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(21) International Application Number: PCT/US91/01403 (22) International Filing Date: 28 February 1991 (28.02.91) (30) Priority data: 486,387 • 28 February 1990 (28.02.90) US (71)(72) Applicant and Inventor: ZUFLE, T., Tyler [US/US]; Square One, Lafayette on the River, Grenta, LA 70053-5835 (US). (74) Agents: SMITH, Homer, A. et al.; Fleit, Jacobson, Cohn, Price, Holman & Stern, The Jenifer Building, 400 Sev- enth Street, N.W., Washington, DC 20004 (US).		(81) Designated States: AT (European patent), BE (European patent), CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), IT (European patent), LU (European patent), MC (European patent), NL (European patent), SE (European patent). Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>
(54) Title: SOFT BODY ARMOR (57) Abstract <p>A soft body armor utilizes a combination of dissimilar materials (14, 16, from Figure 1). This combination provides increased resistance to penetration of the soft body armor by a projectile such as a bullet or other ballistic projectile. The dissimilar materials are arranged in a plurality of layers, or plies of anti-ballistic material (52, 54, and 56 from Figure 4). These materials can be used in the form of a rectangular seat drape (28, 30) extending up behind a vehicle driver or occupant's head.</p>		

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⁺ Any designation of "SU" has effect in the Russian Federation. It is not yet known whether any such designation has effect in other States of the former Soviet Union.

SOFT BODY ARMOR**BACKGROUND OF THE INVENTION****FIELD OF THE INVENTION**

The present invention generally relates to an
5 anti-ballistic body armor and more particularly a soft
body armor in which a combination of dissimilar materials
is utilized to produce a synergistic result as compared
to utilization of a single type of material. The
superior result provides increased resistance to
10 penetration of the soft body armor by a projectile such
as a bullet or other ballistic projectile. The
dissimilar materials are arranged in a plurality of
layers or plies of ballistic material which can be
utilized in various arrangements for protecting
15 individuals and property from injury or damage from a
projectile or other ballistic missile. In one embodiment
of the invention, the multiple plies of ballistic
material include a unique arrangement of multiple plies
of an aramid fiber such as that identified by the
20 trademark "Kevlar" or that identified by the trademark
"TWARON" and multiple plies of non-woven ballistic
material available under the trademark "Spectra Shield".
In another embodiment of the invention, the multiple
plies of ballistic material include a unique arrangement
25 of multiple plies of an aramid fiber identified by the
trademark "Kevlar" or the trademark "TWARON" and multiple
plies of ballistic nylon. Another embodiment of the
invention utilizes an anti-ballistic material constructed
of yarn of two separate materials woven in a standard
30 procedure with the warp yarn being an aramid fiber such
as "Kevlar" or "TWARON" having very low elasticity
characteristics with the fill yarn being constructed of
nylon having high elasticity characteristics with the
blend of the two yarns providing a synergistic yarn in

which the two characteristics, namely, the low elasticity warp yarn and the high elasticity fill yarn, producing a flexible fabric armor that is effective as an anti-ballistic material. The present invention also includes
5 a unique arrangement of soft body armor used to protect vehicle drivers or occupants from ballistic attack which generally is in the form of a rectangular seat drape which holds and retains the soft fabric armor in place with a narrow extension of the drape and armor extending
10 up behind the driver's head thus providing effective protection for a vehicle driver or occupant in which the dissimilar materials provide a synergistic result.

INFORMATION DISCLOSURE STATEMENT

Body armor has been developed for use by
15 individuals to protect the wearer from injury or death by ballistic attack. My prior Pat. Nos. 4,535,478 and 4,578,821 disclose body armor which has been developed for this purpose and which include the use of "Kevlar" as a ballistic material. Law enforcement personnel and
20 other individuals subject to ballistic attack have found body armor effective in significantly reducing injury and death from ballistic attack. Also, the prior art made of record during prosecution of the applications which matured into the above patents disclose developments in
25 body armor and the following U.S. patents also disclose developments relevant to the soft body armor of this invention.

30 2,816,578
3,256,130
4,181,768
4,186,648
4,466,135
4,574,105
4,623,574

35

The prior art does not disclose the use of multiple plies of dissimilar materials to produce a synergistic penetration resistance to soft body armor and do not disclose use of such a soft body armor to protect
5 a vehicle driver or occupant.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a soft body armor incorporating a combination of dissimilar materials utilized in a multiple ply or layer
10 arrangement to produce a synergistic resistance to penetration of the body armor by ballistic projectiles thereby protecting individuals or property from injury or damage from ballistic attack.

Another object of the invention is to provide a
15 soft body armor in which the multiple plies or layers are constructed of "Kevlar" or "TWARON" and "Spectra Shield".

A further object of the invention is to provide a soft body armor in which the multiple plies or layers are constructed of "Kevlar" or "TWARON" and ballistic
20 nylon.

Still another object of the invention is to provide a soft body armor in which the multiple plies or layers are constructed of a ballistic material utilizing warp yarn of "Kevlar" or "TWARON" and fill yarn of nylon.

25 A still further object of the invention is to provide a soft body armor in accordance with the preceding objects utilized in a unique structural arrangement to protect the operator and/or occupants of a vehicle from ballistic attack.

30 Still another significant feature of the invention is the construction of soft body armor of a plurality of plies or layers of dissimilar materials in which the plies or layers of dissimilar materials are

arranged in a unique combination and arrangement of the dissimilar materials to produce a synergistic resistance to penetration by ballistic projectiles.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout.

10

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a plan view of the soft body armor utilizing ballistic material in which the warp yarn and fill yarn are of dissimilar materials.

Figure 2 is an enlarged, fragmental plan view illustrating the warp and fill yarn.

Figure 3 is a detailed, sectional view of a fragment of the ballistic material.

Figure 4 is a fragmental, perspective view of one corner of the multiple plies of dissimilar material used in the body armor.

Figure 5 is a perspective view illustrating the soft body armor of the present invention associated with the driver's seat of a vehicle.

Figure 6 is a fragmental, rear perspective view of the driver's seat illustrating the manner in which the soft body armor is connected to the vehicle seat.

Figure 7 is a fragmental, perspective view similar to Fig. 6 but illustrating the attachment strips on the rear surface of the seat back.

Figure 8 is a plan view of the soft body armor illustrated in Fig. 4.

Figure 9 is a transverse, sectional view, on an enlarged scale, taken substantially upon a plane passing

along section line 9-9 on Fig. 8 illustrating the specific construction and arrangement of the multiple plies or layers of dissimilar materials utilized in the soft body armor of this invention.

5 DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now specifically to Figs. 1-3 of the drawings, the soft body armor of this invention includes ballistic material generally designated by reference numeral 10 and is in the form of an anti-ballistic
10 material 12 of woven material which includes warp yarn 14 and fill yarn 16 woven in a conventional manner with the warp yarn 14 extending lengthwise of the fabric and being constructed of a material having a low modulus of elasticity. The warp yarn 14 is an aramid fiber such as
15 "Kevlar" or "TWARON". The fill yarn 16 has a high modulus of elasticity and is constructed of a thermoplastic material such as nylon. The combination of the low elastic aramid fiber in the warp yarn and the high elastic fiber of nylon in the fill yarn produces a
20 fabric material 12 which has some degree of resiliency in the direction transversely of the warp and very little elasticity in the direction of the warp yarn.

Blending the low and high elasticity characteristics of the two yarns produces a highly
25 effective flexible armor material in which the aramid yarn having low elasticity is in the warp direction and the nylon yarn which has high elasticity is in the fill direction. The fabric resulting from the blending of the two yarns can be layered by placing them on top of each
30 other and can be connected together by stitching, sewing or button tack arrangements at close intervals to make a multi-layered anti-ballistic material. The layers may be arranged in various sequences to produce an effective

penetration resistant fabric. The "Kevlar" or "TWARON" is relatively hard and non-melting, and provided with high tensile strength whereas the nylon is yielding and more readily melts from the heat generated by a projectile trying to penetrate the material as the projectile attempts to pass through the surface of the fabric. This attempt to pass through the material causes great friction at the entry point on the "Kevlar" or "TWARON" yarn which dissipates a large portion of the energy of the projectile. As the diminished energy projectile continues to penetrate the material, the melt of the nylon and additional layers of the material support the melting nylon thus deforming and trapping the projectile.

Referring now specifically to Figs. 4-9, the soft body armor disclosed in this embodiment of the invention is generally designated by reference numeral 20 and is associated with a vehicle seat 22 and seat back 24 having the usual headrest 26 at the upper edge thereof. The body armor 20 includes a generally rectangular panel or seat drape 28 which is positioned against the forward surface of the seat back. The drape 28 includes a narrow central portion 30 projecting from one edge thereof which extends upwardly in front of the headrest 26 to protect the head of the vehicle operator. The rear surface of the narrow extension 30 is provided with a pair of elastic straps 32 attached to the extension 30 by stitching 34 at the ends thereof with the elastic straps being in spaced parallel relation to extend around the headrest 26 to support the head protecting extension 30 along the front surface of the headrest 26 as illustrated in Fig. 6. Alongside of but free of the extension 30, mounting strips 36 are provided as extensions from the

same edge of the seat drape 28 as the extension 30 with the mounting strips being on opposite sides of the extension 30 and being slightly shorter and also narrower than the extension 30. The free end portion of each mounting strip 36 is provided with a generally rectangular area 38 of the pile or loop component of a hook and pile fabric connector such as that sold under the trademark "Velcro". The rear surface of the seat 24 is provided with a pair of spaced strips 40 of the hook component of the hook and pile fabric connector. When the body armor 20 is positioned against the front of the seat, the elastic straps 32 will hold the extension 30 in front of the headrest 26 and the strips 36 will extend over the top edge of the seat back with the pile fabric patches 38 detachably and securely engaged with the hook fabric patches 40 thus securing the body armor in position in relation to the vehicle seat back 24.

The body armor 20 may be increased in width to extend completely across the front seat or rear seat of various types of vehicles including taxi cabs, limousines and conventional passenger cars. The narrow extension 30 which extends up behind the driver or occupant's head includes a rigid component and may be constructed of opaque material or clear material which can protect the driver's head and neck. The "Velcro" equipped straps along with the elastic straps 32 engaging the headrest anchor the armor in place. Also, the seat drape 28 can be elongated to cover the upper surface of the seat 22 and also extend downwardly in front of the seat and along the upper surface of the floor mat or floor board and along the fire wall area as well as extended vertically on the side edges to cover the door area thus affording additional protection for the vehicle operator or

occupant. This type of structure would also serve to deflect a blast from a land mine or grenade thus affording additional protection for the vehicle driver or occupants.

5 In this arrangement, the concept of zoned armor can be used and includes a plurality of outer plies of "Kevlar" or "TWARON" backed by a plurality of plies of ballistic nylon in a sandwich arrangement which provides
10 a synergistic resistance to penetration of a ballistic missile inasmuch as the aramid outer plies are very hard and non-melting while the ballistic nylon is yielding and readily melts from the heat generated by the incoming projectile as it attempts to pass through the "Kevlar" or
15 "TWARON" surface. This causes friction at the entry point on the "Kevlar" or "TWARON" thus dissipating a large portion of the energy of the projectile and as the projectile which has a reduced energy traversing the inner nylon plies and begins an attempt to exit the mat, the outermost plies of the "Kevlar" or "TWARON" at the
20 back of the sandwich support the nylon thus deforming and trapping the projectile. In addition, the use of the combination of the "Kevlar" or "TWARON" and nylon reduces the overall costs of the body armor while still producing the synergistic result.

25 Figs. 4 and 9 illustrate an arrangement of multiple plies or layers of dissimilar materials which can be used in the structure illustrated in Figs. 5-7 but also can be used in various types of soft body armor with the structure including spaced fabric layers 42 and 44
30 stitched together along the periphery as at 46 to form a pocket to receive the layers of dissimilar material. This arrangement may be retained in assembled condition by sewing, stitching or button tack arrangements at a

plurality of points. The body armor includes outer single plies 48 and 50 of "Kevlar" or "TWARON". These outer plies act as a fireproofing device, an impact surface for an incoming projectile and reinforcing plies to support button tacking as the joining mechanism.

Positioned inwardly of the outer ply 48 are eight plies 52 of "Spectra Shield". Likewise, inwardly of the outer ply 50 are eight plies 54 of "Spectra Shield". Positioned between the plies 52 and 54 of "Spectra Shield" are ten plies 56 of "Kevlar" or "TWARON". The layers or plies of materials may be joined together by a button tack arrangement in a specific pattern with the resultant hybrid combination of soft armor materials providing a substantial weight reduction as compared to current industry standards as well as a substantial reduction in the thickness or bulk of the material. While this arrangement may be used in the vehicle occupant armor as shown, it is also useful in many other adaptations requiring protection against ballistic attack.

The ballistic fabric 10 disclosed in Figs. 1-3 utilizes picks and ends of "Kevlar" or "TWARON" in one direction and ballistic nylon in the other direction which produced a synergistic result. However, "Spectra Shield" material is not a woven product but a composite product and can be used in the ballistic material 10 illustrated in Figs. 1-3 with this material utilizing a similar picks and ends arrangement of "Spectra Shield" in one direction and "Kevlar" or "TWARON" in the other. This combination of "Kevlar" or "TWARON" fibers and "Spectra Shield" fibers in the same composite matrix produces a synergistic result of increased resistance to penetration by a ballistic missile.

10

"Spectra Shield" material is made by utilizing a plastic film with adhesive on which closely aligned strands or filaments are brought into contact and bonded thereto and two of these adhesive membrane sheets are
5 then combined in the X-Y axis to form a 0°-90° sandwich.

The materials from which the soft body armor is constructed are commercially available and their characteristics are well known. The aramid fiber
10 available under the trademark "Kevlar" is manufactured by Dupont and a specification sheet is attached hereto and identified as Attachment A. The aramid fiber available under the trademark "TWARON" is manufactured by Akzo and specification sheets are attached hereto and identified
15 as Attachment B. The non-woven ballistic fabric is sold under the trademark "Spectra Shield" and is available from Allied Chemical Company. A specification sheet relating to "Spectra Shield" is attached hereto and identified as Attachment C with these attachments forming
20 a part of the disclosure in this application.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the
25 invention to the exact construction and operation shown and described, and, accordingly, all suitable modifications and equivalents may be resorted to, falling within the scope of the invention.

30

WHAT IS CLAIMED AS NEW IS AS FOLLOWS:

1. A soft body armor comprising multiple plies of ballistic material, said plies being constructed of dissimilar material.
- 5 2. The soft body armor as defined in claim 1 wherein said ballistic material is woven with warp yarns having a low modulus of elasticity and fill yarn having a high modulus of elasticity.
3. The soft body armor as defined in claim 2
10 wherein said warp yarn is constructed of aramid fiber, said fill yarn being constructed of thermoplastic material.
4. The soft body armor as defined in claim 3 wherein said aramid fiber includes a hard surface and
15 high tensile strength to dissipate energy of a ballistic projectile trying to penetrate the armor.
5. The soft body armor as defined in claim 4 wherein said thermoplastic material forming the fill yarn is nylon and is meltable from heat generated by a
20 ballistic projectile attempting to pass through and between the aramid fiber yarn.
6. The soft body armor as defined in claim 5 wherein said multiple plies of ballistic material are retained in overlying contacting relation to form soft
25 body armor.
7. A ballistic armor for use in combination with a supporting structure in protective relation to a protected surface to prevent damage to the surface by a projectile approaching the surface at a relatively high
30 velocity, said armor comprising a plurality of overlying plies, said multiple plies of ballistic material including single outer plies of an aramid fiber and a plurality of layers of aramid fiber and non-woven

ballistic material with two groups of multiple plies of non-woven ballistic material engaging the outermost single plies of aramid fiber and a group of a plurality of plies of aramid fiber between the groups of non-woven
5 fibers.

8. The structure as defined in claim 7 wherein said groups of non-woven ballistic fabric are "Spectra Shield" and the group of aramid fibers is "Kevlar" or "TWARON".

10 9. The structure as defined in claim 8 wherein each of the two groups of "Spectra Shield" includes eight plies thereof, said group of plies of "Kevlar" or "TWARON" including ten plies.

15 10. The structure as defined in claim 7 wherein the armor is combined with a vehicle seat structure, said armor including a panel overlying a surface component of a vehicle seat to protect the occupant of the seat.

20 11. The structure as defined in claim 10 wherein said panel includes an extension of narrow construction at one edge thereof with the extension extending in front of a headrest at the upper edge of a seat back.

25 12. The structure as defined in claim 11 wherein said extension includes strap means securing the extension to the headrest at the upper edge of the seat back.

30 13. The structure as defined in claim 12 wherein said panel also includes a pair of mounting strips extending from the edge of the panel along each side of the narrow extension extending in front of the headrest, said mounting strips extending over the top edge of the seat back and including means securing the mounting strips to the back surface of the seat back to

13

retain the panel in overlying relation to a surface of the vehicle seat.

14. The structure as defined in claim 13 wherein said extension oriented in front of the headrest
5 includes a rigid structure to retain the extension in vertical position rearwardly of the head of the occupant of the seat for protecting the occupant's head.

15. A soft body armor comprising a plurality of layers of ballistic material, said layers including
10 layers of an aramid fiber and layers of a thermoplastic fiber with the layers of aramid fiber and thermoplastic fiber cooperating to provide a resistance to penetration by a ballistic missile greater than the summation of the resistance to penetration provided by an equal number of
15 layers of each of the materials when used separately as a ballistic material.

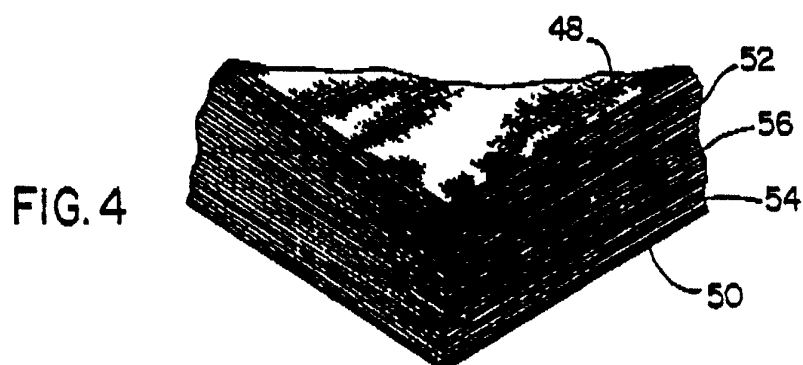
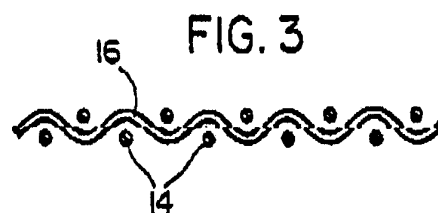
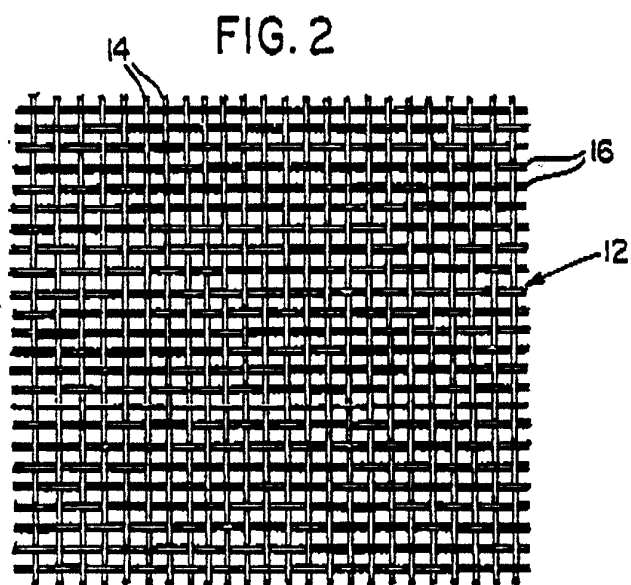
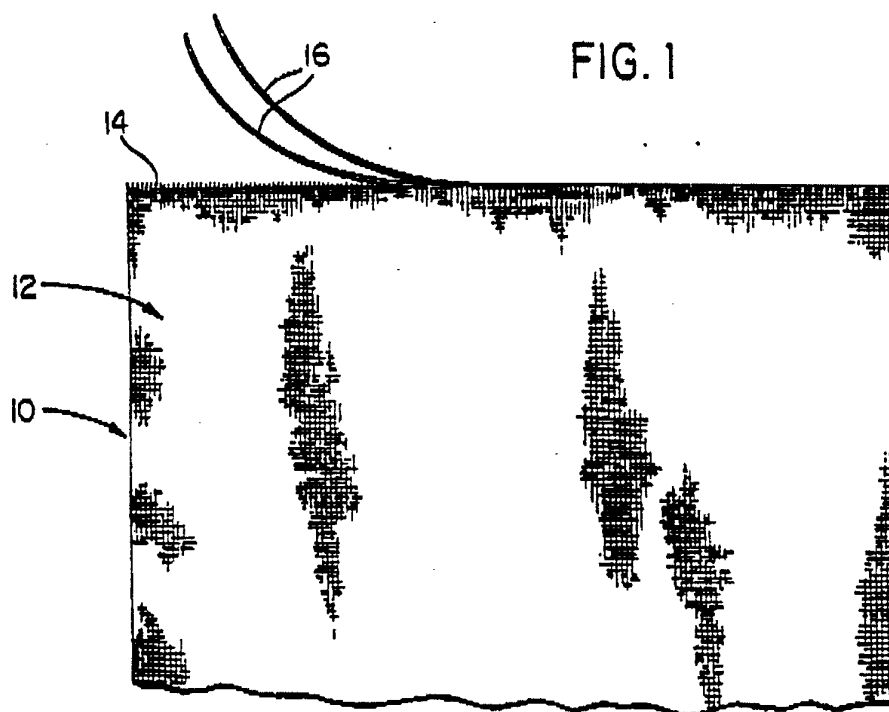
16. The soft body armor as defined in claim 15 wherein said aramid fiber is "Kevlar" or "TWARON".

17. The soft body armor as defined in claim 16
20 wherein said thermoplastic fiber is nylon.

18. The soft body armor as defined in claim 16 wherein the thermoplastic fiber is a laminated, non-woven plastic film available under the trademark "Spectra Shield".

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1/3



SUBSTITUTE SHEET

2/3

FIG. 5

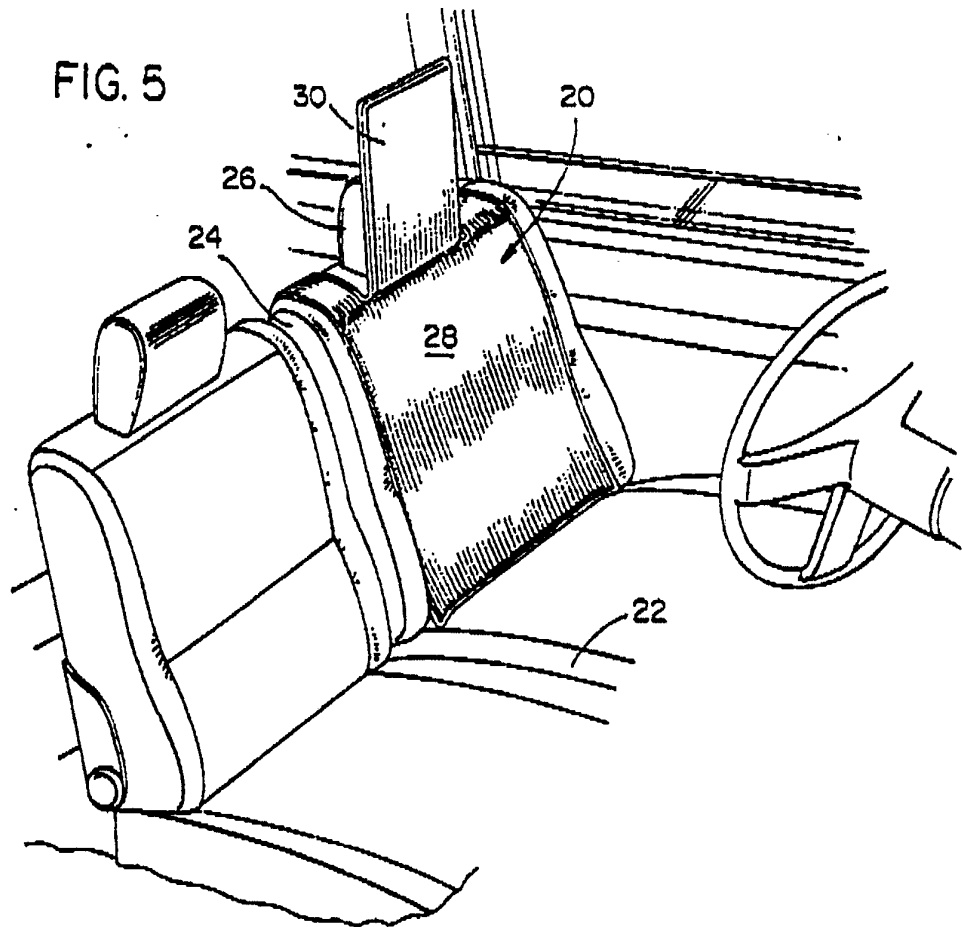


FIG. 6

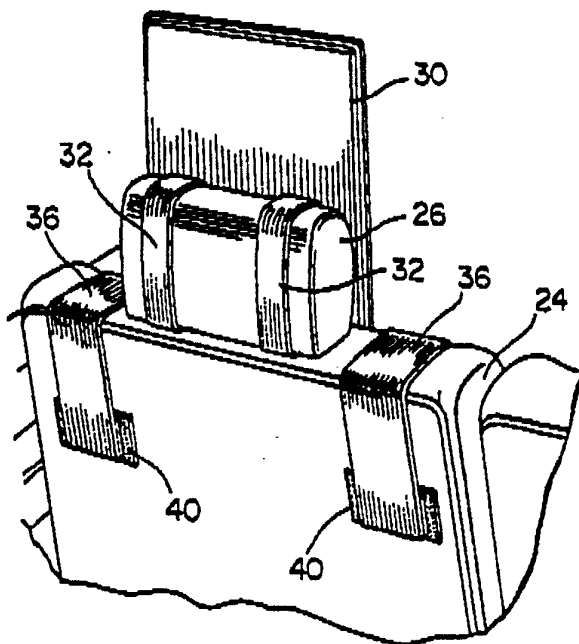
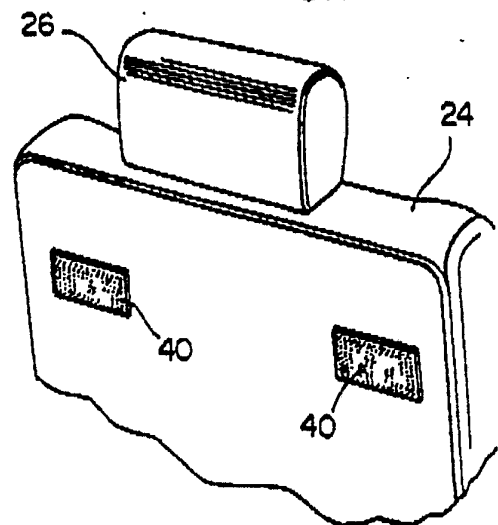


FIG. 7



SUBSTITUTE SHEET

3/3

FIG. 8

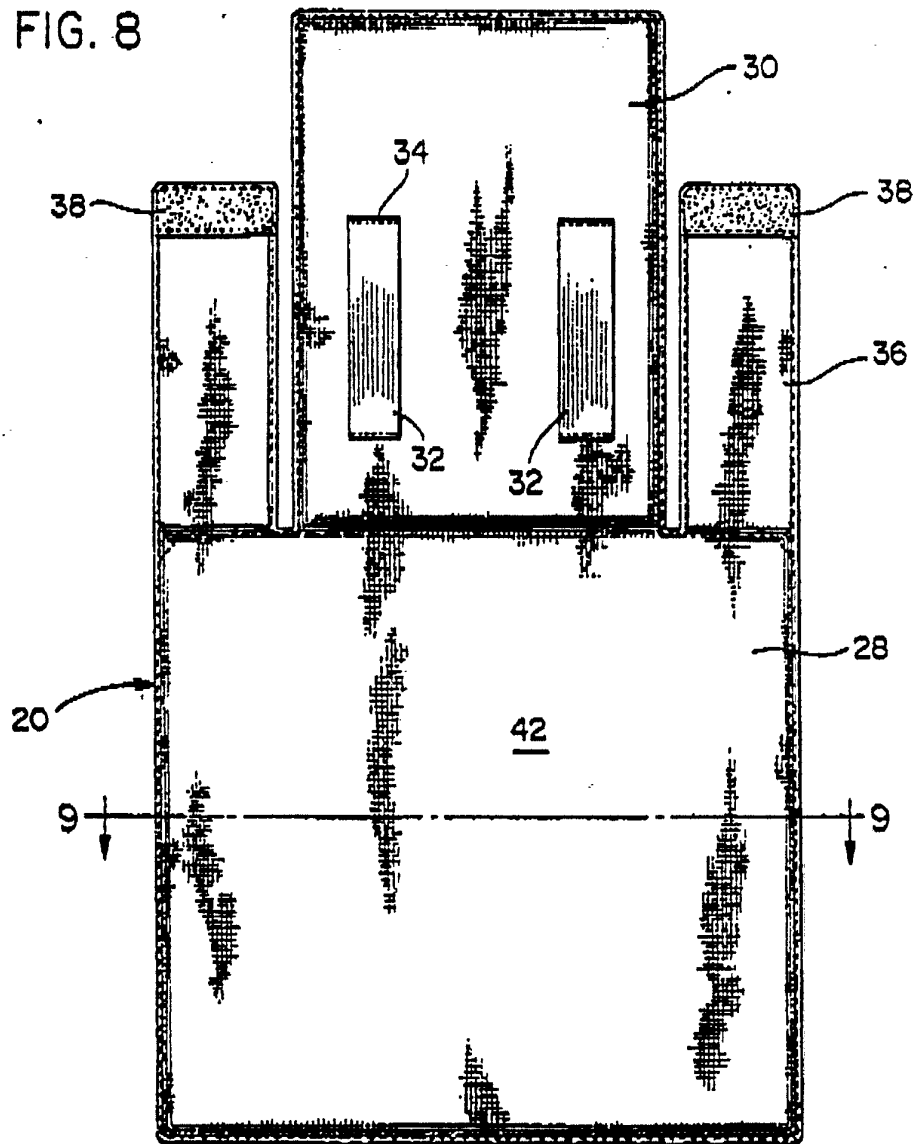
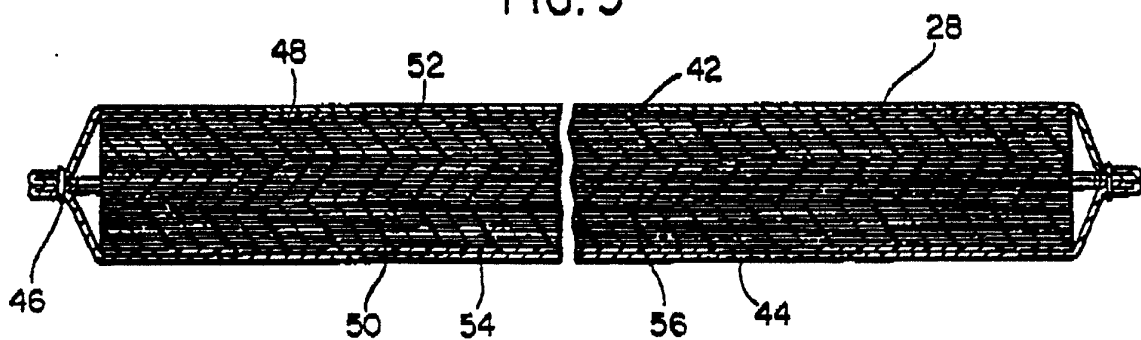


FIG. 9



SUBSTITUTE SHEET

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US91/01403

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) *		
According to International Patent Classification (IPC) or to both National Classification and IPC		
INT. CL. (5): B32B 5/12 7/02; F41H 3/00		
U.S. CL.: 428/113,218,911; 89/36.02		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
U.S. CL.	428/113,218,911 89/36.02	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹		
Category ⁶	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
X	US,A, 4,883,700, Published 28 NOVEMBRE 1989 HARPELL et al., See the example on columns 12 and 13.	1-9 and 15-18
X	US,A, 4,953,234, Published 04 SEPTEMBER 1990 LI et al. See column 6, lines 45-57 in particular	1-9 and 15-18
A	US,A, 4,623,574, Published 18 NOVEMBER 1986 HARPELL et al.	
A	US,A, 4,737,402, Published 12 APRIL 1988 HARPELL et al.	
A	US,A, 4,916,000 Published 10 APRIL 1990 LI et al.	
<p>* Special categories of cited documents: ¹⁰</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>-&" document member of the same patent family</p>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search		Date of Mailing of this International Search Report
18 FEBRUARY 1992		12 MAR 1992
International Searching Authority		Signature of Authorizing Officer
ISA/US		PETE NELSON