

CARRIER STRIP TRIMMING

Field of the Invention

5 This invention relates to the cutting or trimming of strip material, especially the trimming of carrier strips used in the fabrication of encapsulated ball-grid array type circuit devices.

Background of the Invention

10 In the manufacture of circuit devices of the so-call ball-grid array type, integrated circuit devices are formed on a substrate which comprises a ribbon or strip of a reinforced thermosetting resin material. Electrically conductive copper traces extend through the substrate to selected conductive contact members on the opposite side from the circuit device. The
15 contacts, termed balls, are arranged in rows to form a grid with the selected contacts providing a part of an electrical circuit path with other circuit devices within an overall circuit package. After the manufacture of the circuit devices on the carrier
20 strip, the circuit devices are then encapsulated within a charge of an encapsulating resin such as an epoxy. Thereafter, the devices, which are arranged on the

ribbons or strips in one or more rows, must be separated and the excess strip material trimmed off as close as is practical to each device.

5 In the separation of such devices, die cutters are usually employed. Difficulties have been encountered in the cutting process as the die cutters tend to compress the resinous strip material and the compression, in turn, bends and breaks the copper traces which connect the circuit devices to selected
10 contacts within the grids of contacts on the bottom surface of the strip material. As a result, an unacceptable number of non-functional circuit devices are produced.

Summary and Objects of the Invention

15 The present invention provides highly effective apparatus for separating and trimming around circuit devices formed on compressible strip material. This is accomplished in a way which minimizes heat build up and avoids compression of the strip material. The primary
20 objective of the invention is the substantial reduction of damage to the circuit devices and the copper traces extending through the strip material as caused by known prior techniques and equipment. Related objectives are the elimination of defective circuit devices and the
25 provision of means for rapidly and efficiently separating and trimming circuit devices formed on relatively compressible non-metallic, strip-type substrate material.

30 In summary, the invention comprises a holding fixture for releasably holding carrier strips carrying

at least one row of spaced, encapsulated circuit devices, cutter means including first and second sets of spaced apart rotary cutter blades, means for moving said holding fixture in a first path extending
5 transversely of the first set of rotary cutter blades for trimming the carrier strip material a predetermined distance from a first pair of edges of said circuit devices, and means for thereafter moving said holding fixture in a second path extending transversely of the
10 second set of rotary cutter blades for trimming the carrier strip material from a transversely extended pair of edges of said circuit devices.

More specifically in a preferred embodiment of the invention, apparatus for separating and trimming of the
15 circuit devices comprises a holding fixture including pneumatic means engageable with the encapsulated products for releasably holding one or more carrier strips. A cutting means adjacent to a first reciprocatable frame comprises a plurality of rotating
20 circular cutter blades, each having circumferentially spaced cutting teeth. The first reciprocatable frame receives the holding fixture for movement in a first path so that the teeth project through the plane of each carrier strip mounted in the holder to thereby
25 effect a separation of the circuit devices from each other. Means are provided for limiting the projection of the cutter blades so that only the teeth extend into the strip material. As the teeth rotate, each tooth draws air into the cut, thereby preventing the
30 generation of heat in an amount liable to damage the delicate circuit devices. The invention further comprises a second reciprocatable frame for moving the holding fixture in a second path parallel to the first

to effect the trimming of the strip material from the circuit devices along lines which are extended transversely of the cut by the cutters in the first path.

5 Brief Description of the Drawings

Figure 1 is an overall perspective view of the apparatus of the present invention;

Figure 2 is a right sectional view on lines 2-2 of Figure 1;

10 Figure 3 is a sectional view on lines 3-3 of Figure 2;

Figure 4 is a sectional view on lines 4-4 of Figure 2;

15 Figure 5 is a sectional view on lines 5-5 of Figure 2;

Figure 6 is a sectional view on lines 6-6 of Figure 2;

Figure 7 is a sectional view of vacuum holder on lines 7-7 of Figure 6;

20 Figure 8 is a fragmentary view of vacuum holder in section taken on lines 8-8 of Figure 7;

Figure 9 is a sectional view of vacuum holder on lines 9-9 of Figure 7; and

Figures 10-12 are perspective views of circuit devices at various stages in the cutting and trimming process.

5 Detailed Description of the Preferred Embodiment of the Present Invention

10 Circuit devices of the type to which the invention most nearly relates are illustrated in Figures 10-12. Figure 10 illustrates a piece of strip material 5, supporting three encapsulated circuit devices 6. Using the strip cutting means of the invention as described hereinafter, the strip material 5 is intended to be trimmed along lines 7 in a first pass of the cutting means so that the devices are subdivided, as shown in Figure 11, at predetermined distances from a first pair of sides of each circuit device.

15 Thereafter, the circuit devices are cut along lines 8, disposed at right angles to line 7, as illustrated in Figure 11, in a second pass through the equipment of the invention so that the finished devices are ready for use, as illustrated in Figure 12.

20 With reference to Figures 1 and 2, a preferred embodiment of a substantially unautomated version of the invention, best suited for the handling of relatively small production runs, comprises a rectangular housing 10 comprising pairs of side walls 11 and front and rear walls 12. The housing is further provided with a lid 13 formed of an upper lid plate 13a and spaced lower lid plate 13b. The lid is preferably hinged to the side walls 11 by means of hinge pins, one of which is shown at 14 in Figure 1.

Lid 13 is provided with first and second rectangular openings 15 and 16 which correspond to first and second strip material trimming stations, respectively, as will be explained more fully hereinafter.

As shown in Figures 1 and 2, the illustrative embodiment of the invention further comprises cutter means 17 which include spaced cutter wheels disposed beneath openings 15 and 16 for cutting the strip material along the edges of the circuit devices. The strips carrying the circuit devices are held in a holding fixture 18 which is first manually disposed for movement in a first frame 19 for movement in a first pass which effects cutting along the lines 7 of Figures 10-12. Thereafter, the fixture is placed in a second movable frame 20 in which it is positioned at right angles with respect to its position in first frame 19 and is thereafter moved in a second pass which effects cutting of the strip material along the lines 8.

As further shown in Figure 2, the cutter means 17 extends transversely of the rectangular openings 15 and 16. The cutter means 17 preferably comprises a shaft 21 which is journaled in spaced apart bearing supports 22 mounted on each side wall 11 and further includes two sets or groups of circular cutter blades 23 and 24 which are fixed to the shaft 21 at spaced apart locations immediately underneath the first and second rectangular openings 15 and 16, respectively. One such cutter blade 23 is shown in side view in Figure 6. As illustrated, each cutter blade is provided with radially projecting, circumferentially disposed teeth 25 which contact and cut the strip material.

Preferably, the cutter blades of the groups of blades 23 and 24 are identically configured. As is shown in Figure 2 and as described more fully hereinafter, the cutter blades of the first group are spaced apart to effect a trimming of the strip material along lines 7 in Figure 10. Each pair of cutter blades of the second group of blades 24 is spaced apart to effect a trimming along lines 8 in Figure 11.

In order to effect trimming of the strip material along lines 7, the fixture for holding the circuit devices is adapted for support in first reciprocatable frame member 19 which is mounted for sliding movement within first rectangular opening 15 within the space provided between the upper lid plate 13a and lower lid plate 13b. For positioning purposes, spacer bars 27 and 28 support the frame member 19 vertically with respect to the opening 15.

First frame member 19 is provided with a recessed upper surface portion 30 within which the holding fixture 18 is oriented so that the strip material is properly positioned with respect to the blades during the first pass.

With reference to Figures 7-9, holding fixture 18 preferably comprises a rectangular base member 32, a support plate 33 for support in the appropriate orientation on the recessed surface portion 30 and a handle portion 34.

Holding fixture base member 32 has a lower surface 32a in which a plurality of rows of shallow recesses 35 are formed. Recesses 35 are each shaped to receive an

encapsulated circuit device 6 of the kind illustrated in Figures 10-12.

5 Strips having three circuit devices are shown with the encapsulated circuit device interfitted within the recesses 35 in Figures 7 and 9. Although the holding fixture of the illustrative embodiment is provided with nine spaced recesses so that three strips each having three circuit devices can be accommodated, the invention contemplates use of a holding fixture for individual strips having a greater or lesser number of circuit devices in each row and for accommodating strips having more than one row of circuit device disposed in rows extended lengthwise thereof.

15 In the preferred embodiment, as illustrated in Figures 7-9, pneumatic means are employed for holding the circuit devices 6 within the recesses 35 in the base of the fixture 18. The pneumatic means preferably includes a passageway 37 extended through the handle portion 34. Passageway 37 has a connection 39 for connection to a flexible hose 40 which leads to a vacuum source, not illustrated. A series of branch passageways 41 extend downwardly from passageway 37 to vacuum ports 44 centrally located within each recess 35 by means of elongated, transversely extending slots 45 within the base 32. Preferably, a slide valve 46 is slidably mounted within the handle portion 34 from an open position, shown in full lines in Figure 8, to a broken line position, as illustrated at 47, to close the passageway 37 to break the vacuum which holds the circuit devices within the recesses 35.

With reference again to Figure 2, blades 23 are spaced apart to trim excess strip material along first lines 7 extended at predetermined distances from one pair of opposed edges of the circuit devices 6. To provide clearance for the teeth of the blades 23, the bottom surface of the base member 32 is provided with a first series of grooves 50.

A holding fixture 18 is shown mounted in first frame 19 at the first cutting station at the left-hand side of Figure 2. As is illustrated in Figure 2, rectangular support plate 42 fits onto frame recess 30 on the upper surface of the first frame 19. Preferably, support plate 42 is provided with a pair of diagonally positioned openings which receive positioning pins 52 mounted at corresponding corners of the frame recess to assure the proper orientation of the holding device which, in turn, assures that the circuit devices are properly oriented with respect to the cutting blades 23.

With reference again to Figure 2, the second series of cutting blades 24 is illustrated at the right-hand side of the figure. The blades 24 are spaced to effect a trimming along lines 8 which extend transversely of lines 7 adjacent the second set of side edges of the circuit devices. For this purpose, second frame 20 is slidably mounted within slots formed between upper and lower lid plates 13a and 13b. In a manner similarly to the recess 30 within first frame 19, a recess 57 is formed within the upper surface to receive the holding fixture 18 in an orientation in which the holder is rotated 90° with respect to the orientation required for cutting of the strip material

at the first station. To assure proper orientation, positioning pins 59 project upwardly from oppositely disposed corners of recess 57 and interengage with corresponding positioning openings in plate 42 to
5 assure that the fixture is properly oriented with respect to the cutting blades.

As is best shown in Figure 9, grooves 60 extend across the underside of part 30 in a direction which is transversely of the grooves 50. Grooves 60 provide
10 clearance for the cutter blades when the holding device is positioned within second frame 20.

Although the holding fixture may be manually movable in the reciprocal paths within first and second frames 19 and 20, it is preferred that means be
15 provided for automatic reciprocal movement of the frames. The reciprocal motion means may be seen with special reference to Figures 2, 4 and 5 and will now be described.

As best shown in Figure 5 wherein the first frame moving means is disclosed, a pin 61 extends laterally from first frame 19. A slider link 62 is fixed to a bar 63 which is, in turn, mounted on the side wall of a partition 64. Bar 63 preferably is of a dove-tailed cross-section, as is shown in Figure 2. A bracket 65
20 secured to link 62 has a dove-tailed groove as is
25 slidably mounted on the dove-tail shaped bar 63.

A first belt 66 driven by motor 67 (Figure 4) is secured to the link 62 by means such as clamp 68. A downwardly extending trigger arm 69 is secured to link
30 62 for engagement with a microswitch 70 when the arm is

in the left-hand position, as shown in broken lines in Figure 5 and a microswitch 72 when in the right-hand position, as also illustrated in broken lines in Figure 5.

5 A palm switch 73, shown in Figure 1, closes a circuit which activates motor 67 causing the motor to drive belt 66 in the direction of the arrow labelled F. This causes link 62 to be moved to the right in Figure 5, causing movement of the first frame 19 and the
10 fixture 18. The belt 66 moves the first frame and fixture 18 through the cutting station and beyond until arm 69 hits microswitch 72 causing the motor to reverse. Reversal of the motor causes movement of the belt in the direction of arrow R to a position in which
15 arm 69 strikes home microswitch 70 which turns the motor off until reactivation.

 A drive means like the drive means for reciprocating first frame 19 reciprocates the holder device within the second reciprocal frame 20, as is
20 illustrated in Figure 4 wherein like numbers are used to identify like parts. As shown in Figure 4, upright link 62 is fixed to slider bar 63. In the right-hand position, as viewed in Figure 4, downwardly depending arm 69 engages home microswitch 70. Motor 67 drives
25 the second frame 20 via belt 66, the link 62 and a pin 61 which laterally projects from the frame. The palm switch 73 activates motor 67 to drive belt 66 in the direction of arrow F, as shown in Figure 4, driving the slider link 62 and the reciprocal frame 56 and holding
30 fixture 18 through the cutting station to the left of Figure 4. Downwardly depending arm 69 strikes microswitch 72 to cause a reversal of link 62,

returning the second frame 20 and the holding fixture 18 to the home position in which home microswitch 70 is activated to turn off the motor.

5 Preferably, as shown in Figure 3, separate motor 74 is provided for rotatable driving shaft 21 and to thereby drive the cutter blades 23 and 24. Motor 74 is preferably activated by a separate on/off switch 75. A belt 76 interconnects the motor 74 with a gear 77 secured to shaft 21. Preferably, the cutting means is
10 isolated by partitions 78 so as to create a pair of chambers 79 within which chips of strip material created during the cutting action are collected. A vacuum hose 80 comprises vacuum means for evacuating the chips from the chamber 79 to prevent accumulation
15 of excess material in the vicinity of the cutting means.

 To guard against the inadvertent placement of the hands of a worker on the blades, a first blade guard plate 81 is mounted in position to clear the holding
20 fixture handle 34 at the first station. A pair of spaced apart guard plates 82 and 83 constitute a blade guard at the second station. Guard plates 82 and 83 are spaced apart to allow clearance for the handle when the fixture is properly positioned in the second frame
25 and are secured to the side edges of the rectangular opening defining the second station.

 To avoid damage to the circuit devices by heat generated by the cutting action, the vertical spacing of the cutting blades relative to the strip material
30 being cut is of some criticality. Preferably, the blades should be positioned so that during the cutting

operation, the blades do not penetrate an appreciable distance beyond the roots of the teeth 25. When blade penetration is so limited, the air gaps between rotating teeth act to draw sufficient cooling air into the region of the cut, preventing the build-up of excessive heat.

Although the operation of the invention should be clear from the foregoing, a brief summary follows.

With the vacuum means for the holding fixture turned on, three strips each supporting three circuit devices are positioned so that the circuit devices are held within the recesses 35, as shown in Figure 7. The holding fixture is placed within first frame 19 with positioning pins 52 positioning the holding device in the proper orientation on recessed surface 30. On/off switch 75 is turned on causing motor 74 to impart rotational movement to the cutter blades. By depression of palm switch 73, motor 67 is turned on to drive first frame 19 through the first cutting station effecting a separation of the circuit devices on the three strips along lines 7 by cutting along paths which extend through the grooves 50. In this pass, the circuit devices on the three strips are now separated but still held firmly in place within fixture 18. When the downwardly projecting arm 69 contacts switch 72, the switch is closed, and motor 66 is reversed causing a return of the first frame and the fixture device to the first position. At the home position, microswitch 70 is closed, turning off the motor. The operator then removes the fixture from the first frame and positions it within the second frame which is located at the right-hand side of Figure 1.

Palm switch 73 is again depressed and second frame 20 is reciprocated, driving the holding fixture through the second cutting station effecting trimming of the excess strip material along lines 8 adjacent the sides of the circuit devices, as is illustrated in Figure 12. As in the case of the first frame, when the second frame 20 returns to the home position, the home microswitch shuts the motor 67 off. Removal of the holding device from the frame and cutting off the vacuum using slide valve 46 allows for release of the circuit devices from the holder.



CLAIMS

1. Apparatus for trimming excess strip material adjacent the sides of circuit devices mounted in spaced apart relationship on substantially rectangular carrier strips, said apparatus comprising:
- 5 first and second strip material trimming stations;
- a portable carrier strip holding device positionable at said first and second trimming stations;
- 10 cutter means comprising a plurality of spaced, rotatable cutting blades disposed in parallel planes at said first and second trimming stations;
- said cutting blades having circumferentially disposed, radial cutting tooth positions;
- 15 the cutting blades at said first trimmer station being spaced to trim strip material extending a predetermined distance beyond first side edges of said circuit devices held by said holding device and being spaced at said second trimmer station to trim strip material extending a predetermined distance beyond second side edges of said circuit devices, said second side edges being perpendicularly disposed to said first side edges;
- 25 relatively movable means operative when the holding device is at said first station for relative movement of said holding means in a first path extended transversely of the cutting blades at said first trimmer station to trim strip material beyond said predetermined distance from said first pair of said edges of each of said circuit devices disposed in said holder; and
- 30



relatively movable means operative when the holding device is at said second station for thereafter relatively moving said holding means in a path extended transversely of the cutting blades at said second trimmer station to trim strip material beyond said
5 predetermined distance from said second pair of side edges of each of said circuit devices disposed in said holder.

2. Apparatus according to Claim 1, wherein said
10 first and second paths are parallel paths.

3. Apparatus for separation of encapsulated devices mounted in spaced apart, side-by-side relationship on elongated, substantially rectangular carrier strips, said apparatus comprising:
15 a holding fixture for releasably holding said carrier strips;
cutter means comprising an elongated rotatable support having a first and second series of spaced, circular cutter blades mounted for rotation
20 therewith about the axis of said support;
said cutter blades having circumferentially disposed radial cutting tooth portions;
a first reciprocatable frame for receiving said holding fixture, said first reciprocatable frame
25 being located adjacent the first series of said cutter blades and being movable in a path in a plane in which carrier strips held in said holding fixture tangentially intersect the path of rotation of the cutting tooth portions of said first series of circular
30 cutter blades and effect cutting of said strip material along lines extending on opposite sides of said encapsulated devices;



a second reciprocable frame for receiving said holding fixture, said second frame being located adjacent to the second series of cutter blades being movable in a path in a plane in which the carrier strips held in said holder tangentially intersect the path of rotation of the cutting tooth portions of said second series of cutter blades;

means positioning said holding fixture in said second reciprocable frame in a second position disposed at 90° from the first position; and

said second frame being movable in a path in a plan in which carrier strips held in said holding fixture tangentially intersect the path of rotation of the cutting tooth portions of said second series of circular cutter blades to effect cutting of said strip material along lines extending on opposite sides of said encapsulated devices transversely of the first series of lines.

4. Apparatus according to Claim 3, including means radially spacing the paths of the holding fixture relatively to the blades to intersect the blades in planes which pass substantially exclusively through the cutting teeth.

5. Apparatus according to Claim 4, further including a blade guard disposed in overlying relationship with said rotary cutters, said blade guard being vertically offset from said cutters to allow for clearance for said holding fixture upon movement in said first and second paths.

6. Apparatus according to Claim 5, said holding fixture comprising a base member having a holding



surface, each holding surface having at least one port, pneumatic means including fluid passages for creating a negative pressure at said port, said port being interengageable with the upper surface of an encapsulated device for holding said encapsulated device in fixed relationship to said holding surface.

7. Apparatus according to Claim 6, wherein said holding fixture further comprises valve means for selectively terminating said negative pressure created at said port.

8. Apparatus according to Claim 7, further including a plurality of rows of spaced depressions formed in said base member holding surface, said depressions corresponding in number, profile and spacing to receive encapsulated devices encapsulated on said strips, each of said depressions having one of said ports, the ports being in contact with the upper surface of an encapsulated device interfitted within said depressions.

9. Apparatus according to Claim 8, further including blade guide means comprising blade grooves extended between said depressions, said blade grooves providing clearance for the passage of the cutting teeth through the carrier strip.

10. Apparatus for separation of circuit devices encapsulated on elongated, substantially rectangular carrier strips, said apparatus comprising:

a holder for releasably holding carrier strips carrying at least one row of circuit devices in side-by-side relationship;



cutter means including first and second sets of spaced apart rotary cutter blades;

5 means for moving said holder in a first path extending transversely of the first set of rotary cutter blades for trimming the carrier strip material a predetermined distance from a first pair of edges of said circuit devices; and

10 means for thereafter moving said holder in a second path extending transversely of the second set of rotary cutter blades for trimming the carrier strip material from the second pair of edges of said circuit devices.

11. Apparatus according to Claim 10, wherein said first and second paths are parallel paths, further
15 including positioning means for positioning said holder in a first position for moving said carrier strips transversely of the axis of rotation of said first set of rotary cutters for trimming carrier strips from the side edges of said circuit devices and for positioning
20 said holder in a second position disposed at right angles to the first position for moving said carrier strips in said second path transversely of the axis of rotation of said second set of rotary cutters for separating circuit devices one from another.

25 12. Apparatus according to Claim 11, wherein said cutters include radially extending cutter teeth, the cutters being positioned relatively to the plane of movement of said carrier strip material to limit
30 passage of only the cutter teeth through said strip material.



13. Apparatus according to Claim 12, wherein said positioning means comprises first and second sets of fixed positioning pins, said first set of fixed positioning pins maintaining said holder in a first position in which a carrier strip in said holder is oriented in a first position in relation to said first set of blades and said carrier strip is oriented in a second position in relation to said second set of blades, said second position being at right angles to said first position.

14. Apparatus for the separation and trimming of encapsulated devices mounted in spaced apart relationship on one surface of elongated carrier strips formed of a relatively compressible material, said apparatus comprising:

a holding fixture for releasably holding carrier strips;

first and second cutter stations;

cutter means comprising first and second groups of circular, rotatable cutter blades having peripherally disposed cutting teeth disposed respectively at said first and second cutter stations, said blades of the first group being spaced apart to form a first pair of side edges along first trim lines spaced a predetermined distance from said devices, the blades of the second group being spaced to form a second pair of side edges extending perpendicularly to said first pair of side edges and spaced along second trim lines a predetermined distance from said devices; and

movable means at first and second stations for moving said holding fixture relatively to said first group of cutter blades in a path in which the



cutting teeth of said cutter blades intersect said first trim lines to form said first pair of side edges and for thereafter moving said holding device relatively to said second group of cutter blades in a path in which the cutting teeth of said cutter blades intersect said second trim lines to form said second pair of side edges.