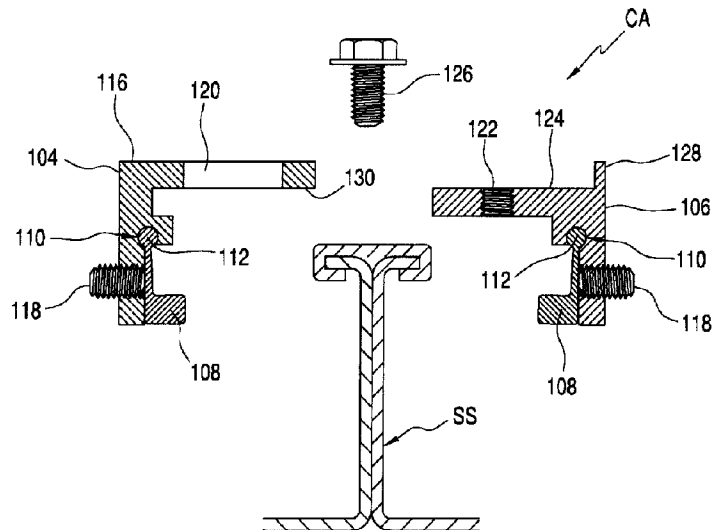




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(54) Titre : ELEMENT A BORDS RELEVES ET ETRIER DE FIXATION POUR JOINTS DEBOUTS
 (54) Title: FLANGED MATERIAL AND STANDING SEAM CLAMP



(57) **Abrégé/Abstract:**

A clamping assembly for attaching loads to various kinds of flanged seams, the assembly comprising a generally U-shaped clamp body, at least one clamping hammer disposed interior of the clamp body, the clamping hammer is secured to the clamp body along the longitudinal axis of the clamp body, at least one adjustment screw extending through the clamp body and adapted to selectively impinge against the clamping hammer and cause it to pivot about its axis or otherwise move inwardly within the clamp body, the adjustment screw extending transverse to the longitudinal axis of the clamping hammer, at least one locking screw adapted to selectively impinge against the clamping hammer to prevent pivoting of the same may be optionally provided whereby a standing seam received within the clamp body may be tightly grasped between the clamp body and the clamping hammer under action of the adjustment screw.



Abstract

A clamping assembly for attaching loads to various kinds of flanged seams, the assembly comprising a generally U-shaped clamp body, at least one clamping hammer disposed interior of the clamp body, the clamping hammer is secured to the clamp body along the longitudinal axis of the clamp body, at least one adjustment screw extending through the clamp body and adapted to selectively impinge against the clamping hammer and cause it to pivot about its axis or otherwise move inwardly within the clamp body, the adjustment screw extending transverse to the longitudinal axis of the clamping hammer, at least one locking screw adapted to selectively impinge against the clamping hammer to prevent pivoting of the same may be optionally provided whereby a standing seam received within the clamp body may be tightly grasped between the clamp body and the clamping hammer under action of the adjustment screw.

FLANGED MATERIAL AND STANDING SEAM CLAMP

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CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is related to but does not claim
10 priority to International application No. PCT/US2012/039283
published on December 6, 2012 and US Patent No. 8,528,888 issued
on September 10, 2013.

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FIELD OF THE INVENTION

[0002] This invention is a clamp assembly for attaching to
various kinds of flanged seams including, but not limited to,
standing seam roofing.

BACKGROUND OF THE INVENTION

[0003] Standing seams are often used to interconnect metal panels to form the roof of a building or other structure. The seam is created by bending and profiling together adjacent side edges of two metal sheets to form an upwardly extending portion that interlocks the sheets as it extends the width or length of the roof surface. The head or uppermost portion of the seam may be formed in a variety of shapes depending upon the manner in which the sheets are profiled together. For example, the head of a standing seam may be L-shaped, T-shaped, rounded, doubled over or have some other profile correlating to the nature of end use.

[0004] It is desirable to attach a structure to a standing seam, especially in the case of roofing. Rooftops are obvious locations for mounting of solar panel arrays, walkways, plumbing, wiring or other ancillary structures including but not limited to snow catchers, ice dams, etc.

[0005] When attaching a structure to standing seam, drilling or penetration of the seam is avoided because doing so can affect the life of the roof. Clamp assemblies that do not penetrate a standing seam are known; however, these devices use bolts that are tightened directly against the seam which can

damage the seam and ultimately affect the integrity of the roof. Prior art clamping assemblies also produce an uneven clamping pressure that is not evenly distributed against the seam eventually leading to clamp or roof failure. Many other roofs clamps are known, but in each of these cases the device is complicated and difficult to install quickly.

BRIEF SUMMARY OF THE INVENTION

[0006] The present invention is a clamping assembly comprising a generally U-shaped clamp body for receiving a standing seam, an I-beam or similar structure, either a pair of cooperating clamping hammers or a single clamping hammer are disposed interior of the clamp body, the clamping hammers are hingedly secured to the clamp body along a longitudinal axis of the body and each is provided with at least one adjustment screw adapted to movably extend through the clamp body and selectively impinge against the hammer and cause it to pivot about its axis to open and close the clamp, the adjustment screw being disposed transverse to the longitudinal axis of the clamping hammer, each clamping hammer is also provided with a typical or optional one locking screw that movably extends through the clamp body to selectively impinge against the hammer and prevent pivoting whereby a standing seam or other structure received within the

clamp body may be tightly grasped between the pair of cooperating hammers (or single hammer) to clamp and lock it into place.

[0007] The present invention is also directed to a clamping assembly comprising a generally U-shaped clamp body comprising two interconnected body members for receiving a standing seam, an I-beam or similar structure, either a pair of cooperating clamping hammers or a single clamping hammer are disposed interior of the clamp body, the clamping hammers are hingedly secured to the clamp body along a longitudinal axis of the body and each is provided with at least one adjustment screw adapted to movably extend through the clamp body and selectively impinge against the hammer and cause it to pivot about its axis to open and close the clamp, the adjustment screw being disposed transverse to the longitudinal axis of the clamping hammer, each clamping hammer is also provided with at least one locking screw that movably extends through the clamp body to selectively impinge against the hammer and prevent pivoting whereby a standing seam or other structure received within the clamp body may be tightly grasped between the pair of cooperating hammers (or single hammer) to clamp and lock it into place.

[0008] The present invention is also directed to a clamping assembly comprising a generally U-shaped clamp body for

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receiving a standing seam, an I-beam or similar structure, either a pair of cooperating clamping hammers or a single clamping hammer are disposed interior of the clamp body, the clamping hammers are hingedly secured to bottom of the clamp body and each is provided with at least one adjustment screw adapted to movably extend through the clamp body and selectively impinge against the hammer and cause it to pivot upwardly about its axis to open and close the clamp, the adjustment screw being disposed transverse to the longitudinal axis of the clamping hammer, each clamping hammer may also provided with at least one locking screw that movably extends through the clamp body to selectively impinge against the hammer and prevent pivoting whereby a standing seam or other structure received within the clamp body may be tightly grasped between the pair of cooperating hammers (or single hammer) to clamp and lock it into place.

[0009] The present invention is also directed to clamping assembly comprising a generally U-shaped clamp body for receiving a standing seam, an I-beam or similar structure, either a pair of cooperating clamping hammers or a single clamping hammer that generally I-shaped in cross section and disposed interior of the clamp body within a longitudinal slot, the clamping hammers are fitted within the clamp body along a

longitudinal axis of the body and each is provided with at least one adjustment screw adapted to movably extend through the clamp body and selectively impinge against one side of the hammer to cause it shift laterally open and close the clamp, the adjustment screw being disposed transverse to the longitudinal axis of the clamping hammer, each clamping hammer is also provided with an increased clamping surface area to provide contact against a seam to be clamped whereby a standing seam or other structure received within the clamp body may be tightly grasped between the pair of cooperating hammers (or single hammer) to clamp and lock it into place.

[0010] The present invention is also directed to a clamping assembly comprising a generally U-shaped clamp body for receiving a standing seam, an I-beam or similar structure, either a pair of cooperating clamping hammers or a single clamping hammer are disposed interior of the clamp body, the clamping hammers comprise a block fitted with a washer and rivot secured to the clamp body along a longitudinal axis of the body and each is provided with at least one adjustment screw fixed at one end thereof to the washer and rivot and adapted to movably extend through the clamp body and selectively impinge against the block to cause it to travel inwardly within the clamp to clamp a standing seam, the adjustment screw being disposed

transverse to the longitudinal axis of the clamping block. In the alternative, the washer and rivot may be replaced with a free spinning washer and nut to move the clamping block.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0011] Figure 1 is a perspective view showing a typical overlap type standing seam that may be clamped by the present invention;

[0012] Figure 2 is a perspective view showing the clamp assembly according to the present invention with portions broken away;

[0013] Figure 3 is perspective view of the clamp shown in figure 2 when clamping standing seam with portions of the clamp shown in broken lines;

[0014] Figure 4 is a cross-sectional view taken along lines 4-4 of figure 3;

[0015] Figure 5 is a cross-sectional view taken along lines 5-5 of figure 3;

[0016] Figure 6 is a cross-sectional view of an alternative embodiment of the clamp assembly shown in figures 4;

[0017] Figure 7 is cross sectional view of the clamp shown in figure 4 when clamping a double lock type standing seam;

[0018] Figure 8 is cross-sectional view of the clamp shown in figure 4 when clamping a trapezoid double lock type standing seam;

[0019] Figure 9 is a cross-sectional view showing an alternative embodiment of the clamp shown in figure 4 when clamping an angled seam;

[0020] Figure 10 is a cross-sectional view showing an alternative embodiment of the clamp shown in figure 4 when clamping a seam having a round head;

[0021] Figure 11 is a cross-sectional view showing an alternative embodiment of the clamp shown in figure 4 when clamping an off-set seam;

[0022] Figure 12 is a cross-sectional view showing an alternative embodiment of the clamp according to the present invention with a pair of protective gaskets;

[0023] Figure 13 is a cross-sectional view showing an alternative embodiment of one clamp according to the present invention having an isolation gasket or membrane to protect a roof or other structure from vibration, sound or the like or otherwise increase surface tension;

[0024] Figure 14A is an exploded cross-sectional view showing an alternative embodiment of the clamp according to the present invention.

[0025] Figure 14B is a cross-sectional view of the clamp shown in figure 14A when assembled and secured to a standing seam;

[0026] Figure 15 is a cross-sectional view showing an alternative embodiment of the clamp shown in figures 14A and 14B;

[0027] Figure 16A is a cross-sectional view showing an alternative embodiment of the clamp shown in figures 14A and 14B;

[0028] Figure 16B is a cross-sectional view showing an alternative embodiment of the clamp shown in figures 14A and 14B;

[0029] Figure 17A is a cross-sectional view showing an alternative embodiment of the clamp according to the present invention and prior to securing to a standing seam;

[0030] Figure 17B is a cross-sectional view showing an alternative embodiment of the clamp according to the present invention when securing to a standing seam;

[0031] Figure 18 is a cross-sectional view showing another alternative embodiment of the clamp according to the present invention when securing to a standing seam;

[0032] Figure 19 is a cross-sectional view showing an alternative embodiment of the clamp according to the present invention prior to securing to an L-shaped standing seam;

[0033] Figure 20 is a cross-sectional view showing an alternative embodiment of the clamp according to the present invention when secured to an L-shaped standing seam;

[0034] Figure 21 is a cross-sectional view showing an alternative embodiment of the clamp according to the present invention;

[0035] Figure 22 is a cross-sectional view showing an alternative embodiment of the clamp shown in figures 21;

[0036] Figure 23 is a cross-sectional view showing an alternative embodiment of the clamp shown in figures 21;

[0037] Figure 24 is a cross-sectional view showing an alternative embodiment of the clamp shown in figures 21;

[0038] Figure 25 is a cross-sectional view showing an alternative embodiment of the clamp shown in figures 21;

[0039] Figure 26 is a cross-sectional view showing an alternative embodiment of the clamp according to the present invention;

[0040] Figure 27A is a cross-sectional view showing an alternative embodiment of the clamp shown in figure 26;

- [0041]** Figure 27B is a cross-sectional view showing an alternative embodiment of the clamp shown in figure 26;
- [0042]** Figure 28A is a cross-sectional view showing an alternative embodiment of the clamp according to the present invention prior to clamping;
- [0043]** Figure 28B is a cross-sectional view showing the clamp in figure 23A when in a clamping position;
- [0044]** Figure 29A is a cross-sectional view showing an alternative embodiment of the clamp according to the present invention;
- [0045]** Figure 29B is a cross-sectional view showing an alternative embodiment of the clamp shown in figure 29A;
- [0046]** Figure 30 is an end view showing a tool according to the present invention for use when assembling a clamp to a standing seam;
- [0047]** Figure 31 is a top view of figure 30;
- [0048]** Figure 32 is a cross-sectional view showing an alternative embodiment of a clamp according to the present invention;
- [0049]** Figure 33 is a cross-sectional view showing the tool in figures 30 and 31 fitted over a standing seam to be clamped;

[0050] Figure 34A is a cross-sectional view showing the tool shown in figures 30 and 31 in use with the clamp shown in figure 32;

[0051] Figure 34B is a cross-sectional view of figure 34 after the tool has been removed and the clamp is secured against a standing seam;

[0052] Figure 35 is an exploded cross-sectional view of an alternative embodiment according to the present invention;

[0053] Figure 36 is a cross-sectional view of a clamp fitted with the clamping structure shown in figure 35 and prior to being secured to a standing seam;

[0054] Figure 37 is a cross-sectional view of the clamp shown in figure 36 when clamped to a standing seam;

[0055] Figure 38 is an alternative embodiment of the clamp shown in figure 36; and

[0056] Figure 39 is a cross sectional view showing another embodiment of the clamp according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0057] Figure 1 shows a standard overlap-type standing seam SS comprising metal sheets 2 and 4 interconnected at upstanding portion 6 and head portion 8. The standing seam SS is formed by bending or profiling together adjacent edges of sheets 2 and 4

to interlock the edges at head portion 8 in a known manner. The present invention is applicable for clamping other standing seams as will be explained further below.

[0058] Referring to figures 2 through 5, the clamp assembly CA of the present invention is shown in greater detail. As best seen in figure 2, the clamp assembly CA comprises a generally U-shaped clamp body 10, formed from metal such as extruded aluminum or a high density plastic or other material, and having a top 12 and sides 14 that define an interior region 16 for receiving a standing seam. The clamp body 10 may be of variable length and thickness depending upon the end use of the clamp and the strength requirements necessary for that particular use.

[0059] Adjustment screws 18 are provided along both sides 14 of the clamp body. The apertures for each of the adjustment screws 18 are disposed adjacent the bottom edge of each side 14 and each extends through the sides 14 so such that the adjustment screw may be selectively moved into and out of interior region 16 of the clamp body.

[0060] Locking screws 20 may be provided along both sides 14 of the clamp body. The apertures for each of the locking screws 20 are disposed adjacent the top edge of each side 14 and each extends through the sides 14 so that it can be selectively moved into and out of the interior region 16 of the clamp body to lock

the clamp onto a seam as will be further explained below. The number of locking screws 20 and adjustment screws 18 provided on the clamp is variable. In general, the clamp body 10 will have a pair of adjustment screws on each of side of the clamp, the pairs aligned as mirror images and at least one locking screw per side.

[0061] A threaded aperture 22 is provided within the top 12 of the clamp body 10 to receive a threaded bolt (not shown) that may be used to attach a solar panel, wiring or other structure to the clamp body. Similarly, and as best shown in figure 3 and 4, a threaded aperture A may be provided in either or both of the sides 14 of the clamp body to receive a threaded bolt (not shown) to attach a solar panel, wiring, or some other structure to the clamp body.

[0062] Turning to figures 3 through 5, additional features of the clamp assembly CA are shown together with operation of the clamp. The interior region 16 comprises side walls 24 and top wall 26. The width and height of interior region 16 may be varied depending upon the size of the standing seam to be clamped.

[0063] A pair of movable clamping jaws or hammers 28 are provided within interior region 16 of the clamp body 10 for clamping against a seam. As best shown in figures 4 and 5, the

clamping hammers are disposed as mirror images of each other and in one embodiment, are generally L-shaped to accommodate the head portion of a conventional folded seam as will be further explained below. The hammers 28 extend the length of the clamp body 10 from a first end to a second end and are pivotally secured within the clamp body at hinge member 30. The hammers may be constructed from metal, such as extruded aluminum, or from a high density plastic or other material suitable to the use of the clamp.

[0064] Hinge member 30 comprises a cylindrical member 32, provided at the top of the clamping hammer 28 and extending the length of the hammer, and a cooperating groove 34 provided within the clamp body, the groove 34 sized to receive the cylindrical member 32 such that hammer 28 is adapted to freely pivot about the longitudinal axis of hinge member 30. During assembly of the clamp, a series of inwardly extending detents (not shown) may be provided at each end of the groove 34 to retain the clamping hammer 28 within the groove 34.

[0065] As best shown in figure 4, the adjustment screws 18 are aligned transverse to the longitudinal axis of the clamping hammers 28. Selectively turning the adjustment screw 18 will cause it to move inwardly or outwardly and consequently, into and out of engagement with a respective clamping hammer 28. When

a standing seam SS is disposed interior of clamp body 10 and the adjustment screws 18 associated with the clamping hammers 28 are turned inwardly, the hammers are likewise caused to pivot inwardly about hinge 30 and engage against the upstanding portion 6 of a seam SS. The L-shape of the clamping hammers 28 allow the head portion 8 of the seam to be received between the hammers without damaging the head. The present invention generates a clamping pressure against the seam that is continuous and evenly distributed along the entire length of the clamp assembly. By spreading the load along the length of the clamp, damage to the seam is avoided and failure of the clamp is greatly reduced.

[0066] As best shown in figure 5, after the seam SS is engaged by the clamping hammers, the locking screws 20 associated with each of the hammers are tightened which causes the screw to contact cylindrical member 32 and prevent pivoting of hinge 30 which is then in a locked position. As is apparent, to remove the assembly from a seam, the adjustment and locking screws are loosened which causes the hammers to pivot out of engagement thereby allowing the clamp to be separated from the seam.

[0067] Figure 6 illustrates an alternative embodiment of the present invention whereby the inwardly facing surfaces of the

clamping hammers 28 have secured to the surfaces an elastomeric coating (or a sheet) of material to provide an isolation gasket, membrane or filler material 36 for purposes of, for example, increased friction, dampening vibration or providing insulation to the clamped seam or otherwise function as a spacer.

[0068] Figure 7 illustrates the clamp assembly of the present invention when clamped to a double lock standing seam. In this embodiment, the clamping hammers are angled inwardly to a greater degree than would be the case with an overlap type standing seam. The invention is adapted to accommodate different kinds of seams having varying shapes and head sizes.

[0069] Figure 8 illustrates the clamp assembly of the present invention when clamping to a trapezoid double lock type standing seam.

[0070] Figure 9 illustrates an alternative embodiment of the present invention. The clamping hammer 28 noted earlier are interchanged in this embodiment to adapt the clamp assembly CA to clamp an angled seam AS. In this embodiment, one of the two clamping hammers in figures 2 through 5 is replaced with an angled seam clamping hammer 38. The angled seam clamping hammer 38 is shown to have a stepped configuration to accommodate the head portion 8 of the angled seam AS which extends transverse to the longitudinal axis of the seam.

[0071] Figure 10 illustrates a further embodiment of the present invention. Both clamping hammers in this embodiment are changed from that shown in the previous embodiments so as to adapt the clamp assembly CA for clamping a seam having a round head 8. The round head clamping hammers 42 include an abutment region 40 that extends inwardly and includes a downwardly sloping surface 44 for engaging the lower regions of the rounded head 8 and jaw portions 46 for engaging the upstanding portion of the seam.

[0072] Figure 11 illustrates another embodiment of the present invention. Both clamping hammers in this embodiment are changed from that shown in the previous embodiments so as to adapt the clamp assembly CA for clamping a seam having an offset head 8. The offset head clamping hammers 48 and 50 have different thicknesses and heights. Offset head clamping hammer 50 has a greater height than offset head clamping hammer 48 and further includes a jaw portion 52. Offset head clamping hammer 48 includes a thickened region or abutment 54 so that when the hammers are urged against the offset head 8, it is held securely between both hammers and the top 12 of the clamp body is maintained parallel to the surface from which the seam extends.

[0073] Figure 12 illustrates another embodiment of the present invention. In this embodiment, the interior wall

surfaces 58 of the clamp body 10 are provided with parallel keyway tracks 60 extending the length of the clamp for selectively receiving a gasket or membrane 56 having a male keyway portion 62 adapted to interfit and interlock the keyway track 60. A modified clamping hammer 64 is provided at the opposite side of the gasket or membrane 56. The modified clamping hammer 64 is shown to include a keyway track 66 for receiving a male keyway portion 68 of gasket or membrane 70. An adjustment screw 18 (not shown) is provided to cause the modified clamping hammer 64 to move inwardly and clamp and insulate (sound, vibration, etc.) a seam between the resilient gasket or membrane 56 and 70.

[0074] Figure 13 is an alternative embodiment of figure 12 wherein a clamping hammer 28 as shown in figures 2 through 5 is used in place of the modified clamping hammer 64 to clamp the seam (not shown) between a gasket or membrane 56 and the clamping hammer 28 by way of adjustment screws (not shown) and locking screws (not shown). As can be seen, the gasket or membrane 56 is provided with a key member 62 that interlocks with the interior wall 58 of U-shaped member 10 at female keyway 60.

[0075] Turning to figure 14A, a clamp assembly provided with a two piece clamp body is shown. This embodiment is well adapted for attachment to relatively larger standing seams where the clamping hammers are sized or otherwise shaped such that a one piece clamp body is impractical or otherwise not well suited for the application. The clamp assembly CA is shown for attachment to a standing seam SS that is T-shaped. As is apparent, this embodiment is adapted to be connected to a standing seam other than a T-shaped seam or to some other upstanding member such as a joist, beam, etc. The clamp body 102 comprises a first portion 104 and second portion 106. Each of first portion 104 and second portion 106 may be of variable width depending upon the dimension of the standing seam SS to be clamped. In this embodiment, the clamp body 102 comprises first and second generally L-shaped clamp portions 104, 106, and the first and second clamp portions 104, 106 are adjustably interconnected to form a generally U-shaped clamp body 102 of variable width.

[0076] Each of first portion 104 and second portion 106 is provided with a separate one of a pair of movable jaws or hammers 108 that are shown to be generally L-shaped. As is apparent, the shape of the hammer is variable depending upon the specific application for the clamp. In the present embodiment, the lower portion of the hammer is increased in size so that it will effectively clamp against the underside of the T-shaped standing seam as best shown in figure 14B. The hammers 108 extend the length of the clamp portions 106 and 108 and are pivotally secured within the respective clamp portions at hinge member 30. As in the embodiments described earlier, hinge members 30 comprises a cylindrical member 112 provided on each hammer that is adapted to axially rotate

within a cooperating groove that extends within each of clamp portions 106 and 108 and as shown in the figure. Adjustment screws 118 and locking screws (not shown) as set forth in the earlier noted embodiments are provided.

5 [0077] The top surface 116 of the first clamp portion 104 is provided with an aperture 120 having variable size that cooperates with a threaded aperture 122 provided in the top contact surface 124 of second clamp portion 106. A bottom contact surface 130 is provided on first clamp portion 104.

10 Top and bottom contact surface will engage against each other when the clamp is in an assembled position as will be further explained below. An abutment 128 extends upwardly from second clamp portions 106 and functions as a stop member for limiting the width of the clamp when assembled and as best

15 shown in figure 14B. It is within the scope of the present invention to not provide an abutment. A connecting member 126 shown in the figures to be a screw is provided and adapted to be received within apertures 120 and 122 to interconnect the two clamp portions and secure it to a standing seam as best

20 shown in figure 14B. As is apparent, a washer of varying diameter may be provided to accommodate interconnection of the two clamp portions when a clamp having a relatively greater width is required. In this embodiment, at least one threaded fastener 126 interconnects the two piece clamp body

25 102 by extending through the clamp body 102 top wall. The two piece clamp body 102 is provided with a slot 120 for interconnecting the two pieces 104, 106 that form the clamp body 102. One of the two pieces 104, 104 that form the clamp body 102 is provided with an abutment 128 for restricting the

30 width of the clamp body 102.

[0078] The embodiment shown in figures 14A and 14B reduce the width of the clamp body 102 from that which would otherwise be necessary if the clamp body were constructed from a single unitary piece. Accordingly, the clamp body in this embodiment
5 is adapted to interconnect T-shaped standing seams of variable width without the need to provide several clamp bodies of varying widths. The first and second clamp portions may be machined or cut to any desired length. The clamp portions and the hammers may be constructed of any suitable
10 material adapted to be shaped via extrusion, casting or injection molding.

[0079] Turning to figure 15, an alternative embodiment of the clamp shown in figures 14A and 14B is shown. In this embodiment, the top contact surface 116 and the bottom
15 contact surface 130 are shown to be serrated or otherwise scoured or rendered not smooth. When the clamp is assembled, friction between the first clamp portion 104 and the second clamp portion 106 is increased and any lateral movement of-
the clamp portions relative to each other is prevented. Other
20 means to enhance connection between

the surfaces are within the scope of the present invention. For example, the top and bottom contact surface may be provided with a cooperating set of teeth of varying width and depth depending upon the application of use. The cooperating set of teeth are adapted to mesh together or otherwise interconnect so as to allow indexing of the clamp width.

[0080] Figures 16A and 16B illustrate a further modification of the clamp shown in figures 14A and 14B. In this embodiment, a T-shaped groove 134 is provided within the top surface 116 of the first portion 104 and extends longitudinally along the length of the clamp portion. The connecting member 118 and aperture 120 shown in the earlier embodiments are also provided, but are not shown in these figures. A straight extension member 136 (figure 16A) or an angled extension member 138 (figure 16B) are shown to extend upwardly from the top surface 116 of the first clamp portion 104. Each of the extension members 136 and 138 are provided with a T-shaped end portion 140 adapted or otherwise shaped to be received within the T-shaped groove as shown. The extension members may be used as supports for securing supplementary structures to the clamp after it has been secured to a standing seam. For example, a conduit or other object that needs to be run along the length of a roof. As is apparent, it is within the scope of the invention to vary the

size and shape of the extension member depending upon the application required and to include one or more features of the embodiments noted above. It is also within the scope of the present invention to provide the T-shaped slot within a separate block as opposed to within the clamp body portion 104. The block is then secured to the top of the clamp portion by screws or other connection means. This enables the T-shaped slot to be varied relative to the clamp body. For example, it could be aligned transverse to the longitudinal axis of the clamp body.

[0081] Figures 17A and 17B illustrate another embodiment of the present invention where the location of the hinge members is reversed from that as shown in the previous embodiments together with an alteration of the hammer configuration. This embodiment expands the number of applications for which the clamp may be adapted and/or improves the ease-ability of clamping to certain standing seams.

[0082] Turning to figures 17A and 17B, the clamp body 102 is shown to include an upper longitudinal groove 114 as depicted in the earlier described embodiments and a pair of lower longitudinal grooves 142 including a pair of recess portion 141 that are mirror images of each other. As is apparent, it is within the scope of the present invention to provide only lower longitudinal grooves if desired. Also, the clamp body 102 may be

modified to increase its width or height or otherwise be provided with a greater mass so as to accommodate standing seams having a increased height or greater load requirements. The reverse hammer 144 is shown to have a generally S-shaped configuration as opposed to the generally L-shaped configuration of the above noted embodiments. Each reverse hammer 144 is provided with a horizontally extending cylindrical member 112 similar to that described above with respect to the earlier embodiments and in addition, a head portion 146 for contacting against a standing seam to be clamped. A leg portion 148 extends between and interconnects the cylindrical member to the head portion. As is apparent, it is within the scope of the present invention to provide the reverse hammer with a shape other than an S-shape depending upon the application of use.

[0083] As best shown in figure 17A, the recess portions 141 of the clamp body 102 are adapted to receive the head portion 146 of each of the hammers 142 so that a standing seam SS may be received within the interior of the clamp body prior to clamping. Turning to figure 17B, the device is shown clamping a seam whereby the adjustment screws 118 are turned inwardly to cause the head portion of each hammer to move inwardly and engage against a standing seam. Once the seam has been properly engaged, the locking screws (not shown) are sufficiently turned

so that the hinge member for each hammer is fixed in its position.

[0084] Figure 18 discloses an embodiment where the clamping hammers adapted to be secured to a standing seam SS and where the sides of the seam are of unequal height. In this embodiment, a standing seam SS has a first side 150 of a first height and a second side 152 having a height great than that of the first side. Seam lips 154 are provided and cooperate to form a seam head. The sides 14 of the clamp body 102 provided with a height that corresponds to the respective sides of the seam. In addition, each of the clamping hammers 28 are provided with a height that corresponds to the height of either the first side 150 or the second side 152 of the clamp. As can be seen, the adjustment screws 118 are positioned at different clamp heights to correspond with the height of the respective clamping hammer.

[0085] Figures 19 and 20 disclose a further embodiment where the clamping hammers have an unequal height. In this embodiment the standing seam SS is L-shaped and the hammers are adapted to provide a uniform clamping force against the seam. The shorter clamping hammer 156 is shown in the figures to engage the seam just under the seam lip whereas the clamping hammer 158 having a greater length is shown to engage the seam a distance below that of clamping hammer 156. Clamping hammer 158 provides more

clearance when the clamping assembly is placed onto a seam to be clamped. This embodiment also allows for a more uniform clamping force to be provided against the seam than would otherwise be the case if the hammers were the same length. In addition, two sets of grooves 114 are provided within the clamp body 102. In this way, the clamp assembly CA is adapted to engage an L-shaped standing seam SS including a seam lip oriented transverse to either side of the standing seam.

[0086] Turning to figures 21 and 22 a gravity clamping hammer adapted to slide perpendicular toward a standing seam under action of the set screws and lock the clamp to a standing seam. When the set screws are loosened, clamping hammer will recede away from the seam due to gravitational forces. The clamp body 102 is provided with a pair or cooperating recesses 160 that extend the longitudinal axis of the clamp body 102 and have a general configuration in cross-section of a parallelogram. A slot 161 is provided within each of the side walls 24 of the interior region 16 to provide an opening between the clamp interior region 16 and the recesses 160. A clamping hammer 162 is disposed within each recess 160. The clamping hammer 162 comprises a head portion 166, neck 168 and end portion 170. The opposite ends of the clamp body may be staked or pinned to prevent the clamping hammer from sliding out of the clamp body.

[0087] In operation, when the adjustment screws are turned clockwise, it moves inwardly and impinges upon the end portion 170 of the clamping hammer 162. This causes the clamping hammer to slide perpendicular toward the standing seam to clamp the same. To loosen the clamp, the adjustment screws 118 are turned counterclockwise whereby the clamps slide away from the standing seam under the force of gravity. Figure 21 illustrates an embodiment whereby the clamp body 102 may be machined to provide a upper recess so as to accommodate a standing seam having a greater height. Clamp body 102 may be manufactured by extrusion, casting or injection molding and the gravity-type clamping hammers 162 may be manufactured in a variety of sizes and lengths and from a number of materials, including, but not limited to, metal, elastomeric rubber, DELRIN or other thermoplastics having high stiffness, high or low friction and excellent dimensional stability.

[0088] Figure 23 illustrates an alternative embodiment of the invention shown in figures 21 and 22. In this embodiment, the slot associated with the recesses 160 is removed and the entire inward face of the recess 160 is opened to receive a clamping hammer 162 having an expanded neck portion 174 that generally occupies the entire recess 160. A head portion 166 is also provided to engage against a standing seam.

[0089] Figures 24 and 25 disclose alternative embodiments of the invention shown in figures 21 through 23. Figure 24 discloses a clamp body that combines a gravity type clamping hammer 162 as set forth in figure 22 in combination with a clamping hammer 28 as disclosed in figure 2. A second adjustment screw is not provided for hammer 28. Figure 25 discloses a clamp body that combines a gravity type clamping hammer 162 as set forth in figure 23 in combination with a clamping hammer 28 as set forth in figure 2. A second adjustment screw (not shown) may be provided for hammer 28.

[0090] Figure 26 discloses another embodiment of the present invention that includes detent type hammers or blocks instead of pivoting or gravity hammers. A cooperating pair of hammers or blocks 176 is shown retained within a generally C-shaped recess or cavity forming the interior region of the clamp body 102. The detent type hammer or block 176 may be manufactured by extrusion, casting or injection molding and in a variety of sizes and lengths and from a number of materials, including, but not limited to, metal, elastomeric rubber, DELRIN or other thermoplastics having high stiffness, higher or low friction and excellent dimensional stability. Adjustment screws 118 extending transverse to the longitudinal axis of the block are rotated and contact block 176 to urge it inwardly against a standing steam

clamp (not shown). Once both blocks have adjusted against a standing seam clamp, pair of locking members 178 shown to be screws or detents are engaged to force a downward pressure against the aligned block thereby locking it into place. It is within the present invention to provide a groove in block 176 that is aligned perpendicular to the longitudinal axis of the hinge groove 34 for receiving the locking member 178. This assists in retaining the block within the clamp body and preventing it from falling out until clamped against the seam.

[0091] Figure 27A discloses a further embodiment whereby a single elongated shaped block 176 is provided to engage against an L-shaped standing seam (not shown). Figure 27B discloses another embodiment whereby a single elongated shaped block 176 is provided to engage against a vertical standing seam having no head portion (not shown). The clamp body 102 is not provided with a single L-shaped leg member 180 with the opposite leg member 182 shown to be generally planar.

[0092] Figure 28A and 28B are directed to a further embodiment of the present invention whereby the clamp body is spring loaded to retain a detent block within the interior region of the clamp body. Figure 28A discloses a detent block that has been shaped at the top and bottom regions to allow it to pivot inwardly when engaged by an adjustment screw 118. As

can be seen, the bottom edges 184 of detent block 176 is tapered inwardly to provide a pivot point at the bottom of the block. The upper portion of the detent block 176 is provided with a through-hole 186 through which a retaining rod 188 is inserted, the rod being secured at both ends to the sides of the clamp body. A rod is threaded through a spring member 190 and is sized within the interior of the clamp body such that it will urge the detent block 176 into an open position as shown in figure 28A. A clamping hammer 28 is provided opposite the detent block. As best shown in figure 28B, when the adjustment screw 118 is rotated clockwise, it is caused to impinge against the detent block 176 and cause it to pivot inwardly against the force of the spring to engage a standing seam (not shown). The spring ensures the block will always return to a open position away from the standing seam when the adjustment screws are unscrewed and be prevented from falling out of the clamp body. A locking screw as shown in figure 26 may be provided to lock the clamp into place after engaging a standing seam.

[0093] Figure 29A is another embodiment of the present invention and discloses hinged pivoting hammers 190 that operate in the manner as disclosed earlier but the hammers slide in the ends of the clamp. The head portion 192 of each hammer is custom shaped to match and engage the contours of the standing seam SS.

Figure 29B is an alternative embodiment that provides a non-hinged detent block 194 the interior surface of which is custom shaped to match and engage the contours of the standing seam SS. A pair of locking screws is also provided.

[0094] Figures 35 through 38 disclose an alternative embodiment of the present invention. Turning to figure 35, a washer and rivot 196 is provided to retain a fastener 198 in place and prior to actuation of the adjustment screw 118. The fastener 198 is provided with a T-shaped recess adapted to receive the washer and rivot 196. Fastener 198 is made with enough tolerance within the T-shaped recess so as to allow it to pivot about the washer. This enable fastener 198 to adapt to seams that may be out of plane or otherwise be slightly angled along the longitudinal axis. The range of pivot of fastener 198 compensates for slight variations in the plane of the seam by matching the slight angular differences. It is further noted that a gasket of other type of device may be applied to the fastener 198 to create a better contact surface having higher shear. Figure 36 illustrates the entire clamp assembly for this embodiment. All of the adjustment screws 188 are rotated inwardly to align the washer and rivot 196 so that the fastener 198 can be slid over each of the washers to align it within the interior of the clamp body. As best seen in figure 37, the

adjustment screws 118 are further rotated to urge the faster against the head of a standing seam SS to clamp the same. In the alternative, the washer and rivot 196 may be replaced with a freely spinning nut member to secure the washer to the end of the screw member 118. Figure 38 illustrates a further embodiment where the clamping hammer is replaced with a gasket 56 which is received within a keyway track for receiving a male keyway portion of the gasket. Clamp body 102 may be manufactured by extrusion, casting or injection molding and the fastener 198 may be manufactured in a variety of sizes and lengths and from a number of materials, including, but not limited to metal, elastomeric rubber, DELRIN or other thermoplastics having high stiffness, high or low friction and excellent dimensional stability and as noted earlier.

[0095] Figures 30 through 34B disclose another embodiment of the present invention and in particular a tool application for using a spring loading the clamp member. Figures 30 and 31 illustrate the tool member 200 shown to comprise a generally U-shaped member provided with a finger hole 202. As best shown in figure 33, the tool 200 is adapted to be slid over a standing seam SS to be clamped. Figure 32 illustrates the clamp embodiment shown in figures 17A and 17B but having the clamping hammers loaded using a pair of spring member 204 with the use of

adjustment screw 118 (not shown) to tightly clamp the hammers against a seam. It is within the scope of the present invention to not employ adjustment screws if the specific application does not require them. After the standing seam is covered by the tool 200, the user slides the clamp assembly CA over the top of the tool 200 and as best shown in figure 34A which in turn causes the spring loaded hammers to be pushed out of the way and into an open position so that the standing seam can be received within the interior region of the clamp. Once the clamp is in place, the user will pull the tool 200 from the interior of the clamp by grasping the finger hole 202. As shown in figure 34B, the spring loaded hammers are urged into engagement against the sides of the standing seam to clamp the same.

[0096] Figure 39 illustrates another embodiment of the present invention wherein the body 102 of the clamping assembly CA is provided with a pair of notches that extend along the longitudinal axis of the clamp body so as to receive a clamping hammer 201 that is provided with a hook member at one end which is received within a notch and is adapted to pivot inwardly or outwardly under action of the adjustment screw 118.

[0097] It is within the scope of the present invention to vary the use of adjustment and locking screws depending upon the end use of the clamp. In some situations a locking screw may not

be necessary and the force of the adjustment screw is sufficient to lock the clamp onto the seam. The use of multiple locking screws has been seen to reduce any vibration of the clamp due to conditions during use. As is apparent, in all embodiments the clamp body 102 and all components of the assembly may be manufactured by extrusion, casting or injection molding and the various clamp components may be manufactured in a variety of sizes and lengths and from a number of materials, including, but not limited to metal, elastomeric rubber, DELRIN or other thermoplastics having high stiffness, high or low friction and excellent dimensional stability and as noted earlier. The clamp body and all components forming the clamp assembly may be machined and milled as required in order to adapt it to its specific end use. The embodiments employing gaskets can be provided with hinges and without employing adjustment screws. It is also within the scope of the present invention to interconnect two or more clamps that are aligned parallel to each other with a bridge member secured at each end to a separate clamp. The bridge member may be constructed from any suitable material including, but not limited to, aluminum, stainless steel, etc. The bridge member would allow for the optional attachment of rooftop assembly devices such as fall protection structure, gutters, etc.

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[0098] While this invention has been described as having a preferred design, it is understood that it is capable of further modifications, uses and adaptations, both in whole and in part, while following the general principle of the invention and including such departures from the present disclosure as is known or customary practice in the art to which this invention pertains, and as may be applied to the central features of this invention.

WHAT IS CLAIMED IS:

1. A clamping assembly comprising:
a clamp body having an interior region for receiving a structure to be clamped, the clamp
5 body comprising a first clamp portion and a second clamp portion, wherein the first
clamp portion and the second clamp portion are generally L-shaped and adjustably
interconnected to form a generally U-shaped clamp body of variable width;
a clamping hammer disposed within the interior region of the clamp body, wherein the
clamping hammer is hingedly secured to the clamp body along a longitudinal axis
10 thereof; and
an adjustment screw extending through the clamp body and adapted to selectively impinge
against the clamping hammer so as to cause it to pivot about the longitudinal axis, the
adjustment screw extending transverse to the longitudinal axis of the clamping
hammer.
- 15
2. The clamping assembly of claim 1, wherein the clamping hammer includes a jaw portion
extending from an end of the clamping hammer inward into the clamp body.
3. The clamping assembly of any one of claims 1 to 2, wherein:
20 the clamp body comprises a top wall, a first side wall, and a second side wall; and
the first side wall and the second side wall are aligned as mirror images.
4. The clamping assembly of any one of claims 1 to 2, wherein:
the clamp body comprises a first side wall, a second side wall, and a top wall therebetween;
25 the adjustment screw extends through the first side wall.
5. The clamping assembly of any one of claims 1 to 2, further comprising a threaded aperture,
the threaded aperture extending into an exterior surface of a top wall of the clamp body.

6. The clamping assembly of any one of claims 1 to 5, wherein the clamping hammer is generally L-shaped in cross-section and includes a lower leg facing the interior region.
7. The clamping assembly of any one of claims 1 to 5, wherein the clamping hammer is generally step-shaped in cross-section and includes a lower leg facing the interior region.
8. The clamping assembly of any one of claims 1 to 5, further comprising:
a second clamping hammer disposed within the interior region of the clamp body;
wherein the clamping hammer is generally step-shaped in cross-section and includes a first lower leg facing the interior region;
wherein the second clamping hammer is hingedly secured to the clamp body along a second longitudinal axis thereof; and
the clamping hammer and the second clamping hammer are aligned as mirror images.
9. The clamping assembly of claim 8, wherein the second clamping hammer is generally L-shaped in cross-section and includes a second lower leg facing the first lower leg.
10. The clamping assembly of claim 8, wherein:
the clamping hammer and the second clamping hammer each are generally step-shaped in cross-section; and
the second clamping hammer includes a second lower leg facing the first lower leg.
11. The clamping assembly of any one of claims 8 to 10, further comprising a second adjustment screw, the second adjustment screw extending through a second side wall and adapted to selectively impinge against the second clamping hammer so as to cause it to pivot about the second longitudinal axis, the second adjustment screw extending transverse to the second longitudinal axis.

12. The clamping assembly of any one of claims 8 to 11, wherein the clamping hammer and the second clamping hammer each are shaped to accommodate therebetween a head portion of a standing seam to be clamped.
- 5 13. The clamping assembly of claim any one of claims 1 to 11, wherein the clamping hammer is shaped to accommodate therebetween a head portion of a standing seam to be clamped.
14. The clamping assembly of any one of claims 3 to 13, further comprising:
a cylindrical recess, the cylindrical recess extending into the clamp body;
10 wherein the clamping hammer includes at a first end thereof a first cylindrical hinge member received within the cylindrical recess such that the clamping hammer is hingedly movable between the first side wall and the second side wall.
15. The clamping assembly of any one of claims 1 to 14, further comprising:
15 a threaded fastener;
wherein the threaded fastener interconnects the first clamp portion and the second clamp portion.
16. The clamping assembly of claim 15, wherein the threaded fastener extends through the
20 clamp body.
17. The clamping assembly of any one of claims 1 to 16, further comprising an elastomeric material secured to the clamping hammer.
- 25 18. The clamping assembly of any one of claims 1 to 17, wherein the first clamp portion includes a slot for receiving the second clamp portion.
19. The clamping assembly of claim 18, wherein:
the second clamp portion includes an extension member extending away from a second
30 clamp portion top surface; and

the slot is adapted to receive the extension member.

- 5 20. The clamping assembly of any one of claims 1 to 19, wherein the first clamp portion includes an abutment for engagement against the second clamp portion and restricting a clamp body width.
- 10 21. The clamping assembly of claim 20, wherein the second clamp portion includes a second abutment for engagement against the first clamp portion and restricting the clamp body width.
22. The clamping assembly of any one of claims 1 to 21, wherein the first clamp portion and the second clamp portion each include serrated surfaces to enhance contact therebetween.
- 15 23. The clamping assembly of any one of claims 1 to 22, wherein:
a top surface of the first clamp portion includes a first aperture being a slot;
a top surface of the second clamp portion includes a second aperture being threaded; and
the first aperture cooperates with the second aperture to allow varying a width of the generally U-shaped clamp body.
- 20 24. A clamping assembly comprising:
a clamp body comprising a first overlapping clamp portion and a second overlapping clamp portion aligned along a common longitudinal axis, the clamp body including a top wall, a first side wall, a second side wall and an interior region between the first side wall and the second side wall;
25 a first clamping hammer and a second clamping hammer disposed within the interior region, wherein the first clamping hammer and the second clamping hammer each are hingedly secured to the clamp body, with the first side wall restricting pivoting of the first clamping hammer and the second side wall restricting pivoting of the second side wall to within the interior region;

a first adjustment screw extending through the first side wall to selectively engage against the first clamping hammer and cause the first clamping hammer to pivot toward the second clamping hammer; and

5 a second adjustment screw extending through the second side wall to selectively engage against the second clamping hammer and cause the second clamping hammer to pivot toward the first clamping hammer.

10 25. The clamping assembly of claim 24, wherein at least one of the first clamping hammer and the second clamping hammer includes a jaw portion extending from an end of the first clamping hammer and the second clamping hammer inward into the clamp body.

26. The clamping assembly of any one of claims 24 to 25, wherein the first side wall and the second side wall are aligned as mirror images.

15 27. The clamping assembly of any one of claims 24 to 26, wherein the first clamping hammer and the second clamping hammer are aligned as mirror images.

20 28. The clamping assembly of any one of claims 24 to 27, further comprising a threaded aperture, the threaded aperture extending into an exterior surface of the top wall.

29. The clamping assembly of any one of claims 24 to 28, further comprising:
a cylindrical recess, the cylindrical recess extending into the clamp body;
wherein the first clamping hammer includes at a first end thereof a first cylindrical hinge member received within the cylindrical recess such that the first clamping hammer is
25 hingedly movable between the first side wall and the second side wall.

30. The clamping assembly of any one of claims 24 to 29, further comprising:
a second cylindrical recess, the second cylindrical recess extending into the clamp body;
wherein the second clamping hammer includes at a second end thereof a second cylindrical
30 hinge member received within the second cylindrical recess such that the second

clamping hammer is hingedly movable between the second side wall and the first side wall.

31. The clamping assembly of any one of claims 24 to 30, wherein:
5 the first clamping hammer and the second clamping hammer each are generally L-shaped in cross-section;
the first clamping hammer includes a first lower leg facing the interior region; and
the second clamping hammer includes a second lower leg facing the first lower leg.
- 10 32. The clamping assembly of any one of claims 24 to 30, wherein:
the first clamping hammer and the second clamping hammer each are generally step-shaped in cross-section;
the first clamping hammer includes a first lower leg facing the interior region; and
the second clamping hammer includes a second lower leg facing the first lower leg.
- 15 33. The clamping assembly of any one of claims 24 to 32, wherein the first clamping hammer and the second clamping hammer each are shaped to accommodate therebetween a head portion of a standing seam to be clamped.
- 20 34. The clamping assembly of any one of claims 24 to 33, further comprising:
a threaded fastener;
wherein the threaded fastener interconnects the first overlapping clamp portion and the second overlapping clamp portion.
- 25 35. The clamping assembly of claim 34, wherein the threaded fastener extends through the clamp body.
- 30 36. The clamping assembly of any one of claims 24 to 26, further comprising an elastomeric material secured to the first clamping hammer.

37. The clamping assembly of any one of claims 24 to 36, wherein the first overlapping clamp portion includes a slot for receiving the second overlapping clamp portion.
38. The clamping assembly of any one of claims 37, wherein:
5 the second overlapping clamp portion includes an extension member extending away from a second clamp portion top surface; and
the slot is adapted to receive the extension member.
39. The clamping assembly of any one of claims 24 to 38, wherein the first overlapping clamp
10 portion includes an abutment for engagement against the second overlapping clamp portion and restricting a clamp body width.
40. The clamping assembly of claim 39, wherein the second overlapping clamp portion includes
15 a second abutment for engagement against the first overlapping clamp portion and restricting the clamp body width.
41. The clamping assembly of any one of claims 24 to 40, wherein the first overlapping clamp
20 portion and the second overlapping clamp portion each include serrated surfaces to enhance contact therebetween.
42. The clamping assembly of any one of claims 24 to 41, wherein:
a top surface of the first overlapping clamp portion includes a first aperture being a slot;
a top surface of the second overlapping clamp portion includes a second aperture being
threaded; and
25 the first aperture cooperates with the second aperture to allow varying a width of the clamp body.

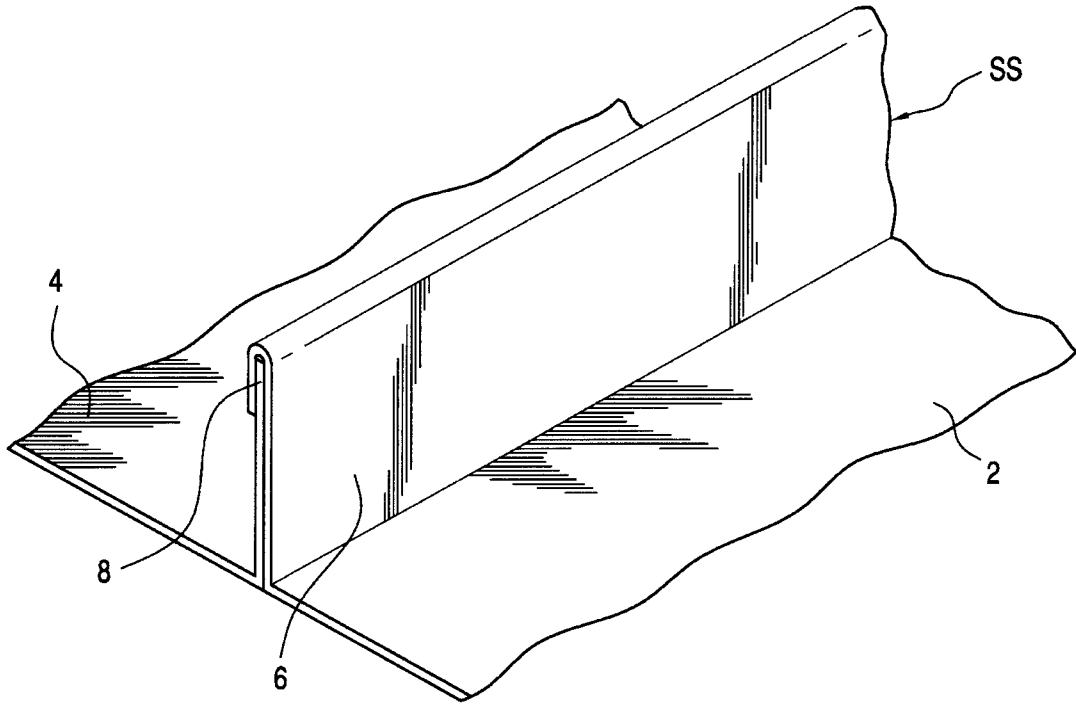


FIG. 1

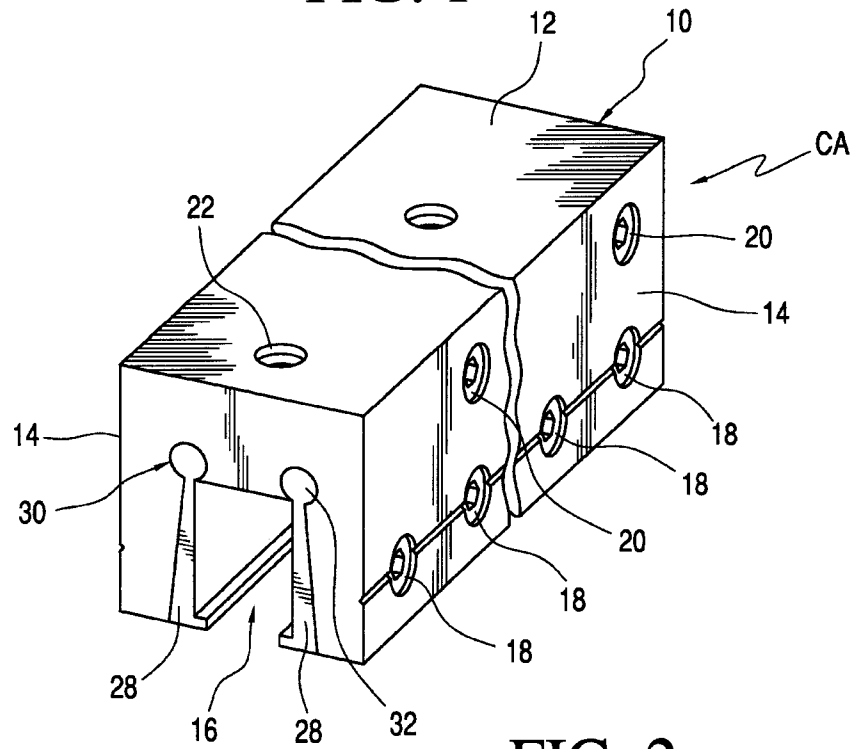
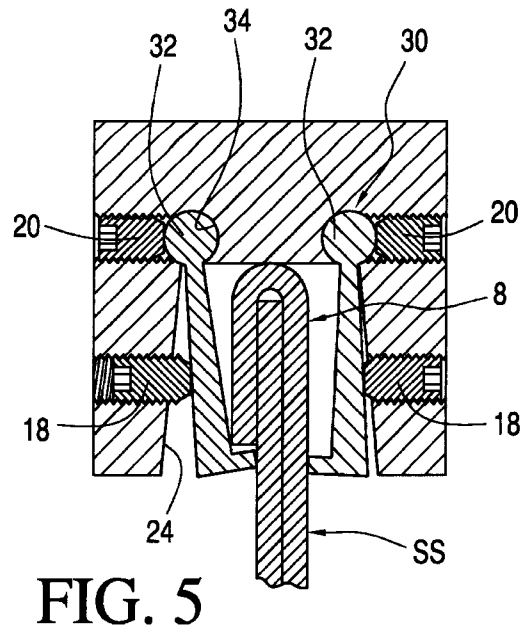
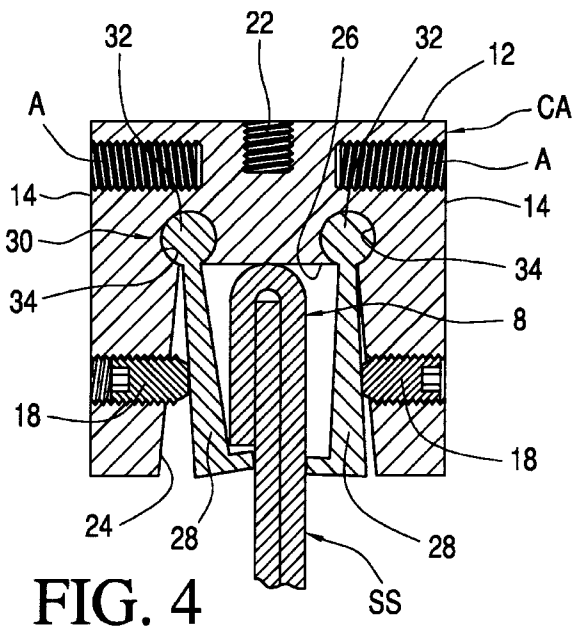
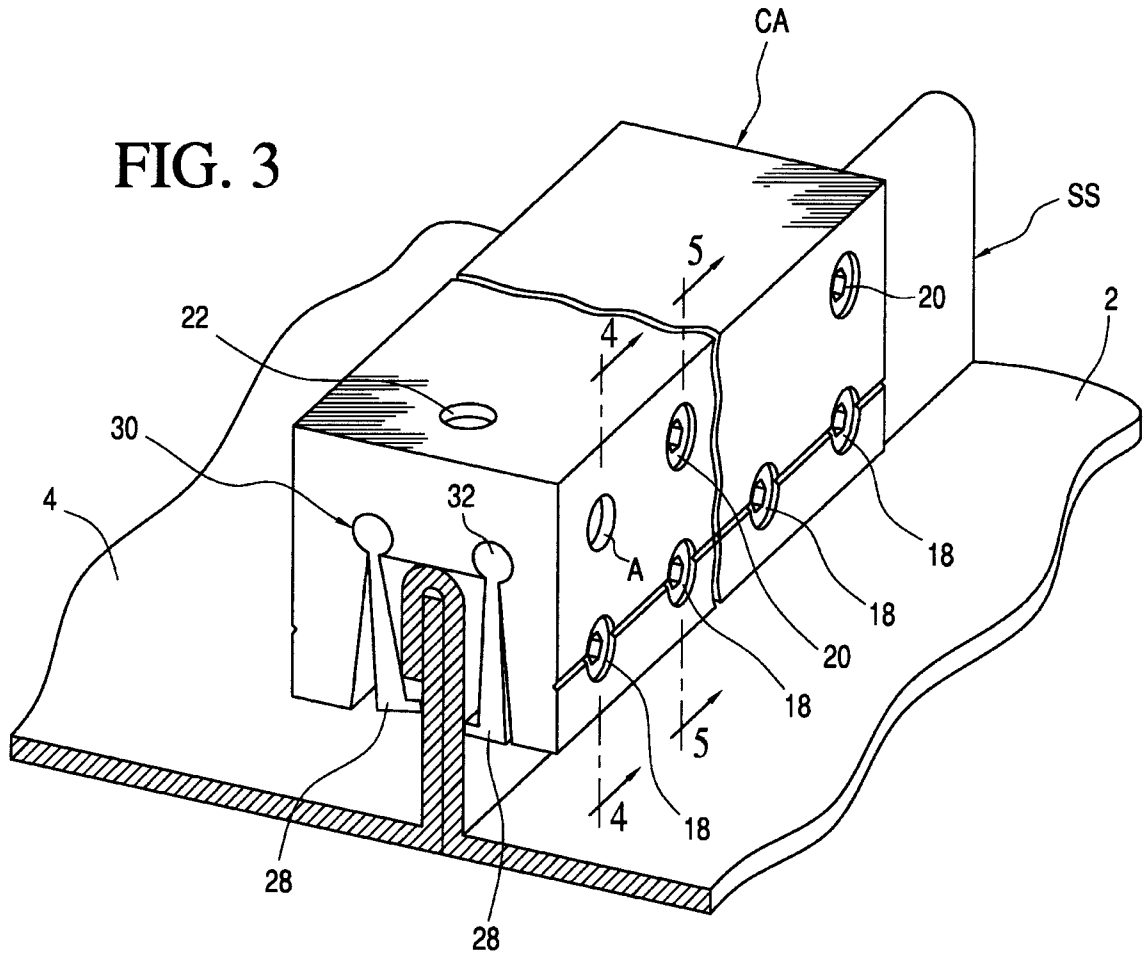


FIG. 2



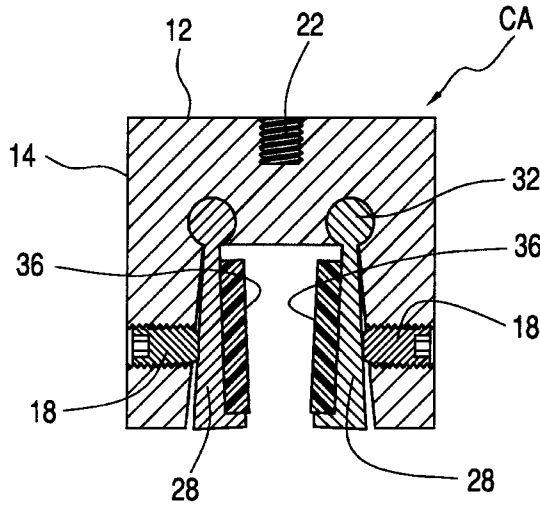


FIG. 6

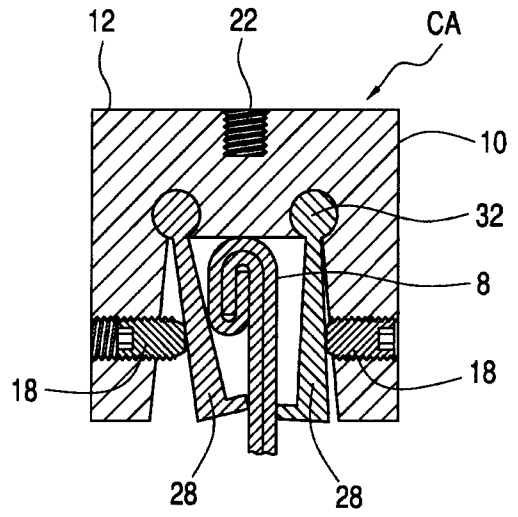


FIG. 7

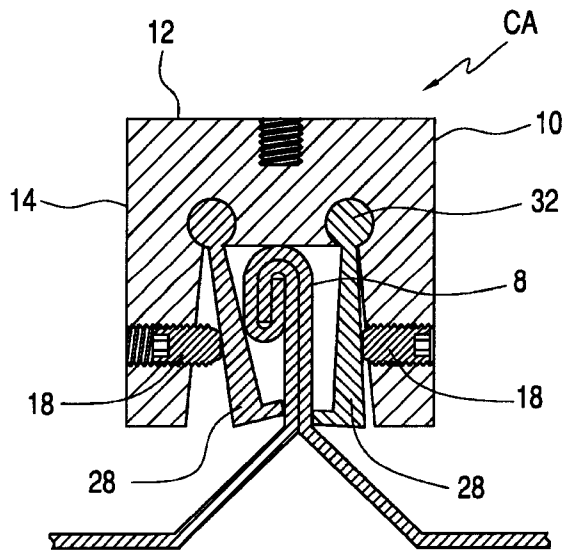


FIG. 8

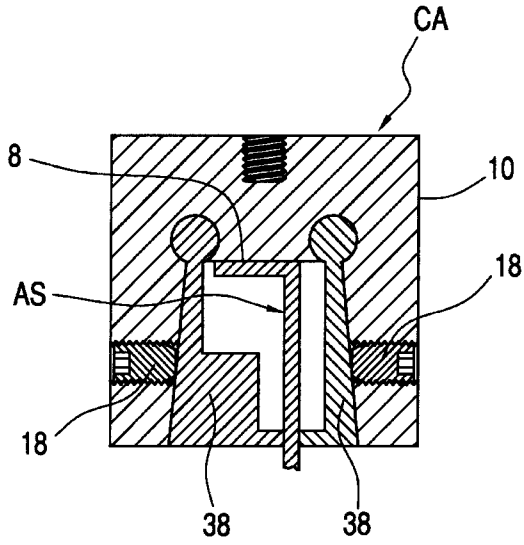


FIG. 9

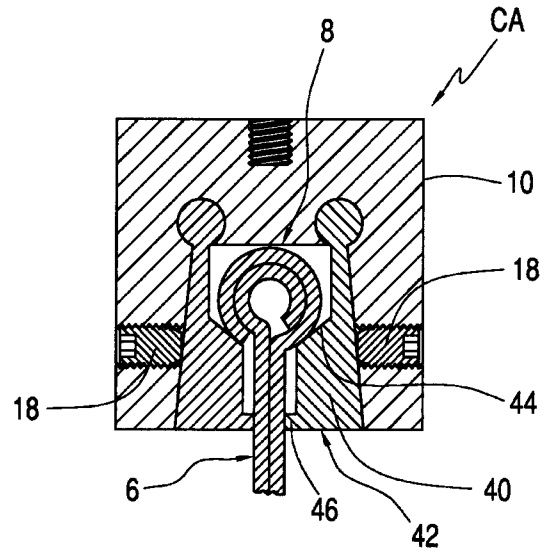


FIG. 10

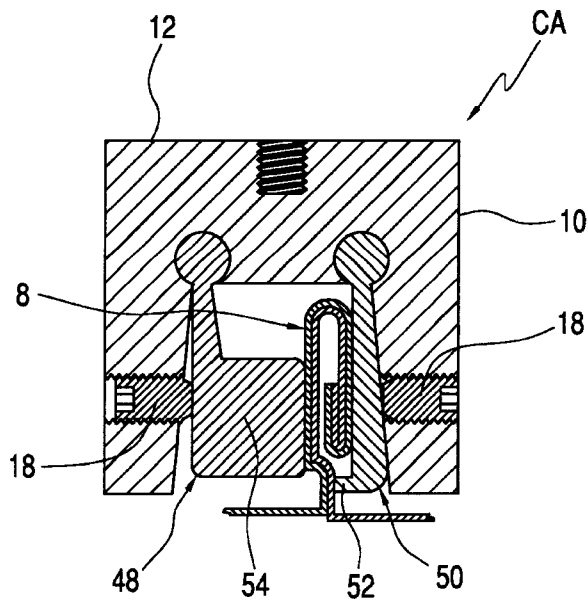


FIG. 11

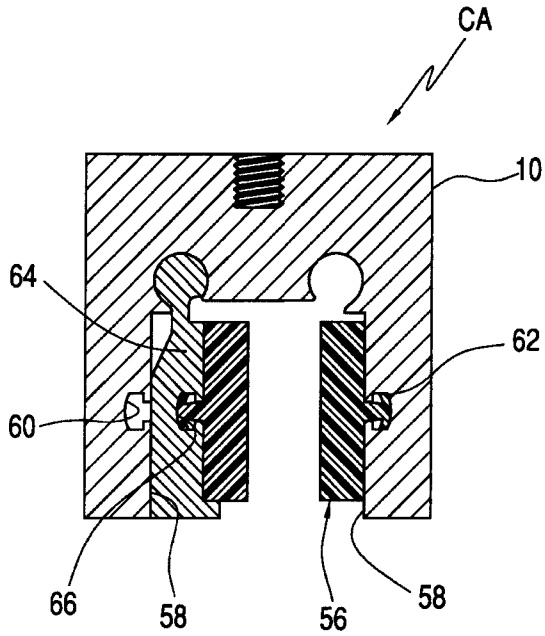


FIG. 12

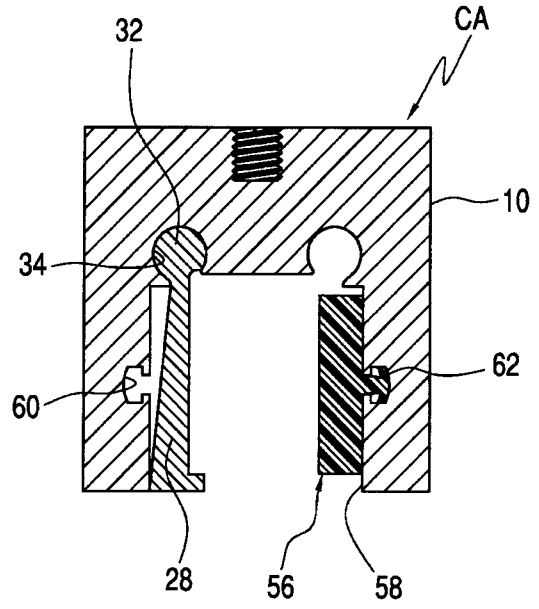


FIG. 13

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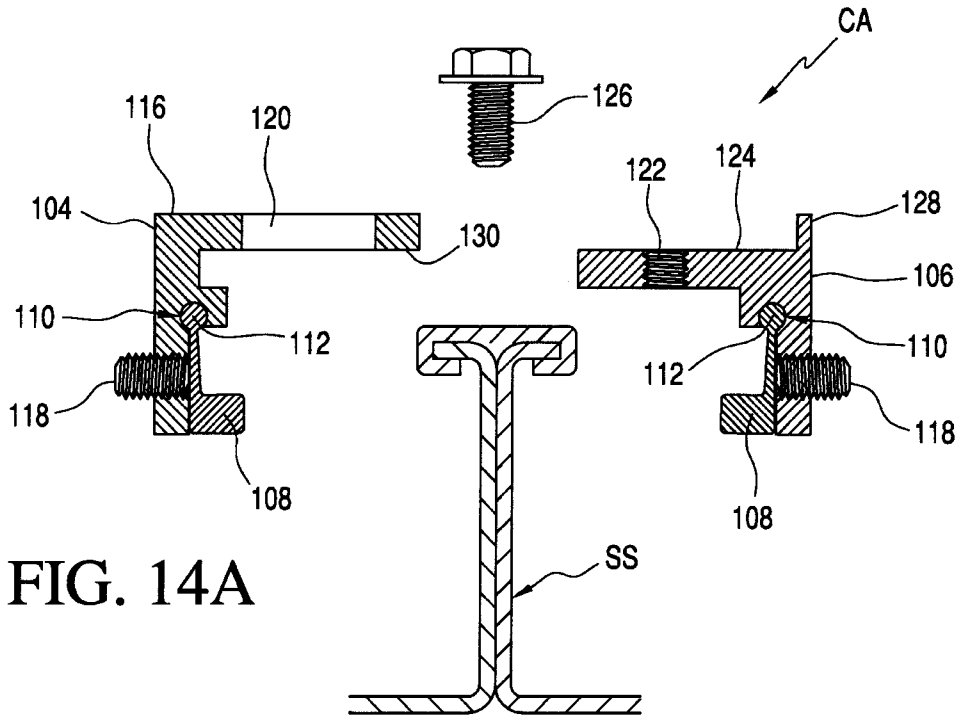


FIG. 14A

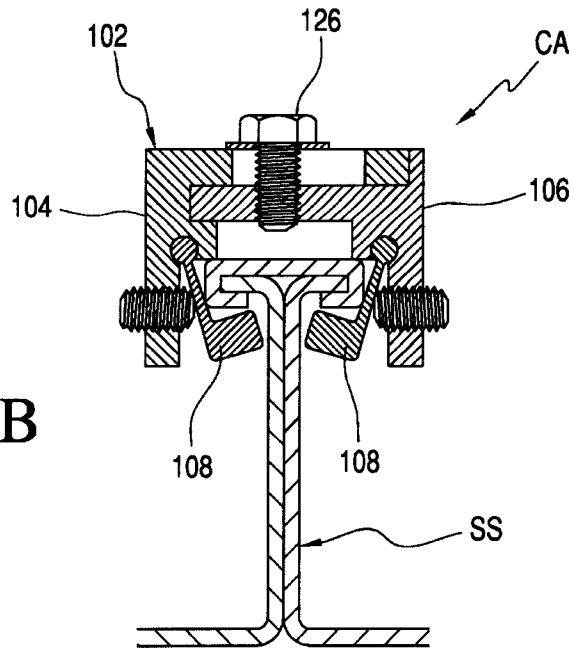


FIG. 14B

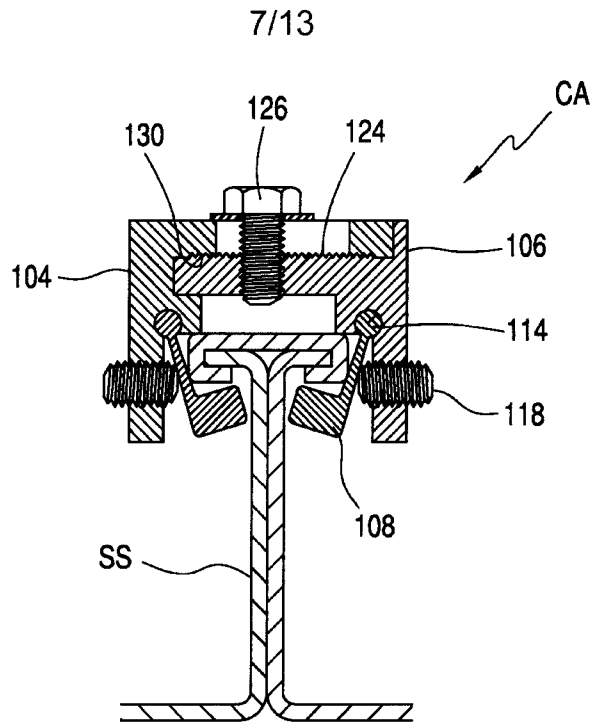


FIG. 15

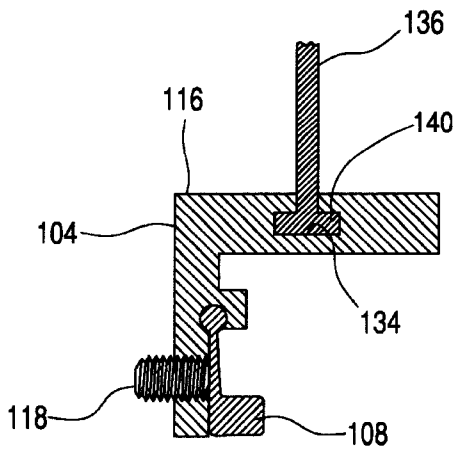


FIG. 16A

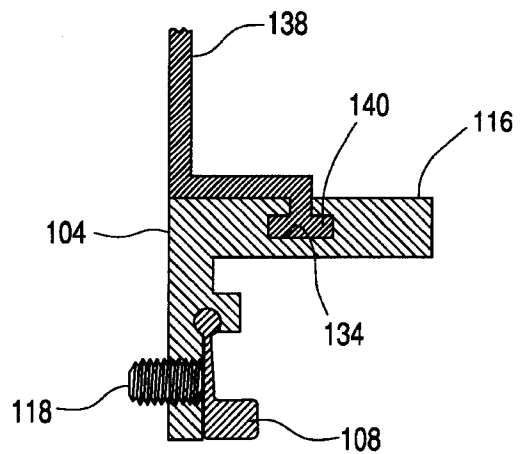


FIG. 16B

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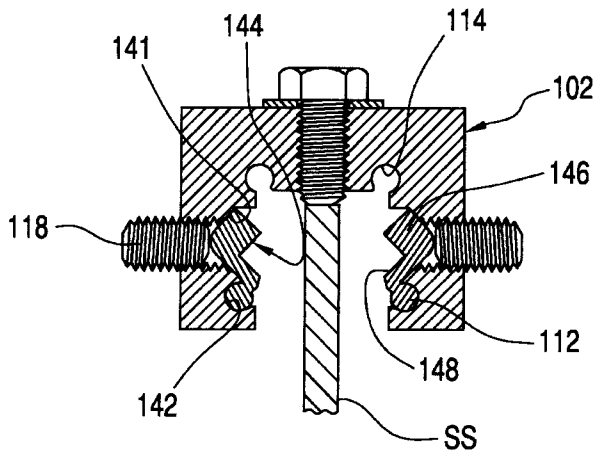


FIG. 17A

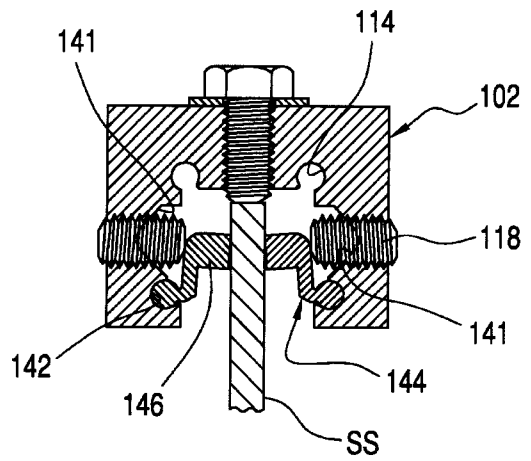


FIG. 17B

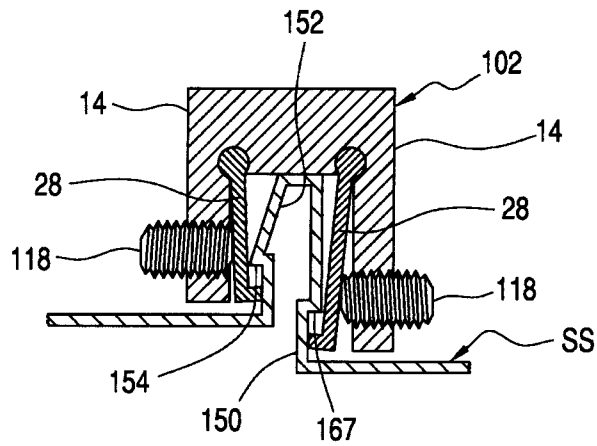


FIG. 18

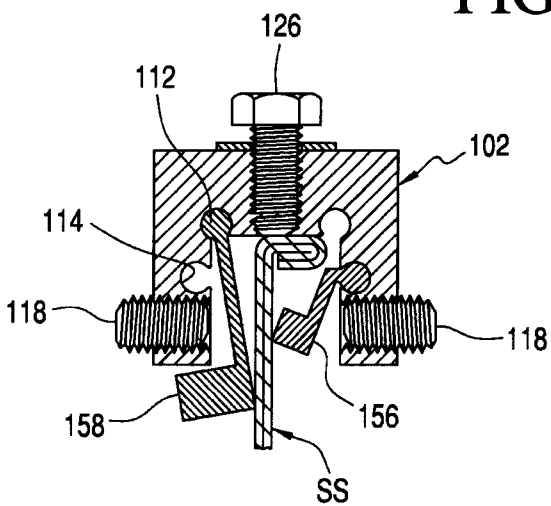


FIG. 19

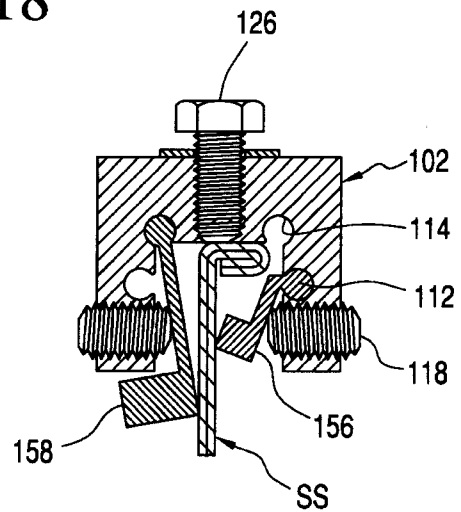


FIG. 20

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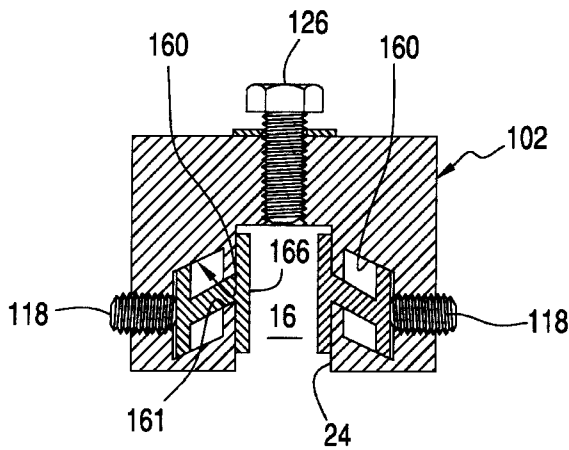


FIG. 21

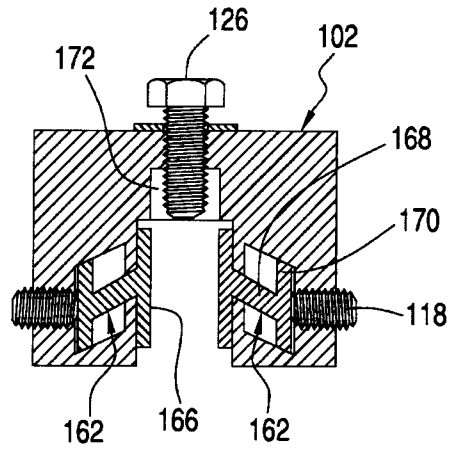


FIG. 22

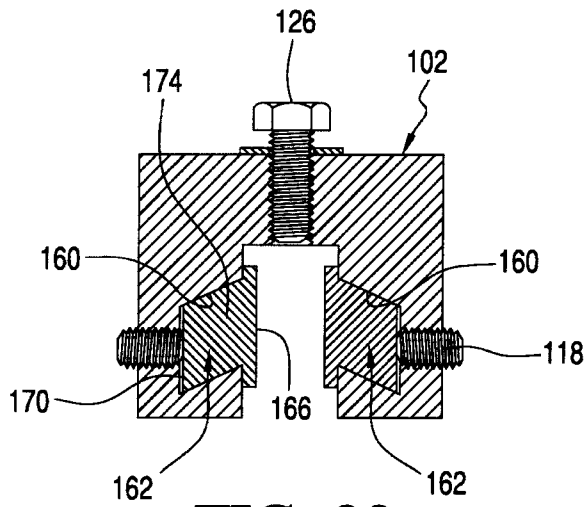


FIG. 23

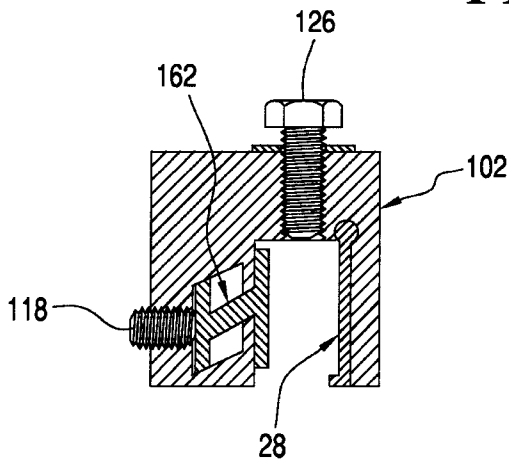


FIG. 24

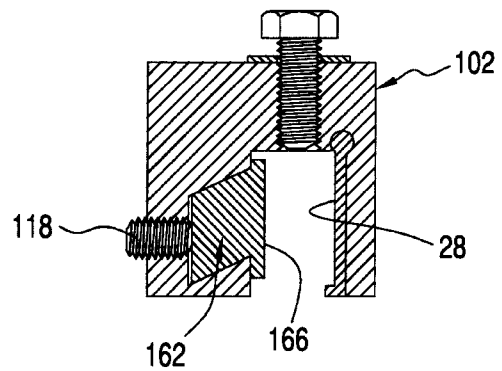


FIG. 25

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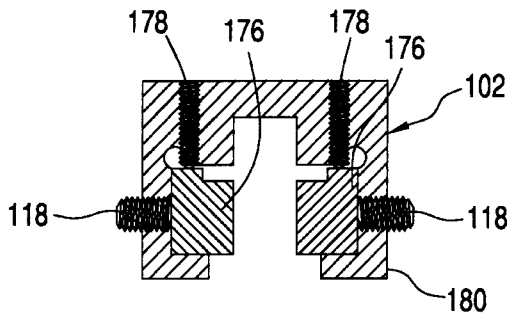


FIG. 26

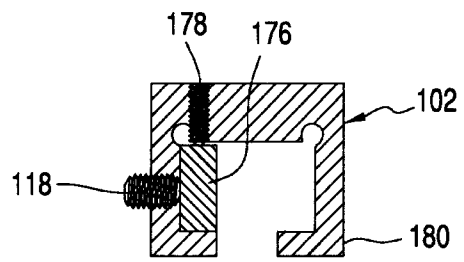


FIG. 27A

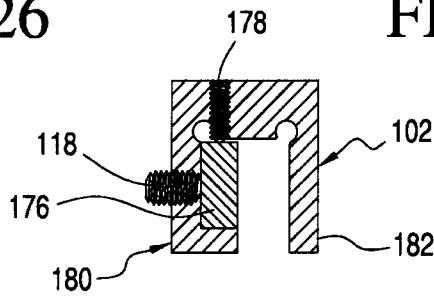


FIG. 27B

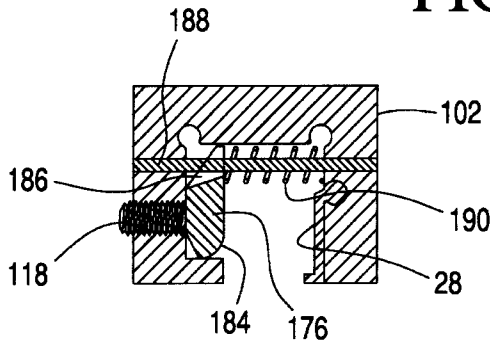


FIG. 28A

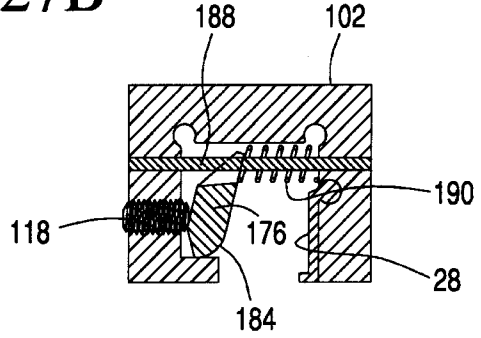


FIG. 28B

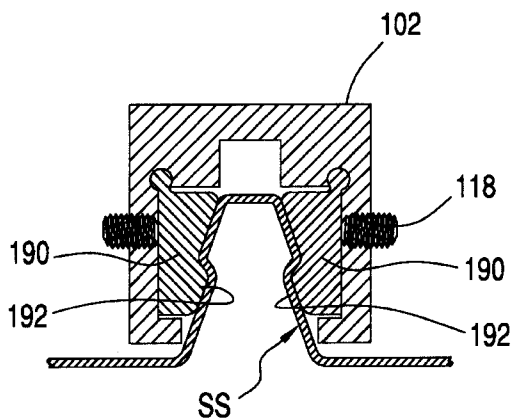


FIG. 29A

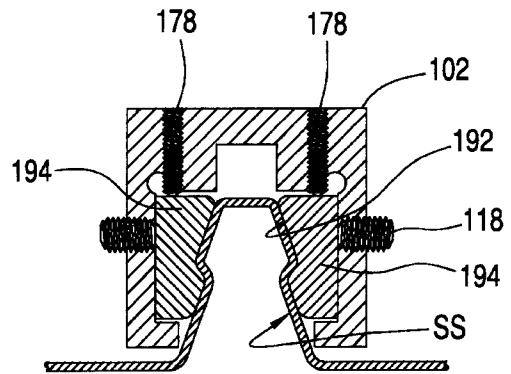


FIG. 29B

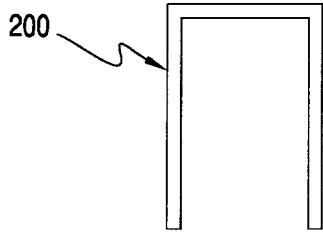


FIG. 30

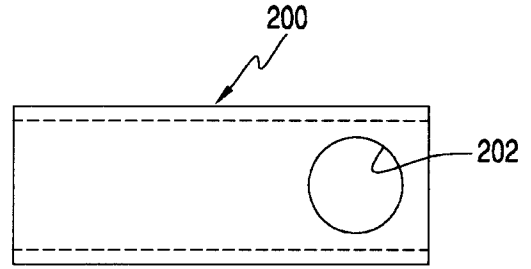


FIG. 31

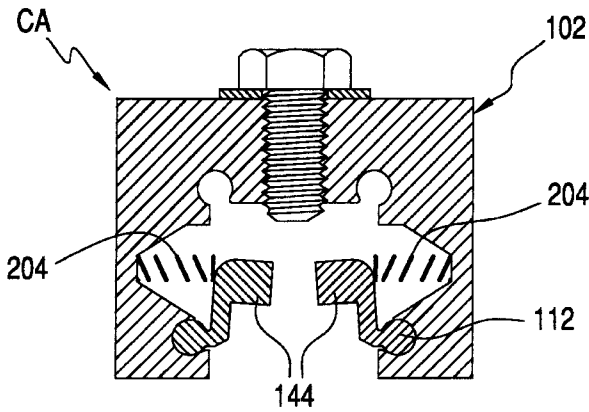


FIG. 32

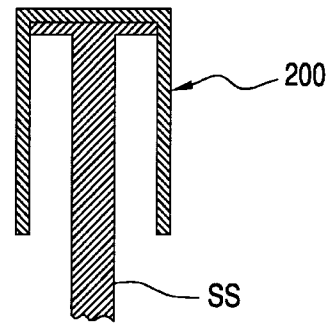


FIG. 33

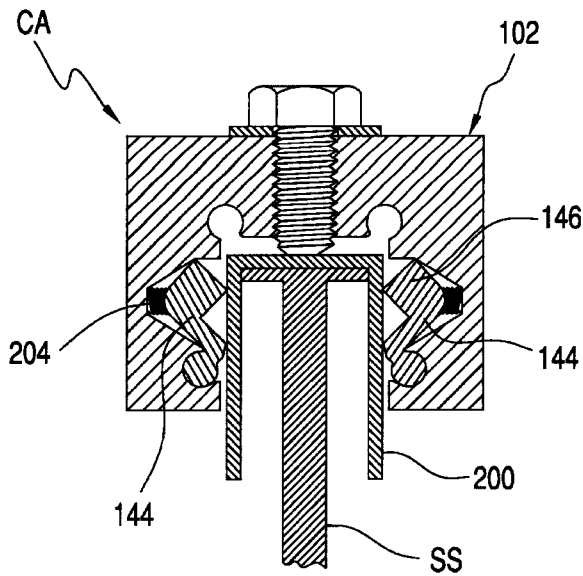


FIG. 34A

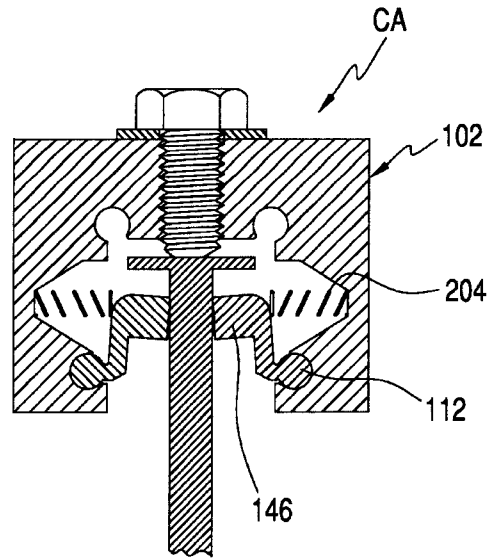


FIG. 34B

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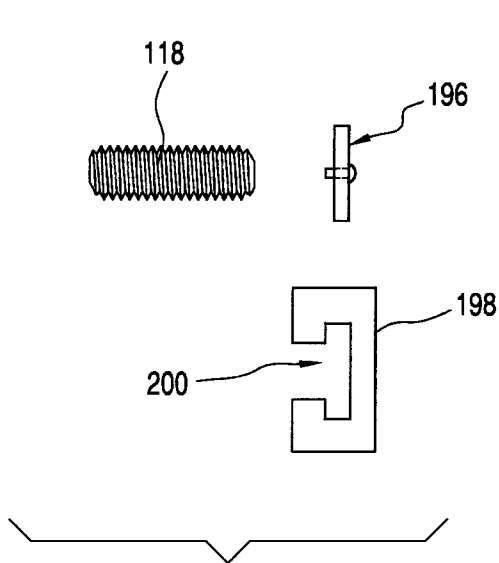


FIG. 35

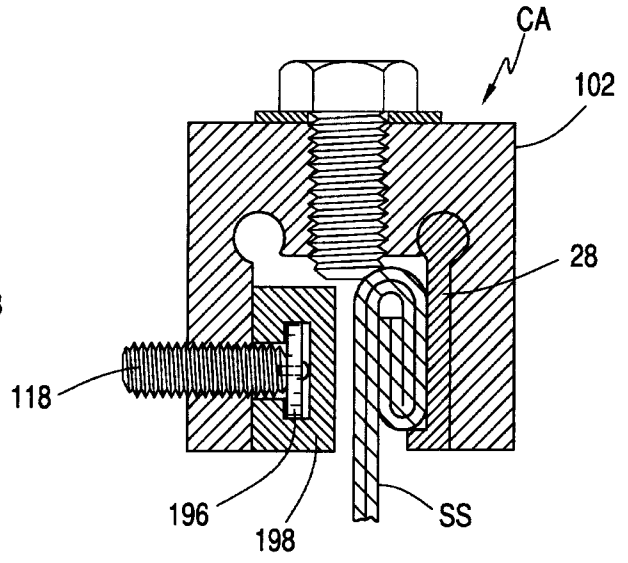


FIG. 36

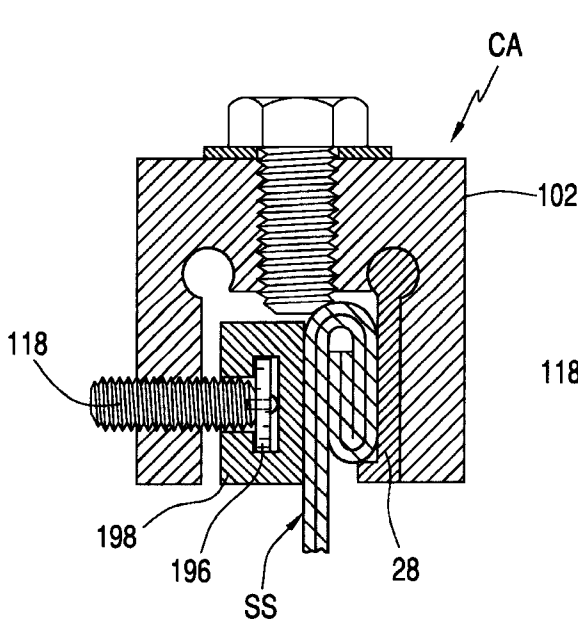


FIG. 37

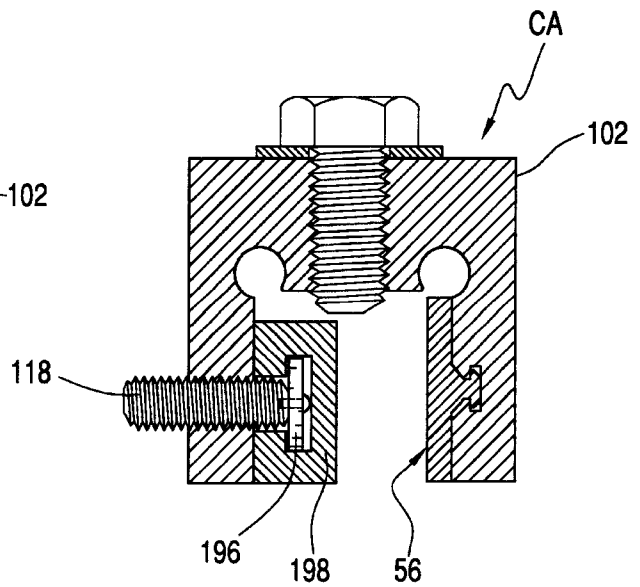


FIG. 38

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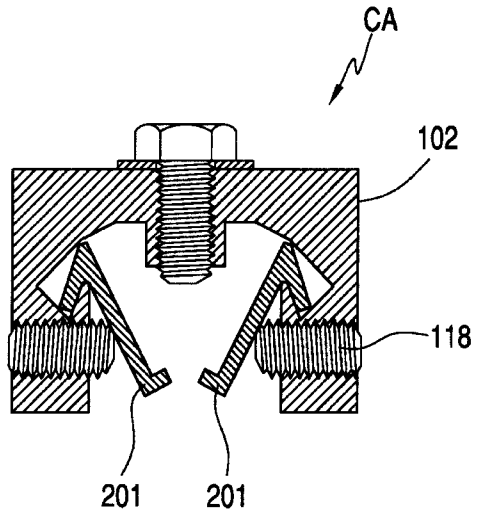


FIG. 39

