

**United States Patent** [19]  
**Leach et al.**

[11] **3,891,996**  
[45] **July 1, 1975**

[54] **BALLISTIC VEST** 3,557,384 1/1971 Barron et al. .... 2/2.5  
3,562,810 2/1971 Davis ..... 2/2.5  
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[22] Filed: **July 29, 1974**  
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[52] **U.S. Cl.** ..... 2/2.5  
[51] **Int. Cl.** ..... **F41h 1/02**  
[58] **Field of Search** ..... 2/2.5; 161/404, 227, 92

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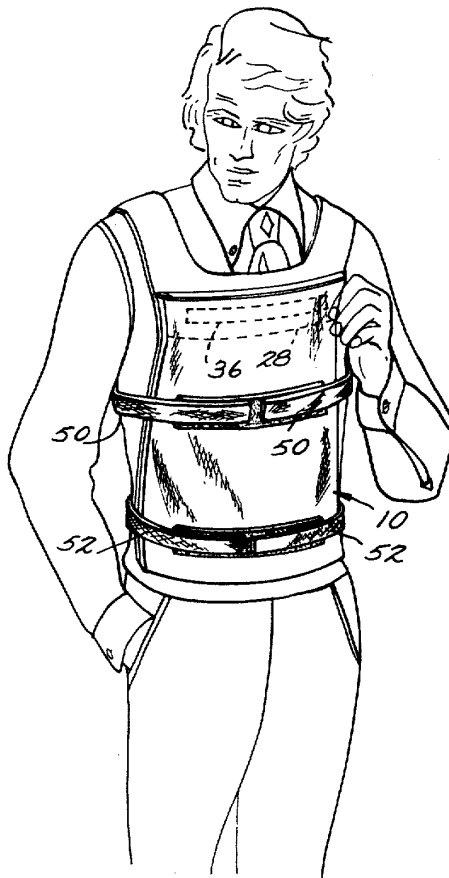
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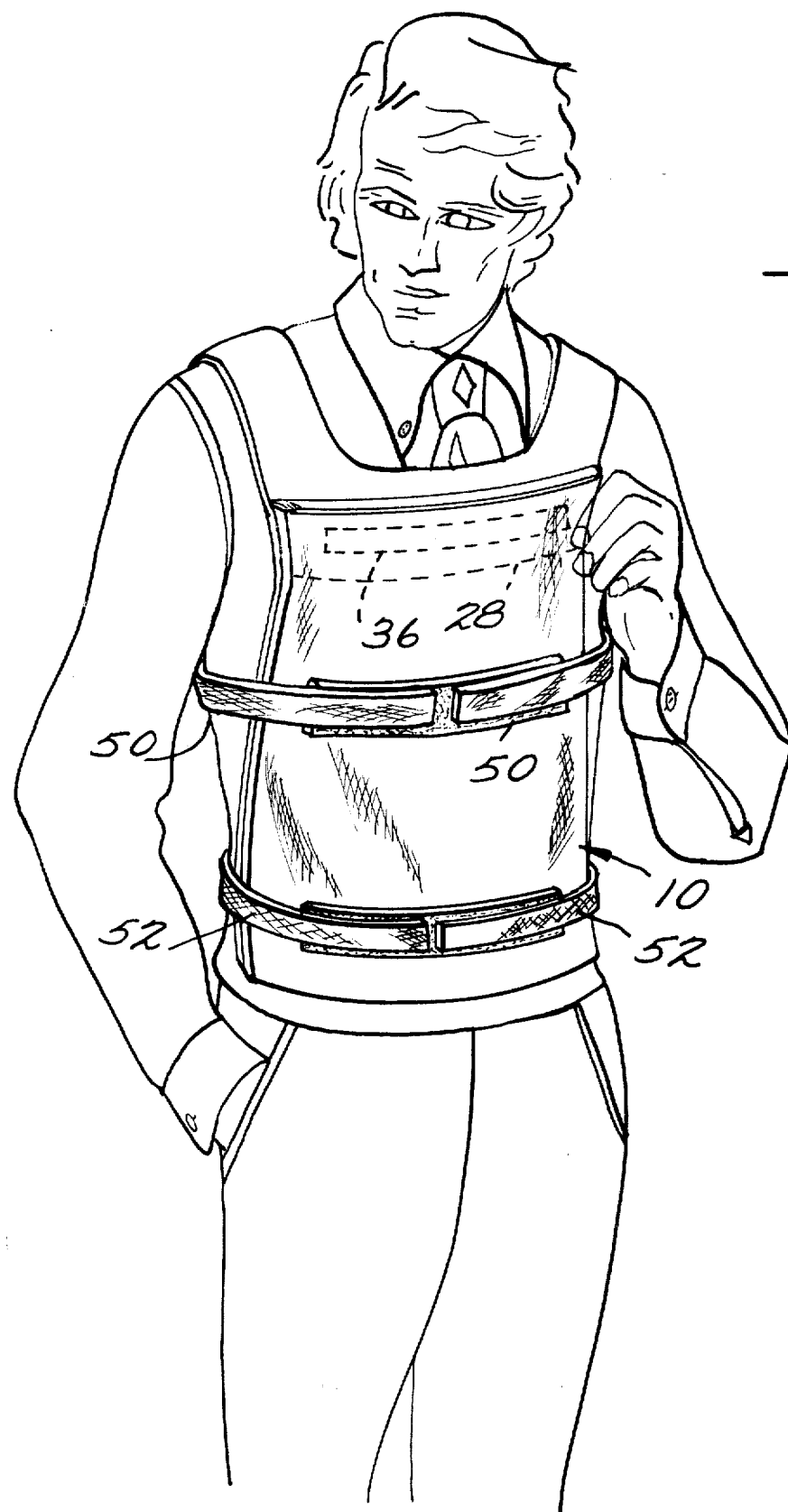
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[57] **ABSTRACT**

A ballistic vest having ballistic members which are positioned in the front and rear of the torso of a person each member having a plurality of layers of alternately spaced woven fabric sheets of (1) ballistic nylon fiber and (2) aramid fiber. The members are contained within envelopes which are fastened together so as to be draped over the shoulders of the wearer and held in position around the torso by means of a plurality of straps.

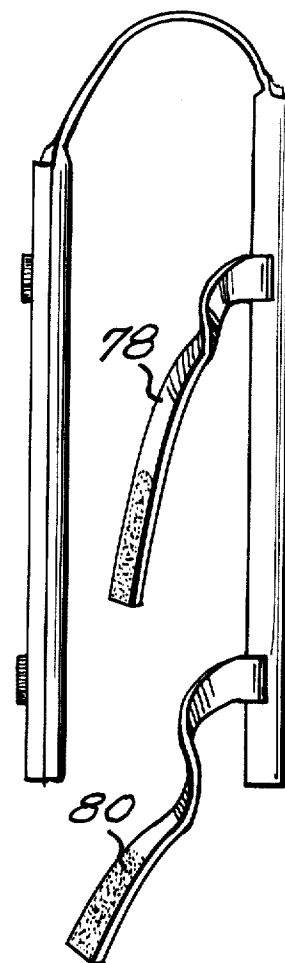
**11 Claims, 8 Drawing Figures**



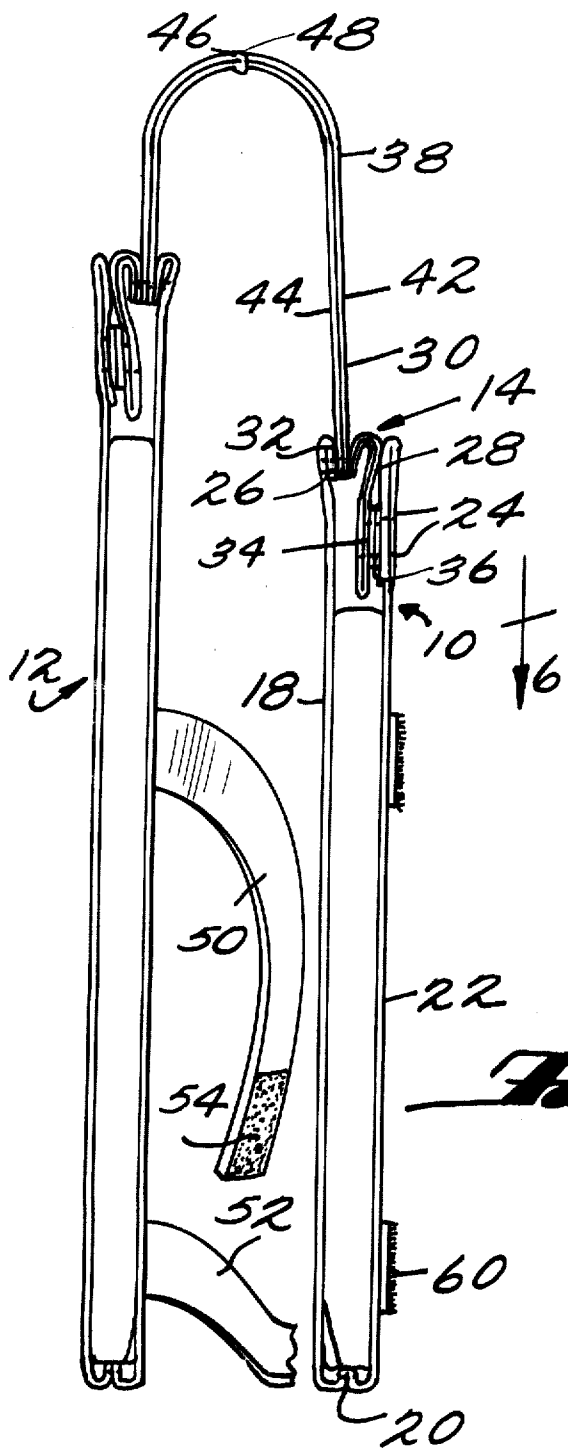


*Fig. 1.*

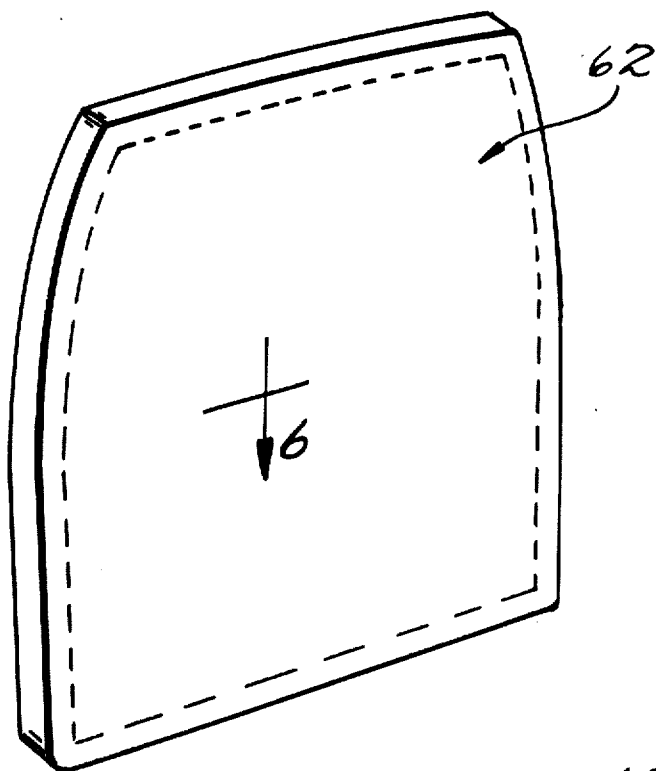
*Fig. 2.*



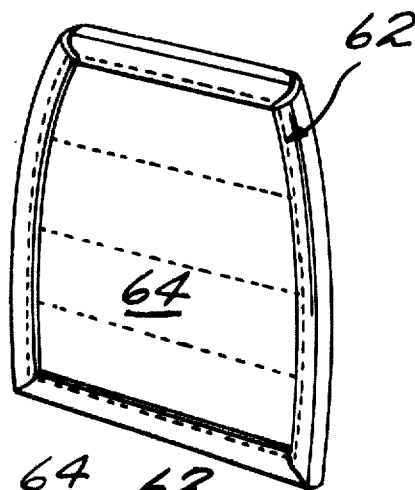
*Fig. 3.*



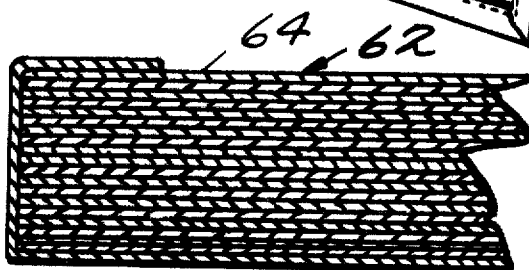
*Fig. 4.*



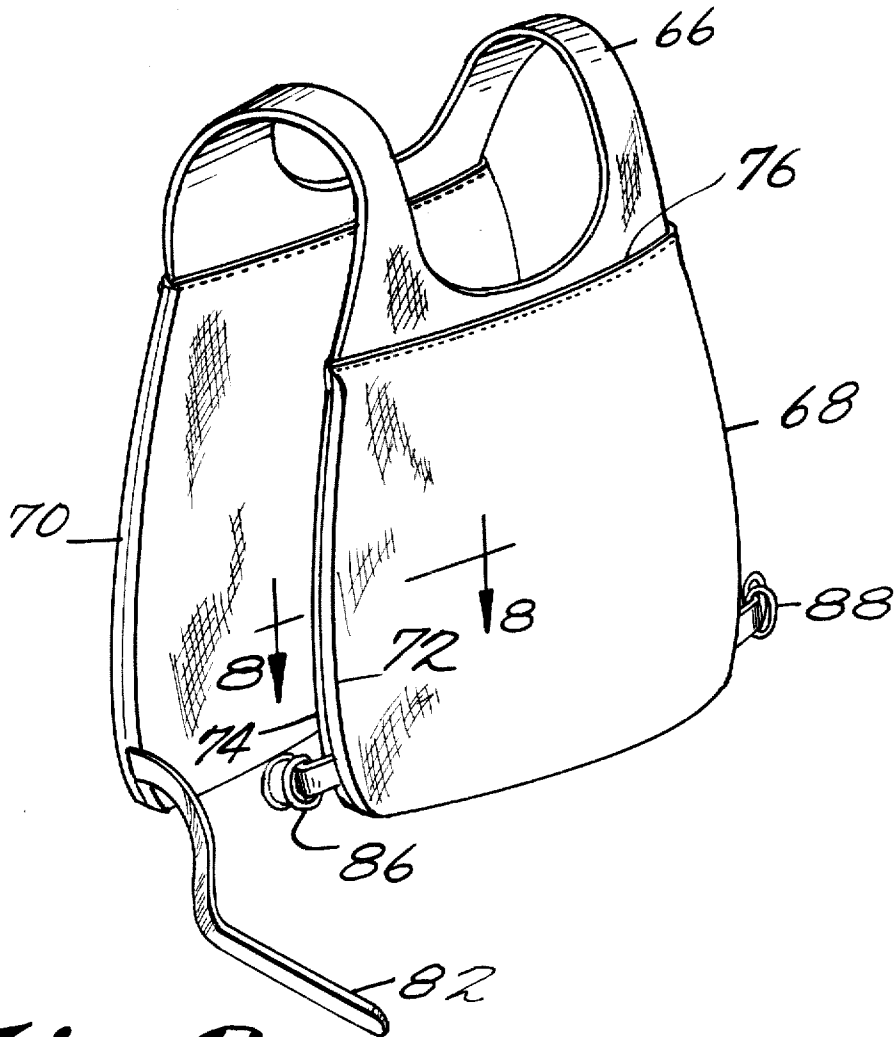
*Fig. 5.*



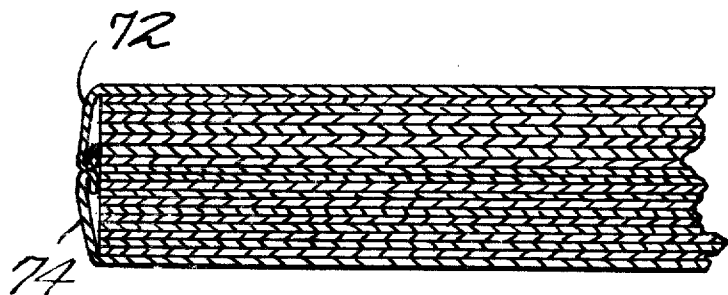
*Fig. 6.*



*Fig. 7.*



*Fig. 8.*



**BALLISTIC VEST****BACKGROUND OF THE INVENTION****1. FIELD OF THE INVENTION**

This invention relates to ballistic protective devices and more particularly to a ballistic protective vest which can be conveniently and comfortably worn by an individual.

**2. PRIOR ART**

Prior art bulletproof garments have generally taken two forms of development; (1) where the garment was made entirely of a plurality of layers of ballistic cloth and (2) where the garment utilizes both a plurality of layers of ballistic cloth and at least one thin sheet of metal or ceramic plates or resin/fiberglass molded panels contained within or used as backing for the ballistic cloth to substantially enhance its ability to prevent penetration of a projectile entirely through the garment. The latter device is usually the more effective since the plate substantially enhances the ability to prevent penetration of a projectile, however, the weight of the garment is greatly increased by the addition of such plate, and, thus, there is usually a tradeoff between the ability of the garment to prevent penetration of projectiles and the weight of the garment so that it may be worn for extended periods of time. The tradeoff is dependent upon the condition under which the garment is to be utilized. For example, where the garment is to be worn for a long period of time it is desired to have a lighter garment and, thus, one utilizing a plate is usually not as desirable as one having only the plurality of layers of ballistic cloth since the latter would be lighter and, thus, more comfortable for the wearer. The result of such a tradeoff is usually the decrease in protection available for the wearer. With regard to those garments which are intended to be worn for prolonged periods of time, the developments have been along the lines of devising ways for securing the plurality of layers of cloth together and/or increasing or decreasing both the number of layers of the cloth as well as the denier or cross-sectional area of the fibers used in the individual layers so as to increase the ability of the garment to prevent penetration by a projectile. Such an attempt is disclosed by U.S. Pat. No. 3,562,810 in which a plurality of layers are sewn together in a particular manner to increase the effectiveness against penetration of a projectile.

Although the design of bulletproof garments was initially developed as a result of an anticipated use for members of the armed services during combat conditions, in recent years due to the decrease in such needs or on the other hand, due to the increased need of such protection by policemen and similar civilian oriented protective agencies for use in defeating projectiles fired from hand guns, the design considerations have changed to some extent as a result of the difference in criteria for such protective devices. The early design of ballistic fabric vests and jackets were developed in World War II to protect aircraft crews from injury by shrapnel from exploding anti-aircraft shells. Subsequently, in Korea and Vietnam, the vests were worn by field soldiers as protection from the shrapnel from exploding land mines, grenades and booby traps. Thus, the attractiveness to today's intended users of bulletproof vests constructed entirely of material, rather than containing metallic sheets, etc., is increased since a sufficient thickness of layers of ballistic cloth, usually bal-

listic nylon, can be provided to defeat hand gun fired projectiles. Of course, there are many hand guns available on the market which, in order to prevent them from penetrating such a garment would require so many layers of ballistic nylon that it would be entirely too heavy and cumbersome to be an acceptable means of protection for civilian police use. As a result, there have been constant attempts to enhance the penetration preventive characteristics of such a garment while reducing the weight or keeping the weight at an acceptable maximum so as to allow an individual to wear the garment for a reasonable period of time without being fatigued due to the weight.

**SUMMARY OF THE INVENTION**

The present invention provides a ballistic vest which is not stiff or cumbersome due to the inclusion of plates therein and which is sufficiently light in weight to allow the wearer to wear the garment for a reasonable length of time without becoming fatigued as a result of the burden of its weight.

This object is achieved through use of a plurality of layers of alternately placed woven fabric sheets of (1) ballistic nylon fiber and (2) aramid fiber with the layers being sewn together so as to prevent substantial relative movement between them. A member formed in this manner is suspended around the torso of a person, at least one such member being suspended in the front or chest portion of a person, and an additional member may be suspended to the back portion of the torso of a person to provide protection from the rear.

Certain alternative constructions in the individual members are believed to also be effective in providing solutions to the above described problems and objectives where units of two or more layers of woven fabric sheet of either aramid fiber or nylon fiber are alternately placed in a plurality of layers so that, for example, there will first be two layers of nylon and then two layers of aramid, etc.. Also, a construction wherein a unit utilizing multiple alternately placed layers of nylon and aramid fibers are combined with other units similarly constructed so that occasionally in the member two layers of the same type of fabric, for example nylon, would be positioned adjacent to one another rather than alternately interspaced with fabric made of aramid fiber.

Also, although the preferred embodiment utilizes woven fabrics constructed of 1050 denier nylon fiber and 1500 denier aramid fiber, other deniers are believed to be satisfactory such as 200 denier aramid fiber. Naturally, if the denier of the fiber is decreased substantially the number of layers of fabric utilized must be increased accordingly to present substantially the same thickness of each of the nylon and aramid fibers.

Although many means have been devised for securing the bulletproof members to the torso of a human being, one convenient method as disclosed herein utilizes two envelope-like members secured to one another by laterally spaced straps which will hold the envelopes in proper relation to the torso of an individual by resting on the shoulders of the individual. Contained within each of these envelopes is one of the protective members constructed as described above. The envelopes are designed with a releasable closure means at the top of each so as to allow the members to be removed and permit the garment, consisting of the enve-

lopes and straps, to be easily cleaned or washed. This is of particular advantage where such garments are to be frequently utilized such as in the day to day activities of a police officer where perspiration would be absorbed by the outer envelopes of cloth and would become extremely annoying after prolonged periods of use.

In addition to these envelopes some means must be provided to maintain each of the members contained in the envelopes against the torso of the wearer. Thus, a plurality of straps are provided which extend around the sides of the wearer and are secured between the envelopes containing the members.

An alternative supporting means for maintaining the protective members in proper relation to the wearer is similar to that described above with the exception that the envelopes are sewn so as to completely enclose each member and no means is provided for removing the members from the envelopes to permit the envelopes and supportive straps to be cleaned.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a preferred embodiment of the ballistic vest secured to a person;

FIG. 2 is a side perspective view of another embodiment of the vest;

FIG. 3 is a side perspective view in partial cross-section of the preferred embodiment illustrated in FIG. 1;

FIG. 4 is a perspective view of a bulletproof protective member constructed in accordance with the present invention;

FIG. 5 is a rear view of the member illustrated in FIG. 4;

FIG. 6 is a cross-section along line 6—6 of the embodiment illustrated in FIG. 4;

FIG. 7 is a perspective view of the embodiment illustrated in FIG. 2 with an alternative strap means; and

FIG. 8 is a cross-sectional view along line 8—8, illustrating the seam construction in the cross-section of a bulletproof protective member as shown in FIG. 7.

### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A preferred form of the ballistic vest is shown in FIG. 1 disposed properly on a person to provide protection for a major portion of his torso. The ballistic vest contains two envelopes 10 and 12 (best shown in FIG. 3) preferably constructed of non-ballistic material which is easily cleaned or washed, although they may be made of ballistic material if it is so desired so as to increase or provide additional protection. Both envelopes 10 and 12 are constructed substantially the same, although, as shown in FIG. 3 the envelope 12 to be positioned on the back of the wearer can be larger than the envelope 10 to be positioned on the front of the wearer since the top portion 14 of envelope 10 must be positioned low enough on the wearer so as to permit freedom of movement of the head whereas the envelope 12 will not inhibit such movement if it is designed so as to have the top portion 16 positioned slightly higher on the back of the wearer.

Since the construction of envelopes 10 and 12 is similar, the actual construction of only envelope 10 will be explained. A woven fabric back portion 18 is stitched at 20 to a woven fabric front portion 22, the stitching 20 extending up both sides and across the bottom of en-

velope 10 so as to form a pocket therein with the upper portion 14 being left open. The top of member 22 is folded inwardly and downwardly and sewn at 24 to prevent unraveling and provide additional support for the top of envelope 10. The top of member 18 is likewise folded inwardly and downwardly and sewn at 26 to provide additional support therefore as well as to prevent unraveling.

An additional piece of fabric 28 is folded double and sewn along with strap 30 (to be described more fully below) at 32. One portion 34 of a Velcro fastener is secured to member 28 and another portion 36 is secured to member 22. Naturally, any other means of securing the upper portion of the envelope together may be utilized, such as a zipper.

Support member 30 is preferably made of the same material as members 18 and 22. The support member 30 is actually constructed in two portions 38 and 40. The front portion 38 is further composed of two pieces of fabric 42 and 44 sewn together along the entire outer length of the sides and also the entire inner length of the neck portion. The back portion 40 is constructed in a similar manner and then the two portions 38 and 40 are sewn together by inserting the end 46 of member 40 into the end 48 of member 38 and sewing the two together.

Straps 50 and 52, one of each of which is sewn to each side of back member 12, are provided preferably with a portion 54 and 56 of a Velcro fastener with corresponding portions 58 and 60 being secured to the front side of member 10. The straps should be of sufficient length to provide adjustment of the fit of the ballistic vest to a normal variety of human torsos. The Velcro fasteners provide means for adjusting the fit to the particular wearer. Again, naturally, other similar means of fastening the straps 50 and 52 to the front member 10 may be utilized.

Turning to the construction of the ballistic member 62 which is to be inserted within the pockets 10 and 12, its outer edges are contoured to allow the member to provide maximum cross-sectional area coverage of the torso of a person while permitting freedom of movement of the arms by narrowing towards the top. One construction of member 62 consists of multiple layers of alternately placed sheets of woven fabric made of (1) ballistic nylon fiber which is prepared to comply with military specification MIL C-12369E(GL) incorporated herein by reference, and (2) aramid fiber. Aramid fibers are a generic class of fibers whose technical name is "aromatic polyamide" and which is produced by a reaction of paraphenylenediamine and terephthaloyl chloride, given the designation "aramid" by the Federal Trade Commission as published in the Federal Register, Volume 38, Number 237 — Tuesday, Dec. 11, 1973 at page 34112, et seq., which is specifically incorporated herein by reference. The preferred construction of member 62, as can best be seen in FIG. 6, consists of 9 layers of closely woven 1500 denier aramid fiber sheets interspersed between 11 layers of closely woven 1050 denier ballistic nylon with two of the layers, in this case shown as two centrally placed layers, being of ballistic nylon placed side by side. The importance of the weave, i.e., how many ends and picks, has not been determined, however, it is believed that a fairly close weave such as 42 ends and 42 picks is preferable to a much looser weave since the increased number of fibers would seem to provide more

strength since a projectile would strike more fibers at one time and be less likely to allow a projectile to pass between the fibers.

It has also been found that a member constructed of multiple units consisting of multiple layers of ballistic nylon alternately placed with multiple layers of aramid fiber sheet are effective in preventing penetration of projectiles. Both of the above constructions should be sewn around their entire periphery as well as internally, as shown in FIG. 5, with multiple rows of spaced stitching, to maintain the layers in position relative to each other and to prevent substantial movement between layers when they are struck by a projectile.

The outer layer of the member 62 is sufficiently larger than the other layers of ballistic cloth including the aramid fiber cloth, to permit the edge portions thereof to be folded around and encompass all of the other layers of fabric and extending over the back layer 64 so that it may be sewn as shown in FIG. 5, the sewing extending entirely through the entire member 62.

The construction described above utilizing 9 layers of woven aramid fiber sheets alternately spaced with 11 layers of woven ballistic nylon fibers sheets, with the exception of two internally placed ballistic nylon sheets being placed back to back, will defeat standard (commercially available) lead nosed bullets fired from a .357 magnum, a .44 magnum, a .38 Special, and will defeat projectiles fired from any hand guns whose energy upon leaving the muzzle of the gun is equivalent to those projectiles listed and which is a lead nosed projectile. The construction will defeat certain copper jacketed or steel jacketed projectiles consistently, particularly those of lower muzzle energy such as those commonly fired from a .38 caliber pistol.

A similar construction, i.e., one consisting of 20 layers, but consisting solely of layers of ballistic nylon cloth will not consistently defeat all of the above projectiles. Also, although 20 layers of aramid fiber sheets will be somewhat more effective than 20 layers of nylon, it would be considerably more expensive. It is, therefore, believed that a substantial synergistic effect is created by the alternate placement of multiple layers of aramid fiber and ballistic nylon. This effect is believed to be the result of the combination of the high strength of the aramid fiber, which is much stronger than ballistic nylon, with the greater elongation of nylon before rupture.

A further embodiment of the invention utilizes the same construction of members 62 but has a different envelope construction as is shown in FIGS. 2 and 7. The support member 66 is constructed substantially the same as support member 30 and will, therefore, not be discussed in detail. The envelopes 68 and 70 are preferably constructed on non-ballistic nylon or other cloth which is easily dyed so as to provide the desirable color and are constructed by sewing along the outer periphery of the two portions 72 and 74 of bag 68 the construction of bag 70 being similar and will not be further discussed. The member 62 is then inserted through the top 76 of each of the envelopes 68 and 70 and then the envelope is permanently closed across the top by sewing so as to prevent removal of the member 62 from either member 68 or 70. Thus, unlike the previously described envelopes 10 and 12 for containing the ballistic member 62, the members may not be removed so as to clean or separately wash the envelopes and support. The embodiment in FIG. 2 is different from that in FIG.

7 in that straps 78 and 80 shown on the embodiment in FIG. 2 use the Velcro fastener for providing adjustable support of the members against the torso while FIG. 7 illustrates alternative straps 82 and 84 (not shown) which provide adjustment by means of fastening through D-rings 86 and 88 to fit a particular torso.

Although the foregoing illustrates the preferred embodiment of the invention, it will be obvious to one skilled in the art that modifications can be made. Any such modifications which would be obvious to one skilled in this art are believed to be within the scope of this invention.

What is claimed is:

1. A ballistic vest comprising:

at least one member formed of a plurality of layers of alternately placed woven fabric sheets of (1) ballistic nylon fiber and (2) aramid fiber, said member being sewn so as to prevent substantial relative movement between said layers; and means for securing said member to the torso of a person.

2. A ballistic vest as defined in claim 1, wherein said layers of nylon each comprises a tightly woven fabric of 200 - 1500 denier nylon fiber and said layers of aramid each comprises a tightly woven fabric of 200 - 1500 denier aramid fiber.

3. A ballistic vest as defined in claim 1, wherein said layers of nylon each comprises a tightly woven fabric of 1050 denier nylon fiber made substantially in accordance with United States military specification MIL-C-12369 and said layers of aramid each comprises a tightly woven fabric of 1500 denier aramid fiber.

4. A ballistic vest as defined in claim 1, wherein said means for securing said member to the torso of a person includes:

at least one casing made of fabric sewn to form a pocket in which said member is received; means secured to said casing for maintaining said casing and member so as to present sufficient cross-sectional area to protect a major portion of the torso of the wearer.

5. A ballistic vest as defined in claim 4, wherein a first of said members is disposable in front of the wearer and a second of said members is disposable in back of said wearer;

each said member being contained in a separate casing;

said securing means including a pair of straps secured to the upper portions of each of said casings and laterally spaced so as to support said vest on the shoulders of the wearer, and other means secured to the lower portion of at least one of said casings for securing both said casings to the body of the wearer.

6. A ballistic vest as defined in claim 5, wherein said other means for securing is a strap secured to one of said casings and a strap engaging member secured to the other of said casings which permits adjustable securement of said strap to hold said vest against the body of the wearer.

7. A ballistic vest as defined in claim 5, wherein said casing is sewn peripherally so as to permanently enclose said members in said pockets.

8. A ballistic vest as defined in claim 6, wherein each said casing is sewn along the bottom and two side edges with the top portion being open;

means for releasably securing said open top portion  
so as to permit removal or insertion of said member  
in said pocket.

9. A ballistic vest comprising:

at least one member formed of a plurality of layers of 5  
woven fabric sheet, some of the sheets being made  
of nylon fiber and others of aramid fiber, the sheets  
being arranged in groupings where multiple layers  
of the same woven fiber sheets are placed alter-  
nately with multiple layers of the other woven fiber 10

sheets.

10. A ballistic vest as defined in claim 1 and including  
multiple groupings of said members juxtaposed as to  
one another.

11. A ballistic vest as defined in claim 10, wherein a  
total of 9 layers of aramid fiber sheets and 11 layers of  
nylon fiber sheets are utilized in said groupings to form  
said member.

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