

WIRE SPRING GRIP, LEAD FRAME CARRIER BELT AND PLATING SYSTEM

The invention relates to a semiconductor IC lead frame, gripping belt and in particular to such a belt used in strip to strip or reel to reel plating of electronics components using the P-Dips method.

In the field of packaged electronics components, it is well known to plate the leads that protrude from the insulating packaging layer before use. The leads are generally in the form of cylindrical wires or flat tines punched from sheet material. Whatever their form it is necessary to plate the wires, with for example a copper or iron based alloy, so as provide corrosion and mechanical protection and to facilitate interconnection with other components, e.g. by soldering. In the latter case, plating is generally with tin preceded with a flash coating of copper in the case of leads made from an iron based alloy.

Traditional methods of plating such as rack and barrel plating have been replaced by methods in which parts to be plated are conveyed on conveyors or belts through a series of treatment stations.

In US-A-534843 an apparatus for the plating of the contact elements of encapsulated electronic components is disclosed. The parts to be plated are carried through each of a plurality of treatment stations including the principal plating baths, on a continuous, flexible conveyor belt constructed from an electrically conductive material, wherein the conveyor belt acts as one of the electrodes of the plating current supply system. The disclosed conveyor belt consists of a stainless steel belt running in a horizontally aligned loop with the web of the belt vertical. A portion of this belt

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holding a strip of components is shown in figure 1. The lower edge of the belt 1 is formed into an array of flexible gripping fingers 2 provided with projections 3 suitable for engagement with laterally disposed cams, on alternating sides of the belt for successive grip fingers. With the belt 1 stationary and the cams activated to separate the fingers, a loading device inserts a strip of components 4 between the fingers 2. The cams are disengaged from the projections 3 and the fingers 2 grip the strip of components 4. The parts are then moved through the processing stations, supported by the belt. After plating the components 4 are removed by cam action on the grip fingers 2.

The construction shown in figure 1 has a disadvantage in that the frictional force that can be exerted by the gripping fingers is very low. The low gripping force limits the maximum weight of components that can be carried by the belt. Furthermore, after prolonged use the gripping force applied by the gripping fingers will tend to deteriorate. Because the gripping fingers are an integral part of the belt, it is necessary to replace the entire belt once the gripping force has decreased to an unacceptable level.

Improvements have been suggested to the P-Dips strip carrier belt of the above US Patent. It has been proposed to provide a belt having removable gripping means in the form of a plurality of stainless steel leaf springs as shown in figure 3a. One end of each leaf spring 5 has a tab 6 extending at a right angle. The tab 6 is inserted into a slot 7 in the belt 1 and abuts the front of the belt 1 to lock the spring in place. Each spring 5 extends out from the web of the belt at a right angle. A spring finger 8 extends from a curved portion 9 towards the bottom of the belt web where it passes through an aperture 10. A bent tip 11 of the spring finger 8 hooks over the edge of the



aperture so that it is biased against, and lies flat on, the belt web. The tip 11 extends to the bottom edge of the belt web to provide a gripping means. The spring fingers can be opened in a similar manner to the gripping fingers of US-A-453483 to allow automatic loading and unloading. The advantages of the leaf spring gripping fingers over the gripping fingers of US-A-453483, include the ability to replace each of the gripping fingers once the gripping force has deteriorated. The fingers are simply unclipped manually from the belt. However, the leaf spring gripping fingers still have relatively low gripping force, which deteriorates quickly requiring frequent replacement.

In each of the above-described prior art IC lead frame carrier belts the maximum load that can be carried is approximately 300g per 5cm of belt or 160g per gripping point; this is not sufficient for e.g. reel to reel plating processes. In UK Registered Design No. 2074865 to AEM Pte, an alternative belt is shown where the leaf springs of the second above described belt are replaced by wire springs incorporating a double coil. figure 2 shows the belt of the AEM design. The belt 1 is similar to previous designs and is shown in figure 3b. The gripping means consists of a plurality of stainless steel wire springs 12 having a cross sectional diameter of about 1.2mm. The wire springs 12 are clipped into place in a similar manner to the leaf springs of figure 3a. A curved, central portion 13 of each wire spring 12 is bent double and used as a tab 6a inserted through the slot in the belt 1.

Two arms of the spring extend at right angles through the belt 1. Each arm is formed at a central portion thereof into a series of spring coils 14 having approximately two and a half turns. Each coil rests against the belt 1 and the ends of the arms extend through two vertical slots 15 at the bottom of the belt 1 as shown in



figure 3b. At their tips 16 the arms are bent to form two wire-gripping fingers that replace the single broad tip 11 of the leaf spring design. It can be seen that the profile (side view) of the wire spring gripping means is substantially the same as the leaf spring gripping means except for the presence of the spring coil. The wire spring gripping means has advantages over the leaf spring gripping means in that the gripping force is increased as compared with the above prior art to around 200g per gripping point.

The presence of the coils in the spring gripping means increases the force that the fingers exert both downward on the slot and also against the belt. To open the fingers it is necessary to press upwards - in the plane of the belt web - to lift the fingers up the slot creating a gap between the bent portions and the belt web. Thus the amount of tension that can be put in the spring is determined by the maximum amount of pressure that can be applied to the spring to open the gripping fingers. It is necessary to open the fingers a long way so that the gripping means can be replaced. The maximum gripping force is, therefore, determined by practical considerations of the loading / unloading machinery as well as the necessity of being able to remove the gripping means easily.

All of the above prior art suffer from the phenomenon of whiskering. Whiskering is the propensity of metals such as tin to grow thin crystals projecting outward from the surface. The tendency to whisker is greatly increased as the speed of the web through the plating apparatus increases. Whiskering is undesirable not only because of aesthetic problems but also because of its corrosive nature when present in plating baths. Whiskering can also cause electrical shorting especially where the lead density is high.



It is an object of the present invention to overcome at least some of the problems with each of the prior art products discussed above. In particular it is an object of the present invention to provide a wire spring gripping means having fewer gripping points and that can be easily opened and replaced if necessary whilst maintaining a high gripping force on the IC lead frames.

Accordingly, the present invention provides a wire spring grip for an IC lead frame carrier belt, the grip comprising a wire formed to provide two arm portions extending from a curved portion, a portion of each arm being formed into a coil having a plurality of turns and wherein said curved portion forms a gripping portion of the spring grip. In the present invention, because the central portion of the wire forms the gripping finger, a rounded edge is presented which eliminates or substantially alleviates the problem of whiskering.

The end of each arm may be formed into a connecting portion for connecting the grip to a lead frame carrier belt.

The end of each arm may be angled to form an arm tip portion for engaging with a belt web so as to support the grip. Each tip portion may be angled from the plane including the immediately adjacent arm portions substantially at $90^\circ \pm 2^\circ$.

The curved portion may be angled from the plane including the portions of the arms immediately adjacent the curved portion to form said gripping portion. The angle formed by the curved portion to the plane including the adjacent arm portions may be approximately $117^\circ \pm 2^\circ$.

Between each coil and the curved portion, each arm is angled to form an engagement portion for biasing the arms against the tension in the coils. The angle

formed by the arm portions between each coil and the curved portion is approximately $127^\circ \pm 2^\circ$.

Each arm of the wire spring may have a coil having at least three turns.

The angle formed between the two portions of each arm immediately adjacent each coil may be greater than $90^\circ \pm 2^\circ$. The angle formed between the two portions of each arm immediately adjacent each coil is preferably approximately $132^\circ \pm 2^\circ$.

The wire may have a cross-sectional diameter of approximately 1mm.

The invention also provides a belt for carrying IC strips or lead frames, the belt comprising a plurality of wire springs as set out above.

The belt may have a row of apertures having an axis aligned parallel with the edges of the belt and proximate an edge thereof for receiving the curved portion of said grips.

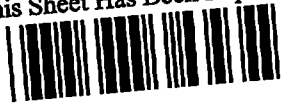
The belt may have a row of holes parallel having an axis aligned parallel with the edges of the belt and proximate a central portion of the belt web for receiving the tip portions of the grips.

For each grip on said belt a portion of each arm member adjacent the coil may extend towards an edge of said belt substantially parallel to the belt web.

In another aspect the invention provides a plating system for IC packages comprising a plurality of process stations and a horizontal conveyor comprising a belt having a vertically disposed web and including detachable gripping fingers which may be in accordance with the above described wire spring grips. The system may have a plurality of rollers disposed below the conveyor for supporting the IC packages from below.

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The system may include automatic loading and unloading stations each comprising at least two reels for supplying and receiving IC lead frame strips.

The invention will now be described in more detail, and by way of example only, with reference to the accompanying drawings in which:-

Figure 1 is a perspective view of a portion of a IC strip carrier belt according to the prior art;

Figure 2a and 2b shows plan and side views respectively of an IC lead frame carrier belt grip according to another example of the prior art;

Figure 3a is shows side and front views of an IC lead frame carrier belt and grips according to a still further example of the prior art;

Figure 3b shows side and front views of an IC lead frame carrier belt and grips according to the second example of prior art shown in figure 2;

Figure 3c shows side and front views of an IC lead frame carrier belt and grips according to the invention;

Figure 4a and 4b show plan and side views respectively of an IC lead frame carrier belt grip according to the invention;

Figure 5 shows a perspective view of a generic process module forming part of a reel to reel or strip to strip processing system according to another aspect of the invention;

Figure 6 is a side sectional view of a portion of the modular system according to an embodiment;

Figure 7 is a side view of the driving unit of a loading station according to an embodiment;



Figure 8 is a plan view of the driving unit of figure 7;

Figure 9 is a plan view of an unloading station according to an embodiment.

Referring to figures 3c, 4a and 4b, the belt of the present invention has a plurality of clips 20 made from stainless steel 316 spring wire. The belt 100 is of a slightly different design to the prior art belt 1 so as to accommodate the wire spring grips of the present invention. In an embodiment, each grip is formed by a stainless steel wire having a cross-sectional diameter of 1mm. As best shown in figure 4 a wire is formed to provide two parallel arms 21 separated by a distance of 3mm and extending from a substantially semi-circular central portion 22. The central portion 22 makes an angle of about 117° with the adjacent arm portions to form a gripping portion 22. The end of each arm is angled to form an arm tip portion 23 about 5.5mm long. A coil 24 of about 3.5mm radius is formed in each arm 21 proximate the tip portions 23. The coils have three and a half turns approximately.

Between each coil 24 and the central portion 22 each arm is angled to form an engagement portion 25 for biasing the arms against the tension in the coils. The length of wire from the coil to the bend in the arm is about 13.7mm. From the bend in the arm to the grip portion 22 there is approximately 8mm of wire.

In the present embodiment, the tolerances for angles are $\pm 2^\circ$ and for dimensions are generally $\pm 0.2\text{mm}$

The grips 20 are removably supported on the belt 100 by inserting the tip portions 23 through a series of parallel holes 26 provided in the belt 100 at an upper portion thereof. A plurality of parallel, square or rectangular apertures 27 are provided in the belt 100 in a lower portion thereof to receive the gripping portions 22. Each



gripping portion 22 is forced upwards and inwards against the tension in the coils 24 to pass through the aperture 27 to lie against the front of the belt web. By pressing on the engagement portions 25, using a cam mechanism, the gripping portions 22 can be moved away from the belt 100 to form a gap for receiving a lead frame of component strip. Further pressure on the engagement portion 25, allows a grip to be removed and this can be achieved manually.

The lead frame or component strip carrying belt of the present invention can be used with a typical prior art P-Dips strips plating system, for example that described in 4534843. A plating system in accordance with another aspect of the present invention will now be described with reference to figure 5 to 9. The present applicants have designed a plating system comprising a plurality of modules or process cells using a modular construction. Figure 5 shows a single process station 30 according to an embodiment. A top cover 31 covers the storage tank and supply pipes that provide liquid or gaseous components to the cell 32. The top cover 31 provides openable covers 33 for exhaust control knobs and the like. The cell itself which may be a plating bath, for example, is covered by openable covers 34 which are either transparent or have see through viewing portions 35. The covers 34 are typically made of polypropylene. The belt (not shown) carrying a strip of components passes through the cell 32, through side slots 36.

The plating system of the present invention may have a plurality of such cells or similar process stations including, but not limited to, one or more of cells performing, descaling, electro-deflashing, anodic activation, rinsing using mains water, rinsing using de-ionised water by spraying and/ or high pressure jet, electro-degreasing, acid etching, solder plating, neutralising, air knife, drying, buffering,



stripping. Other baths or stations may be included or substituted depending on the desired process and product.

At one end of the line of cells or modules there is an automatic loader and at the other an automatic unloader.

Figure 6 shows a cross section through a portion of the production line. The belt 100, carrying a reel lead frame 40, is suspended horizontally with the belt web vertical. The belt 100 carries the lead frame 40 by means of the grips 20. Figure 5 shows at least parts of three different cells and the belt passes through each of, a pre-dip process cell 41, a buffer cell 42 and a plating process cell 43, in that order.

In the present embodiment, the lead frames are not simply held by the belt and grips, but are also supported on a plurality of spaced rollers 44 (one is shown in figure 6). The height of the roller 44 can be varied by an air regulated cylinder actuator 45 so as to accommodate various size of lead frame. The lead frames are held top and bottom by the system of the embodiment, ensuring zero droppages even after a long run.

Figures 7 and 8 show side and plan views respectively of the auto loader and drive unit 50 of the present invention. The auto loader is provided with a double reel system allowing uninterrupted supply of components to the belt 100. Reel A and reel B each have their roller systems including tensioning rollers 51 actuated by compressed air cylinders 52. The lead frame reel is clamped by X-Y indexer 53 including clasper 53a. The position of the indexer 53 is shifted to pick up the lead frame from either reel A or reel B.

The lead frames can also be loaded manually. An adjustable height belt drive 54 is provided and a manual strip lead frame 55 is top loaded. The belt drive 54 or the



reels A and B supply the lead frame strips to a top indexer 56, which uses air grippers 57 and 58 to feed the lead frame strips to the open fingers of the belt 100. Belt 100 is driven on wheel 59 in a continuous loop. The fingers are opened automatically using a cam system (not shown).

At the other end of the continuous loop of the belt 100 is the unloading station including an automatic reel to reel unloader 60. Drive wheel 61 drives the belt 100 in conjunction with wheel 59 of the loading station 50. A lead frame strip unloading tray 62 is provided for manually loaded lead frames. A tensioning roller 63 driven by compressed air receives the strip of lead frames from the conveyor via roller 64. The unloading station also has two reel systems A and B for receiving the strips from the conveyor via roller 64 and tensioning roller 63 allowing uninterrupted unloading.

The plating system of the invention is suitable for both strip to strip and also reel to reel plating. The conveyor can support heavy packages or narrow rail bar lead frames e.g. the TO220 package. The system can perform solder plating etc. operations for all types of packages – ranging from DIPs, SOLCs, PLCCs, QFPs and TO devices.

The auto loader holds two magazines in a vertical arrangement for loading the strips onto the conveyor. The lead frames are supported from beneath as well as from above by means of the rollers.

The spring grip means of the present invention has a gripping force comparable to the prior art wire grips and there are fewer point contacts per unit length. The belt of the present invention provides a gripping force of about 300g per gripping point. The spring grips of the present invention have three full turns in each coil compared with two full turns for the prior art wire spring grips. The extra turns in the coils increase the life span of the grips by about 10%. A feature of the wire spring



grips of the present invention is the bend in the wire arms providing the engagement portion. The engagement portion, which in use i.e. with the grips clipped into place on the belt, lies substantially parallel with the belt web, allows easy removal of the grips for replacement. Thus the spring grips of the present invention provide increased ease of maintenance.

Whilst an embodiment of the invention has been described, various modifications will suggest themselves to those skilled in the art without departing from the scope of the invention as defined in the appended claims. In particular, the various angles may vary depending on the size of the wire spring grips.



CLAIMS

1. A wire spring grip for an IC lead frame carrier belt, the grip comprising a wire formed to provide two arm portions extending from a curved portion, a portion of each arm being formed into a coil having a plurality of turns and wherein said curved portion forms a gripping portion of the spring grip.
2. A wire spring grip as claimed in claim 1, wherein the end of each arm is formed into a connecting portion for connecting the grip to a lead frame carrier belt.
3. A wire spring grip as claimed in claim 2, wherein the end of each arm is angled to form an arm tip portion for engaging with a belt web so as to support the grip.
4. A wire spring grip as claimed in claim 3, wherein each tip portion is angled from the plane including the immediately adjacent arm portions substantially at $90^\circ \pm 2^\circ$.
5. A wire spring grip as claimed in any one previous claim, wherein said curved portion is angled from the plane including the portions of the arms immediately adjacent the curved portion to form said gripping portion.





6. A wire spring grip as claimed in claim 5, wherein the angle formed by the curved portion to the plane including the adjacent arm portions is approximately $117^\circ \pm 2^\circ$.
7. A wire grip as claimed in any one previous claim, wherein between each coil and the curved portion each arm is angled to form an engagement portion for biasing the arms against the tension in the coils.
8. A wire spring grip as claimed in claim 7, wherein the angle formed by the arm portions between each coil and the curved portion is approximately $127^\circ \pm 2^\circ$.
9. A wire spring grip as claimed in any one previous claim, wherein each arm of the wire spring has a coil having at least three turns.
10. A wire spring grip as claimed in any one previous claim, wherein the angle formed between the two portions of each arm immediately adjacent each coil is greater than $90^\circ \pm 2^\circ$.
11. A wire spring grip as claimed in claim 10, wherein the angle formed between the two portions of each arm immediately adjacent each coil is approximately $132^\circ \pm 2^\circ$.
12. A wire spring grip as claimed in any one previous claim, wherein the wire has a cross-sectional diameter of approximately 1mm.





13. A belt for carrying IC strips or lead frames, the belt comprising a plurality of wire springs as claimed in any one preceding claim.

14. A belt as claimed in claim 13, wherein the belt has a row of apertures having an axis aligned parallel with the edges of the belt and proximate an edge thereof for receiving the curved portion of said grips.

15. A belt as claimed in claim 13 or 14, wherein the belt has a row of holes having an axis aligned parallel with the edges of the belt and proximate a central portion of the belt web for receiving the tip portions of the grips.

16. A belt as claimed in claim 13, 14 or 15, wherein for each grip on said belt a portion of each arm member adjacent the coil extends towards an edge of said belt substantially parallel to the belt web.

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