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(54) **Pre-assembled slidable fastener device and method of mounting**

(57) The present invention relates to a pre-assembled slidable fastening device comprising first and second fastening elements, each of which having a base sheet and a plurality of parallel ribs projecting from a first major surface of the base sheet. The ribs of the first and second fastening elements are engaged with each other so as to provide a holding power of at least 23 N/cm² in a direction perpendicular to the first major sur-

faces of the base sheets of the first and second fastening elements but allow sliding movement of the fastening elements relative to each other in at least one direction a plane parallel to the first major surface of the base sheet. The pre-assembled slidable fastening device furthermore comprises attachment means provided in a first and/or second fastening element(s) at a surface opposite the first major surface(s) thereof.

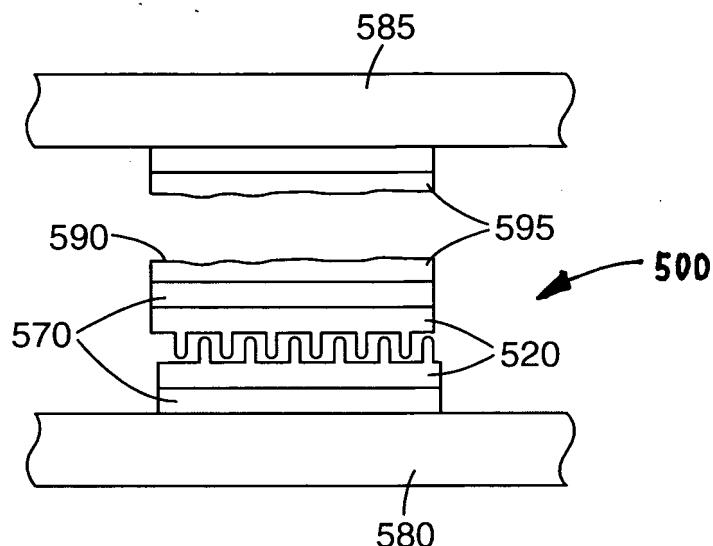


Fig. 8

Description

TECHNICAL FIELD

[0001] The present invention relates to a pre-assembled slidable fastener device or mounting device providing movement of two or more substrates relative to one another in at least one direction, and a method of mounting a substrate, particularly in sheet form, like a headliner, to another substrate, like the roof of an automobile.

BACKGROUND ART

[0002] In known applications, motion of an assembly or substrate along one axis is typically provided by ball bearing slides, or by creating a hole in the assembly and sliding it along a suspended rod or wire. This simple type of motion can be created also by sliding two engaged lengths of reclosable fastener film having ribs relative to one another along the rib direction, such as the self-mating fasteners as described in U.S. Patent No. 6,367,128.

[0003] Self-mating fasteners, such as those described in U.S. Patent No. 6,367,128, comprise a base sheet and a multiplicity of parallel, narrowly spaced, elastically deformable ribs with at least one flange projecting from a major surface of the base sheet. The width and spacing of the ribs are chosen so that when the ribbed surface of the fastener is pressed against an identical ribbed surface in order to engage them, the ribs of one surface will be accommodated between the ribs of the other surface, and ribs on the two surfaces can deform and their flanges move past one another to engage and hold the surfaces together.

[0004] Similar fasteners of this type are described, e.g., in U.S. Patent Nos. 6,546,604, 6,588,074, and 5,119,531.

[0005] Another engaging fastener member and fastener is known from WO 94/09279. According to one embodiment, this fastener member comprises a base section and a plurality of parallel engaging strips projecting from and extending longitudinally of the base section. The engaging strips each have a vertical portion adjoining the base section, a head portion adjoining the vertical portion, and two end faces. The engaging strips are adapted for engagement with a projecting head portion of an opposed fastener member, and the head portion of at least one of the engaging strips has a plurality of transverse slots formed therein. The slots formed through the head portion of the engaging strips guide the projecting head portion of the opposed fastener member and facilitate the compression engagement of the head portions. In another embodiment of WO 94/09279, the engaging fastener member comprises a base section and a plurality of parallel engaging strips projecting from and extending longitudinally of the base section. The engaging strips each have a vertical portion adjoining the base section, a head portion adjoining the vertical portion, and two end faces. The engaging strips

are adapted for engagement with a projecting head portion of an opposed fastener member, and the end faces are inclined with respect to the base section to facilitate sliding engagement of the fastener member with an opposed fastener member.

[0006] It would now be desirable to develop further engaging fasteners, preferably fasteners in which the generally conflicting requirements of holding power on the one hand and ease of connection on the other hand are mitigated and the fastener combines good holding power with ease of connection. Typically, for good holding power against pull and peel forces, the fastener members must engage intensely and strongly. If, however, the fasteners are engaged by applying a compressive force, this process requires a weaker rib interaction to be feasible which is contrary to the holding power requirement. Compression engagement thus provides a relatively loose interaction among the ribs which may cause rattling, noise etc. It would be desirable to find fasteners in which the opposing requirements are reconciled at least from an end-user's point of view.

SUMMARY OF THE INVENTION

[0007] In one aspect of the invention, there is provided a pre-assembled slidable fastening device comprising a first fastening element having a base sheet and a plurality of parallel ribs projecting from a first major surface of the base sheet, and a second fastening element having a base sheet and a plurality of parallel ribs projecting from a first major surface of the base sheet. The ribs of the first and second fastening elements are engaged with each other so as to provide a holding power of at least 23 N/cm² in a direction perpendicular to the first major surfaces of the base sheets of the first and second fastening elements but allow sliding movement of the fastening elements relative to each other in at least one direction in a plane parallel to the first major surfaces of the base sheets. The pre-assembled slidable fastening device of the invention furthermore comprises attachment means provided on the first and/or second fastening element(s) at a surface opposite the first major surface(s) thereof. Typically, these attachments should allow for easy engagement of the pre-assembled slidable fastening device with a substrate in connection with which the device is to be used.

[0008] Preferably, the holding power of the engaged ribs of the first and second fastening elements is at least 30 N/cm², and more preferably at least 40 N/cm². The holding power may be as high as, for example, 60 N/cm².

[0009] According to one embodiment of the invention the pre-assembled slidable fastening device furthermore comprises at least one slider having a base sheet, a plurality of parallel ribs projecting from a first major surface of the base sheet to form a first bearing piece, and a plurality of parallel ribs projecting from an opposite second major surface of the base sheet to form a second

bearing piece. The at least one slider is interposed between the first fastening element and the second fastening element such that the ribs of the first bearing piece are engaged with the ribs of the first fastening element and the ribs of the second bearing piece are engaged with the ribs of the second fastening element so as to allow sliding movement of the fastening elements relative to each other in at least one direction in a plane parallel to the base sheets. The slider may be adapted such that one-dimensional motion is provided, e.g., by providing the ribs of the first and second bearing pieces parallel to each other and also parallel to the ribs of the first and second fastening elements. For two-dimensional motion of the first and second fastening elements the ribs of the first bearing piece are not parallel to the ribs of the second bearing piece. Generally, for two-dimensional motion, the ribs of the second bearing piece are essentially perpendicular to the ribs of the first bearing piece.

[0010] Two-dimensional motion can also be achieved without an intermediate slider when the ribs are intermittently cut to allow slidability along a direction opposite or perpendicular to the direction of the ribs.

[0011] Another aspect of the present invention relates to an automotive headliner having at least one attachment portion for mounting the headliner to an automobile, wherein the attachment portion is provided with at least one pre-assembled slidable fastening device as described above. The overall holding force of the fastening device(s) provided at the head liner is preferably at least 120 N, more preferably at least 150 N, and even more preferably at least 170 N.

[0012] A further aspect of the invention concerns an automobile comprising a passenger compartment with a roof being provided with a headliner, wherein the headliner is attached to the roof by means of at least one pre-assembled slidable fastening device as described above. Preferably, the headliner is attached to the roof by a plurality of these fastening devices and the fastening devices provide an overall holding force of at least 120 N, more preferably 150 N, and even more preferably at least 170 N.

[0013] Yet another aspect of the invention relates to the use of the above described pre-assembled slidable fastening device for attaching automotive parts, particularly automotive trims, seat covers and headliners, to an automobile.

[0014] A still further aspect of the invention relates to a method of mounting a first substrate, e.g., a headliner, to a second substrate, e.g., a roof of an automobile, which method comprises the steps of providing a first substrate having at least one attachment portion, attaching at least one pre-assembled slidable fastening device as described above to each attachment portion of the first substrate by means of the attachment means of the first or second fastening element, attaching the first substrate with the fastening device to the second substrate by means of the attachment means of the oth-

er of the first and second fastening elements, positioning the first substrate relative to the second substrate by moving the first substrate relative to the second substrate, and fixing the position of the substrates relative to each other.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The present invention will be further described with reference to the accompanying drawings, in which:

Fig. 1 is a perspective and cross-sectional view of one embodiment and of the pre-assembled fastening device of the invention allowing two-dimensional movement.

Fig. 2 is a top plan view of another embodiment of the pre-assembled slidable fastening device of the invention having a plurality of slidable fastening elements engaged with a plurality of sliders.

Fig. 3 is a perspective view of a pre-assembled slidable fastening device according to an embodiment according to the invention having tabs for limiting movability.

Fig. 4 is a perspective view of a pre-assembled slidable fastening device according to another embodiment of the invention.

Fig. 5 is a perspective view of a pre-assembled slidable fastening device on a substrate in accordance with an embodiment of the invention.

Fig. 6 is a perspective view of an embodiment of the pre-assembled slidable fastening device of the invention with rotational elements.

Fig. 7 shows a cross-sectional view of a fastening element that may be used in the pre-assembled slidable fastening device of the invention.

Fig. 8 is a schematic side view of one embodiment of the pre-assembled slidable fastening device of the invention attached to a first substrate allowing one-dimensional movement.

Fig. 9 is a view similar to that of Fig. 8 in which the first substrate with the pre-assembled slidable fastening device have been attached to a second substrate.

Fig. 10 is a microphotograph of a fastening element that can be used for the pre-assembled slidable fastening device of the invention.

DETAILED DESCRIPTION

[0016] The present invention provides a pre-assembled slidable fastening device using mating mechanical fasteners between at least two substrates or surfaces. As used herein the term "mating mechanical fastener" refers to fasteners comprising a base sheet with a plurality of parallel ribs with at least one flange projecting from a major surface of the base sheet. Preferably the ribs are elastically deformable. As used herein, the term "rib" includes both continuous and discontinuous pro-

jections from a base sheet, such as the continuous rail structure disclosed in U.S. Patent No. 6,367,128, and the discontinuous series of closely spaced projections of varying shapes disclosed in U.S. Patent Nos. 5,077,870 and 4,290,174. The width and spacing of the ribs are chosen so that when the ribbed surface of the fastener is engaged with a mating ribbed surface, the ribs of one surface will be accommodated between the ribs of the other surface. Self-mating mechanical fasteners are mating fasteners in which the ribbed surfaces are identical.

[0017] This fastening device allows continuous translational movement of one substrate along at least one axis in a plane, i.e., the X-Y plane, relative to the other substrate, while preferably preventing substantial motion in a third planar direction, i.e., the Z axis. For ease of reference, the present invention can be described in reference to the X-Y-Z axes to describe motion in the relative planes. However, it should be understood that the present invention would include a fastening device with translational motion in the X-Z or Y-Z plane without limitation.

[0018] For nominal loads, typically about 15 kg, and where extreme precision is not required, with a number of repeat cycle movements that is in the hundreds or thousands, the mechanical fasteners can be interconnected to form fastening devices of the present invention which provide one dimensional or two-dimensional guided motion for minimal cost.

[0019] The present invention can also provide easy customization by an end user. For example, fastening devices laminated with a pressure sensitive adhesive as an attachment means and a liner thereon can be made available to end-users to create customized pre-assembled slidable fastening devices with no need of special tools or equipment.

[0020] As shown in FIG. 1, an embodiment of the pre-assembled slidable fastening device 10 of the present invention permits continuous translational movement of two slidable fastening elements 20 parallel to their surfaces in the X-Y plane, i.e., two-dimensional motion. This two-dimensional or biaxial motion is created by a slider 60 that is capable of engaging with the slidable fastening elements 20. The two slidable fastening elements 20 are, e.g., fastener films of varying lengths and width with a ribbed surface on one side. The slider 60 is also constructed with one or more fastener films 30 having a ribbed surface 40 and a flat surface 50 opposite the ribbed surface 40. The slider 60 can be any length and width but is typically smaller in dimension than slidable fastening elements 20. The slider 60 may be created by attaching the flat surface 50 of one bearing piece to the flat surface 50 of another bearing piece such that the ribbed surfaces 40 are not parallel for two-dimensional movement. Alternatively, the slider 60 may be formed as a single piece, for example, by injection molding.

[0021] In FIG. 1, the slider 60 is provided such that

the ribbed surfaces 40 on each bearing piece are perpendicular to each other. However, in alternate embodiments the ribbed surfaces on each bearing piece can range between 0 and 180 degrees from parallel to each other. The bearing pieces can be laminated to one another using an adhesive, or other means of attaching flat surfaces. The opposing ribbed surfaces 40 of the slider 60 are engaged with the two slidable fastening elements 20 to create the device 10. At the flat surface opposite the ribbed surface 40 of the first and/or second fastening element(s) attachment means 70 are provided to attach the device to a substrate.

[0022] In FIG. 2, an embodiment of the present invention is provided using multiple sliders 60 (shown by dashed lines) engaged with multiple slidable fastening elements 20.

[0023] In an alternate embodiment shown in FIG. 3, the flat surface of slidable fastening elements 110 and 112 are laminated to rigid substrates 120 which may be the same or different. A slider 60, similar to the one shown in FIG. 1, is located between the rigid substrates 120. The ribbed surfaces of slider 60 are engaged on opposite sides with the ribbed surfaces of slidable fastening elements 110 and 112. The slider 60 engaged with the slidable fastening elements 110 and 112 allows biaxial motion of the rigid substrates 120 in the X-Y plane, wherein movement perpendicular to the plane of the rigid substrates 120 is preferably substantially restricted due to the high holding power or disengagement forces between slider 60 and fastening elements 110, 112. More than one slider 60 can be included to facilitate movement of rigid substrates 120 relative to one another. In alternate embodiments not shown, one or more of the substrates may be flexible and/or curved.

[0024] If it is desired to limit the motion of the substrates as shown in FIG. 3, e.g., in order to prevent disengagement of the pre-assembled slidable fastening device, then a cross direction tab 160 of fastener film can be placed strategically on slidable fastening element 110 and/or 112. The tab 160 is constructed of sufficient thickness to prevent further movement of the substrate. The tab 160 located on slidable fastening element 110 stops motion of the opposite rigid substrate 120 when the second slidable fastening element 112 contacts the tab 160.

[0025] Optionally, to limit translational motion of the slidable fastening element 112 machine direction tabs 170 are provided. As shown, machine direction tabs 170 comprise two roughly similar pieces of fastener film. Machine direction tabs 170 form spacers that stop slidable fastener 112. The tabs 170 contact raised edge 180 on slidable fastening element 110 to prevent tabs 170 from moving beyond edge 180. Alternatively, multiple cross direction tabs 160 and machine direction tabs 170 can be used on slidable fastening elements 110 and 112 either together or alone.

[0026] Other means exist to provide stops of relative motion of the substrates and/or prevent disengagement.

For instance, holes may be placed through substrates laminated with fastener film and a pin positioned through a hole in the upper substrate which is aligned with a hole in the lower substrate. As another example, the ribs can be offset at certain points to limit or prevent movement, for example, as disclosed in U.S. Patent No. 5,119,531. In addition, deformations of the rib structure are also useful to limit relative movement of the fastening elements in the bearing assembly. One such deformation structure, or dam, can be conveniently formed by contact of the ribbed surface of an extruded web with projections on a heated wheel, whereby longitudinally spaced portions of the ribbed structure are periodically pressed down and accumulate as a raised structure or dam.

[0027] In certain embodiments, a less severe deformation in the ribbed structure (for example, a notch, slit, bulge, edge, or curve) can provide a temporary cessation of axial movement. The deformation can be overcome, and axial motion resumed, with additional application of force without disengaging the fastening elements. Examples of such deformations include those described in U.S. Patent No. 5,119,531.

[0028] In some embodiments, these deformations may also affect engagement and/or disengagement, for example by controlling or limiting engagement and/or disengagement between deformations. The deformation can be overcome, and engagement or disengagement resumed, with additional application of force without disengaging the fastening elements.

[0029] In an alternate embodiment shown in FIG. 4, the flat surfaces of slidable fastening elements 210 and 212 are laminated to rigid substrates 220. On the side of rigid substrates 220 opposite the slidable fastening elements, knobs 230 are attached to allow manipulation of the rigid substrates 220. A slider 240 is constructed by laminating the flat surface of bearing pieces 250 to one side of a rigid plate 251, and laminating the flat surface of bearing pieces 252 to the opposite side of rigid plate 251 such that the ribbed surface on bearing pieces 250 is perpendicular to the ribbed surface on bearing piece 252. In alternate embodiments not shown, the ribbed surfaces of 250 and 252 (and also 210 and 212) can range between 0 and 180 degrees from parallel to each other.

[0030] The ribbed surfaces of 250 and 252 of slider 240 are engaged on opposite sides with the ribbed surfaces of slidable fastening elements 210 and 212. When the two knobs 230 are grasped and manipulated to move the rigid substrates 220 relative to one another, the slider 240 engaged with the slidable fastening elements 210 and 212 allow two-dimensional motion of the rigid substrates in the X-Y planes.

[0031] In FIG. 5, a pre-assembled slidable fastening device as shown and described in FIG. 1 is constructed with the flat side of one slidable fastening element 320 attached to a cylinder 310. The slider 60 (shown with dashed lines) slides along the slidable fastening ele-

ment 320 and slidable fastening element 330 assumes continuously variable biaxial motion along the outer surface of the cylinder.

[0032] In an alternative embodiment as shown in FIG. 6, the present invention includes a rotational element to provide substrates 420 with both biaxial motion in the X-Y plane and rotational motion around a hypothetical z-axis that extends through the device. The flat surface of each slidable fastening element 410 is laminated to rigid substrate 420. A slider 440 comprising the flat surface of one bearing piece 450 laminated to the flat surface of a second bearing piece 460, such that the ribbed surfaces are not parallel, is located between the rigid substrates 420. The slider 440 further comprises a rotational element 480 that extends through the base sheet of both bearing pieces 450, 460. In FIG. 6, the rotational element is a two-part metal snap, with one part attached to 450 and the second part attached to 460. Other rotational elements are possible such as a bolt or screw assembly, rivets, an axle and bushing assembly and the like.

[0033] The ribbed surfaces of slider 440 surrounding the rotational element 480 are engaged on opposite sides with the ribbed surfaces of each slidable fastening element 410. The slider 440 engaged with the slidable fastening element 410 allow biaxial motion of the rigid substrates in the X-Y plane. In addition, the rotational element 480 in slider 440 allows rotational movement of rigid substrates 420 around a hypothetical z-axis that extends through slider 440. More than one slider 440 with rotational element 480 can also be included to facilitate movement of rigid substrates 420 relative to one another.

[0034] According to the invention, the surface of at least one base sheet opposite from the ribbed surface on the fastening elements carries attachment means that specially adapts the fastener device to attachment to another substrate. Such attachment means may include mechanical fastening structures such as hooks or loops or headed elements as described, for example, in U.S. Pat. No. 4,290,174, or various adhesive layers. The slidable device of the invention is attached to a substrate by means of the attachment means, e.g., by a separately applied adhesive.

[0035] Alternatively, the pre-assembled slidable fastening device of the present invention can be incorporated into a larger article having other functions besides fastening, e.g., a frame that could be mounted on a wall to support a picture or other display. The device can be incorporated into the larger article in various ways, e.g., by inserting an already prepared fastening device into a mold and molding the rest of the article around at least one slidable fastening element; or by configuring a mold surface with mold structure shaped to form a pre-assembled slidable fastening device of the invention. When the device of the invention is incorporated into a larger article, the term "base sheet" herein includes the structure of the article into which the slidable fastening

device is incorporated.

[0036] One or more embodiments of the device of the invention may provide any of a number of advantages and may adapt the device to a number of uses in which such advantages are desirable. For example, for use in environments where rust or corrosion is possible (such as marine environments); for use as a temporary fastener to allow repositioning prior to permanent fastening; or in cases where many cycles of assembly and disassembly are anticipated (such as in toys or games) to preclude the loss of small parts and pieces. The pre-assembled slidable fastening device can be used wherever mechanical fasteners are currently used such as for automotive, electronic, marine, transportation, point of purchase, and automotive aftermarket uses. For example, the slidable fastener is useful for attachments such as an abrasive disk to a backup pad, access panels, automotive trim, seat covers, headliners, computer monitor covers, carpet, wall decorations, pictures, signage, and displays; closures such as envelopes, mailers, boxes, and pouches; and assemblies such as cell phones, computer printers, office furniture, office panels, toys, and picture frames.

[0037] The device is not limited to a particular fastener shape, but can be realized with any fastener composed of ridges (ribs, rails, etc.) that extend in one direction with the same cross-sectional shape or alternatively ridges that are relatively long and straight. Any fastener shape that, when distributed on a base sheet, allows lateral slippage along the structural fastener elements, can be used in alternative embodiments of the present invention. See, for example, the fasteners described in U. S. Pat. Nos. 3,266,113; 4,290,174; 4,894,060; 5,119,531; 5,077,870; and 6,470,540.

[0038] Although slidable fasteners of the invention generally are used in mating pairs and self-mating pairs are preferred for ease of use, they need not be self-mating pairs, i.e. they also can be engaged with a fastener of a different shape. For example, a fastener having tall and short ribs may be engaged with a fastener in which the ribs are all the same height. A wide variety of alternative fasteners have been disclosed from which headed, engaging elements protrude. See, for example, the fasteners described in U.S. Pat. Nos. 3,266,113; 4,290,174; 4,894,060; 5,119,531; 5,077,870; and 6,470,540.

[0039] In certain embodiments, engagement of the fastening elements provides a verification that engagement has occurred. Verification may be detected by the senses, i.e., the fasteners making sounds as they engage; or may be detected by instrumentation or measurement. The rib shape of the slidable fastening elements selected to construct the device will provide some means of non-destructive engagement (for instance, side insertion) and resist peel, shear, cleavage, and tensile debonding forces. A wide variety of profiles and shapes are known and are suitable for the fastening elements.

[0040] In certain embodiments, the type of engagement/disengagement desired will determine the choice of fastener shape. For example, in applications that require controlled or partial disengagement, a series of projections, such as those described in U.S. Patent No. 4,290,174, can provide point to point disengagement between the fastener elements. Additionally, certain fastener shapes (such as discrete projections to form the rib) will make the alignment of fastener elements for engagement less critical than those fastener elements formed from a continuous ridge or rail. Slidable fastener ribs formed from discrete projections may also allow better conformability to irregular or multidimensional surfaces. Since the fastening device is pre-assembled, the fastener shapes and/or materials may be selected so as to achieve a high holding power (strength) since it is not required to engage or assemble the device by compression.

[0041] As illustrated in FIG. 7, a representative fastener suitable for constructing the pre-assembled device of the present invention comprises a base sheet 11 and a plurality of ribs 12 attached to and projecting upwardly from the base sheet. The ribs 12 are parallel to one another and spaced apart a transverse distance 13. Each rib comprises a stem portion 14 and flanges 15 and 16 attached to each side of the stem portion. Both flanges 15 and 16 are spaced from the base sheet 11, but the right flange 16 is attached to the top of the stem portion 14 while the left flange 15 is attached at a lower height on the stem portion ("right," "left" and "top" refer to positions in FIG. 7; "top" may also be thought of as the surface furthestmost from the base sheet). Both flanges 15 and 16 extend at an angle from their point of attachment on the stem portion 14 toward the base sheet 11, with the result that at their outer or lateral edge the flanges are closer to the base sheet than are their points of attachment to the stem portion. The difference between the flanges 15 and 16 as to their height of attachment to the stem portion 14 makes the ribs 12 asymmetric about a central vertical plane 21. Such an asymmetry has been found to aid the self-mating engagement of fasteners of the invention.

[0042] In Figs. 8 and 9 an embodiment of the pre-assembled slidable fastening device 500 of the invention is shown. The device 500 comprises first and second fastening elements 520 having a base sheet and a plurality of parallel ribs projecting from their base sheets, respectively. The fastening elements 520 may correspond to the fastening elements described above. The ribs of the first and second fastening elements are engaged with each other so as to allow sliding movement of the fastening elements relative to each other in one direction in a plane parallel to the base sheet. On the flat surfaces of the fastening elements 520, i.e., the surfaces opposite the ribbed surface, attachment means are provided. The attachment means in the embodiment of Figs. 8 and 9 is provided in the form of an adhesive layer 570 and/or a mechanical fastener component 590.

As shown in Figs. 8 and 9, an adhesive layer 570 can be used to directly attach the first fastening element 520 of the pre-assembled device to a first substrate 580. The other adhesive layer 570 bonds a mechanical fastener component 590 of a mechanical fastener 595 to the second fastening element 520. A mating mechanical fastener component of the mechanical fastener 595 can be attached to a second substrate 585 so as to be able to mount the first and second substrates 580 and 585 to one another and still allow sliding movement of the connected substrates relative to one another, as shown in Fig. 9. Any suitable components can be used as a mechanical fastener 595.

[0043] The device can be constructed using fastener film with symmetrical ribs, e.g., ribs that have identical flanges attached to the stem portion at the same height on each side of the stem portion. Different applications will determine the selection of the appropriate mating fastener to use. In the embodiments of the present invention, the fastener film used to construct the fastening device may be the fastener film as shown and described in U.S. Patent No. 6,367,128.

[0044] The rib used in the fastening device is generally a representative coextruded rib, which in this case includes two different materials, one constituting the principal portion of the rib and the other constituting a top portion of the rib. More than two materials may be extruded and may constitute different portions of a rib or base sheet (as described, for example, in U.S. Patent No. 6,106,922). For example, the base sheet might comprise one material, e.g., for flexibility or suppleness, and the ribs comprise a different material, e.g., a stiffer material. Or the stem portion of a rib may comprise one material, e.g., having flexibility, elasticity, or fatigue-resistant properties desired for repeated flexing, and the head portion, i.e., the top portion of the rib including the flanges, may comprise a different material, e.g., a stiffer, non-flexing material.

[0045] Fasteners used in the device of the invention may include combinations of features such as those discussed above. When a combination of features is used, the profile formed by the ribs may have more than one regularly repeated deviation in the direction transverse to the length of the ribs from the profile that would be formed by a full population of equally spaced, identical, undivided, symmetric ribs. The asymmetries or profile-deviation features discussed above are illustrative only and are not exhaustive. Profile features may be selected from a variety of features including, as examples only, non-identity of ribs (e.g., some ribs in a regularly repeated pattern being different from other ribs in cross-sectional shape, such as different in rib height, or different in flange shape or flange dimensions), asymmetry of rib shape (e.g., at least some ribs in a regularly repeated pattern being asymmetric in shape about a central vertical plane through the rib), inequality of rib spacing (e.g., the spacing between some ribs being different in a regularly repeated pattern from the spacing between

other ribs), and dividing of ribs (e.g., at least some ribs in a regularly repeated pattern having an elongated opening such as a slot or a slit).

[0046] The size of the ribs may be varied for different applications. Pre-assembled devices of the invention will generally function as desired through a range of rib sizes. Depending on composition and rib shape, larger rib sizes often involve larger disengagement forces than smaller rib sizes. Larger rib sizes may be used for heavy-duty applications, where a fastener pair may be intended to stay engaged longer and/or resist greater disengagement forces; while smaller sizes may be appropriate for lighter-duty applications. Depending on rib size, ten or more ribs of a slidable fastener film are usually engaged with ribs of the bearing in a mated fastener pair.

[0047] The fastener film may have deformable characteristics to allow repeated closing and opening cycles with nondestructive engagement. However, the device can be designed for single use, in which permanent deformation may occur during engagement and/or disengagement.

[0048] For many applications, the lower the force required to achieve engagement while maintaining other desired properties, the better. In contrast to the desire for a lower engagement force, it is generally desired that the disengagement force be high, i.e., higher than what was perceived as the engagement force. Disengagement forces will vary depending on the kind of support that is provided to the fastener. Thus, a fastening device of the invention attached to a rigid substrate will generally experience tensile-type disengagement forces acting perpendicular to the plane of the fastener base sheet or shear or cleavage forces acting parallel to the fastener base sheet, and will experience little if any peel-type forces. On the other hand, a fastening device of the invention attached to a flexible substrate may experience peel-type forces in addition to tensile and shear forces.

[0049] In other embodiments of the invention a friction-reducing agent is incorporated into a fastener film used in the invention, e.g., on the rib surfaces to enhance relative movement between the engaged ribs of a bearing assembly. Such friction-reducing agents, for example silicone materials, also have the advantage that they help molten polymeric material flow during extrusion or other forming of the fastener body and thus assist the material to fill out the desired rib shape.

[0050] The fastener film used in the invention may be made from a variety of materials but most commonly are made from polymeric materials, using generally any polymer that can be melt processed. Homopolymers, copolymers and blends of polymers are useful, and may contain a variety of additives. Inorganic materials such as metals may also be used. The composition is chosen to provide desired bending characteristics, including usually an elastic bending movement of the stem of the rib in a direction lateral to the length of the rib and little if any bending of the flanges during engagement and

disengagement. Generally a modulus of elasticity from 10^3 MPa to 10^7 MPa for the composition of the fastener including any additives is satisfactory but this may change depending on the application.

[0051] Suitable thermoplastic polymers include, for example, polyolefins such as polypropylene or polyethylene, polystyrene, polycarbonate, polymethyl methacrylate, ethylene vinyl acetate copolymers, acrylate-modified ethylene vinyl acetate polymers, ethylene acrylic acid copolymers, nylon, polyvinylchloride, and engineering polymers such as polyketones or polymethylpentanes. Elastomers include, for example, natural or synthetic rubber, styrene block copolymers containing isoprene, butadiene, or ethylene (butylene) blocks, metallocene-catalyzed polyolefins, polyurethanes, and polydiorganosiloxanes. Mixtures of the polymers and/or elastomers may also be used.

[0052] Suitable additives include, for example, plasticizers, tackifiers, fillers, colorants, ultraviolet light stabilizers, antioxidants, processing aids (urethanes, silicones, fluoropolymers, etc.), low-coefficient-of-friction materials (silicones), conductive fillers to give the fastener a level of conductivity, pigments, and combinations thereof. Generally, additives can be present in amounts up to 50 percent by weight of the composition depending on the application.

[0053] A suitable self-mating fastener film can be prepared as described in Example 13 of U.S. Patent No. 6,367,128 (Galkiewicz et al.). A polypropylene resin (SRC-7644 PPco available from Union Carbide; Danbury, CT) may be used along with 5% by weight of MD-50 Silicone pellets (a 50/50 silicone/polypropylene blend available from Dow Corning Corporation; Midland, MI) with a typical hook width of 711-762 micrometers and a mass per area of 363 grams/m².

[0054] Fastener film used in the device can be formed by extruding a polymeric web through a die having an opening cut, for example, by electron discharge machining. The shape of the die is designed to generate a web with a desired cross-sectional shape or profile. The web is generally quenched after leaving the die by pulling it through a quenching material such as water. A wetting agent may be required in the quenching medium to assure good wetting of the whole surface of the extruded web, including spaces between ribs. The extruded web may be further processed, e.g., by cutting extruded ribs and stretching the web to form interruptions in the ribs or by forming structure to limit relative movement between fasteners. Fasteners are then formed, generally by cutting and slitting the extruded web. Extrusion is strongly preferred; but instead of extruding, fasteners of the invention can be prepared in other ways, for example, by injection molding or casting. Methods useful for forming the fastener elements of the present invention include those described in U.S. Patent Nos. 5,868,987; 6,132,660; and International Publication No. WO 03/059110 A2.

[0055] Since the fastening device is pre-assembled,

the engagement of the first and second fastening elements may be done by sliding rather than compressing. Such engagement by sliding can be done by a manufacturer but may not be possible in an actual application by a customer or user. Yet such a sliding engagement can provide for the largest holding force. Because the engagement with the final substrates like headliners and automobile roofs in the actual application is provided by other attachment means, the fastening device combines an easy engagement at the user level with a high holding force. Alternatively, the manufacturer is generally able to apply very high engagement forces, e.g., by a suitable machine, which may not be possible at the user level.

15 Example

[0056] Similar to the embodiment shown in Figs. 8 and 9, a pre-assembled slidable fastening device allowing one-dimensional sliding movement of the fastening elements relative to one another was prepared. The fastening elements were made from a polypropylene copolymer (DOW C104-01 polypropylene resin, Dow Chemical Company) with and without a tie layer of Bynel 50E571 anhydrite modified polypropylene (DuPont Packaging Bynel serie 5000). A microphotograph of a cross-section of the fastening elements used in Example 9 is shown in Fig. 10. The thickness of the base sheet is about 450 μm and, more generally, in the range of between 400 to 600 μm . The width of the stem portion is about 385 μm , and more generally in a range of between 350 to 420 μm . The width of the head portion of the ribs is about 1,309 μm , and more generally in the range of between 1,250 to 1,350 μm . The gap between adjacent rib head portions is about 1,093 μm , and more generally in the range of between 1,000 to 1,200 μm . The stem height of the ribs is about 1,533 μm , and more generally in the range of between 1,450 to 1,600 μm . The rib height is about 1,974 μm and more generally in the range of between 1,900 to 2,100 μm . Accordingly, once the first and second fastening elements are engaged with each other, an overlap of the portions of the ribs of about 302 μm , more generally in the range of between 200 to 400 μm , preferably in the range of between 250 μm and 350 μm , is present.

[0057] The holding power (disengagement force) for disengaging the first and second fastening elements was measured to be about 60 N/cm².

[0058] Various modifications and alterations to this invention will become apparent to those skilled in the art without departing from the scope of this invention. It should be understood that this invention is not intended to be limited by the illustrative embodiments and examples set forth herein and that such examples and illustrative embodiments are presented by way of example only with the scope of the invention intended to be limited only by the claims set forth herein as follows.

Claims

1. A pre-assembled slidable fastening device, comprising:

a first fastening element comprising a base sheet and a plurality of parallel ribs projecting from a first major surface of the base sheet;
 a second fastening element comprising a base sheet and a plurality of parallel ribs projecting from a first major surface of the base sheet, wherein the ribs of the first and second fastening elements are engaged with each other so as to provide a holding power of at least 23 N/cm² in a direction perpendicular to the first major surfaces of the base sheets of the first and second fastening elements but allow sliding movement of the fastening elements relative to each other in at least one direction in a plane parallel to said first major surfaces of the base sheets; and
 attachment means provided on the first and/or second fastening element(s) at a surface opposite the first major surface(s) thereof.

2. The device of claim 1, further comprising at least one slider having a base sheet, a plurality of parallel ribs projecting from a first major surface of the base sheet to form a first bearing piece and a plurality of parallel ribs projecting from an opposite second major surface of the base sheet to form a second bearing piece, wherein:

the ribs of the first bearing piece are not parallel to the ribs of the second bearing piece, and the at least one slider is interposed between the first fastening element and the second fastening element such that the ribs of the first bearing piece are engaged with the ribs of the first fastening element and the ribs of the second bearing piece are engaged with the ribs of the second fastening element so as to allow substantially two-dimensional motion of the first and second fastening elements relative to one another.

3. The device of claim 2, wherein the slider comprises a first fastener film and a second fastener film, each of said fastener films having said plurality of projecting ribs provided on one major surface thereof, wherein the opposite major surface is substantially flat, and the first and second fastener films are connected to one another at their flat major surfaces.
4. The device of claim 2 or 3, wherein the ribs of the second bearing piece are essentially perpendicular to the ribs of the first bearing piece.

5. The device of any of claims 2 to 4, wherein the ribs of the fastening elements and the ribs of the bearing pieces are configured differently but are slidably interengageable.

6. The device of any of claims 2 to 5, wherein the fastening elements and the bearing pieces are self-mating.

7. The device of any of claims 1 to 6, wherein the ribs include a friction-reducing agent to facilitate engagement of the fastening elements and/or bearing pieces.

8. The device of any of claims 1 to 7, wherein at least one of the fastening elements and/or the slider comprises means for limiting the sliding movement relative to each other.

9. The device of claim 8, wherein at least one of the ribs of at least one fastening element is permanently deformed to limit the relative movement.

10. The device of any of claims 1 to 9, wherein the attachment means is provided in the form of an adhesive layer and/or a mechanical fastener component.

11. The device of claim 10, wherein one of the fastening elements is provided with an adhesive as attachment means and the other fastening element is provided with a mechanical fastener component as attachment means.

12. The device of any of claims 2 to 11, wherein the device comprises multiple fastening elements engaged with multiple bearing pieces, wherein the ribs of at least one fastening element are not parallel to the ribs of at least one other fastening element.

13. The device of any of claims 1 to 12, further comprising a rotational element that provides rotational motion of one fastening element relative to another fastening element about a hypothetical axis extending through the fastening elements.

14. The device of any of claims 1 to 13, wherein the parallel ribs comprise a series of closely spaced projections.

15. The device of any of claims 1 to 14, wherein at least some of the ribs of the fastening elements are interrupted to allow two-dimensional motion of the first and second fastening elements relative to one another.

16. The device of any of claims 1 to 15, wherein the engagement force of the device is less than 10 N/

cm², preferably less than 6 N/cm², and more preferably less than 4 N/cm².

17. The device of any of claims 1 to 16, wherein the base sheet of the first and/or second fastening element and/or the base sheet of the slider has a thickness in the range of between 400 to 600 µm. 5
18. The device of any of claims 1 to 17, wherein the ribs of the fastening elements and/or the slider have a stem portion and a head portion, the stem portion having a width of 350 to 400 µm, the head portion having a width of 1250 to 1350 µm. 10
19. The device of any of claims 1 to 18, wherein the gap between adjacent rib head portions is in the range of 1050 to 1150 µm. 15
20. The device of any of claims 1 to 19, wherein the distance between adjacent stems is in the range of between 1900 and 2100 µm. 20
21. The device of any of claims 1 to 20, wherein an overlap of adjacent engaged ribs is in the range of between 200 to 250 µm. 25
22. An automotive headliner having at least one attachment portion for mounting the headliner to an automobile, said attachment portion being provided with at least one pre-assembled slidable fastening device of any of claims 1 to 21. 30
23. The headliner of claim 22, wherein the overall holding power of the fastening device is at least 120 N, preferably at least 150 N, and more preferably at least 170 N. 35
24. An automobile comprising a passenger compartment with a roof being provided with a headliner, wherein the headliner is attached to the roof by means of at least one pre-assembled slidable fastening device of any of claims 1 to 21. 40
25. The automobile of claim 24, wherein the headliner is attached to the roof by a plurality of said fastening devices and said fastening devices provide an overall holding power of at least 120 N, preferably at least 150 N, and more preferably at least 170 N. 45
26. Use of the pre-assembled slidable fastening device of any of claims 1 to 21 for attaching automotive parts, particularly automotive trims, seat covers, and headliners, to an automobile. 50
27. A method of mounting a first substrate to a second substrate, the method comprising the steps of: 55

a) providing a first substrate having at least one

attachment portion;

b) attaching at least one pre-assembled slidable fastening device of any of claims 1 to 21 to each attachment portion of the first substrate by means of the attachment means of the first or second fastening element;

c) attaching the first substrate with the fastening device to the second substrate by means of the attachment means of the other of the first and second fastening elements;

d) positioning the first substrate relative to the second substrate by moving the first substrate relative to the second substrate; and

e) fixing the position of the substrates relative to each other.

28. The method of claim 27, wherein the first substrate is a headliner and the second substrate is a roof of an automobile.

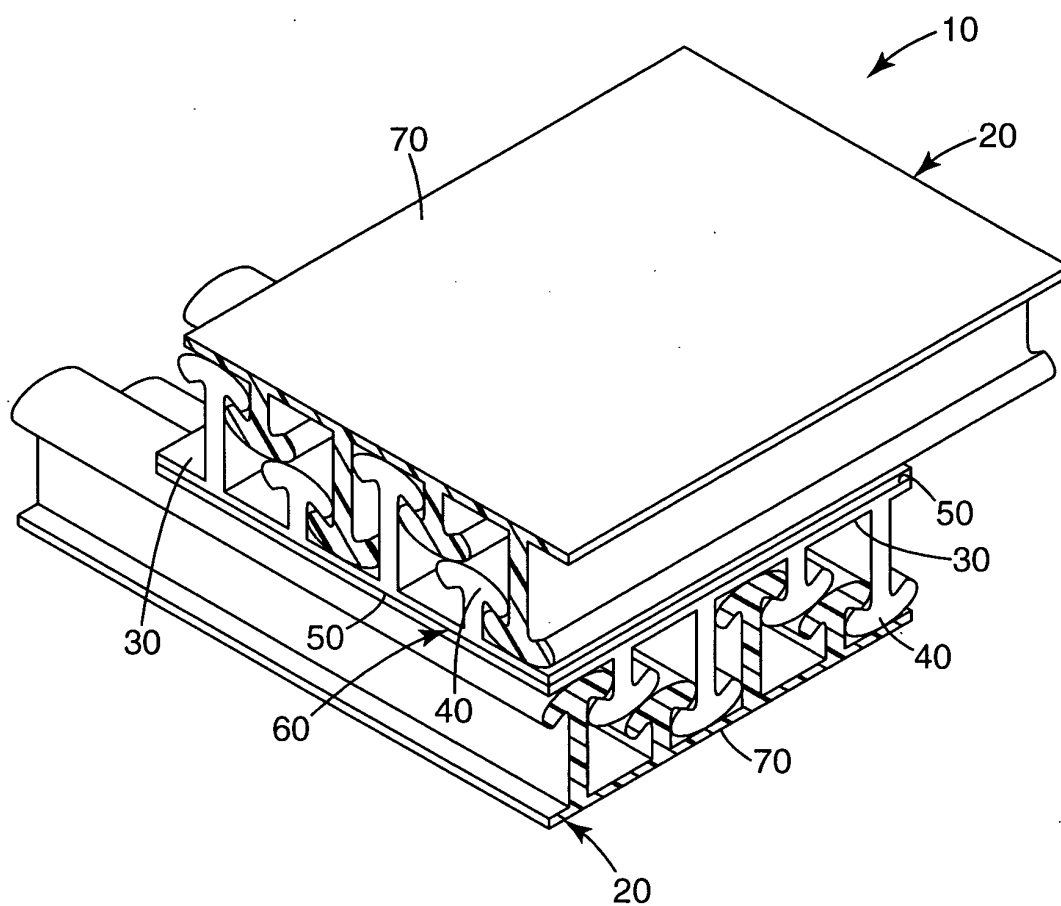


Fig. 1

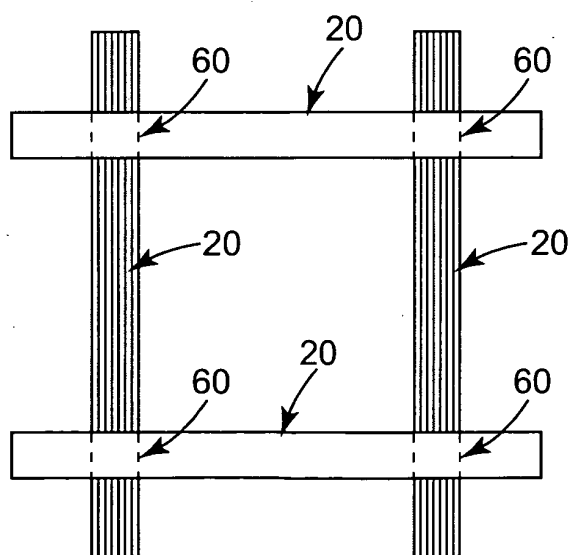


Fig. 2

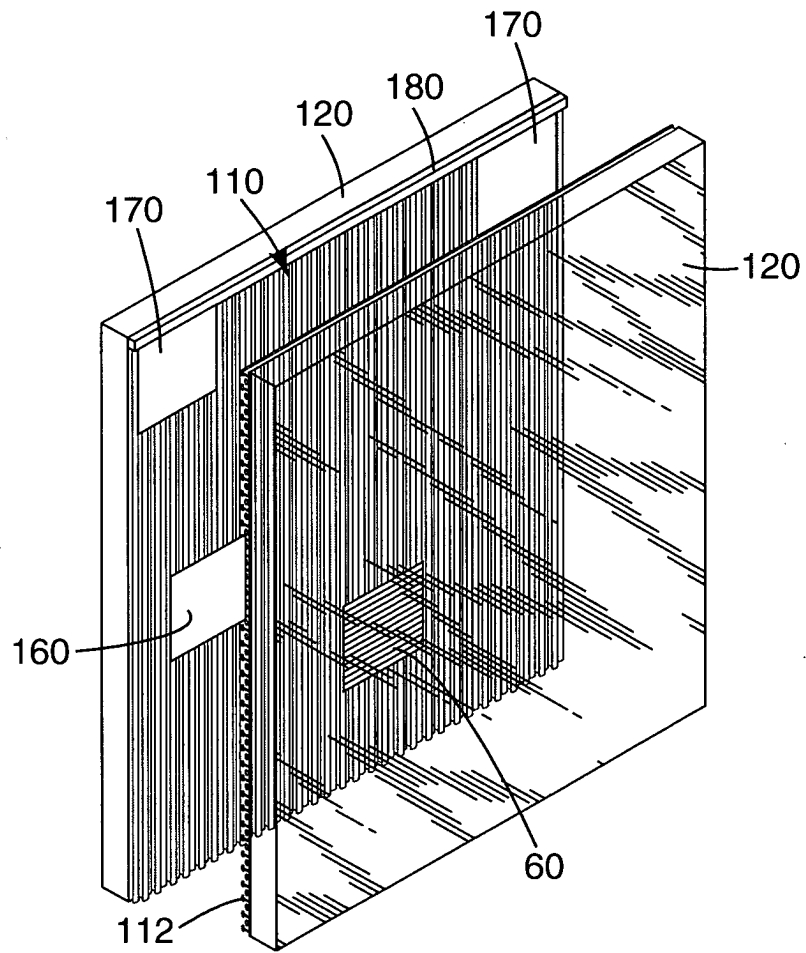


Fig. 3

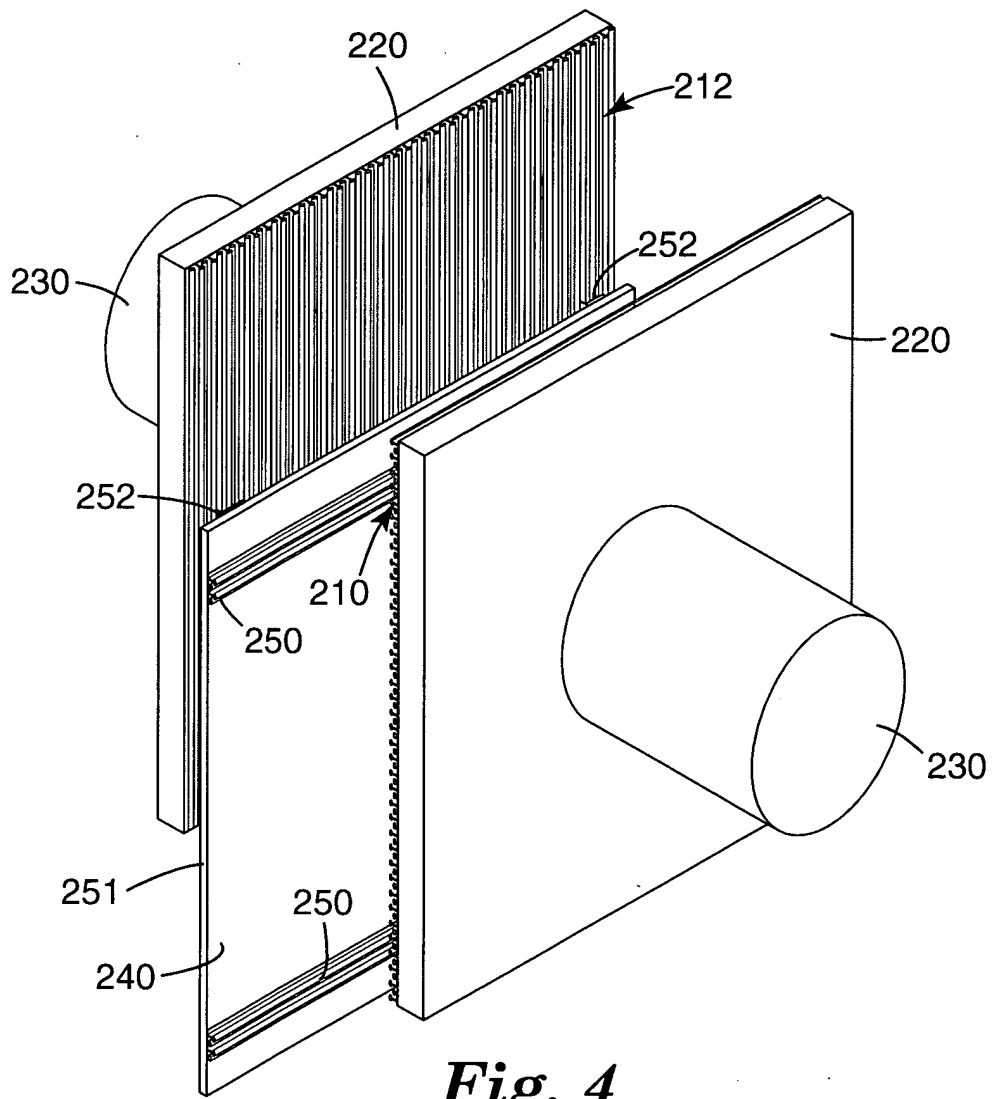


Fig. 4

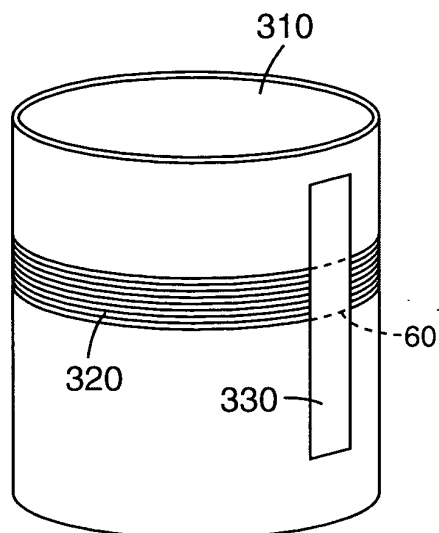


Fig. 5

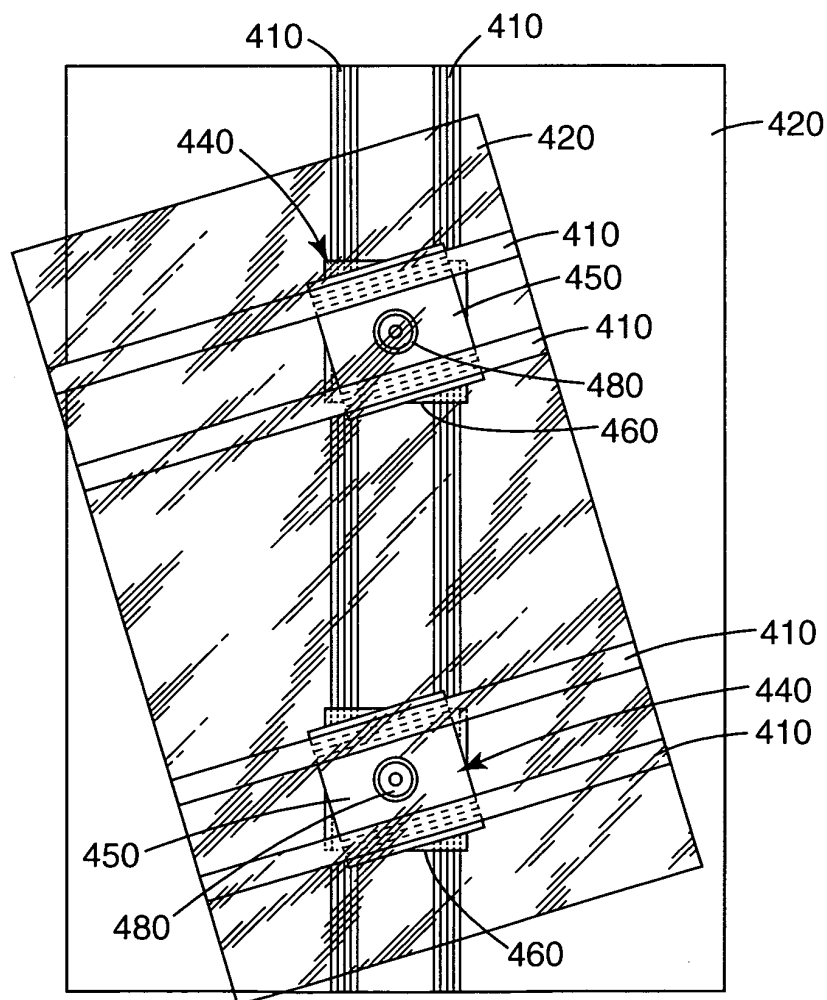


Fig. 6

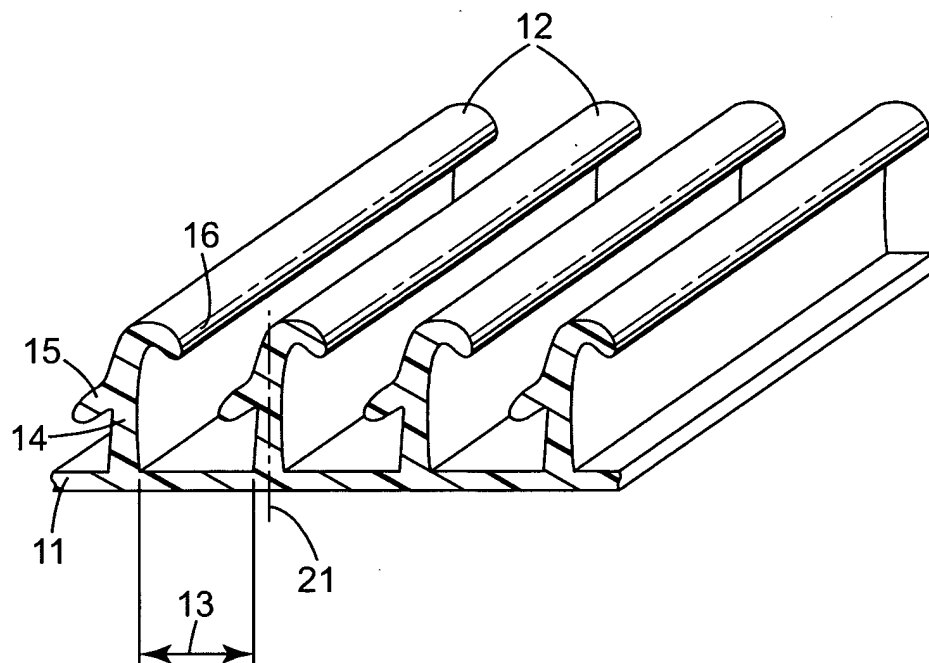


Fig. 7

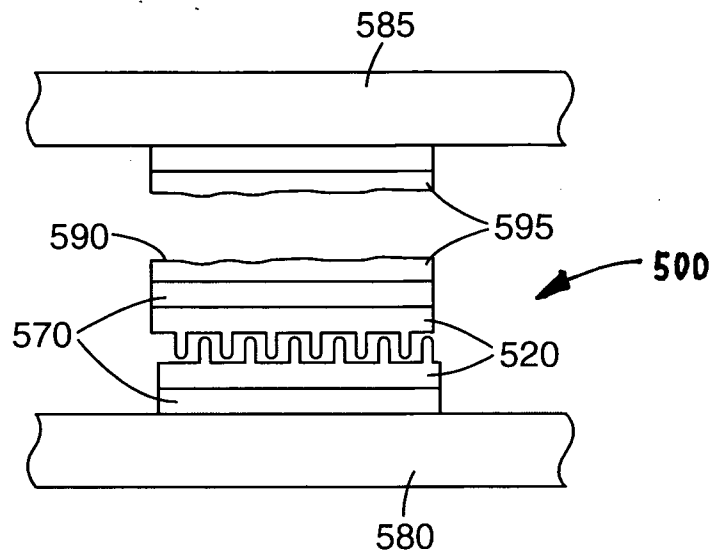


Fig. 8

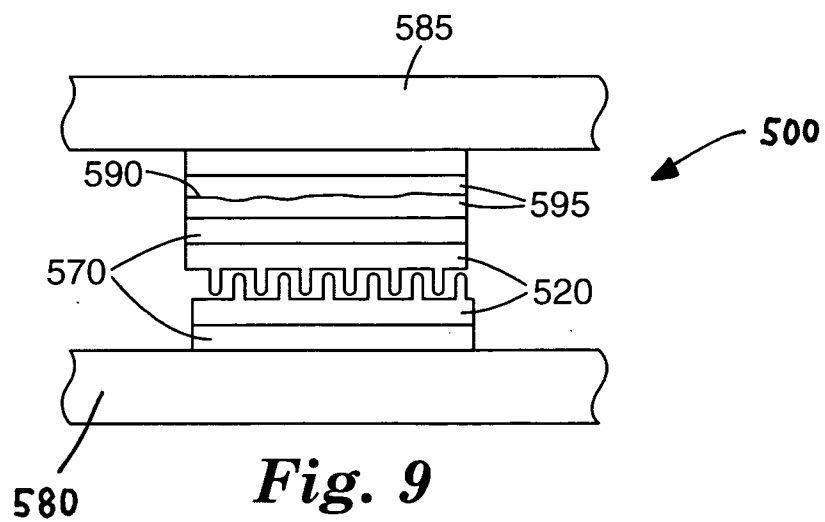


Fig. 9

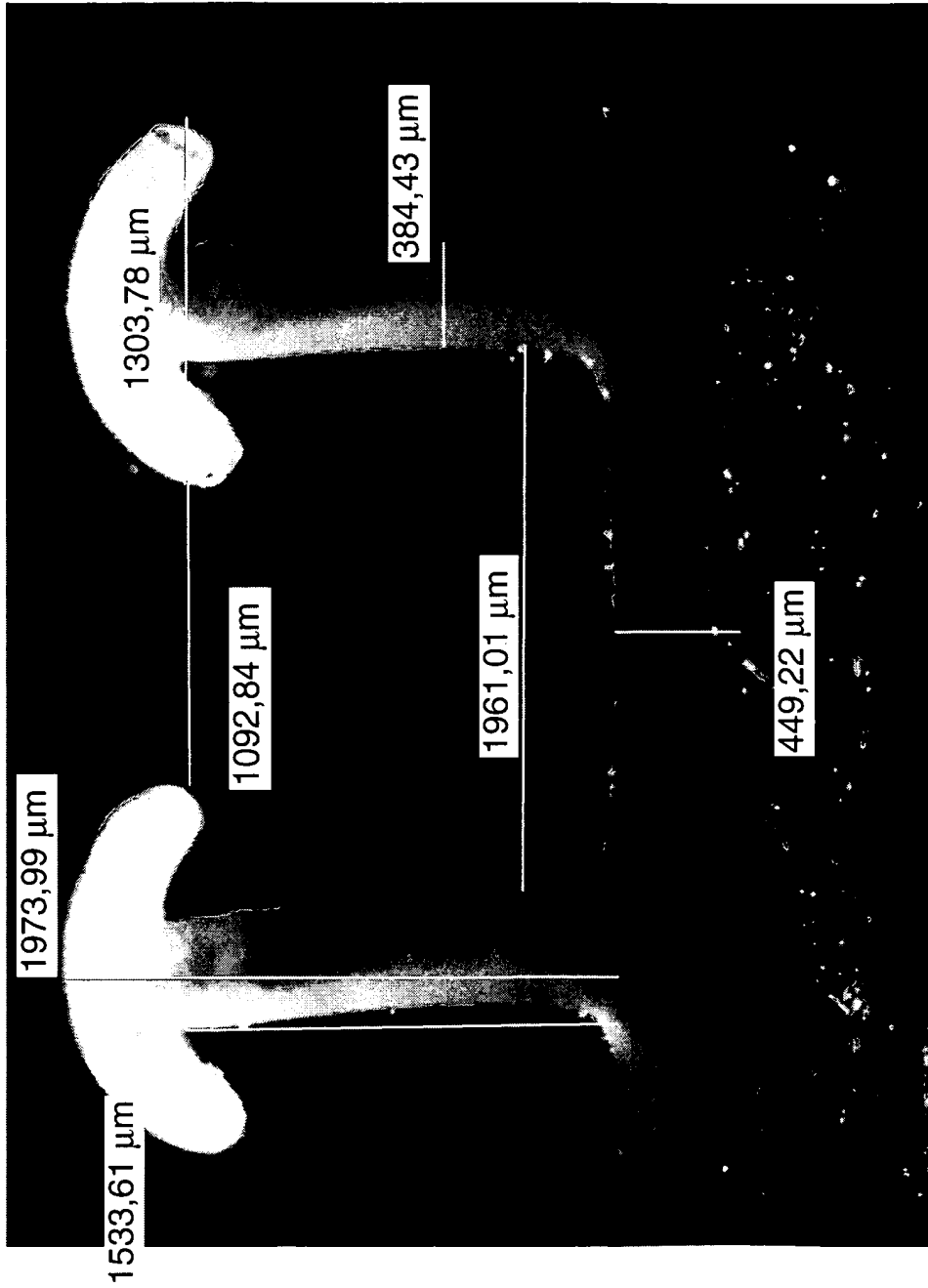


Fig. 10



European Patent
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Application Number
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