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(54) **METHOD AND APPARATUS FOR FLATTENING COVER TAPE**

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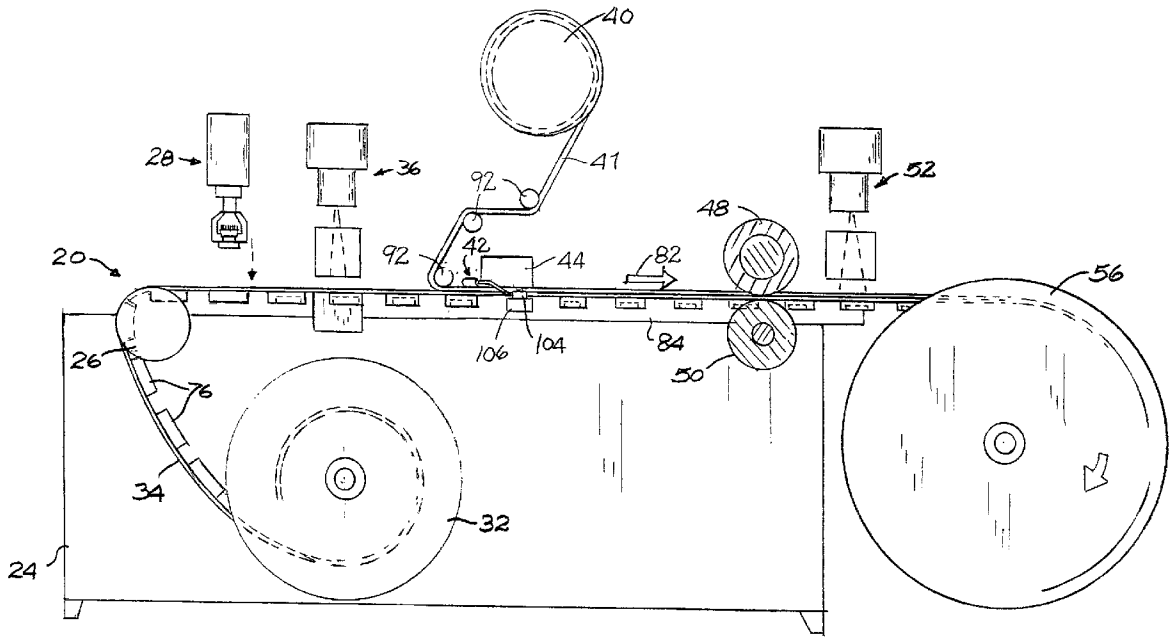
(57) **ABSTRACT**

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.



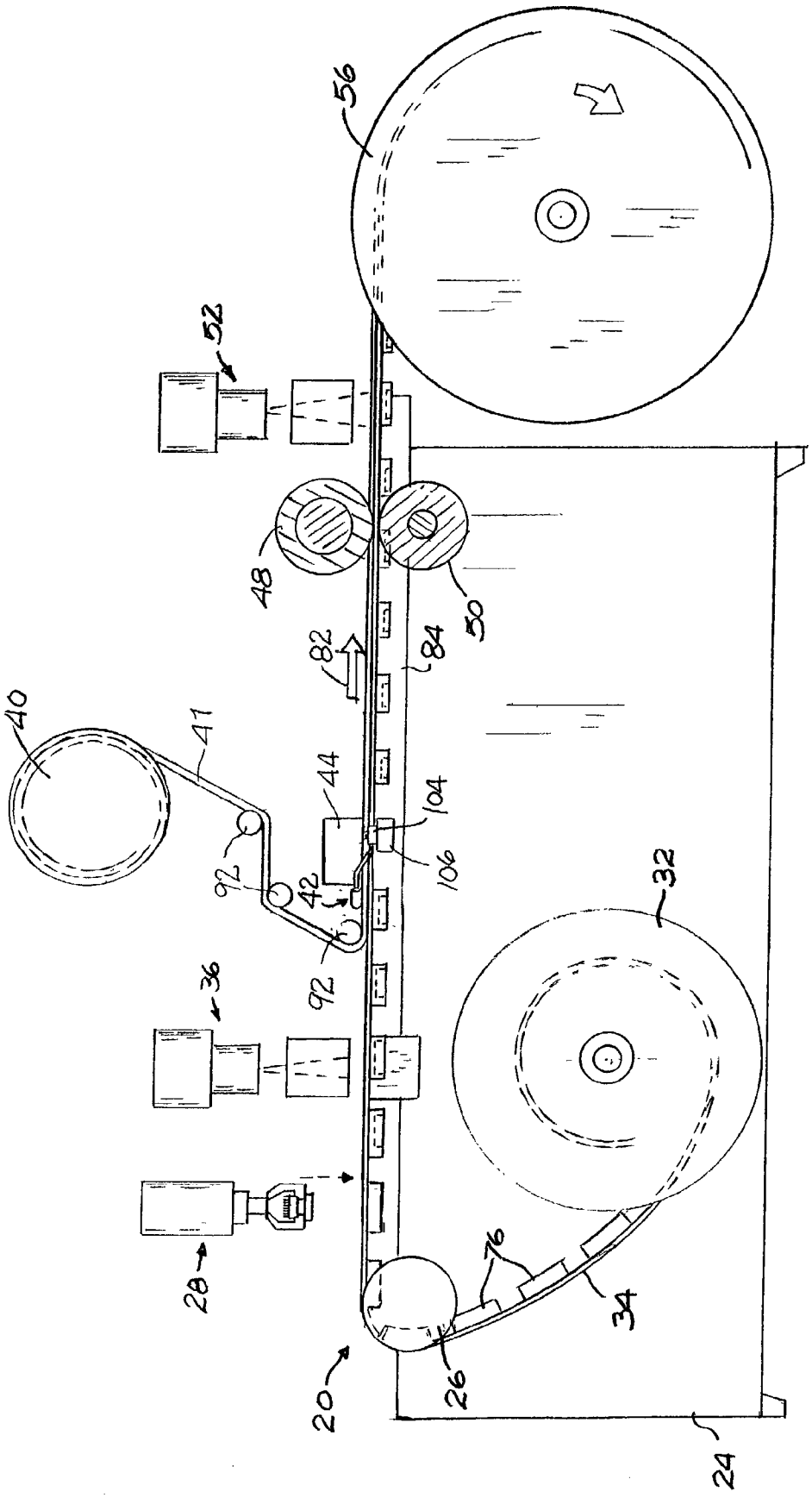


Fig. 1

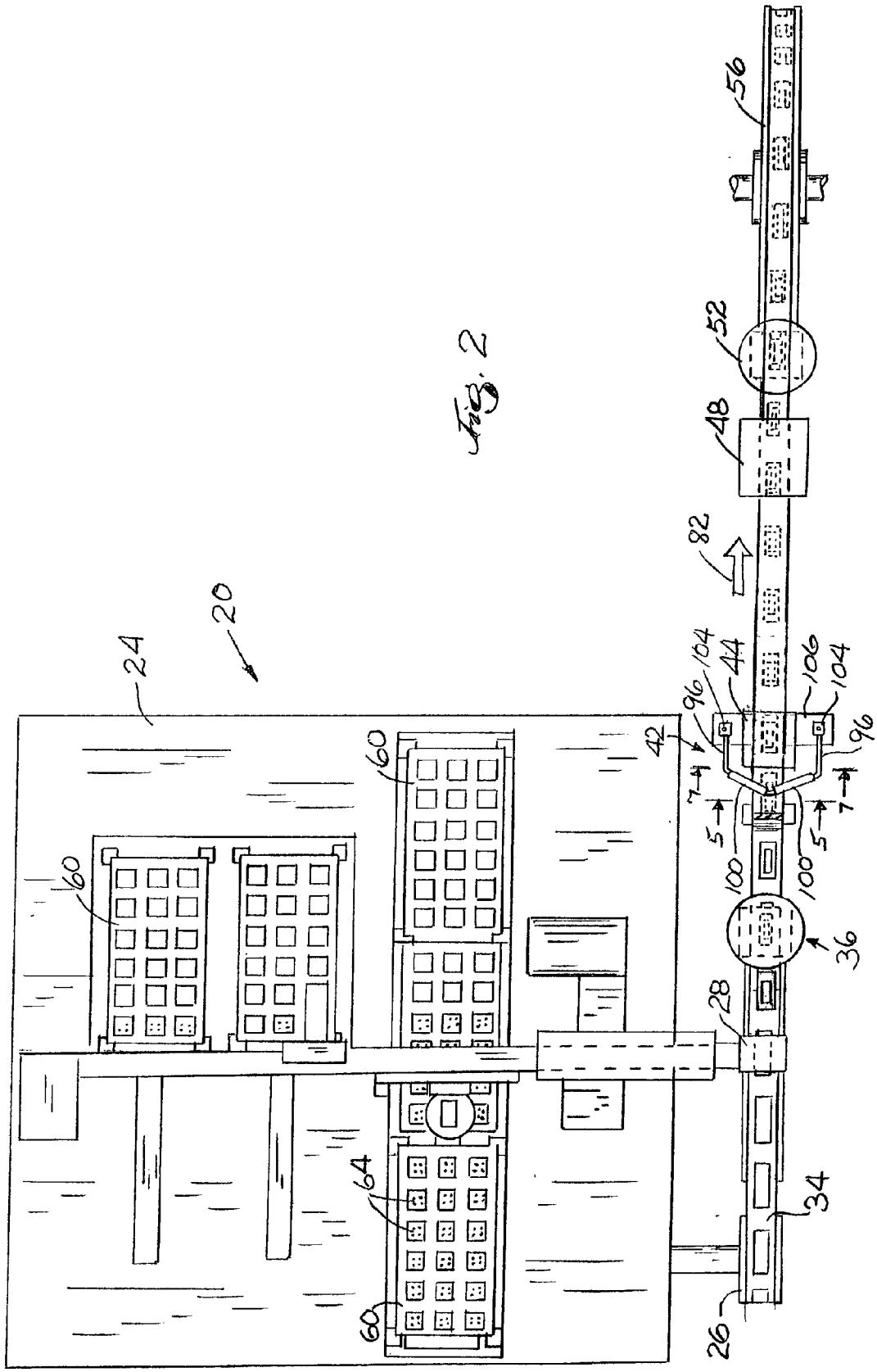

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Fig. 2

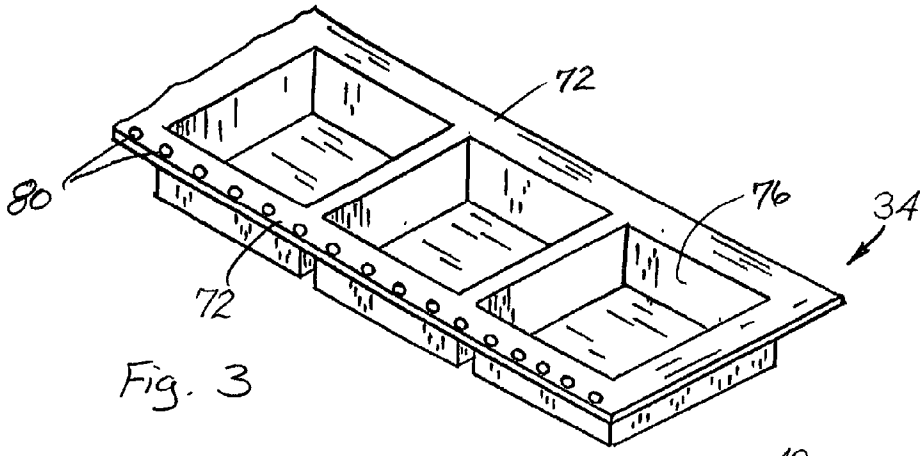

Fig. 3

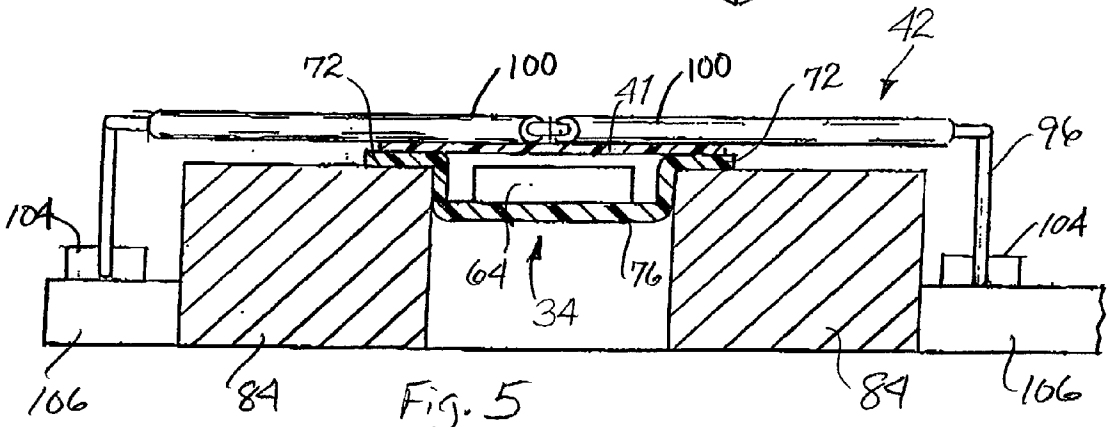

Fig. 5

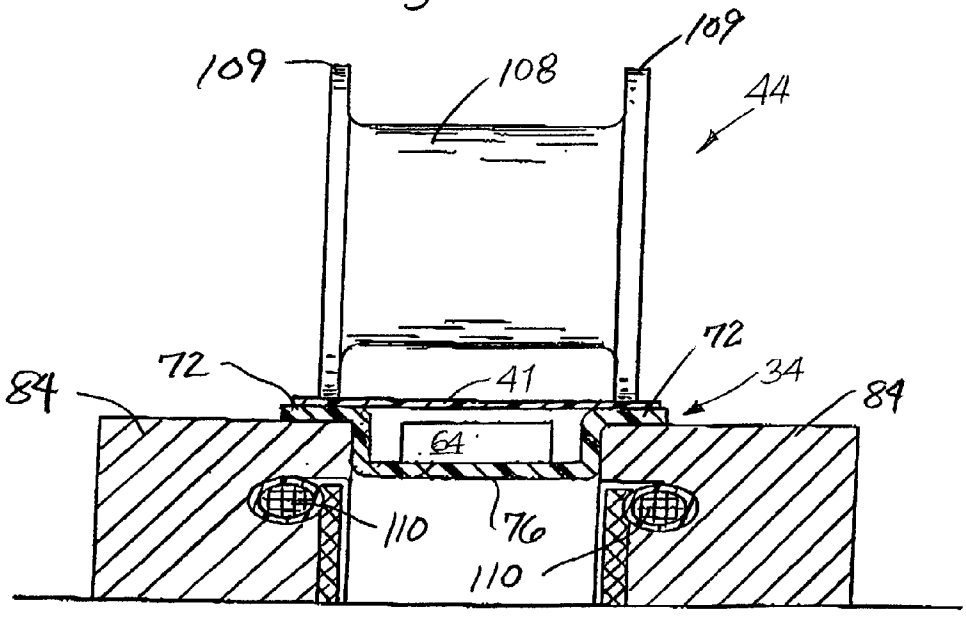

Fig. 7

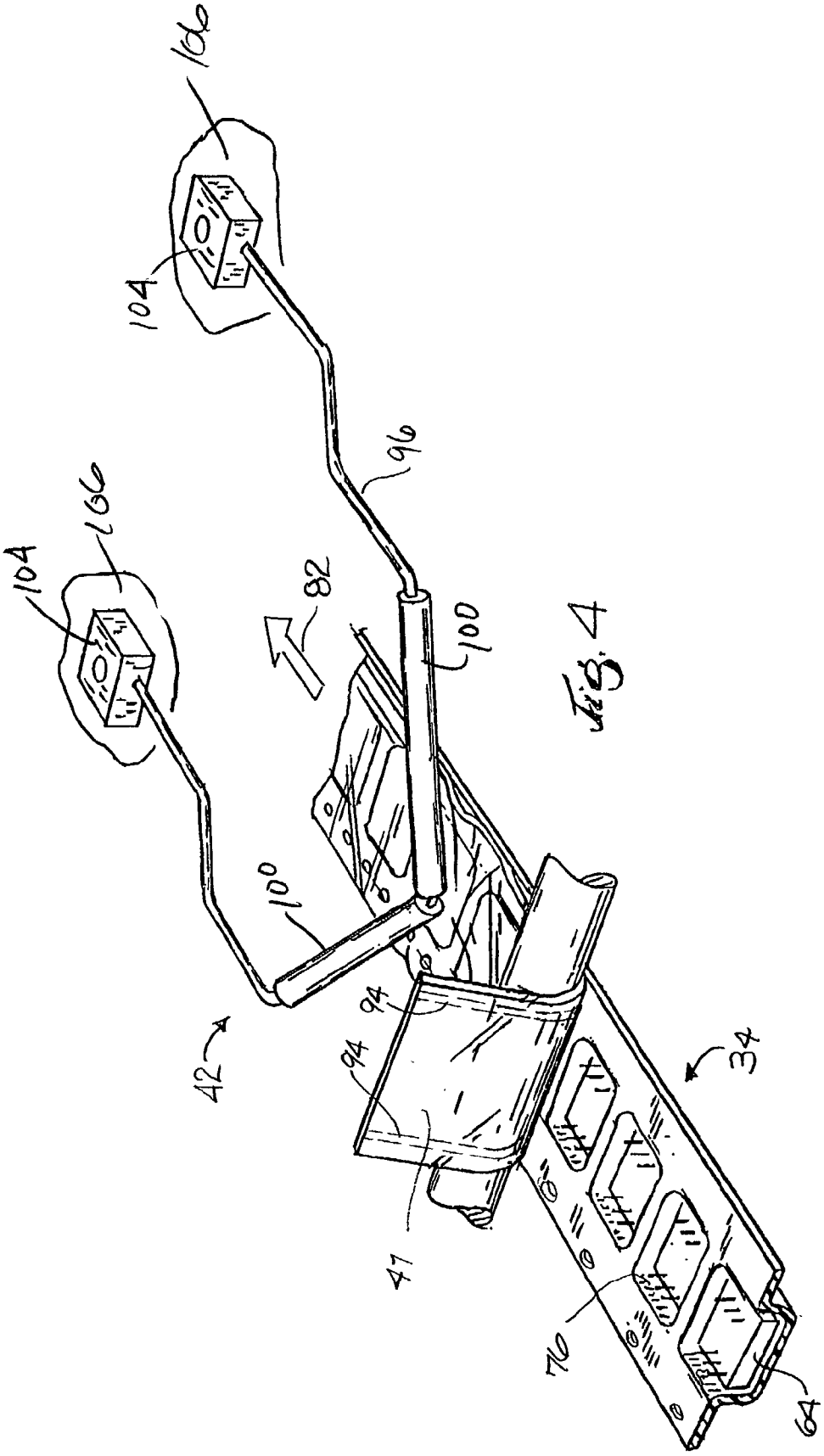

Fig. 4

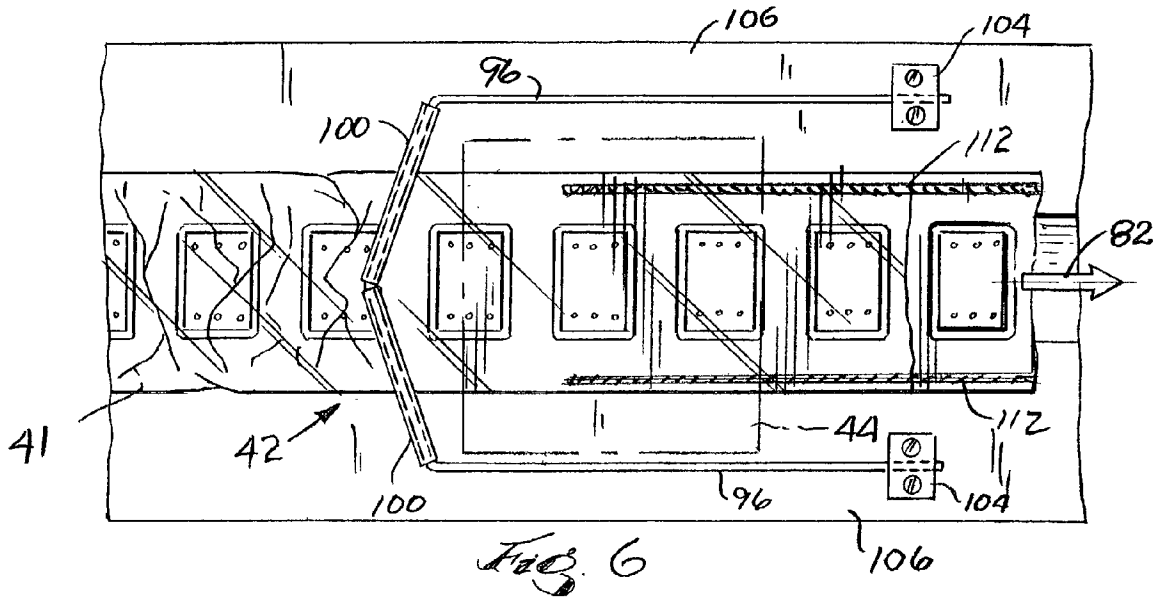

Fig. 6

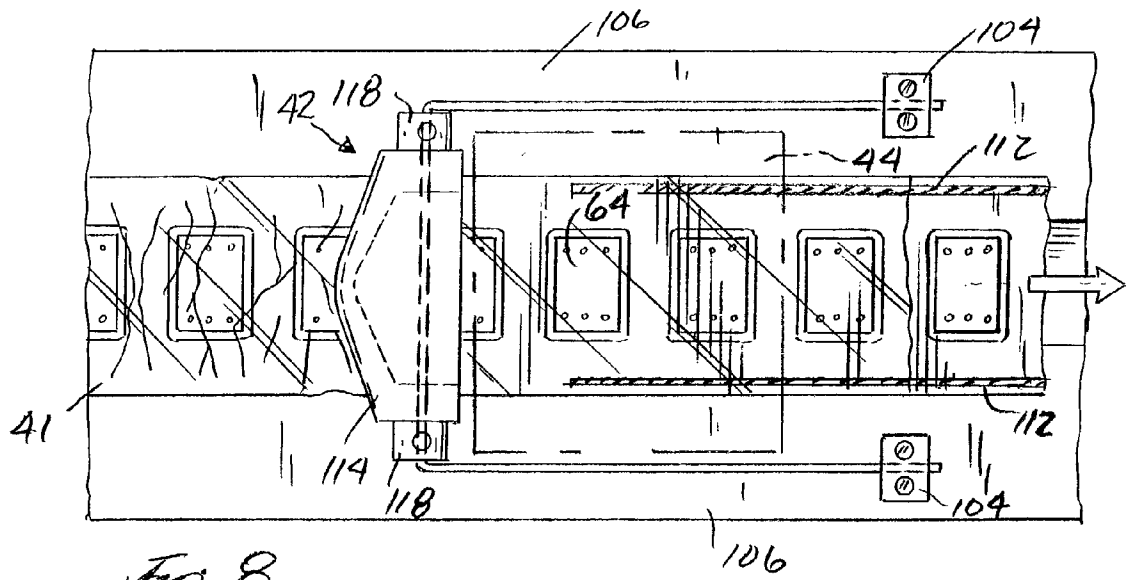

Fig. 8

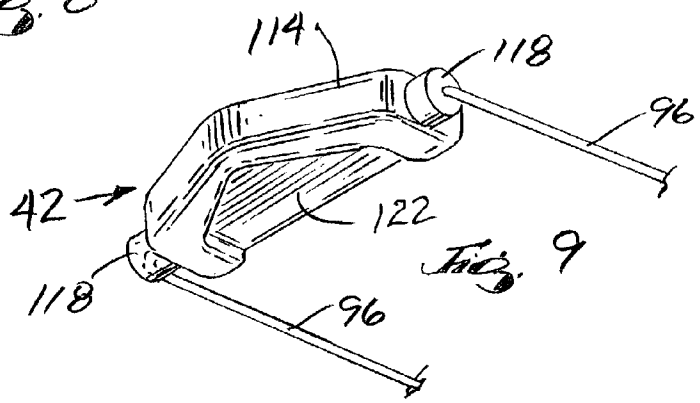

Fig. 9

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 infeed carrier tape drive wheel **26**, a pick-and-place head or transport **28**, a carrier tape infeed 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 sealing shoe **44**, a resilient drive roller **48**, a backup wheel **50**, a camera-after-sealing 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 infeed 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 infeed 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** into 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 perpendicular 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 wire that extends longitudinally through the two tube rollers to define an axis of rotation for the rollers, and wherein the flattening apparatus further includes two mounting clamps securing the ends of the wire to the packaging apparatus, wherein the wire biases the roller tubes into contact with 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 biases 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 biases 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.

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