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(54) **VEHICLE SEAT PAN AND METHOD FOR CONTROLLING VERTICAL DEFLECTION**

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(57) **ABSTRACT**

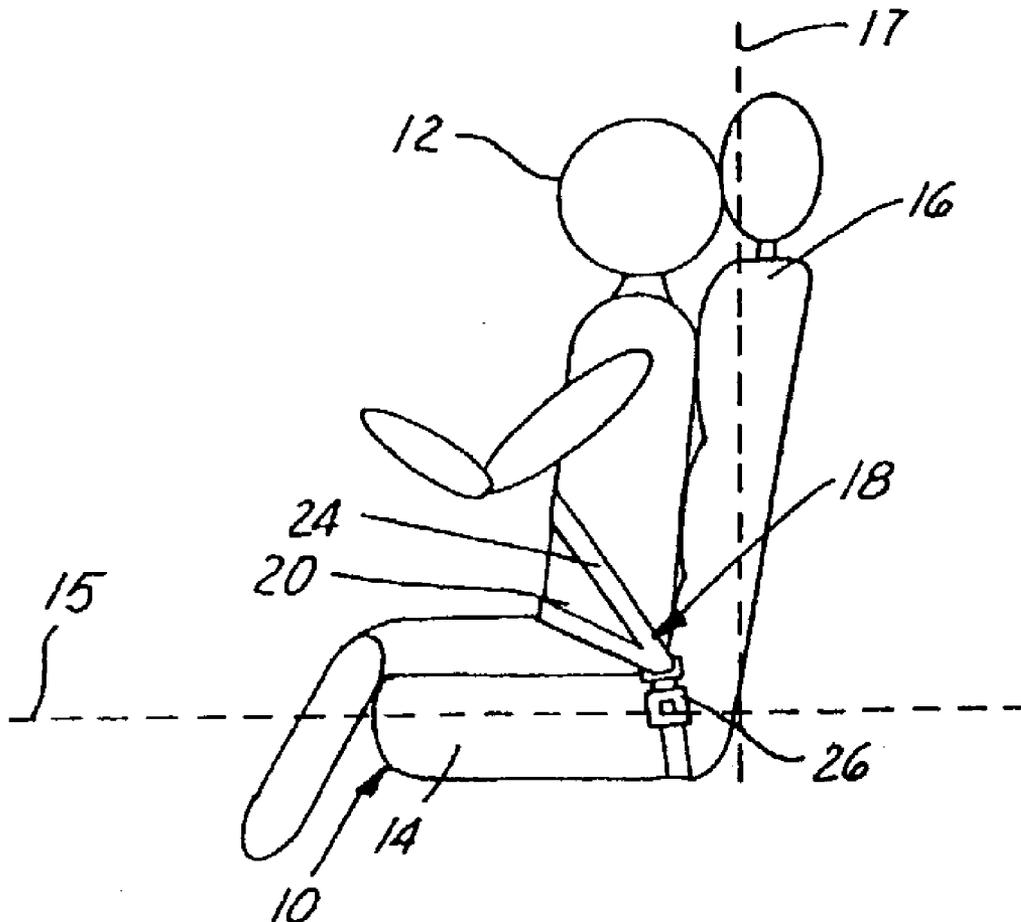
The present invention provides an improved vehicle seat pan and a method for controlling vertical deflection in a vehicle seat pan. A vehicle seat pan in accordance with the present invention includes a frame adapted to be mounted to a vehicle body. A suspension web for supporting a seat cushion is mounted to the frame. A vertical deflection controller is coupled between the web and the frame. The controller may be a leaf spring. Additionally, the controller may be a coil spring and a metal strap that limits the extension of the spring. A method for controlling vertical deflection in a vehicle seat pan is also provided. The method includes the step of mounting a substantially horizontal suspension web to a seat frame. The method further includes the step of coupling a vertical deflection controller between the web and the frame.

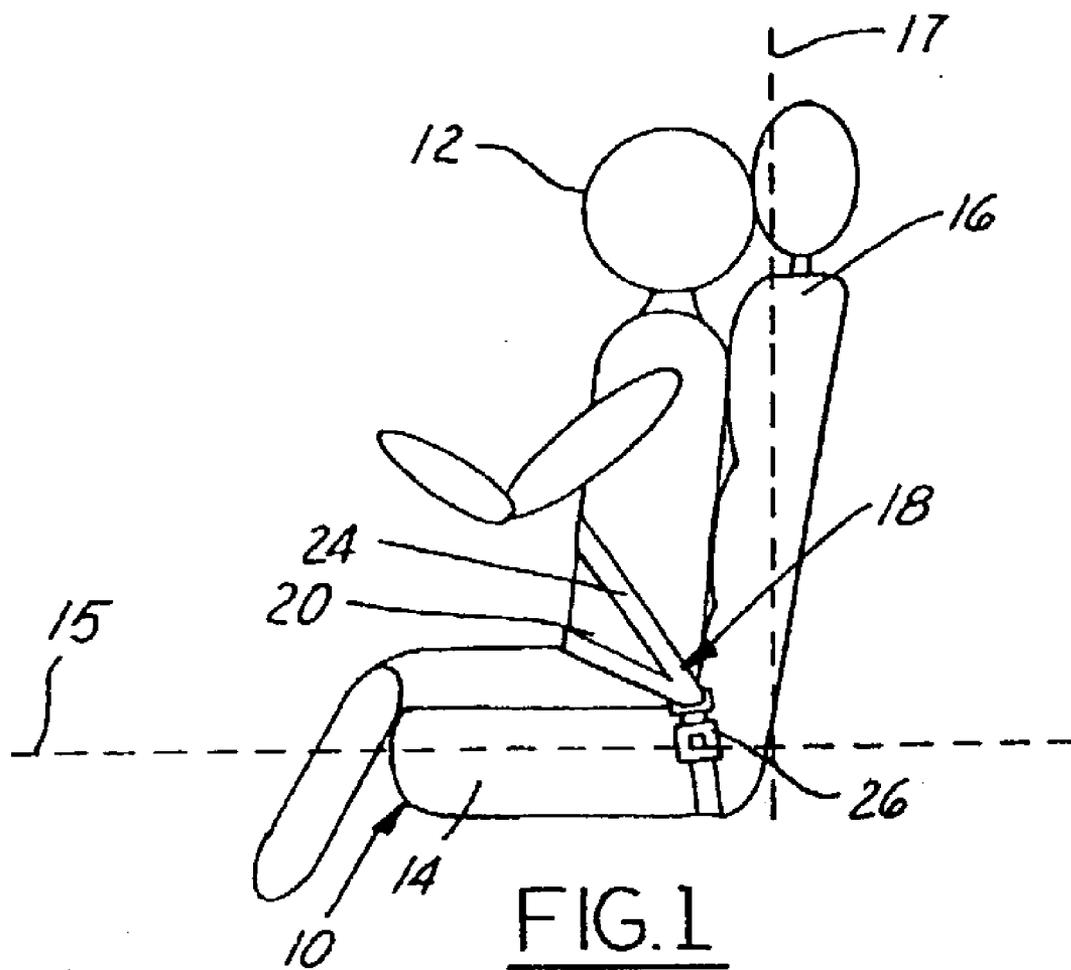
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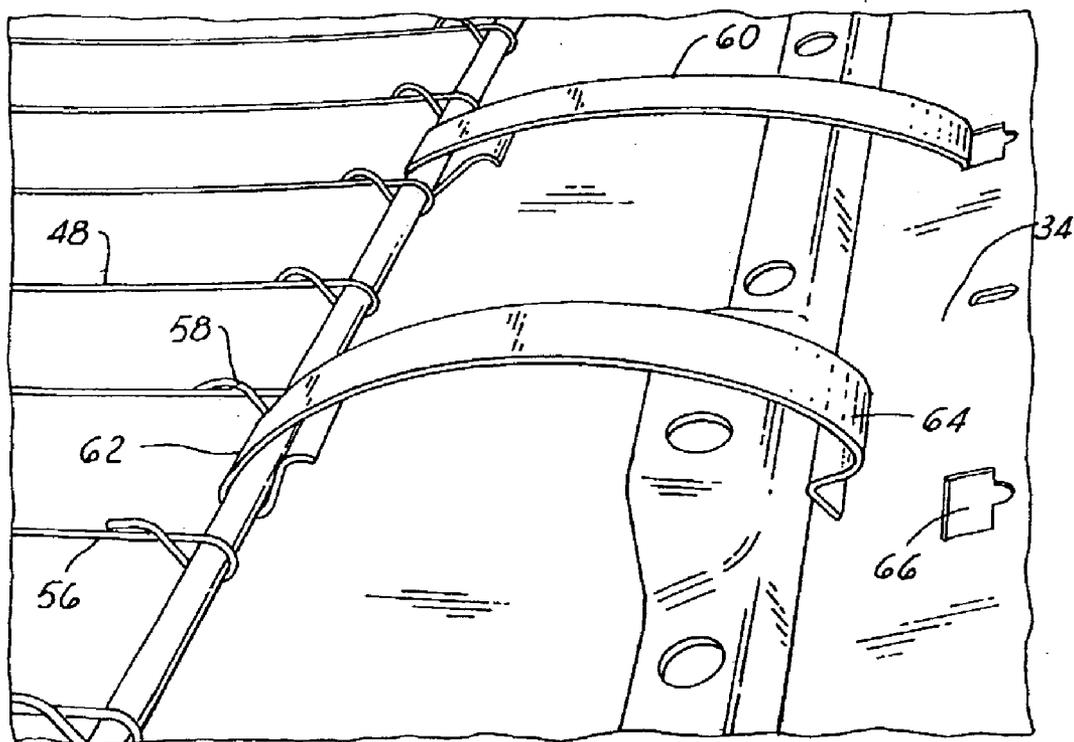


FIG. 3

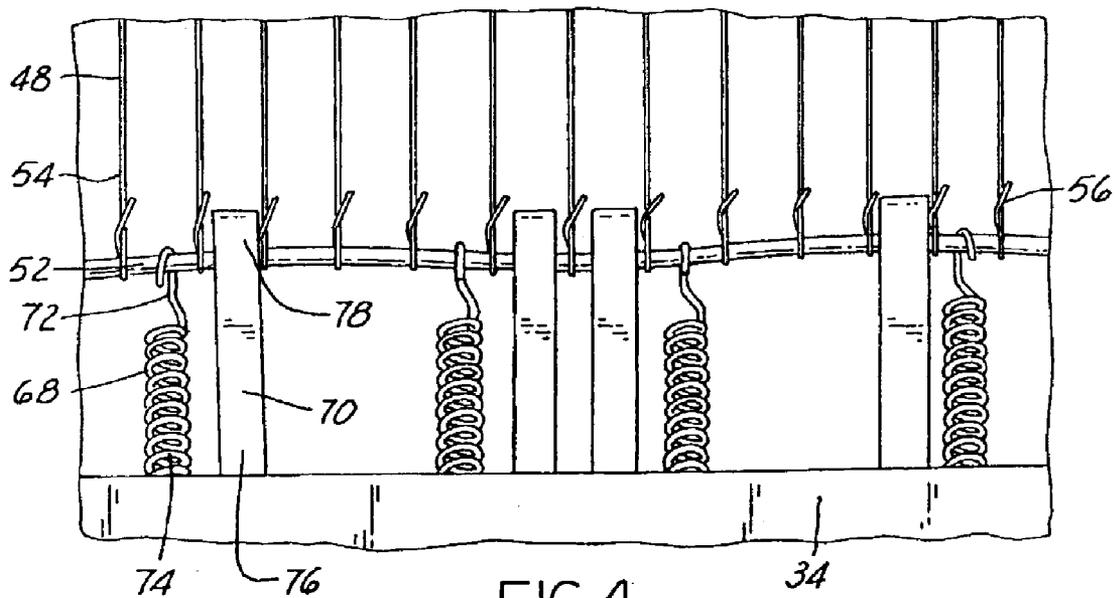


FIG. 4

VEHICLE SEAT PAN AND METHOD FOR CONTROLLING VERTICAL DEFLECTION

BACKGROUND OF INVENTION

[0001] 1. Field of Invention

[0002] This invention relates to a vehicle seat pan and a method for controlling vertical deflection in a vehicle seat pan.

[0003] 2. Background of the Invention

[0004] Occupant restraint systems for vehicles generally include a seat belt that crosses an occupant's pelvic region. Such belts are commonly known as lap belts. Lap belts may reduce injury to a passenger during a collision, emergency, or other sudden deceleration of the vehicle by restraining the occupant's forward momentum relative to the vehicle. A lap belt is most effective when it maintains a position on the iliac crest of an occupant's pelvis. However, under some emergency situations an occupant is thrust both forward and downward relative to the vehicle seat. This downward, or vertical, deflection is commonly known in the automotive industry as "submarining," as detailed in U.S. Pat. No. 3,841,163 to Daniel, U.S. Pat. No. 4,225,178 to Takada, and U.S. Pat. No. 5,697,674 to Aufrere, et al. During submarining, the angle of a seat belt may become shallow, relative to the ground, and the belt may shift over the occupant's iliac crest to restrain the occupant across his abdomen, rather than his pelvis.

[0005] The submarining effect can be minimized by providing a seat with a cushion mounted on a solid base. However, such a design comes at the expense of comfort. Conversely, a seat that incorporates a cushion mounted on a suspension web coupled to a frame by coil springs provides more comfort, since such a seat tends to contour to the shape of the occupant and is softer in the vertical direction under loading. While this vertical deflection affords greater comfort to the occupant, a suspension web coupled to a seat frame by coil springs may lead to an increased chance of submarining.

[0006] As discussed in U.S. Pat. No. 4,225,178 to Takada, one method to mitigate the submarining effect is to provide a vehicle seat pan that has a vertically moveable, rigid seat support plate and a selectively engageable ratchet and pawl device interposed between the seat support plate and the seat frame to lock the plate against vertical movement in the event of a collision. However, such a system may be expensive, unduly complicated, and may not provide the same level of comfort as a spring and suspension web supported seat. Another method for reducing submarining includes installing a support element, such as a metal bar or ramp, in the forward portion of the seat. This alternative, however, may not be effective unless and until the occupant moves forward in the seat. Accordingly, there is a need for an improved seat pan and a method for controlling vertical deflection in a vehicle seat.

SUMMARY OF INVENTION

[0007] The present invention provides an improved vehicle seat pan and a method for controlling vertical deflection in a vehicle seat pan.

[0008] A vehicle seat pan in accordance with the present invention comprises a frame adapted to be mounted to a

vehicle body. A suspension web for supporting a seat cushion is mounted to the frame. A vertical deflection controller is coupled between the web and the frame. The controller may be a leaf spring, or similarly shaped wire spring. Additionally, the controller may be a coil spring and a metal strap that limits the extension of the spring.

[0009] A method for controlling vertical deflection in a vehicle seat pan is also provided. The method includes the step of mounting a substantially horizontal suspension web to a seat frame. The method further includes the step of coupling a vertical deflection controller between the web and the frame.

[0010] A vehicle seat pan in accordance with the present invention has several advantages as compared to conventional systems. The inventive device allows a more comfortable suspension web to support a seat cushion, rather than seat pans with rigid plates or support bars, while still providing significant vertical deflection control. The inventive device further provides a simpler vertical deflection controller, rather than a complicated ratchet and pawl system. These and other features and objects of this invention will become apparent to one skilled in the art from the following detailed description and the accompanying drawings illustrating the features of this invention by way of example.

BRIEF DESCRIPTION OF DRAWINGS

[0011] FIG. 1 is a side view of an occupant and vehicle seat.

[0012] FIG. 2 is a perspective view of a the internal structure of a vehicle seat pan according to the present invention.

[0013] FIG. 3 is a perspective view of the vertical deflection controller shown in FIG. 2.

[0014] FIG. 4 is a bottom view of a portion of the internal structure of a seat pan according to another embodiment of the present invention.

DETAILED DESCRIPTION

[0015] Referring now to the drawings wherein like reference numerals are used to identify identical components in the various views, FIG. 1 generally illustrates a vehicle seat 10 with an occupant 12 seated therein. Vehicle seat 10 is provided to support occupant 12 in a seated position. Seat 10 may be employed in any vehicle in which the advantages of the present invention may be desired, including automobiles, airplanes, marine craft, amusement park rides, and the like. Seat 10 includes seat pan 14 and seat back 16. Seat pan 14 provides a base on which occupant 12 may sit. At an initial position, seat pan 14 may substantially lie in a horizontal plane 15. However, seat pan 14 may be adjustable to various angles relative to horizontal plane 15. Seat back 16 provides back, neck, and head support to occupant 12, and may substantially lie in a vertical plane 17. Seat back 16 may also be adjustable to various angles relative to vertical plane 17.

[0016] Seat 10 may cooperate with an occupant restraint system 18. Restraint system 18 includes a lap belt 20, and may include a shoulder belt portion 22. Ideally, lap belt 20 is operable to restrain occupant 12 across his or her pelvic region, while shoulder belt 22 is operable to restrain occu-

pan 12 over the occupant's rib cage. Restraint system 18 further includes buckle 24. Buckle 24 may be mounted to seat 10, or may be mounted to the vehicle frame. Restraint system 18 is conventional in the art.

[0017] FIG. 2 depicts one embodiment of the internal structure 26 of a seat pan 14 in accordance with the present invention. Seat pan 14 includes frame 28, suspension web 30, and vertical deflection controller 32. Those skilled in the art will recognize that internal structure 26 may be conventionally upholstered with foam or other flexible cushion material and covered with fabric, leather, vinyl or other such materials.

[0018] Frame 28 is provided as a rigid support for seat pan 14, and as a base on which web 30 and controller 32 may be secured. Frame 28 is also adaptable as a base to mount seat 10 to the vehicle, and a base on which seat back 12 may be mounted. As shown in FIG. 2, frame 28 may include front and rear members 34, 36, and side members 38, 40. Front and rear members 34, 36 may each be made out of a steel tube, bar, or other sufficiently rigid support elements. Side members 38, 40 are support members that may be made from folded sheet metal or any similar material that will provide a rigid support. It should be understood, however, that material composition and method of manufacture of members 34, 36, 38, 40, may be varied without departing from the spirit of the present invention. In addition, those skilled in the art will certainly recognize that the terms front, rear, and side are merely used for convenient orientation, and do not limit the construction of frame 28 to a particular configuration. Frame 28 is may be conventional in the art.

[0019] Front and rear members 34, 36, may be conventionally welded to side members 38, 40, or may be secured by other similarly known methods that provide equivalent results. Front and rear members 34, 36, and side members 38, 40, are spaced apart, respectively, to define an interior open space 42. Space 42 provides an open location for suspension web 30 to support a foam cushion or other pad upon which an occupant will sit. Such an arrangement may provide greater comfort than if frame 28 were a rigid plate. In addition, side members 38, 40 may have rails 44, 46 running lengthwise along their top and bottom edges. Rails 44, 46 define lateral support structures between which a foam cushion may extend to find additional support. Rails 44, 46 may be folded, stamped, forged, or cast in side members 38, 40. Alternatively, rails 44, 46 may be affixed to side members 38, 40 by welding, soldering, or similar methods.

[0020] Suspension web 30 generally extends within and is generally coplanar with interior space 42. Web 30 is provided to support and distribute the seated weight of occupant 12. Suspension web 30 may include a plurality of wires 48, mid-bar 50, and end bar 52. Wires 48 may be made from metal or high strength synthetic materials. It should be recognized, however, that material composition and method of manufacture of wires 48 may be varied without departing from the spirit of the present invention. In the embodiment shown in FIG. 2, wires 48 extend in a fore-aft direction of seat pan 14. However, those skilled in the art will recognize that wires 48 may alternatively extend laterally. Moreover, although the embodiment depicts wires 48 extending as straight lines, those skilled in the art will also recognize that

other configurations, such as wires bent to form crenellations or waves in a common horizontal plane will provide similar benefits.

[0021] As shown in FIG. 2, wires 48 may each have first end 54 and second end 56. First end 54 of wires 48 are anchored to rear member 36. End 54 may be secured by bolts, by threading wires 48 through apertures in member 36, or by other conventionally known methods. Alternatively, end 54 of wires 48 may be first secured to a metal bar, which may then be welded or otherwise mounted to member 36. End 56 of wires 48 are secured to end bar 52. As shown in FIG. 3, end 56 of each wire 48 may be looped to form an eye 58. End 56 may be secured to its respective wire 48 by welding, soldering, clamping, or other conventional methods.

[0022] With continued reference to FIGS. 2 and 3, end bar 52 is provided as an anchor for ends 56 of wires 48. End bar 52 may be a cylindrical metal or steel bar, tube, or other similarly rigid structure. Wires 48 may be anchored to end bar 52 by threading bar 52 through eyes 58.

[0023] As shown in FIG. 2, mid-bar 50 lies parallel to end bar 52 across wires 48. Mid-bar 50 provides additional structural support to suspension web 30. In particular, mid-bar 50 may promote the distribution of the weight of occupant 14 across wires 48. Like end bar 52, mid-bar 50 may be a cylindrical metal or steel bar. Mid-bar 50 may be secured to wires 48 by welding, soldering, ties, or other conventional methods.

[0024] Referring now to FIGS. 2 and 3, one embodiment of vertical deflection controller 32 is shown. Vertical deflection controller 32 is coupled between frame 28 and web 30 to limit the range of vertical deflection of suspension web 30, and to reduce the risk of submarining. As shown in FIGS. 2 and 3, vertical deflection controller 32 may be a plurality of leaf springs 60. While the illustrated embodiment depicts a plurality of leaf springs 60, those skilled in the art will certainly recognize that vertical deflection controller 32 may be made from one leaf spring 60. Leaf spring 60 may be a single leaf of tempered steel, or a multi-leaf spring comprising layers of tempered steel leaves. Alternatively, spring 60 may be a similarly shaped wire spring. As best shown in FIG. 3, leaf 60 includes first end 62 and second end 64.

[0025] First end 62 is mounted to end bar 52. As shown in FIG. 3, end 62 may be clamped about end bar 52. Those skilled in the art will recognize that end 62 may be secured to end bar 52 through alternative methods, including welding, soldering, bolting, and the like. Second end 64 is secured to frame 28. In the embodiment shown in FIG. 3, front member 34 of frame 28 may be provided with notches 66. As further shown in FIG. 3, end 64 may have a cross-section shape like the number "2" to engage and lock in notches 66. In this embodiment, after first end 62 is secured to end bar 52, leaf spring 60 is extended and end 64 is inserted in notch 66, and maintained therein by the tension of spring 60. This state of tension also serves to reduce the possibility that leaf spring 60 may rattle against either member 34 or end bar 52.

[0026] FIG. 4 depicts an alternative embodiment of vertical deflection controller 32. As shown, controller 32 may comprise coil spring 68 and rigid support member 70. Spring

68 is conventional in the art and may be made from high-strength tempered metal or steel. Spring 68 may further have curved ends 72, 74, which allow spring 68 to couple two objects. One end 72 of spring 68 is hooked and secured to end bar 52. Spring 68 may then be extended, and end 74 may be hooked and secured to member 34 of frame 28.

[0027] Left uncontrolled, springs 68 could extend significantly and permit suspension web 30 to deflect vertically downward to a degree that causes occupant 14 to undergo submarining during some conditions. Rigid support member 70 is provided to limit the length that spring 68 may extend. In the illustrated embodiment, support member 70 is a strap that may be made from steel, metal, or other sufficiently rigid material. Strap 70 has first end 76 mounted to frame 28, and second end 78 that retains suspension web 30. End 76 may be welded to member 34 of frame 28. Alternatively, end 76 may be soldered, bolted or secured to member 34 through other conventionally known methods. End 78 may be C or U-shaped, and extends aftly slightly beyond end bar 52. As spring 68 extends, web 30 deflects vertically downward until end bar 52 is captured and retained by end 78 of strap 70. The degree to which controller 32 may control the vertical deflection of 32 is based on the distance end 78 extends beyond end bar 52, toward rear member 36. That is, the greater the distance that end 78 extends aftly beyond end bar 52, the greater the distance that spring 68 may extend and that web 30 may deflect. Although FIG. 4 depicts an embodiment having a plurality of coil springs 68 and retaining straps 70, those skilled in the art will recognize that controller 32 may comprise one or more coil springs 68 along with one or more retaining straps 70.

[0028] In conventional seat pan designs, a suspension web may be coupled to a vehicle frame by coil springs at one or more ends of the web. As discussed above, this design provides greater comfort to the occupant, since the seat contours to the shape of the occupant's buttocks, and tends to be softer in the vertical direction than a solid plate. However, conventional web and spring designs can deflect too far under some conditions and cause submarining. The present invention controls the amount of vertical deflection of the seat pan, to provide the rigidity of a solid plate pan seat combined with the comfort of a spring and suspension web design. In one embodiment, a controller 32 that limits the longitudinal deflection of springs to 5 to 6 mm in a typical automobile seat pan will provide increase loading on the occupant sooner to reduce the risk of submarining with no appreciable loss of comfort.

[0029] In addition, while both of the illustrated embodiments serve to control the vertical deflection of web 30, leaf spring 60 can provide advantages over spring coil 68 and strap 70. Leaf spring 60 extends in a non-linear fashion. Accordingly, the further web 30 deflects vertically, the higher the spring load becomes. Unlike coil spring 68 that has a linear spring rate, the spring rate of leaf spring 60 exponentially tends toward infinity as the leaf extends, i.e. as it becomes flatter. Accordingly, coil spring 68 may lead to a shock load when end bar 52 becomes retained by member 70. In contrast, leaf spring 60 provides a smoother transition when web 30 reaches its point of maximum vertical deflection.

[0030] The present invention further includes a method for controlling the vertical deflection of a vehicle seat pan. The

method begins by mounting a substantially horizontal suspension web 30 to a seat frame 28. Next, a vertical deflection controller 32 is coupled between the web 30 and the frame 28. As discussed above, the vertical deflection controller may include one or more leaf springs, coupled between end bar 52 and front member 34. The vertical deflection controller may also include one or more coil springs 68 coupled between end bar 52 and front member 34, along side one or more rigid support member 70, that limits the length springs 68 can extend. In particular, web 30 may be controlled to permit only 5 to 6 mm of vertical deflection.

[0031] While the invention has been particularly shown and described with reference to the preferred embodiments thereof, it will be appreciated by those skilled in the art that various changes and modifications can be made in the invention without departing from the spirit and scope of the invention.

1. A vehicle seat pan, comprising:

- a frame adapted to be mounted to a vehicle body;
- a suspension web for supporting a seat cushion mounted on said frame; and
- a vertical deflection controller, for controlling vertical movement of said suspension web, coupled between said web and said frame.

2. The vehicle seat pan of claim 1, wherein said web comprises a plurality of wires, each having a first end secured to a first member of said frame and each of said wires further having a second end secured to a bar, wherein said controller is coupled between said bar and a second member of said frame.

3. The vehicle seat pan of claim 1, wherein said controller comprises a leaf spring.

4. The vehicle seat pan of claim 3, further comprising a plurality of leaf springs coupled between said web and said frame.

5. The vehicle seat pan of claim 1, wherein said controller comprises a coil spring coupled between said web and said frame, and further comprises a rigid support element coupled between said web and said frame for controlling the extension of said coil spring.

6. The vehicle seat pan of claim 5, wherein said support element comprises a metal strap having a first end anchored to said frame, and having a second end adapted to retain said web.

7. The vehicle seat pan of claim 1, wherein said web is substantially horizontal.

8. The vehicle seat pan of claim 1, wherein said controller limits said web to a maximum vertical deflection of 5 to 6 mm.

9. A vehicle seat pan, comprising:

- a frame adapted to be mounted to a vehicle body;
- a substantially horizontal suspension web for supporting a seat cushion mounted on said frame; and

means for controlling vertical deflection of said web.

10. The vehicle seat pan of claim 9, wherein said web comprises a plurality of wires, each having a first end secured to a first member of said frame and each of said wires further having a second end secured to a bar, wherein said means for controlling is coupled between said bar and a second member of said frame.

11. The vehicle seat pan of claim 9, wherein said means for controlling comprises a leaf spring coupled between said web and said frame.

12. The vehicle seat pan of claim 9, wherein said means for controlling comprises a coil spring coupled between said web and said frame, and further comprises a rigid support element coupled between said web and said frame for controlling the extension of said coil spring.

13. The vehicle seat pan of claim 12, wherein said support element comprises a metal strap having a first end anchored to said frame, and having a second end adapted to retain said web.

14. The vehicle seat pan of claim 9, wherein said means for controlling limits said web to a maximum vertical deflection of 5 to 6 mm.

15. A method for controlling the vertical deflection of a vehicle seat pan, comprising:

mounting a substantially horizontal suspension web to a seat frame;

coupling a vertical deflection controller between said web and said frame.

16. The method of claim 15, wherein the step of coupling said vertical deflection controller further comprises the steps of coupling a coil spring between said web and said frame, coupling one end of a rigid support element to said frame, and retainingly positioning the other end of a rigid support element about said web.

17. The method of claim 15, wherein the step of coupling said vertical deflection controller further comprises the step of coupling a leaf spring between said frame and said web.

18. The method of claim 15, further comprising the steps of mounting a first end of said web to said frame, and coupling said leaf spring between a second end of said web and said frame.

19. The method of claim 15, further comprising the step of limiting vertical deflection of said web to a maximum of 5 to 6 mm.

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