(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
2 March 2006 (02.03.2006)

PCT

(10) International Publication Number
WO 2006/022814 A2

(51) International Patent Classification:
F41H 7/02 (2006.01)

(21) International Application Number:
PCT/US2005/002826

(22) International Filing Date: 2 February 2005 (02.02.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/541,386 2 February 2004 (02.02.2004) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

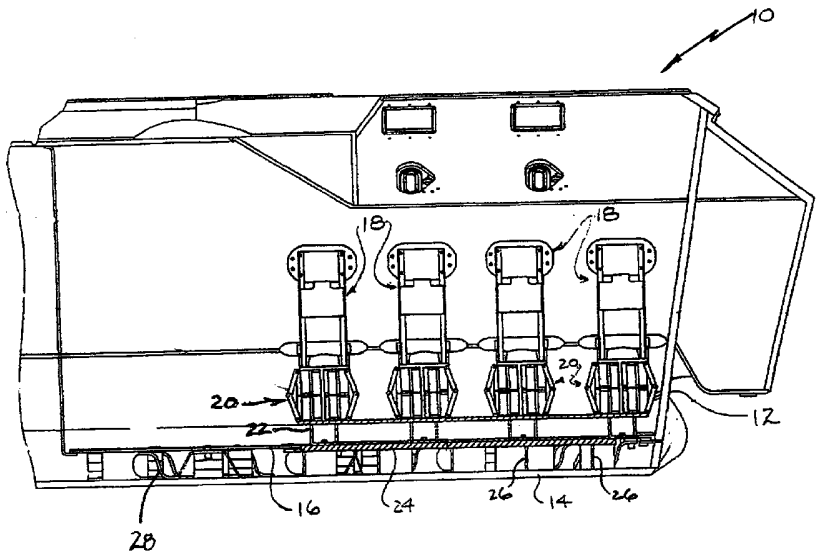
(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *without international search report and to be republished upon receipt of that report*

[Continued on next page]

(54) Title: PERSONNEL PROTECTIVE ARRANGEMENT



(57) Abstract: An armored land vehicle adapted to protect occupants from forces of explosions detonated beneath the vehicle including a penetration resistant bottom plate, a floor plate located substantially above and spaced from the bottom plate, energy absorbing members interposed between the bottom plate and the floor plate and seats on a seat plate supported by acceleration attenuating suspension supports. The personnel protective floor system for an armored vehicle includes crushable members supporting a floor plate on members secured to a bottom plate of the vehicle. These support members are plastically deformable in a predetermined and predicable manner under the forces imposed by a land mine exploding under the vehicle. Since much of the energy of the shock load imposed by the explosion is dissipated by the plastic deformation of the support members, the possibility of injury to personnel inside the vehicle is reduced, particularly injury to the lower extremities.

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PERSONNEL PROTECTIVE ARRANGEMENT

CLAIM TO PRIORITY

This application claims the benefit of U.S. Provisional Application No. 60/541,386, filed February 2, 2004, which is incorporated herein in its entirety by reference.

FIELD OF THE INVENTION

This invention relates to an arrangement for protecting personnel seated inside of a combat vehicle, and more particularly, to such an arrangement that protects against the deleterious effects of land mine detonations.

BACKGROUND

Land combat vehicles, such as armored personnel carriers, for example, are intended for use in a hostile environment, and must be designed to counter various threats expected to be encountered when deployed in such an environment. One such threat is the detonation of a land mine under the vehicle. The force of the exploding land mine is primarily directed upward against the bottom of the vehicle.

Armored personnel carriers (APCs) generally transport infantry soldiers in addition to the crew of the vehicle. The armored vehicle speeds the movement of the soldiers to the area of their deployment and provides protection for the soldiers from attacks that may be made by snipers, aircraft, mines and the use of improvised explosive devices.

Land mines include antipersonnel mines and antiarmor mines such as antitank mines. Antipersonnel mines generally utilize a relatively small explosive charge. An armored land combat vehicle is typically minimally affected by an encounter with an antipersonnel mine because of the large mass of the armored vehicle, its armored protection and the relatively small explosive force delivered by the antipersonnel mine. Antiarmor or antitank mines contain a

much more powerful explosive charge that is often shaped to direct the greatest force of the explosion upwards toward the bottom of a passing vehicle.

Thus, it is important to provide substantial protection to the underside of armored combat vehicles to minimize injury to the vehicle's occupants. Armored personnel carriers have long been provided with an exterior armored bottom plate with a floor plate rigidly secured to and supported by the inner side of the bottom plate. The bottom plate is made to resist penetration, thereby protecting personnel inside from being injured or killed by shrapnel resulting from the explosion.

However, the bottom plate is deformable by the force of an explosion, with explosive force being transferred to personnel seated within the APC. Explosive energy that is applied to the bottom plate of the APC is substantially transmitted through the bottom plate to the floor plate and thus to the seats and the personnel that are seated in them within the vehicle. The abrupt, upwardly directed, acceleration that results to the personnel can cause considerable bodily harm even though the personnel are shielded from the direct force of the explosion and shrapnel that may result. The vertebrae of the back and neck are often particularly vulnerable to injury. This problem has been partially addressed by utilizing seats with a yieldable suspension to absorb most of the shock. While such an arrangement provides some protection, the lower extremities remain especially vulnerable to injury.

An exemplary energy attenuation system utilized in seats includes a seat supported by two vertical rails. The seat includes two hardened cutters. The cutters pass through a channel formed from light alloy material. Shear pins with a predetermined shear value support the seat under normal circumstances. If the seat and a person seated in it are subjected to upward acceleration in excess of the predetermined load the shear pins shear and the cutters are forced to cut through the channels and dissipate energy thus keeping the acceleration load on the seat

occupant below predetermined limits. Other acceleration attenuation systems exist and are specifically contemplated to fall within the scope of the invention.

When acceleration attenuation seats are used the seat's supporting carriage collapses or telescopes in a controlled manner to absorb energy that otherwise would be applied to the occupant's body. As the carriage collapses the seat bucket moves toward the supporting floor. Thus the acceleration attenuating seat protects the occupant's vertebral column but the feet that rest on the floor and the legs may still be subject to unacceptable levels of acceleration.

The military arts would benefit from a way to further protect the occupants of armored vehicles from injury caused by explosions that occur beneath the vehicle. It would be especially beneficial to provide protection from injuries to the lower extremities.

SUMMARY OF THE INVENTION

The present invention overcomes many of the deficiencies of the prior art by supporting a floor plate on energy absorbing members secured to the bottom plate of the vehicle. These support members are plastically deformable in a predetermined and predicable manner under the forces imposed by a land mine exploding under the vehicle. Since much of the energy of the shock load imposed by the explosion is dissipated by the plastic deformation of the support members, the possibility of injury to personnel inside the vehicle is reduced, particularly injury to the lower extremities. In addition, a commercial off the shelf acceleration attenuating seat is mounted on a seat plate that rests upon crushable members to enhance the seat effectiveness and to attenuate acceleration beyond what the seat alone is capable of.

In operation, when an explosive force is applied to the bottom plate, the bottom plate deforms upwardly. As the bottom plate deforms upwardly, the energy absorbing members are crushed or deformed and dissipate some of the energy that would otherwise be transferred to the floor plate and the seat plate. The various energy absorbing members are designed so that the

seats and the floor plate accelerate at a substantially similar rate that is maintained at a level that minimizes injury to the seat occupants and prevents the legs from being subjected to acceleration substantially greater than the rest of the occupants body.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a cross sectional view taken generally along the centerline of a portion of an armored personnel carrier incorporating the present invention;

Fig. 2 is a top plan view of the vehicle shown in Fig. 1 with portions of the top thereof broken away to show the floor and seats in the interior;

Fig. 3 is a view similar to Fig. 2 but with the seats and floor eliminated to show the plastically deformable members;

Fig. 4 is an orthographic view of the vehicle as shown in Fig. 3;

Fig. 5 is a cross-sectional view taken on line 5-5 of Fig. 3;

Fig 6. is a cross-sectional view taken on line 6-6 of Fig. 3; and

Fig. 7 is a cross-sectional view taken on line 7-7 of Fig. 6.

DETAILED DESCRIPTION OF THE INVENTION

Referring to Figs. 1-4, there is shown a portion of an armored personnel carrier, indicated generally at 10, having a conventional hull 12 including a bottom plate 14. A floor plate 16 is supported above the bottom plate 14 by a plurality of plastically deformable members, which members will be more fully described hereinafter. Bottom plate 14 is formed of a heavy armor plate that is particularly adapted to resist penetration from the force of explosions that may be applied to the outer surface of bottom plate 14. Floor plate 16 is substantially lighter material such as aluminum plate with diamond tread texturing embossed thereon to improve traction on the surface.

A plurality of conventional off the shelf seats 18, each of which includes a suspension system 20 for attenuation of acceleration, are arranged in back to back rows and attached to a platform 22. The platform 22 is secured to a seat plate 24, which rests upon a plurality of crushable members 26, as depicted in Fig. 4. The crushable members 26 are formed of a material, such as wrought aluminum alloy, that is sufficiently rigid to normally support the seat plate 24, seats 18 and seat occupants. Crushable members 26 are plastically deformed by and collapse under the force of a mine exploding underneath the bottom plate 14.

The seat plate 24 is provided with a thickness similar to that of the bottom plate 14 so that it is relatively rigid. The rigidity of the seat plate 24 assures that the load is spread relatively evenly among the members 26 so that the seats 18 will move vertically as a unit, and in unison with the floor plate 16. Seat plate 24 is located in a cutout in floor plate 16 so that floor plate 16 surrounds seat plate 24.

Injury to seated personnel, particularly to the legs, is minimized when the vertical acceleration of the floor plate 16 is substantially equal to the vertical acceleration of the seats 18. The rigidity of the seat plate 24 assures the seats 18 move as a unit, and thus with a substantially uniform vertical acceleration. The crushable members 26 and the deformable floor support members, as described below, are designed to plastically yield at substantially the same load so that the vertical accelerations of the floor plate 16 and of the seat plate 24 are substantially the same.

The asymmetrical arrangement of the crushable members 26 is allowable, if necessary, to provide clearance for a plurality of components, such as hydraulic hoses and electrical conduits, that may be routed through the space between the bottom plate 14 and the seat plate 24.

The deformable floor support members include three basic types. As shown in Fig. 5, one type of support member is shown at 28. The lower end 30 of sigmoid support member 28 is welded or otherwise secured to the bottom plate 14. The floor plate 16 rests upon, but is not

secured to the upper end 32. A rubber pad 34 is interposed between the floor plate 14 and the upper end 32 to eliminate noise, such as rattles and squeaks, that may otherwise occur as a result of relative movement therebetween. Rubber pad 34 may also be interposed between lower end 30 and bottom plate 14 if upper end 32 is secured to floor plate 14. Because the upper end 32 is laterally offset from the lower end 30 and because the upper end 32 may move laterally relative to the floor plate 16, the sigmoid support member 28 is essentially a cantilever beam in bending and will readily deform plastically but only when subjected to the forces of an exploding land mine.

A second type of deformable support member is shown at 36 in Fig. 5. Hat channel support member 36 presents lower ends 38 and 40. Each of lower ends 38 and 40 of the hat channel support member 36 is welded or otherwise secured to the bottom plate 14. A rubber pad 42 is also interposed between the lower surface of the floor plate 16 and the middle portion 44 of the hat channel support member 36 to eliminate noise. The middle portion 44 is laterally offset from both of the lower ends 38 and 40. When subjected to the forces created by an exploding land mine, hat channel support member 36 will plastically deform by buckling.

The third type of plastically deformable member 46 is shown in Fig. 6., and is similar to the sigmoid member 28 in its manner of failure, i.e. its plastic deformation under load. However, the securing member 46 also serves to properly locate the floor plate 16 relative to the interior of the vehicle and to secure the floor plate 16 from upward movement. The lower end 48 of securing member 46 is welded or otherwise secured to the bottom plate 14. The upper end 50 is laterally offset from the lower end 48 with a weld nut 52 affixed to the underside of and aligned with a hole 54 formed in the upper end 50.

A rubber pad 56, also provided with a hole 58, is interposed between the lower surface of the floor plate 16 and the upper surface of upper end 50. A bolt 60 extends through a washer 62 and an enlarged hole in the floor plate 16 to threadedly engage the nut 52. A rubber washer 64

is interposed between the washer 62 and the floor plate 16 to limit abrasion and noise. Securing members 46 are generally arranged around the periphery of the floor plate 16, and around the periphery of the seat plate 24 to locate and secure floor plate 16 and seat plate 24.

In operation, when an explosive force is applied to bottom plate 14, bottom plate 14 deforms upwardly. As the bottom plate 14 deforms upwardly, crushable members 26, sigmoid support member 28, hat channel support members 36 and securing members 46 are crushed or deformed and dissipate some of the energy that would otherwise be transferred to the floor plate 16 and the seat plate 24. The various energy absorbing members are designed so that the seats 18 and the floor plate 16 accelerate at a substantially similar rate that is maintained at a level that minimizes injury to the seat occupants and prevents the legs from being subjected to acceleration substantially greater than the rest of the occupants body thus minimizing injury to the occupants. This arrangement especially minimizes injury to the lower extremities.

The present invention may be embodied in other specific forms without departing from the spirit of any of the essential attributes thereof; therefore, the illustrated embodiments should be considered in all respects as illustrative and not restrictive, reference being made to the appended claims rather than to the foregoing description to indicate the scope of the invention.

CLAIMS

1. An armored land vehicle adapted to protect occupants from force of an explosion detonated beneath the vehicle, the vehicle comprising:

a bottom plate, said bottom plate resistant to penetration by explosive shrapnel;

a floor plate covering a first portion of the bottom plate, said floor plate located substantially above and spaced from the bottom plate;

a seat plate covering a second portion of the bottom plate, said seat plate located substantially above and spaced from the bottom plate;

energy absorbing members interposed between the bottom plate and the floor plate, and between the bottom plate and the seat plate ;and

at least one seat supported by acceleration attenuating suspension supports attached to the seat plate.

2. The armored land vehicle as claimed in claim 1, in which the energy absorbing members comprise crushable members and floor support members, said crushable members and floor support members being designed to plastically yield at substantially the same load.

3. The armored land vehicle as claimed in claim 2, in which the crushable members are substantially C-shaped.

4. The armored land vehicle as claimed in claim 2, in which the floor support members comprise deformable substantially sigmoid shaped members.

5. The armored land vehicle as claimed in claim 2, in which the floor support members comprise deformable substantially sigmoid shaped members secured to the floor plate or the seat plate to hold down the floor plate or the seat plate.

6. The armored land vehicle as claimed in claim 2, in which the floor support members comprise deformable substantially hat shaped members.

7. The armored land vehicle as claimed in claim 1, further comprising resilient rubber pads which isolate the energy absorbing members from either the bottom plate or the floor plate.

8. The armored land vehicle as claimed in claim 1, in which the energy absorbing members are formed from wrought aluminum alloy.

9. The armored land vehicle as claimed in claim 1, in which acceleration of the seat plate and the floor plate caused by an explosion are substantially the same whereby injury to seated occupants is minimized.

10. The armored land vehicle as claimed in claim 1, in which the seat plate and the bottom plate have substantially equal thickness.

11. An armored land vehicle adapted to protect occupants from force of an explosion detonated beneath the vehicle, the vehicle comprising:

a bottom plate resistant to penetration by explosive shrapnel;

a floor plate located substantially above a first portion of the bottom plate and spaced from the bottom plate;

seats mounted on a seat plate located substantially above a second portion of the bottom plate and spaced from the bottom plate; and

energy absorbing members interposed between the bottom plate and the floor plate such that the acceleration of the seat plate and the floor plate caused by the explosion beneath the vehicle are substantially the same whereby injury to seated occupants is minimized.

12. The armored land vehicle as claimed in claim 11, in which the energy absorbing members comprise crushable members.

13. The armored land vehicle as claimed in claim 12, in which the crushable members are substantially C-shaped.

14. The armored land vehicle as claimed in claim 11, in which the floor support members comprise deformable substantially sigmoid shaped members.

15. The armored land vehicle as claimed in claim 11, in which the floor support members comprise deformable substantially sigmoid shaped members secured to the floor plate or the seat plate to hold down the floor plate or the seat plate.

16. The armored land vehicle as claimed in claim 10, in which the energy absorbing members comprise deformable substantially hat shaped members.

17. The armored land vehicle as claimed in claim 10, further comprising resilient rubber pads which isolate the energy absorbing members from either the bottom plate or the floor plate.

18. The armored land vehicle as claimed in claim 1, in which the energy absorbing members are formed from wrought aluminum alloy.

19 A method of protecting the occupants of an armored vehicle from injury caused by an explosion beneath the vehicle, the vehicle comprising a bottom plate, said bottom plate resistant to penetration by explosive shrapnel, the method comprising the steps of:

covering a first portion of the bottom plate with a floor plate, said floor plate located substantially above and spaced from the bottom plate;

covering a second portion of the bottom plate with a seat plate, said seat plate located substantially above and spaced from the bottom plate;

interposing energy absorbing members between the bottom plate and the floor plate, and between the bottom plate and the seat plate; and

attaching at least one seat supported by acceleration attenuating suspension supports to the seat plate.

20. The method as claimed in claim 19, wherein the energy absorbing members include crushable members and floor support members, said crushable members and floor support members being designed to plastically yield at substantially the same load.

21. The method as claimed in claim 20, further comprising the step of forming the crushable members to be substantially C-shaped.

22. The method as claimed in claim 20, further comprising the step of forming the floor support members to be substantially sigmoid shaped and deformable.

23. The method as claimed in claim 20, further comprising the step of securing the floor support members to the seat plate to hold down the seat plate.

24. The method as claimed in claim 20, further comprising the step of securing the floor support members to the floor plate to hold down the floor plate.

25. The method as claimed in claim 20, further comprising the step of forming the floor support members to be substantially hat shaped and deformable.

26. The method as claimed in claim 20, further comprising the step of interposing resilient rubber pads which isolate the energy absorbing members between the energy absorbing members and either the bottom plate or the floor plate.

27. The method as claimed in claim 20, further comprising the step of forming the energy absorbing members from wrought aluminum alloy.

28. The method as claimed in claim 20, further comprising the step of forming the energy absorbing members such that acceleration of the seat plate and the floor plate caused by an explosion are substantially the same whereby injury to seated occupants is minimized.

29. The method as claimed in claim 20, further comprising the step of forming the seat plate and the bottom plate to have substantially equal thickness.

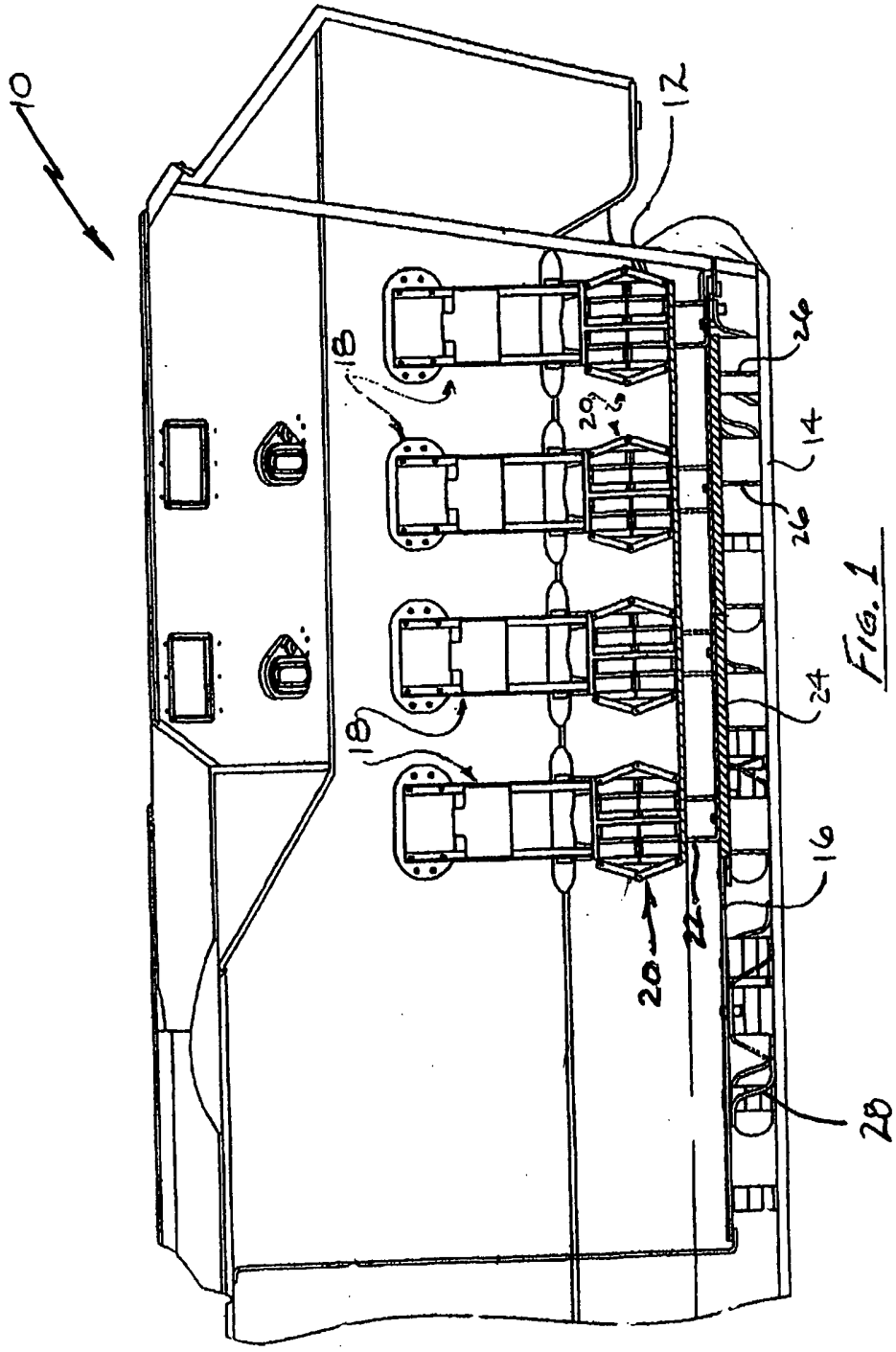

FIG. 1

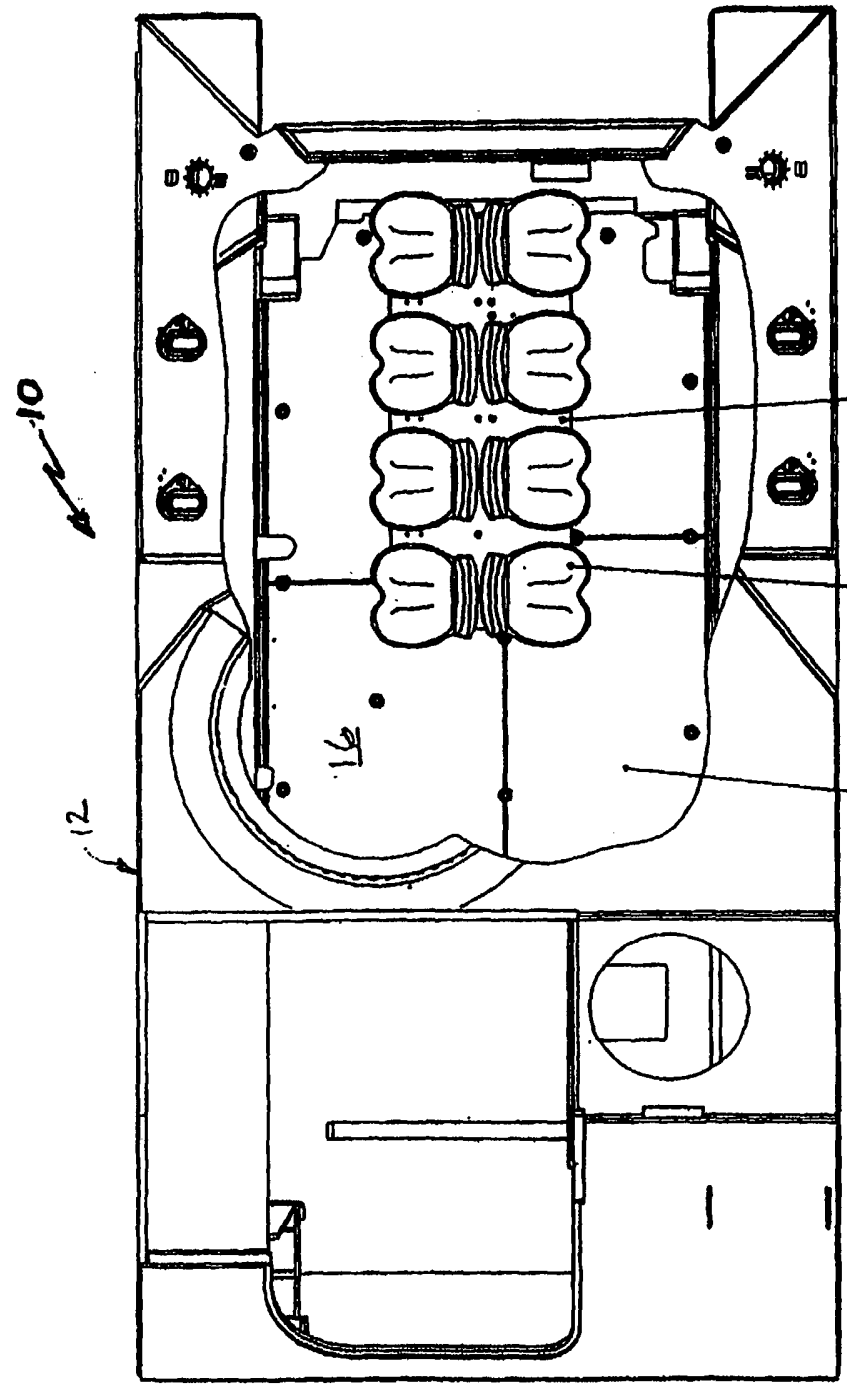

FIG. 2

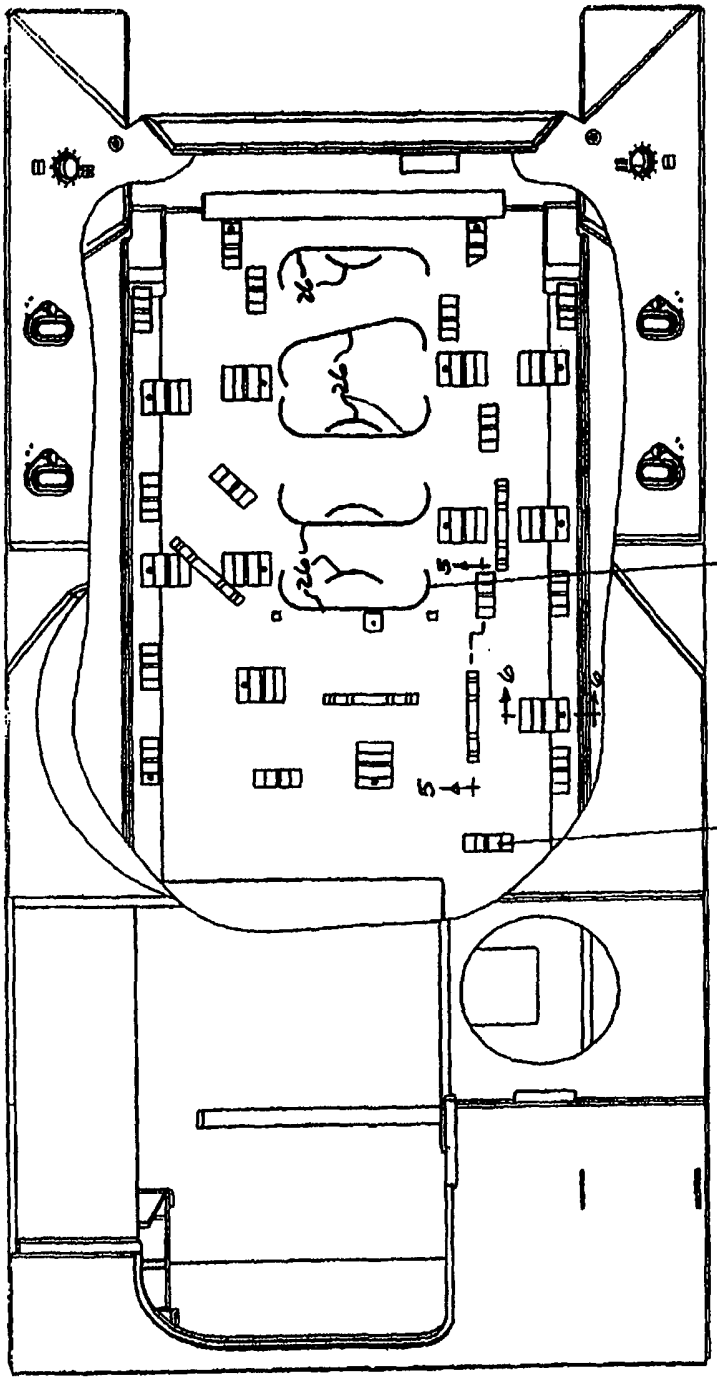

FIG. 3

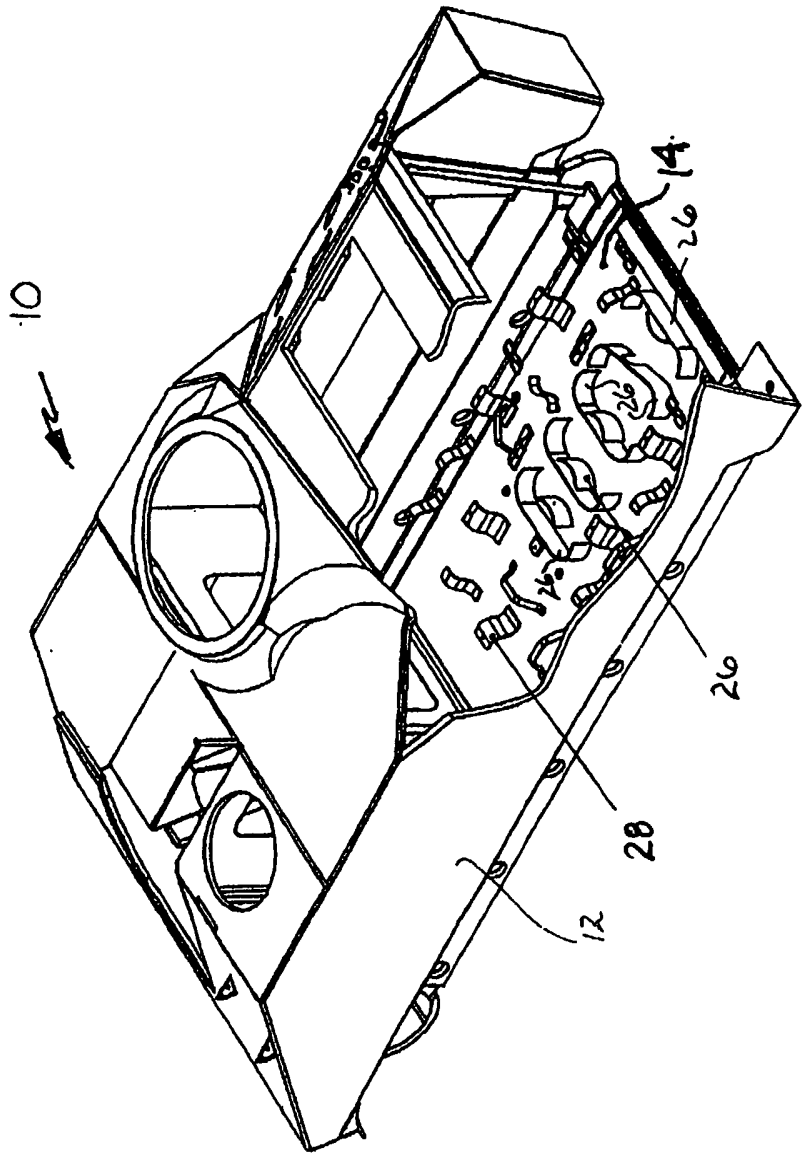

FIG. 4

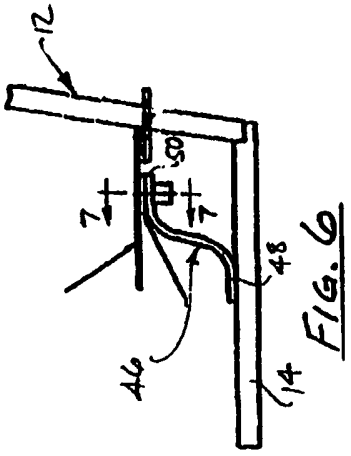

FIG. 6

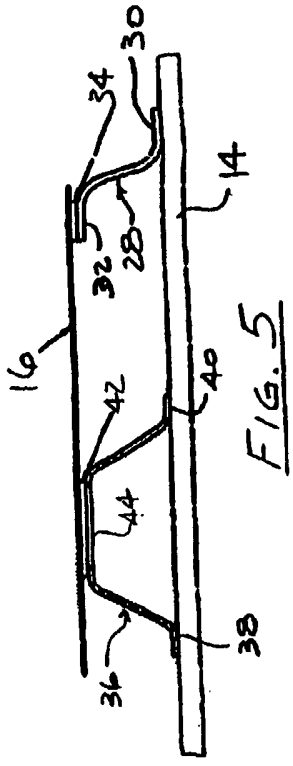

FIG. 5

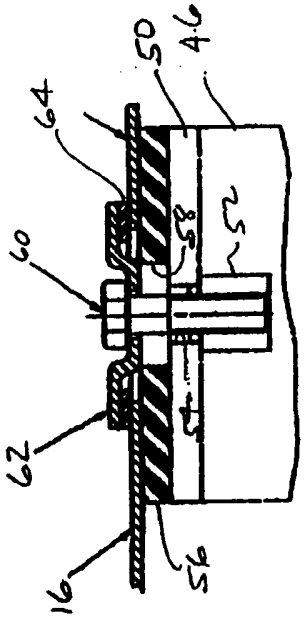

FIG. 7