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Process and device for the shaping of connection pins of integrated circuits

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The invention takes as its starting point a process having the characteristics stated in the precharacterizing clause of Claim 1 and a device having the characteristics stated in the precharacterizing clause of Claim 4.

Integrated circuits (ICs) are predominantly built up on carrier strips and a plastic casing is then injection-moulded around them. The carrier strip is a metal land on which the structures of the connection pins are formed by etching or punching. The connection pins (leads) are arranged laterally on the casing in a common plane. So that the ICs can be soldered onto a circuit support board, the initially planar connection pins have to be bent into a shape suitable for soldering. At this stage, the casings are still connected to the carrier strip by way of bridges at the casing corners. The greater the number of pins the ICs have and the more closely these pins are arranged next to each other, the greater the requirements for precision on bending, since even the smallest deviations in the bending angles and oblique positions of the pins will result in faulty contacts on the circuit support board. The bending tools for the pins are therefore precision tools. Modern, highly integrated ICs having well over a hundred connection pins make particularly high demands on the precision of the bending tools.

The pins are usually bent into a Z shape having two approximate right angles. In order to achieve this, it is known to clamp the connection pins close to the casing against a bending lower die and to bend them, initially at an oblique angle, using a bending upper die approximately 45 degrees downwards towards the complementary bending face of the lower die. The ICs, still connected to the lead frame, are then transferred to an adjacent swage in which the pins are bent between a bending lower die and obliquely guided upper dies into their final shape. For this

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purpose, the bending lower die has a mould matched to the desired Z shape of the pins, into which an upper die is pushed obliquely from above, its tip directed towards the apex of the mould in the bending lower die, and thus pushes the pins into the recess of the bending mould in the lower die. It is inevitable that during this process tin, which is already in the form of a coating on the pins for the subsequent soldering process, will be abraded by a relatively high surface compression between the pins and the bending tool and by friction resulting from the relative movement between the pins and the tool. The abraded tin is deposited on the tool and results in the tool, which costs over DM 100,000.00, having to be changed and cleaned after a relatively short time, i.e. after a few thousand strokes of the tool. At a working speed of two strokes per second, 1000 strokes take only 8 minutes, so that for each machine a number of people to clean the tool and a number of tool sets are required. This results not only in high personnel costs and tool costs but also in relatively long standstill periods due to the frequent changes of tool; this considerably increases the cost of manufacturing chips, quite apart from the fact that each change of tool may lead to damage of the ICs or of the tool itself, due to faulty adjustment during assembly. If a relatively large amount of tin deposit on the bending tool is tolerated so as to avoid an excessively frequent change of tool, the precision of bending will be affected, with the result that not all the bent ends of the pins lie in a common plane, which is absolutely necessary for soldering them onto a circuit support board. Furthermore, in the case of the known bending devices, it is possible that individual pins, groups of pins or all the pins not perpendicular to the original common plane of the pins but somewhat oblique thereto will be bent by the bending process itself, especially if the pins, which are produced by etching, have a cross-section deviating from the rectangular shape. This results in a faulty positioning of the bent ends of the pins, and in particular also in a defective co-planarity. This faulty positioning cannot be compensated when circuit support boards are fitted with components by an automatic fitter. Manufacturers of chips will

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therefore put considerable effort and expenditure into checking the exact position of the bent ends of the pins and, where appropriate, into correcting it (cf. Journal: "SEMICONDUCTOR INTERNATIONAL", May 1992, pages 86 to 90, especially page 90, middle column, penultimate paragraph).

The object of the present invention is to increase precision during the bending of the connection pins of ICs and to reduce the necessity of cleaning tin deposits on the bending inserts of the tools.

This object is achieved by a process having the characteristics stated in Claim 1 and by a device having the characteristics stated in Claim 4. Advantageous further developments of the invention are the subject-matter of the dependent claims.

The present invention constitutes a break from the hitherto conventional procedure of shaping the pins in a swage in which they are merely pushed by a bending upper die into a recess in a lower die mould; instead, the pins are clamped at their free ends in a clamping tool, and the clamped ends of the pins are then forcibly guided along a curved path without any lateral deviation. This is achieved in that the ends of the pins which, for automated soldering of the ICs onto circuit support boards, lie in a precisely determined position in a common plane, are forcibly guided by the clamping tool and - unlike the prior art - have no opportunity of deviating laterally during the bending procedure, so that they inevitably achieve their predetermined position. There is no displacement, no relative movement and thus no friction between the tool and the pins, since bending is carried out with the aid of the clamping tool and the clamping tool holds the ends of the pins securely. Compared with the operating method of the prior art, the risk of tin being abraded from the pins and being deposited on the tool is therefore extremely small, so that the operating periods, after which cleaning of a tool may again become necessary, are drastically increased by comparison with the prior art. The expense of

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cleaning the tools is therefore extremely small, and the same is true of the standstill periods (refit periods) of the machine, caused by the cleaning work. Furthermore, since the pins are forcibly guided at their ends, faulty positioning of the ends after the bending, caused by irregular cross-sections of the pins, is highly unlikely, because deviations will be prevented by the forcible guiding of the ends of the pins. Subsequent corrections of faulty positionings of the pins which result in high levels of expenditure in the prior art are virtually a thing of the past when the present invention is applied.

In applying the invention it is generally possible to bend the pins in free space, fixed on the one hand by the clamping in the forcibly guided clamping tool and on the other hand by receiving the IC casing, with the pins also being capable of being clamped in a section adjoining the edge of the IC casing in order to protect the IC casing. The flexion stresses are in this way not transmitted to the casing.

Since in most application cases the pins are to be bent into a Z shape, the clamping tool is preferably guided in such a way that the alignment of the clamped ends of the pins is maintained while they are forcibly guided on the curved path, i.e. the ends of the pins remain parallel to the common plane in which they originally lay.

The pins are generally somewhat irregular because of the tin coating. In order, however, to ensure that the pins are firmly gripped simultaneously on all four sides of the IC casing, the procedure can preferably be such that the pins are not gripped and bent together on all four sides of the casing but separately and independently of one another, by separate clamping tools.

The device according to the invention uses as the clamping tool two jaws which act on the upper side and the lower side of the pins next to the receiver of the casing. They are arranged rotatably about axes which lie parallel to the common plane in

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which the pins originally lie and at right angles to the longitudinal extent of the pins, the axes being mounted displaceably transverse to the common plane, not separate from one another but together, while maintaining the clamping. The common plane in which the pins originally lie is indirectly present in the device according to the invention, defined by the device for fixing the casing in a predetermined position.

The longitudinally displaceable arrangement of the jaws combined with their pivotal arrangement has the effect that the jaws, once they have clamped the ends of the pins and are then displaced, necessarily describe a curved path because they "hang" from the pins they have clamped, as from their own lasso. Because the bending jaws are deflected during the bending procedure, the forces are increased in the direction of the bending movement to further perform the bending, as a result of a toggle lever action on the bending jaws. Further guide means for the clamping tool are not necessary, so that the construction of the device according to the invention is in this respect very simple.

Even though it is generally possible to bend the pins in free space, it is advantageous for a reproducible uniform bending procedure which produces mutually identically shaped connection pins if one of the jaws has, adjacent to its clamping face in the direction towards the device of the casing receiver, a bending face against which the pins can abut during the bending, so that this bending face, which is preferably convexly rounded, determines the shape of the bent pins. Preferably, this bending face interacts with a counter-mould which has a surface region which is complementary to the bending face and towards which the bending jaw is moved with its bending face, so that, at the end of the bending procedure, the pins are clamped between the bending face and the complementary surface region, as a result of which the central region of the connection pins is also necessarily given a predetermined shape, without however any friction between the pins and the bending face on the one hand and the complementary surface region on the other hand, so that

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the advantages of the invention resulting from the forcible guidance of the clamped ends of the pins is entirely maintained.

The complementary surface region is conveniently constructed on the device for the casing receiver as a bending lower die mould.

In order to initiate the bending procedure by longitudinally displacing the jaws, it is not necessary for both jaws to have a separate activating device, but rather it is sufficient for only one of the jaws to be advanceable by an activating device and for the other jaw to be mounted resiliently, such that it yields for example to a spring force when the first jaw is advanced. It goes without saying that the spring force must be of a size sufficient to hold the ends of the pins securely between the jaws. Conveniently, it is the jaw equipped with the bending face which is advanceable by the activating device. Preferably, there is additionally provided for this jaw a pivot drive which enables the jaw additionally to be pressed towards the device for receiving the casing and the bending lower die mould. This pivot drive is not required to move the clamping tool formed by the two jaws along the predetermined curved path, but will enable it, once the bending procedure is already substantially complete and the pins lie between the bending face and the surface complementary thereto, to give an additional push or indeed to over-bend somewhat if this should be convenient or desirable in the particular application case. Preferably, the pivot drive is spring-mounted in order to protect the pins and the tools. Thus, the forces occurring can easily be determined by way of the spring force.

So that the jaws can automatically pivot back into their initial position once the bending procedure is complete, a respective restoring spring is preferably associated with them.

It has already been mentioned that the pins projecting out of a common side of the casing are preferably gripped and bent together, but independently from the other pins. In a further

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development of the invention this requires four pairs of jaws mounted according to the invention to be provided for a casing having pins projecting from its four sides. The pins of one side may still be connected at the ends to a common bridge which is separated after the moulding. In order to arrive at a compact and simple tool construction, the jaws lying on the same side as the plane with the pins are arranged and guided, together with the die lying on the same side, within a common casing.

Instead of gripping and bending the pins between pivotal jaws, it is of course also possible to use jaws which are displaceable both in the longitudinal direction of the pins and transversely thereto, for example in that the jaws are clamped between two further, external jaws and are mounted longitudinally displaceably therein, the external jaws being transversely displaceable.

Two embodiments of the invention are illustrated diagrammatically in the enclosed drawings.

Figure 1 shows a partial section through a device according to the invention, where the plane of the section is perpendicular to the common plane of the pins,

Figure 2 shows, as a detail Z from the illustration according to Figure 1, the central region of the device with the clamping tool and the device for receiving the IC casing and with the IC placed in front, prior to the bending of the pins,

Figure 3 shows in an illustration like that of Figure 2 the tool arrangement during the bending procedure,

Figure 4 shows in an illustration corresponding to Figure 2 the tool arrangement when the bending procedure is complete, and

Figure 5 shows diagrammatically, in a view corresponding to Figure 2, a tool arrangement with a modified clamping tool.

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The device illustrated in Figure 1 has two guide casings 1 and 2 which are arranged at a distance from one another. Both guide casings 1 and 2 are arranged on a common tool guide and can be moved independently of one another in the longitudinal direction (arrows 38 and 39). Two guide rails 3 and 4 are located in the free space between the two casings and have slits 5 and 6 facing one another and running perpendicular to the plane of the drawing, to guide a lead frame 7 on its two longitudinal edges.

In order to receive the casing 8, which is connected to the lead frame and is of synthetic material, in a predetermined position, a casing receiver 9 is arranged in the guide casing 1 and a casing receiver 10 is arranged in the guide casing 2. The receiver 10 is displaceable along the longitudinal axis 11 of the arrangement in opposition to a spring force. The edges 12 and 13 of the casing receivers 10 and 11 reach around the edge of the casing and clamp the pins at the outlet from the casing. This clamped section is not available for the bending procedure.

The one casing receiver 9 has, adjacent to its clamping face, a mould 15 into which the pins 14 are bent by means of their central section, so that the shape of the mould 15 determines the later shape of the pins 14 in this region. It thus also simultaneously forms the bending lower die.

To receive the casing 8 and to clamp the connection pins 14, the casing receiver 9 is advanced to the casing by way of a movement mechanism and is held in this position. The casing receiver 10 is then advanced by way of a push rod 16 which is spring-mounted by a spring 33 on its rear side, and in this way the pins 14 are clamped close to the casing edge.

To bend the pins 14, a movable clamping tool is provided which has two jaws 18 and 19 for each casing side, and these grip the pins 14 close to their ends and clamp them between them. The jaw 18 is mounted pivotally in the jaw guide 34 about an axial pin 20 running parallel to the original common plane 21 and

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perpendicular to the longitudinal direction of the pins 14.

At the same time, the jaw guide 34 and thus the axial pin 20 and with it the jaw 18, may be advanced from behind - indicated symbolically by the arrow 22 - in the direction of the other jaw 19 by an activating device, for example a compressed-medium cylinder or a driven cam disc, supported for safety reasons by way of a spring 23. The jaw 19 for its part is mounted in the jaw receiver 35 pivotally about an axial pin 24 parallel to the axial pin 20. The jaw receiver 35 is acted upon by the spring 17 with the clamping force (counter-force) so that the jaw 19 is also spring-mounted by the spring 17.

The marginal region of the jaw 18 opposite the mould 15 serves as the bending face 26 and therefore has a shape complementary to the recess 15 (mould).

The jaw 18 has a lateral shoulder 28 which is affected at the rear by the action of a pushrod 29 which is parallel to the axis 11 and which can be advanced with the interposition of a spring 30 by an activating device symbolized by the arrow 21 and not shown in more detail, e.g. a compressed-medium cylinder, as a result of which the jaw can be acted upon additionally by the spring force 30 and pivoted further in.

The device operates as follows:

When, as a result of advancing the lead frame 7, a casing 8 is positioned precisely between the casing receivers 9 and 10, it is clamped between these, the bending jaw 18 is advanced by the activating device 22 and the pins 14 are clamped at their free ends between the jaws 18 and 19. As the jaw 18 continues to advance, the jaw 19 yields in opposition to the spring force of the spring 17 and, because they are suspended from the pins 14 as a result of the clamping and are mounted pivotally, both perform a curved movement resulting in bending of the pins in their central region (Figure 3). Because the two jaws 18 and 19

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are deflected during the bending procedure, the forces are increased in the direction of the bending movement to further perform the bending, as a result of a toggle lever action on the jaws. During this, the pins first of all continue to bear against the bending face 26 and, at the end of the bending procedure, are pushed by these into the recess 15 of the die 9 complementary thereto (Figure 4), it being possible at this moment for subsequent pressing of the bending face 26 into the recess 15 to be performed by the activating device 31.

The bending jaws 18 and the clamping piece 10 are now retracted so that the jaws 18 and 19 are no longer clamping but are pivoted back into their initial position by spring-loaded pistons 32 and 33 mounted transversely to them. As soon as the die 10 has retracted far enough, the lead frame 7 with the casing 8 suspended therein is transported further and the subsequent casing in the lead frame is positioned for the bending procedure.

In the embodiment shown in Figure 5, parts corresponding to the parts of the first embodiment are designated by corresponding reference numerals. The example of Figure 5 differs from that of Figure 2 in that the jaws 18 and 19, which clamp the pins 14 between them, are not mounted pivotally but longitudinally displaceably, and in particular are mounted in the longitudinal direction of the pins displaceably in a further pair of jaws 38 and 39 which clamp the jaws 18 and 19 between them. The external jaws 38 and 39 are for their part displaceable perpendicular to the plane of the pins 14. If they are displaced in this direction from the die 10 in the direction of the die 9, then the jaws 18 and 19 draw the clamped pins 14 as a result of the continued clamping somewhat out of the jaws 38 and 39 until the pins 14 are pushed into the recess 15. Thus, the jaws 18 and 19 undergo only a slight friction in the jaws 38 and 39 and may for example be mounted displaceably on needles. - Claims -

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Claims:

1. A process for the shaping of connection pins of integrated circuits (ICs) from which pins (14) lying in a common plane (21) project, by fixing the ICs and bending the pins (14), characterized in that
the pins (14) are clamped at a spacing from the IC and then, while maintaining the clamping, the ends of the pins (14) are forcibly guided along a curved path which lies in a plane running perpendicular to the common plane (21) and containing the respective pins (14).

2. A process according to Claim 1, characterized in that the alignment of the ends of the pins (14) is substantially retained while they are guided on the curved path.

3. A process according to Claim 1 or 2, characterized in that the mutually parallel pins (14) projecting from the IC on one side are gripped together and bent together, but in that the groups of pins (14) projecting from different sides of the casing (8) are gripped and bent independently of one another.

4. A process according to one of the preceding claims, characterized in that in the case of an IC having a casing (8) from which the pins (14) project, the pins (14) are gripped and clamped directly next to the casing (8) and the IC is thus fixed.

5. A process according to one of the preceding claims, characterized in that the pins (14) are clamped close to their free ends and are then bent.

6. A device for the shaping of connection pins (14) of integrated circuits (ICs) from which pins (14) lying in a common plane (21) project,
having a device (9, 10) for fixing the respective IC,
characterized in that next to the device (9, 10) for fixing the IC there are arranged two jaws (18, 19) of a clamping tool for

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clamping pins (14), these jaws (18, 19) being pivotal about axial pins (20, 24) which run parallel to the common plane (21) and perpendicular to the longitudinal extent of the pins (14), and in that the axial pins (20, 24) are mounted displaceably transverse to the common plane (21), while maintaining the clamping.

7. A device for the shaping of connection pins (14) of integrated circuits (ICs) from which pins (14) lying in a common plane (21) project,
having a device (9, 10) for fixing the respective IC,
characterized in that next to the device (9, 10) for fixing the IC there are arranged two jaws (18, 19) of a clamping tool for clamping pins (14), these jaws (18, 19) being mounted to maintain the clamping in the longitudinal direction of the pins (14) and displaceable transversely to the common plane (21).

8. A device according to Claim 7, characterized in that the jaws (18, 19) are mounted, clamped between two external jaws (38, 39) which are displaceable transversely to the common plane (21), displaceably in the longitudinal direction of the pins (14).

9. A device according to Claim 6, 7 or 8, characterized in that one of the jaws (18) has, adjoining the clamping face in the direction of the device (9, 10) for fixing the IC, a bending face (26) against which the pins (14) abut during the bending, so that this bending face (26) determines the shape of the bent pins (14).

10. A device according to Claim 9, characterized in that the bending face (26) is convexly rounded.

11. A device according to one of Claims 6 to 10, characterized in that the device (9, 10) for fixing the IC has two receivers (9, 10) working in opposition for abutment against the upper side and the underside of the IC.

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12. A device according to one of Claims 6 to 11, characterized in that, to process ICs which have a casing (8) from which the pins (14) project, the jaws (18, 19) are arranged relative to the device (9, 10) such that they securely clamp the pins (14) at a spacing from the casing (8), preferably close to their free ends.

13. A device according to one of Claims 6 to 10 and according to Claim 12, characterized in that the receivers (9, 10) have projections (12, 13) which reach past the casing edges in order to grip and clamp the pins (14) at the edge of the casing (8).

14. A device according to Claim 9 or 10 and according to Claim 11 or 13, characterized in that the casing receiver (9) obliquely opposing the bending face (26) has a surface region (15) complementary to the bending face (26).

15. A device according to one of Claims 6 and 9 to 14, characterized in that the one jaw (18) is displaceable in the longitudinal direction in the guide casing (22), and the other jaw (19) is mounted resiliently.

16. A device according to Claims 9 and 15, characterized in that the jaw (18) equipped with the bending face (26) may be advanced by the activating device (22).

17. A device according to Claim 6 and 9 or 10, characterized in that, for the jaw (18) equipped with the bending face (26), a pivot drive (29, 30, 31) is in addition provided for a pivotal movement directed towards the device (9, 10) for receiving the casing (8).

18. A device according to Claim 17, characterized in that the pivot drive (29, 30, 31) is spring-mounted (30).

19. A device according to one of Claims 6 to 18, characterized in that restoring springs (32, 33) are associated with the jaws (18, 19).

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20. A device according to one of Claims 6 to 19, characterized in that in each case a common pair of jaws (18, 19) is provided for the group of pins (14) projecting out of a common side of the IC.

12. A device according to Claim 20, characterized in that the pairs of jaws (18, 19) may be activated independently of one another.

22. A device according to Claim 20 or 21, characterized in that the jaws (18) lying on the same side of the plane (21) as the pins (14) are guided together with the upper die (10) lying on the same side in a common casing (2).

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