

METHOD OF BENDING OUTSIDE LEADS OF SEMICONDUCTOR
PACKAGE AND AN APPARATUS THEREFOR ✓

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This invention relates to a method of bending outside leads of a semiconductor package into a predetermined shape and to a device for carrying out such a method.

Semiconductor IC packages having J-shaped outside leads are now widely used for mounting on printed wiring boards. Fig. 5 schematically depicts an example of such a semiconductor package designated by the reference numeral 1. The package 1 has one or more side ends (two opposite side ends 1a and 1b in the illustrated case) from which a plurality of parallel leads 2, each coated with a solder layer, extend outward. Thus, the leads 2 are arranged in one direction along each of the side ends 1a and 1b. Each of the leads 2 has a root portion 2a extending outward from the side end, a leg portion 2b contiguous with and vertically extending from the root portion 2a and a tip portion 2c contiguous with the leg portion 2b and sharply inwardly curved and, thus, is J-shaped as a whole.

The above leads structure is produced by bending preforms as shown by the dotted line in Fig. 5. Namely, through a series of machining operations such as punching and bending, the lead preforms each having a loosely inwardly curved tip portion 2c' is produced. As a final step, the preforms are subjected to a bending operation to form the sharply curved tip portions 2c as shown by the solid line in Fig. 5.

The final bending step has been hitherto performed, as shown in Figs. 4(a) and 4(b), by ironing. Thus, the preforms are positioned above a die 43 (Fig. 4(a)) and a knock out plate 45 is then lowered as shown by the arrow, so that the loosely inwardly curved tip portions 2c' of the preforms are bent in conformity with the shape of an operating surface 42 of the die 43, thereby forming the sharply curved tip portions 2c. The ironing method, however, poses a problem because the solder layers covering the leads 2 are apt to be scratched, abraded and/or delaminated as a

result of the sliding and frictional contact between the leads 2 and the operating surface 42 of the die. Since the solder dusts are accumulated in the operating surface 42, it is necessary to frequently clean the surface 42. This is troublesome and lowers the productivity. Further, the solder dusts are apt to deposit on the leads 2. Since the space between adjacent leads 2 is very small, the deposition of the solder dusts on the leads 2 causes serious problems such as short circuit.

The present invention has been made in view of the foregoing problems. In accordance with the present invention there is provided a lead bending method wherein a plurality of parallel leads extending outward from a semiconductor package, terminating at respective tip ends and arranged in one direction are shaped with a die so that a portion of each of said leads adjacent said tip end is formed into a predetermined shape conforming to the shape of said die, characterized in that said package is positioned at such a fixed location that a part of said portion of each of said leads is brought into engagement with said die, and in that said die is then rotated about a rotational axis extending in parallel with said one direction so that said portion of each of said leads is pressed inward by said die and bent into said predetermined shape.

In another aspect, the present invention provides a device for bending a plurality of parallel leads arranged in one direction and each extending outward from a semiconductor package, comprising:

- a die having an operating surface;

- means for securing said package in a fixed position so that a portion of each of said leads is brought into engagement with said operating surface of said die; and

- means for rotating said die about a rotational axis extending in parallel with said one direction.

The present invention will be described in detail

below with reference to the accompanying drawings, in which:

Fig. 1 is a fragmentary elevational view diagrammatically illustrating the roll bending of a lead according to the present invention;

Fig. 2 is an elevational view diagrammatically illustrating one embodiment of a bending device according to the present invention;

Fig. 3 is an elevational view similar to Fig. 2 showing the state where the bending has been completed;

Fig. 4 is an elevational view diagrammatically illustrating the conventional ironing operation for bending leads; and

Fig. 5 is a perspective view schematically illustrating a semiconductor package.

Referring to Fig. 1, in accordance with the method of the present invention, a plurality of parallel leads 2 extending outward from a semiconductor package 1, terminating at respective tip ends and arranged in one direction (see Fig. 5) are bent with a die 3 so that an end portion of each of the leads 2 adjacent the tip end is formed into a predetermined shape conforming to the shape of a curved operating surface 4 of the die 3. Each of the leads 2 preferably has a root portion 2a extending horizontally outward from a side end 1a of the semiconductor package 1, a leg portion 2b contiguous with and vertically extending downward from the root portion 2a and a gently inwardly curved tip portion 2c' contiguous with the leg portion 2b, so that each of the leads is J-shaped.

The package 1 is placed on a support 7 and secured thereon in a fixed position by a vertically moveable fixing member 6. In this state, the package 1 is positioned at such a fixed location that a part of the end portion of each of the leads 2 is brought into engagement with the curved operating surface 4 of the die 3. In the illustrated embodiment, an intermediate portion P of each of the leads 2

is brought into engagement with an edge 5 of the curved operating surface 4 of the die 3. The intermediate portion P may be a juncture portion of leg portion 2b with the tip portion 2c' of each of the leads 2.

The die 3 is then rotated in the direction shown by the arrow A about a rotational axis extending in parallel with the above-mentioned direction along which the leads are arranged, so that that an end portion of each of the leads is pressed inward by the die 3 and bent into the predetermined shape conforming to the shape of the curved operating surface 4 of the die 3. In the illustrated embodiment, the end portion of each lead 2 which extends from the intermediate portion P to the tip end is shaped into the sharply curved J-shaped form as shown by the solid line in Fig. 1. Preferably, the rotational axis coincides with the edge 5 of the operating surface 4 of the die 3.

According to the method of the present invention, the leads are not bent by ironing in which the die and the leads are relatively displaced in the vertical direction. Rather, the leads 2 are bent by rotation of the die so that the sliding contact between the operation die surface 4 with the leads 2 is decreased. Such a sliding contact is minimized when the axis about which the die 3 is rotated coincides with the edge 5 of the operating surface 4. As a consequence of the decrease of the sliding contact, the formation of solder dusts can be minimized so that the interval of the die cleaning operations may be lengthened, thereby improving the productivity. Further, the quality of the products is improved.

The above roll bending process according to the present invention may be suitably carried out using a device as shown in Figs. 2 and 3. Figs. 2 and 3 are views illustrating the states before the start of the bending of the leads 2 and after the completion of the bending operation, respectively. The roll bending device of Figs. 2

and 3 is adapted to simultaneously bend the leads 2 provided on opposite side ends 1a and 1b of the package 1. Thus, two similar structures are symmetrically disposed at positions corresponding to the leads 2 of the opposite side ends 1a and 1b. For the sake of simplicity of explanation, however, the following description will be made on only one side structure.

Designated as 17a is a base frame having a vertical frame 17b upwardly extending therefrom. A pair of pins 19a and 19b are planted on the frame 17b for receiving a die 3 thereon. The die 3 has a curved operating surface 4 extending along the side end 1a of the package 1 and engageable with the plurality of arrayed leads 2. Designated as 5 is an edge line of the operating surface 4 which line extends along the side end 1a. The die 3 also has an arched slot 20 into which the pair of pins 19a and 19b are fitted. In the illustrated embodiment, the center of the arched slot 20 is positioned at the edge line 5 of the operating surface 4 so that the die 3 is adapted to rotated about an axis which coincides with the edge line 5. The rotation of the die 3 is restricted by the pins 19a and 19b. The die 3 has the center of gravity at such a point that the die 3 is normally maintained in the state where one end of the slot engages with the pin 19a as shown in Fig. 2.

The die 3 has an arm 21 engageable by a first cam 16 of a cam member 13 pivoted about a support shaft 15. The cam member 13 has a second cam 14. Designated as 11 is a pushing rod vertically moved up and down by any suitable mechanism using, for example, an air cylinder or a motor. The pushing rod 11 has a bottom face 12 engageable by the second cam 14 of the cam member 13.

Thus, in the state shown in Fig. 2, when the pushing rod 11 is actuated and moved downward, the second cam 14a is pressed by the bottom face 12 of the pushing rod 11 so that the cam member 13 is rotated counter clockwise. The

rotation of the cam member 13 causes the die 3 to rotate clockwise, through the contact of the first cam 16 of the cam member 13 with the arm 21 of the die 3, until the end of the slot 20 is engaged with the pin 19b, as shown in Fig. 3. As a result of the rotation of the die 3, the pair of plurality of leads 2 on both side ends 1a and 1b of the package 1 are simultaneously bent as described above with reference to Fig. 1. Throughout the bending operation, the package 1 is fixedly secured in position between the support 7 and fixing member 6 (Fig. 1). When the pushing rod 11 is retracted, the die 3 is rotated counter clockwise by its own weight so that the cam member 13 is rotated clockwise and again assumes the position shown in Fig. 2.

The die 3 may be rotated by any other suitable mechanism such as by using a combination of a motor and gears.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all the changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.



What Is Claimed Is:

1. A lead bending method wherein a plurality of parallel leads extending outward from a semiconductor package, terminating at respective tip ends and arranged in one direction are shaped with a die so that a portion of each of said leads adjacent said tip end is formed into a predetermined shape conforming to the shape of said die, characterized in that said package is positioned at such a fixed location that a part of said portion of each of said leads is brought into engagement with said die, and in that said die is then rotated about a rotational axis extending in parallel with said one direction so that said portion of each of said leads is pressed inward by said die and bent into said predetermined shape.

2. A method as claimed in claim 1, wherein each of said leads has a root portion extending outward from a side end of said semiconductor package, a leg portion contiguous with and vertically extending from said root portion and a tip portion contiguous with said leg portion and gently inwardly curved so that each of said leads is J-shaped, wherein said juncture portion of said leg portion is brought into engagement with an edge of a curved operating surface of said die, and wherein said die is rotated about said edge so that said tip portion of each of said leads is bent into a relatively sharply inwardly curved J-shape.

3. A device for bending a plurality of parallel leads arranged in one direction and each extending outward from a semiconductor package, comprising:

a die having an operating surface;

means for securing said package in a fixed position so that a portion of each of said leads is brought into engagement with said operating surface of said die; and



means for rotating said die about a rotational axis extending in parallel with said one direction.

4. A device as claimed in claim 3 further comprising:
a frame;

a slot formed in said die, curved about said rotational axis and having first and second ends;

a pair of parallel, spaced apart, horizontally extending first and second pins secured to said frame, each of said first and second pins being fitted in said slot so that said die is supported by said pins and rotatable between a first position where said first pin is engaged by said first end of said slot and a second position where said second pin is engaged by said second end of said slot;

an arm formed on said die; and

means engageable with said arm and operable to move said arm so that said die is rotated about said rotational axis between said first and second positions.