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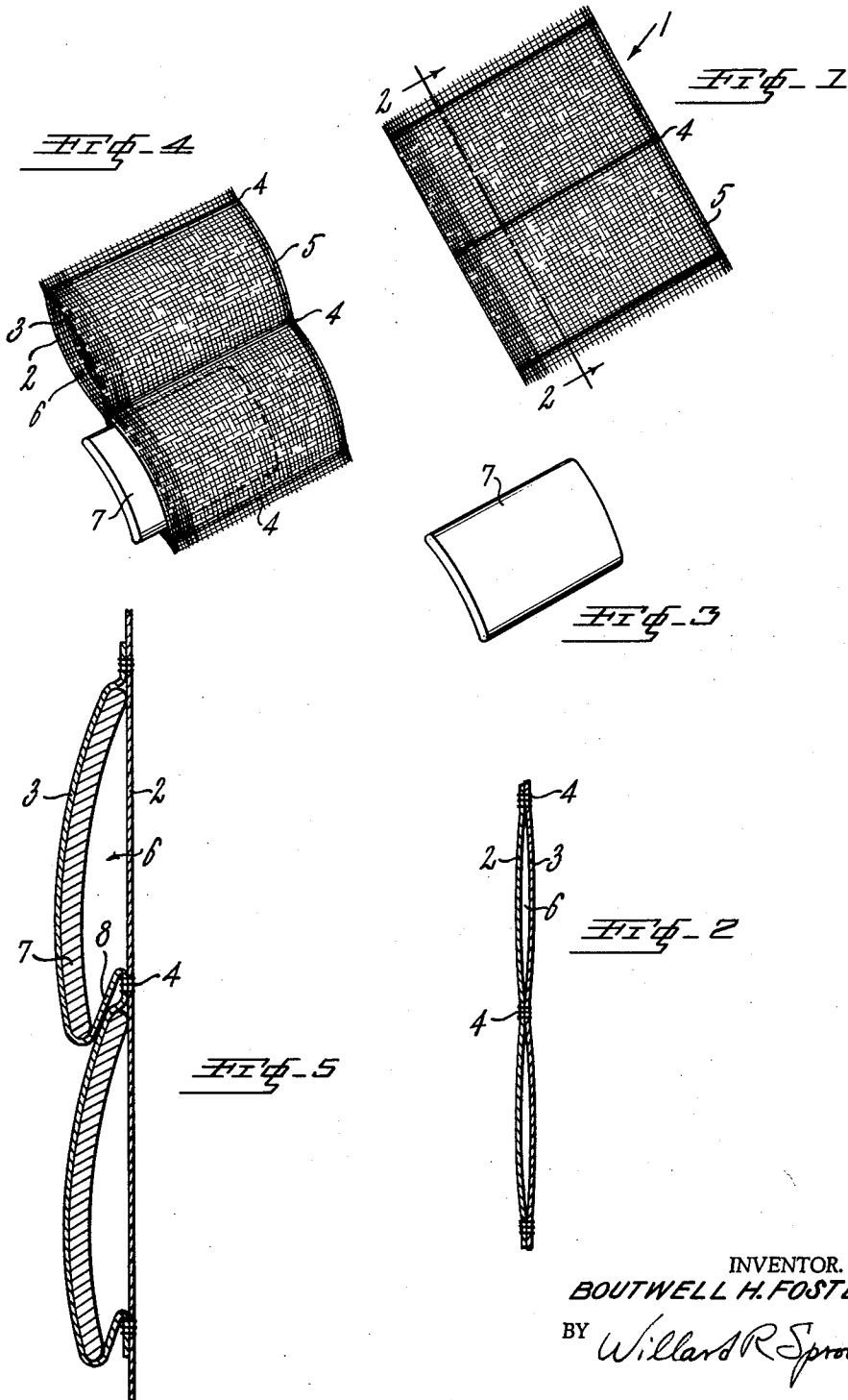
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3,061,839

ARMORED HOUSING FABRIC

Filed Sept. 17, 1959

2 Sheets-Sheet 1



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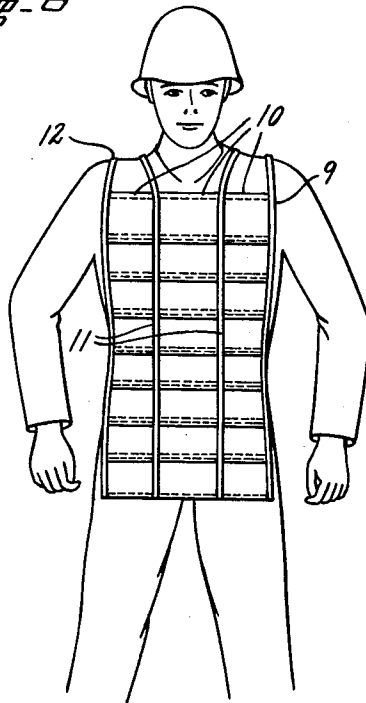
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2 Sheets-Sheet 2

Fig. 6



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ARMORED HOUSING FABRIC

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4 Claims. (Cl. 2—2.5)

This invention is useful as a "bullet-proof" fabric having a capacity to resist penetration by moving objects such as shrapnel, bullets and other relatively low energy missiles and thus protect a wearer while engaged in a combat area. This invention particularly relates to a housing fabric having shrinkable pockets or spaces which tightly enclose rigid armor panels or plates inserted therein and to a method for making the armored fabric.

Prior methods of protecting soldiers have involved the use of metal breast plates which were heavy and uncomfortable, and restricted a soldier's performance during combat. In order to overcome the disadvantages inherent in the use of heavy inflexible protective apparel, "bullet-proof" garments made of a housing fabric having pockets in which missile resistant panels are placed have been developed as shown in the patent to Lewis, No. 2,748,391. However, such garments employ conventional non-shrinkable fabrics. In this type of garment, missile resistant armor panels are enclosed in panel receiving pockets which are formed by sewing superposed fabric layers together at their edges (leaving no edge open) and thus preventing the panels from being released or lost.

One object of this invention is to eliminate the sewing steps conventionally used to completely enclose the armor panels and to provide a "bullet-proof" armored fabric which is simple and less costly to manufacture. Another object of this invention is to provide a "bullet-proof" fabric having overlapping armor panels enclosed and held in fixed relative position by tightly embracing pockets.

This is accomplished generally by providing a double ply fabric having face and back fabrics formed of heat shrinkable yarn woven, stitched or otherwise joined together at spaced apart rows and at spaced apart width at regularly spaced intervals to form pockets of desired dimensions and having rigid armor panels inserted in said pockets; the fabric is heat shrunken and thereby the panels are held tightly by the embracing fabric plies.

A more complete description and a better understanding of this invention may be had by referring to the drawings, in which:

FIGURE 1 is a top view of the fabric housing showing the fabric layers;

FIGURE 2 is a cross-sectional view taken along line 2—2 of FIGURE 1 illustrating the connection of one fabric layer to the other;

FIGURE 3 shows the armor insert or panel;

FIGURE 4 shows the armor panel after it has been partially inserted in the pocket of the fabric housing; and

FIGURE 5 is a sectional view of the fabric housing showing the position of the armor insert after the fabric has been shrunken;

FIGURE 6 is a front view showing a garment made of the housing fabric of FIGURE 5.

Referring now to the drawings, there is disclosed at FIGS. 1 and 2 a fabric housing 1 composed of spaced apart fabric layers 2 and 3 joined together as by stitching or weaving along substantially parallel seams 4 and a lateral connecting seam 5. Each of the fabrics may be woven on a conventional loom and utilizes thermoplastic yarns in both the warp and fill directions. The housing fabric is joined together so that a space or pocket be-

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tween the layers is provided. These pockets are utilized to receive an armor panel 7 which has a width somewhat smaller than the width of the pocket formed in the housing fabric. While the shape of the panel may be varied as necessary, the panel shown in FIG. 3 has a slight curvature in the lateral direction.

Inasmuch as the fabric is to be shrunken to embrace the armor panel 7, one or both of the fabric layers 2 and 3 is composed of heat shrinkable yarns. Further the heat shrinkable yarns in the warp and fill directions may have different shrinkable capacities. Also one layer may have a greater shrinkable capacity than the other.

In FIG. 5 there is shown a sectional view of the fabric housing after the armor panel 7 has been completely inserted and after the fabric housing has been subjected to heat so that one of the fabric layers has been shrunken. In the housing shown in FIG. 5, the back layer 2 is composed of fill yarns having a much higher capacity for being shrunken than the fill yarns of the front fabric layer 3. Therefore after the fabric housing is subjected to heat the back layer 2 shrinks considerably more than the fabric 3 and tends to pull the fabric layer 3 around the edge of the panel forming an overlapping section at 8. This insures that there is no spacing between the various pockets at which a projectile could penetrate.

In the method of making this fabric housing, a plurality of fabric layers having different heat shrinkable properties are positioned one above the other and are sewn or fastened together along parallel rows and also along lateral connecting portions. The pockets thus formed are slightly larger than the armor elements which are to be inserted therein. After the plates are inserted in the pocket the entire assembly is immersed in hot water causing the fabric to shrink; the sides of the pockets, as they are drawn together, embrace each plate tightly around three sides thereof and at the same time, each row of plates overlaps the plates of the next row along one edge of each adjacent plates.

To insure that the plates overlap in a desired manner, the fabric housing is gradually inserted longitudinally (along the direction in which the plates are to overlap) into a bath of hot water at any desired angle, preferably between 30° and 90°. Since the filling yarns of the back and front fabrics are thermoplastic and have unequal shrinkage properties, the back filling yarn having the higher, the immersion of the fabric housing into the hot water causes the back filling fabric to shrink more than the front filling fabric and pull the edge of one plate over the edge of the adjacent plate in an overlapping shingle effect.

It will be recognized by those skilled in the art that the amount of shrinkage can be regulated by controlling one or more of the following variables: first, the type of thermoplastic yarn that is used; second, the temperature of the heating medium (in the case described the water temperature); third, the time immersed; and fourth the dimensions of the pocket of the fabric housing. The specifications of the fabrics that have performed adequately in the above described embodiment are listed below. The Drawing-In-Draft information is included to provide the weaver with instructions as to making the fabric.

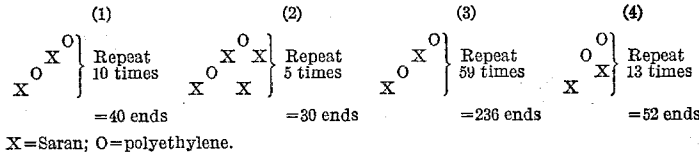
*Specification of Housing Fabric to Hold 5¼" x 5¼" x ⅛" Curved Armor Plate **

- (1) Warp Yarn:
174 ends of .012" monofilament P.E. 184 ends of 010" monofilament Saran.
- (2) Filling yarn: 40 picks/in. .010" monofilament Saran.
- (3) Reed: 22 dents/in.
- (4) Ends/dent: Variable—in accordance to Drawing-In-Draft.

- (5) Width in reed: 7¼".
- (6) Weave: Double fabric—U-shaped and stitched at regular intervals to form pockets, in accordance with weave chain.
- (7) Width of fabric: 613/16".
- (8) Distance between stitchings: 6¼".

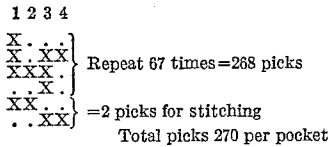
with the spirit and concept of my invention may be made by those skilled in the art.
Having thus described my invention, what I claim and desire to protect by Letters Patent is:
1. A method of making an armored fabric which comprises the steps of joining two fabrics along spaced apart

DRAWING—IN DRAFT



- (1) Enter 1st 8 ends in one dent, the remainder 4 ends per dent.
- (2) Enter 3 ends per dent.
- (3) Enter 2 ends per dent.
- (4) Enter 2 ends per dent.

WEAVE CHAIN



* NOTE: Shrinkage was produced by immersion in boiling water for less than one minute.

It will be readily apparent that a larger bullet-proof fabric may be formed by sewing several layers of the housing fabric together as, for example in the shape of a bullet-proof vest as shown in FIG. 6 of the drawings. The bullet-proof vest 9 is made by joining housing fabric layers 10 along seams 11. An identical back piece may be made in a similar manner and joined to the front piece by shoulder straps 12 which may be draped over the wearer's shoulders as illustrated in FIG. 6. Likewise layers of housing fabric may be attached to a harness-like garment made of narrow webbing thereby providing flexibility and comfort as the layers of housing fabric may be bent or slid past one another as the wearer moves about under combat conditions. For example, the layers may be attached to substantially parallel web members at only one side of the layers to provide a flapping or overlapping effect. Since the fabric is of a relatively open weave, comfort is enhanced by its greater air permeability around corners of the plates and between overlapping layers although its projectile-resistance is not thereby affected.

Since the plates are not rigidly sewn into place, a garment made of the housing fabric can be easily folded without fear of ripping or breaking the supporting threads.

The simplicity of the fabric construction makes it feasible to protect the legs, arms, and other generally unprotected parts of the body through the use of different size plates in suitably designed pockets.

While I have described a preferred embodiment in complete terms, I do not wish to be limited to the specific construction set forth therein since many modifications

substantially parallel rows and along a single row substantially perpendicular to said rows so as to form adjacent pockets between said fabrics, at least one of said fabrics having heat-shrinkable yarns extending substantially parallel to said single row, inserting plates of a lesser width than the distance between adjacent spaced apart rows into said pockets, and heating said fabric to shrink said shrinkable yarns to draw said fabrics into tight engagement with said plates and to position said plates relative to one another.

2. A method of making an armored fabric which comprises the steps of joining two fabrics along spaced apart substantially parallel rows so as to form adjacent spaces between said fabrics, at least one of said fabrics having heat-shrinkable yarns extending transversely of said spaced apart rows, inserting plates of a lesser width than the distance between adjacent spaced apart rows into said spaces, and heating said fabrics to shrink said shrinkable yarns to draw said fabrics into tight engagement with said plates.

3. A projectile resistant garment comprising first and second fabrics, means joining said first and second fabrics along spaced apart substantially parallel rows so as to form adjacent spaces between said fabrics, heat-shrinkable thermoplastic yarns in only said first fabric disposed transversely to said spaced apart rows and shrinkable with respect to said second fabric, and an armor plate in each of said adjacent spaces and held firmly in place by said fabrics.

4. A housing fabric comprising first and second fabrics, means joining said first and second fabrics along spaced apart substantially parallel rows so as to form adjacent spaces between said fabrics, heat-shrinkable thermoplastic yarns in at least said first fabric disposed transversely to said spaced apart rows, the ratio of shrinkage of said first fabric with respect to said second fabric being greater than unity, and an armor plate in each of said adjacent spaces and held firmly in place by said fabrics.

References Cited in the file of this patent

UNITED STATES PATENTS

2,052,684	Wisbrod	Sept. 1, 1936
2,230,788	Ullendahl	Feb. 4, 1941
2,748,391	Lewis et al.	June 5, 1956