A method and apparatus for flattening cover tape prior to the cover tape being sealed to a carrier tape. The apparatus includes a cover tape flattener with a leading edge angled in the direction of the moving carrier tape and cover tape. The method and apparatus provide for smoothing the cover tape and sealing the cover tape to the carrier tape.
METHOD AND APPARATUS FOR FLATTENING COVER TAPE

RELATED APPLICATION

[0001] This application claims the benefit of U.S. Provisional Application No. 60/335,560, filed Oct. 31, 2001.

BACKGROUND

[0002] The invention relates to taper machines in which electronic parts are positioned within the compartments of a carrier tape, and in which a cover tape is laid over the carrier tape and sealed thereto to trap the parts within the compartments. More specifically, the invention relates to a method and apparatus for flattening the cover tape prior to the cover tape being sealed to the carrier tape.

SUMMARY

[0003] The present invention provides a flattening mechanism for flattening wrinkles out of cover tape prior to the cover tape being bonded to carrier tape. The flattening mechanism is biased against the cover tape and includes a leading edge that is angled with respect to the direction of travel of the cover tape. The leading edge may be defined by rollers or a plate. As the cover tape moves under the flattening mechanism, the wrinkles are flattened out to edge of the carrier tape sides. The cover tape is therefore substantially flat or planar as it is bonded to the carrier tape.

[0004] Other features and advantages of the invention will become apparent to those skilled in the art upon review of the following detailed description, claims, and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] FIG. 1 is a side elevation view of a taper machine embodying the invention.

[0006] FIG. 2 is a top plan view of the taper machine.

[0007] FIG. 3 is a perspective view of a portion of carrier tape.

[0008] FIG. 4 is a perspective view of the cover tape flattening assembly.

[0009] FIG. 5 is a cross-section view taken along line 5-5 in FIG. 2.

[0010] FIG. 6 is a top view of the flattening mechanism in operation.

[0011] FIG. 7 is a cross-section view taken along line 7-7 in FIG. 2.

[0012] FIG. 8 is a top plan view of an alternative flattening mechanism in operation.

[0013] FIG. 9 is a bottom perspective view of the alternative flattening mechanism.

[0014] Before one embodiment of the invention is explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangements of the components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments and of being practiced or being carried out in various ways. Also, it is understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. The use of “including” and “comprising” and variations thereof herein is meant to encompass the items listed thereafter and equivalents thereof as well as additional items. The use of “consisting of” and variations thereof herein is meant to encompass only the items listed thereafter. The use of letters to identify elements of a method or process is simply for identification and is not meant to indicate that the elements should be performed in a particular order.

DETAILED DESCRIPTION

[0015] FIGS. 1 and 2 illustrate an inspection, handling, and packaging apparatus 20 that includes a support stand 24, an infed carrier tape drive wheel 26, a pick-and-place head or transport 28, a carrier tape infed reel 32 dispensing carrier tape 34, a camera-over-tape or “COT” inspection module 36, a cover tape reel 40 dispensing cover tape 41, a cover tape flattening, smoothing, or combing mechanism 42, a scaling shoe 44, a resilient drive roller 48, a backup wheel 50, a camera-after-scaling inspection module or “CASI” module 52, and an output reel packaging module 56. The support stand 24 supports a plurality of part input trays 60 that contain parts 64 to be inspected and packaged. The transport 28 picks the parts 64 off the input trays 60, and transfers the parts 64 to the carrier tape 34. The transport 28 is preferably a pick-and-place type transport utilizing a vacuum head.

[0016] The carrier tape 34 is best illustrated in FIG. 3, and includes a pair of flanges 72 running along its length, and compartments 76 formed between the flanges 72. One or both of the flanges 72 may include sprocket holes 80 to facilitate advancing the carrier tape 34 through the apparatus 20 and/or other machinery. For example, the infed carrier tape drive wheel 26 may be a pinwheel having sprocket pins that engage the sprocket holes 80 of the carrier tape 34. The drive wheel 26 may be driven under power by a motor (not illustrated) to pull the carrier tape 34 off the infed reel 32. Alternatively, the drive wheel 26 may have a smooth or flat surface and/or be passive or not driven by a motor.

[0017] The resilient drive roller 48 rotates under the power of a motor (not illustrated) to pull the carrier tape 34 through the apparatus 20 in a downstream direction 82 (an upstream direction being opposite the downstream direction 82). The flanges 72 of the carrier tape 34 are pinched between the drive roller 48 and the backup wheel 50 to facilitate the advancement of the carrier tape 34 under the influence of the rotating drive roller 48. Alternatively, the drive roller 48 may include pins that engage the sprocket holes 80 in the tape flanges 72 to facilitate advancing the carrier tape 34 through the apparatus 20. The carrier tape 34 is supported at its flanges 72 by guide rails 84 (FIGS. 1, 5, and 7) that extend substantially the entire length of the apparatus 20.

[0018] Referring again to FIGS. 1 and 2, the transport 28 places a single part 64 in each compartment 76 of the carrier tape 34. The COT inspection module 36 is downstream of the transport 28, and includes a camera, which inspects the parts 64 in the carrier tape compartments 76 as the carrier tape 34 is advanced through the apparatus 20.

[0019] The cover tape 41 is laid on top of the carrier tape 34 downstream of the COT inspection module 36, and is pulled through the apparatus 20 along with the carrier tape 34. The cover tape 41 is guided from the cover tape reel 40.
to the carrier tape 34 by a plurality of tensioning rollers 92. The cover tape 41 extends between the flanges 72 and completely covers the compartments 76. The adhesive, which is on the cover tape 41 surface, faces the carrier tape 34. Heat activated cover tape has adhesive across the complete cover tape surface. Pressure sensitive activated cover tape has only two strips 94 of adhesive (FIG. 4) that are located over the flanges 72 of the carrier tape 34. The adhesive is used to seal the cover tape 41 to the flanges 72 of the carrier tape 34.

[0020] Referring to FIGS. 1, 2, and 4-6, the flattening mechanism 42 is downstream 82 of the last tension roller 92 such that both the cover tape 41 and carrier tape 34 pass under the flattening mechanism 42. The flattening mechanism 42 includes a length of spring wire 96, a pair of roller tubes 100, and a pair of mounting clamps 104. To assemble the flattening mechanism 42, the spring wire 96 is extended longitudinally through the roller tubes 100, and the spring wire 96 is then bent into the shape illustrated. The mounting clamps 104 secure the ends of the spring wire 96 to a support structure 106 alongside the guide rails 84. The resiliency of the spring wire 96 biases the roller tubes 100 downwardly against the cover tape 41.

[0021] The spring wire 96 is bent at its center to define a peak that points in the upstream direction. The roller tubes 100 are therefore angled or swept back from the center of the cover tape 41 in the downstream direction 82 to the outer edges of the carrier tape 34. The roller tubes 100, which are preferably made of brass or any other suitable material, freely rotate about the spring wire 96 as the carrier tape 34 and cover tape 41 pass under the flattening mechanism 42. The bottoms of the roller tubes 100 contact the cover tape 41 and define the leading edge of the flattening assembly 42.

[0022] Referring to FIG. 6, because the roller tubes 100 are angled with respect to the longitudinal extent of the cover tape 41 and carrier tape 34 and with respect to the downstream direction 82, wrinkles in the cover tape 41 are flattened, smoothed, or combed to the edges of the carrier tape prior to the cover tape 41 and carrier tape 34 moving under the sealing shoe 44 (i.e., the cover tape 41 is substantially free from wrinkles downstream 82 of the rollers 100). The flattening mechanism 42 therefore helps to maintain the cover tape 41 in a substantially planar condition immediately prior to the cover tape 41 being bonded to the carrier tape 34 by the sealing shoe 44.

[0023] Referring now to FIGS. 1 and 7, the sealing shoe 44 is immediately downstream of, and should be as close as possible to, the flattening mechanism 42. The sealing shoe 44 includes a sealing mechanism 108 that is either a spool-shaped wheel or longitudinal flat shoe. The sealing mechanism 108 has flanges or edges 109 aligned over the flanges 72 of the carrier tape 34, and in alignment with the lines of adhesive 94 on the cover tape 41 if pressure sensitive adhesive is used. A downward force is applied to the sealing mechanism 108 to pinch the cover tape 41 and carrier tape 34 together between the sealing flanges 109 and the guide rails 84.

[0024] If heat is required to activate the adhesive, heating elements 110 (FIG. 7) may be inserted into the guide rails 84 under the sealing shoe 44 for that purpose. Thus, as the carrier tape 34 and cover tape 41 pass under the sealing shoe 44, the adhesive forms a bond (as at 112 in FIG. 6) between the cover tape 41 and the carrier tape 34 to secure the cover tape 41 over the compartments 76 of the carrier tape 34 and thereby trap the parts 64 within the compartments 76.

[0025] Referring back to FIGS. 1 and 2, the CASI module 52 is downstream 82 of the sealing shoe 44 and includes a camera that looks down at the tape 34, 41 (substantially as seen in FIG. 6 downstream 82 of the rollers 100) and inspects the sealing bonding process for possible sealing shoe position errors or inconsistent sealing perimeters. By flattening the cover tape 41 prior to sealing it to the carrier tape 34, the flattening mechanism 42 helps to reduce false rejections by the CASI module 52. Such false rejections may be caused by the camera of the CASI module 52 mistaking wrinkles in the cover tape 41 as flaws.

[0026] The loaded carrier tape 34 is then wound onto the output reel-packaging module 56. The apparatus 20 also includes a processor (not illustrated) that receives information from the COT and CASI modules 36, 52. The processor has memory that records which of the parts 64 have been indicated by the inspection modules 36, 52 as having flaws. The flawed tape sealing process or bad parts in tape are later reviewed and, within another operational processes, the good parts 64 are taken from the carrier tape 34 for their end use.

[0027] FIGS. 8 and 9 illustrate an alternative construction of the flattening mechanism 42. Similar elements in these drawings are given the same reference numerals introduced above. In this construction, the spring wire 96 extends across the cover tape 41 and carrier tape 34 substantially perpendicularly to the downstream direction 82 and to the longitudinal extent of the tapes 41, 34, and the rollers 100 are replaced with a flattening plate 114 having angled edges. The wire 96 extends through the flattening plate 114, and the flattening plate 114 is pivotal about the wire 96. A pair of set collars 118 are mounted to the wire 96 on either side of the flattening plate 114 to prevent the flattening plate 114 from sliding along the wire 96, and to maintain the flattening plate 114 over the cover tape 41.

[0028] The flattening plate 114 is angled or swept back from the center of the cover tape 41 in the downstream direction 82 to the outer edges of the carrier tape 34, substantially as the rollers 100 in the above-described first construction are. A cavity 122 is provided in the bottom of the flattening plate 114 to reduce the surface area of the flattening plate 114 that is in contact with the cover tape 41. This in turn reduces the frictional forces applied to the cover tape 41 by the flattening plate 114 and therefore reduces the pulling force required to move the cover and carrier tapes 41, 34 through the apparatus 20. The flattening plate 114 operates substantially as described above with respect to the first construction, except that the leading edge of the flattening plate 114 slides (as opposed to rolling) over the cover tape 41 to flatten out wrinkles in the surface of the cover tape 41.

What is claimed is:

1. A part packaging apparatus for packaging parts in a carrier tape having serially spaced-apart compartments and at least one flange extending alongside the compartments, and for applying a cover tape over the carrier tape, the carrier
tape and cover tape traveling in a downstream direction, the apparatus comprising:

a part placement head adapted to position parts in the carrier tape compartments;

a cover tape applicator for laying the cover tape over the carrier tape;

a flattening apparatus having a leading edge that contacts the cover tape to smooth the cover tape; and

a sealing apparatus downstream of the flattening apparatus to seal the cover tape to the carrier tape.

2. The apparatus of claim 1, wherein the flattening apparatus includes a tube roller that defines the leading edge and rolls across the cover tape to smooth the cover tape.

3. The apparatus of claim 1, wherein the flattening apparatus includes at least two tube rollers that each define a leading edge and that together define a peak that points in an upstream direction.

4. The apparatus of claim 3, wherein the leading edges are swept back from the peak in the downstream direction such that wrinkles in the cover tape are smoothed to the sides as the cover tape moves downstream.

5. The apparatus of claim 3, wherein the peak is centered with respect to the side edges of the cover tape.

6. The apparatus of claim 3, wherein the flattening apparatus includes a plate that defines the leading edge and that glides across the cover tape to smooth the cover tape.

7. The apparatus of claim 1, wherein the leading edge extends to the outer edges of the carrier tape.

8. The apparatus of claim 1, wherein the flattening apparatus includes a plate that defines the leading edge and that glides across the cover tape to smooth the cover tape.

9. The apparatus of claim 8, wherein the plate includes two edges swept back from the peak in the downstream direction and extending to the outer edges of the carrier tape.

10. The apparatus of claim 9, wherein a wire extends through the plate such that the plate pivots about the wire and wherein the flattening apparatus further includes two mounting clamps securing the ends of the wire to the packaging apparatus, wherein the wire bias the plate into contact with the cover tape.

11. The apparatus of claim 8, wherein the plate includes a cavity on the bottom of the plate to reduce the surface area of the plate that is in contact with the cover tape.

12. The apparatus of claim 1, wherein the cover tape is transparent, and the apparatus further comprising an inspection module to inspect the part in the compartment through the cover tape.

13. A method of smoothing cover tape and sealing parts in a carrier tape having serially spaced-apart compartments and at least one flange extending alongside the compartments, the method comprising:

positioning parts in the carrier tape compartments;

applying the cover tape over the carrier tape;

applying pressure on the cover tape with a flattening apparatus having a leading edge as the cover tape travels in a downstream direction;

smoothing the cover tape as it travels under the leading edge of the flattening apparatus; and

sealing the cover tape to the carrier tape.

14. The method of claim 13, wherein sealing the cover tape to the carrier tape includes applying heat to the carrier tape to activate adhesive on the cover tape.

15. The method of claim 13, wherein sealing the cover tape to the carrier tape includes sealing the cover tape to the carrier tape flange.

16. The method of claim 13, wherein smoothing the cover tape includes removing wrinkles from the cover tape.

17. The method of claim 13, wherein smoothing the cover tape includes removing wrinkles from the middle of the cover tape to the outer edges of the cover tape.

18. The method of claim 13, wherein the flattening apparatus includes a tube roller, and wherein smoothing the cover tape includes rolling the tube roller across the cover tape to smooth the cover tape.

19. The method of claim 13, wherein the flattening apparatus includes a plate, and wherein smoothing the cover tape includes gliding the plate across the cover tape to smooth the cover tape.

20. The method of claim 13, wherein the cover tape is transparent, and further comprising inspecting the part in its compartment through the cover tape with an inspection module after the cover tape is sealed to the carrier tape.

21. A part packaging apparatus for packaging parts in a carrier tape having serially spaced-apart compartments and at least one flange extending alongside the compartments, and for applying a cover tape over the carrier tape, the carrier tape and cover tape traveling in a downstream direction, the apparatus comprising:

a part placement head to position parts in the compartments;

an inspection module to inspect the part in the carrier tape compartment;

a flattening apparatus including

a plate that glides across the cover tape, the plate having a leading edge that contacts the cover tape to smooth the cover tape, the leading edge angled in the downstream direction and extending to the outer edges of the carrier tape,

a wire that extends through the plate such that the plate pivots about the wire, and

at least one mounting clamp securing the end of the wire to the packaging apparatus, wherein the wire bias the plate into contact with the cover tape;

a sealing apparatus to seal the cover tape to the carrier tape; and

a seal inspection module to inspect the part in the compartment through the cover tape.

22. The apparatus of claim 21, wherein the plate includes two leading edges that define a peak that points in an upstream direction.

23. The apparatus of claim 22, wherein the leading edges are swept back from the peak in the downstream direction such that wrinkles in the cover tape are smoothed to the sides as the cover tape moves downstream.

24. The apparatus of claim 22, wherein the peak is centered with respect to the side edges of the cover tape.
25. The apparatus of claim 21, wherein the plate includes a cavity on the bottom of the plate to reduce the surface area of the plate that is in contact with the cover tape.

26. A part packaging apparatus for packaging parts in a carrier tape having serially spaced-apart compartments and at least one flange extending alongside the compartments, and for applying a cover tape over the carrier tape, the carrier tape and cover tape traveling in a downstream direction, the apparatus comprising:

- a part placement head to position parts in the compartments;
- an inspection module to inspect the part in the carrier tape compartment;
- a flattening apparatus including
  - a tube roller that rolls across the cover tape to smooth the cover tape, the tube roller having a leading edge that contacts the cover tape to smooth the cover tape, the leading edge angled in the downstream direction and extending to the outer edges of the carrier tape,
  - a wire that extends longitudinally through the tube roller to define an axis of rotation for the roller, and

- at least one mounting clamp securing the end of the wire to the packaging apparatus, wherein the wire biases the tube roller into contact with the cover tape;
- a sealing apparatus to seal the cover tape to the carrier tape; and
- a seal inspection module to inspect the part in the compartment through the cover tape.

27. The apparatus of claim 26, wherein the flattening apparatus includes at least two tube rollers that each define a leading edge and that together define a peak that points in an upstream direction.

28. The apparatus of claim 26, wherein the leading edges are swept back from the peak in the downstream direction such that wrinkles in the cover tape are smoothed to the sides as the cover tape moves downstream.

29. The apparatus of claim 26, wherein the peak is centered with respect to the side edges of the cover tape.