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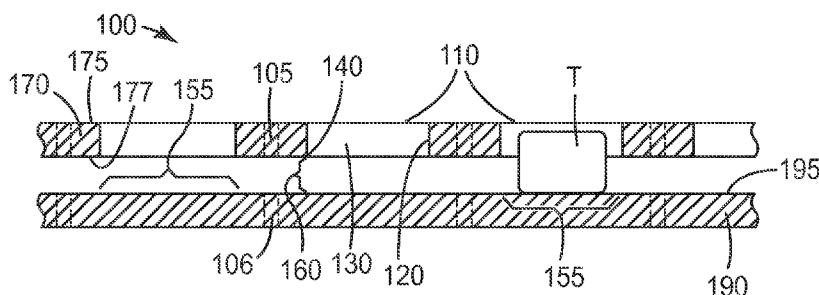


FIG. 5A

(57) Abstract: A flexible carrier tape for transporting a plurality of components, including a plurality of pockets spaced apart along a longitudinal axis of the flexible carrier tape, each pocket having: one or more sidewalls defining a pocket opening for insertion of a component, the pocket opening having a perimeter; and a bottom wall opposite the pocket opening; the one or more side walls and the bottom wall defining a gap therebetween that extends along at least 50% of the perimeter. A plurality of spacers can also be involved in defining the gap between the one or more side walls and the bottom wall.



FLEXIBLE CARRIER TAPE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application No.

5 61/861,502, filed August 2, 2013, the disclosure of which is incorporated by reference in its entirety herein.

TECHNICAL FIELD

10 [0002] The invention relates generally to carrier tapes for transporting components from a component manufacturer to a different manufacturer that assembles the components into new products.

BACKGROUND

15 [0003] In general, carrier tapes for transporting components from a component manufacturer to a different manufacturer that assembles the components into new products are well known. For example, in the field of electronic circuit assembly, electronic components are often transferred from a source of such components to a specific location on a circuit board for attachment thereto.

20 [0004] Carrier tapes are often manufactured in a thermoforming operation in which a web of thermoplastic polymer is delivered to a mold that forms the component pockets. The thermoformed web is usually cooled to ambient temperature.

25 [0005] There is a tendency for components to flip or jump out of the pocket, thus a vacuum hole is sometimes incorporated in the bottom of the pocket. This vacuum hole is used to hold down the components while the carrier tape is being indexed by applying a negative pressure to the hole, which holds the component against the bottom of the pocket.

[0006] However, as the components get smaller and lighter, there are increased incidences of components flipping and jumping out of the pocket, even when the pocket includes a vacuum hole.

SUMMARY

30 [0007] In an aspect, a flexible carrier tape is provided for transporting a plurality of components, having a plurality of pockets spaced apart along a longitudinal axis of the

carrier tape. Each pocket includes one or more sidewalls defining a pocket opening for insertion of a component, the pocket opening having a perimeter; and a bottom wall opposite the pocket opening. The one or more side walls and the bottom wall define a gap therebetween that extends along at least 50% of the perimeter. In some embodiments, the gap extends along the entire perimeter.

[0008] In an aspect, a flexible carrier tape is provided for transporting a plurality of components, includes a first flexible substrate extending along a longitudinal axis of the flexible carrier tape and defining a plurality of through openings, each through opening being defined by one or more side walls that extend from a top surface of the first flexible substrate beyond a bottom surface of the first flexible substrate. A second flexible substrate extends along the longitudinal axis of the carrier tape and is disposed below the first flexible substrate. A plurality of spacers defines a gap between the one or more side walls of each through opening and a top surface of the second flexible substrate. The gap extends along at least 50% of a perimeter of the through opening. In some embodiments, that gap extends along the entire perimeter of the through opening.

BRIEF DESCRIPTION OF DRAWINGS

[0009] The accompanying drawings are included to provide a further understanding of embodiments and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments and together with the description serve to explain principles of embodiments. Other embodiments and many of the intended advantages of the embodiments will be readily appreciated as they become better understood by reference to the following detailed description. The elements of the drawings are not necessarily to scale relative to each other. Like reference numerals designate corresponding similar parts.

[0010] FIG. 1 is a schematic view of a prior art carrier tape;

[0011] FIG. 2 is a schematic view of a carrier tape according to the prior art;

[0012] FIG. 3 is a schematic cross-sectional view of another carrier tape according to the prior art;

[0013] FIG. 4 is a schematic view showing a flexible carrier tape according to an embodiment of the present disclosure;

[0014] FIG. 5A is a schematic cross-sectional view of the flexible carrier tape shown in FIG. 4;

[0015] FIG. 5B is a schematic cross-sectional view of a flexible carrier tape according to another embodiment of the present disclosure;

5 [0016] FIG. 6A is a perspective view of a portion of a flexible carrier tape according to an embodiment of the present disclosure;

[0017] FIG. 6B is a perspective view of a portion of a flexible carrier tape according to an embodiment of the present disclosure;

10 [0018] FIGS. 7A-7C are schematic views showing a portion of a flexible carrier tape according to an embodiment of the present disclosure;

[0019] FIG. 8A is a schematic cross-sectional views showing a flexible carrier tape according to an embodiment of the present disclosure; and

[0020] FIG. 8B is a schematic cross-sectional views showing a flexible carrier tape according to an embodiment of the present disclosure.

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DETAILED DESCRIPTION

[0021] In the following Detailed Description, reference is made to the accompanying drawings, which form a part hereof, and in which is shown by way of illustration specific embodiments in which the invention may be practiced. In this regard, directional terminology, such as “top,” “bottom,” “front,” “back,” “leading,” “trailing,” etc., is used with reference to the orientation of the Figure(s) being described. Because components of embodiments can be positioned in a number of different orientations, the directional terminology is used for purposes of illustration and is in no way limiting. It is to be understood that other embodiments may be utilized and structural or logical changes may be made without departing from the scope of the present invention. The following detailed description, therefore, is not to be taken in a limiting sense, and the scope of the present invention is defined by the appended claims.

25 [0022] Carrier tapes are well known in the industry of semiconductor manufacture. For example, it is known for a carrier tape to include pocket portions that are for receiving materials to be transported, along with holes for transporting the carrier tape, wherein the pocket portions and the holes may be arranged at uniform intervals. Such an arrangement is advantageous to an automated process, and an example of such a prior art carrier tape A

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is shown in FIG. 1 and is also described in U.S. Patent Application Publication No. 2009/0173660 (Lee et al.).

[0023] FIG. 1 is a schematic showing a perspective view of a portion of a carrier tape A according to the prior art, showing a polymer tape B having a plurality of pocket portions C spaced apart along a longitudinal axis D of carrier tape A. Pocket portions C include sidewalls F defining a pocket opening G. A plurality of holes E (i.e., sprocket holes) for transporting carrier tape A is also spaced apart along a longitudinal axis of carrier tape A.

[0024] FIG. 2 is a schematic showing a perspective view of a portion of a carrier tape A' according to the prior art, where carrier tape A' further includes a lower cover tape L and an upper cover tape U attached to polymer tape B'. Lower cover tape L can provide a bottom wall for pocket portions C', in order to keep materials to be transported (e.g., semiconductor components) from falling through the pocket openings in carrier tape A'. Typically, the materials to be transported (not shown) are placed into pocket portions C' and onto an upper surface of lower cover tape L (e.g., using pick-and-place automation), and then an upper cover tape U is attached to polymer tape B' in order to keep the material in place for transportation. Plurality of holes E' is not covered by cover tapes L or U, to permit automated transportation of carrier tape A'.

[0025] FIG. 3 is a schematic view showing a cross-sectional view of a portion of another carrier tape A'' according to the prior art, showing polymer tape B'' having a plurality of pocket portions C'' spaced apart along carrier tape A'', as well as a spaced apart plurality of holes E'' for transporting carrier tape A''. The pocket portions C'' include sidewalls F'' defining a pocket opening. The spaced apart pocket portions C'' include a bottom wall M. Bottom wall M can support a material to be transported T (e.g., a semiconductor component). Carrier tape A'' therefore does not require a lower cover tape in order to carry material to be transported T.

[0026] A problem with some prior art carrier tapes is that as the materials to be transported (e.g., semiconductor components) become ever smaller, these materials can have an increased tendency to flip or otherwise change orientation (and/or position) either during or after their placement into a pocket of a carrier tape. Such failure modes in a carrier tape can result in loss of manufacturing efficiency and increase in manufacturing costs.

[0027] One solution that has been pursued for ensuring correct orientation and position of the material to be transported is to provide a carrier tape having pockets that include a vacuum hole or vacuum slit in the bottom wall of the pockets as described, for example, in PCT International Publication No. WO 2010/065335 (Ling et al.). The conventional method of producing a vacuum hole in the pockets is by mechanically punching through the base of the carrier tape. With the increasing miniaturization of electronic components, the existing punching method faces its manufacturability limitation. In addition, punching creates waste (slugs) and dust that may contaminate the components, which can be of special concern when manufacturing precision electronic parts. In addition, thermoplastic webs used for making some carrier tapes may be tough, resilient materials that can be difficult to punch. As a result, the punches wear out or break and have to be frequently replaced. Precision punches are expensive and replacing them is a time consuming process that requires delicate realignment and retiming of the new punch.

[0028] Thus, there is a need for improved carrier tapes and methods of making them that can provide a low failure rate in the correct placement of miniaturized material to be transported, in combination with facility and fidelity in the manufacture of the carrier tape itself.

[0029] The present disclosure presents carrier tapes that make use of vacuum to aid with correctly orienting and positioning a material to be transported. Rather than having a vacuum slit or vacuum hole in base of the pockets, the carrier tap of the present disclosure does not require such a vacuum slit or vacuum hole. Instead, a gap is provided, the gap being defined by one or more sidewalls of the pocket and the bottom wall of the pocket. Thus, one or more of the sidewalls of the pocket do not adjoin the bottom wall of the pocket, and this leaves a gap which provides a path for applying a vacuum to the pocket to permit more efficient loading of the pockets with components. In some embodiments, none of the sidewalls of the pocket adjoin the bottom wall of the pocket, such that the gap extends along an entire perimeter of a pocket opening.

[0030] In some embodiments, the length of the sidewalls of the pockets coincides with the thickness of a first flexible substrate layer that is part of the carrier tape construct. In other words, in such carrier tape constructs the sidewalls do not extend beyond upper or lower major surfaces of such first flexible layer. More specific details regarding a flexible

carrier tape of the present disclosure, including embodiments with various configurations of sidewalls and gaps, will now be described with reference to the drawings.

[0031] FIG. 4 is a schematic showing a plan view (i.e., a “top” view) of a portion of a flexible carrier tape 100 of the present disclosure. Flexible carrier tape 100 includes a plurality of pockets 110 spaced apart along a longitudinal axis 180 of flexible carrier tape 100. Each pocket 110 has one or more sidewalls 120 defining a pocket opening 130 for insertion of a component (not shown), the pocket opening 130 having a perimeter 140, and a bottom wall 155 opposite the pocket opening 130. In this top view, bottom wall 155 can be seen through pocket opening 130. For each pocket, the one or more side walls 120 and the bottom wall 155 define a gap 160 therebetween that extends along at least 50% of the perimeter 140 (gap 160 can be seen better by considering FIGS. 5A and 5B). An optional plurality of spaced apart holes 105 for transporting flexible carrier tape 100 is also shown, running parallel to longitudinal axis 180.

[0032] FIG. 5A is a schematic view showing a profile view of a portion of the flexible carrier tape 100 shown in FIG. 4. Flexible tape carrier 100 includes a first flexible substrate 170 extending along the longitudinal axis (i.e., 180 in FIG. 4) of the flexible carrier tape 100 and a second flexible substrate 150 also extending along the longitudinal axis of the flexible carrier tape 100. The one or more sidewalls 120 of each pocket 110 are formed in the first flexible substrate 170 and extend from a top surface 175 of the first flexible substrate 170 toward a top surface 195 of the second flexible substrate 190, the second substrate 190 comprising the bottom wall 155 of each pocket 110. In the embodiment shown in FIG. 5A, the one or more sidewalls 120 extend through the thickness of first flexible substrate 170, but not beyond the thickness of first flexible substrate 170. Thus, the one or more sidewalls 120 of pocket 110 need not physically contact second flexible substrate 190. A material to be transported T is shown disposed within an individual pocket 110 and on a bottom wall 155 of pocket 110.

[0033] A plurality of spaced apart holes 105 in first flexible substrate 170 is shown, and a second plurality of spaced apart holes 106 in second flexible substrate 190 is also shown. Either or both pluralities of spaced apart holes 105, 106 can be included for transporting flexible carrier tape 100, and can be vertically aligned or vertically nonaligned, depending on the particular embodiment selected.

[0034] FIG. 5B is a schematic view showing a profile view of a portion of a flexible carrier tape 500 of the present disclosure. Flexible carrier tape 500 is similar to the flexible carrier tape 100 shown in FIG. 5A, having a first flexible substrate 570 and a second flexible substrate 590, with flexible substrates 570 and 590 both extending along a longitudinal axis of flexible carrier tape 500. A plurality of pockets 510 is spaced apart along the longitudinal axis of flexible carrier tape 500, and each pocket 510 has one or more sidewalls 520 defining a pocket opening 530 for insertion of a component T, the pocket opening 530 having a perimeter 540, and a bottom wall 555 opposite the pocket opening 530. The one or more walls 520 extend from a top surface 575 of first flexible substrate 570 toward a top surface 595 of second flexible substrate 590. Notably, in flexible carrier tape 500 at least a portion of the one or more sidewalls 520 extends beyond the thickness of first flexible substrate 570 (i.e., beyond a “bottom” surface 577 of first flexible substrate 570).

[0035] In the embodiment schematically shown in FIG. 5B, a gap 560 is defined by the one or more sidewalls 520 and the bottom wall 555, and the gap 560 extends along the entire perimeter of pocket opening 530. In some other embodiments (not shown), one or more of the side walls 520 can extend all the way towards bottom wall 555, touching second flexible substrate 590, while still leaving gap 560 around at least a portion of the perimeter 540 of pocket opening 530. In some embodiments, gap 560 can extend along at least 90%, at least 80%, at least 70%, at least 60%, or even at least 50% of the perimeter of the pocket opening 530.

[0036] In some embodiments, a plurality of spacers can be provided between the first flexible substrate (170 in FIG. 5A, or 570 in FIG. 5B) and the second flexible substrate (190 in FIG. 5A, or 590 in FIG. 5B), to aid in defining a gap between the one or more sidewalls and the bottom wall. While a plurality of spacers is not explicitly shown in FIGS. 5A or 5B, it will be understood that the plurality of spacers can be included in a flexible carrier tape of the present disclosure, to aid in defining the gap between the one or more side walls and the bottom wall. In some embodiments, the plurality of spacers can be integral to the first or second flexible substrates (as discussed regarding FIGS. 7A-7C, 8A, and 8B below).

[0037] FIG. 6A is a schematic view showing a portion of a flexible carrier tape 601 of the present disclosure, including a flexible first substrate 670, having a plurality of pockets

610 spaced apart along a longitudinal axis of flexible carrier tape 601. Each pocket 610 has one or more sidewalls 620 defining a pocket opening for insertion of a component (not shown). Flexible carrier tape 601 is shown “inverted”, with the one or more sidewalls 620 extending upwards from “bottom” surface 677, also facing upwards in this figure (with “top” surface 674 facing downwards in this figure). Individual sidewalls 621, 622, 623, and 624 are called out, and when these sidewalls face a second flexible substrate (not shown) they define a gap that extends along the entire perimeter of the pocket opening.

[0038] FIG. 6B schematically shows a portion of a flexible carrier tape 602 of the present disclosure that differs from flexible carrier tape 601 in that individual sidewall 624 extends only through the thickness of first flexible substrate 670, while individual sidewalls 621, 622, and 623 extend beyond lower bottom surface 677. When individual sidewalls 621, 622, and 623 face a second flexible substrate (not shown), they again define a gap that extends along the entire perimeter of the pocket opening. Thus, some of the one or more sidewalls can be have a length equal to the thickness of the first flexible substrate, while others of the one or more sidewalls can have a length that is longer than the thickness of the first flexible substrate. In other words, it is not a requirement that all of the more or more sidewalls have the same length.

[0039] Referring again to FIG. 5B, in some additional embodiments the one or more sidewalls 520 of at least some of the pockets 510 in the plurality of pockets can form an integral portion of a spacer (not shown) extending from bottom surface 577 of first flexible substrate 570 to a top surface 595 of second flexible substrate 590, provided that a gap 560 still extends around at least 50%, at least 60%, at least 70%, at least 80%, or even at least 90% of a perimeter of the pockets. That is, a portion or portions of the one or more sidewalls can aid in defining the gap 560 by acting as spacers between the first and second flexible substrates.

[0040] FIG. 7A is a schematic view showing a portion of a flexible carrier tape 700 of the present disclosure, including flexible first substrate 770, as viewed from “bottom” surface 777. Flexible first substrate 770 includes a plurality of pocket openings 730 spaced apart along a longitudinal axis 780, and each pocket opening has a perimeter defined by one or more sidewalls. Portions of flexible first substrate 770 extend from bottom surface 777 to form spacers 701 and 703. A plurality of spacers 701 and 703 is spaced apart aligned along longitudinal axis 780. In the embodiment shown, spacers 701 and 703 are shown in

an alternating, interdigitated arrangement. In other embodiments (not shown), plurality of spacers 701 and 703 can be arranged directly opposite each other, or even having varied frequencies of being spaced apart. For example, a first plurality of spacers 701 and a second plurality of spacers 703 may be spaced apart in a 1:1 ratio, a 2:1 ratio (e.g., two 701 spacers 701 for every spacer 703), or any other suitable ratio. An optional plurality of spaced apart holes 705 for transporting flexible carrier tape 700 is also shown, running parallel to longitudinal axis 780. While the plurality of spaced apart holes 705 is shown as coinciding with plurality of spacers 703, such coincidence is not a requirement, and other suitable configurations can be used (e.g., having a spaced apart hole occurring in every other spacer, other third spacer, or even not always occurring on a spacer).

[0041] FIG. 7B is a schematic view showing a perspective view (from the “bottom” surface) of the portion of flexible carrier tape 700 shown in FIG. 7A, illustrating plurality of spacers 701 extending outward from “bottom” surface 777 of first flexible substrate 770. In the embodiment shown, a plurality of indentations 711 coincide with plurality of spacers 701 (i.e., when viewed from “top” surface 775, the 711 features appear as indentations). During manufacture of first flexible substrate 770, it may be convenient to start with a flat first flexible substrate and press spacer features 701 and 703 via conventional techniques. As is evident, the one or more sidewalls of the plurality of pocket openings 730 are shown as having a length coinciding with the thickness of first flexible substrate 770.

[0042] FIG. 7C is a cutaway-profile view showing the first flexible substrate layer 770 of FIG. 7A from an end-on orientation, showing a pocket opening 730 having at least one sidewall 720. Indentations 711 and 715 corresponding with spacers 710 and 703 are illustrated. In the embodiment shown, spacers 701 and 703 extend from surface 777 by the same amount, although this is not a requirement. Spacers 701 and 703 are also shown having relatively flat, smooth major surfaces, and while this is preferred, it is not a requirement, and other geometries (e.g., a rounded dome surface, or posts, or vertical rectangular walls) could be used.

[0043] FIG. 8A is a schematic end-on cutaway profile view of a flexible carrier tape 800 including first flexible substrate 870 having “top” surface 875 (note the inversion of the first flexible substrate 870 relative to first flexible substrate 770 in FIG. 7C). The flexible carrier tape 800 includes a second flexible substrate 890 disposed on plurality of spacers

801 and 803. A pocket 810 includes one or more sidewalls 820 and a portion of second flexible substrate 890 serving as a bottom wall 855. A component T (not part of the carrier tape 800) is disposed within pocket 810, against bottom wall 855. Various other features in FIG. 8A have corresponding features in FIG. 7C (e.g., 805, 811, and 815).

5 Second flexible substrate 890 is selected to have a width sufficient to provide bottom wall 855, without covering hole 805. It is generally desirable to keep hole 805 available for enabling automated transport of flexible carrier tape 800 during pick and place operations.

[0044] FIG. 8B is a schematic end-on cutaway view that is essentially identical to FIG. 8A except that a flexible cover layer 881 is disposed on the top surface 875 of first flexible layer 870, thus sealing the top opening of pocket 810 (preferably with component T disposed inside pocket 810).

[0045] In some embodiments, the one or more side walls can extend beyond a major surface of the first flexible substrate (see, for example, side walls 621, 622, 623, and 624 in FIG. 6A). Referring again to FIGS. 7A-7C and 8A-8B, another way of describing such a flexible carrier tape of the present disclosure (i.e., a flexible carrier tape having side walls longer than a thickness of the first flexible layer) can include having a first flexible substrate 770 (or 870) extending along a longitudinal axis 780 of the flexible carrier tape 700 (or 800) and defining a plurality of through openings 710 (or 810), each through opening being defined by one or more side walls that extend from a top surface of the first flexible surface beyond a bottom surface of the first flexible substrate (note that in FIGS. 7A-7C, first flexible substrate is shown upside down, with top surface 775 facing downwards). In other words, the one or more side walls would extend further than the thickness of the first flexible substrates shown in FIGS. 7C, 8A and 8B. A second flexible substrate extends along the longitudinal axis of the flexible carrier tape and is disposed below the first carrier tape, and a plurality of spacers defines a gap between the one or more sidewalls of each through opening and a top surface of the second substrate. In these embodiments, the gap extends along at least 50%, at least 60%, at least 70%, at least 80%, or even at least 90% of a perimeter of the through openings. In some embodiments, the gap extends along the entire perimeter of the through opening. In some further embodiments, the spacers are integral to the second flexible substrate and are regularly arranged along the longitudinal axis of the flexible carrier tape, and the bottom surface of the first flexible substrate is attached to the top surface of the plurality of spacers.

Alternatively, in some other embodiments the spacers are integral to the first flexible substrate and are regularly arranged along the longitudinal axis of the flexible carrier tape, and the top surface of the second flexible substrate is attached to the bottom surface of the plurality of spacers.

5 [0046] In general, pockets (e.g., 110, 510, 610, and 810) are designed to conform to the size and shape of the components that they are intended to receive. Although not specifically illustrated, the pockets may have more or less side walls than the four that are shown in the drawings. Thus, the pockets may be circular, oval, triangular, pentagonal, or have other shapes in outline. Each of the one or more sidewalls may also be formed with a slight draft (i.e., a 2° to 12° slant toward or away from the center of the pocket) in order to facilitate insertion of the component. The depth of the pocket can also vary depending on the component that the pocket is intended to receive. In addition, the interior of the pocket (including the bottom wall) may be formed with ledges, ribs, pedestals, bars, mils, appurtenances, and other similar structural features to better accommodate or support particular components, which the proviso that any such structural features do not completely occlude the gap defined in the pockets of the present disclosure. Although a single column of pockets is illustrated in the drawings, two or more columns of aligned pockets could also be formed along the length of the flexible carrier tape in order to facilitate the simultaneous delivery of multiple components. It is expected that the columns of pockets would be arranged parallel to each other with pockets in one column being in aligned rows with the pockets in the adjacent column(s).

15 [0047] In any of the above embodiments, the first flexible substrate may be formed of any polymeric material that has a sufficient gauge and flexibility to permit it to be wound about the hub of a storage reel. A variety of polymeric materials may be used including, but not limited to, polyester (e.g., glycol-modified polyethylene terephthalate), polycarbonate, polypropylene, polystyrene, polyvinyl chloride, and acrylonitrile-butadiene-styrene. The first flexible substrate may be optically clear, pigmented or modified to be electrically dissipative. In the latter case, the first flexible substrate may include an electrically conductive material (e.g., carbon black, or vanadium pentoxide) that is either interspersed within the polymeric material or is subsequently coated onto the first flexible substrate. The electrically conductive material allows an electric charge to dissipate throughout the flexible carrier tape and preferably to the ground. This feature

may prevent damage to components contained within the flexible carrier tape due to an accumulated static electric charge.

[0048] A first flexible substrate of the present disclosure can be manufactured in the form of a polymer film. In embodiments of the present disclosure where the one or more sidewalls have a length that coincides with a thickness of the first flexible substrate, the first flexible substrate can be manufactured by forming a plurality of pocket openings and holes for transferring the flexible carrier tape in the polymer film obtained by blending a copolymer composition (which can comprise, for example, polypropylene (PP), polystyrene (PS) and a styrene-butadiene copolymer). The pocket openings for receiving materials to be transported, and the holes for transferring the flexible carrier tape may be formed by punching the polymer film. In other words, the holes for transferring the flexible carrier tape may be formed by punching the polymer film so that the polymer film is perforated. Meanwhile, the pocket openings for receiving materials to be transported may be formed by punching the polymer film in such a manner that the polymer film is perforated with pocket openings portions.

[0049] In another embodiment of the present invention, the first flexible substrate can be manufactured by blending the copolymer composition of, for example, polymer materials comprising polypropylene (PP), polystyrene (PS) and a styrene-butadiene copolymer, and extruding it while forming pocket openings for receiving materials to be transported and holes for transferring the carrier tape. For example, in the process of extrusion, the blended copolymer composition of polymer materials extruded in a melt film state may be wound on a rounded tool having pocket shapes to form pocket openings for receiving materials to be transported, and after a few seconds (3 to 5 seconds) it may be punched at its lateral side to form holes for transferring the flexible carrier tape. In this case, forming pocket openings and holes for transferring the flexible carrier tape is performed simultaneously with the extrusion of film, the process becomes simple and the productivity can increase.

[0050] The second flexible substrate may be formed of any of the materials listed above for forming the first flexible substrate. The second flexible substrate provides the bottom walls for the plurality of pockets, and typically the bottom walls will include an adhesive that is either a pressure-sensitive adhesive such as an acrylate material, or a heat-activated adhesive such as ethylene vinyl acetate copolymer. The adhesive can aid in holding the

components in the correct orientation and position when placed into the pocket and against the bottom wall.

[0051] The first and second flexible substrates can be attached to each other. In some embodiments, where a plurality of holes (e.g., 105, 705, or 805) is included in the first flexible substrate for transporting the flexible carrier tape, the second flexible substrate should not cover the plurality of holes. The first and second flexible substrates can be attached to each other by any suitable means, including, for example, being adhered by a pressure-sensitive adhesive (e.g., an acrylate material) or other suitable adhesive. The first and second flexible substrates should be attached in such a manner that a path for a drawing a vacuum on the plurality of pockets via the gaps is not compromised.

[0052] The plurality of spacers (e.g., 701, 703, 801, 803) define the gap between the one or more sidewalls and the bottom wall of each pocket, and the individual spacers can have any suitable geometry, including those shown in FIGS. 7A-7C and 8A-8B. The plurality of spacers can be integral to the first flexible substrate or the second flexible substrate, or the first flexible substrate can include a first plurality of spacers, and second flexible substrate can include a second plurality of spacers. In some embodiments, at least some of the spacers can be integral to pocket sidewalls (when the sidewalls extend beyond the thickness of either the first flexible substrate or the second flexible substrate).

[0053] The plurality of spacers (for example, spacers 701 and 703 shown in FIGS. 7A-7C) can be in the form of “pedestals” spaced apart along a longitudinal axis of the first flexible substrate (e.g., along longitudinal axis 80 in FIG. 7A). In some embodiments, these “pedestals” can be conveniently spaced apart by a distance of about 2 mm between any two pedestals. In an embodiment, individual pedestals can have a width selected to be about 2 mm. However, the distance between pedestals and width of pedestals, or even the shape of the pedestals, can be selected to be suitable for the size of components being carried in the flexible carrier tape of the present disclosure.

[0054] When the plurality of spacers is integral with either the first or second flexible substrates, individual spacers can be formed during manufacture of the respective flexible substrate by any suitable process including, for example, stamping, thermoforming, an extrusion process, or combinations of these operations.

[0055] An important role of the plurality of spacers is to define and maintain a gap between one or more of the sidewalls and the bottom wall in each pocket in the plurality

of pockets. The gap serves as a path for a vacuum to be drawn in each pocket. As mentioned earlier, a hole or slit need not be formed in the bottom wall of the pocket, and gap suffices to provide a path for the vacuum to be drawn.

[0056] A suitable distance for the gap defined by the one or more side walls and the bottom wall is on the order of about 0.1 mm. The gap should not be large enough to cause any functional problem where components drop out from the flexible carrier tape, while still being sufficiently large to let vacuum be applied to the plurality of pockets via the gaps. FIGS. 8A and 8B give an example of gap 860 defined by one or more sidewalls 820 and bottom wall 855, where component T will not drop out of pocket 810 through gap 860, especially once flexible cover layer 881 is applied. In other words, gap 860 is selected to at least be smaller than a component T.

[0057] An overall thickness of the flexible carrier tape of the present disclosure will largely be guided by a thickness of the component T to be carried in the flexible carrier tape. It is achievable to accommodate a component of a thickness, for example, of about 0.1 mm without leaving extra vertical room in the pocket for the component to flip or otherwise be dislodged within the pocket once covered with a flexible cover layer.

[0058] In some embodiments, a flexible carrier tape of the present disclosure includes a flexible cover layer. For example, FIG. 8B shows a flexible cover layer 881 attached to first flexible substrate 870 after a component T has been placed into pocket 810. The flexible cover layer may be formed of any polymeric material that has a sufficient gauge and flexibility to permit it to be wound about the hub of a storage reel. A variety of polymeric materials may be used including, but not limited to, polyester (e.g., glycol-modified polyethylene terephthalate), polycarbonate, polypropylene, polystyrene, polyvinyl chloride, and acrylonitrile-butadiene-styrene. As with the first flexible substrate, flexible cover layer may be optically clear, pigmented or modified to be electrically dissipative. For example, flexible cover layer 881 can be transparent, to permit visualization of components placed within the flexible carrier tape, although this is not a requirement.

[0059] In some embodiments, at least a portion of the flexible cover layer is removable, to permit automated removal of components from the flexible carrier tape. For example, in some embodiments a central strip of the flexible cover layer can be peeled back during an automated process to sequentially expose pockets for automated removal of components

carried in the flexible carrier tape. In some other embodiments, the flexible cover layer can be releasably secured to the upper surface of the first flexible substrate so that it can subsequently be removed to access the stored components. For example, a pressure sensitive adhesive (e.g., an acrylate material), or a heat-activated adhesive such as an ethylene vinyl acetate copolymer may be used to adhere the flexible cover layer to the upper surface of the first flexible substrate. The flexible cover layer should not cover any spaced apart holes (e.g., 105, 505, 705, or 805), if present, for transporting the flexible carrier tape.

[0060] In embodiments including those schematically represented in FIGS. 7A-7C and 8A-8B, an advantage of the design includes being able to apply a vacuum to the pockets even after a flexible cover layer is applied. The flexible cover layer can be disposed on the plurality of spacers, and in this way an air-slot gap can be maintained between the individual spacers (e.g., 701, 703, 801, or 803), thus allowing a path to apply a vacuum from sides of the flexible carrier tape, if desired.

[0061] The flexible carrier tapes of the present disclosure are particularly useful in the electronics industry for transporting and delivering electronic components such as memory chips, integrated circuit chips, resistors, connectors, dual in-line processors, capacitors, gate arrays, capacitors, etc. However, the carrier tapes of the invention may also be used to transport other small components that are typically delivered to precision placement machines such as watch springs, small screws, surface mount electric component shields, and the like.

Various items are described that are articles of the present disclosure.

Item 1. A flexible carrier tape for transporting a plurality of components, comprising a plurality of pockets spaced apart along a longitudinal axis of the flexible carrier tape, each pocket comprising: one or more sidewalls defining a pocket opening for insertion of a component, the pocket opening having a perimeter; and a bottom wall opposite the pocket opening; the one or more side walls and the bottom wall defining a gap therebetween that extends along at least 50% of the perimeter.

Item 2. The flexible carrier tape of item 1, wherein the gap extends along at least 60% of the perimeter of the pocket opening.

Item 3. The flexible carrier tape of item 1, wherein the gap extends along at least 70% of the perimeter of the pocket opening.

Item 4. The flexible carrier tape of item 1, wherein the gap extends along at least 80% of the perimeter of the pocket opening.

5 Item 5. The flexible carrier tape of item 1, wherein the gap extends along at least 90% of the perimeter of the pocket opening.

Item 6. The flexible carrier tape of item 1, wherein the gap extends along the entire perimeter of the pocket opening.

10 Item 7. The flexible carrier tape of any one of items 1 to 6, wherein the flexible carrier tape comprises a first flexible substrate extending along the longitudinal axis of the flexible carrier tape and disposed on a second flexible substrate extending along the longitudinal axis of the flexible carrier tape, the one or more sidewalls of each pocket being formed in the first flexible substrate and extending from a top surface of the first flexible substrate toward a top surface of the second flexible substrate, the second
15 substrate comprising the bottom wall of each pocket, a plurality of spacers defining the gap between the one or more side walls and the bottom wall of each pocket.

Item 8. The flexible carrier tape of item 7, wherein at least a portion of the one or more sidewalls extends beyond a bottom surface of the first flexible substrate.

20 Item 9. The flexible carrier tape of item 7, wherein the plurality of spacers are integral to the first or second flexible substrates.

Item 10. The flexible carrier tape of item 7, wherein at least one sidewall in the one or more sidewalls of each pocket is longer than a thickness of the first flexible substrate.

Item 11. The flexible carrier tape of item 7, wherein each sidewall in the one or more sidewalls of each pocket is longer than a thickness of the first flexible substrate.

25 Item 12. A flexible carrier tape for transporting a plurality of components: a first flexible substrate extending along a longitudinal axis of the flexible carrier tape and defining a plurality of through openings, each through opening being defined by one or more side walls that extend from a top surface of the first flexible substrate beyond a bottom surface of the first flexible substrate; a second flexible substrate extending along the longitudinal
30 axis of the carrier tape and disposed below the first flexible substrate; and a plurality of spacers defining a gap between the one or more side walls of each through opening and a

top surface of the second flexible substrate, the gap extending along at least 50% of a perimeter of the through opening.

Item 13. The flexible carrier tape of item 12, wherein the gap extends along at least 60% of the perimeter of the through opening.

5 Item 14. The flexible carrier tape of item 12, wherein the gap extends along at least 70% of the perimeter of the through opening.

Item 15. The flexible carrier tape of item 12, wherein the gap extends along at least 80% of the perimeter of the through opening.

10 Item 16. The flexible carrier tape of item 12, wherein the gap extends along at least 90% of the perimeter of the through opening.

Item 17. The flexible carrier tape of item 12, wherein the gap extends along the entire perimeter of the through opening.

15 Item 18. The flexible carrier tape of any one of items 12 to 17, wherein the spacers are integral to the second flexible substrate and are regularly arranged along the longitudinal axis of the flexible carrier tape, the bottom surface of the first flexible substrate being attached to top surfaces of the plurality of spacers.

20 Item 19. The flexible carrier tape of any one of items 12 to 17, wherein the spacers are integral to the first flexible substrate and are regularly arranged along the longitudinal axis of the flexible carrier tape, the top surface of the second flexible substrate being attached to bottom surfaces of the plurality of spacers.

25 **[0062]** While the specification has described in detail certain exemplary embodiments, it will be appreciated that those skilled in the art, upon attaining an understanding of the foregoing, may readily conceive of alterations to, variations of, and equivalents to these embodiments. Various exemplary embodiments have been described. These and other embodiments are within the scope of the following claims.

CLAIMS:

1. A flexible carrier tape for transporting a plurality of components, comprising a plurality of pockets spaced apart along a longitudinal axis of the flexible carrier tape, each pocket comprising:

one or more sidewalls defining a pocket opening for insertion of a component, the pocket opening having a perimeter; and

a bottom wall opposite the pocket opening;

the one or more side walls and the bottom wall defining a gap therebetween that extends along at least 50% of the perimeter.

2. The flexible carrier tape of claim 1, wherein the gap extends along at least 60% of the perimeter of the pocket opening.

3. The flexible carrier tape of claim 1, wherein the gap extends along at least 70% of the perimeter of the pocket opening.

4. The flexible carrier tape of claim 1, wherein the gap extends along at least 80% of the perimeter of the pocket opening.

5. The flexible carrier tape of claim 1, wherein the gap extends along at least 90% of the perimeter of the pocket opening.

6. The flexible carrier tape of claim 1, wherein the gap extends along the entire perimeter of the pocket opening.

7. The flexible carrier tape of any one of claims 1 to 6, wherein the flexible carrier tape comprises a first flexible substrate extending along the longitudinal axis of the flexible carrier tape and disposed on a second flexible substrate extending along the longitudinal axis of the flexible carrier tape, the one or more sidewalls of each pocket being formed in the first flexible substrate and extending from a top surface of the first flexible substrate toward a top surface of the second flexible substrate, the second

substrate comprising the bottom wall of each pocket, a plurality of spacers defining the gap between the one or more side walls and the bottom wall of each pocket.

8. The flexible carrier tape of claim 7, wherein at least a portion of the one or more sidewalls extends beyond a bottom surface of the first flexible substrate.

9. The flexible carrier tape of claim 7, wherein the plurality of spacers are integral to the first or second flexible substrates.

10. The flexible carrier tape of claim 7, wherein at least one sidewall in the one or more sidewalls of each pocket is longer than a thickness of the first flexible substrate.

11. The flexible carrier tape of claim 7, wherein each sidewall in the one or more sidewalls of each pocket is longer than a thickness of the first flexible substrate.

12. A flexible carrier tape for transporting a plurality of components:

a first flexible substrate extending along a longitudinal axis of the flexible carrier tape and defining a plurality of through openings, each through opening being defined by one or more side walls that extend from a top surface of the first flexible substrate beyond a bottom surface of the first flexible substrate;

a second flexible substrate extending along the longitudinal axis of the carrier tape and disposed below the first flexible substrate; and

a plurality of spacers defining a gap between the one or more side walls of each through opening and a top surface of the second flexible substrate, the gap extending along at least 50% of a perimeter of the through opening.

13. The flexible carrier tape of claim 12, wherein the gap extends along at least 60% of the perimeter of the through opening.

14. The flexible carrier tape of claim 12, wherein the gap extends along at least 70% of the perimeter of the through opening.

15. The flexible carrier tape of claim 12, wherein the gap extends along at least 80% of the perimeter of the through opening.

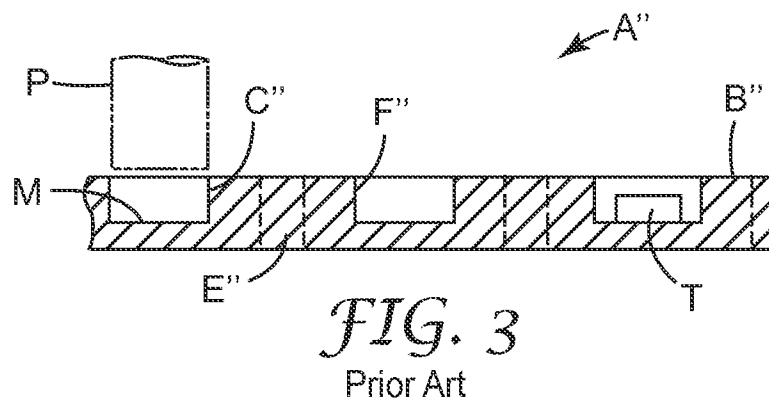
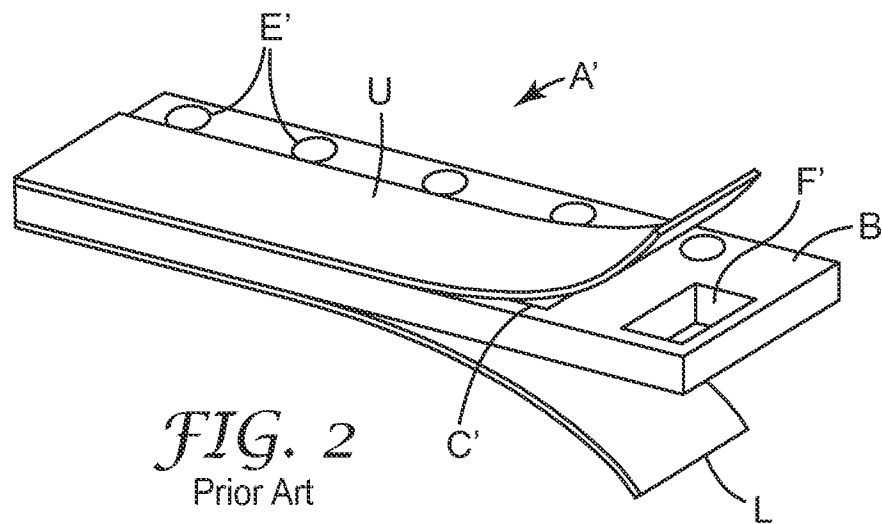
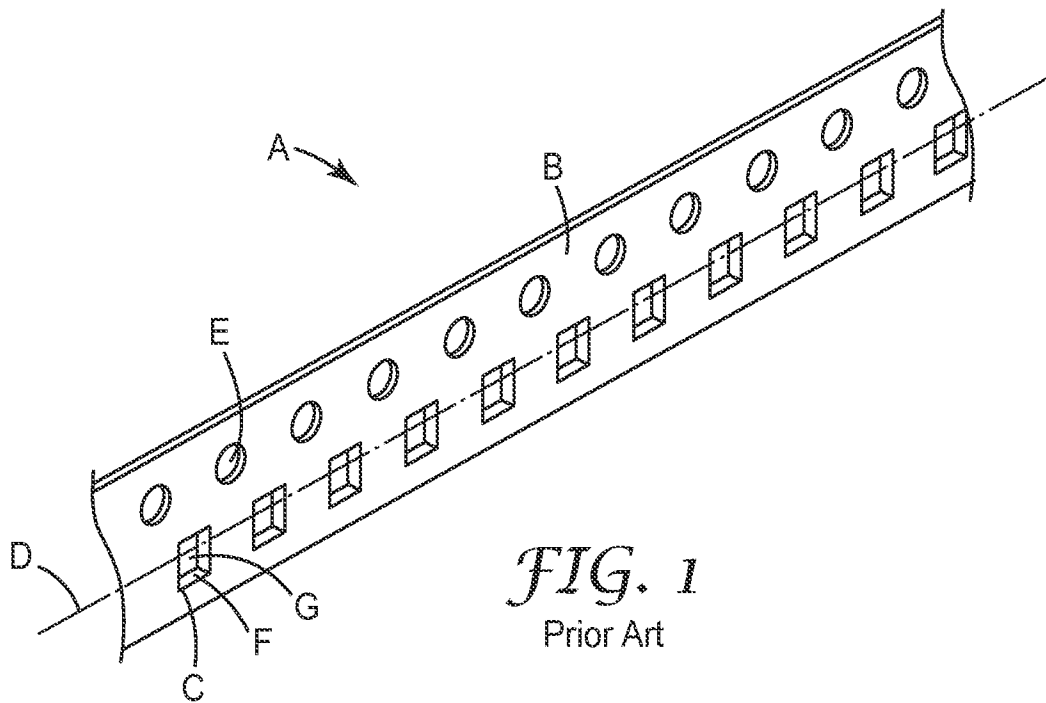
16. The flexible carrier tape of claim 12, wherein the gap extends along at least 90% of the perimeter of the through opening.

17. The flexible carrier tape of claim 12, wherein the gap extends along the entire perimeter of the through opening.

18. The flexible carrier tape of any one of claims 12 to 17, wherein the spacers are integral to the second flexible substrate and are regularly arranged along the longitudinal axis of the flexible carrier tape, the bottom surface of the first flexible substrate being attached to top surfaces of the plurality of spacers.

19. The flexible carrier tape of any one of claims 12 to 17, wherein the spacers are integral to the first flexible substrate and are regularly arranged along the longitudinal axis of the flexible carrier tape, the top surface of the second flexible substrate being attached to bottom surfaces of the plurality of spacers.

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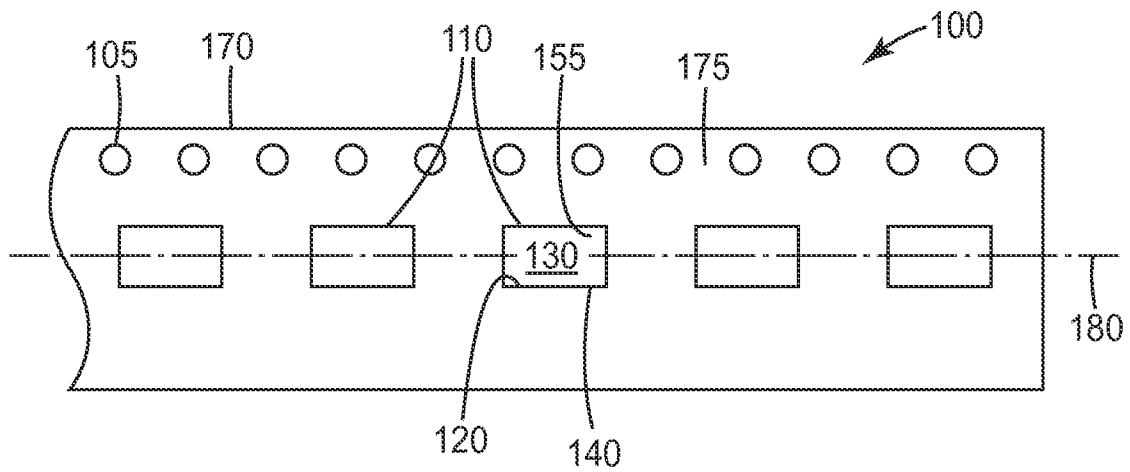


FIG. 4

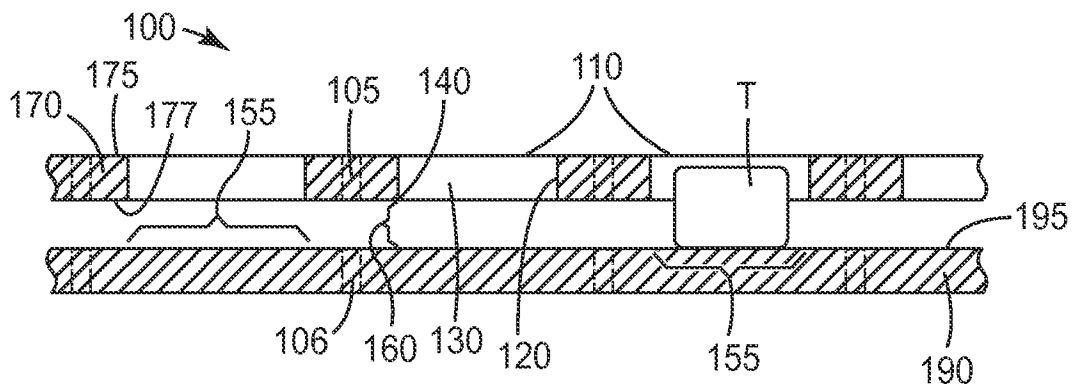


FIG. 5A

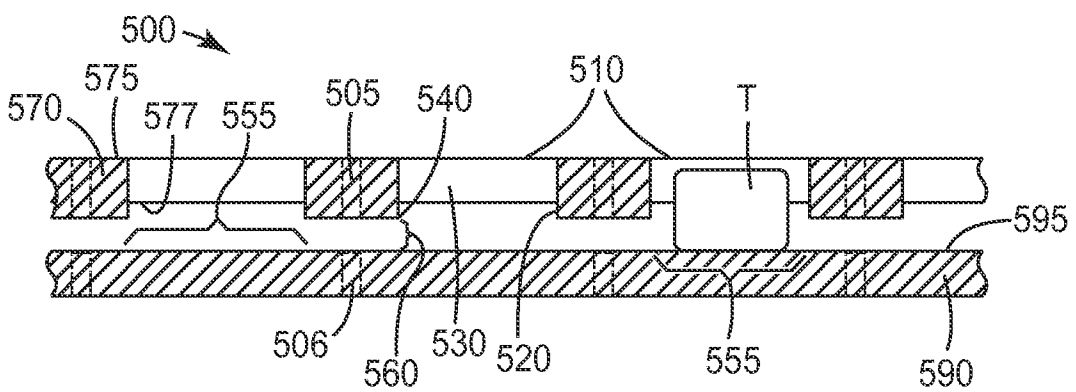


FIG. 5B

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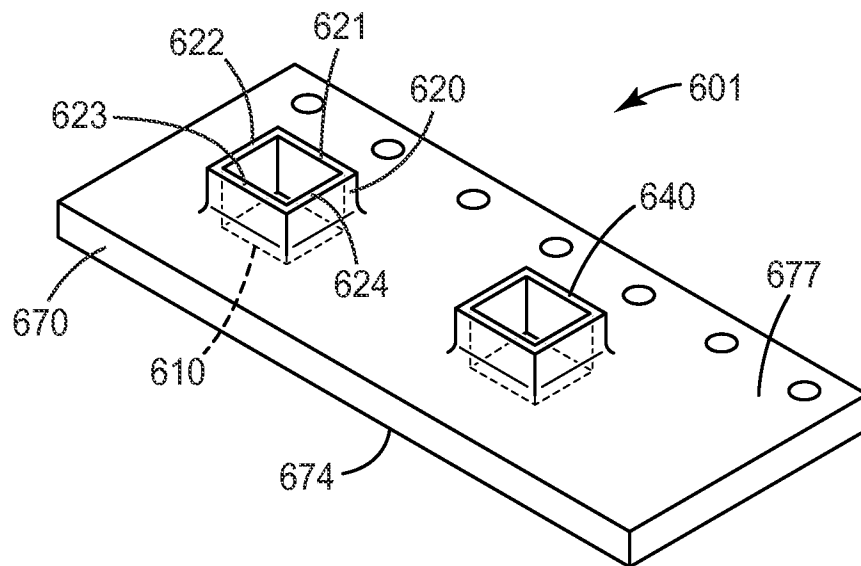


FIG. 6A

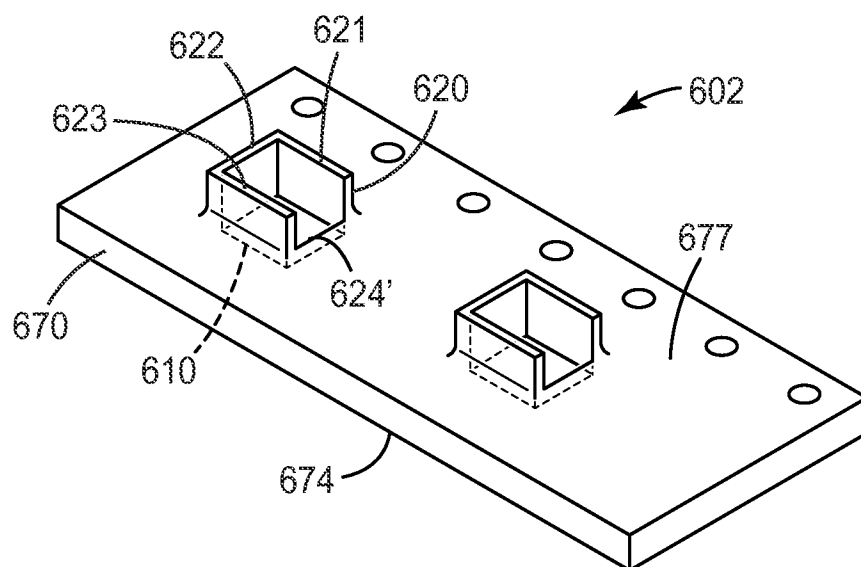


FIG. 6B

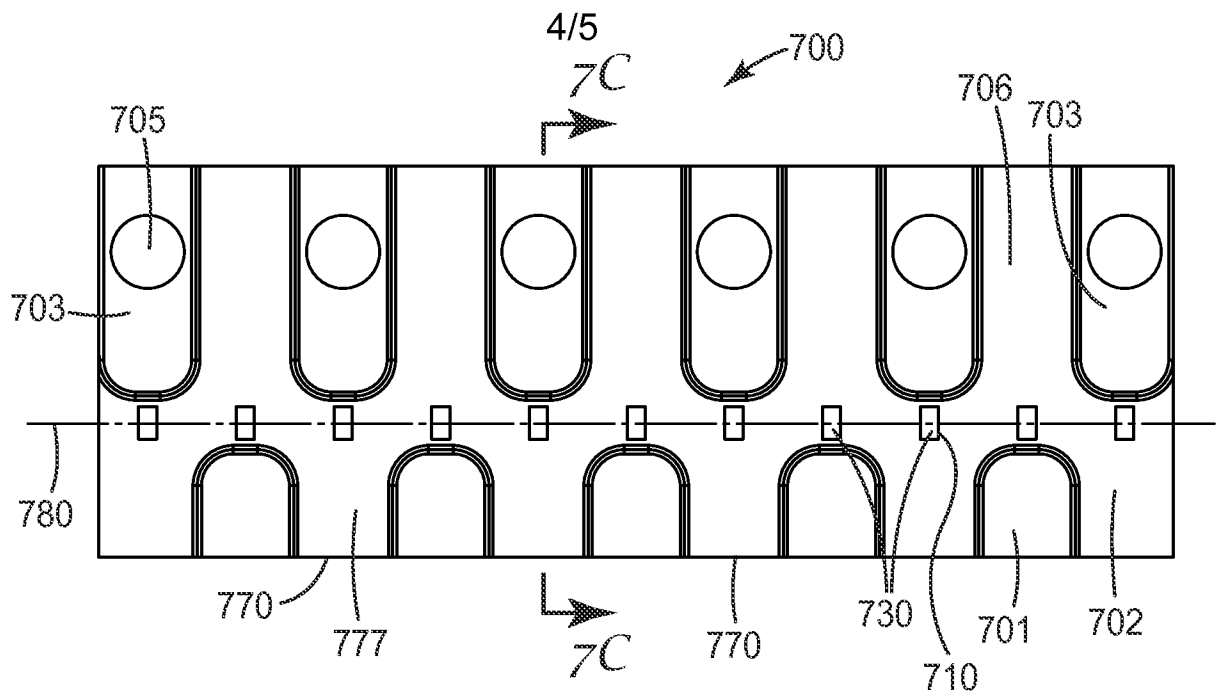


FIG. 7A

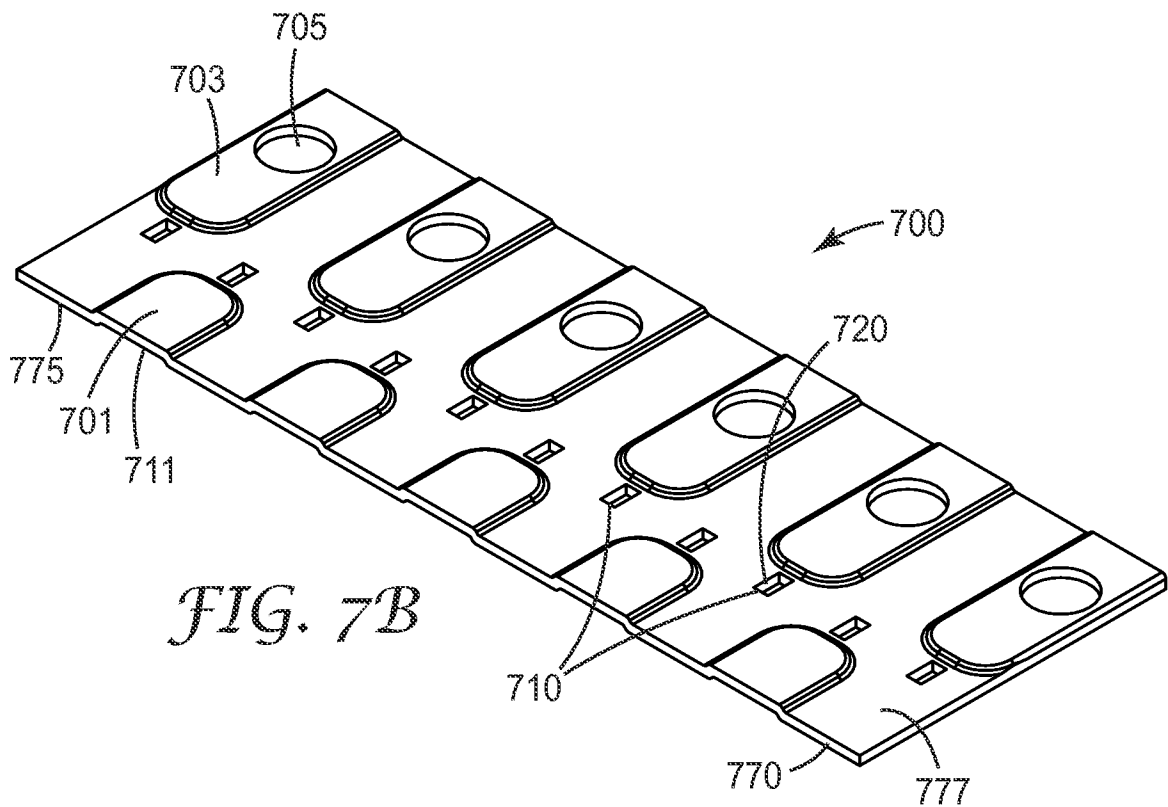


FIG. 7B

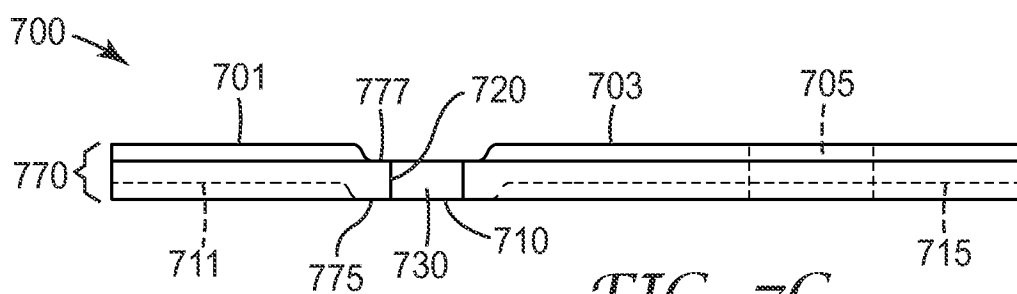


FIG. 7C

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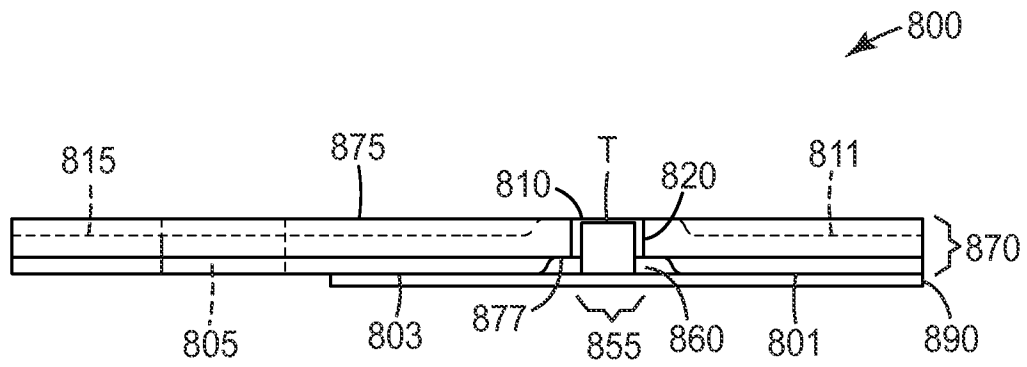


FIG. 8A

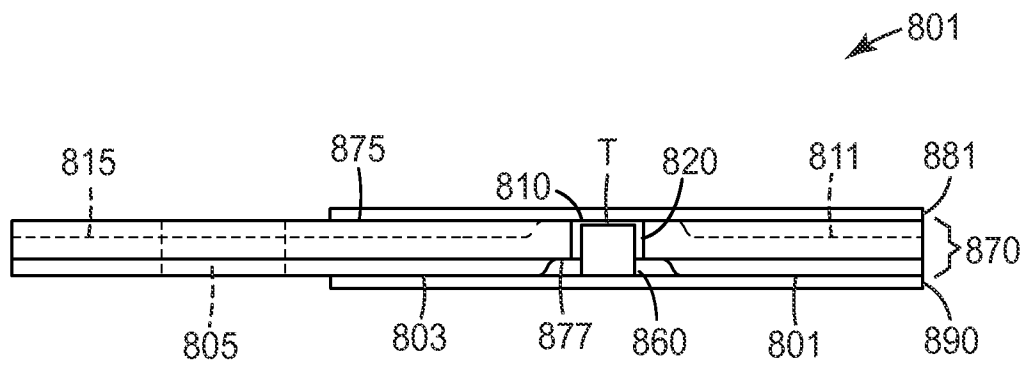


FIG. 8B

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2014/049132

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B65D 73/02 (2014.01)

CPC - B65D 73/02 (2014.10)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) - B65B 11/00; B65D 73/02, 85/00, 85/30, 85/86 (2014.01)

CPC - B65D 73/02 (2014.10)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 206/713, 714, 716 (keyword delimited)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PatBase, Orbit, Thomson Innovation Derwent, Google Patents, Google Scholar, Engineering Village

Search terms used: carrier, tape, web, substrate, pocket, cavity, recess, gap, spacer, sidewall

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 7,296,963 B2 (SOTO) 20 November 2007 (20.11.2007) entire document	1-19
A	US 2012/0037538 A1 (TOKOI et al) 16 February 2012 (16.02.2012) entire document	1-19
A	US 4,657,137 A (JOHNSON) 14 April 1987 (14.04.1987) entire document	1-19

☐ Further documents are listed in the continuation of Box C.

* Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

21 October 2014

Date of mailing of the international search report

28 NOV 2014

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