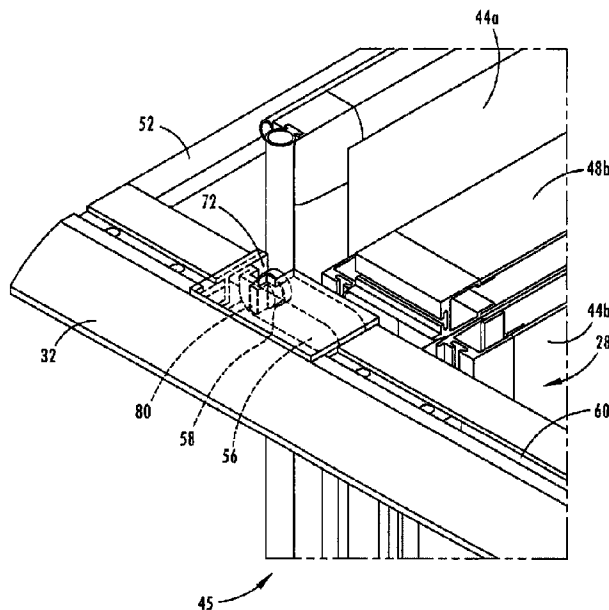




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(54) Title: TONNEAU SYSTEM FOR USE WITH A PICKUP TRUCK



(57) **Abrégé/Abstract:**

A tonneau system for use with a pickup truck is provided. The tonneau system includes a tonneau cover, a frame, and at least one latch. The tonneau cover has a plurality of tonneau sections. The plurality of tonneau sections has at least a first tonneau section and a second tonneau section. A first hinge system couples the first tonneau section to the second tonneau section, enabling stacking and expanding of the first tonneau section relative to the second tonneau section. The frame has a first side rail securable to a first side of a cargo box of a pickup truck and a second side rail securable to a second side of the cargo box of the pickup truck. The frame is pivotally connected to the third tonneau section distal to the second hinge system. The at least one latch releaseably secures the tonneau cover to the first side rail and to the second side rail. When the at least one latch is released, the stacked tonneau sections are permitted to depend into the cargo box.

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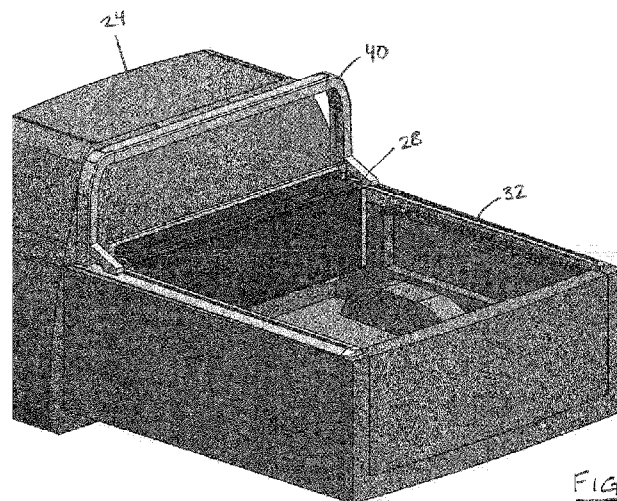
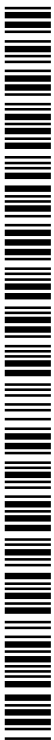
(54) **Title:** TONNEAU SYSTEM FOR USE WITH A PICKUP TRUCK

FIG. 15

(57) **Abstract:** A tonneau system for use with a pickup truck is provided. The tonneau system includes a tonneau cover, a frame, and at least one latch. The tonneau cover has a plurality of tonneau sections. The plurality of tonneau sections has at least a first tonneau section and a second tonneau section. A first hinge system couples the first tonneau section to the second tonneau section, enabling stacking and expanding of the first tonneau section relative to the second tonneau section. The frame has a first side rail securable to a first side of a cargo box of a pickup truck and a second side rail securable to a second side of the cargo box of the pickup truck. The frame is pivotally connected to the third tonneau section distal to the second hinge system. The at least one latch releaseably secures the tonneau cover to the first side rail and to the second side rail. When the at least one latch is released, the stacked tonneau sections are permitted to depend into the cargo box.



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TONNEAU SYSTEM FOR USE WITH A PICKUP TRUCK

TECHNICAL FIELD

[0001] The following relates generally to tonneaus. In particular, the following relates to a tonneau system for use with a pickup truck.

SUMMARY

[0002] In one aspect, a tonneau system for use with a pickup truck is provided, the tonneau system comprising: a tonneau cover, comprising: a plurality of rigid tonneau sections, the plurality having at least a first tonneau section and a second tonneau section; a first hinge system coupling the first tonneau section to the second tonneau section, enabling stacking and expanding of the first tonneau section relative to the second tonneau section; and a frame, comprising a first side rail securable to a first side of a cargo box of a pickup truck and a second side rail securable to a second side of the cargo box of the pickup truck, the frame being pivotally connected to the first tonneau section distal to the first hinge system; at least one latch releaseably securing the tonneau cover to the first side rail and to the second side rail and, when released, enables the stacked tonneau sections to depend into the cargo box.

[0003] The tonneau system may further comprise at least a second hinge system coupling a third tonneau section to the second tonneau section along an edge of the second tonneau section spaced apart from the first hinge system.

[0004] The first hinge system may comprise a piano hinge. The second hinge system may comprise a pair of piano hinges coupling a spacer member between the second tonneau section and the third tonneau section.

[0005] The first side rail and the second side rail may each comprise a pin slot, and the first tonneau section may have a pair of pins projecting therefrom at each side thereof, the pins being received in the pin slots to provide the pivotal connection of the frame to the first tonneau section.

[0006] The pin slots may comprise a notched top opening and a generally rearward-sloping channel.

[0007] A cap may be removably securable to the pin slots to prevent the pair of pins from being removed from the pin slots.

[0008] The pins may each comprise a flat protrusion that cooperate with the pin slots to prevent removal of the first tonneau section from the side rails when the first tonneau section is in an extended position.

[0009] The flat protrusions may cooperate with the pin slots to permit removal of the first tonneau section from the side rails when the first tonneau section is in a vertical position.

[0010] The at least one latch may comprise a catch secured to the side rail and a latchbolt extending from the first tonneau section.

[0011] The latchbolt may be disposed upon a flange extending from a bottom surface of the first tonneau section.

[0012] The latchbolt may comprise an actuator causing movement of a cable coupled to the latchbolts, wherein actuating the actuator causes a release of the latchbolt from the catch to permit free pivotal movement of the tonneau system.

[0013] A tonneau section distal from the first tonneau section may have a pair of latches projecting therefrom at each side thereof, the latches being securable to the side rails to retain the tonneau system in an extended position.

[0014] The at least one latch may comprise a catch secured to the side rail and a latchbolt extending from the tonneau section.

[0015] The latchbolt may be disposed upon a flange extending from a bottom surface of the tonneau section.

[0016] The latchbolt may comprise an actuator causing movement of a cable coupled to the latchbolts, wherein actuating the actuator causes a release of the latchbolt from the catch to permit pivoting of the tonneau section.

[0017] The pivotal connection may permit pivoting the tonneau cover upwards or downwards relative to the frame when the tonneau cover is in a nested position.

[0018] The tonneau system may further comprise a pair of struts pivotally connected to the bottom surface of the first tonneau section, the struts coupleable to the side rails to maintain the stacked tonneau sections in a generally upright position above the cargo box.

[0019] The tonneau system may further comprise a dead panel in fixed relationship to the frame, the dead panel being pivotally coupled to the first tonneau section and having a cable-activated release mechanism to permit the first tonneau section to be selectively pivoted thereto.

[0020] At least one tonneau section may comprise a solar panel disposed on the top surface thereof, and the tonneau system couples the solar panel to a battery to store power generated therefrom.

[0021] Each tonneau section may be coupled by an electrical cabling system comprising a cable extending from a sheath, wherein the cable is decoupleable to permit removal or replacement of the respective tonneau section.

[0022] Each tonneau section and spacers separating each tonneau section may comprise electrical contacts disposed along edges thereof to permit electrical coupling among the tonneau sections.

[0023] The electrical contacts may be spring-loaded pins.

[0024] The frame may comprise a utility track along the top surface of at least one of the first side rail and the second side rail thereof to permit an attachment to be secured thereto.

[0025] The frame may comprise a utility track along the inner side surface of at least one of the first side rail and the second side rail thereof to permit an attachment to be secured thereto.

[0026] The frame may comprise a first utility track along the top surface of at least one of the first side rail and the second side rail and a second utility track along the inner side surface of the at least one of the first side rail and the second side rail thereof, to permit an attachment to be secured simultaneously to the first utility track and the second utility track.

[0027] In another aspect, a tonneau system is provided for use with a cargo box of a pickup truck, the tonneau system comprising: a tonneau cover including a plurality of tonneau sections comprising at least a first tonneau section and a second tonneau section; a first hinge system coupling the first tonneau section to the second tonneau section whereby the first and second tonneau sections are moveable between an expanded position covering the cargo box and a stacked position where the second tonneau section overlies the first tonneau section forming a stack; a frame having a first side rail securable to a first side of the cargo box and a second side rail securable to a second side of the cargo box, the frame being pivotally connected to the first tonneau section at a pivotal connection; and at least one releasable latch, when engaged the latch

securing the tonneau cover to the first and second side rails, and, when released the latch permitting the stack to pivot from a horizontal position above the cargo box to a vertical position depending into the cargo box.

[0028] In another aspect, a tonneau system is provided for use with a cargo box of a pickup truck, the cargo box having first and second sides, the tonneau system comprising: a tonneau cover having a plurality of tonneau sections, the tonneau sections being moveable between an unfolded position and a folded position, in the unfolded position the tonneau sections substantially covering the cargo box, in the folded position the tonneau sections being arranged in a stack; first and second side rails respectively mountable to the first and second side of the cargo box; a latch securing the tonneau cover to the first and second side rails; the stack being pivotable about a pivot axis extending transversely to the first and second side rails between a first position located above the cargo box and a second position depending into the cargo box.

[0028a] In another aspect, a tonneau system is provided for use with a cargo box of a pickup truck, the cargo box having first and second sides, the tonneau system comprising: a tonneau cover having a plurality of tonneau sections, the tonneau sections being moveable between an unfolded position and a folded position, in the unfolded position the tonneau sections substantially covering the cargo box, in the folded position the tonneau sections being arranged in a stack; first and second side rails respectively mountable to the first and second sides of the cargo box, a latch securing the tonneau cover to the first and second side rails; the stack being pivotable about a pivot axis extending transversely to the first and second side rails between a first position located above the cargo box and a second position depending into the cargo box.

[0028b] In another aspect, a tonneau system is provided for use with a cargo box of a pickup truck, the cargo box having opposing first and second sidewalls and also having a front sidewall extending between the first and second sidewalls at one end thereof and a rear sidewall extending between the first and second sidewalls at another end thereof, the tonneau system comprising: a first side rail configured to be respectively mounted to the first sidewall of the cargo box; a second side rail configured to be respectively mounted to the second sidewall of the cargo box; a tonneau cover having at least two tonneau sections including a

first tonneau section and a second tonneau section, the tonneau sections being moveable relative to one another between an unfolded state and a folded state, in the unfolded state the tonneau sections substantially covering the cargo box, in the folded state the tonneau sections being arranged in a stack with the tonneau sections arranged one atop another, the first tonneau section being the tonneau section located closest to the front sidewall of the cargo box in the unfolded state; and the stack of tonneau sections being pivotally connected to at least one of the first and second side rails by a pivot connection, the pivot connection including first and second portions being moveable between secure and release positions, in the secure position the stack being retainingly engaged with the first and second side rails, in the release position the stack being removably engaged with the first and second side rails whereby the stack is removable from the cargo box while the first and second side rails remain mounted therewith.

[0028c] In another aspect, a tonneau system is provided for use with a pickup truck, comprising: a frame having a first side rail securable to a first side of a cargo box of a pickup truck and a second side rail securable to a second side of the cargo box of the pickup truck; a tonneau cover, including: a plurality of rigid tonneau sections, the plurality having at least a first tonneau section and a second tonneau section; a first hinge system coupling the first tonneau section to the second tonneau section, enabling stacking and expanding of the first tonneau section relative to the second tonneau section; a dead panel being fixed relative to the frame and located adjacent to the first tonneau section, a locking hinge system coupling the dead panel to the first tonneau section, the locking hinge system being lockable to fix the dead panel relative first tonneau section.

[0028d] In another aspect, a tonneau system is provided for use with a pickup truck, comprising: a tonneau cover including: a plurality of tonneau sections, the plurality having at least a first tonneau section and a second tonneau section; a first hinge system coupling the first tonneau section to the second tonneau section, enabling stacking and expanding of the first tonneau section relative to the second tonneau section; a solar panel disposed on the top surface of at least one of the plurality of tonneau sections; and a battery coupled to the solar panel to store power generated therefrom.

[0028e] In another aspect, a tonneau system is provided for use with a pickup truck, comprising: a frame having a first side rail securable to a first side of a cargo box of a pickup truck and a second side rail securable to a second side of the cargo box of the pickup truck; a tonneau cover, including: a plurality of tonneau sections, the plurality having at least a first tonneau section and a second tonneau section; a first hinge system coupling the first tonneau section to the second tonneau section, enabling stacking and expanding of the first tonneau section relative to the second tonneau section; and a first latching system including a first latch and first catch, the first catch being mounted to one of the first and second side rails and the first latch being mounted to the second tonneau section; a second latching system including a second latch and second catch, the second catch being mounted to one of the first and second side rails and the second latch being mounted to the first tonneau section.

[0028f] In another aspect, a tonneau system is provided for use with a pickup truck, comprising: a tonneau cover including: a plurality of tonneau sections, the plurality having at least a first tonneau section and a second tonneau section; a first hinge system coupling the first tonneau section to the second tonneau section, enabling stacking and expanding of the first tonneau section relative to the second tonneau section; and a frame having a first side rail securable to a first side of a cargo box of a pickup truck and a second side rail securable to a second side of the cargo box of the pickup truck, the tonneau cover being coupled to the first and second side rails, the frame including a utility track extending along a surface of at least one of the first and second side rails to permit an attachment to be secured thereto.

[0028g] In another aspect, a tonneau system is provided for use with a pickup truck, comprising: a tonneau cover including: a plurality of tonneau sections, the plurality having at least a first tonneau section and a second tonneau section; a first hinge system coupling the first tonneau section to the second tonneau section, enabling stacking and expanding of the first tonneau section relative to the second tonneau section; and a frame having a first side rail securable to a first side of a cargo box of a pickup truck and a second side rail securable to a second side of the cargo box of the pickup truck, the tonneau cover being coupled to the first and second side rails, the first and second side rails each including an integrated clamp for clamping the side rail to the side of the cargo box.

[0029] These and other aspects are contemplated and described herein. It will be appreciated that the foregoing summary sets out representative aspects of a tonneau system to assist skilled readers in understanding the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] A greater understanding of the embodiments will be had with reference to the Figures, in which:

[0031] Figure 1 is a side perspective view of a tonneau system for use with a pickup truck in accordance with one embodiment thereof;

[0032] Figure 2a is a top perspective view of the tonneau cover and frame of the tonneau system of Figure 1;

[0033] Figure 2b is a bottom perspective view of the tonneau cover and frame of Figure 2a;

[0034] Figure 3 shows a left side view of the tonneau cover 28 of Figure 2a;

[0035] Figure 4 shows a portion of a side railing of the frame of Figure 1 having a slot for receiving the tonneau cover;

[0036] Figure 5 shows a portion of a pivot pin of the tonneau cover of Figure 1 to be received by the slot of Figure 4;

[0037] Figure 6 shows the slot of a side rail of Figure 4 having received the pivot pin of Figure 5 of the tonneau cover in a stacked state;

[0038] Figure 7 shows the orientation of the pin of Figure 5 relative to the slot of Figure 4 when the tonneau cover is in an expanded state covering the cargo box of the pickup truck;

[0039] Figure 8 shows a sectional view of the side rail at line A--A in Figure 1;

[0040] Figure 9 shows a sectional view of the side rail at line B--B in Figure 1;

[0041] Figure 10 shows a latch between a front-most tonneau section and the side rail of Figure 2 in an open position as the stacked tonneau sections are being pivoted up out of the cargo box of the pickup truck;

[0042] Figure 11 shows the latch of Figure 10 after engagement;

[0043] Figure 12 shows the tonneau cover in a stacked state after engagement of the latch as shown in Figure 11;

[0044] Figure 13 shows an end view of a portion of a side rail and a catch of another latch for releaseably securing the tonneau cover to the side rail of the frame;

[0045] Figure 14 shows a bottom perspective view of the latch of Figure 13 after engagement;

[0046] Figure 15 shows the tonneau cover of Figure 1 in a stacked state and depending into the cargo box of the pickup truck;

[0047] Figure 16 shows the tonneau cover of Figure 1 in a stacked state and oriented vertically above the cargo box of the pickup truck;

[0048] Figure 17 shows the position and orientation of the pin of the tonneau cover inside the slot of Figure 4 when the tonneau cover is stacked and oriented vertically as shown in Figure 16;

[0049] Figure 18 shows a side view of the stacked tonneau cover oriented vertically out of the cargo box of Figure 17;

[0050] Figure 19 shows the stacked tonneau cover being propped above the cargo box via a pair of struts;

[0051] Figure 20 shows a tonneau system similar to that of Figure 1, wherein solar panels are positioned at the top surfaces of the tonneau cover sections;

[0052] Figure 21 shows an electrical coupling system for the tonneau cover sections of Figure 20;

[0053] Figure 22 shows a schematic view of the power collection and conversion system of the tonneau system of Figure 20;

[0054] Figure 23 shows an electrical coupling system for the tonneau cover sections of Figure 20 in an alternative embodiment;

[0055] Figure 24 shows a tonneau system in accordance with another embodiment, wherein the front latch is further forward than that of Figure 1;

[0056] Figure 25 shows a side rail for a tonneau system wherein the slot is diagonally sloped forward and down;

[0057] Figure 26 is a sectional view of a side rail similar to that of Figure 8 in accordance with another embodiment, wherein the side rail is clamped to a horizontal portion of the side wall of the cargo box;

[0058] Figure 27 shows an exemplary fastener for maintaining the tonneau system in a nested stacked arrangement; and

[0059] Figure 28 shows a bottom view of an alternative tonneau cover arrangement in which a dead panel is provided ahead of the first tonneau section.

DETAILED DESCRIPTION

[0060] For simplicity and clarity of illustration, where considered appropriate, reference numerals may be repeated among the Figures to indicate corresponding or analogous elements. In addition, numerous specific details are set forth in order to provide a thorough understanding of the embodiments described herein. However, it will be understood by those of ordinary skill in the art that the embodiments described herein may be practised without these specific details. In other instances, well-known methods, procedures and components have not been described in detail so as not to obscure the embodiments described herein. Also, the description is not to be considered as limiting the scope of the embodiments described herein.

[0061] Various terms used throughout the present description may be read and understood as follows, unless the context indicates otherwise: "or" as used throughout is inclusive, as though written "and/or"; singular articles and pronouns as used throughout include their plural forms, and vice versa; similarly, gendered pronouns include their counterpart pronouns so that pronouns should not be understood as limiting anything described herein to use, implementation, performance, etc. by a single gender; "exemplary" should be understood as "illustrative" or "exemplifying" and not necessarily as "preferred" over other embodiments. Further definitions for terms may be set out herein; these may apply to prior and subsequent instances of those terms, as will be understood from a reading of the present description.

[0062] The following provides a tonneau system for use with a pickup truck. The described tonneau system includes a tonneau cover, a frame, and at least one latch. The tonneau cover has a plurality of tonneau sections. The plurality of tonneau sections has at least a first tonneau section and a second tonneau section. In the following description, a third tonneau section is also included. In the following description, the section referred to as the first tonneau section is the one most closely abutting the truck cab.

[0063] A first hinge system couples the first tonneau section to the second tonneau section, enabling stacking and expanding of the first tonneau section relative to the second tonneau section. A second hinge system couples the second tonneau section to the third tonneau section, enabling stacking and expanding of the second tonneau section and third tonneau section, when stacked, relative to the first tonneau section. When installed on a pickup truck, the frame has a first side rail secured to a first side of a cargo box of a pickup truck and a second side rail secured to a second side of the cargo box of the pickup truck. The frame is pivotally connected to the first tonneau section distal to the first hinge system. The at least one latch releaseably secures the tonneau cover to the first side rail and to the second side rail. When the at least one latch is released, the stacked tonneau sections are permitted to depend into the cargo box. In preferred embodiments, this prevents or mitigates blockage of the rearview window of the pickup cab.

[0064] An exemplary tonneau system 20 for use with a pickup truck 24 is shown in Figure 1. The tonneau system 20 includes a tonneau cover 28 covering a cargo box of the pickup truck 24. The tonneau cover 28 is secured in an unfolded (expanded) state to a frame that

includes two side rails 32 that are secured to the side walls of the cargo box. A back edge 36 of the tonneau cover 28 lies adjacent a tail gate of the cargo box. A utility rack 40 is optionally secured to front end of each of the side rails 32 for securing large apparatus such as ladders thereto.

[0065] Figures 2a, 2b, and 3 show the tonneau cover 28 and frame 38 of the tonneau system 20 in more detail. The tonneau cover 28 can have a plurality of sections, but in the illustrated example, has four tonneau sections 44a, 44b, 44c, and 44d. The number of sections can be determined by designing the sections so that they are no longer than the height of the truck bed for reasons that will become apparent. It is possible that the sections can be slightly longer than such height depending on the location of a hinge member on the section closest to the truck cab, again for reasons that will become apparent.

[0066] The tonneau sections 44a, 44b, 44c, and 44d have hinge systems therebetween to pivotally couple them. The hinge systems in this embodiment are piano hinges and spacer members used to enable nested stacking of the tonneau sections 44a, 44b, 44c, and 44d one atop another forming a stack 45 as seen in FIG. 12. In particular, a first spacer member 48a pivotally couples the tonneau section 44a that is closest to the front of the cargo box when deployed and the adjacent tonneau section 44b via piano hinges 50. A second spacer member 48b pivotally couples the tonneau section 44b to the adjacent tonneau section 44c via piano hinges 50. The tonneau section 44c is pivotally coupled to the rear-most tonneau section 44d via piano hinge 50.

[0067] In the embodiment shown, the tonneau sections 44a, 44b, 44c, and 44d and the spacer members 48a and 48b are constructed from aluminum panels housing a honeycomb structure therein to provide rigidity. Rubber or other suitable wipers, gaskets or sealing mechanisms (not shown) may be provided in between the tonneau sections and spacer members to prevent liquid ingress to the truck bed. Similarly, suitable wipers, gaskets or sealing mechanisms 96 may be provided between the frame side rails 32 and the tonneau cover 28 to prevent liquid ingress.

[0068] The frame 38 includes a front cross member 52 spanning the two side rails 32 at a front end thereof. The front end is adjacent the truck cab when the tonneau system is placed upon a truck bed.

[0069] A pin slot 56 is located along each side rail 32 for receiving a pin 58 projecting from each side of the tonneau section 44a distal from the first spacer member 48a.

[0070] A utility track 60 is located along the top of each side rail 32. The utility track 60 enables various attachments to be secured to the side rail 32 for securing tools, tool boxes, and the like thereto. The utility track 60 may be vented by one or more apertures along a rear and/or bottom surface thereof to permit water to drain from the utility track 60.

[0071] A pair of front latches 64 secures the tonneau section 44a at a rear end thereof to the side rails 32 to retain the first tonneau section in an extended position. A pair of rear latches 68 secures the tonneau section 44d at a rear end thereof to the side rails 32 to retain the tonneau cover as a whole in an extended position.

[0072] An alternative embodiment is shown in Figure 28, in which a dead panel 702 is provided ahead of the first tonneau section 44a. In this case, a hinge 704 couples the dead panel 702 to the first tonneau section 44a so that the first tonneau section 44a can be pivoted into the bed during use. The dead panel is fixed in orientation to the frame, for example being integrated therein or fastened thereto.

[0073] Figure 4 shows the pin slot 56 of the left side rail 32 having a notched top opening 72 and a generally rearward-sloping channel. The right side rail 32 has a corresponding pin slot 56 with a similar notched top opening 72 and a generally rearward-sloping channel.

[0074] Figure 5 shows a pin 58 located on a left side of the tonneau section 44a that is received by the pin slot 56 of Figure 4. The pin 58 has a flat protrusion 80. A cap 71 may be removably engaged to the top of the notched top opening 72 to retain the pin 58 in the slot 56 for further securing the pin from sliding out of the side rail 32 during operation. The cap 71 is a thin plate 73 that has a protrusion 75, allowing it to slide over the side opening of the notched top opening 72, preventing the tonneau cover's pin 58 from sliding out of the rail 32 during operation.

[0075] In another embodiment, the protrusion 80 of the pin 58 may be round to permit easier removal of the pin 58 from the slot 56. It will be appreciated that it is possible to remove the tonneau cover 28 altogether and utilize the frame with the pin slot 56 to engage a third party cover for the truck bed. For example, a soft cover or other device could be adapted to fit the frame.

[0076] As shown in Figure 6, when the tonneau section 44a and pin 58 are oriented vertically, the flat protrusion 80 of the pin 58 is received by the notched top opening 72 of the slot 58 to allow the pin 58 to enter the channel of the pin slot 56.

[0077] Figure 7 shows the tonneau section 44a oriented horizontally after insertion of the pins 58 through the notched top opening 72 into the pin slots 56 of the side rails 32. As will be understood, upward lifting of the tonneau section 44a is prohibited by abutting of the flat protrusion 80 of the pin 58 against the notched top opening 72 of the pin slot 56, thereby securing the front of the tonneau section 44a to the side rail 32.

[0078] As will be appreciated, by reorienting the tonneau cover 28 such that tonneau section 44a is disposed vertically relative to the side rails 32, as shown in Figure 6, when it is deployed on the pickup truck 24, the tonneau cover 28 can be removed from the pickup truck 24, thus providing full access to the cargo box. The tonneau cover 28 can then be stored elsewhere or in the cargo box until required again.

[0079] Figure 8 shows a cross section of the right side rail 32 atop a sidewall 82 of the cargo box of the pickup truck 24 at line A—A in Figure 1. As shown, the side rail 32 has a utility track 60 along a top edge thereof. The side rail 32 is clamped along a vertical portion 84 thereof to the sidewall 82 of the pickup truck 24 by a clamp 86. A side utility track 88 is positioned along the vertical portion 84 to enable various attachments to be secured to the side rail 32 inside the cargo box for securing tools, tool boxes, and the like thereto. The attachments are generally additional components to be mounted inside the cargo box or to allow secondary mounting for accessories that require additional support like seating or items that will hold heavy cargo loads. Attachments may be securable to either or both of the side utility track 88 and the utility track 60 so that the utility tracks 60, 88 can accept independent accessories (one thing mounted to the top and a separate thing mounted to the inside) or one item that mounts in both slots simultaneously for additional support/rigidity. The inner utility track ends at the tonneau section 44a so that the tonneau cover can pass through to depend into the cargo bed without being obstructed by the inner utility track.

[0080] The side utility track 88 may be vented by one or more apertures along a rear and/or bottom surface thereof to permit water to drain from the inner utility track 88.

[0081] A tonneau rest 92 projects perpendicularly from the vertical portion 84 to provide a horizontal support for the tonneau cover 28. A sealing strip 96 is adhered to the upper part of the vertical portion 84 of the side rail and along the top surface of the tonneau rest 92 to provide a water-resistant seal and to dampen movement of the tonneau cover 28 during travel of the pickup truck 24. A flexible upper lip 100 of the tonneau cover 28 helps cover the gap between the tonneau cover 28 and the side rail 32.

[0082] Figure 9 shows a cross section of the right side rail 32 atop of the sidewall 82 of the cargo box of the pickup truck 24 at line B—B in Figure 1. As shown, the side utility track 88 and tonneau rest 92 continue from the back end of the side rail 32 until just before the back edge of the tonneau section 44a when the tonneau section 44 is oriented horizontally. The profile of the side rail 32 further front from that is as shown in Figure 9. The tonneau cover 28 does not rest on a horizontal surface at the front end of the side rail 32.

[0083] Figures 10 and 11 show the tonneau cover 28 being pivoted about the pin 58 in the pin slot 56 from a position in which the nested stacked tonneau cover 28 depends generally vertically into the cargo box to a generally horizontal position. To achieve the vertical orientation of the nested stacked tonneau cover, a latch and catch system may be used. Referring now to Figure 10, the front latches 64 include a catch 104 secured to the side utility track 88, and a latchbolt 108 on a flange 112 extending from a rear bottom surface of the tonneau section 44a. The latchbolt 108 includes an actuator 114 to which a cable is fastened. The cable is then fastened to the actuator 114 of the corresponding latchbolt 108 on the other side of the tonneau section 44a. Pulling the cable releases the latchbolts 108 from the catches 104 to permit free pivotal movement of the nested stacked tonneau cover 28. The actuating of the actuator may be accomplished by hand or electrically.

[0084] As shown, the tonneau cover 28 has clearance 90 from the forward end of the inner side utility track 88 when nested and stacked to pivot about the pin 58 from a position in which it depends generally vertically in the cargo box to a position in which the tonneau cover 28 is generally horizontal and above the cargo box.

[0085] Figure 11 shows the nested stacked tonneau cover 28 in a horizontal orientation with the front latch 64 engaged to restrict pivoting of the nested stacked tonneau cover 28.

[0086] Figure 12 shows the horizontal position of the nested stacked tonneau cover 28 when the front latches 64 are engaged. The front latches 64 are sufficiently robust to support the weight of the tonneau cover 28 thereon.

[0087] Figure 13 shows the rear end of the left side rail 32. A catch 116 of the rear latch 68 is shown secured to the side utility track 88.

[0088] Figure 14 shows the underside of the tonneau cover 28 wherein a latchbolt 120 of the tonneau section 44d is engaged with the catch 116 to secure the tonneau cover 28 in a fully extended and horizontal position in which it covers the cargo box of the pickup truck 24. In this extended horizontal position, the rear three tonneau sections 44b, 44c, and 44d rest atop of the tonneau rests 92 of the side rails 32. Like the latchbolt 108, the latchbolt 120 includes an actuator 122 to which a cable is fastened. The cable is then fastened to the actuator 122 of the corresponding latchbolt 120 on the other side of the tonneau section 44d.

[0089] In order to put the tonneau cover 28 into the nested stacked horizontal position shown in Figure 12, the cable between latchbolts 120 is pulled to release the latchbolts 120 from the catches 116. Once the rear latches 68 are released, the tonneau section 44d can be pivoted upward and forward about the hinge 50 into a stacked position atop of the tonneau section 44c. Stacked tonneau sections 44c and 44d can then be pivoted upward and forward about the second spacer member 48b into a stacked position atop of the tonneau section 48b. Similarly, nested stacked tonneau sections 44b, 44c, and 44d can be pivoted upward and forward about the first spacer member 48a into a stacked position atop of the tonneau section 48a, which is locked in a horizontal position via the front latches 64.

[0090] Releasing the front latches 64 allows the nested stacked tonneau cover 28 to be pivoted downward so that it depends into the cargo box, as shown in Figure 15. As the pivot axis 59 of the pin 58 and pin slot 56 are close to the front edge of the cargo box, the nested stacked tonneau cover 28 tucks into the cargo box proximal to a front wall of the cargo box. Thus, in this manner, the tonneau cover 28 can be first stacked in a nested manner above the cargo box in a first position and then pivoted into the cargo box in a second position at the front edge thereof, thereby requiring little clearance inside the cargo box proximal to the front edge thereof. When the nested stacked tonneau cover 28 is pivoted down into the cargo box, it only occupies about a foot of cargo room at the front of the cargo box.

[0091] Alternatively, when the front latch 64 is released, the nested stacked tonneau cover 28 can be pivoted upwards and forwards to provide access to the cargo box, as shown in Figure 16.

[0092] Figure 17 shows the position and orientation of the pin 58 of the tonneau section 44a relative to the pin slot 56 when the nested stacked tonneau cover 28 pivoted vertically upwards above the cargo box.

[0093] Figure 18 shows a side view of the nested stacked tonneau cover 28 when oriented vertically above the cargo box. As shown, the nested stacked tonneau cover 28 nests inside the utility rack 40 in this position.

[0094] Figure 19 shows a pair of struts 128 pivotally connected to the bottom surface of the tonneau section 44a that can be snap connected to locations along the side rails 32 to maintain the nested stacked tonneau cover 28 in a generally upright position above the cargo box to provide access to cargo stored at the front end of the cargo box. When no longer required, the struts 128 are unsnapped from the side rails 32 so that the nested stacked tonneau cover 28 is free to pivot. In another embodiment, as shown in Figure 28, a dead panel 702 in fixed relationship to the rails has one or more locking hinges 704 that are activated by cables 706, that allow the cover 28 to rotate upwards or downwards and locking at various angles, e.g., in 45 degree increments.

[0095] While in the above-described embodiment, the tonneau sections are primarily made of an aluminum shell housing a honeycomb structure, it can be desirable to modify their structure in certain scenarios.

[0096] Figure 20 shows a tonneau system 200 in accordance with another embodiment that is similar to the previously described embodiment and illustrated in Figures 1 to 19, wherein solar panels 218 are installed on the top surface of a tonneau cover 204. Preferably the panels 218 are fastened, for example with screws or bolts and nuts, to be easily removable for service, repair, or upgrades. For example, solar panels can be interchanged with metal panels to add or remove solar function. The tonneau cover 204 rests between a pair of side rails 208. Like the tonneau cover 28 shown in Figure 1, the tonneau cover 204 includes four tonneau sections 212a, 212b, 212c, and 212d. The tonneau sections 212a, 212b, 212c, and 212d have hinge systems therebetween to pivotally couple them. The hinge systems are piano hinges and spacer members

216a and 216b are used to enable nested stacking of the tonneau sections 212a, 212b, 212c, and 212d one atop another. In particular, a first spacer member 216a pivotally couples the tonneau section 212a that is closest to the front of the cargo box when deployed and the adjacent tonneau section 212b via piano hinges. A second spacer member 216b pivotally couples the tonneau section 212b to the adjacent tonneau section 212c via piano hinges. The tonneau section 212c is pivotally coupled to the rear-most tonneau section 212d via a piano hinge.

[0097] The tonneau section 212a and the spacer members 216a and 216b are constructed from aluminum panels housing a honeycomb structure therein to provide rigidity. The tonneau sections 212b, 212c, and 212d are constructed having solar panels 218 along their top surfaces.

[0098] A utility rack 220 has a brake light aperture 224 along a top bar thereof to enable visibility of the brake light at the top of the rear of the cabin when the tonneau system 200 is deployed thereon.

[0099] In order to transfer power generated from each solar panel 218 in tonneau sections 212b, 212c, and 212d, the solar panels 218 are coupled to a battery that stores the power.

[0100] Figure 21 shows the electrical cabling system employed with the tonneau cover 204. A plug 228 on the bottom of tonneau section 212d adjacent the front edge thereof receives a cable 232 that extends from a sheath 236 on the bottom surface of the tonneau section 212c adjacent a rear edge thereof. The cable 232 is rigid enough to resist bunching and pinching between the tonneau sections 212c, 212d when they abut one another in an expanded state. The sheath 236 extends into the tonneau section 212c and is sufficiently long enough to permit compression of the cable 232 therein when the tonneau section 212d is stacked atop of the tonneau section 212c. The cable 232 can be unplugged from the plug 228 to permit disassembly of the tonneau cover 204, for example, to replace a tonneau section having a faulty solar panel. Such cabling and connections are employed between tonneau sections 212a, 212b, 212c, and 212d and spacer members 216a and 216b. As will be understood, the slack length of the cable 232 between tonneau sections 212c, 212b, 212a and spacer members 216b, 216a is not as great as between the tonneau section 212c and the tonneau section 212d.

[0101] Each solar panel 218 may require its own cable to the battery. As a result, there may be two cables 232 between the tonneau section 212c and the tonneau section 212b, and three cables 232 between the tonneau section 212b and the tonneau section 212a.

[0102] Figure 22 is a schematic diagram of the power elements of the tonneau system 200 relative to a pickup truck 240 in which it is deployed. An inlet plug 244 can receive three cables from the tonneau section 212a. The cables are sufficiently long to permit pivoting of the tonneau cover 204 when stacked in a nested manner. The inlet plug 244 has a cable 248 extending back between the side rail 208 and the sidewall of the cargo box of the pickup truck 240. The cable 248 extends to a battery 252 in a retaining basket secured to a side utility track of the side rail 208. The battery 252 receives the power generated by the solar panels 218 and stores it. A transformer outlet 256 is coupled to the battery 252 for drawing power therefrom, converting it to alternating current, and powering a set of power outlets, such as a standard 220 volt household outlet, a USB port, etc. In this way, tools can be charged using solar power when they are not being used and when the tonneau cover 204 is extended to cover the cargo box of the pickup truck 240.

[0103] Figure 23 shows a variation of the tonneau system of Figure 20, wherein, a tonneau cover 300 does not employ external cabling between tonneau sections 304a, 304b, 304c, and 304d. Instead, a set of spring-loaded pins 312 along a front edge of each tonneau section 304 or spacer member 308 are urged towards a set of contacts 316 along a rear edge of an adjacent tonneau section 304 or spacer member 308. The number of sets of spring-loaded pins 312 and contacts 316 is increased from one set between the tonneau section 304d and the tonneau section 304c to two sets between the tonneau section 304c, the spacer member 308b, and the tonneau section 304b, to three sets between the tonneau section 304b, the spacer member 308a, and the tonneau section 304a. Further, such sets of spring-loaded pins 312 and contacts 316 can be employed between the tonneau section 304a and a front cross-member of a frame. Use of such spring-loaded pins and contacts avoids issues with the physical wearing of external cables that are articulated regularly.

[0104] Figure 24 shows an alternative configuration of a tonneau system 400. A frame 402 of the tonneau system 400 has two side rails 404 that include tonneau rests 408. A tonneau cover has tonneau sections 412a, 412b, 412c, and 412d, and spacer members 416a and 416b,

similar to the configuration of the tonneau cover 28 of Figure 1. A front latch 420 is shown under the tonneau section 412a forwards from its rear edge. The front latch 420 has a catch that is machined into the inside surface of the side rail 404. The tonneau rests 408 of the side rails 404 extend forward to about the rear edge of a spacer member 416a to permit the tonneau cover to pivot upwards or downwards unimpededly.

[0105] Figure 25 shows a side rail 500 for use with a tonneau cover, the side rail 500 having a slot 504 that is angled forward and downward. While a tonneau cover will generally remain securely therein when latched in place, a locking bracket 508 for securing a pin of the tonneau cover in place in the slot 504 is secured in a utility track 512 along the top of the side rail 500. The locking bracket 508 can be biased between an open position, as shown, and a locking position, in which a locking slot 516 on a front edge of the locking bracket 508 can engage and secure the pin of the tonneau cover, via a ridge 520. The locking bracket 508 is secured in the open and locking positions via a protuberance on the inside of the locking bracket and indentations on the side rail 500. Removal of the tonneau cover is facilitated with the slot 504 as it can be pulled up and backward out of the slot 504 once the locking bracket 508 is moved to the shown open position.

[0106] Figure 26 shows a side rail 600 similar to that of Figure 8 in accordance with another embodiment, wherein the side rail 600 has a clamping element 604 that clamps a horizontal portion of the side wall 82 of the cargo box. A rubber end 608 of the clamping element 604 is provided to reduce damage to the surface of the side wall 82 of the cargo box.

[0107] While certain configurations for the slot have been shown, those skilled in the art will appreciate that slots having other paths other than those shown can also be utilized. Preferably, the front of the tonneau cover cannot be lifted directly out of the slot when it is latched in, such as with a substantially vertical slot, unless additional securing means are employed to impede removal from the slot.

[0108] While the power elements connected to the solar panels have been described as separate from the main electrical systems of a pickup truck, those skilled in the art will appreciate that it may be advantageous to couple the solar panels electrically to the main battery of a pickup truck, especially in cases where the pickup truck is a hybrid or electrically-powered vehicle.

[0109] The tonneau sections may be made so as to receive either solar panels or non-solar panels, allowing customization after purchase and replacement of a solar panel unit if faulty. Access to the panels can be provided via a removable panel fastened to the underside of the tonneau sections via screws, etc. The tonneau sections can provide a frame into which the solar panels or non-solar panels can be fitted.

[0110] While the tonneau sections have been described as rigid above, those skilled in the art will appreciate that the main panels of the tonneau sections, where not using solar panels, can be either rigid or flexible. Rigid panels for the tonneau sections can be constructed from, for example, fiberglass, plastic, or metal. Alternatively, the panels can be flexible and secured over a rigid frame.

[0111] Flexible panels for the tonneau sections can be made from any weather-resistant flexible material that is also resistant to wear, such as vinyl coated tarpaulin.

[0112] Instead of using tonneau rests along the side rails of the cargo box extending backward behind the first tonneau section, each of the other tonneau sections can also be held in a horizontal cover position via a locking mechanism such as the slam latches described above, etc.

[0113] As shown in Figure 27, a retaining mechanism, such as a buckle or plurality of buckles, may be provided to maintain the sections in stacked orientation. The buckle 700 may comprise two portions, one 701a of which is secured to the first tonneau section 44a and the other 701b to either spacer 48b or the second tonneau section 44b so that closing the buckle 700 retains the third tonneau section 44c and fourth tonneau section 44d nested within an envelope created by the first tonneau section 44a, spacer 48a, second tonneau section 44b and spacer 48b.

[0114] Although the invention has been described with reference to certain specific embodiments, various modifications thereof will be apparent to those skilled in the art. The scope of the claims should not be limited by the preferred embodiments, but should be given the broadest interpretation consistent with the description as a whole.

CLAIMS

1. A tonneau system for use with a cargo box of a pickup truck, the tonneau system comprising:

a tonneau cover including a plurality of tonneau sections comprising at least a first tonneau section and a second tonneau section;

a first hinge system coupling the first tonneau section to the second tonneau section whereby the first and second tonneau sections are moveable between an expanded position covering the cargo box and a stacked position where the second tonneau section overlies the first tonneau section forming a stack;

a frame having a first side rail securable to a first side of the cargo box and a second side rail securable to a second side of the cargo box, the frame being pivotally connected to the first tonneau section at a pivotal connection; and

at least one releasable latch, when engaged the latch securing the tonneau cover to the first and second side rails, and, when released the latch permitting the stack to pivot from a horizontal position above the cargo box to a vertical position depending into the cargo box.

2. The tonneau system of claim 1, further comprising a second hinge system coupling a third tonneau section to the second tonneau section along an opposing edge of the second tonneau section the first hingesystem.

3. The tonneau system of claim 1 or claim 2, wherein the first hinge system comprises a piano hinge.

4. The tonneau system of claim 2 or claim 3 when dependent upon claim 2, wherein the second hinge system includes a first hinge coupling the second tonneau section to a spacer member and a second hinge coupling the spacer member to the third tonneau section.

5. The tonneau system of any one of claims 1 to 4, wherein first and second side rails each comprise a pin slot, a pair of pins projecting from opposing sides of the first tonneau section, the

pins being received in the pin slots and defining the pivotal connection between the frame and the first tonneau section.

6. The tonneau system of claim 5, wherein the pin slots comprise a notched top opening in an upper surface of the first and second side rails and a generally rearward-sloping channel.

7. The tonneau system of claim 5 or claim 6, further comprising a cap removably secured to each of the pin slots, the caps preventing the pins from being removed from the pin slots.

8. The tonneau system of claim 5 or claim 6, wherein the pins include a flat protrusion, when the first tonneau section is in an extended position the flat protrusions being oriented such that the flat protrusion are prevented from exiting the pin slots and thereby prevents removal of the first tonneau section from the first and second side rails.

9. The tonneau system of claim 8, wherein when the first tonneau section is perpendicular to the first and second side rails the flat protrusions being oriented such that the flat protrusions are permitted to exit the pin slots and permit removal of the first tonneau section from the first and second side rails.

10. The tonneau system of any one of claims 1 to 9, wherein the releasable latch includes a catch provided in one of the first and second side rails and a latchbolt extending from the first tonneau section.

11. The tonneau system of claim 10, wherein the latchbolt is disposed on a flange extending from a bottom surface of the first tonneau section.

12. The tonneau system of claim 11, wherein the latchbolt includes an actuator coupled to a cable, wherein pulling of the cable causes actuating of the actuator and a release of the latchbolt from the catch to permit free pivotal movement of the tonneau system.

13. The tonneau system of any one of claims 1 to 12, further comprising a rear-most tonneau section distally located from the first tonneau section, the rear-most tonneau section including a pair of releasable rear latches, when engaged the releasable rear latches securing the rear-most tonneau section and the tonneau cover to the first and second side rails in an extended position.

14. The tonneau system of claim 13, wherein the rear latches include a rear catch provided in each of the first and second side rails and a rear latchbolt extending from the rear-most tonneau section.

15. The tonneau system of claim 14, wherein the rear latchbolt is disposed upon a flange extending from a bottom surface of the tonneau section.

16. The tonneau system of any one of claims 13 to 15, wherein each of the rear latchbolts includes an actuator coupled to a cable extending between the rear latchbolts, wherein actuating of the cable causes a release of the rear latchbolt from the rear catch to permit pivoting of the rear-most tonneau section.

17. The tonneau system of any one of claims 1 to 16, wherein the pivotal connection permits pivoting of the stack both upwards and downwards relative to the frame.

18. The tonneau system of any one of claims 1 to 17, further comprising a pair of struts pivotally connected to a bottom surface of the first tonneau section, each strut be connectable to one of the first and second side rails wherein the stack is maintained in a generally upright position extending away from the first and second rails above the cargo box.

19. The tonneau system of any one of claims 1 to 18, wherein the tonneau system further comprises a dead panel in coupled to the frame, the dead panel being pivotally coupled to the first tonneau section and permitting the first tonneau section to be selectively pivoted with respect thereto.

20. The tonneau system of any one of claims 1 to 19, wherein at least one tonneau section comprises a solar panel disposed on the top surface thereof, and the tonneau system couples the solar panel to a battery to store power generated therefrom.
21. The tonneau system of claim 20, wherein each tonneau section is coupled by an electrical cabling system comprising a cable extending from a sheath, wherein the cable is decoupleable to permit removal or replacement of the respective tonneau section.
22. The tonneau system of claim 20, wherein each tonneau section and spacers separating each tonneau section comprise electrical contacts disposed along edges thereof to permit electrical coupling among the tonneau sections.
23. The tonneau system of claim 22, wherein the electrical contacts are spring-loaded pins.
24. The tonneau system of any one of claims 1 to 23, wherein the frame comprises a utility track along the top surface of at least one of the first side rail and the second side rail thereof to permit an attachment to be secured thereto.
25. The tonneau system of any one of claims 1 to 23, wherein the frame comprises a utility track along the inner side surface of at least one of the first side rail and the second side rail thereof to permit an attachment to be secured thereto.
26. The tonneau system of any one of claims 1 to 23, wherein the frame comprises a first utility track along the top surface of at least one of the first side rail and the second side rail and a second utility track along the inner side surface of the at least one of the first side rail and the second side rail thereof, to permit an attachment to be secured simultaneously to the first utility track and the second utility track.

27. A tonneau system for use with a cargo box of a pickup truck, the cargo box having first and second sides, the tonneau system comprising:

a tonneau cover having a plurality of tonneau sections, the tonneau sections being moveable between an unfolded position and a folded position, in the unfolded position the tonneau sections substantially covering the cargo box, in the folded position the tonneau sections being arranged in a stack;

first and second side rails respectively mountable to the first and second side of the cargo box;

a latch securing the tonneau cover to the first and second side rails;

the stack being pivotable about a pivot axis extending transversely to the first and second side rails between a first position located above the cargo box and a second position depending into the cargo box.

28. The tonneau system according to claim 27, wherein the latch releasably secures the stack to the first and second side rails.

29. The tonneau system according to claim 28, wherein the latch secures the stack to the first and second side rails in the first position.

30. The tonneau system according to any one of claims 27 to 29, wherein in the unfolded position covering the cargo box the tonneau sections extend in a horizontal plane, and in the first position the tonneau sections of the stack are generally parallel with the horizontal plane.

31. The tonneau system according to claim 30, wherein in the second position the tonneau sections of the stack are generally perpendicular to the horizontal plane.

32. The tonneau system according to any one of claims 27 to 31, wherein the stack is a nested stacked configuration of the tonneau sections.

33. The tonneau system according to any one of claims 27 to 32, wherein from the first position the stack is pivotally moveable about the pivot axis in two directions.

34. The tonneau system according to any one of claims 27 to 33, wherein the stack is pivotally moveable about the pivot axis over a range of motion of about 180 degrees.

35. The tonneau system according to any one of claims 27 to 34, wherein the latch includes a catch and a latchbolt, the latchbolt being releasably engageable with the catch.

36. The tonneau system according to claim 35, wherein the catch is mounted to one of one of the tonneau sections and one of first and second side rails.

37. The tonneau system according to claim 35, wherein the latchbolt is mounted to one of one of the tonneau sections and one of first and second side rails.

38. The tonneau system according to claim 35, wherein the catch is mounted to one of the first and second side rails and the latchbolt is mounted to one of the tonneau sections.

39. The tonneau system according to any one of claims 35 to 38, wherein the latchbolt is coupled to an actuator and the actuator is configured to release the latchbolt from engagement with the catch.

40. A tonneau system for use with a cargo box of a pickup truck, the cargo box having first and second sides, the tonneau system comprising:

a tonneau cover having a plurality of tonneau sections, the tonneau sections being moveable between an unfolded position and a folded position, in the unfolded position the tonneau sections substantially covering the cargo box, in the folded position the tonneau sections being arranged in a stack;

first and second side rails respectively mountable to the first and second sides of the cargo box,

a latch securing the tonneau cover to the first and second side rails;

the stack being pivotable about a pivot axis extending transversely to the first and second side rails between a first position located above the cargo box and a second position depending into the cargo box.

41. The tonneau system according to claim 40, wherein the latch releasably secures the stack to the first and second side rails.

42. The tonneau system according to claim 41, wherein the latch secures the stack to first and second side rails in the first position.

43. The tonneau system according to any one of claims 40 to 42, wherein in the unfolded position covering the cargo box the tonneau sections extend in a horizontal plane, and in the first position the tonneau sections of the stack are generally parallel with the horizontal plane.

44. The tonneau system according to claim 43, wherein in the second position the tonneau sections of the stack are generally perpendicular to the horizontal plane.

45. The tonneau system according to any one of claims 40 to 44, wherein the stack is a nested stacked configuration of the tonneau sections.

46. The tonneau system according to any one of claims 40 to 45, wherein from the first position the stack is pivotally moveable about the pivot axis in two directions.

47. The tonneau system according to any one of claims 40 to 45, wherein the stack is pivotally moveably about the pivot axis over a range of motion of about 180 degrees.

48. The tonneau system according to any one of claims 40 to 47, wherein the latch includes a catch and a latchbolt, the latchbolt being releasably engageable with the catch.

49. The tonneau system according to claim 48, wherein the catch is mounted to one of one of the tonneau sections and one of first and second side rails.

50. The tonneau system according to claim 48, wherein the latchbolt is mounted to one of one of the tonneau sections and one of first and second side rails.

51. The tonneau system according to claim 48, wherein the catch is mounted to one of the first and second side rails and the latchbolt is mounted to one of the tonneau sections.

52. The tonneau system according to any one of claims 48 to 51, wherein the latchbolt is coupled to an actuator and the actuator is configured to release the latchbolt from engagement with the catch.

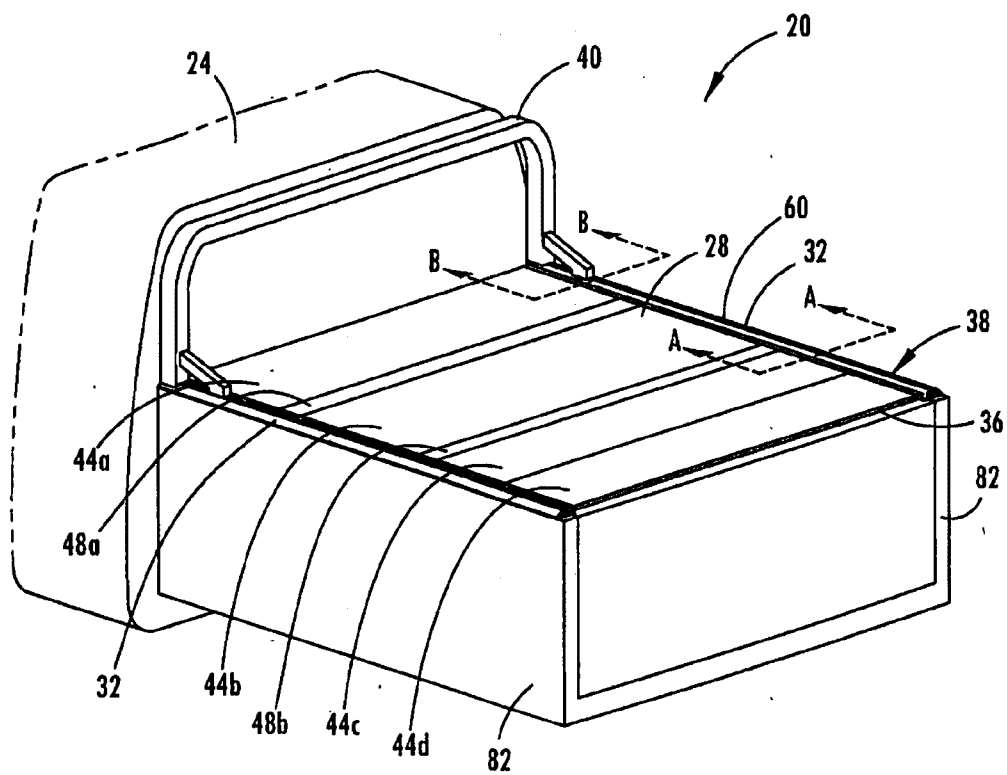


FIG. 1

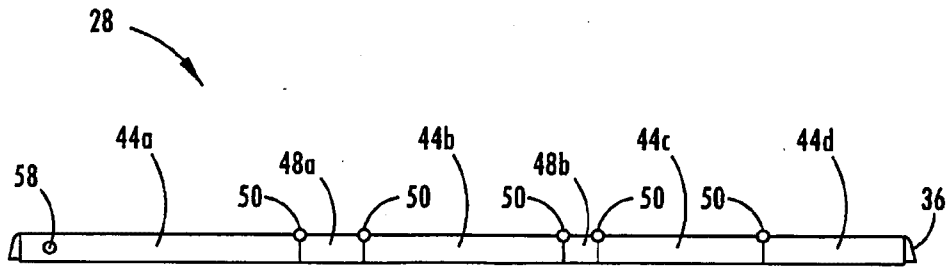


FIG. 3

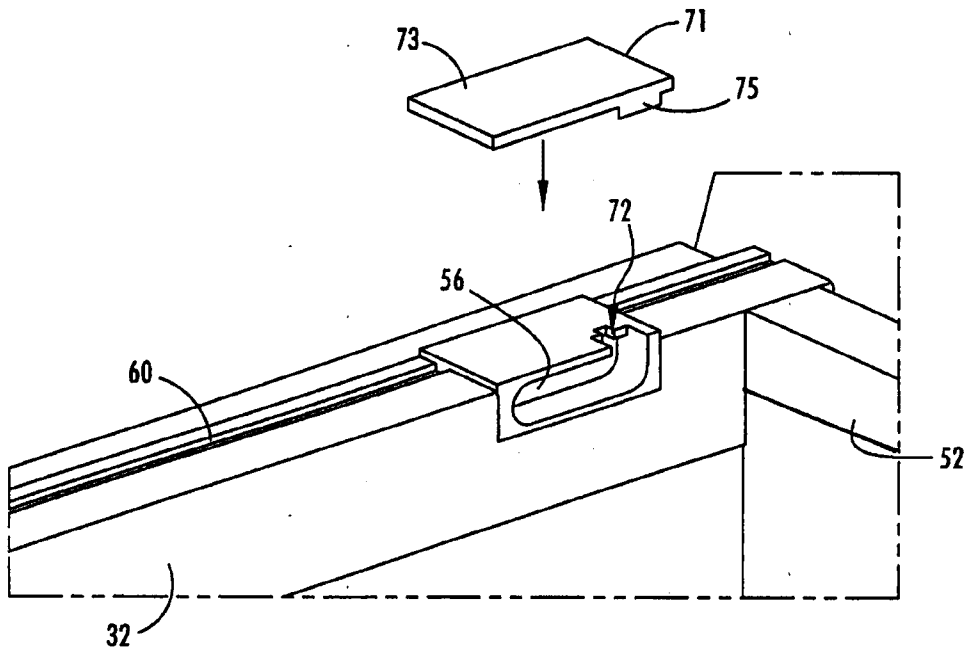


FIG. 4

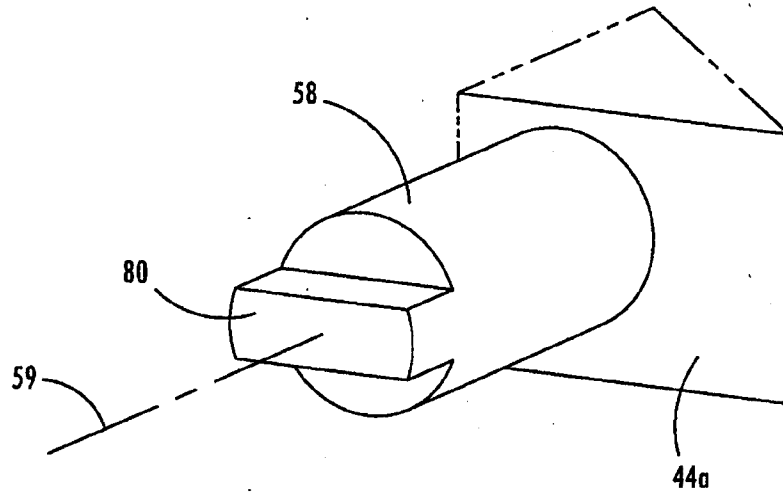


FIG. 5

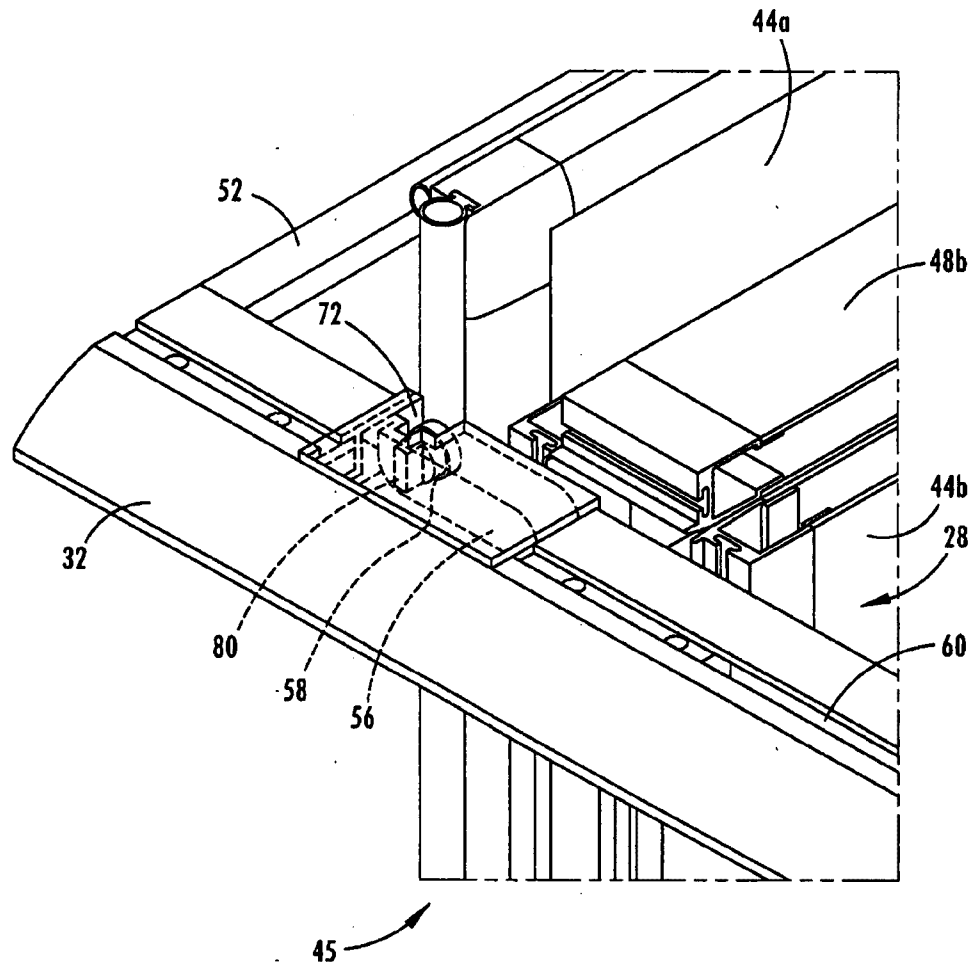


FIG. 6

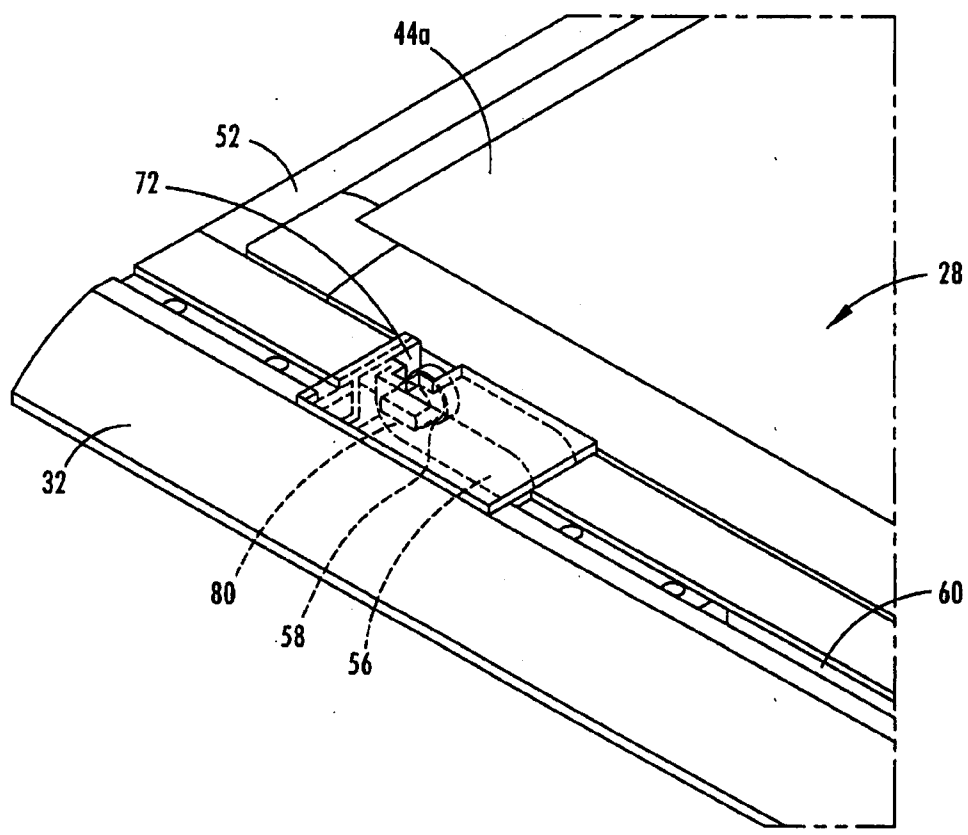


FIG. 7

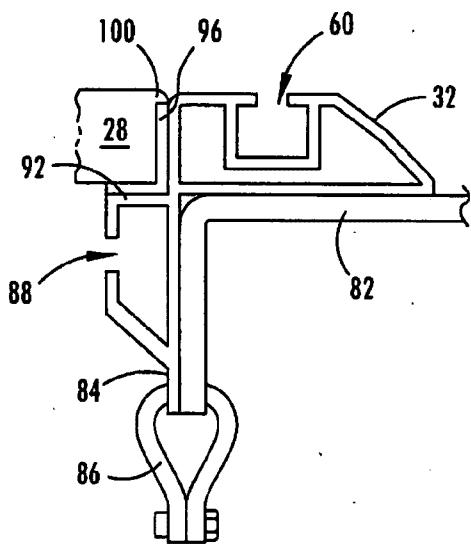


FIG. 8

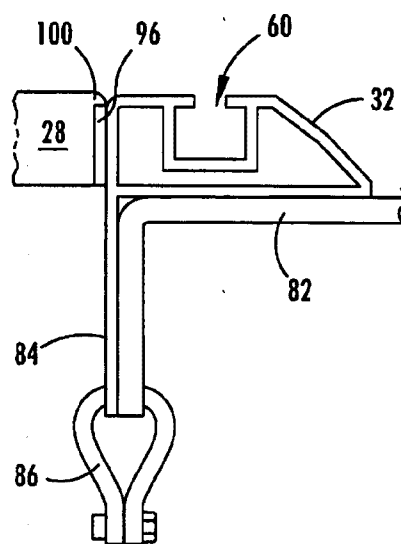


FIG. 9

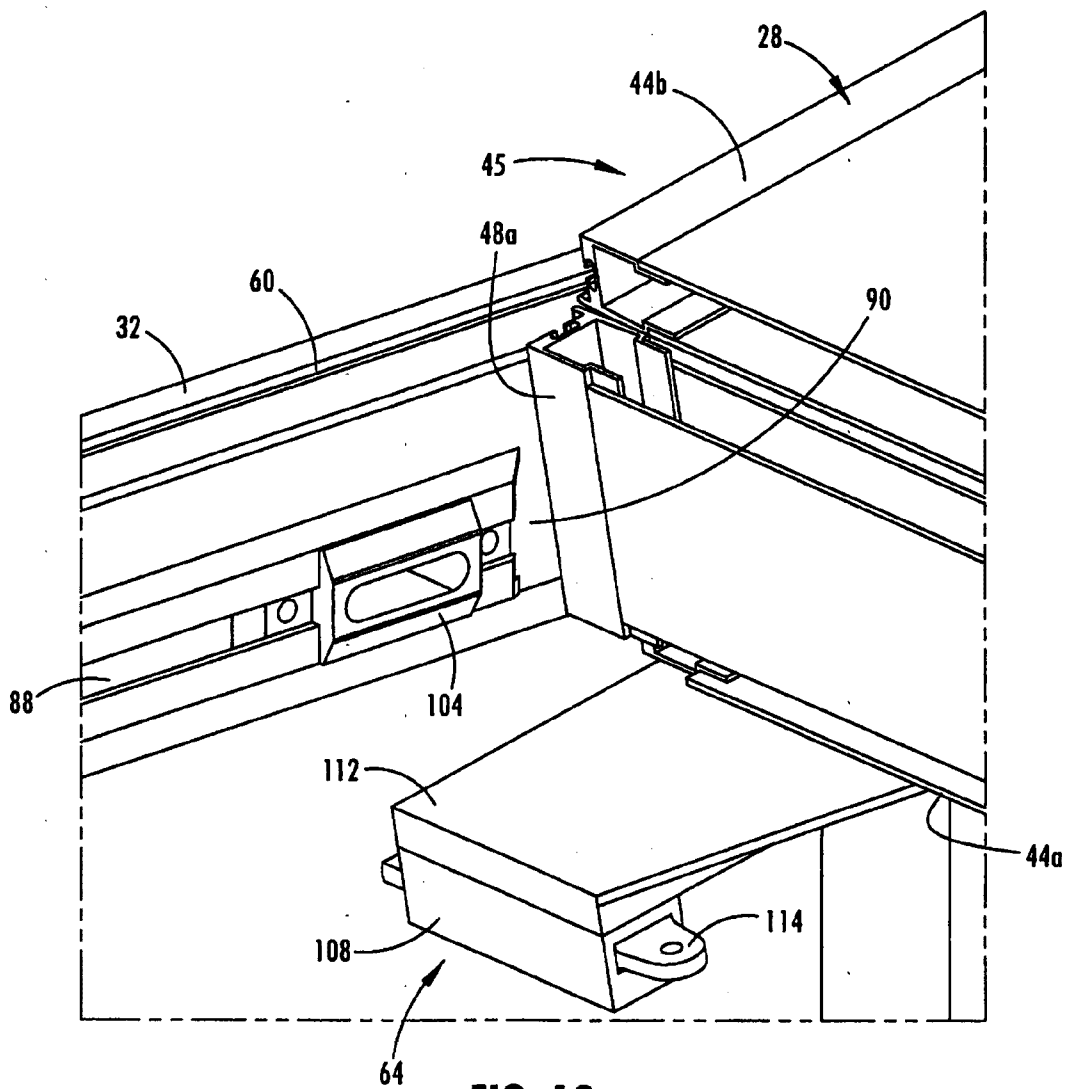


FIG. 10

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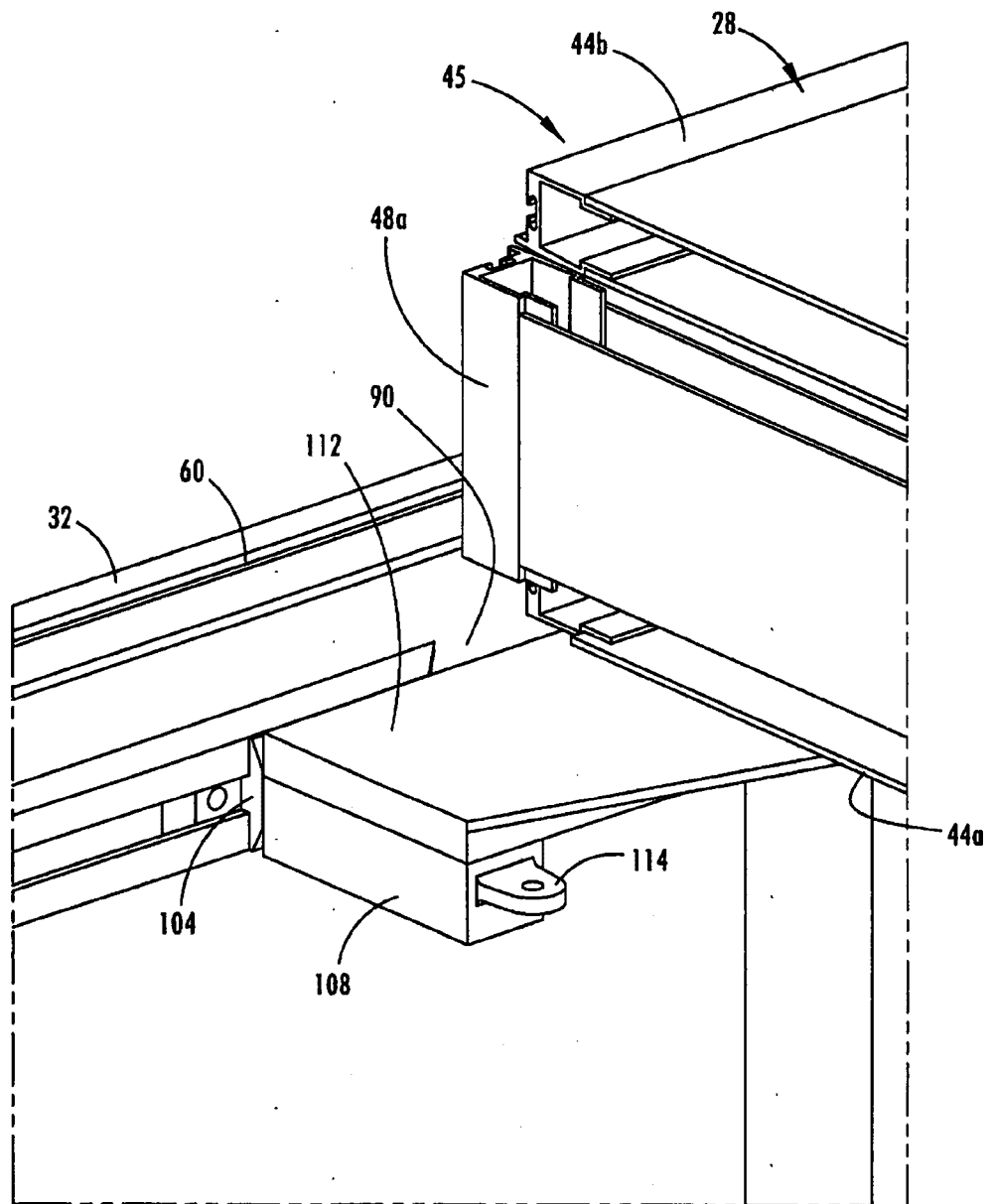


FIG. 11

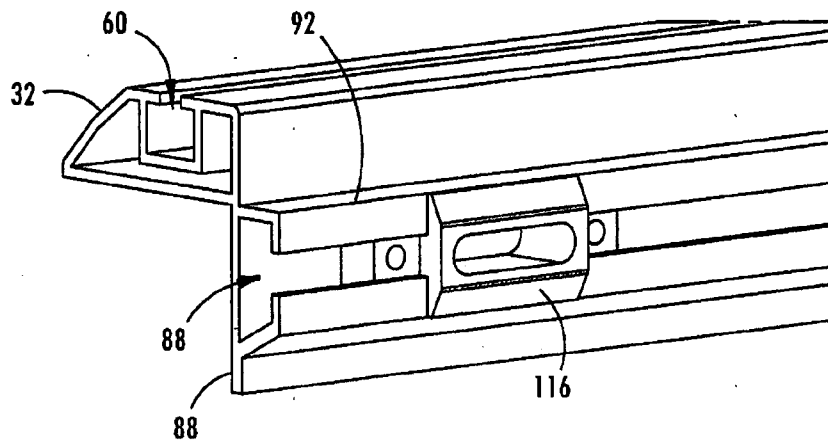


FIG. 13

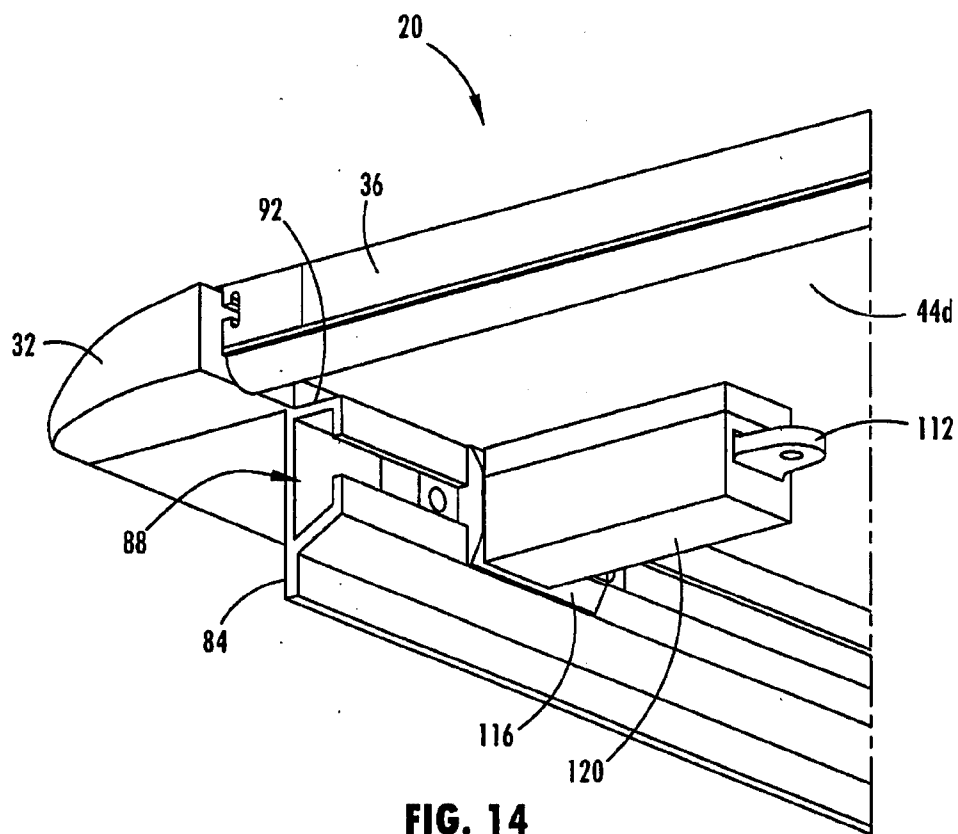


FIG. 14

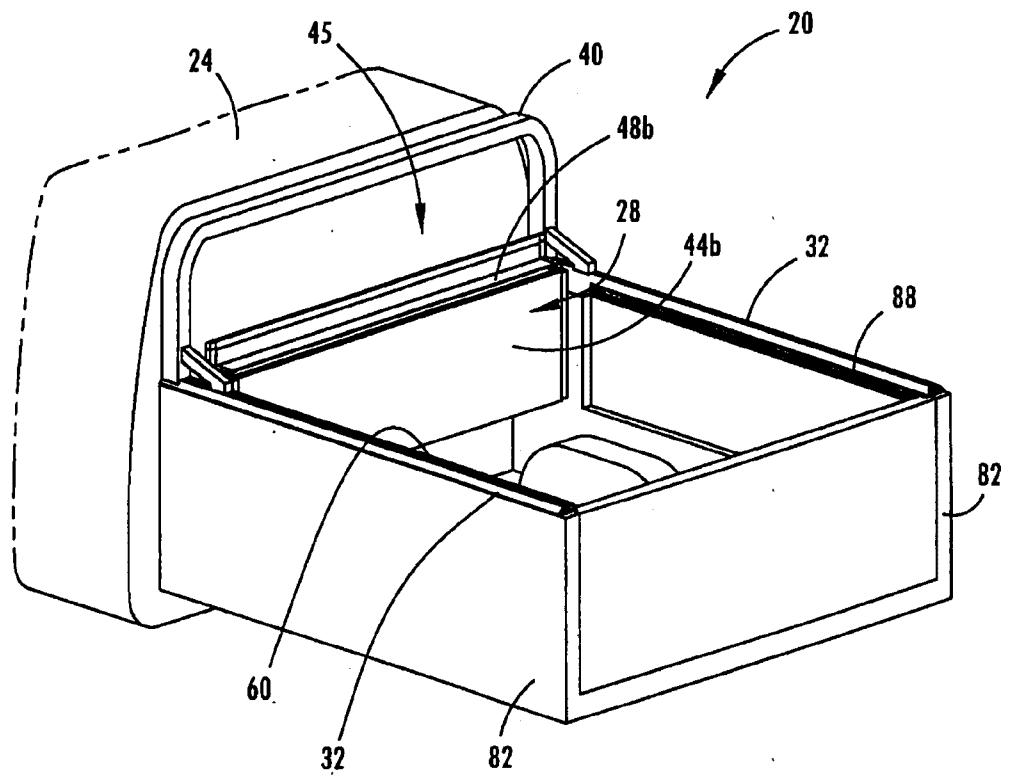


FIG. 15

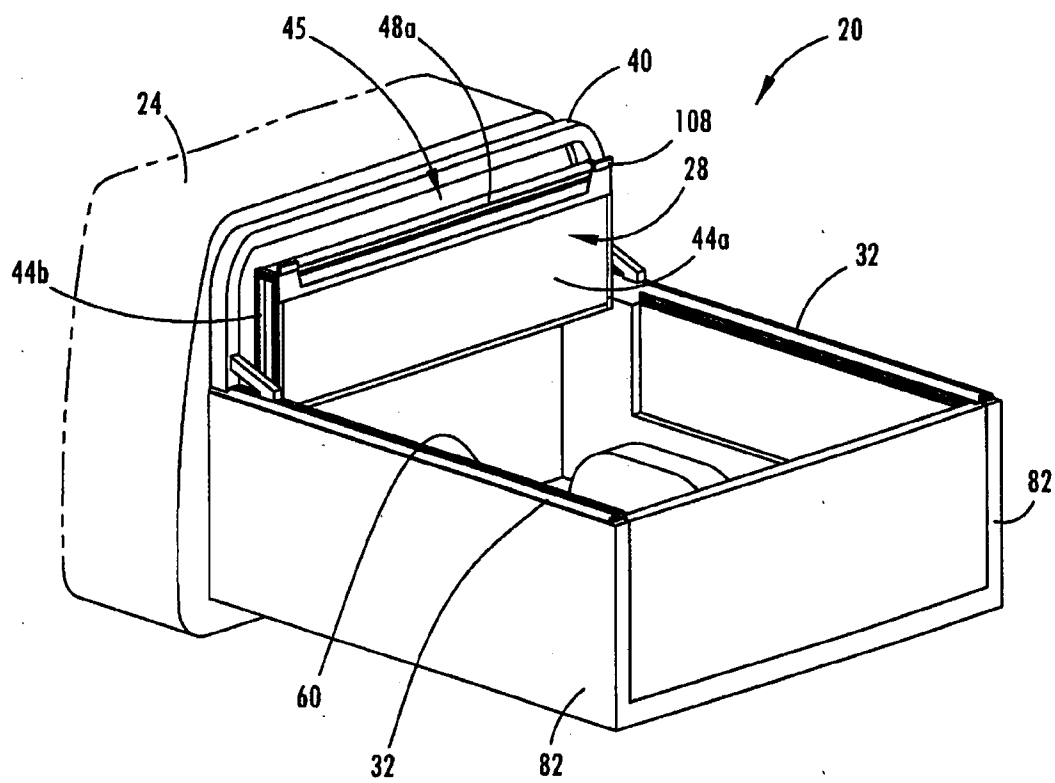


FIG. 16

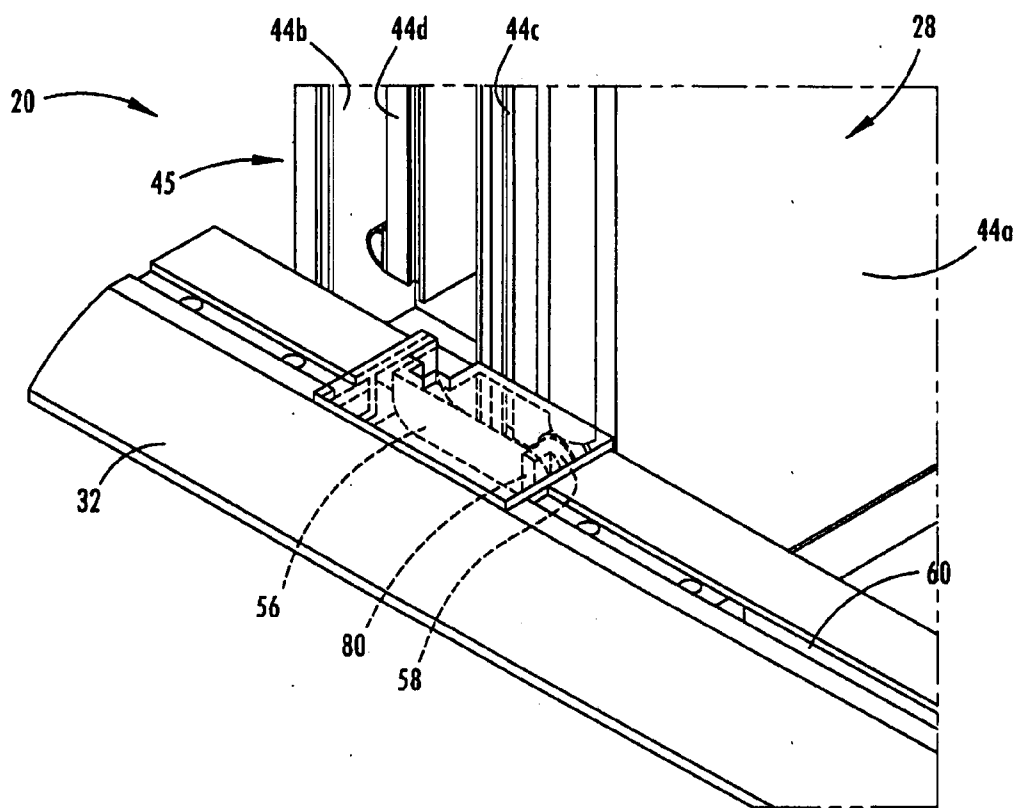


FIG. 17

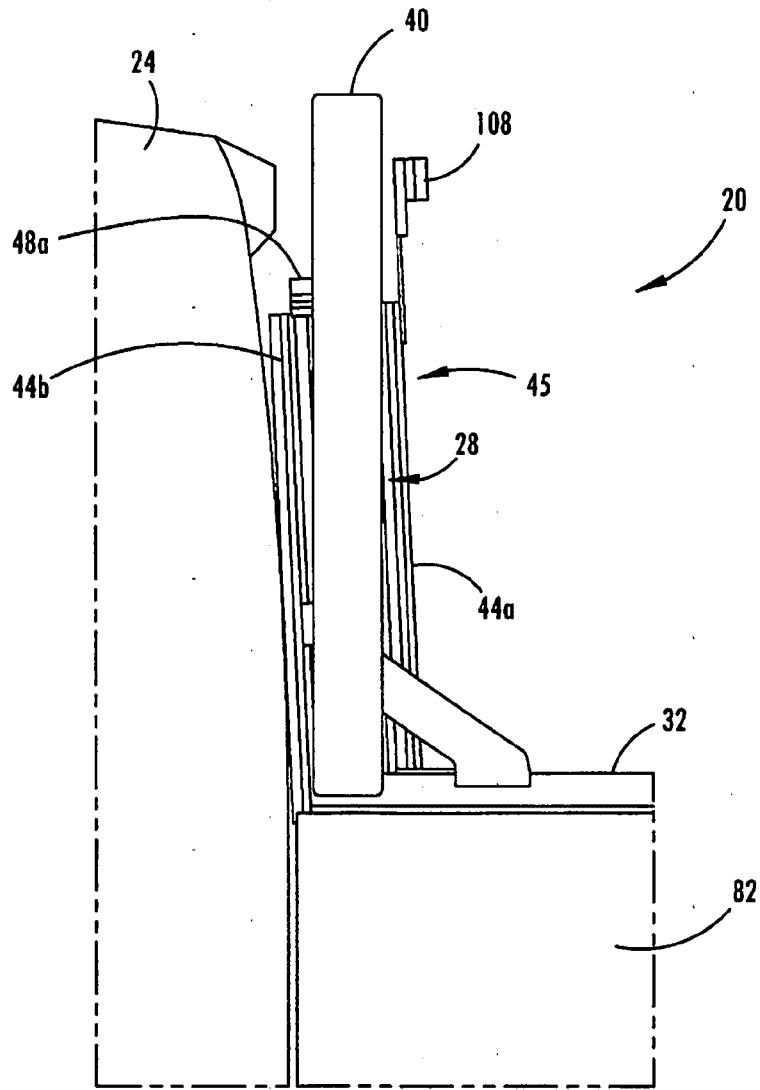


FIG. 18

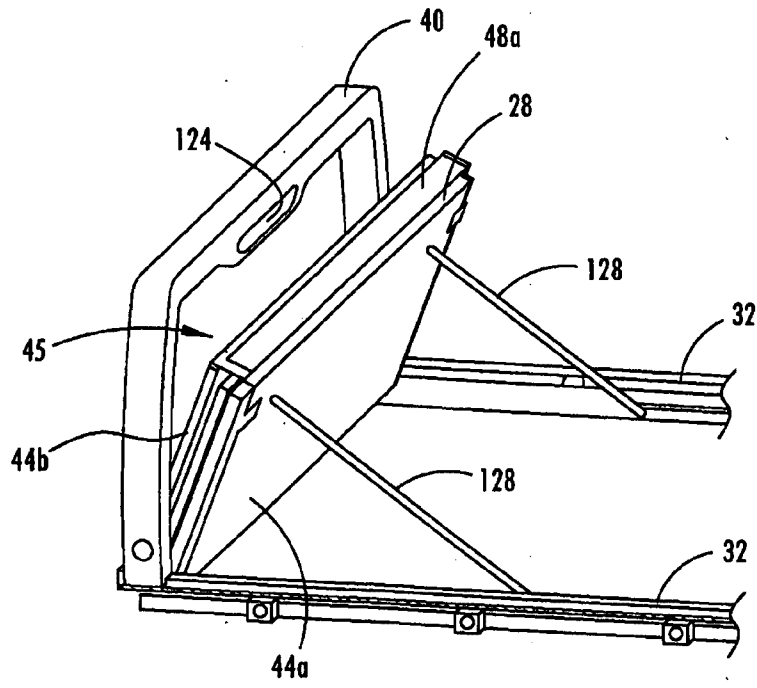


FIG. 19

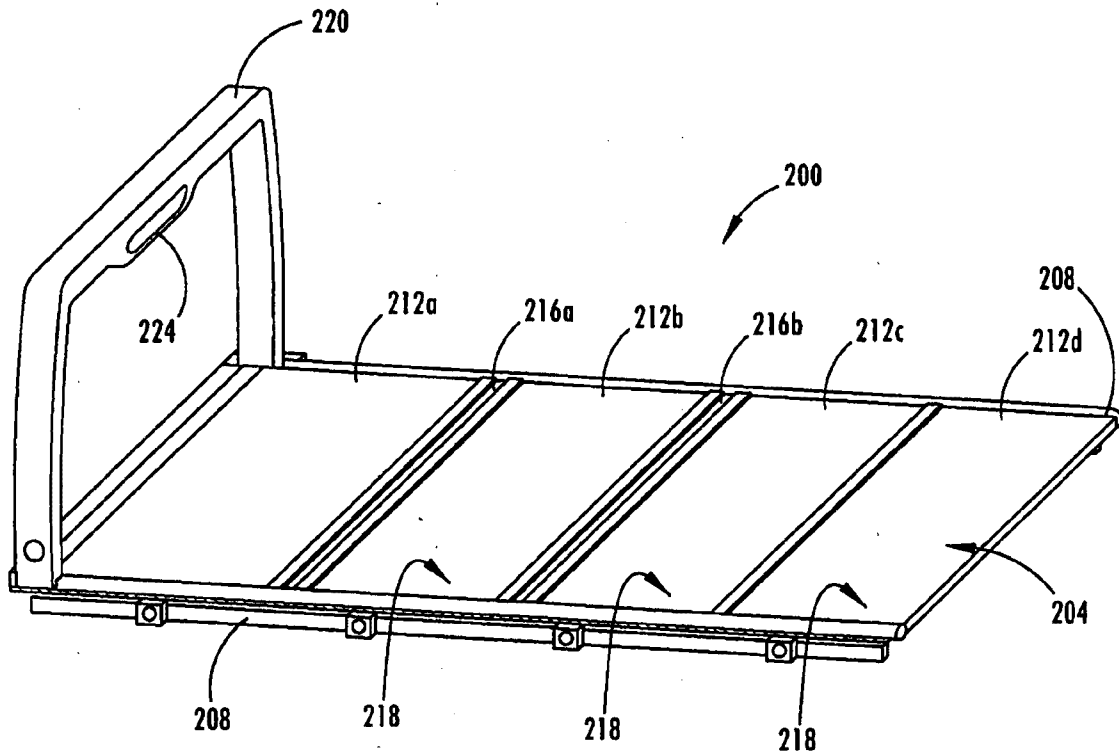


FIG. 20

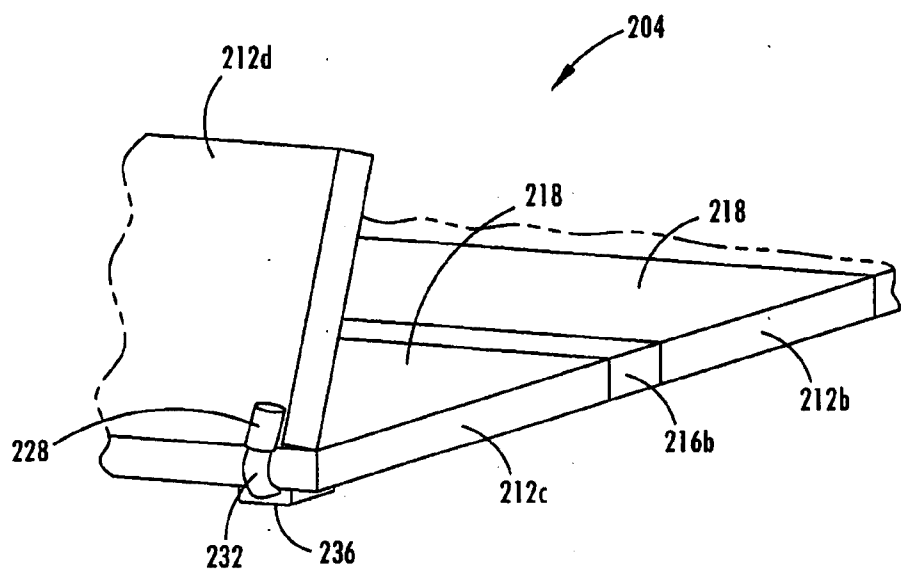


FIG. 21

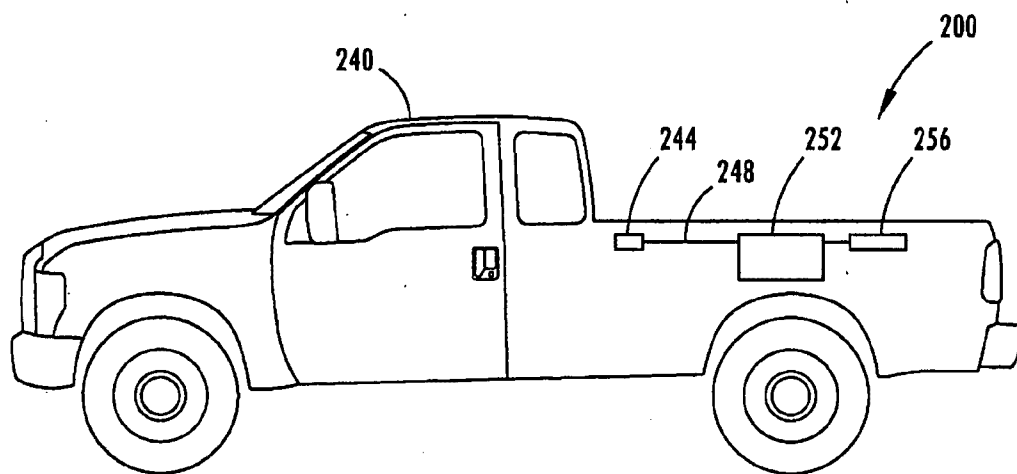


FIG. 22

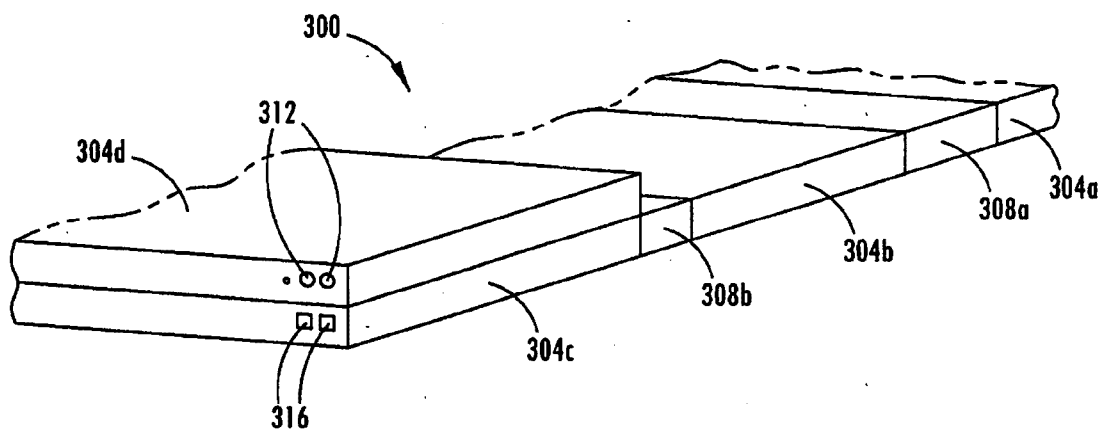


FIG. 23

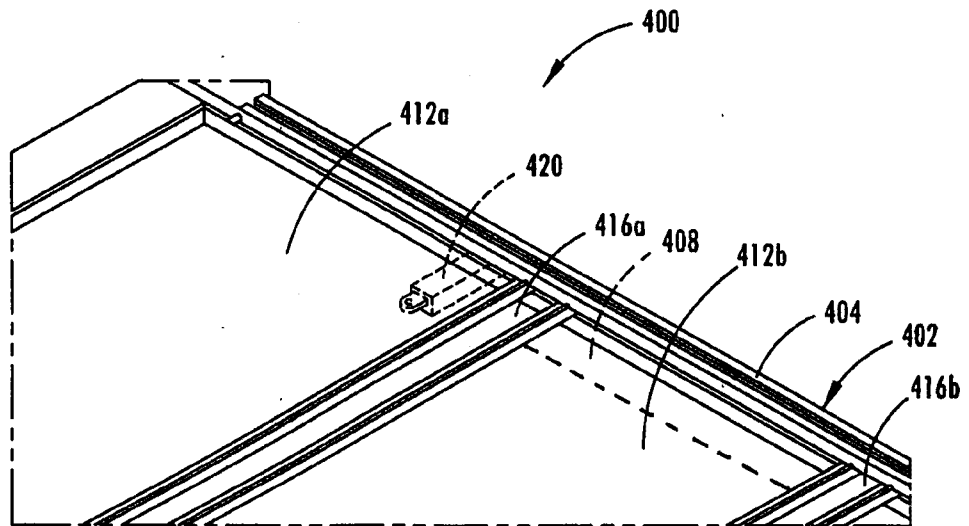


FIG. 24

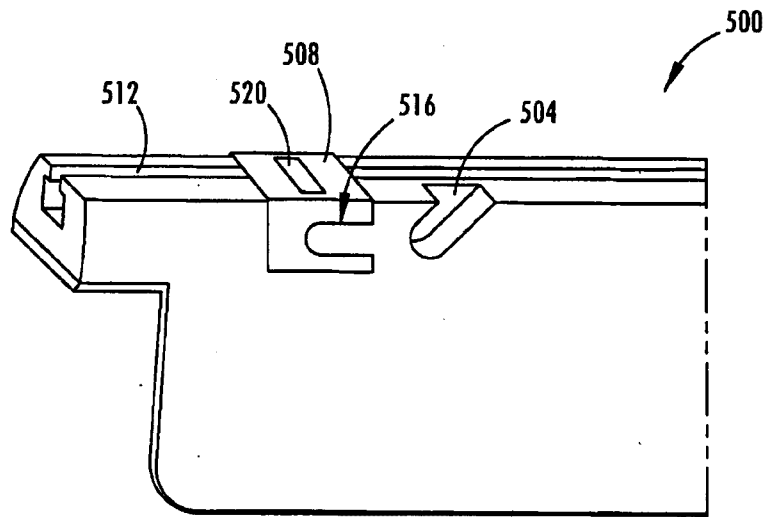


FIG. 25

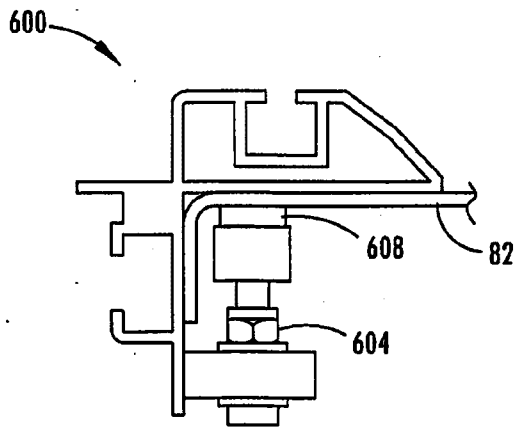


FIG. 26

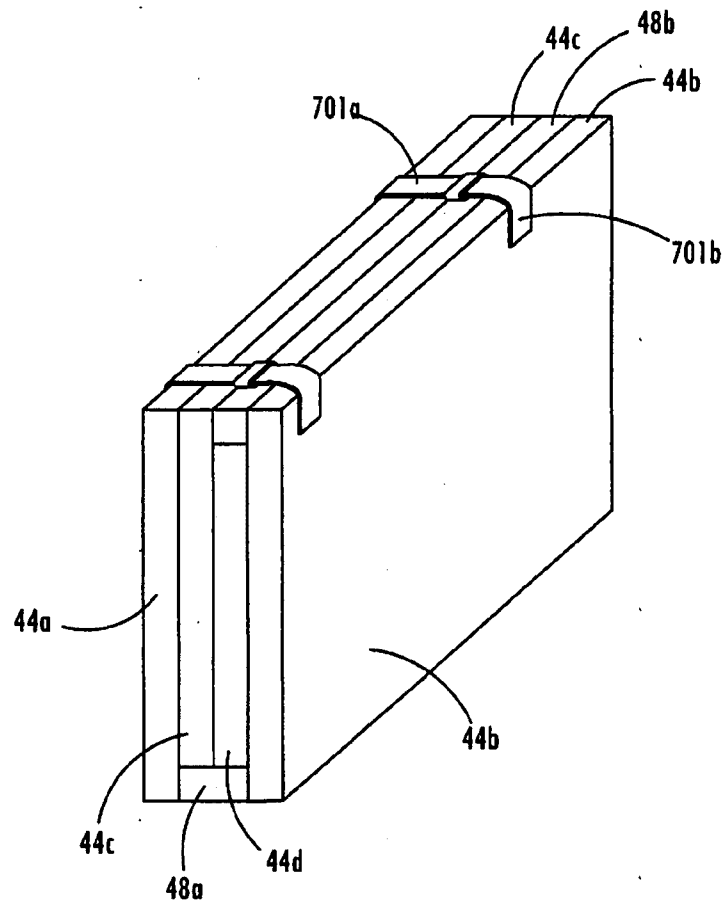


FIG. 27

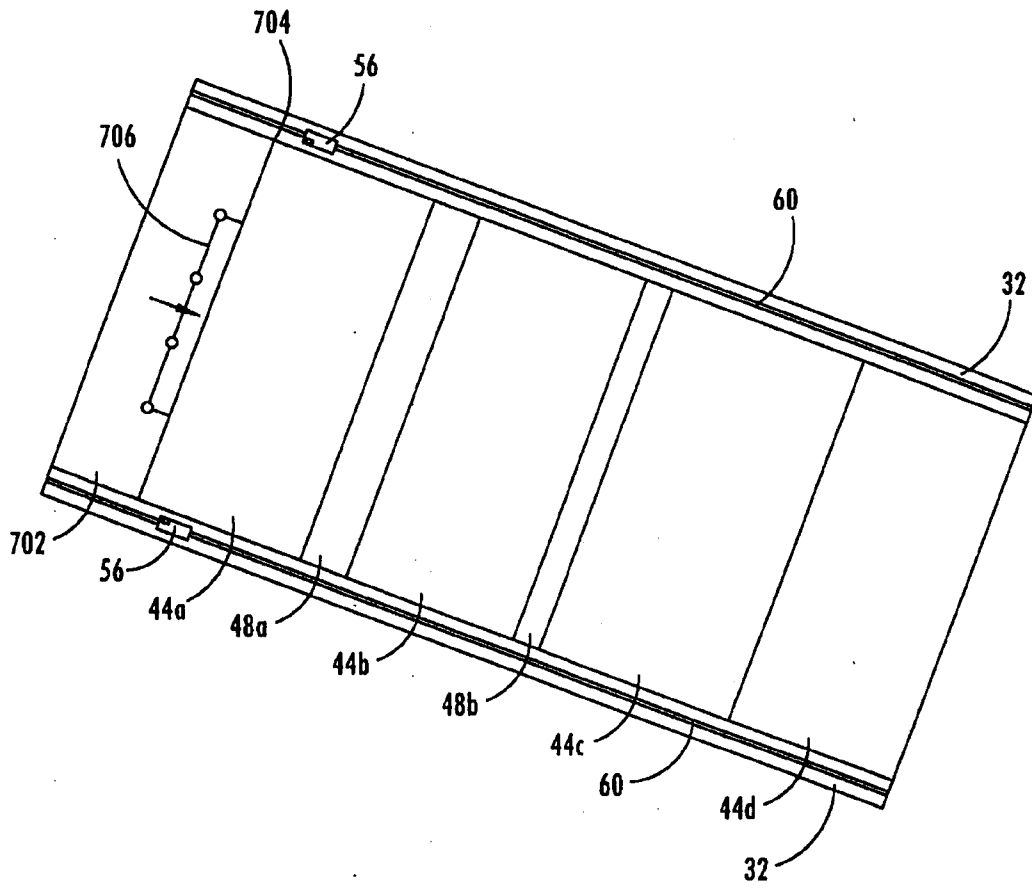


FIG. 28

