May 3, 1966 G. E. MORGAN 3,248,738

PROTECTIVE PADDING STRUCTURES

Filed May 28, 1963 2 Sheets-Sheet 1

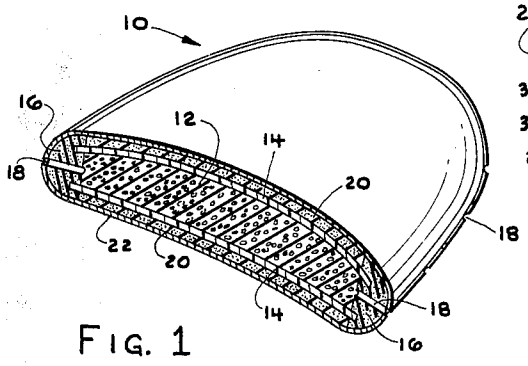

FIG. 1

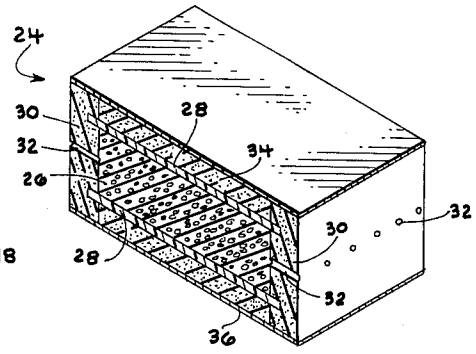

FIG. 2

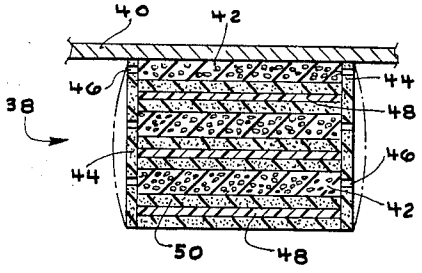

FIG. 3

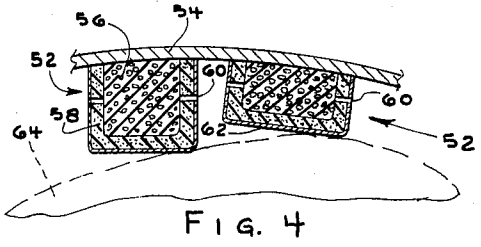

FIG. 4

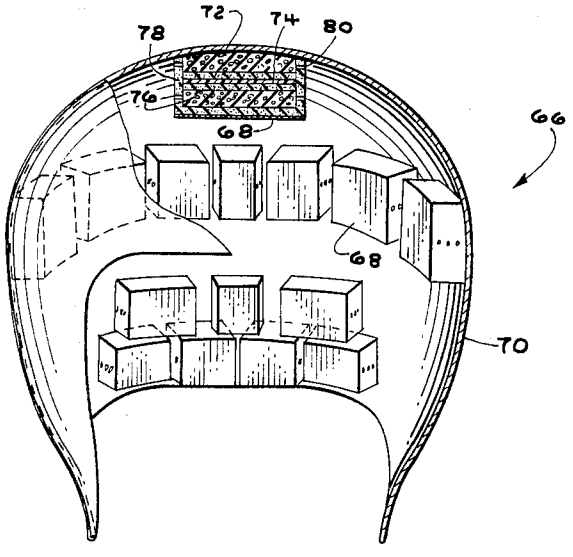

FIG. 5

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FIG. 6

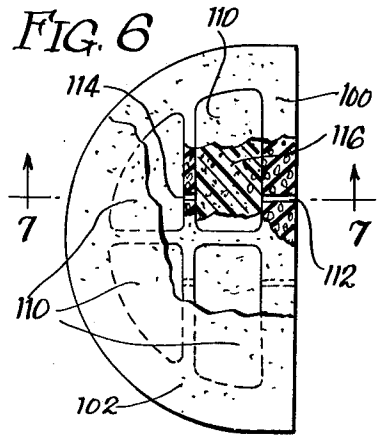


FIG. 7

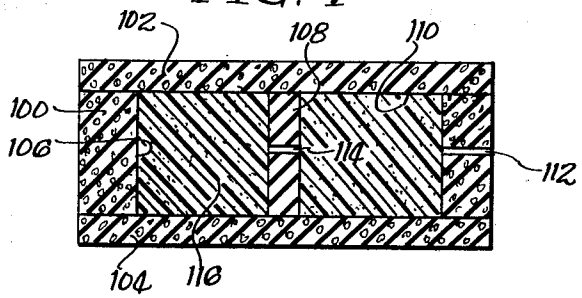
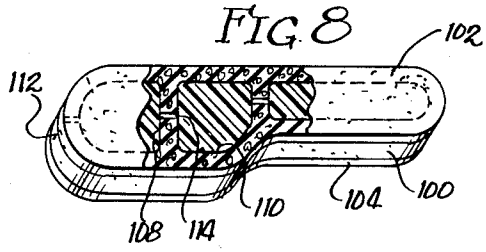


FIG. 8



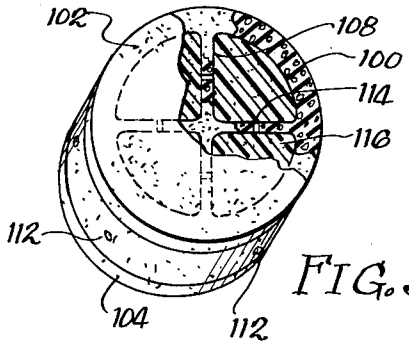
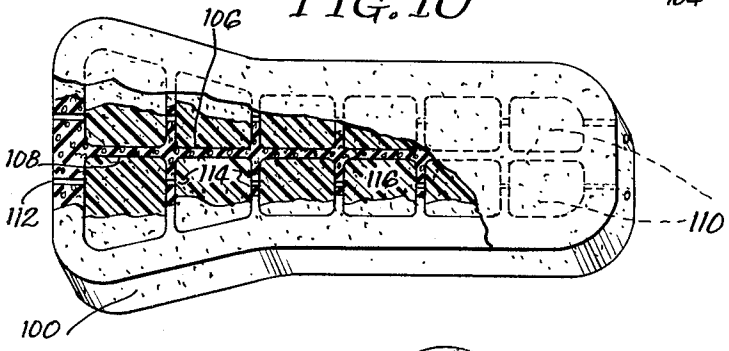


FIG. 9

FIG. 10



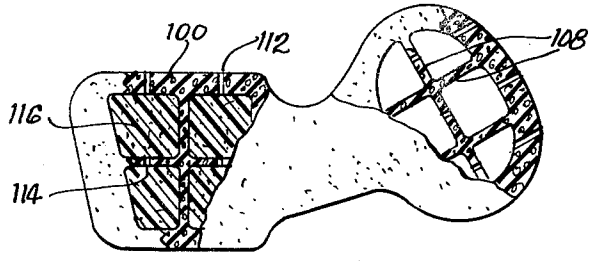


FIG. 11

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3,248,738

PROTECTIVE PADDING STRUCTURES

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Filed May 28, 1963, Ser. No. 283,937
9 Claims. (Cl. 2—2)

This invention relates to protective padding structures and it is in particular related to novel padding constructions which provide effective protection against blows, even when used in relatively thin sections.

This application is a continuation-in-part of application Serial No. 164,368, filed January 4, 1962, and entitled "Protective Padding" (now abandoned).

There are many well-known applications for protective padding. Thus, automobile dashboards and other locations in vehicles are padded to avoid injury if an individual is thrown against such locations. Stationary objects such as gymnasium walls or floors and goalposts are also often padded since persons running into these objects would otherwise be severely injured.

Players in contact sports such as football and hockey traditionally wear padding to offset the detrimental effect of blows received. Shoulders, hips, ribs and thighs are protected, and padding is also customarily included in headgear.

When conventional padding materials are employed, the amount of protection is proportional to the thickness of the padding. Thus, if foam rubber or other resilient material can be employed in extremely thick sections, virtually all injury occasioned by direct impact can be avoided. This is, however, impractical in most applications, since the permissible padding thickness is usually limited by space considerations or the necessity of preserving freedom of movement.

It is an object of this invention to provide an improved padding construction which provides effective protection against blows even when used in relatively thin sections.

Another object of the invention is to provide a novel pad design in which the decelerating action of resilient materials is effectively supplemented and enhanced by the pneumatic action of air escaping from the pad under controlled conditions.

These and other objects of this invention will appear hereinafter and, for purposes of illustration but not of limitation, specific embodiments of this invention are shown in the accompanying drawings in which:

FIGURE 1 is a perspective cross-section of one exampe of a padding construction incorporating the features of this invention;

FIGURE 2 is a perspective cross-section of a modified version of the protective padding structure:

FIGURE 3 is an elevational view in cross-section illustrating an additional modification in the padding structure;

FIGURE 4 is an elevational view in cross-section illustrating a still further modified structure;

FIGURE 5 is a diagrammatic elevational view, partly in section, illustrating a helmet construction which incorporates the protective padding of this invention;

FIGURE 6 is a plan view, partly cut away, of an alternative protective padding structure;

FIGURE 7 is a cross sectional view taken about the line 7—7 of FIGURE 6;

FIGURE 8 is a perspective view, partly cut away, of a different shape of a padding structure;

FIGURE 9 is a perspective view, partly cut away, of a still further alternative shape;

FIGURE 10 is a perspective view, partly cut away, of an additional alternative shape; and,

FIGURE 11 is a plan view, partly cut away, of a still further alternative shape.

The protective padding structures of this invention are all characterized by interior portions which are formed of porous resilient material. These interior portions are all at least partially surrounded by a resilient, essentially air-impervious barrier. Remaining portions of the porous interior may be surrounded by more rigid barriers but in any case, communication with the outside atmosphere is achieved by means of small-diameter port means which relieve the essentially air-impervious barriers. The port means which characterize the structures of this invention are so dimensioned as to momentarily retain pressure within the padding structure when a blow is directed to the structure. The resilient portions of the structure may all be compressed, or the interior portions may be compressed while the resilient air-impervious barrier portions may stretch in response to the build-up of pressure in the interior. The pressurized air is maintained in the porous interior portions momentarily and, thereafter, the air is gradually released in the period immediately following the initial impact of the blow. The combination of factors described effectively minimizes any detrimental effects which the blows might otherwise occasion.

A padding construction of this invention is used in conjunction with relatively rigid surfaces disposed on the opposite sides of the porous interior. Hence a blow directed to the padding is transmitted to the porous interior through one of the rigid surfaces, resulting in compression of the porous interior between the opposed rigid surfaces.

The rigid surfaces above described can be directly integrated into the padding and air-impervious, resilient material can be provided on the sides of the pad to enclose the otherwise exposed sides of the porous interior. The port or ports which form an important feature of the invention are placed in these resilient side walls or in other positions which insure that the ports will be free of hindrance for proper exhaustion of air.

In some instances, the padding to be employed will be disposed upon a rigid surface, and in such cases one of the rigid members above described can be eliminated, its function being taken over by the rigid surface on which the padding structure is disposed.

Integrated rigid members can be completely eliminated from the padding construction in applications where the pad is to be used between a pair of relatively rigid objects. For example, if the padding is to be employed within a helmet, the skull of the wearer serves as one rigid member and the rigid shell of the helmet serves as the other. Impervious, resilient material having one or more ports therein will completely surround the porous material in pads designed for such applications. It will be apparent that a blow directed to the helmet so padded will result in compression of the porous interior between two rigid members, namely, the helmet shell and the skull of the wearer.

Certain embodiments of this invention can be more readily understood when considering the specific constructions illustrated in the accompanying drawings. FIGURE 1 depicts a padding construction **10** having an interior porous portion **12** disposed between a pair of relatively rigid impervious plates **14**. A resilient layer **16** formed of an impervious closed cell material is provided to surround the sides of the porous interior. Ports **18** extend laterally from the porous interior to the outside of the padding structure. A layer **20** of reilient material can be provided as a covering for the plates **14** and a thin skin **22**, such as a vinyl dip coating, may be included.

The pad shown in FIGURE 1 is provided with rounded corners and is tapered. It will be apparent that various contours can be employed in order to fit the pads of this invention for various applications, and it is contemplated

that the modified structures to be described be employed in various configurations.

The pad 24 illustrated in FIGURE 2 is of rectangular shape but is composed of essentially the same elements as the pad of FIGURE 1. Thus, the pad 24 includes a porous interior portion located between relatively rigid plates 28. A resilient, non-porous layer 30, having ports 32 formed therein, completes the enclosure of the porous interior. As in the design of FIGURE 1, a resilient layer 34 and flexible skin 36 can be provided.

The modification shown in FIGURE 3 includes a pad 38 mounted on a rigid surface 40, which may be the shell of a helmet. The pad includes a porous interior portion 42 located adjacent the surface 40. An impervious layer 44 of resilient material is provided with ports 46 for communication with the porous interior. It will be noted that no rigid plate is interposed between the interior 42 and the surface 40, since that surface functions as a rigid backing and cooperates in achieving the improvements of this invention.

FIGURE 3 also illustrates the provision of a plurality of porous interior portions 42. These interior portions are disposed between rigid plates 48 and are enclosed by a non-porous layer 44. Ports 46 communicate with each of the interior portions 42, and the structure illustrated, therefore, is essentially a plurality of interconnected structures each of which has the characteristics of the previously described individual structures.

Where a combination of the padding structures is provided, as illustrated in FIGURE 3, the structures cooperate to provide improved performance. Each of the plates 48 functions with respect to the adjacent porous material whereby this material is compressed when a blow is delivered to the padding structure. Similarly, each of the porous interior portions has associated therewith ports 46 and an impervious layer 44 which cooperate to initially retard passage of pressurized air and which then gradually permit escape of the air. As in the previous constructions, separate layers 50 of resilient material may, if desired, be provided to overlay the plates 48.

The arrangement shown in FIGURE 4 provides padding structures 52 located on the rigid surface 54. Each of the structures 52 includes a porous interior portion 56 disposed immediately adjacent the rigid surface. A surrounding layer 58 of impervious, resilient material is provided with ports 60. A skin 62 may also be provided as in the other embodiments already described.

The design of the padding structure shown in FIGURE 4 is particularly suitable for the protection of an essentially rigid portion of the human body, as opposed to a fleshy portion. It will be noted that the rigid surface 54 provides a barrier on one side of the structures 52, and the body portion 64 to be protected will function as the rigid barrier needed for full achievement of the invention's objects.

In connection with the design shown in FIGURE 4, it will be understood that a rigid member can be integrated with the padding structure even where the padding is to be employed adjacent the skull or other hard portion of the body. The structure of FIGURE 4 is intended to illustrate the fact that such an integrated rigid member may be dispensed with in this specific circumstance.

The arrangement shown in FIGURE 4 is also intended to illustrate that great variations in size of the pads, location of the pads and the contour of the structures are possible. In instances where pads of different thicknesses are employed, varible pressures are provided. Thus, the thicker pad will compress more readily than the thinner pad and will give soft interpretation of the blow before the thinner pad is compressed. The adjacent thinner pad will then provide additional resistance when reacting to the applied forces. It will also be appreciated that for various applications the padding arrangement must be modified in order to conform to the body contour of other particular limitations of the objects with which they are associated.

FIGURE 5 provides a diagrammatic showing of an application of the padding structures of this invention to a football helmet. The helmet 65, of the type used by football players or others subject to blows about the head, is provided with a plurality of pads 68 disposed within the helmet in a manner such that the head of the wearer will be in contact only with the pads and will be out of contact with the rigid shell 70 of the helmet.

The individual pad 68 shown in section includes a porous resilient interior 72 located immediately adjacent the rigid shell 70. An interposed rigid member 74, a second porous portion 76 and a non-porous outer layer 78 provided with ports 80 complete the padding structure. Since the helmet will be worn on the head, there is no need for a rigid member intermediate the head and the porous interior portion 76. The plate member 74 is included in order to provide for compression of the porous interior 72 whereby a cooperative arrangement of the type referred to in the discussion of FIGURE 3 results. Similarly, the pad construction of FIGURES 1 and 2 may be employed in a helmet of the sort shown in FIGURE 5, since inclusion of the integrated rigid members is not detrimental even of the pads are located on a rigid surface for the protection of hard parts of the body.

FIGURES 6 through 11 illustrate an alternative form of this invention which generally comprises a padding structure having two or more interior chambers. Each of these chambers is filled with porous resilient material, and air-impervious resilient material is provided for at least partially enclosing these chambers. Additional air-impervious material enclosing the interior chambers may comprise relatively rigid members; however, in any case, communication with the outside atmosphere is provided by means of small-diameter port means defined in the air-impervious outer layers. In addition, this construction provides air-impervious interior walls which act to subdivide the structure into the interior chambers. These walls are also relieved by small-diameter port means whereby air can be momentarily retained in each of the individual chambers and then gradually released in response to an impact. The relief of pressure from within any individual chamber may be accomplished through passage of air into adjacent chambers and, ultimately, through passage of air to the outside atmosphere. In any case, each of the interior chambers will communicate with the outside atmosphere either directly or through adjacent chambers.

In the drawings, each of the padding structures illustrated includes outer side walls 100 formed of an air-impervious resilient material. Upper and lower walls 102 and 104 are also formed of resilient material in the illustrated embodiment, and the combination of these walls defines interior portions 106. Interior walls 108 extend within the interior portion between opposing side walls whereby a plurality of separate chambers 110 are provided within each of the padding structures.

Small-diameter port means 112 are formed in the side walls 100 whereby the interior of the padding structures will communicate with the outside atmosphere. The interior walls 108 are relieved by small-diameter port means 114 whereby the respective chambers within the structure will intercommunicate. Porous resilient material 116 fills each of the interior chambers 110 whereby the structural form of the padding will be maintained without impeding the flow of air during operation of the construction.

The padding structures illustrated in FIGURES 6 through 11 will operate in a manner similar to the structures above described. Thus, when the structures are disposed between two relatively rigid surfaces and when a blow is delivered to one of these surfaces, the interior chambers will be reduced in size whereby the air therein will be pressurized. Since the port means 112 and 114

are small, they will gradually release the pressurized air. If a given chamber does not communicate directly with the outside atmosphere, the air will be released to an adjacent chamber while chambers communicating with a port **112** will pass air to the atmosphere.

The structures illustrated in FIGURES 6 through 11 are particularly advantageous since they can be designed in virtually any form to accommodate the shape of the structure with which they are to be associated. The designs illustrated in FIGURES 6, 10 and 11 can advantageously be employed in hip pads wherein various different contours are required. The design illustrated in FIGURE 8 can advantageously be employed in shoulder pads, for example as illustrated in copending application Serial No. 255,495, filed February 1, 1963, now Patent No. 3,158,871 and entitled "Shoulder Pad Construction." As illustrated in this patent, a particular section of this shoulder pad may be provided with several of the structures of this invention having various shapes and sizes particularly suitable for protection of the bone or muscle structure over which this section of the pad will be fitted. In considering the designs shown in FIGURES 6 through 11, it will be appreciated that many other size variations can be provided. Furthermore, one or more rigid members can be formed integrally with the padding structures as suggested in the preceding description.

When a blow is delivered to any pad embodying this invention, the interior portion or portions are compressed between two rigid bodies and air within the porous interior is immediately placed under pressure. The non-porous, resilient layer, which forms part of the enclosure for the porous interior, will expand as the pressure within the pad is increased, and the port or ports provided are small enough to prevent immediate release of the pressurized air. The dotted lines in FIGURE 3 illustrate the manner in which the non-porous layer **44** will expand when a blow is delivered to the pad structure.

The improved results of this invention are achieved by this combination of factors and due to the gradual release of air through the ports in the interval immediately following the striking of the pad. This interval of time may be only a fraction of a second, but it has been found that the build-up of air under pressure within the pad, even for such a short time, is highly beneficial in absorbing energy and thereby reducing the detrimental effects of blows and collisions.

As the pressure decreases with the release of air following a blow, the resilient materials take over to further decelerate the striking object and, by compression, to absorb energy from it. When the blow is ended and the striking object has moved away from the pad, the resilient materials will return to their original shape and air will be sucked back into the structure through the ports.

The rigid members associated with the padding structure serve to distribute the force of a blow or collision over the whole area of the pad, so that the full effect is not concentrated at a single point. This effect is particularly valuable when a pad receives a sharp blow from a relatively small object.

One contemplated alternative form of this invention includes a plurality of independent structures disposed within a resilient matrix, the latter being laid out on a rigid surface such as inside of a helmet. The independent structures each include a porous interior portion and an impervious outer layer relieved by port means. In a construction of this form a single port can be provided in each impervious layer for communication with the exterior of the impervious layer. Where employed for the protection of the skull, the padding can be placed in direct contact therewith. However, where desired, integrated rigid means can be employed, either in the form of a single plate covering each of the independent structures, or each of the structures could be provided with a single plate.

Tests have made it clear that where the various described pad structures have been employed, the detrimental effects of blows or collisions can be greatly reduced or eliminated. For a given thickness of conventional padding, the padding of this invention can be employed in the same thickness with far more satisfactory results.

Various well-known materials can be employed for the padding of this invention. A closed cell plastice foam known as "Ensolite," manufactured by the U.S. Rubber Company, is suitable for the outer impervious, resilient layer. For the porous interior, various well known open cell materials of low density can be employed, such as plastic foam, natural sponge, synthetic vinyl sponge, or rubber sponge.

The rigid plate members integrated with the padding structure can be formed of high modulus linear polyethylene or fiberglass. A low density material is preferred, when the padding is to be worn by human beings, in order that the weight of the padding may be kept down.

As a specific example of a suitable pad, use has been made of 3" x 5" rectangular pads. The pads were manufactured to a one inch thickness with a one-quarter inch non-porous, flexible layer of "Ensolite" enclosing the sides. A porous interior of plastic foam was provided with six 1/32" diameter ports on each of the four sides of the pad structure and the top and bottom of the interior were covered with polyethylene plates. The pads were provided with a thin vinyl dip outer coating for moisture protection and sanitary purposes. In other designs tested, which excluded integral plates, it has been found that the 1/32" ports have also been suitable.

It will be understood that in referring to "diameter" in the above noted description and in the appended claims, a circular opening is not necessarily intended. Thus, openings of different cross sections can be employed and reference to a diameter is intended to include all openings having cross-sectional areas corresponding to the cross-sectional area of a circular opening having the specified diameter.

The combination of structures described are adapted for use in any application where padding is of importance, including use by individuals as a padding for any part of the body and as protective padding for objects with which individuals may collide.

It will be understood that various modifications can be made in the above described padding structure which provide the characteristics of this invention without departing from the spirit thereof, particularly as defined in the following claims.

That which is claimed is:

1. A protective padding structure interposed between the surfaces of a pair of rigid members, said structure comprising an interior portion formed of a porous, resilient material, an essentially air-impervious layer of resilient material surrounding said interior portion, said impervious layer being relieved by small diameter port means operative to provide communication between said interior portion and the space externally of said impervious layer, said port means being sufficiently small to momentarily retain pressurized air within said structure when a blow delivered to one of said rigid members compresses said interior portion and being adapted to thereafter gradually release said pressurized air.

2. A padding structure according to claim **1** wherein the opposed faces of said interior portion are disposed immediately adjacent said surfaces of said rigid members and wherein said resilient layer encloses at least the remaining portions of said interior portion.

3. A protective padding structure comprising a pair of substantially rigid plates, a porous interior portion of resilient material interposed between said plates, an essentially air-impervious layer of resilient material completing an enclosure for said interior potrion, said impervious layer being relieved by a plurality of small port means

operative to provide communication between said interior portion and the space externally of said impervious layer, said port means being sufficiently small to momentarily retain pressurized air within said structure when a blow to said structure compresses said interior portion and being adapted to thereafter gradually release said pressurized air.

4. A padding structure according to claim 3 wherein said plates are formed of an air-impervious material.

5. A padding structure according to claim 3 including a plurality of said interior portions and at least one adidtional substantially rigid plate, said interior portions and said additional plate being sandwiched between said first mentioned plates, said port means being so disposed in said impervious layer whereby all of said interior portions are vented to said space.

6. A protective padding structure comprising a first interior portion formed of a porous resilient material, a second porous interior portion, a substantially rigid member interposed between said first and second interior portions, an essentially air-impervious layer including resilient material surrounding said interior portions, said impervious layer being relieved by at least two small-diameter port means operative to provide communication between each of said interior portions and the space externally of said impervious layer, said port means being sufficiently small to retain pressurized air momentarily within said structure when a blow to said structure compresses said interior portion and simultaneously stretches the air-imprevious layer, and being operative thereafter to gradually release said pressurized air.

7. A protective padding structure adapted to have one face disposed adjacent an essentially air-impervious relatively rigid member, said structure comprising an outer wall formed of an essentially air-impervious resilient material, at least one interior wall extending between opposing portions of said outer wall and thereby subdividing the interior of said structure into at least two chambers, porous resilient material substantially filling each of said chambers, at least one small-diameter port means defined in said outer wall communicating the interior of said structure with the space externally of said outer wall, and at least one small-diameter port means defined in said interior wall communicating said chambers, said port means being sufficiently small to retain pressurized air momentarily within said chambers when a blow to said structure compresses said porous resilient material and simultaneously stretches said air-impervious resilient material, and being operative thereafter to gradually release said pressurized air, said one face of the structure being secured to the surface of said relatively rigid member, and wherein a relatively rigid plate member is secured over the opposite face of said structure whereby said structure is adapted to be disposed over a relatively soft body portion of an individual wearing said padding.

8. A protective padding structure wherein one face thereof is designed to be used adjacent the surface of a rigid member, said structure comprising a substantially rigid plate, a porous interior portion of resilient material positioned to be interposed between said surface and said plate, at least one additional porous interior portion and at least one additional plate, said additional interior portion being sandwiched between said first mentioned plate and said additional plate, an essentially air-impervious layer of resilient material completing an enclosure for both of said interior portions, said impervious layer being relieved by a plurality of small ports providing communication between said interior portions and the space externally of said impervious layer, said ports being sufficiently small to momentarily retain pressurized air within said structure when a blow to said structure compresses said interior portion and being adapted to thereafter gradually release said pressurized air.

9. A protective padding structure interposed between the surfaces of a pair of rigid members, said structure comprising an interior portion formed of a porous, resilient material, an essentially air-impervious layer of resilient material surrounding said interior portion, said impervious layer including an outer side wall and top and bottoms walls, at least one interior wall of air-impervious material, said interior wall being disposed perpendicular to said top and bottom walls and extending between opposing side walls to thereby subdivide the interior of said structure into at least two chambers, said impervious layer being relieved by small diameter port means operative to provide communication between said interior portion and the space externally of said impervious layer, and said interior wall defining a small diameter port means to provide communication between said chambers, said port means being sufficiently small to momentarily retain pressurized air within said structure when a blow delivered to one of said rigid members compresses said interior portion and being adapted to thereafter gradually release said pressurized air.

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