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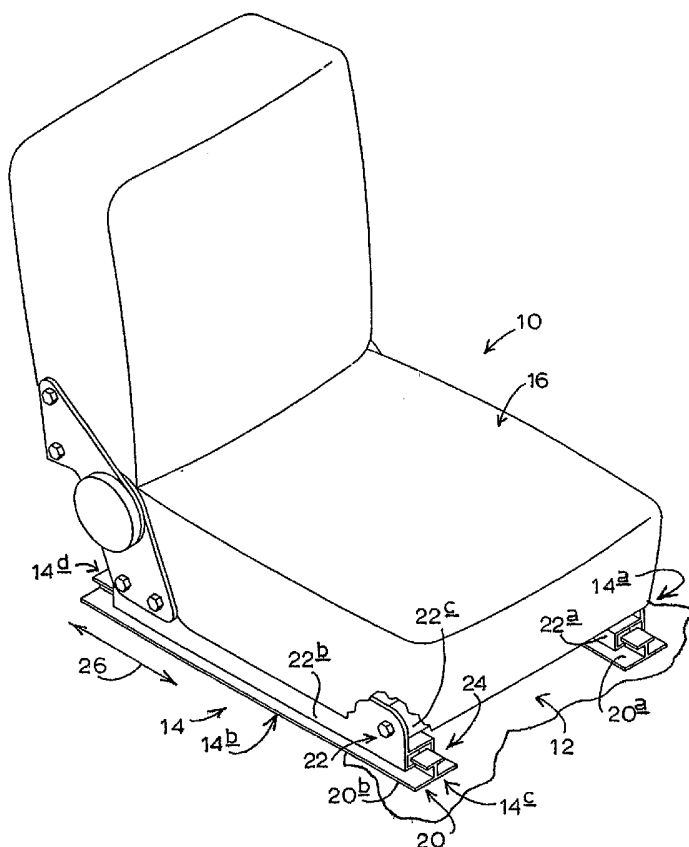
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[Continued on next page]

(54) Title: SEAT STRUCTURE WITH ANTI-SPRING SPANNER ELEMENT



(57) Abstract: A shock-load G-force minimizing seat structure (10) which responds principally in non-springy compression, rather than in spring-loading bending, to vertically directed shock loads. The seat structure features an anti-springy frame structure (14) which supports a thin and very lightweight seat cushion support spanner web (15) formed preferably of a non-stretchy material, such as a material made out of elongate carbon-fibre strands.



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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

SEAT STRUCTURE WITH ANTI-SPRING SPANNER ELEMENT

Background and Summary of the Invention

This invention pertains to seat structure, and in particular to anti-spring, web spanner structure for supporting an occupant-seating cushion in seat structure
5 designed for use in the setting of high-speed vehicle, such as an aircraft, to minimize injuries in hard and/or catastrophic impact events. The invention also pertains to such seat structure which further includes an anti-spring, compression-load seat-base structure.

Conventional seat design, insofar as it has been aimed at minimizing injuries
10 caused from a hard "bottoming-out" event, such as in a crash landing in an aircraft, have typically introduced structural arrangements which, unfortunately, and to some extent accidentally, tend to exacerbate the impact-injury problem. Such design often utilizes a collapsing or "stroking" behavior in an effort to minimize the total load delivered to a seat occupant. This approach, however, frequently introduces
15 undesirable weight, complexity, and expense issues, and also additionally enhances "springiness" in a seat structure -- a situation that can actually lead to an amplification of damaging accelerations applied to a seat occupant's spine. Increased springiness, counter-intuitive as this may seem, introduces an enlarged rebound counter-acceleration fractions of a second after a dangerous impact occurs, and such increased
20 counter-acceleration significantly contributes to serious, and often fatal, injury

The present invention addresses this issue with an innovative seat structure which, in use, is interposed a seat occupant and a vehicle frame, such as an aircraft frame, and which possesses substantially no spring-loading and spring-back behavior. This seat structure, disclosed in the environment of an aircraft, and in a preferred and
25 best mode embodiment which is specifically illustrated and described herein, features

a very thin, occupant-cushion-supporting spanner web formed of substantially non-stretchy and non-springy strand material, such as elongate carbon fiber, or Kevlar®, strand material, which is deployed under very modest tension between a pair of transverse, spaced, parallel, elongate and very robust cylindrical tubes. These tubes
5 are carried on an adjustable, selectively fore and aft repositionable, slider sub-frame which, in turn, rides slideably on a pair of spaced, lateral and parallel I-beam-like rails (seat-frame substructures) which are, effectively, directly anchored to the aircraft frame. The mechanism furnished for enabling selectable slide repositioning, and positional unlocking and locking associated with this capability, do not form any part
10 of the present invention, and are neither described nor illustrated herein.

These components of the seat frame - - tubes, slider mechanism, rails and associated structures - - load principally in very modest-deflection compression, rather than in bending, and consequently make an important contribution to the non-spring-back performance of the entire seat-structure. The spanner web, non-
15 stretchable as it is, offers an extremely light weight, thin-format direct cushion support structure which also specially exhibits substantially no spring-loading, spring-back response to loading activity, such as an impact-produced sharp, high-level accelerative loading.

These and other features and advantages which are offered by the present
20 invention will become more fully evident and appreciated as the description that now follows is read in conjunction with the accompanying drawings.

Description of the Drawings

Fig. 1 presents an isometric, side-frontal view of a preferred and best mode embodiment of seat-structure constructed in accordance with the invention. Fig. 1 includes a fragmentary illustration of an aircraft's frame structure with respect to
5 which this seat-structure is anchored.

Fig. 2 gives a larger-scale, top-plan view (with seat-back structure removed) of what is shown in Fig. 1.

Figs. 3-5 inclusive, each present an even larger-scale, fragmentary view (partially cross-sectional) of structural details taken along the lines 3-3, 4-4, and 5-5,
10 respectively, shown in Fig. 2.

Fig. 6 presents three, story-telling, isometric views which describe, at least in part, assembly of the cushion-supporting spanner structure which is employed in the seat structure of the present invention.

Fig. 7 is a simplified fragmentary detail illustrating one modified form of the
15 invention.

Fig. 8 is a fragmentary cross section taken generally along the line 8-8 in Fig.
7.

Detailed Description of the Invention

Turning now to the drawings, and referring first of all to Figs. 1-5, inclusive,
20 shown generally at 10 is a preferred and best-mode anti-spring-back seat structure which is constructed in accordance with the present invention. Very specifically, this illustrated seat-structure is constructed in accordance with a preferred and best mode embodiment of the invention. Illustrated fragmentarily at 12 is structure that represents an aircraft frame with regard to which seat-structure, or seat, 10 is suitable
25 rigidly anchored.

Seat 10 includes a non-springy, rigid frame 14, and mounted thereon, as will be described, a thin, nominally flexible, substantially unstretchable spanner web 15 of material which is intended to support an appropriate, direct occupant-supporting cushion which is shown at 16 in Fig. 1. The design and construction of this cushion form no part of the present invention, but preferably, cushion 16 is made of a somewhat "soft" material which does not possess a springy nature.

Frame 14 includes lower and upper sub-frames 20, 22 respectively, which are functionally united, in the region designated 24, for selected fore-and-aft relative positional sliding and adjustment as is represented by double-ended arrow 26. The left and right lateral sides of frame 14 (from an occupant's point of view) are shown at 14a, 14b (see particularly Figs. 1 and 2), and the front and rear sides of this frame are shown at 14c, 14d, respectively.

Lower sub-frame 20, also referred to herein as a mounting structure, includes two, elongate, laterally spaced, substantially parallel side members 20a, 20b. These side members have a kind of I-beam-like cross section, with different-width upper and lower flanges joined by a central upright web, as shown. Members 20a, 20b are suitably anchored to the aircraft frame.

Upper sub-frame 22 includes two, elongate, laterally spaced, substantially parallel side members 22a, 22b, each of which has the cross-sectional configuration clearly illustrated in Fig. 5. As can be seen, the lower portion of each of these side-members has a downwardly facing, somewhat C-shaped look. Projecting upwardly from this lower portion is a substantially vertically disposed web which resides at the laterally outer sides of members 22a, 22b. Members 22a, 22b are slideably mounted on members 20a, 20b, respectively, in lower sub-frame 20, with the C-shaped lower portions of members 22a, 22b receiving the upper flanges of members 20a, 20b,

respectively. Low-friction-material shoes 28, made of a material such as ultra high molecular weight polyethylene (UHMWPE), are interposed these four lateral members (20a, 20b, 22a, 22b) as shown (see particularly Figs 4 and 5).

As was mentioned earlier, an appropriate mechanism (not shown) is provided
5 for allowing a seat occupant selectively to adjust (in a lockable and unlockable manner) the fore and aft positions of members 22a, 22b on members of 20a, 20b.

Further included in upper sub-frame 22 are elongate, front and rear, transverse members 22c, 22d, respectively. These members, which are referred to herein as web anchor members, each has a stout, cylindrical/tubular configuration, with a central
10 strengthening web which is partially removed adjacent opposite ends to accommodate the installation of closure end caps, such as end cap 30 which is shown in Fig. 5. With specific reference to each end cap 30, each cap includes a central, inwardly facing, hexagonal socket 30a which, in a sliding-fit fashion, receives a hexagonal nut 32 that receives a mounting bolt 34 which functions to anchor one end of the
15 associated tubular member to the upright web in a upper sub-frame lateral member (22a, 22b). A cross-nut-end-bolt assembly 36 is employed to capture each end cap within an end of one of the tubular members, with each hex nut 32 being initially freely received in a socket 30a prior to assembly of each tubular member with an end of one of members 22a, 22b. Collectively, members 22a, 22b, 22c, 22d define what is
20 referred to herein as a rectangular, personnel support span, or region, 36 (see particularly Figs. 2 and 3).

The several elongate components which make up the lower and upper sub-frames in seat-structure 10 exhibit substantially no springy bending under circumstances where a vertical load, such as an impact/shock load, is delivered
25 between a seat occupant and the frame of the aircraft. Rather, these components

respond to such a load primarily in compression. This is an important feature of the present invention.

Suitably anchored to members 22c, 22d, and substantially entirely spanning previously mentioned rectangular region 36, is previously mentioned spanner web 15.

5 Referring to Fig. 6 along with Figs. 1-5, inclusive, web 15 is effectively a two-layer structure, including preferably an inner layer 40 and a jacketing, outer layer 42. Inner layer 40 is formed of a substantially non-stretchable strand material, such a Kevlar® fabric material, which includes plural, elongate strands 40a (see Figs. 2, 5 and 6) that end up extending in a fore-and-aft direction between upper sub-frame members 22c,
10 22d. Layer 40 is preferably woven in nature, with cross fibres or strands having an orthogonal relationship. Outer jacketing layer 42 is formed preferably of rip-stop Nylon®. Fig. 6 shows how spanner web 15 may be formed. The several stages of construction are pictured in a quite self-explanatory way from left-to-right in the three views which are presented in Fig. 6. Stitching 44 (Figs. 2, 3 and 6) binds opposite
15 ends of the effectively continuous loop of the spanner web in final stages of construction. The finished "loop" has a somewhat "figure-8" (with a flattened, offset center) configuration as viewed from a lateral side, or edge, of the loop. This configuration gives the spanner web a pair of opposite-end (front and rear) reverse loops 15a, 15b, respectively.

20 While this spanner web has been described in conjunction with formation from a Kevlar®-strand woven fabric material, it should be understood that other similar and suitable materials are and may become available made out of , for example, carbon-fiber material.

The completed spanner web is installed on sub-frame members 22c, 22d as shown, with the installed web nominally possessing a certain modest amount of tension whereby it does not sag between these sub-frame members.

Figs. 7 and 8 illustrate a somewhat modified form of spanner-web construction and mounting. Here, such a modified web is shown fragmentarily at 46. With regard to this modified web, the modifications exist at the two, opposite-end reverse bends which loop around upper sub-frame members 22c, 22d. Specifically, at these two locations, two additional web layers 48, 50 have been added so that they lie intermediate previously described outer layer 42 and members 22c, 22d when the web is mounted in place. Layer 48 is joined directly to layer 42, and is formed of an appropriate load-spreading material, such as Poron® 90. Layer 50 is joined to layer 48, and is preferably formed of an acceleration-rate-sensitive material, such as any one of the specific viscoelastic materials known as CF-42, CF-45, and CF-47.

Operational Description

With an occupant in seat 10, substantially the full weight of that occupant is borne by the spanner web. The web carries this load in non-stretching tension. From the spanner web, occupant load is transferred directly and dividedly to upper sub-frame 22 via front and rear tubular members 22c, 22d, respectively, which respond to such load transfer, at least insofar as vertical load components are concerned, in compression rather than in springy bending. From members 22c, 22d, this divided occupant load is transferred in compression to upper sub-frame members 22a, 22b, through which members this transferred load is delivered in compression through shoes 28, and lower sub-frame members 20a, 22b, in compression, to the aircraft frame.

In the event of a catastrophic or other vertically jolting occurrence, G-loads delivered to an occupant through seat 10 upon initial impact will not cause any noticeable spring-back, vertical loading to occur in any portion of seat 10. Hence, there will not occur any springy rebound in the seat frame and spanner web structure, and in particular not any rebound of the kind that we have learned is heavily responsible for delivering extremely damaging, and even fatal, injuries to a seat occupant. "Crash" tests performed with regard to the seat of this invention, with respect to "numbers" generated that relate to injury causation, are remarkably low, and have proven to be, consistently and repetitively, well below established "danger" thresholds. One important key to this remarkable behavior is the fact that, in sharp distinction relative to conventional seat structures, the seat structure of this invention does not introduce a damaging rebound response to impact events.

Accordingly, a preferred embodiment and methodology of the present invention have been described and illustrated herein. Counter-intuitively, the structure and methodology of this invention furnish a seat support structure including spanner web structure which, by reducing almost to non-noticeability any spring rebound action with respect to a catastrophic vertical load imposed by a seat occupant on the seat structure, damaging G-force transmission to that occupant is significantly minimized. Those who are skilled in the art, after reading and reviewing the description and illustrations herein regarding this invention will appreciate that variations and modifications may be made without departing from the spirit of the invention.

WE CLAIM:

1. Anti-spring-back, personnel-support seat structure designed to react non-yieldingly to load delivered to the structure via the contacting body of a person supported by the structure comprising
 - 5 a non-springy, rigid frame possessing a non-springy, rigid sub-frame defining a personnel support span whose dimensions and configuration remain effectively unchanged during the application of a body-contact load delivered to the sub-frame through the body, and
 - a thin and nominally flexible web of material formed of plural, elongate
 - 10 strands of a non-stretchable material secured to said sub-frame and substantially spanning said span.
2. The seat structure of claim 1, wherein said material takes the form of a fabric which includes plural, elongate, generally parallel, carbon fiber strands.
- 15 3. The seat structure of claim 1, wherein said material takes the form of a fabric including plural, elongate, generally parallel Kevlar® strands.
4. The seat support of claim 2, wherein said fabric takes the form of a
- 20 woven material.
5. The seat structure of claim 3, wherein said fabric takes the form of a woven material.

6. The seat support of claim 4, wherein said fabric includes generally orthogonally related carbon fiber strands.

7. The seat structure of claim 5, wherein said woven fabric includes
5 generally orthogonally related Kevlar® strands.

8. The seat structure of claim 1, wherein said sub-frame includes two, spaced web anchor members disposed generally on a pair of opposite sides of said span.

10

9. The seat structure of claim 8, wherein said sub-frame has front, rear, and lateral sides, said web anchor members effectively define said front and rear sides, and the sub-frame's lateral sides are defined by spaced, elongate lateral members which join with said anchor members and are mounted in such a manner
15 that they cannot respond to a load in bending.

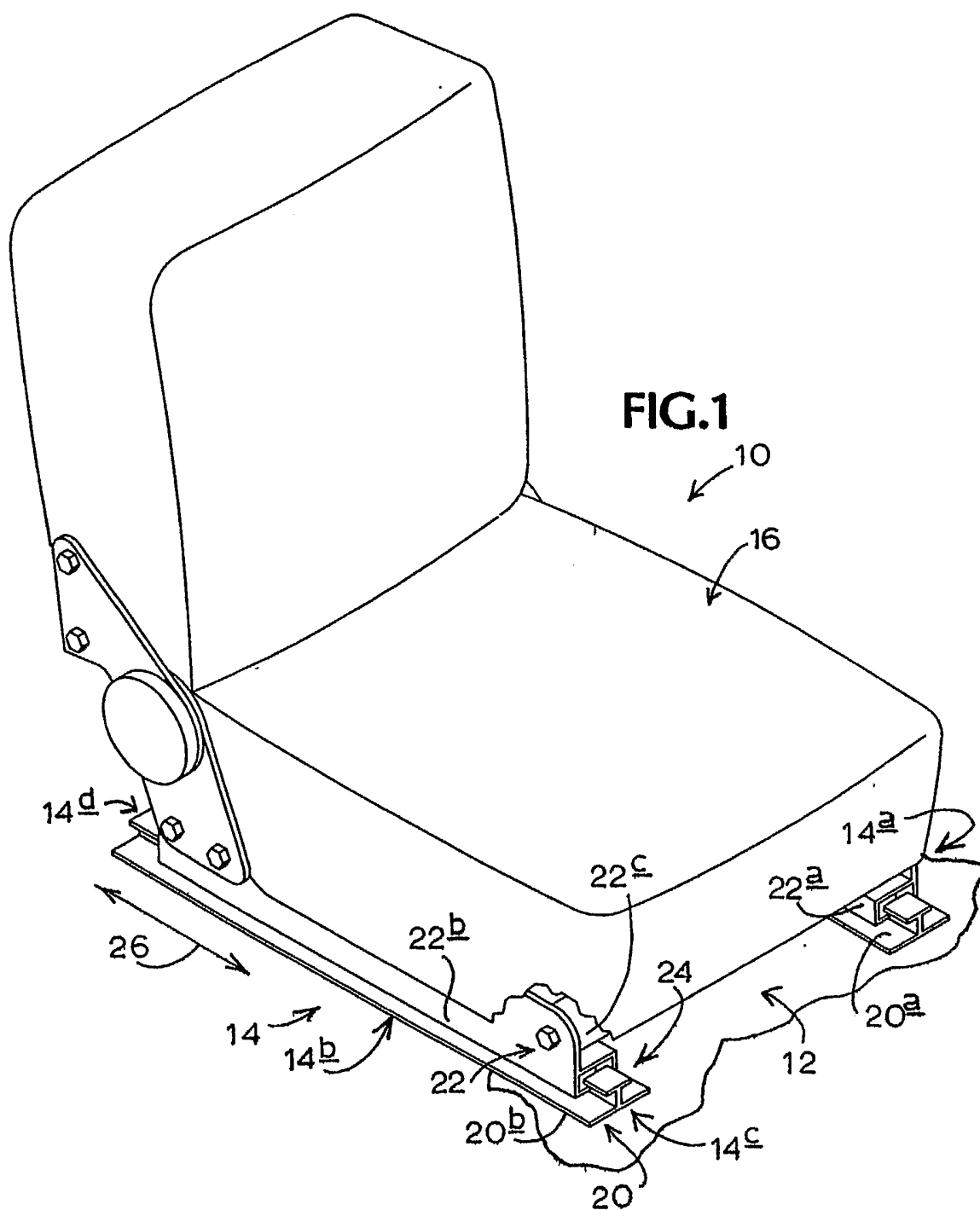
10. The seat structure of claim 9, wherein said frame further possesses another sub-frame which acts as a mounting structure adapted to mount the frame as a whole onto an external structure, and to permit the lateral members of the first-
20 mentioned sub-frame, and hence the first-mentioned sub-frame as a whole itself, to be reversibly and translationally positionally shiftable generally along a line which is a fore-and-aft line in relation to the seat structure.

11. A method of minimizing G-force impact injury to a person seated in a
25 vehicle which has a non-springy vehicle frame comprising

creating a person-seating structure which exhibits substantially no vertical spring-load-type rebound to a vertical compressive shock introduced to this structure, and

following said creating, anchoring the created person-seating structure
5 effectively directly to the vehicle frame.

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SUBSTITUTE SHEET (RULE 26)

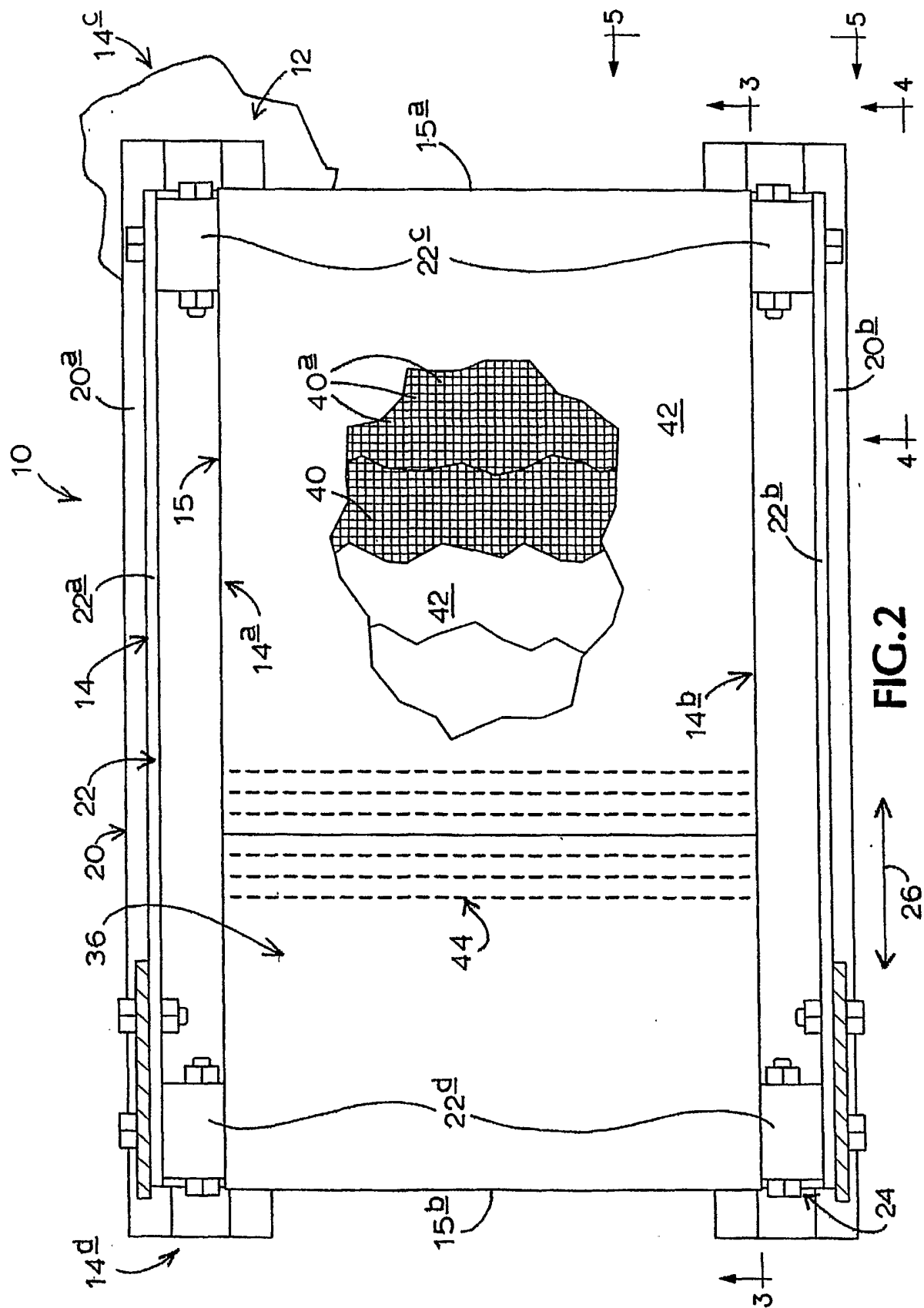


FIG. 2

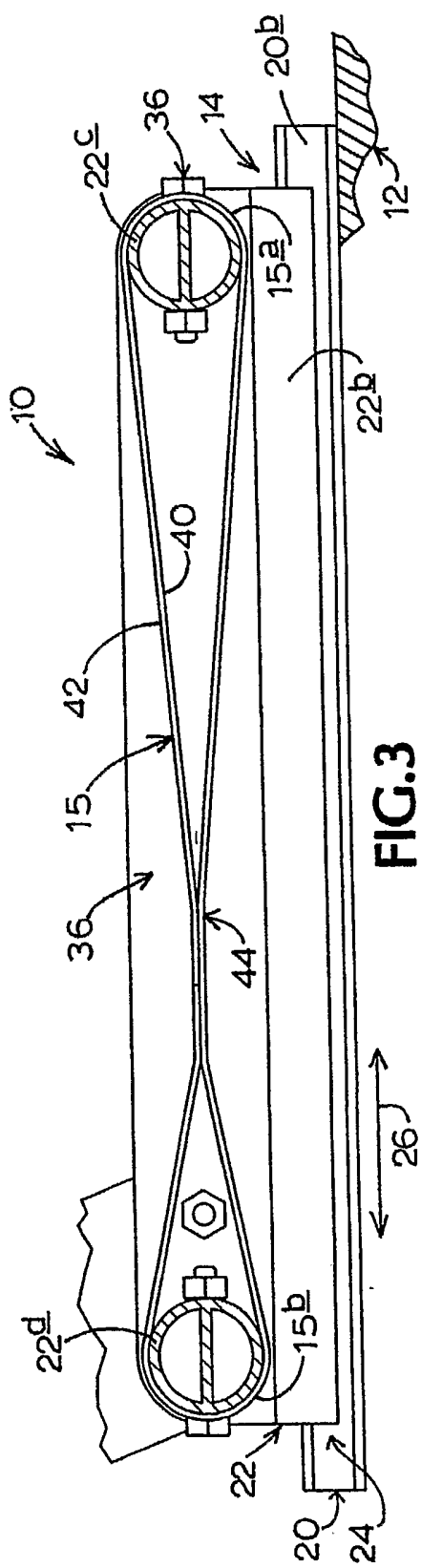
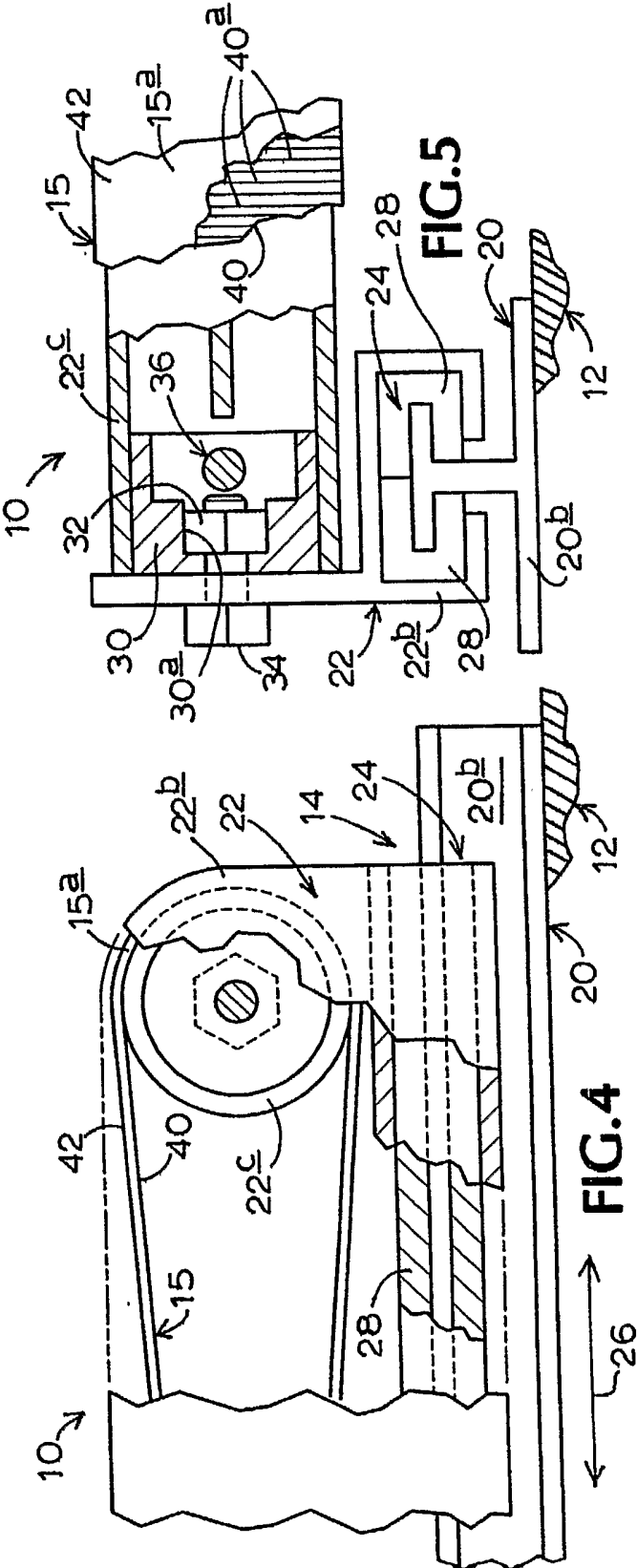


FIG. 3



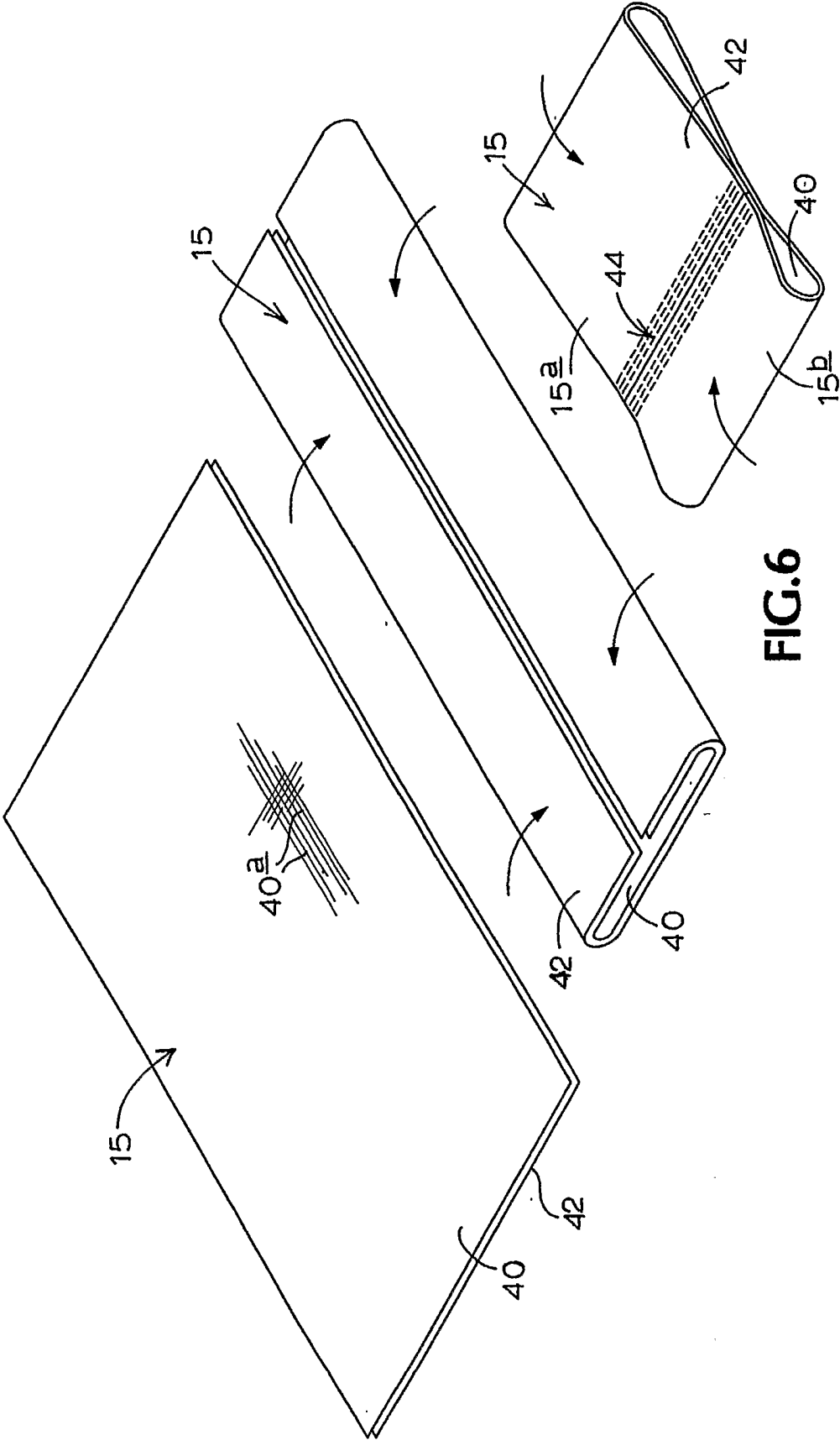
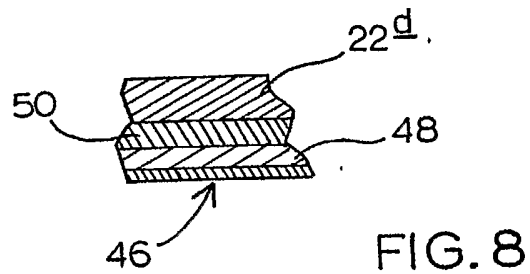
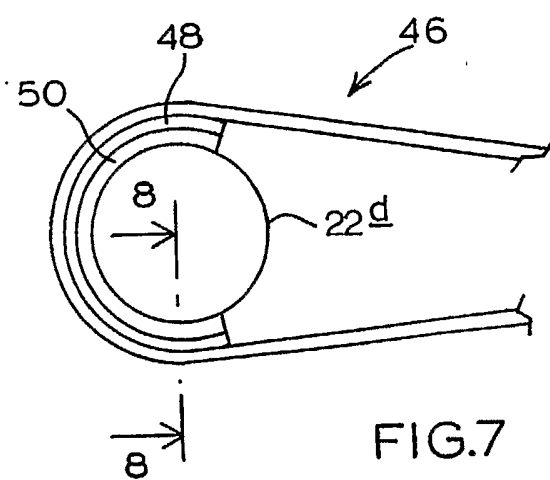


FIG. 6

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INTERNATIONAL SEARCH REPORT

International application No.

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A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : B60N 2/42, B60R 21/02, A47C 7/14

US CL : 297/216.1, 216.15, 216.16, 452.13, 452.14, 452.56

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 297/216.1, 216.15, 216.16, 452.13, 452.14, 452.56

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EAST

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6,193,318 B1 (BECKER ET AL) 27 February 2001 (27/02/01), see entire document.	1-11
X	US 6,561,580 B1 (BERGEY) 13 May 2003 (13/05/03), see entire document.	1-11
X	US 5,441,331 A (VENTO) 15 August 1995 (15/08/95), see entire document.	1-11
X	US 5,013,089 A (ABU-ISA ET AL) 07 May 1991 (07/05/91), see entire document.	1-11
X	US 6,675,269 B1 (MAEDA ET AL) 23 April 2002 (23/04/02), see entire document.	1-11
X	US 4,492,408 A (LOHR) 08 January 1985 (08/01/85), see entire document.	1-11

☒ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No.
/PCTU/S0415045

C. (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	US 4,723,816 A (SELBERT ET AL) 09 February 1988 (09/02/88) see entire document.	1-11
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