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(71) Applicant *(for all designated States except US)*: **DOW GLOBAL TECHNOLOGIES INC.** [US/US]; Washington Street, 1790 Building, Midland, MI 48674 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **PARSONS, Thomas, J.** [US/US]; 206 W. Hotchkiss, Freeland, MI 48623-9317 (US). **FLAVIN, Franklin, J.** [US/US]; 1808 Candlestick, Midland, MI 48642 (US). **KRZCIOK, Gregory, J.** [US/US]; 4651 Lakeview Drive, Beaverton, MI 48612 (US). **WERLE, Kenneth, C.** [US/US]; 7680 Ellie, Saginaw, MI 48609 (US). **MASHUE, Donald, H.** [US/US]; 2857 Nold Road, Midland, MI 48640 (US). **HUBER, James, R., II** [US/US]; 3004 Canterbury, Midland, MI 48642 (US). **HERTEMA, Daryl, J.** [US/US]; 199 W. Pine River Road, Midland, MI 48642 (US). **JIALANELLA, Gary, L.** [US/US]; 437 Thorne Hill Trail, Oxford, MI 48371 (US). **VON DIEST, Konstantin** [DE/US]; Müehlbackweg 5, 61118 Bad Vilbel (DE).

(74) Agent: **DOBRUSIN, Eric, M.**; Dobrusin & Thennisch PC, 401 S. Old Woodward Avenue, Ste. 311, Birmingham, MI 48009 (US).

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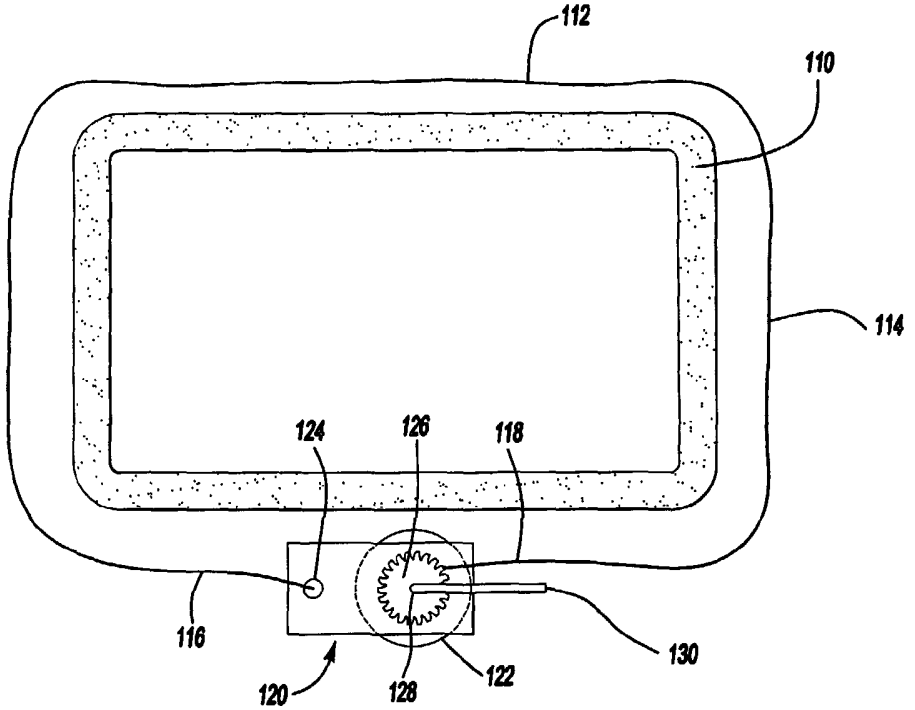
(54) Title: METHOD AND APPARATUS FOR ADHESIVE JOINT SEPARATION



(57) Abstract: Devices and methods for cutting an adhesively bonded joint (110), premised upon providing a joint (110) that includes an adhesive, a first component and a second component are part of the present invention. The cutting of the adhesive (110) may be by a cutter including a cutting portion (112) that is advanced about at least a portion of the periphery of the joint by an advancing mechanism (122). Kits for repairing and/or replacing components that include an adhesively bonded joint are also contemplated.

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METHOD AND APPARATUS FOR ADHESIVE JOINT SEPARATION

Cross-Reference to a Related Patent Application

[0001] This application claims the benefit of U.S. Provisional Application Serial No. 60/390,305, filed June 21, 2002 and of U.S. Provisional Application Serial No. 60/430,620, filed December 2, 2002, both hereby incorporated by reference.

Technical Field

[0002] The present invention relates to repair or replacement of adhesively bonded articles, and more particularly to repair and replacement of adhesive joints for automotive valve cover assemblies.

Background of the Invention

[0003] It has become increasingly desirable in the manufacture of automotive engine assemblies to adhesively bond two or more components together, especially where the materials of the respective components are dissimilar. Examples of technology aimed toward meeting this need (and for which the present invention also finds utility for repair or replacement) include commonly owned co-pending applications serial no. 10/051,417 ("Adhesively Bonded Valve Cover Cylinder Head Assembly"), serial no. 09/922,030 ("Adhesively Bonded Water Conductor Assembly"), serial no. 09/921,636 ("Adhesively Bonded Oil Pan Assembly"), and serial no. 09/825,721 ("Adhesively Bonded Radiator Assembly"), hereby incorporated by reference.

[0004] It is especially desirable to increase the use of plastics for engine components. Among the advantages of being able to fabricate engine components of plastic are the resultant weight savings and the ability to fabricate intricately shaped components. Additionally it is also possible to integrate plural functions into a single component, heretofore served by separate components, thereby serving also to reduce overall part count for a vehicle. An example of one such structure is shown in commonly owned co-pending applications serial no. 10/146,251 "Automotive Valve Cover With Integral Positive Crankcase Ventilation" (filed May 15, 2002), hereby incorporated by reference.

[0005] Efforts by others to employ adhesive joints (whether to join plastic to plastic, metal to plastic, or metal to metal) in mass production vehicles have been

hampered thus far particularly because of the difficulties encountered in attempting to separate engine components at the joint without destruction of or damage to one or more of the components. It is recognized that the demand for lighter and smaller vehicles has resulted in the compression of the available under-the-hood real estate available for engine placement. Parts tend to be placed closer together than historically, making access to joints (such as the joint between the valve cover and engine cylinder head) more limited and the risk of damage increased to nearby components (e.g., hoses, lines, wires, wire harnesses, etc.). In addition, the time that may be allocated to separate an adhesive joint for the removal of a component, such as a valve cover, typically needs to be on the order of less than 15 minutes and more preferably less than 5 minutes, in order to meet serviceability needs of most technicians. Further, any process needs to avoid contamination of the engine. For instance, while it is possible to simply cut the adhesive in the joint, there is also an attendant need to prevent the displacement of the "saw dust" from the joint from entering the cylinders.

Summary of the Invention

[0006] The present invention meets the above needs and others by providing an improved approach for the repair or replacement of an adhesively bonded joint, and particularly an adhesively bonded valve cover assembly. In general, the present invention contemplates providing a bonded assembly that includes a first substrate, and a second substrate joined to the first substrate via an adhesive, such as a structural adhesive. Though it is preferable that at least one of the first or second substrates is a plastic material, either or both may be a material other than plastic, such as a metal, a ceramic, a composite or otherwise.

[0007] In general, the present invention contemplates generally that a cutter is provided and secured in cutting position relative to the adhesive joint and particularly is such that a cutting portion of the cutter is disposed generally in the plane of the joint along with at least a portion of any advancing portion, such as a cord. The cutting portion is then advanced continuously or in increments (e.g., by ratcheting) through the adhesive in the joint for cutting the adhesive. As the cut is being made, measures are preferably taken so that the cutting portion remains generally within the joint.

[0008] In accordance with the above, there is therefore provided at least two different general approaches for advancing the cutting portion. In a first approach the cutting portion comprises a cord that is passed through the adhesive joint and cutting occurs generally in the region about the leading edge of the cord. In a second approach the cutting portion comprises a blade that is passed through the adhesive joint and cutting occurs generally in the region about the leading edge of the blade. Under both approaches there is also contemplated the employment of a mechanism for advancing the cutting portion through the adhesive joint. For example, the mechanism may include a manually operated or a machine operated mechanism for pulling the cutting portion through the adhesive. It may alternatively include a manually operated or a machine operated mechanism for pushing the cutting portion through the adhesive.

[0009] The present invention also contemplates the employment of devices and techniques for bonding a first substrate to a second substrate where one or both of the substrates has been repaired or replaced after separation of a joint according to the present invention. In general, after such separation, the mating surfaces of the respective substrates are prepared for receiving an adhesive. For example, some or all of the adhesive from the pre-existing joint may be removed from the mating surfaces of the respective substrates, such as by scraping or cutting, and then the surface is optionally degreased, primed or both, and then one or more beads of adhesive applied about the mating surfaces. In another preferred approach, temporary or permanent locators are placed between the substrates for helping to assure proper substrate separation, such as for optimizing control over engine noise, vibration and harshness.

[0010] The present invention also thus contemplates providing kits having therein one or more of the tools or materials for performing the repair or replacement techniques in accordance with the present invention. Thus, for example, in one embodiment, a kit is provided including a cutter, an adhesive and optionally at least one of a primer, a degreaser, a scraper, or a handling device.

[0011] The present invention thus contemplates methods of cutting joints of each of these types in which such joint is provided and the joint is cut using a cutter in accordance with the present invention. Repair or replacement is thereafter effectuated.

Brief Description of the Drawings

[0012] Fig. 1A shows a sectional view through a cutting plane illustrating an advancing mechanism and a cord cutting portion.

[0013] Fig. 1B shows a sectional view through a cutting plane illustrating the path of a cord that is partially advanced through a joint.

[0014] Figs. 2A and 2B show a perspective and cross-sectional view of a cutting portion with a rip cord attached to a stationary, ratcheted advancing mechanism.

[0015] Figs. 3A and 3B show a perspective and cross-sectional view of a cutting portion with a rip cord attached to a traveling, rack-and-pinion advancing mechanism.

[0016] Fig. 4 shows an advancing mechanism with a cutting portion with a cutting blade partially advanced through a joint.

[0017] Figs. 5A and 5B are plan and side views of an example of a cutting portion having a cutting blade and one type of linkage.

[0018] Figs 6A-6D show cross-section views of a cutting portion with a blade where the blade is place in various locations on the body and at various angles with respect to the joint.

[0019] Figs. 7A-7D show a body for a cutting portion with a blade, a cross-sectional view and a perspective view of cutting portion with a blade and a strap.

[0020] Figs. 8A and 8B show a perspective and top view of a cutting portion with a blade attached to a stationary ratcheted advancing mechanism.

[0021] Fig. 9 shows an exploded view of a cutting portion with a cutting blade in the joint where the body of the cutting portion rides in a groove in one of the components.

[0022] Fig. 10 shows an exploded view of a cutting portion with a cutting blade in the joint where the body of the cutting portion rides in a groove in one of the components and where the body and the components cooperate to ensure the cutting portion does not pull up of the joint.

[0023] Figs. 11A and 11B show a perspective and cross-sectional view of a cutting portion with a blade attached to a traveling, rack-and-pinion advancing mechanism located on the top of the valve cover.

[0024] Figs. 12A and 12B show a perspective and cross-sectional view of a cutting portion with a blade attached to a traveling, rack-and-pinion advancing mechanism located on a flange of the valve cover.

[0025] Figs. 13A and 13B show a perspective and side view of a cutting portion with a pair of blades attached to a clamp advance mechanism.

[0026] Figs. 14A-14C are examples of handling devices for use in assembling components of an adhesively bonded joint.

Detailed Description of the Preferred Embodiment

[0027] By way of overview, in preferred embodiments for bonded automotive engine component applications, preferably the components are adapted to provide one or more mating surfaces, which may be adhesively secured to a corresponding mating surface of another component. The material selection of the components is not critical. They may be metal, plastic, ceramic, composites or combinations thereof. For a preferred application, in which a valve cover is bonded to an engine cylinder head, the head is preferably formed of a metal (e.g., cast iron, steel, magnesium, aluminum, titanium or the like) and the valve cover is preferably formed of a plastic component. In one preferred embodiment, at least one (and preferably all) of the components is a rigid structure. In a particularly preferred embodiment, it is a rigid structure. In another particularly preferred embodiment, the component is substantially entirely opaque. In another particularly preferred embodiment, the component is re-used; thus, the component is part of a first joint, which is separated in accordance with the teachings herein and then re-attached with another layer of adhesive.

[0028] Again, though not critical, any or all of the bonded components or the adhesive may be suitably treated (uniformly or locally) as desired to improve corrosion resistance, oxidation resistance, thermal resistance, or another characteristic of the final product. For instance, they might be admixed, impregnated or coated with suitable additives for achieving a desired property. In some instances, adhesive bond strengths or performance might be enhanced by further contacting one or more substrate associated with the components with a suitable primer. In another embodiment a component may include a coating or film on the exterior or interior which functions to improve overall performance of the assembly, such as a carbon-silica based plasma deposited coating, e.g., as described in U.S. Patent 5,298,587; U.S. Patent 5,320,875; U.S. Patent 5,433,786 and U.S. Patent 5,494,712, all hereby incorporated herein by reference. Other surface treatments

might also be employed such as plasma surface treatment pursuant to art disclosed teachings as found in U.S. Patent 5,837,958, incorporated herein by reference.

[0029] In accordance with the teachings herein, typically the adhesive is preferably provided over at least a portion of the surfaces to be joined, and preferably sufficiently about the periphery so that there are no appreciable gaps that result between joined components. In one embodiment, a bead of adhesive is placed (e.g., by pumping) on the respective mating surface of at least one of the components and the opposing mating surface is brought into contact with it. The assembly is then cured. In another embodiment, the adhesive is precoated (e.g., by spraying, dipping, brushing, swabbing, or the like) on one or both of the mating surfaces of the respective components and then the components are joined and cured. Any other suitable joining technique may likewise be employed. Preferably the amount of adhesive employed is sufficient to achieve the desired performance characteristics of the assembly. Such amount will vary from application to application. It should be recognized, of course that the above steps are contemplated to have been optionally employed for preparing a bonded assembly requiring cutting in accordance with the teachings herein. They are also contemplated to be employed for re-assembly of a repaired assembly or in the replacement of a component in accordance herewith.

[0030] The present invention is particularly advantageous because it enables, in addition to conventional materials and fabrication techniques, the prominent use of advanced engineering materials such as plastics. Thus, as indicated in the above, in a preferred embodiment at least one of the substrates is a plastic engine component. Though preferably it is a molded plastic component (e.g., injection molded, blow molded, compression molded), it may also be thermoformed, rotational molded, extruded, or formed using another art-disclosed technique. The material may be a thermoplastic, thermoset, or a combination thereof. Optionally, it may be substantially entirely elastomeric (natural, synthetic or a combination thereof), or only partially elastomeric. The component may also include a shell defining a cavity filled with a foam material that is different from the shell material, such as an acoustic foam for attenuating sound.

[0031] Accordingly, in one preferred embodiment, at least one component of a joint of the present invention preferably is made from a thermoplastic material. In a particularly preferred embodiment, it is made from a high strength thermoplastic

resins such as polystyrenes, nylons (e.g., nylon 6, or nylon 6,6), olefins, polycarbonates or mixtures thereof. Alternatively, the component (e.g., a valve cover) is made from, for example, acrylonitrile butadiene styrene, polycarbonate/ acrylonitrile butadiene styrene, polycarbonate, polyphenylene oxide/polystyrene, polybutylene terephthalate, polybutylene terephthalate/polycarbonate, polyamide, polyesters, vinyl esters, polyethylene, and mixtures thereof. In one particularly preferred embodiment, the material is formed of a syndiotactic polystyrene, a polyamide (e.g., nylon 6 or nylon 6,6), or a combination thereof (e.g., a blend of a polyamide and a syndiotactic polystyrene).

[0032] In one preferred embodiment, the component is formed of blow-molded polypropylene. In another preferred embodiment, the component (e.g., a valve cover) is formed of blow-molded nylon or a blow molded blend of a nylon and a syndiotactic polystyrene. In a highly preferred embodiment, the nylon or the polypropylene may be modified with up to about 10% by weight filler or reinforcement (e.g., glass, mineral or combinations thereof, such as glass and mineral filled), more preferably about 10% to about 50% by weight filler or reinforcement and most preferably 18% to about 40% (e.g., about 30%) by weight filler or reinforcement or more for increasing the impact resistance or otherwise modifying the properties of the component.

[0033] To reiterate, the materials of the components that form joints according to the teachings herein need not be only plastic and plastic or plastic and metal. They may also be metal and metal, ceramic and metal, ceramic and ceramic, ceramic and plastic or otherwise. Composite materials may also be employed as desired.

[0034] The adhesive interface width (e.g., the width over which the adhesive spans when spread between opposing mating surfaces) is not critical, but in a preferred embodiment, it is less than about 35 mm, and more preferably less then about 25 mm. For example a joint might have an adhesive interface width in the range of about 3 to about 20 mm and more preferably about 5 to about 15 mm.

[0035] The adhesive may be applied in the immediate vicinity of the location where the components are to be joined with each other or it may be applied in a location remote from where or when the components are to be contacted. Remote as used herein refers can refer to one or both of time and location. In the embodiment where the adhesive is applied to one or more of the components

remote from the place wherein the components are joined together, a cure-on-demand adhesive may be used.

[0036] The adhesive of the present invention may be any suitable adhesive for the intended application. It may be a water based adhesive, a solvent based adhesive or otherwise. It may be a single component adhesive or a multi-component adhesive (e.g., a two-component adhesive). The multi-component adhesive may be use the components simultaneously (e.g. an epoxy) or sequentially. It may be air cured, moisture cured, heat cured, radiation cured (e.g., IR or UV), radio frequency cured, solvent loss cured, or otherwise cured. It may be a melt flowable, a liquid, a film, a powder, a gel or otherwise. It may be a pressure sensitive, an RTV adhesive, a hot-melt adhesive. It may be a structural adhesive in certain applications. Optionally the adhesive may be a curable on demand material. It should be recognized that the use of the term adhesive herein is not intended to foreclose primers or other bonding agents from the scope of the present invention

[0037] Any adhesive that after cure can withstand the conditions of use of an engine (e.g., for an automotive vehicle) can be used. Preferably such adhesive does not decompose or delaminate at temperatures of up to about 138°C (280°F), more preferably up to about 143°C (290°F), even more preferably up to about 160°C (320°F) and most preferably up to about 191°C (375°F). Though not critical, in one embodiment, the adhesive that is employed in a joint herein has a resulting tensile strength of at least about 70 psi (about 500 kPa), more preferably about 145 psi (about 1MPa), still more preferably about 420 psi (about 3MPa). In some applications, such as where a structural adhesive is used, the resulting tensile strength may be as high as about 4000 psi (about 28 MPa), more preferably at least about 6500 psi (about 45 MPa), and still more preferably at least about 9000 psi (62 MPa). It will be appreciated that in some applications, the strength of the joint may be greater than the strength of at least one, and preferably more than one, of the individual joined components.

[0038] It will further be appreciated that a preferred adhesive is able to withstand exposure to hydrocarbon materials (e.g., natural or synthetic oils), calcium chloride, brake fluid, glycol coolants, windshield washer solvents and the like, at the above-mentioned temperatures and the pressures to which the internal combustion engine reaches internally. In an optional embodiment, the adhesive is able to bond to other engine components, which may be metallic, ceramic, composite, plastic, or the like.

[0039] In another embodiment, the adhesive may be a cure-on-demand adhesive, requiring a separate operation to cause the adhesive to begin to cure. In one embodiment this is achieved by using an encapsulated curing agent which is ruptured during assembly. In another embodiment this is achieved by removing a protective coating to expose the adhesive to ambient conditions. Cure can be initiated by exposing the adhesive to heat, infrared or ultraviolet light sources, or to shearing forces and the like. Of course, it is always possible to employ an adhesive that does not have cure on demand capability.

[0040] An adhesive selected from any suitable adhesive family may be employed such as polyesters, polyamides, polyurethanes, and polyolefins, epoxies, ethylene vinyl acetates, urethanes, acrylics, silanes, thioethers, fluorosilicones, fluorocarbons or the like. The adhesive may be a high temperature epoxy resin, a polyimide, a hybrid polyimide/epoxy resin adhesive, an epoxy novolac/nitrile rubber adhesive, a polythioether epoxy or the like. Exemplary compositions for possible adhesives are disclosed in a patent application titled, "Amine Organoborane Complex Polymerization Initiators and Polymerizable Compositions", PCT Publication No. WO 01/44311 A1, U.S. Serial No. 09/466,321, herein incorporated by reference. A highly preferred adhesive will include an elastomeric component or exhibit elastomeric properties, such as for acoustical or vibrational damping.

[0041] The type of joint is not especially critical though it is illustrated herein by particular reference to a butt joint. The present invention may be employed for separating any of a different number of joint types, such as without limitation, scarf joints, lap joints, tongue and groove joints, dove tail joints, or otherwise. It will be appreciated that it may be necessary to make suitable hardware modifications in order to cut certain joints, such as providing a suitably shaped cutting portion (e.g., a curved blade that has a cutting edge that conforms generally to the shape of the joint).

[0042] In general, the present invention contemplates generally that a cutter is provided and secured in cutting position relative to the adhesive joint, and particularly, is such that a cutting portion of the cutter is disposed (e.g., through the use of suitable guides, pulleys or other structure, in order that the advancing mechanism may be positioned in or out of plane of the joint) generally in the plane of the joint, and even more preferably so that torque generally normal to the plane of the joint is substantially minimized locally. For example, one way to accomplish this

is to position at least a portion of the cord (though not necessarily the advancing mechanism itself) so that it is maintained generally in the plane of the joint or substantially parallel to the plane of the joint during cutting. The cutting portion is then advanced continuously or in increments (e.g., by ratcheting) through the adhesive in the joint for cutting the adhesive. The cutting portion may be advanced around the entire joint or just a portion of the joint. As the cut is being made, measures are taken so that the cutting portion remains generally within the joint.

[0043] In accordance with the above, there is therefore provided at least two different general approaches for cutting the adhesive of the joint. In a first approach, the cutting portion comprises a cord that is passed through the adhesive joint and cutting occurs generally in the region about the leading edge of the cord. The cord effectively acts as a "noose" for "choking" the adhesive of the joint, whereby the cord is effectively dragged through the adhesive for cutting. In a second approach, the cutting portion comprises a blade that is passed through the adhesive joint and cutting occurs generally in the region about the leading edge of the blade.

[0044] Under either or both cutting approaches, there is also contemplated the employment of a mechanism for advancing the cutting portion through the adhesive joint. For example, the advancing mechanism may include a manually operated or a machine operated mechanism for pulling the cutting portion through the adhesive. It may alternatively include a manually operated (e.g., a one-person hand operation) or a machine operated mechanism for pushing the cutting portion through the adhesive. Preferably the force that is applied to the cutting portion is a constant force, although it may be an intermittent force, an oscillating force, a variable force, or combinations thereof.

[0045] Referring to Fig. 1A, one preferred approach to cutting an automotive engine component adhesive joint 110 in accordance with the teachings herein includes providing a cutter that has a cutting portion 112 that is substantially entirely a cord 114. The cord 114, having a first end 116 and a second end 118, is positioned about the periphery of the joint 110 and is anchored at the one or both of the first or second ends to a bracket assembly 120 that is adapted to be preferably secured (either stationary or for translation) to an under the hood component of the automotive vehicle, such as the engine head. The bracket assembly 120 may be mountable to the component and should have sufficient stability to carry out the cutting operation. The particular manner of securing the bracket to the component is

not critical. An advancing mechanism 122 is carried on or part of the bracket assembly 120. Though any of a number of alternative structures are possible for carrying the advancing mechanism, preferably the advancing mechanism is carried by bracket assembly that includes a frame (of any suitable configuration), a fastener, clamp, or other suitable connector external of but carried with the frame. The bracket assembly also includes one or more receptacles 124 for receiving one of the cord ends116 and anchoring it in place. The other end of the cord 118 is secured to the advancing mechanism so that the advancing mechanism can apply tension to the cord to pull the cord through the joint. As can be gathered, the bracket assembly might have its functions split between two or more separate components or combined into an integral component. The bracket assembly may also omit one or more of the above functions or add additional functions.

[0046] In one preferred embodiment, the advancing mechanism 122 includes a pulley or a reel 126 onto which the cord may be wound as it is advanced. The cord is preferably tensioned in a suitable manner, such as by cranking or otherwise driving the pulley or reel (e.g., with a motor or otherwise). A suitable crank may be employed, for example, which includes a post 128 and a crank arm 130. The post and crank arm may be suitably combined into an integrated crank device and the structure is not critical. However, it is preferred that the crank device is such that there is ample clearance between any actuator (e.g., a technician's arm, a power actuated driver, or otherwise) and adjacent engine components.

[0047] Also preferred, though not mandatory, is that a suitable ratcheting mechanism (such as one that may include one or more anti-reverse locks) be employed so that the cord is advanced through the joint in increments. In a highly preferred embodiment, for any advancing mechanism employed, it is preferable that the rate of advancing is sufficient to permit the cord to relax under the applied tension. In this manner it is possible to control resulting potential energy build up. In turn, in the event of cord breakage, the amount of cord travel in the engine compartment is also substantially minimized and controlled to help avoid damage to adjoining components. Of course, it is also possible to employ suitable mechanisms in which, upon advancing, the mechanism itself will store substantially all of the potential energy, such as a wind up spring motor, and particularly one with a gear reduction.

[0048] In use, the cord 114 is looped around the component and seated in the adhesive joint. The ends of the cord 114 are secured to the bracket assembly 120, with at least one end being secured to the advancing mechanism 122. With the ends of the cord in place, the cord is tensioned in a manner so as to effectively reduce the length of cord available for cutting. As the advancing mechanism winds the cord, the cord length available for cutting is reduced, and the cord is advanced through the adhesive of the joint. The cord effectively chokes the adhesive of the joint to cause the cord to pass through the adhesive. Fig. 1B shows a joint in the process of being cut where the adhesive joint 110 has been partially severed by the cord 114.

[0049] It will be recognized that the advancing of the cord in this embodiment, along with every other embodiment disclosed herein, in which a cord is tensioned, is not limited to strictly winding a cord around a reel. For example, the cord may be pulled and clamped in place, and then pulled again, and re-clamped, repeating these steps until completion. Further the mode of applying tension is not confined to the above. A suitable power driver (e.g., a driver with a suitable step-down gear) may be attached to an actuating arm, (e.g., a suitable post), and power supplied for driving the driver and the actuating arm. A suitable motor or winch may also be used.

[0050] The above is not limited to the use of only a single driving mechanism nor to a single take-up reel. Plural such components may be employed, including multiple cords. For example, it is possible that both ends of the cord are secured to one or more driving mechanisms that pull the respective ends of the cords in opposite directions. Thus, tension may be applied from one or both ends of the cord.

[0051] The path of the cord is not critical. In one embodiment the cord advances uniformly through the adhesive of the joint at approximately the same rate about the perimeter of the joint or so that a substantial portion of the adhesive about the entire joint is cut at the same time. In another embodiment, the cord advances through the joint from one portion of the assembly to another, such that the adhesive about the entire joint is cut at different times.

[0052] In another embodiment employing a cord, the cord may be moved so as to abrade the adhesive in the joint. For example, the cord may be oscillated in a back and forth motion or may be dragged across the surface of the adhesive. Slack in the cord may be periodically taken up to insure the cord remains in contact with the adhesive.

[0053] In another embodiment employing a cord, a rip-cord may be embedded into the joint, such that upon removal of the cord, the joint is served. As seen in Figs. 2A and 2B, a rip-cord 210 is embedded in the adhesive joint 212 between the valve cover 214and the engine head 216 at the time of formation of the joint. To sever the joint, the rip cord is simply pulled out of the adhesive. An advancing mechanism 218 may be used to pull the rip-cord 210 out of the adhesive. In this embodiment, the advancing mechanism 218 is stationary. The rip-cord 210 is placed in the adhesive in such a manner that one end is anchored near the advancing mechanism and the loose is attached to the advancing mechanism. A loop of the rip-cord is laid in the adhesive around the perimeter of the joint, effectively doubling the length of rip cord in the adhesive. In this way, as seen in Fig. 2Bat dotted line 220, as the rip-cord 212 is taken up by the advancing mechanism 218, the adhesive 212 is cut by the trailing end of the rip cord shown at 222.

[0054] As seen in Figs. 3A and 3B, a single length of rip cord 310 may also be used. The cord 310 is place in the adhesive 312 and pulled through the adhesive by an advancing mechanism that winds the cord 310 on to a reel 316 while the mechanism is moveable along the perimeter of the valve cover 318. A rack and pinion device may be used to move the advancing mechanism.

[0055] The cord will typically be made of a metal, a composite, a plastic or otherwise. Preferably it will exhibit a break strength of at least about 5 pounds (about 2 kg), more preferably at least about 15 pounds (about 6 kg), and still more preferably at least about 50 pounds (about 20 kg). It may also be one or two orders of magnitude higher in strength that the above, or higher (e.g., 500 pounds (about 200 kg) or higher). It may be woven, braided, or otherwise formed as a cable, or it may comprise a single fiber or wire. It may be coated, uncoated or otherwise include a surface finish to increase it abrasiveness, strength or other property. The cord may also have a cross-section other than circular (e.g. triangular) to increase its cutting ability. Examples of preferred materials for the cord include aircraft cable, piano wire, fishing line, liquid crystal polymer, high crystalline polyolefin, woven stainless steel, nylon coated cable, aramid fiber (e.g., Kevlar®), carbon fiber, or the like. The skilled artisan will appreciate that such cordage materials are available commercially through suppliers such as Saunders Thread Co., Zipper Cord, J& M, Cortland Cable or other vendors. Cords are not limited to small diameter threads or wires, but may also be a suitable chain, a belt, a strap or the like, of any suitable

width thickness or diameter. Accordingly, as used herein "cord" refers to any such part.

[0056] In another preferred embodiment, as discussed above, and also with reference to Fig. 4, cutting is accomplished by providing a cutting portion that includes a blade. In this approach, the blade (shown in shadow at 410) is preferably advanced through the adhesive joint 412 by pulling it, such as with a cord 414 or other suitable tow line or by pushing it with a suitable advancing mechanism 416.

[0057] As seen in Figs. 5A and 5B, the cutting portion 500 includes a blade 510, a body 512 and a linkage 514. The blade 510 is attached to the body 512, while the linkage 514 is attached to or part of the body 512. The blade does that actual cutting of the adhesive, while the linkage is where the tow line connects to the body.

[0058] The body is preferably adapted for articulation such that the blade stays in the adhesive as the blade is advanced over or around corners or over other surface irregularities. One way to insure the blade stays in the adhesive is to select the length of the body and the blade so that the body will not operate as a lever that disengages the blade entirely from the adhesive as the cutter is advanced. Typically a shorter body will lessen the leverage produced by the body. Alternately, the body may include a joint such as a ball in socket joint. It might have a swivel, pivot or even, hinge, a chain link mechanism (such as a bicycle chain) or the like. Other such structures are also possible as the skilled artisan will appreciate. The body may also be suitably configured with a lip 516 to help guide the cutter over surface irregularities.

[0059] The linkage is simply the structure by which the tow line is connected to the body. The linkage may be as simple as a loop through which the tow line (e.g. a cord) is passed. By way of example, the linkage might include an eyelet 518 to which a cord is attached. The eyelet may be omitted and substituted with alternative structure. When the tow line is a strap, the linkage may be a series of openings in the body through which the strap is threaded to secure the tow line to the body.

[0060] The tow line may be a cord, a strap or other suitable cable-like device, such as those described with respect to the choke type cutter.

[0061] Any of a number of different blade shapes may be employed herein. The blade shape preferably is such that, in proximate relation to the end of the blade portion closest to the plane of any linkage, the blade tip 520 is located furthest forward of the other blade parts. The blades may be any suitable shape but

preferably has a shape that would generally form an acute angle as between the tip 520 and the body 512. The blade thus may be generally triangular, rectangular, or shaped as another polygon, with one or more straight or curved (e.g., convex or concave) outer edges. The blade may be solid, or it may contain a cutout (e.g., like a cheese blade). The blades may have a substantially straight cutting edge, an arcuate concave cutting edge, and/or one or more bevels thereon. The blade may include a bulbous or other enlarged or thickened tip that will help resist pull-out of the blade from the adhesive during cutting. It may also be possible that the blade will have notches along edges opposing the cutting edge to help resist pull-out.

[0062] The blade may be centrally disposed on the cutter, offset toward one of the sides or ends of the cutter, or even disposed at angle, as desired. By way of example, Figs. 6A-6D illustrate alternative joint structures adapted for use in connection with the present invention, where like parts are represented by like reference numerals. The joints 610 include a head 612, a valve cover 614, and a cutter 616 having a blade 618 that penetrates through and cuts adhesive 620. The cutter 616 rides in a suitable track 622 that generally includes groove in the valve cover, the head or both, or which may be defined by an overhang 624, as in Fig. 6D.

[0063] As mentioned in the above, in one preferred aspect, a cutter of the present invention is adapted to receive a blade in a laterally offset location. Referring to Fig. 7A, for example, a cutter 710 is shown having a blade holder 712 proximate an edge 714 of the cutter 710. This particular cutter (though adaptable for other types of cords) is particularly attractive for use with a cord that is a strap. Thus, the cutter 710 is preferably configured with a strap attachment portion 716, preferably adjacent one of the ends 718 of the cutter 710. In this manner, a strap 720 (as seen in Fig. 7B (which also depicts an illustrative blade 722)) can be threaded onto the cutter for secure attachment. Any suitable strap material may be employed. For example, a woven fabric web may be employed, as may be a fiber or wire reinforced plastic strap. Other variations are also possible.

[0064] Fig. 7C illustrates another threading configuration for a cutter, in which the strap attachment portion is on an opposite end relative to the configuration of Fig. 7B. Fig. 7D illustrates a preferred strategy for advancing the blade 722 through an adhesive 724. As is seen the cutter is preferably disposed at a suitable cutting angle, preferably ranging from about 3 to about 60 degrees, and more preferably is less than about 45 degrees.

[0065] Preferably the blades will include a cutting edge 130 of a suitable length, such as from about 3 mm to about 50 mm, more preferably about 5 mm to about 25 mm, and still more preferably about 10 to about 20 mm. It will also be appreciated that more than one blade type may be employed for a single cutting application.

[0066] Preferably the cutting portion is a relatively low mass device, so that in the event of disengagement from the adhesive; the cutter will exert relatively insignificant force upon nearby components. For example, the cutting portion preferably weighs less than 1 kg, more preferably less than 500 g, more preferably less than 250 g and still more preferably less than 125 g.

[0067] As seen in Figs. 8A and 8B, the blade 810 may be connected to a tow line 812 and dragged through the adhesive 814 by an advancing mechanism 816. In this figure the advancing mechanism 816 is stationary and the tow line 814 is taken up on a reel in the advancing mechanism, thus pulling the blade through the adhesive to cut it.

[0068] To help ensure that the blade remains in the adhesive during cutting, the components of the joint may have defined about their outer periphery, a peripheral track or like guide surface along which the body or another portion of the cutting portion will ride during cutting. As seen in Fig. 9, a valve cover 910 and an engine head 912 are shown in an exploded view. A track 914 runs around the periphery of the engine head 912. A portion of the track may formed by the valve cover 910. The body 916 of the cutting portion slidably resides in the track 914, with the blade 918 cutting the adhesive 920 as the cutting portion is advanced through the use of a strap 922. As seen in Fig. 10, the valve cover 1010 may include a flange 1012 which overhangs so as to partially enclose or wholly enclose (shown in shadow) the track 1014. Openings 1016in the flange correspond to posts 1018 on the body 1020 such that when the body 1020 is placed in the track 1014, the posts 1018 are accepted in the openings 1016. When advanced, the body is slidably held in the track by the combination of the lip and posts. Thus, the blade is effectively held in the adhesive around the entire periphery of the components. Further, in the event cord breakage, the cutting portion will be maintained in the track.

[0069] Also, a restraint cord may be used with a tow cord, such that the restraint cord remains about the periphery of the joint to be cut. In this manner, when the blade becomes disengaged from the joint, such as upon completion of a cut or an

interruption in cutting, the restraint cord will keep the cutting portion proximate to the cutting location.

[0070] In addition to those mechanisms discussed above, numerous different kinds of advancing mechanisms may be used in the present invention. In one mechanism used with a blade cutting portion, one end of the cord is anchored and a motor or other suitable advancing mechanism is attached to a remote portion. The motor or other advancing mechanism may have a blade attached thereto. With the end of the cord to guide it to its destination, the motor or advancing mechanism will crawl along to advance the blade through the adhesive. The assembly will thus effectively function as a retractable tether.

[0071] In another mechanism a suitable track structure formed in the components of the joint will provide a loop about the periphery of the joint to guide the direction of movement of the blade. Guide posts or tracks may also be used selectively about only portions of the periphery of the joint, such as at the corners.

[0072] It may also be possible to advance a cutter by employing a suitable lever, a suitable rack and pinion device or a combination thereof. For example, attached to the advancing mechanism may be a cutter including a blade. By operating an actuator (e.g., squeezing a hand operated lever or turning a crank) the mechanism is advance along a rack molded into one of the components of the joint (e.g., a valve cover). The rack preferably has two or more gears separated by groove. The groove rides in a flange on the rack. The flange acts as a guide around contours and also as a rail to keep the blade of the cutter in the cut. This would allow for simple one-handed operation and a controlled cutting action. Other blades may be used, but with the use of a preferred curved or angled blade the resultant cutting advantageously forces draws the blade into the cut thereby allowing for greater control of the cut. Figs. 11A and 11B illustrate the use of a rack 1110 on the valve cover 1112 such that the blade 1114 is propelled through the adhesive 1116 by an advancing mechanism 1118 that engages the rack 1110. Figs. 12A and 12B show the use a rack 1210 on a flange 1212 of the valve cover 1214. Here too, the blade 1216 is propelled through the adhesive 1218 by an advancing mechanism 1220 that engages the rack 1210.

[0073] In another mechanism, as seen in Figs. 13A and 13B, a clamp-advance mechanism (CAM) 1310 may be used to advance the blade through the joint. In this case one or more blades (e.g., two) 1312 are attached to the CAM and cutting the

joint 1314 is accomplished by bringing the blades together through squeezing the actuating handle-lever 1316 through positions around the joint. For example, an actuating mechanism of clamping or spreading device such as a QUICK-GRIP QUICK CHANGE™ manually operated (e.g., with a single hand) or power driven bar clamp spreader (QUICK GRIP® brand of tools from Newell Rubbermaid Inc./American Tool Companies, Inc.) may be suitable adapted to include blade mounted on one or more of the opposing jaws that are positioned opposite each other on a suitable carrier (such as a metal bar, e.g., a heat treated steel or aluminum bar). The blade can be advanced manually, for example, by squeezing a handle, such as a pistol grip handle, on the assembly. U.S. Patent No. 6,367,787 illustrates an example of a clamp that could be modified to carry a blade, such as by the substitution of a suitable blade holder for one or more of the jaws. Similar results are obtained by using other CAM configurations. For example, the CAM may include a crankable ratcheting mechanism, as described herein, for pulling or pushing the blade through the adhesive.

[0074] From the above, it will be appreciated that, even though the materials for the cutters are not necessarily critical, there are certain materials that are believed to perform better than others for the present intended application of separating adhesively bonded engine components. The cutters or any portion thereof may be selectively treated for achieving desired properties within the cutter. By way of example, the cutting portion of a cutter may be hardened, surface treated, coated or the like to achieve or preserve a hard cutting edge, to reduce friction or a combination thereof. For example, a blade or cord may be diamond coated, ceramic coated (e.g., with TiN), plastic coated (e.g., such as with PTFE, e.g. Teflon®), wax coated, graphite coated, chrome plated, cryogenically treated, or otherwise. The cutting portion material preferably is a suitable ceramic or metal, and is preferably a steel such as (without limitation) high speed steel, high carbon steel, stainless steel or the like.

[0075] In one embodiment of the present invention a friction reducing substance is provided on a blade or cord before cutting, during cutting or a combination of the two. For example, an oil, a wax, a graphite or other lubricant may be applied. It may also be that the blade or cord is pre-treated with a lubricant, such as by soaking in a lubricant or otherwise impregnating with a lubricant.

[0076] The cutting portions herein may be provided intended for single use application only or for plural repeated usage. Under either scenario, the cutting portion is provided to include a suitable cap or sheath. Such cap or sheath may be detachably removable from the cutting portion.

[0077] For multi-piece devices, it may be possible that the cutting portion will be provided with a suitable chuck or like connector mechanism for permitting attachment of the cutting portion to the cord or other advancing portion. In this manner, it is possible that the cord or other advancing portion will be part of a mechanism that is subsequently re-used, while the cutting portion is replaced or interchanged with another cutting portion after a limited usage (e.g., after a single use or for cutting a different material, with possible later re-usage). The cutting portion thus may be provided as a cartridge in a holder containing other cartridges of the same or different type.

[0078] The present invention may be used to make a complete or a partial cut of the adhesive in the joint between the components. A complete cut would separate the components from each other by splitting the entire joint between the components. A partial cut would, on the other hand, split only a portion of the joint and leaving adhesive holding the components together. The remaining adhesive could be cut by another cutting device, or merely split by using manual force. For example, a cutter with a blade cutting portion may be used to cut the adhesive on three sides of a valve cover, leaving the valve cover attached to the engine block by an adhesive strip. The adhesive strip could then be torn by applying manual force to the valve cover. In other embodiments, portions of sides may be cut or several partial cuts may be made in the joint. The partial cut embodiment has the advantage of not requiring the cutting portion to be maintained in the adhesive through the entire joint. This will simplify the complexity of the cutter and its use.

[0079] It will be appreciated from the discussion herein that the present invention is not intended to be limited to the use in connection with bonded valve cover assemblies. It finds useful application in any of a number of applications, particularly those in which a plurality of substrates are joined together by an adhesive layer, such as where high integrity sealing is important, including but not limited to adhesively bonded automotive engine component assemblies, adhesively bonded automotive window assemblies, adhesively bonded aircraft or spacecraft component assemblies, adhesively bonded marine craft component assemblies, adhesively

bonded construction or building material assemblies (e.g., building window assemblies), shipping containers, storage containers, furniture, computer hardware, underwater devices, navigation or communications equipment hardware, or the like. The present invention thus contemplates methods of cutting joints of each of these types in which such joint is provided and the joint is cut using a cutter in accordance with the present invention. Repair or replacement is thereafter effectuated.

[0080] The present invention is particularly advantageous in that it affords a continuous cutting operation to occur, substantially free of interruption. That is, the cutting portion can separate an entire joint (or a portion of a joint) without removal of the cutting portion from between first and the second components of the joint (e.g., of a joint including at least one component that is relatively rigid). Further, cutting advantageously is performed upon a joint that is confined within an enclosable space, such as under the hood of an automotive vehicle. The ability to be able to use the present invention for repair or replacement of adhesively bonded valve covers or other parts heretofore attached using mechanical fasteners is further demonstrated by the simplification of part design made possible by adhesive bonding.

[0081] It will also be appreciated that the present invention can be used with more than a first and second substrate (e.g., a third, fourth or more). The substrates can be of the same or a different material. A joint between a first and second substrate of a first and second material respectively may be separated and one or more of the substrates replaced by another substrate of yet a different material.

[0082] The present invention covers the employment of cutting for the purpose of separating a joint that includes a layer of adhesive that is in direct contact with (either via a primer or not) the joined components. It is also possible to vary this approach. For example, a "sacrificial" gasket might be employed. Under this approach, preformed gasket or a formed in place gasket of a suitable first adhesive or other suitable gasket material is wetted or otherwise contacted on either or both of its faces with a suitable second adhesive (e.g., a very light coating, or a more thick coating) before, during or after when the assembly is put together. The first adhesive is preferably selected so that it provides a material that is easier to cut than the second adhesive, or it may itself include a suitable tear strip on its interior, the exterior or both. The first adhesive may in turn be cut with a suitable cutting knife or any of the other structures disclosed herein. This system may employ notches cut into one or both of the both components joined.

[0083] Under another approach, particularly for a valve cover, a two piece valve cover may be employed. A first piece is attached directly to the engine cylinder head. A second piece is adhesively attached to the first piece (e.g. with a RTV or elastomeric type adhesive, and optionally with fasteners) and is positioned remote from the cylinder head. Access to the cylinder head is gained by separating the first piece from the second piece in accordance with the teachings herein.

[0084] The present invention is not limited to the above joint separation techniques but may also encompass other techniques. By way of example, any of the following techniques might be employed. An adhesive structure, composition or both might be employed to offer tear or crack propagation in one direction such that once started, a cut will "open" like a sardine can. It may then be re-bonded, such as with a wet adhesive. In another approach, a living hinge might be incorporated into the joint which can controllably place the adhesive in a "peel" mode, where the force needed to separate the joint can be reduced. In another approach, the structure of the bonded assembly is configured so that a vertically disposed shear bond line is provided for easier access for cutting. In this approach it may also be desirable to use a low cost conformable material to provide a temporary seal for adhesive dispensing. In another approach, a rolling seal may be provided (so as to enable the adhesive to be placed in peel mode) and employed with a pressure sensitive adhesive. In yet another approach for a bonded valve cover, a suitable structure, such as a steel stamping, is bonded to an engine cylinder head. The stamping or the cover has slots to receive detents in the opposing part. The opposing part in turn has an overmolded seal with locking detents. In yet another approach, components are bonded together with an adhesive and a second mechanical seal is also employed, such as an extruded seal strip having a structure such as found in a Zip-Lock™ brand bag, to provide an additional force (e.g., a compressive force) for sealing. In yet one additional approach a selective heating or radiation is applied to the adhesive to locally degrade the adhesive. This can be done about the periphery of the joint.

[0085] It will be appreciated that the present invention may take advantage of one or a combination of different joint structures as between an engine head, a valve cover, and any intermediate structure or member. In one embodiment, though not required in every instance herein, a suitable guide track is formed in the joint, into which a cutter can be place, and over which it will ride during cutting. The track may

be formed substantially about the periphery of the engine head, the valve cover, any additional intermediate structure or a combination thereof. Any suitable joint may be employed, including but not limited to butt joints, scarf joints, tongue and groove joints, lap joints or otherwise. Preferably the adhesive is such that it does not project substantially away from either an inner wall or an outer wall of the respective engine component to which it is applied. Either or both of the valve cover or the engine head may include a suitable cutout for receiving the blade of the cutter.

[0086] The present invention also contemplates the employment of devices and techniques for bonding a first substrate to a second substrate where one or both of the substrates has been repaired or replaced after separation of a joint according to the present invention. In general, after such separation, the mating surfaces of the respective substrates are prepared for receiving an adhesive. For example, some or all of the adhesive from the pre-existing joint may be removed from the mating surfaces of the respective substrates, such as by scraping or cutting, and then the surface is optionally degreased, primed or both, and then one or more beads of adhesive applied about the mating surfaces. In another preferred approach, temporary or permanent locators are placed between the substrates for helping to assure proper substrate separation, such as for optimizing control over engine noise, vibration and harshness.

[0087] The present invention also thus contemplates providing kits having therein one or more of the tools or materials for performing the repair or replacement techniques in accordance with the present invention. Thus, for example, in one embodiment, a kit is provided including a cutter, an adhesive and optionally at least one of a primer, a dispensing nozzle, a handling device (e.g., as described herein), gloves, wipes, a degreaser (or other solvent that is applied to prepare a surface for joining with an adhesive), a scraper, cutting lubricant or other tools (e.g., a wrench, screw driver or otherwise). The above components, of course, may be employed independently of whether they are provided as a kit. The kit may be packaged in any suitable manner. For example, one or more components may be shrink-wrapped in plastic, provided in a container (e.g., a cardboard box), or a combination thereof. The adhesive may be supplied in any suitable container, such as a dispensing tube, a bladder, a drum, a pail, or the like. It may also be possible to supply a suitable applicator in the kit, such as a glue gun (e.g., adapted for receiving one or a plurality

of tubes that dispense through a common nozzle (such as for a two component adhesive) or separate nozzles).

[0088] Turning to Figs. 14A-14C there are shown examples of suitable handling devices that facilitate placement of one or more of the components at the time of creating the adhesive joint. The handling devices 1410 preferably include a jaw portion 1412, and one or more handle portions 1414. The jaw portion preferably includes one or both of a spacer (e.g. a projection or other suitable structure) 1416 or an alignment arm 1418. The spacer functions to space the components 1420, 1422 being joined by an adhesive 1424 at a predetermined spacing (e.g., about 1 to about 50 mm, more preferably about 2 to about 30 mm, and still more preferably about 3 to about 10 mm). The alignment arm functions to help locate opposing parts in a predetermined mating relation. The devices may include one or a plurality of opposing jaw portions. Plural jaw portions may be positioned transversely spaced relative to each other (e.g., Fig. 14A), orthogonally relative to each other, or otherwise. They may be separated as plural individual handling devices or joined in a common frame, such as in Fig. 14A. The handling devices may be made of any suitable material, such as a metal, a plastic, or a composite. The jaw portions may be selectively coated or otherwise covered with a suitable non-marring material, such as an elastomeric material. Grips may be integrated onto the handle portions. Though not mandatory, in one embodiment, the spacing between opposing jaw portion ends preferably is less than the corresponding dimension of the component being handled. In this way the jaws, upon spreading to fit the component, will be in compression. It will be appreciated that the number of opposing jaw may be as little as two. For example, a single pair of opposing jaws may be advanced along a length of a component by simultaneously advancing both jaws along the lengthy or alternating translation of one followed by another.

[0089] It will be appreciated that some of the above features may be omitted. The features may also be used in combination with one or more additional embodiments disclosed, such as the use of an anti-rotation member with another cutter or blade, the use of a different joint type, the use of a different cord, the use of a manual or power driven advancing mechanism or combinations thereof.

[0090] Unless stated otherwise, dimensions and geometries of the various structures depicted herein are not intended to be restrictive of the invention, and other dimensions or geometries are possible. Plural structural components step can

be provided by a single integrated structure or step. Alternatively, a single integrated structure step might be divided into separate plural components or steps. However, it is also possible that the functions are integrated into a single device.

[0091] In addition, while a feature of the present invention may have been described in the context of only one of the illustrated embodiments, such feature may be combined with one or more other features of other embodiments, for any given application. It will also be appreciated from the above that the fabrication of the unique structures herein and the operation thereof also constitute methods in accordance with the present invention.

[0092] It is understood that the above description is intended to be illustrative and not restrictive. Many embodiments as well as many applications besides the examples provided will be apparent to those of skill in the art upon reading the above description. The scope of the invention should, therefore, be determined not with reference to the above description, but should instead be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. The disclosures of all articles and references, including patent applications and publications, are incorporated by reference for all purposes.

CLAIMS

What is claimed is:

Claim 1 A method for cutting an adhesively bonded joint, comprising:

providing a joint that includes an adhesive, a first component and a second component; and

cutting the adhesive with a cutter including a cutting portion that is advanced with an advancing mechanism about at least a portion of a length of the joint.

Claim 2 The method of claim 1, wherein the cutting portion is advanced about the at least a portion of the length of the joint without being removed from between the first and the second components.

Claim 3 The method of claims 1 or 2 wherein the cutting portion includes a cord.

Claim 4 The method of claims 1 to 3, wherein the cutting portion includes a rip-cord that is embedded in the joint.

Claim 5 The method of claims 1 to 4, wherein the cutting portion includes a blade.

Claim 6 The method of claims 1 to 5, wherein the advancing mechanism includes a tow line, a reel, a pulley, a lever, a crank, a ratcheting mechanism, a manual mechanism, a power drive mechanism, a rack and pinion mechanism, a clamp advance mechanism, and combinations thereof.

Claim 7 The method of claims 1 to 6, wherein the advancing mechanism applies a force to the cutting portion wherein the force is selected from a constant force, an intermittent force, an oscillating force, a variable force and combinations thereof.

Claim 8 The method of claims 1 to 7, wherein the cutting portion includes a cord and the advancing mechanism includes a reel and a ratcheting mechanism.

Claim 9 The method of claims 1 to 8, wherein the cutting portion includes a blade and the advancing mechanism includes a tow line and a reel.

Claim 10 The method of claims 1 to 9, wherein the first component and second component cooperate to form a track in which the cutting portion slidably rides.

Claim 11 The method of claims 1 to 10, wherein the first component includes an overhanging flange and at least one opening in the flange adapted to accept a post on the cutting portion.

Claim 12 The method of claims 1 to 11, further comprising a restraint line.

Claim 13 The method of claims 1 to 12, wherein the advancing mechanism is attached to the first component, the second component or both components.

Claim 14 The method of claims 1 to 13, wherein the first component and the second component form an automotive vehicle component assembly.

Claim 15 The method of claims 1 to 14, wherein the automotive vehicle component assembly is selected from the group consisting of an adhesively bonded valve cover cylinder head assembly, an adhesively bonded water conductor assembly, and adhesively bonded oil pan assembly and an adhesively bonded radiator assembly.

Claim 16 A kit for repairing or replacing an adhesively bonded joint of an automobile, comprising:

a cutter having a cutting portion adapted for translation about at least a portion of a length of a bonded joint of an automotive vehicle component assembly having at least a first and a second engine component; and

an adhesive for bonding at least one of the first or second engine components upon assembly of the same with another of the components or a replacement therefor.

Claim 17 The kit of claim 16, further comprising at least one of a primer, a degreaser, a scraper, or a handling device.

Claim 18 A kit for practicing the method of claims 1 to 15.

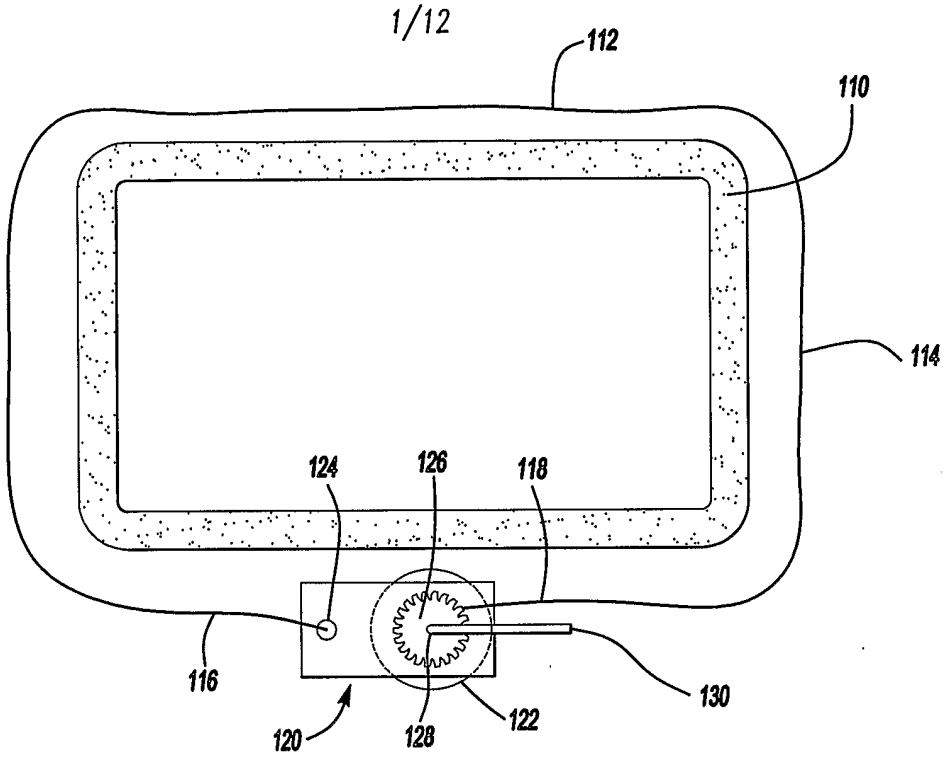


Fig-1A

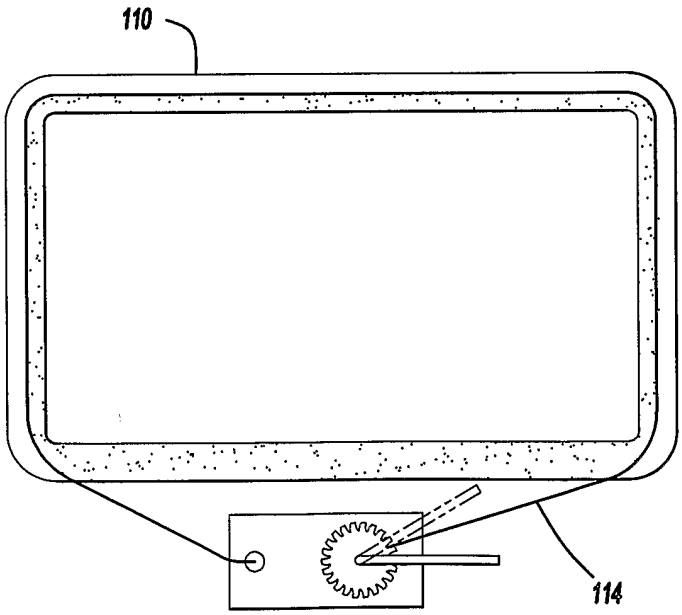


Fig-1B

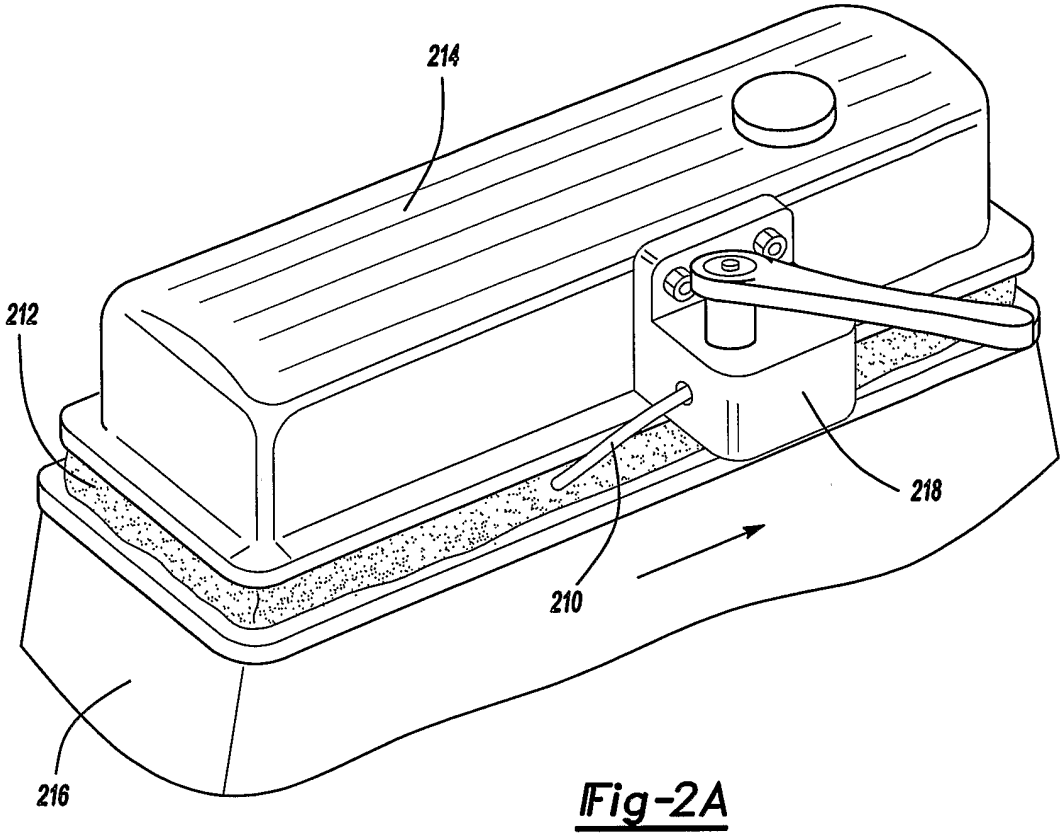


Fig-2A

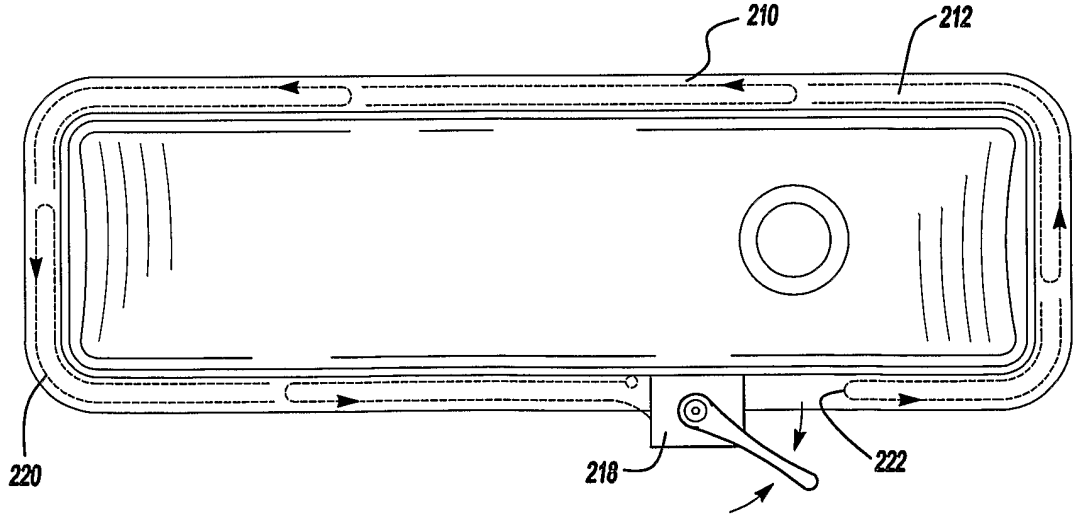


Fig-2B

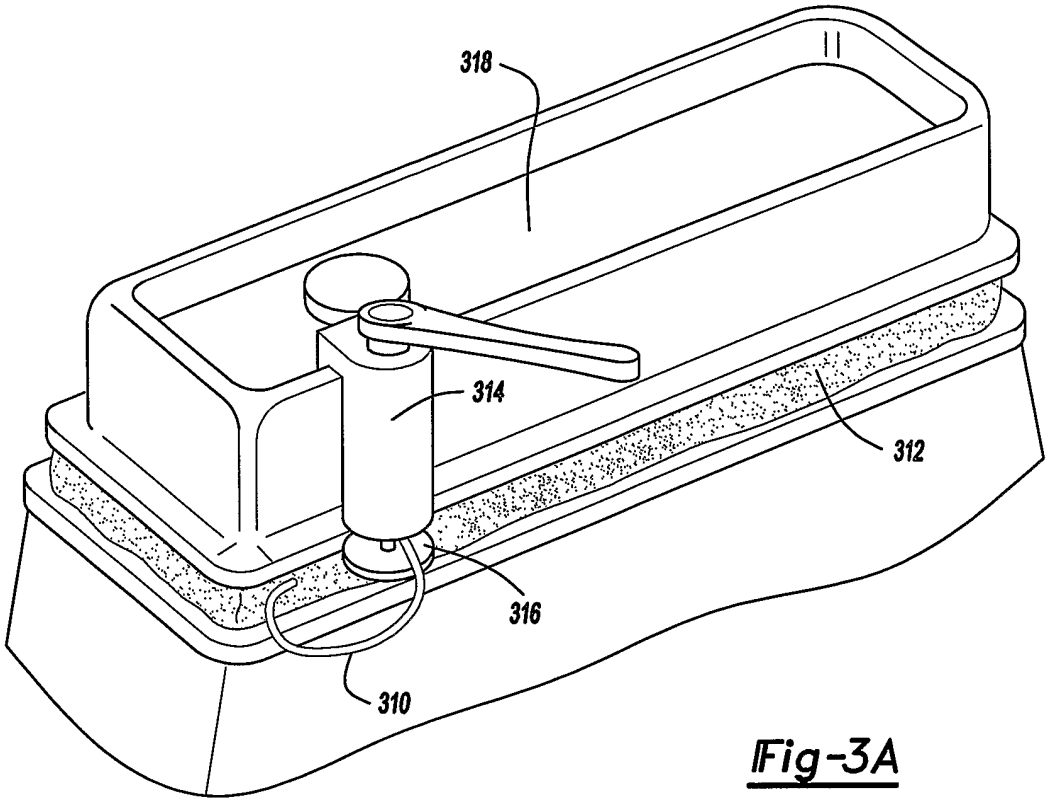


Fig-3A

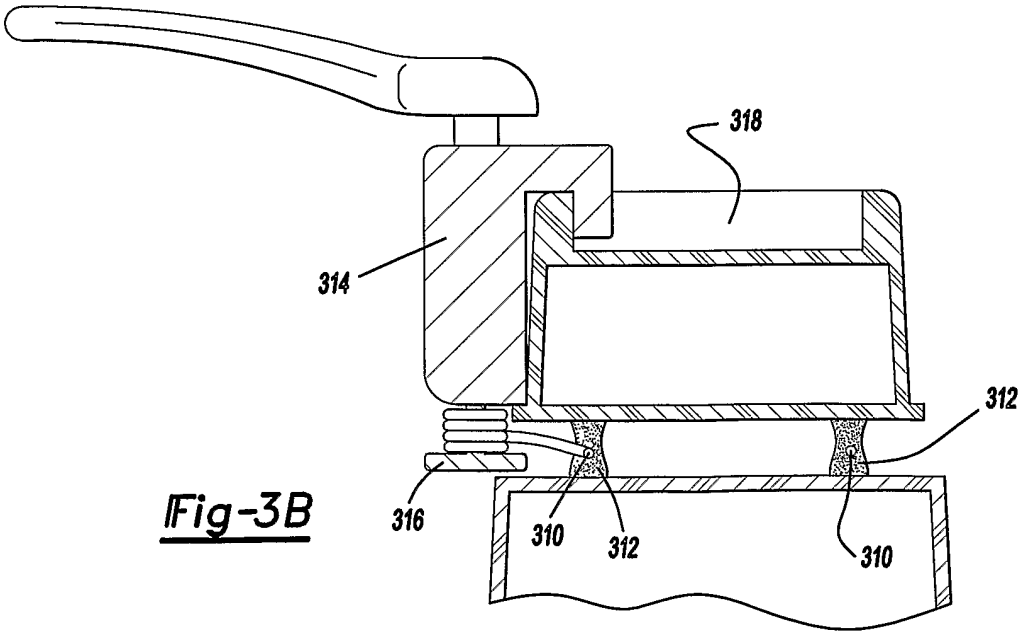


Fig-3B

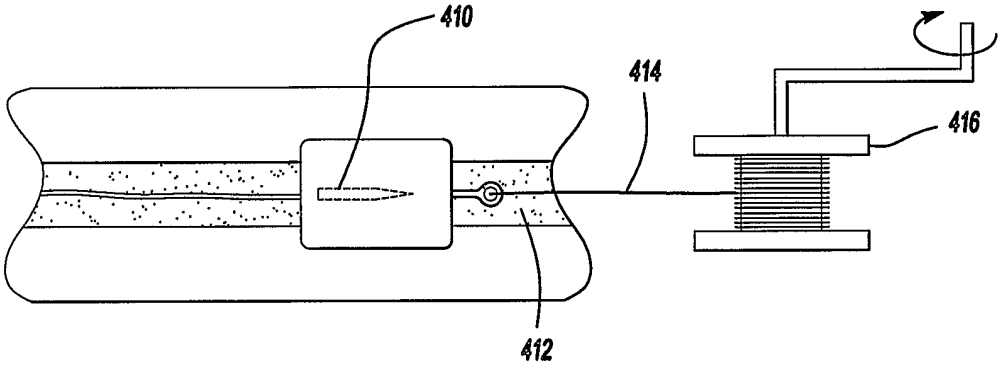


Fig-4

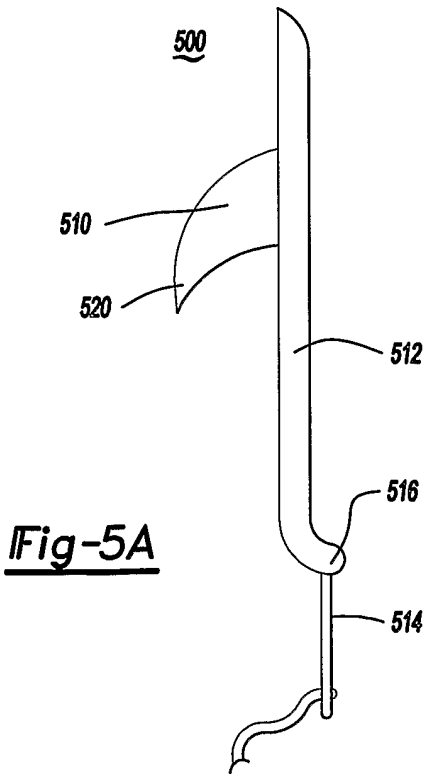


Fig-5A

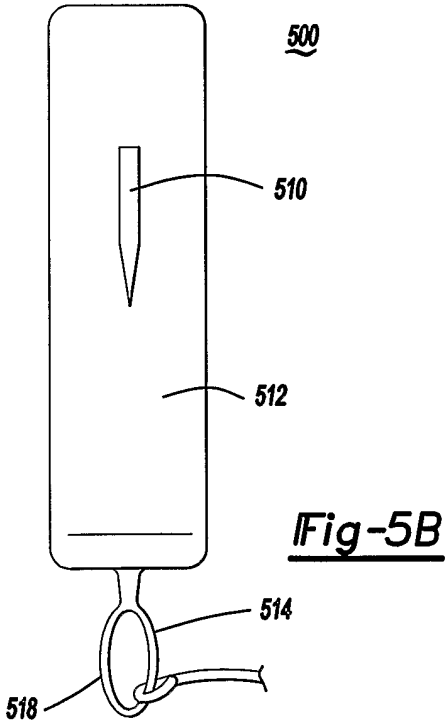


Fig-5B

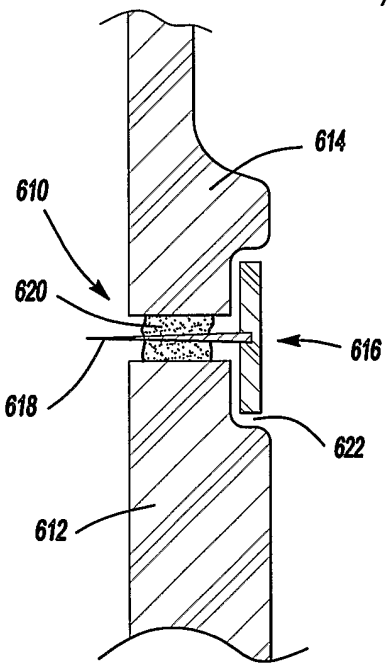


Fig-6A

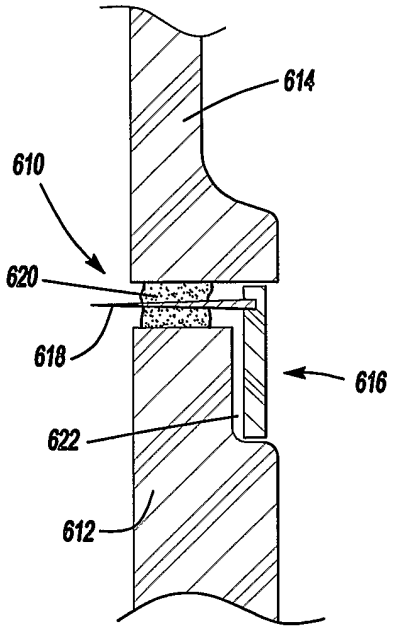


Fig-6B

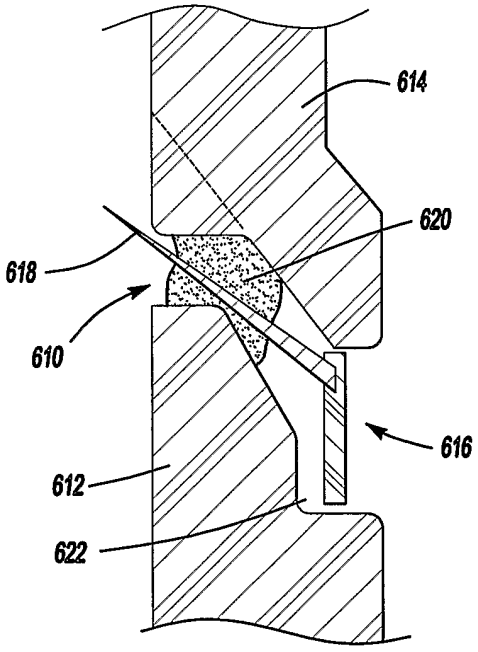


Fig-6C

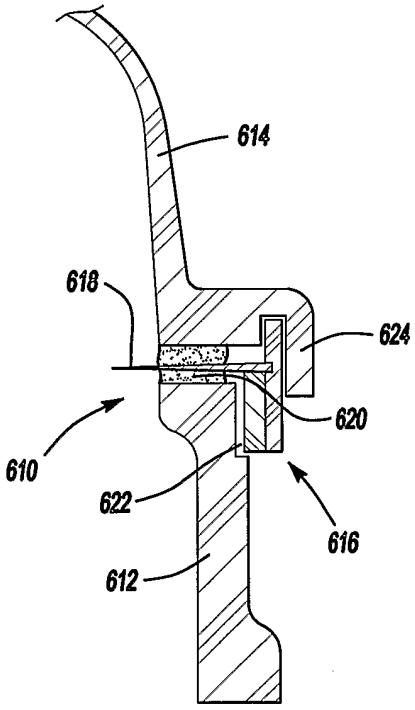


Fig-6D

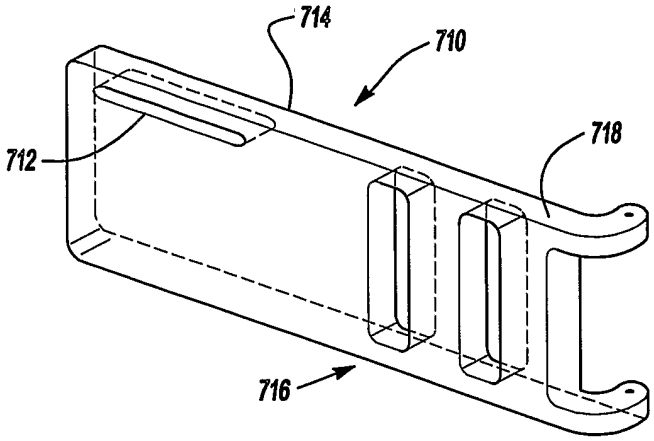


Fig-7A

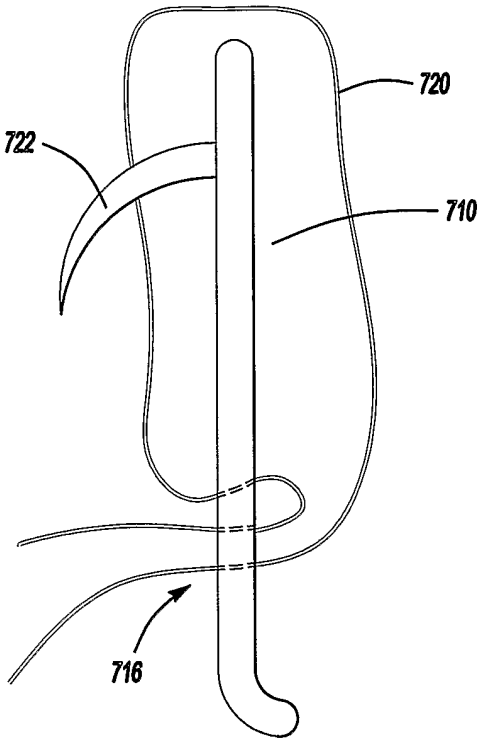


Fig-7B

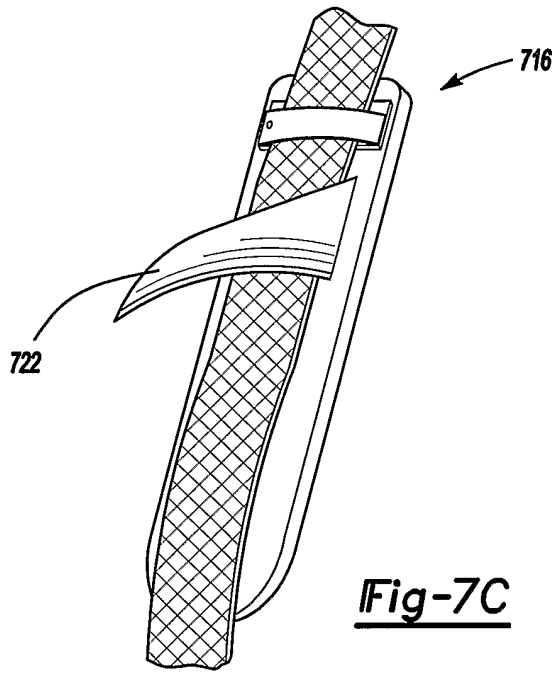


Fig-7C

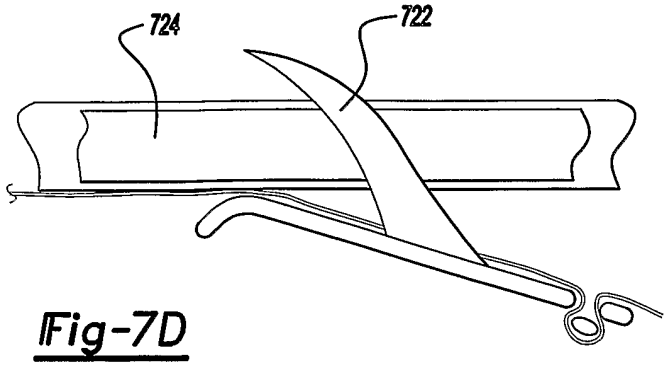


Fig-7D

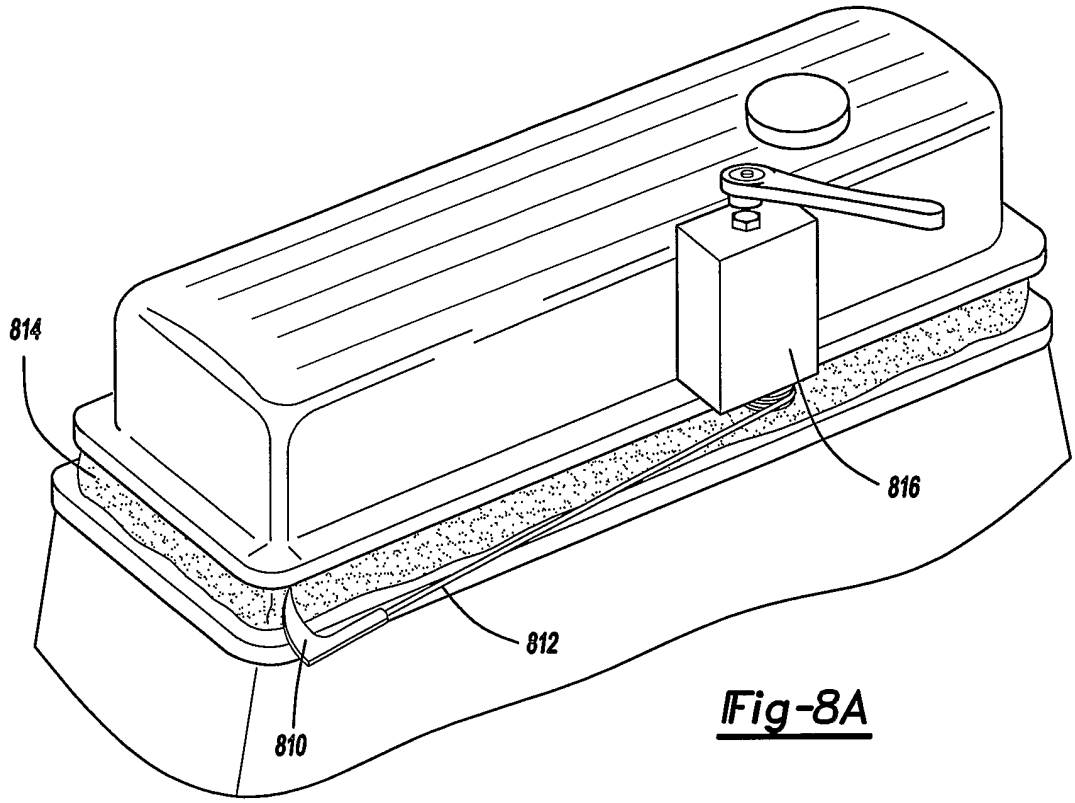


Fig-8A

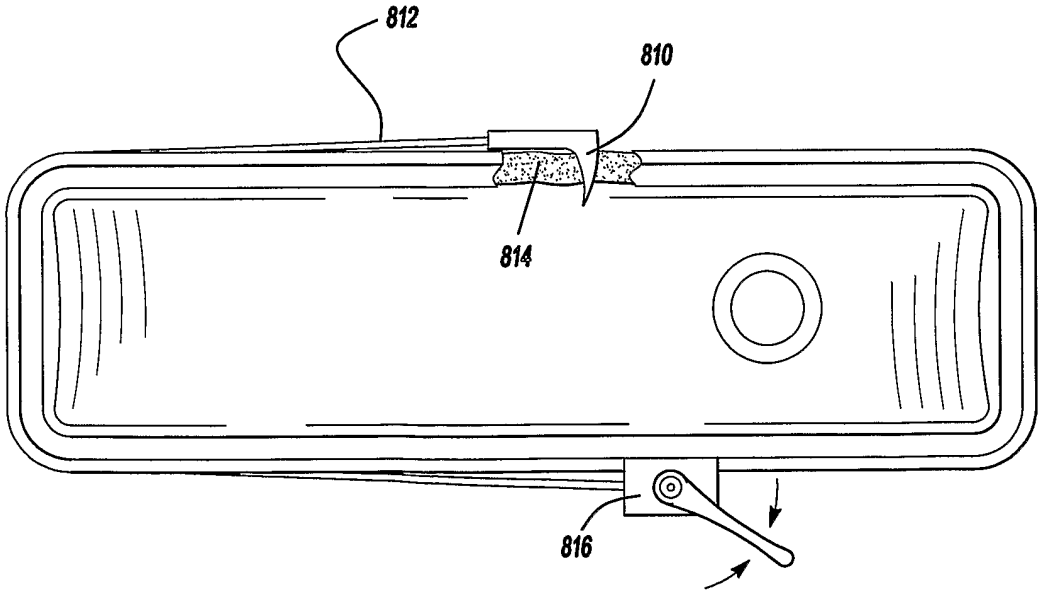


Fig-8B

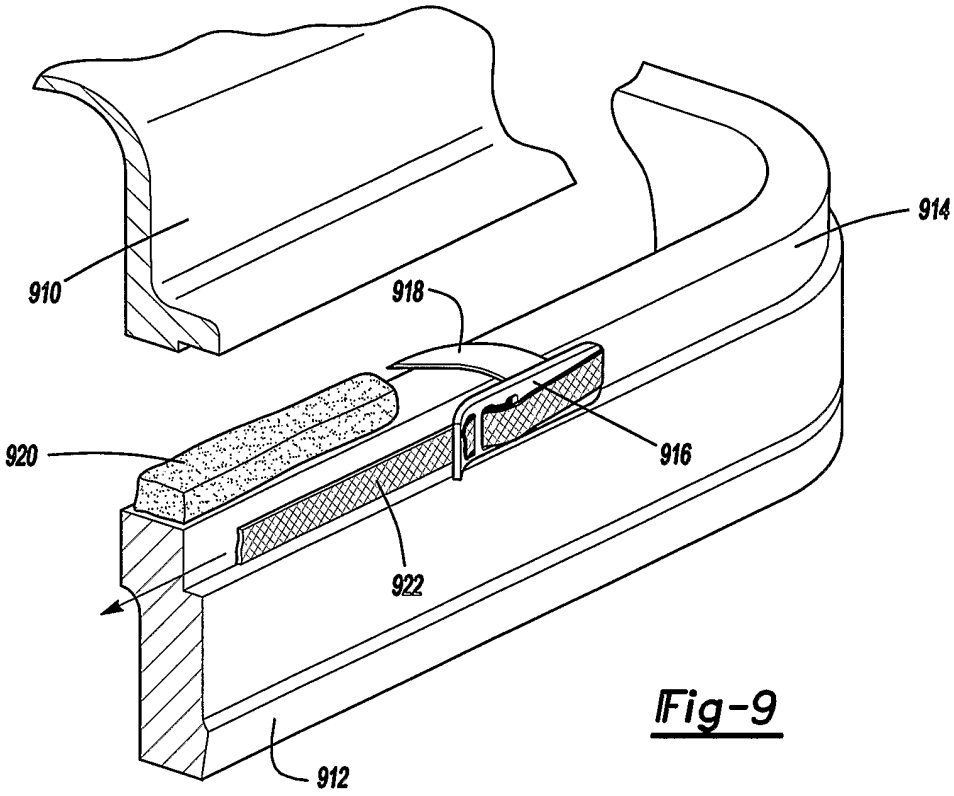


Fig-9

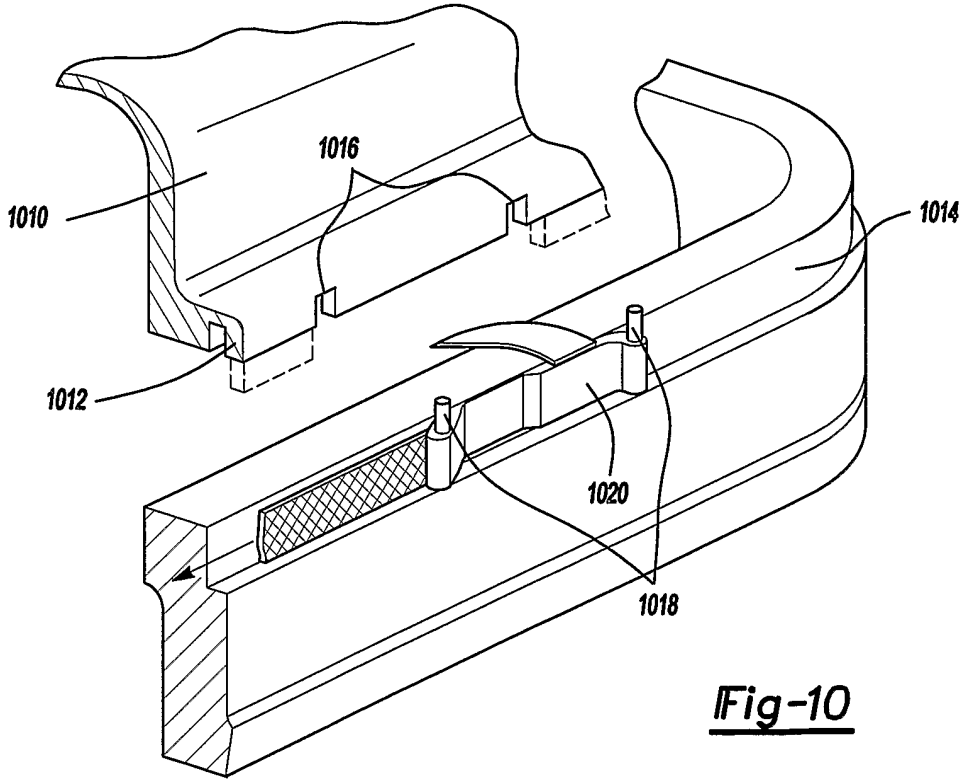


Fig-10

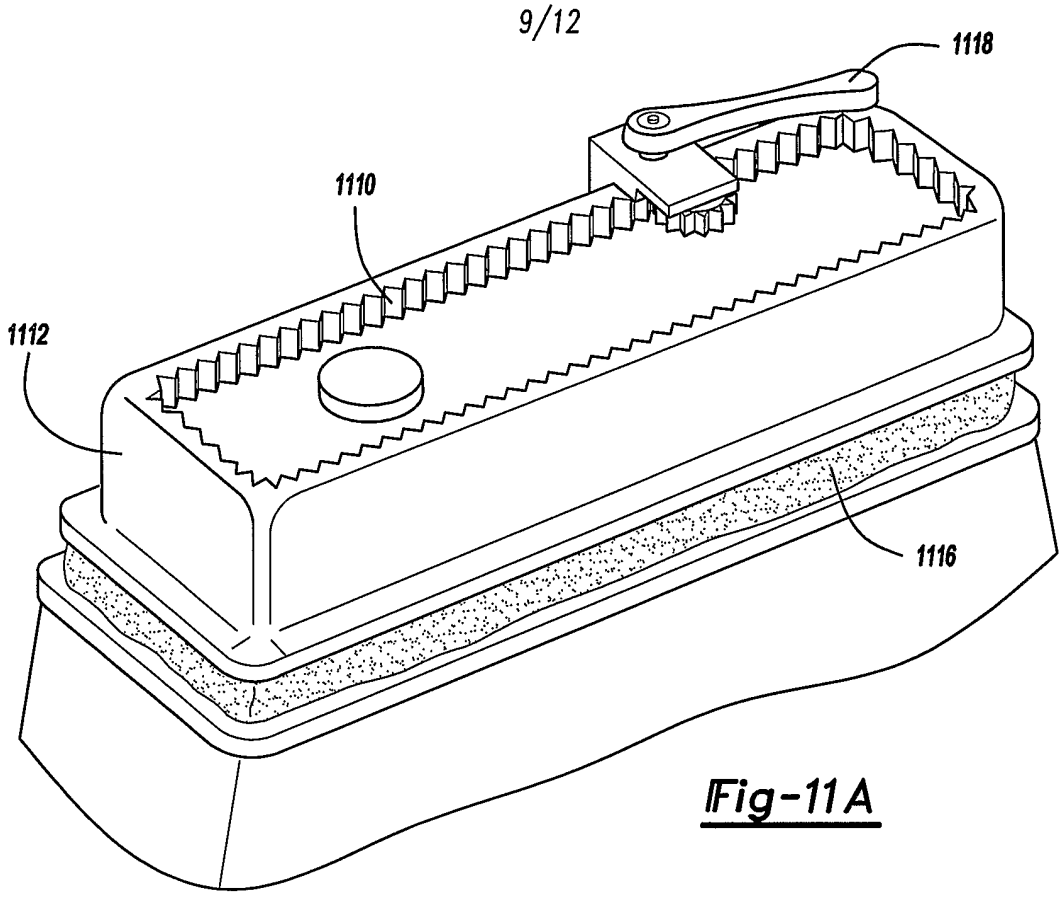


Fig-11A

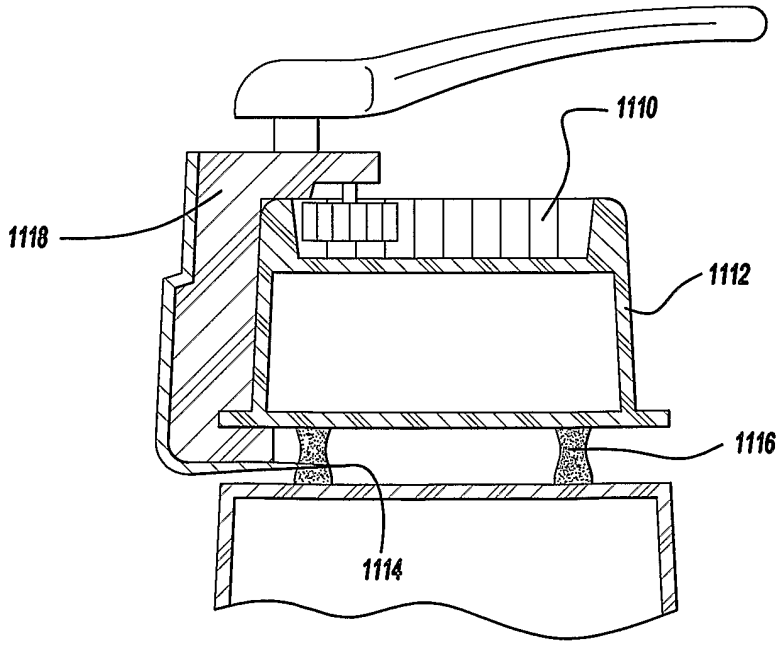


Fig-11B

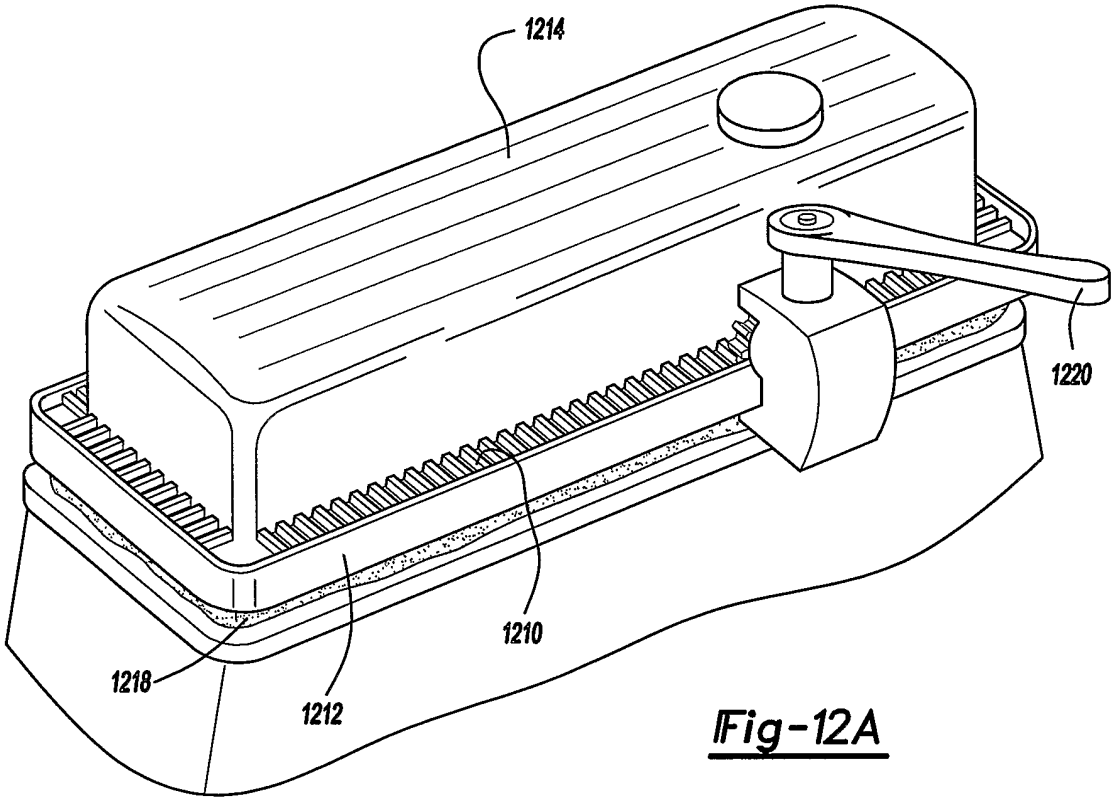


Fig-12A

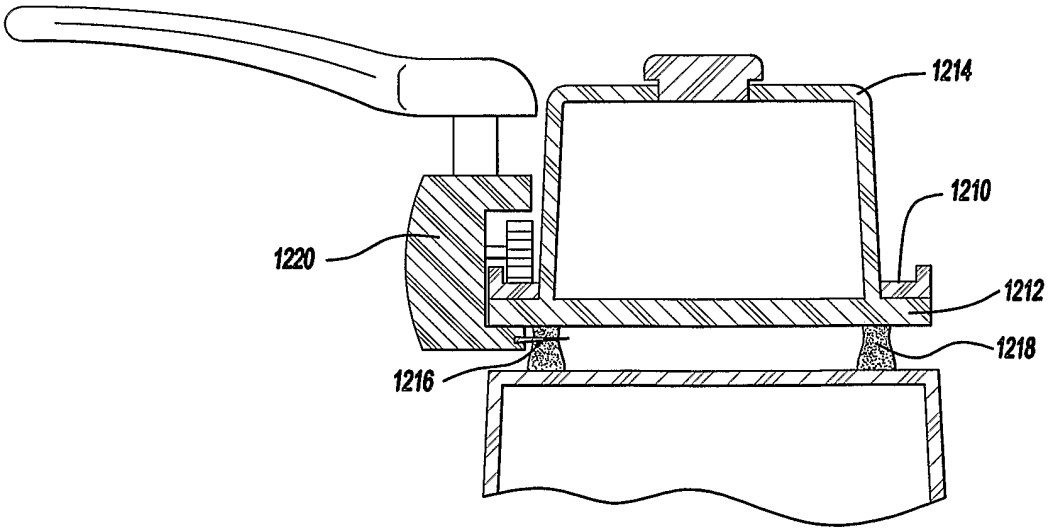


Fig-12B

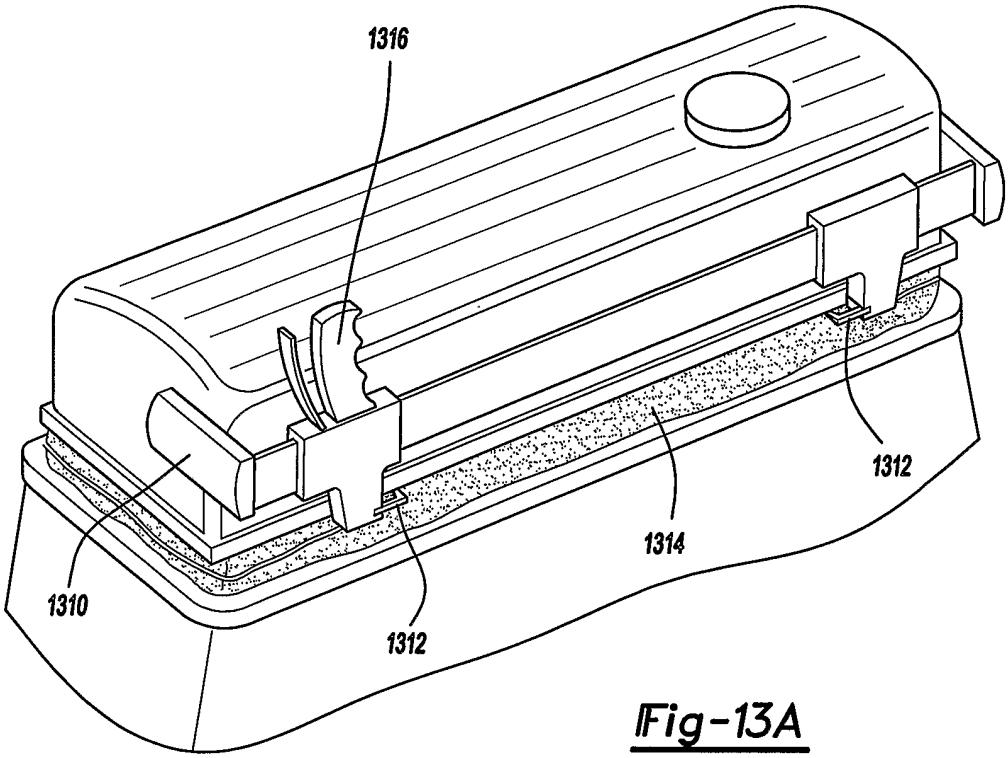


Fig-13A

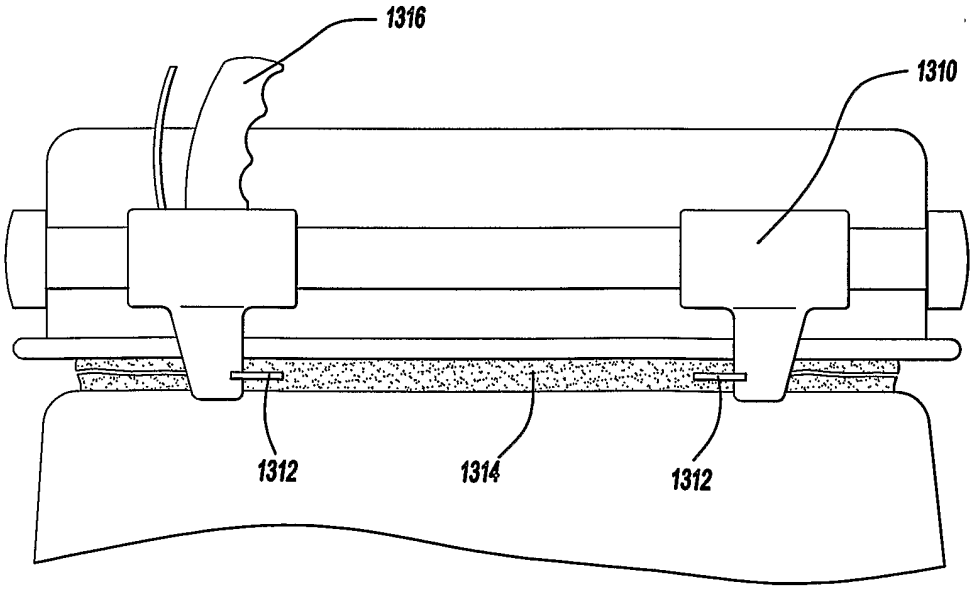
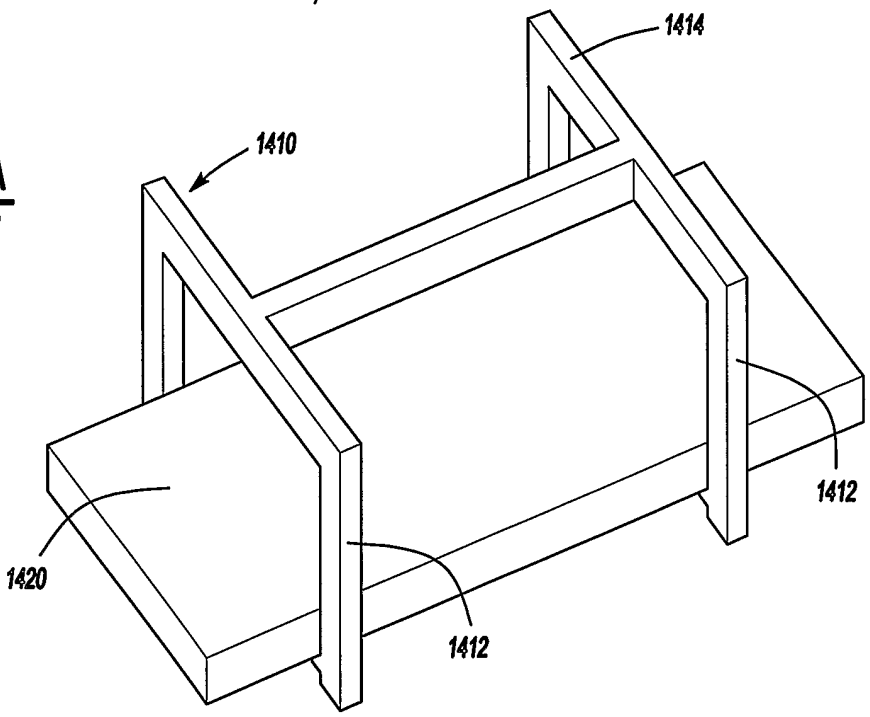


Fig-13B

Fig-14A



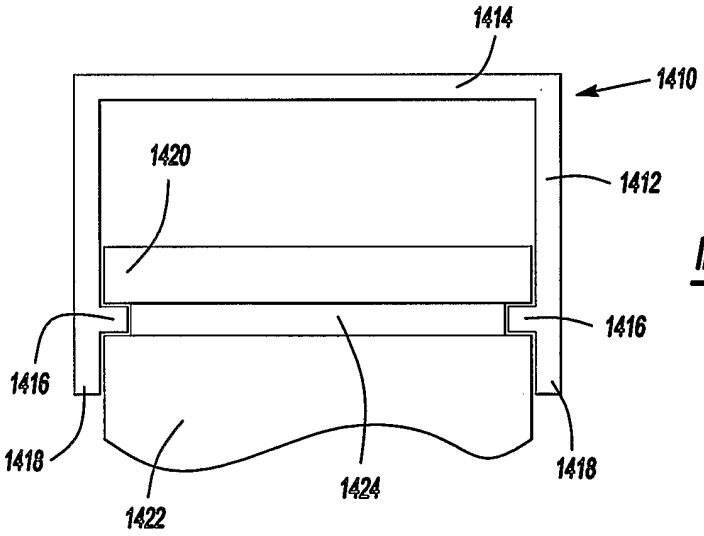


Fig-14B

Fig-14C