the existing processing lines.

Although it has been suggested in the field of extraction of electronic components, use of electromagnetic transducers is reserved for moving, without the need for any great accuracy, mechanical elements that have considerable inertia due to their great mass and/or to additional elastic elements. Yet the movements of electromagnetic transducers involve moving very few parts that move practically without friction. Their inertia is thus low, especially in voice coil motors in which the mobile part is an electric coil whereas the heavier elements, especially the magnets, are

fixed. Electromagnetic transducers in general and voice coil motors in particular are thus capable of very strong accelerations allowing very fast movements, in particular over short distances. The inventive device thus takes advantage of these characteristics by using a linear electromagnetic actuator whose fast movements are directly transmitted to the extractor or extractors whose mass and resistance against displacement are also low. The present invention thus makes it possible to realize extracting devices that can achieve very high speeds.

According to the preferred embodiment of the invention, the extracting device further has means enabling the frame holding the cutout wafer to rotate in the horizontal plane, thus reducing considerably the free space needed around the point of extraction.

The present invention will be better understood by means of the description of its preferred embodiment illustrated by the Figures 1 to 6, in which:

Fig. 1 shows a perspective view of the component extracting device, associated to a testing and/or processing line, according to the preferred embodiment of the invention,

Fig. 2 shows a side view of the component extracting device according to the preferred embodiment of the invention,

Fig. 3 shows a front view of the component extracting device according to the preferred embodiment of the invention,

Fig. 4 shows a detail of the extracting device's head and of the mechanism for holding the cutout wafer,

Fig. 5A to 5C illustrate the movements of the extracting device's needle and of the aspiration head during extraction of a chip from a cutout wafer,

Fig. 6 illustrates diagrammatically the free space needed around the point of extraction according to the preferred embodiment of the invention.

In its preferred embodiment illustrated by Figure 1, the extracting device according to the invention comprises a conveyor 1, preferably circular, around which a certain number of processing stations (not represented) are distributed, for example testing or micro-welding stations. The movements of the conveyor 1 are preferably indexed, thus defining at its periphery a predetermined number of locations at which the processing stations can be placed. Component-holders 11, preferably aspiration heads, are regularly distributed on the periphery of the conveyor 1, thus allowing the electronic components to be transported from one processing station to another. For better legibility, only a single aspiration head 11 has been represented in Figure 1.

One of the locations defined around the conveyor is occupied by a guiding nose 3 mounted onto a support 25 that is preferably cylindrical and vertical, at the center of which there is a needle (not represented in Figure 1) serving to extract the electronic components. At each step of the conveyor 1, an aspiration head 11 finds itself precisely above the center of the guiding nose 3 and consequently above the needle.

A camera 8 permitting to check the centering, over the guiding nose 3, of the electronic component to extract is placed over the latter. Its objective 80 is preferably oriented downwards and centered relative to the guiding nose 3.

A push ring 4 placed between the objective 80 of the camera 8 and the guiding nose 3 allows the vertical movement of the aspiration head 11 to be moved while leaving free the center of the vision field of the camera 8. The push ring 4 enables the aspiration head 11 to be pushed downwards by pressing on the extremities of its upper part. The movements of the push ring 4 are generated by a voice coil motor 40 placed on a fixed plate 50 located above the aspiration heads 11 and

connected by rigid fastening elements 51, for example by rigid rods, to a fixed element 5 of the device's structure. On the fixed plate 50 there also is a measuring rule 49 allowing the displacements of the voice coil motor 40, and consequently of the push ring 4, to be measured.

The cutout wafer (not represented), from which the electronic components are to be extracted, is held in its frame between the guiding nose 3 and the aspiration head 11 by a X-Y plate (not represented) that also allows it to be displaced horizontally.

The main elements of the extracting device according to the preferred embodiment of the invention are illustrated in more detail by the Figures 2 and 3. Barring any indications to the contrary, the same reference numbers designate the same element or elements on all the figures. The structure and functioning of the inventive extracting device are described here after in the framework of the extraction of electronic chips from a cutout semiconductor wafer. The one skilled in the art will however understand that the structure and the functioning described are also applicable to the extraction of any other type of electronic components presented in wafers or in leadframes during at least part of their manufacturing process, for example to the extraction of LLPs from a cutout leadframe.

The cylindrical support 25 on the top of which the guiding nose 3 is located is fastened on the reference surface 6 of the extracting device. On this reference surface 6 are also fastened the other processing stations (not represented) located around the circular conveyor 1. An extension tube 23 is held inside the cylindrical support 25 by two ball bearing bushings 251, 252 allowing it to slide vertically. A support 21 carrying the needle 2 for extracting the chips is fastened to the top of the extension tube 23. The extremity of the needle 2 can issue from the center of the guiding nose 3 through an opening that also serves to let through air for the aspiration and blowing of the flexible film.

The extension tube 23 extends downwards through the reference surface 6 under which it is fastened to a mobile plate 22, itself connected to the mobile coil 201 of a voice coil motor 20.

Voice coil motors are electromagnetic transducers whose mobile part is a coil placed in a magnetic field generated by fixed magnets. When a current is injected into the mobile coil, the latter is subjected to a force whose direction depends on the sense of the current, thus causing it to move. The coil is preferably guided, for example by rails or in ball bearing guide bushings, and can thus travel along a linear axis. According to the preferred embodiment of the invention, this guiding function is fulfilled by the ball bearing bushings 251, 252 with the aid of the pin 220 capable of sliding in an adapted hole under the reference surface 6 and thus preventing the mobile plate 22 from rotating.

The voice coil motor 20 controlling the movements of the needle 2 as well as the elements connected thereto are advantageously fastened on a fixed support 60 located under the reference surface 6 to which it is fastened, for example screwed, thus freeing the reference surface 6 for the X-Y plate (not represented). The voice coil motor 20 is preferably placed so that the displacements of its mobile coil 201 occur along a vertical axis. The electric terminals 200 of the mobile coil 201 are connected to a power source controlled by the device's control system (not represented). The control system can thus control the upward or downward movements of the mobile coil 201, and consequently of the needle 2, by having an electric current with a determined direction and intensity circulate in the mobile coil 201.

The displacements of the mobile plate 22, and consequently of the needle 2, are measured by a measuring rule 29 and the information provided is processed by the control system.

The lower extremity of the extension tube 23 is connected by a conduit 230 to a pneumatic system (not represented) that is also controlled by the device's control system. The pneumatic system can aspirate and/or

blow air through the extension tube 23 that is open at its upper extremity, under the support 21 of the needle 2. An air vacuum and/or overpressure whose use will be explained further below can thus be generated in the guiding nose 3.

The aspiration heads 11, of which only one is represented in Figures 2 and 3, are held by ball bearing bushings 12 fastened to the extremity of the arms 10 of the circular conveyor 1 and into which they can slide vertically. A spring 13 placed between the arm 10 of the conveyor 1 and the upper part 110 of the aspiration head 11 holds the latter in its high position. A stopping element 112 clasping the upper part of the aspiration head 11 determines this high position by limiting the upward displacement of the aspiration head 11. The stopping element 112 preferably comprises a pin 113 capable of sliding in a corresponding opening provided in the arm 10 of the conveyor 1, thus preventing the aspiration head 11 from rotating.

The push ring 4 allows the aspiration head 11 located above the guiding nose 3 to descend. It is connected by a pin 42 to a mobile plate 41 united with the mobile coil 401 of the voice coil motor 40. The pin 42 is held in a ball bearing bushing 52 fastened on the fixed plate 50 and in which it can slide vertically. A spring 43 placed between the fixed plate 50 and the mobile plate 41, preferably around the pin 42, holds the push ring 4 upwards, resting against the fixed plate 50. In this position, the push ring 4 is not in contact with the aspiration head 11 located under it and the conveyor 1 can be advanced by one step in order to present a new aspiration head 11 under the push ring 4.

The terminals 400 of the mobile coil 401 of the voice coil motor 40 are connected to a power source (not represented) preferably controlled by the device's control system. The movements of the mobile coil 401, and consequently of the push ring 4, are thus controlled by the control system that can in particular lower the mobile plate 41 against the force of the spring 43 by having a current with appropriate direction circulate through the mobile coil 401. The push ring 4, when lowered, drives in its movement the aspiration head 11 situated under it by pushing on the extremities of its

upper part 110. In order to avoid any undesirable rotation, the push ring 4 comprises a pin 48 sliding in a bushing 58 fastened to the fixed plate 50 (Figure 3).

The movements of the mobile plate 41 are preferably measured by a measuring rule 49 and the data supplied are processed by the control system, thus allowing the latter a better control of the movements of the push ring 4 and therefore of the aspiration head 11 situated under the push ring 4, above the guiding nose 3.

The position of the camera 8 is illustrated in Figure 3. The objective 80 is oriented downwards, above the guiding nose 3, opposite the opening 45 of the push ring 4. During the movements of the conveyor 1, the aspiration head 11 having removed an electronic chip is moved away from the guiding nose 3, thus freeing the field of the camera 8 that can then film, through the opening 45 of the push ring 4, the position of the next chip to extract located on the guiding nose 3. The field of the camera 8 is then occupied again by the new aspiration head 11 presented above the guiding nose 3 by the conveyor 1.

Figure 4 shows in cross section a detail of the guiding nose 3 on which the cutout wafer 9 is located. The cutout wafer 9 is glued on the elastic membrane 90 that is stretched on a frame (not represented). The cutout wafer 9 is positioned so that the next electronic chip to extract 91 is placed at the center of the guiding nose 3. The guiding nose 3 comprises nozzles 30 connected to the extension tube 23 and distributed around the needle 2 through which air can be aspirated in order to firmly pin the elastic membrane 90 against the upper surface of the guiding nose 3. Preferably, these nozzles 30 can also insufflate air in order to make easier the displacement of the wafer 9 during the centering of the electronic chip to extract 91.

Once it has been centered, the electronic chip to extract 91 is situated precisely above the needle 2. The main steps of the extraction of the chip 91 are illustrated by the Figures 5A to 5B. In a first step, the

aspiration head 11 is lowered until it comes into contact with the chip 91. The nozzle of the aspiration head 11 aspirates air in order to hold the chip 91 through air vacuum. The needle 2 and the aspiration head 11 are then raised simultaneously, thus lifting the electronic chip 91 and removing it partially from the elastic membrane 90. The perfect synchronization of the movements of the needle 2 and of the aspiration head 11 is very important for the quality and reproducibility of the extraction. It is achieved optimally thanks to the symmetry of the motorization: the same voice coil motor and the same measuring rule are used for both elements and the laden masses are similar.

During extraction, the electronic chips next to the chip to extract 91 remain pinned against the surface of the guiding nose 3, under the action of the air aspirated by the nozzles 30. The aspiration head 11 is then raised to the maximum whilst the needle 2 is lowered again. The chip 91 is then removed from the elastic membrane 90 that returns to its initial position. The conveyor 1 can then advance by one step in order to transport the chip 91 to the next processing station, for example to a testing station.

After each extraction of an electronic chip, when the conveyor advances by one step, the cutout wafer 9 is displaced by the X-Y plate in order to present a new chip to extract to the center of the guiding nose 3. During the displacements of the cutout wafer 9, air is preferably blown by the nozzles 30, thus facilitating the sliding of the membrane 90 on the surface of the guiding nose 3. In a first movement, the wafer 9 is displaced without visual control so as to move the next chip to extract closer to the center of the guiding nose 3. The true position of the next chip to extract is filmed by the camera 8 when its objective 80 is free from any aspiration head 11. The data are transmitted to the control system that calculates the necessary corrections in order for the chip to be perfectly centered. The position of the wafer 9 is then corrected according to the instructions of the control system during the last instants of the movement of the conveyor 1. The nozzles 30 of the guiding nose 3 hen aspirates air in order to pin the elastic membrane 90 against the surface of the guiding nose 3. The next chip can then be extracted from the cutout wafer 9.

As the moving mass of the voice coil motors 20, 40 used for motorizing the needle 2 and the push ring 4 of the device according to the preferred embodiment of the invention is very low, generally barely higher than the mass of their mobile coil 201, 401, these motors can be subjected to very strong accelerations, thus allowing repeated movements at very high speeds, particularly over short distances. Use of such actuators for the motorization of a needle 2 for extracting electronic chips allows extracting devices to be designed whose speed is sufficient to be directly integrated into automated processing lines without slowing down the latter. The chips can thus be extracted directly from the cutout wafer 9 by the component-holders 11 of the conveyor that will also transport them onto the following processing stations, thus avoiding any intermediary transporting equipment.

The chips are however generally produced in large series on wafers of relatively large dimensions. In order for all the chips to be extracted from the cutout wafer 9, the latter must be capable of being displaced freely around the point of extraction, within a radius at least equal to the wafer's diameter. This constraint makes difficult, if not impossible, the placing of the extraction needle 2 under the component-holders 11 of a conveyor, in particular of a circular conveyor 1 whose arms 10 are rarely very far from its center.

The X-Y plate (not represented) of the device according to the preferred embodiment of the invention, which holds the cutout wafer 9 between the guiding nose 3 and the aspiration head 11, thus preferably comprises an actuator allowing the cutout wafer to be turned in the horizontal plane. In this way, for example, the electronic chips situated in the half of the wafer closest to the conveyor's center can be extracted first, the wafer being then turned by 180° to allow the chips from the other half of the wafer to be extracted without the frame having to be moved closer to the center of the conveyor 1.

The reduced space requirement around the point of extraction achieved thanks to the rotation of the cutout wafer 9 is illustrated in Figure

6 which shows a diagrammatic view from above of the device according to the preferred embodiment of the invention. The conveyor 1 of the device is a circular conveyor having thirty-two discrete positions and consequently thirty-two potential locations and thirty-two component-holders 11 at its periphery.

The cutout wafer 9, glued on the elastic membrane 90, is held on the frame 99. The frame 99 is placed horizontally between the guiding nose (not represented) and one of the aspiration heads 11 of the conveyor 1. According to the disposition illustrated diagrammatically in Figure 6, the cutout wafer 9 is centered on the guiding nose. The inventive device comprises an actuator (not represented) capable of turning the frame 99, and consequently the cutout wafer 9, by 180° in the horizontal plane. In a first step, only the electronic chips situated in the half of the cutout wafer 9 closest to the conveyor's center are extracted. The frame 99 is then turned by 180° and the half of the cutout wafer 9 still comprising chips to extract is then in its turn situated closer to the center of the conveyor 1. Thus, only the chips to extract situated in the half of the wafer 9 closest to the center of the conveyor 1 must be capable of being brought over the center of the guiding nose.

The perimeter in which, according to this method, the frame 99 must be capable of being displaced by the X-Y plate (not represented) is indicated by the outline 98. It is clearly visible in Figure 6 that thanks to this rotation, the guiding nose can be placed considerably closer to the center of the conveyor, allowing all the chips of the wafer 9 to be extracted directly by the component-holders 11 of the conveyor 1, without the latter having to be placed too far from the center of the conveyor 1.

The one skilled in the art will understand that this method for rotating the cutout wafer 9 can also be adapted to any other prior art extraction system in order to reduce the free space necessary around the point of extraction of the electronic chips.

Figure 6 further shows that the space necessary for displacing the cutout wafer 9a round the guiding nose generally prevents use of all the defined locations around the conveyor. In order to avoid finding itself inside the perimeter 98, the next processing station 100 must be placed several locations further away from that occupied by the guiding nose.

The extracting device according to the preferred embodiment of the invention comprises a single extraction needle. It is thus particularly suited for extracting electronic components of very small size. The one skilled in the art will however easily understand that the inventive device can be adapted to comprise several needles allowing components of a larger size to be extracted.

The one skilled in the art will also understand that the extraction needle or needles can be replaced, within the framework of the invention, by any other type of mobile extractor pushing the electronic component to extract out of the cutout wafer. The extractor or extractors can for example comprise an upper part adapted specifically to a particular type of component whose form it espouses in order to avoid any damage during extraction.

The extracting device according to the preferred embodiment of the invention comprises a circular conveyor. It is however conceivable to design other shapes of conveyors such as linear conveyors for example.

Claims

1. Device comprising at least one extractor (2) for extracting electronic components from a cutout wafer (9) by pushing an electronic component to be extracted (91) out of the cutout wafer (9), characterized in that said at least one extractor (2) is actuated by a linear electromagnetic transducer (20).

2. Device according to the preceding claim, said at least one extractor being an extraction needle (2).

3. Device according to one of the preceding claims, said linear electromagnetic transducer being a voice coil motor (20).

4. Device according to one of the preceding claims, comprising a conveyor (1) for transporting said electronic components (91) to a plurality of successive processing stations (100).

5. Device according to the preceding claim, said conveyor (1) comprising at least one aspiration head (11) for removing and holding said electronic components (91).

6. Device according to one of the claims 4 or 5, said conveyor (1) being a circular conveyor with indexed movement, said successive processing stations (100) being placed at the periphery of said circular conveyor (1).

7. Device according to one of the claims 4 to 6, comprising a pushing element (4) for controlling the vertical movements of said at least one aspiration head (11) during removal of said electronic components (91).

8. Device according to the preceding claim, said pushing element (4) being actuated by a second linear electromagnetic transducer (40).

9. Device according to the preceding claim, said second linear electromagnetic transducer being a voice coil motor (40).

10. Device according to one of the claims 7 to 9, comprising a camera (8) for controlling the position of said electronic component to extract (91), said camera (8) being placed more or less vertically above said pushing element (4).

11. Device according to the preceding claim, said control being performed during the movement of said conveyor (1).

12. Device according to one of the preceding claims, comprising an actuator for horizontally rotating said cutout wafer (9).

13. Method for extracting electronic components (91) from a cutout wafer (9), said extraction being effected by means of at least one extractor (2) pushing an electronic component to be extracted (91) out of said cutout wafer (9), characterized in that said at least one extractor (2) is actuated by an electromagnetic transducer.

14. Method according to the preceding claim, said extractor being an extraction needle (2).

15. Method according to one of the preceding claims, said extraction comprising the following steps:

lowering an aspiration head (11) situated above an electronic component (91) to be extracted from said cutout wafer (9) until said aspiration head (11) comes into contact with said electronic component to extract (91),

holding by air aspiration said electronic component to extract (91) against said aspiration head (11),

simultaneously raising said at least one needle (2) and said aspiration head (11),

lowering said at least one needle (2) to its initial position and simultaneously raising the aspiration head (11).

16. Method according to the preceding claim, further comprising a step of rotating said cutout wafer (9).

17. Method according to one of the claims 15 or 16, said aspiration head (11) being associated to a conveyor (1).

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