

United States Patent

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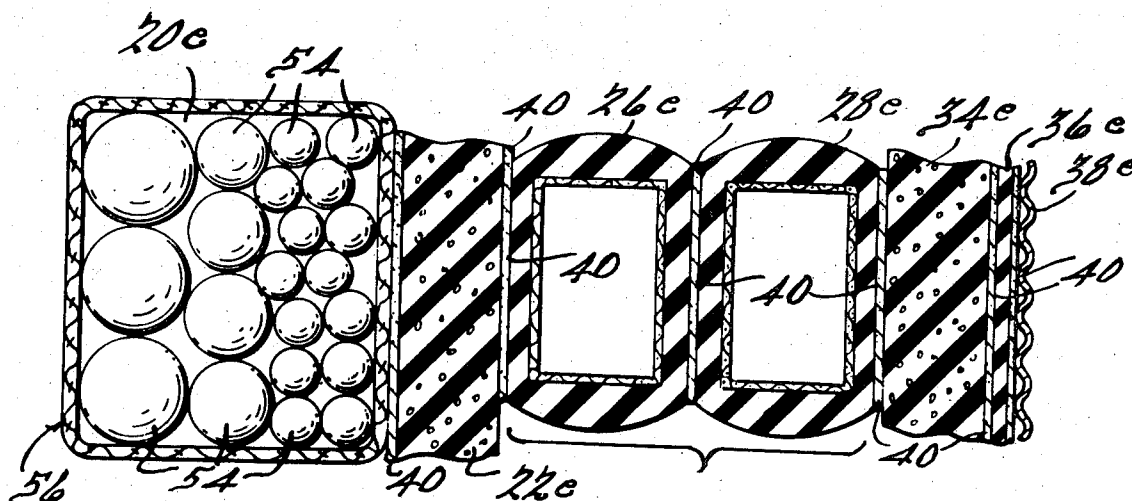
[54] **SHOCK SHIELDING STRUCTURE**
2 Claims, 9 Drawing Figs.

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 [51] Int. Cl. **E04b 1/345,**
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 [50] Field of Search..... **52/2, 167,**
 173, 80, 81, 309; 188/1 C; 105/369 B; 161/139,
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ABSTRACT: A shelter for protecting a wall of a structure or a structure against the adverse effects of shock waves produced by an explosion or the like, wherein the shelter embodies a wall structure adapted to attenuate the shock wave impinging against the shelter as a result of the explosion to a very high degree. The wall structure includes a series of adjacently oriented shielding layers or laminations, with at least some of the layers having dissimilar or mismatched resilient characteristics. Also, as a supplement, at least one of the shielding layers may be rendered easily deformable in response to a shock wave impinging against the shelter, and at least one of the layers may be inflatable and therefore adapted to be internally pressurized or inflated to a predetermined internal pressure, whereby a portion of such layer is adapted to move inwardly or "retreat" in response to a pressure wave striking the wall structure.



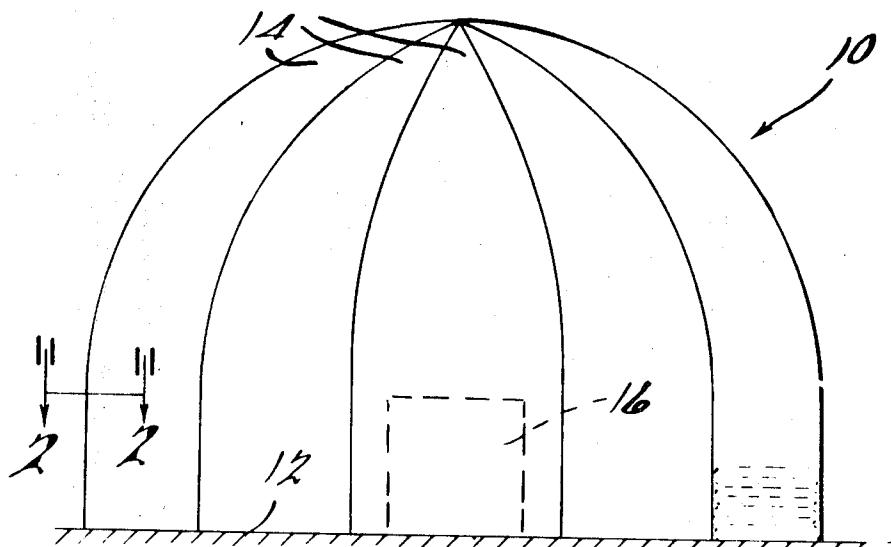


FIG. 1.

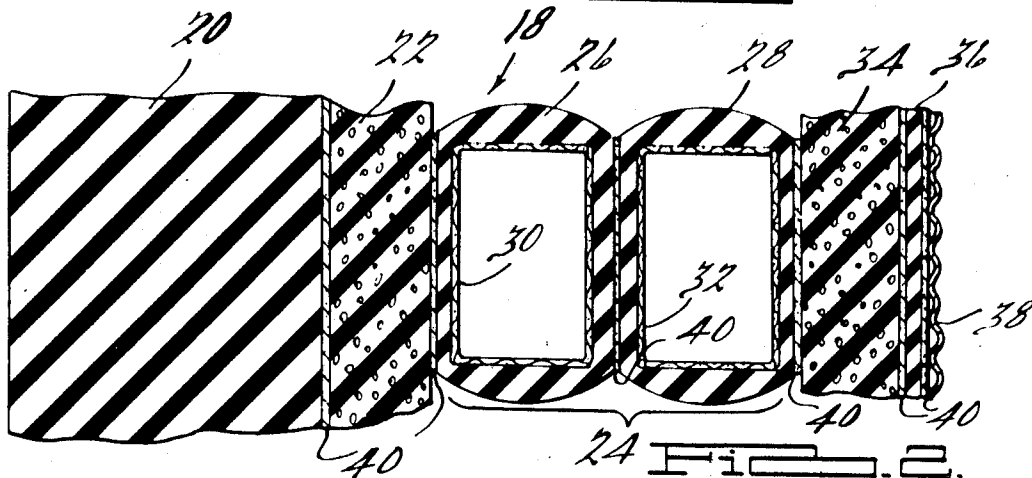


FIG. 2.

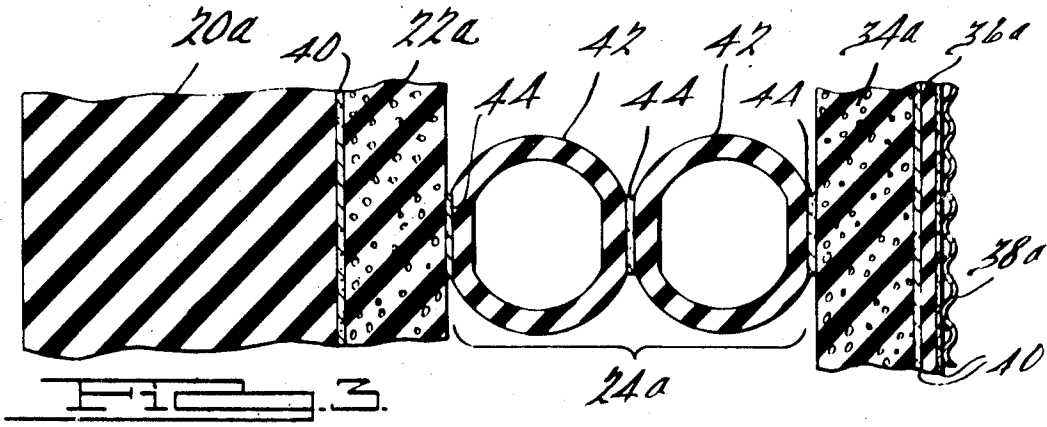
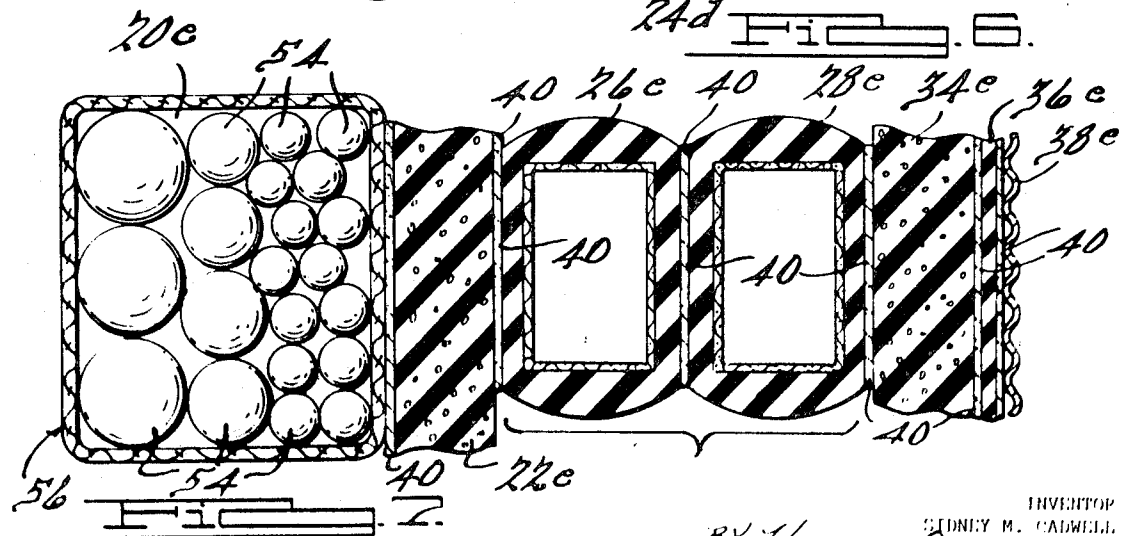
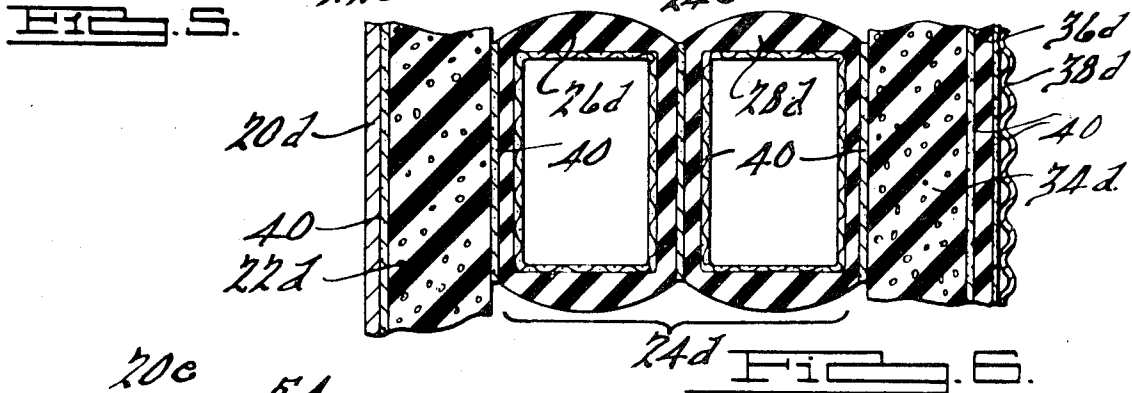
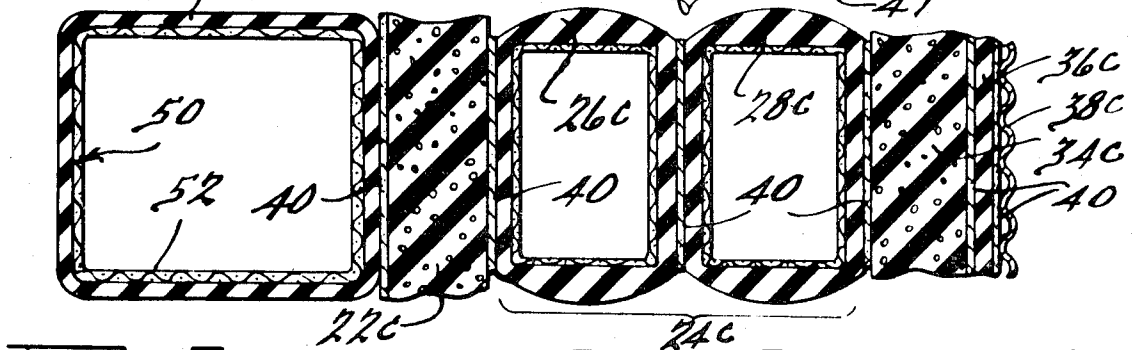
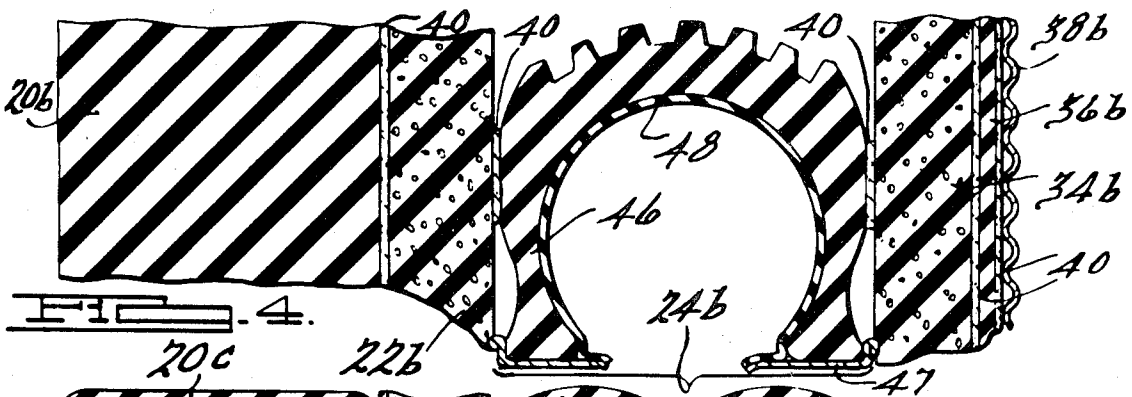


FIG. 3.

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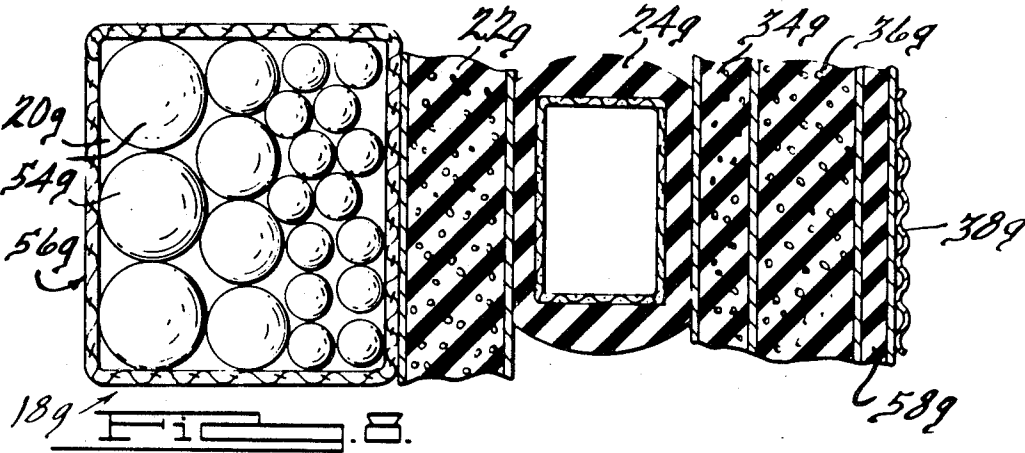
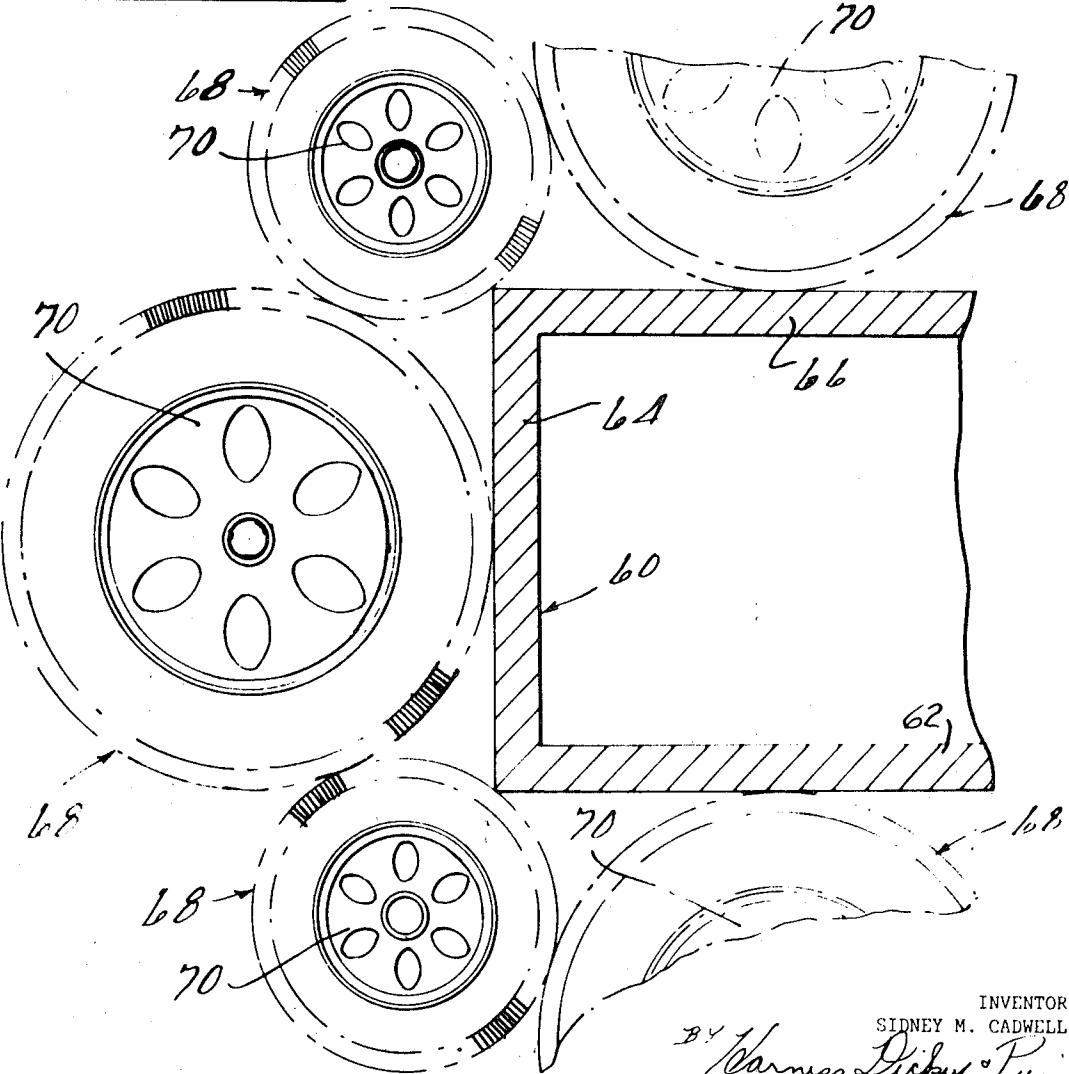


FIG. 9.



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SHOCK SHIELDING STRUCTURE

BACKGROUND OF THE INVENTION

With the advent of modern warfare and the increasing emphasis on the use of atomic, as well as other types of thermal-nuclear weapons, the problem has arisen with regard to protecting civilian and military personnel and/or equipment against the adverse effects of such weapons.

Generally speaking, it has been found that the total destructive effect of a thermal-nuclear explosion is not limited to the devastation created by the fire, radiation, etc. of the initial explosive blast thereof, but that substantial destruction, insofar as total area is concerned, results from the effects of the enormous pressure or shock wave which is produced by the explosion. The main reason why these pressure or shock waves are of such a destructive character resides in the fact that the waves are capable of inflicting damage ranging all the way from the trivial destruction of the windows of a building, to the total destruction of such buildings, depending primarily on the proximity of the structure relative to the ground zero area of the explosion. Generally, the pressure of such a shock wave can be calculated through the relationship that the shock wave pressure decreases inversely as the cube of the distance from the center of the explosion.

Although various devices and structures have heretofore been proposed for protecting personnel and equipment from the destruction effects of the shock waves produced by thermal-nuclear explosions, such heretofore known and used devices have been objectionable for a number of different reasons, namely, their relatively large size, weight and excessive manufacturing and assembly expenses. Also, such heretofore known and used devices have been objectionable due to their inability to effectively protect objects against the damage caused by shock waves and repeated shock waves, and from the standpoint of such devices being of limited mobility.

In the applicant's now abandoned copending application, Ser. No. 425,497 filed Jan. 14, 1965 for Shelter, a new and improved shelter structure is disclosed which is intended to substantially reduce virtually all of the aforementioned objectionable characteristics through the provision of a structure using principles of internal pressurization for protecting personnel and equipment disposed within the shelter. The present invention is generally related to the subject matter of the applicant's copending application insofar as it contemplates the use of a shelter construction for purposes of protecting men and equipment from the effects of a shock wave, and repeated shock waves. However, the present invention relates to a new and improved wall structure for such shelter constructions and, as such, is intended to be used either completely independently or in conjunction with the principles shown in the aforesaid copending application.

More particularly, the applicant has invented a new and improved shock shielding wall structure that incorporates several different shock wave attenuating concepts or characteristics, each of which has been found to at least partially attenuate or minimize the effect of a shock wave, and all of which in combination function to substantially attenuate the adverse effects created when individual, as well as repeated or successive shock waves strike a shelter or other structure having a wall construction embodying such concepts. It has been found that the shock wave from an explosion generally rises to a peak overpressure in a very short period of time and subsequently subsides over a greater period. This peak reflected pressure may be of the order of 10 to 20 times the overpressure present at a point in time when the pressure is subsiding. In utilizing certain concepts of the present invention, the peak overpressure is, in effect, dissipated by the system over a long period of time relative to the duration of the peak pressure. Accordingly, while the product of pressure and time remains the same, the peak pressure is very greatly reduced.

The first of these concepts which the applicant has incorporated in the present invention is the provision of a wall

structure consisting of a plurality of different shielding layers or laminations, at least one of which layers is adapted to deform or yield in response to a shock wave impinging against the structure. Secondly, the applicant has incorporated in a wall structure of the above character, the concept of providing a plurality of layers, each of which layers exhibits different resilient properties, i.e., having a different spring rate or period of vibration, whereby to effectively attenuate a shock wave. Finally, the applicant has combined in the aforesaid wall structure the concept of attenuating a shock wave by moving or "retreating" a portion of the wall structure in the direction of the wave propagation.

Such a retreating wall concept has been found to be best carried out by means of an inflatable member, the interior of which is pressurized to a preselected internal pressure, whereby one portion of the inflatable member is adapted to deform or yield in response to the shock wave and against the resistance of the internal pressure within the member. As above stated, each of the aforesaid concepts has been found to function by itself in at least partially attenuating or minimizing the effect of a shock wave; however, the applicant has discovered that by properly combining each of these concepts in a single wall structure, such attenuating concepts cooperate to virtually eliminate the entire effect of such a shock wave, with the result that a shelter having a wall structure embodying each of these concepts in combination will serve to effectively protect any structure and personnel or equipment located therewithin from the shock wave effects of an atomic or other type of explosion.

In carrying out the present invention in its simplest form, it is contemplated that a shelter, which may be of virtually any configuration but which is preferably of a generally arcuate shape for reasons later to be described, is provided with a wall structure comprising a series of shielding layers or laminations, each of which layers is fabricated of a material exhibiting preselected resilient characteristics. In the illustrated embodiment, at least one of the layers is constructed of an inflatable material, the interior of which is intended to be pressurized in a preselected manner such that at least a portion of the member is movable inwardly or is adapted to retreat as a shock wave strikes the wall. Also, at least one of the layers is adapted to readily deform in a manner such that the desired shock wave attenuation is achieved. The various layers may be fabricated of any suitable flexible material and are preferably connected together by any suitable means, such as by bonding the materials together or by some external means.

It is contemplated that one relatively rigid layer be provided in the wall structure for the purposes of reinforcing the shelter. Insofar as the above described inflatable layer of the subject wall structure, it is contemplated that a number of different types of constructions may be employed. In one preferred form of the present invention, the inflated layer consists of a plurality of inflated tubular members arranged in a circular or serpentine configuration. Alternatively, in another preferred construction, such tubes may be replaced by a multiplicity of deformable elastomeric balls, and in still another form of the present invention, such tubes may be replaced by conventional inflatable tires as are commonly used on automotive vehicles.

SUMMARY OF THE INVENTION

This invention relates generally to shelter structures for use against the dangers incident to large explosions and, more particularly, to a new and improved wall structure adapted to find particularly useful application in shelters of the type used to protect personnel and/or equipment or structures against the effects of all types of shock waves produced as, for example, by thermal-nuclear explosions and the like.

Accordingly, it is a general object of the present invention to provide a new and improved structure or shelter for protecting personnel and equipment from the effects of shock waves produced by thermal-nuclear or other types of explosions.

It is a more particular object of the present invention to provide a shelter of the above character which incorporates a wall structure that is adapted to minimize to the extreme the adverse effects of such shock waves.

It is a further particular object of the present invention to provide a protective system of the type described which is adapted to dissipate the peak overpressure created by the shock wave of an explosion or the like over a relatively long period of time with respect to the duration of the shock.

It is another object of the present invention to provide a new and improved shelter construction of the above character wherein the wall structure thereof comprises a series of layers of materials having preselected resilient characteristics, and which may, if desired, be provided with auxiliary support means.

It is yet another object of the present invention to provide a new and improved shelter of the above character wherein the wall structure thereof includes at least one layer adapted to move or retreat inwardly in response to a shock wave impinging against the shelter.

It is a further object of the present invention to provide a shelter construction of the above character having a wall structure comprising a series of adjacent oriented layers, at least one of which is readily deformable in response to a shock wave impinging against the shelter.

It is still another object of the present invention to provide a new and improved shock shielding shelter which is of a durable construction, may be easily assembled and economically manufactured and is rendered highly mobile.

It is yet another object of the present invention to provide a new and improved shock shielding shelter which is readily adapted to withstand the adverse effects of repeated or successive shock waves.

It is still a further object of the present invention to provide a new and improved shock shielding shelter of the above character which utilizes conventional automotive vehicle type tires or the like for purposes of attenuating a shock wave.

Other objects and advantages of the present invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of an exemplary shock shielding structure or shelter incorporating a preferred embodiment of the shielding wall structure of the present invention therein;

FIG. 2 is an enlarged transverse cross-sectional view of a portion of the wall structure of the shelter shown in FIG. 1, as taken substantially along the line 2-2 thereof;

FIG. 3 is a cross-sectional view similar to FIG. 2 and illustrates an alternate embodiment of the shock wave shielding wall structure of the present invention;

FIG. 4 is a cross-sectional view similar to FIG. 2 illustrating still another embodiment of the shock wave shielding wall structure of the present invention;

FIG. 5 is a cross-sectional view similar to FIG. 2 and illustrates yet another embodiment of the shock wave shielding wall structure of the present invention;

FIG. 6 is a cross-sectional view similar to FIG. 2 and illustrates still a further alternate embodiment of the shock wave shielding wall structure of the present invention;

FIG. 7 is a cross-sectional view similar to FIG. 2 illustrating still a further embodiment of the shock wave shielding wall structure of the present invention;

FIG. 8 is a cross-sectional view similar to FIG. 2 illustrating another preferred embodiment of the shock wave shielding wall structure of the present invention; and

FIG. 9 is a cross-sectional view of still another embodiment of the shock shielding structure of the present invention.

DESCRIPTION OF A PREFERRED EMBODIMENT

For purposes of description, the terms "inwardly" and "outwardly," as well as the various derivatives thereof, will have

reference to the geometric center of the shelter construction hereinafter to be described, with the outermost side of the wall structure thereof being located at the left sides of FIGS. 2 through 7.

Referring now in detail to the drawings, a shock shielding shelter 10, which may be of virtually any suitable size and configuration depending on the contemplated use thereof, is illustrated in FIG. 1 in an exemplary dome-shape or hemispherical configuration. The shelter 10 is adapted to function in housing or enclosing substantially any type of personnel and/or equipment and is preferably disposed on and fixedly anchored to a suitable rigid foundation 12, which, for example, may be fabricated of concrete or the like. As shown in FIG. 1, the shelter 10 may consist of a plurality of arcuate, pie-shaped sections, generally designated by the numeral 14, one of which sections may be provided with suitable door means 16 of a size commensurate with the type of equipment to be stored or housed therewithin. If desired, the various shelter sections 14 may be constructed so as to be detachably connectable to one another, and thereby provide for convenient assembly and disassembly of the shelter 10.

In accordance with the principles of the present invention, the shelter 10 is constructed of a wall structure 18 which comprises a series of adjacently oriented, coextensive and substantially coplanar shielding layers or laminations which are adapted to cooperate with one another in attenuating or absorbing the effects of a shock wave impinging against the shelter 10. More particularly, the wall structure 18 comprises a plurality of shielding layers, at least some of which are fabricated of resilient or elastomeric materials, with at least one of the layers being of an inflatable character in the preferred embodiment, and, for certain applications, may be internally pressurized to a preselected degree such that at least a portion of the wall structure 18 is deformable in response to a shock wave striking the shelter 10, while other portions of the wall structure 18 are adapted to move inwardly or retreat in response to a shock wave impinging against the shelter 10, as will hereinafter be described in detail.

Referring now in detail to an embodiment of the wall structure 18, as best illustrated in FIG. 2, the structure 18 comprises a relatively thick outer shielding layer 20 which is fabricated of a compounded or uncompounded vulcanized elastomeric material. In selecting a material for the outer shielding layer 20, consideration should be made, not only to the desired resilient characteristics, but also to resistance against heat and radiation effects of thermal-nuclear explosions, as well as to resistance against chemical and bacteriological attack. One preferred form of such material is carbon black rubber consisting of 100 parts of Goodrich-Gulf polymer 01710, (styrene butadiene copolymer) 75 parts HAF black and 37.5 parts aromatic oil. This composition is 23.5 percent bound styrene and contains both fatty and rosin acids, and has a Mooney viscosity of approximately 60.

Disposed directly interiorly from the outermost layer 20 is a somewhat thinner shielding layer 22 which is also fabricated of a suitable elastomeric or plastic material. In the preferred embodiment of the wall structure 18, the layer 22 is constructed of Rubitex 041 (closed cell sponge) or other suitable spongelike or articulated closed cell material which exhibits resilient characteristics whereby that the material is depressed approximately 25 percent when a force of approximately 3.5 pounds per square inch is exerted thereagainst. An alternative material that has been found satisfactory for the shielding layer 22 is a stiffer form of Rubitex or equivalents, as for example, Rubitex 045.

Located directly inwardly from the layer 22 is another shielding layer, generally designated by the numeral 24. Broadly speaking, the layer 24 is intended to be of an inflatable character; that is, it is constructed so that the interior thereof may be pressurized to a predetermined internal pressure. As will later be described, the shielding layer 24 may be of various forms, but in the preferred construction illustrated in FIG. 2, the layer 24 comprises inner and outer layers of in-

inflatable tubes, namely an outermost tube layer 26 located directly inwardly from the layer 22, and an innermost tube layer 28 located directly inwardly from the layer 26. The various inflatable tubes constituting the layers 26, 28 may be of any suitable construction adapted to be internally pressurized to a predetermined degree or valved to slowly release internal air. With such a construction, the outermost wall portions of the inflatable layers 26, 28 are adapted to move inwardly or retreat toward the interior of the wall structure 18 as a shock wave impinges against the shelter 10, whereby to attenuate and thus minimize the effect of such shock waves.

The inflatable tubes of the layers 26, 28 may be arranged in various configurations within the wall structure 18 without departing from the spirit of the present invention. By way of example, in a construction where the shelter 10 comprises a single unitized structure, i.e., no individual detachable sections 14, the layers 26 and 28 may each consist of a single continuous tube wound around the shelter 10, with each convolution of the tubes being disposed directly above or below the adjacent convolutions. In the event that the shelter 10 is constructed in the manner illustrated in FIG. 1, that is, comprises a plurality of detachably connected sections 14, each of the sections 14 could have the tubes constituting the outer and inner layers 26 and 28 arranged in a generally serpentine configuration, as shown by the dotted lines in FIG. 1. It will be readily apparent, of course, that the tubes of the layers 26, 28 may assume various other configurations, depending upon the size and shape of the shelter 10; however, it is preferable that the tubes comprising the layers 26, 28 be arranged such that the lengths thereof are relatively short, whereby to minimize the effort of pressurizing the layers 26, 28, i.e., it is desirable to minimize the number of inlet valves required to communicate a pressurized fluid into the tubes. Toward this end, suitable fluid conduit means may be provided between the outer and inner tubes of the layers 26, 28, whereby only a single valve would be necessary to communicate pressurized fluid into the interior of the layers 26, 28. It will be noted, however, that when the layers 26, 28 are thus connected, in the event that any portion of either of the layers is punctured, the entire pressurization of the inflatable layer 24 will be lost.

In a preferred construction, the tubes comprising the layers 26, 28 are interiorly pressurized to a pressure equal to the shock pressure incident to the layers 26, 28, less the amount of pressure absorbed as the walls of the tube layers 26, 28 move inwardly or retreat in response to the shock wave impinging against the shelter 10. According to various experiments performed by the applicant, an internal pressure of between 5 and 15 p.s.i. or approximately 2 percent of the pressure of the shock wave impinging against the shelter 10, has been found to provide for satisfactory attenuation.

The interior walls of the tubes in the layers 26, 28 are preferably provided with reinforcing means 30 and 32, respectively, which may consist of glass fiber or steel cord, woven fabric, wire mesh, or other suitable strong material such as Nylon, whereby to reinforce the tubes and assure that they will not rupture due to a sudden increase in exterior pressure as would occur when a shock wave impinges against the shelter 10.

Disposed directly inwardly from the inflatable layer 24 is another elastomeric layer 35 which is preferably of the same thickness and constructed of the same material as the aforesaid layer 22, and located immediately inwardly from the layer 34 is still another layer 36 which is of a relatively thin cross section and is fabricated of a substantially rigid vulcanized elastomeric material. In a preferred construction of the wall structure 18, the layer 36 comprises a single unitized member and has a resiliency of approximately 44 durometer. Alternatively, the layer 36 may be provided by laminating a series of relatively thin layers of elastomeric materials together to provide a unitized layer having the desired resilient characteristics.

The interiormost or inner shielding layer 38 of the wall structure 18 is in the form of a relatively rigid material, for ex-

ample, sheet metal, which is of a generally corrugated or undulated configuration, whereby to provide for reinforcement and support of the wall structure 18. It will be noted that for certain applications, the shielding or support layer 38 may be omitted and that the wall structure 18 will still be entirely self-supporting.

By way of example, in a typical operative embodiment of the hereinabove described wall structure 18, the outermost layer 20 would be approximately 6 inches thick, the layers 22 and 34 approximately 2 inches thick, the layer 36 approximately ½-inch thick, and the innermost reinforcing layer 38 would have corrugations approximately ¼-inch deep.

In a preferred construction of the wall structure 18, the various layers 20, 22, 24, 34, 36 and 38 are secured to one another in a manner so as to prevent any relative movement in the direction of the plane of the shelter wall. Means for thus securing the various wall layers may be provided by any suitable fastening means as, for example, cord or an adhesive material. Also, other means could be used such as a heat and weather resistant glue or mastic material as is commonly available and is indicated herein by the numeral 40.

While the above described embodiment of the wall structure 18 is considered preferable for achieving maximum attenuation of a shock wave, it will be noted that satisfactory shock wave attenuation may be achieved by means of a wall structure constructed of different types of elastomeric materials, with the various shielding layers thereof being of different relative dimensions, provided however, that the wall structure is characterized by having shielding layers or laminations of such resilient characteristics that the spring constants and/or periods of vibration thereof are dissimilar or mismatched, as above described, and also provided that at least one of the layers is of a sufficient resilient character to deform in response to a shock wave impinging against the wall structure, while another layer is adapted to move inwardly or retreat in response to such a shock wave striking the shelter. As hereinabove stated, while desirable shock wave attenuation characteristics are achieved by means of a wall structure having any one of the above characteristics, it is highly desirable and preferred to have a wall structure which incorporates each of these attenuating features.

Insofar as the overall size and shape of the shelter 10, it may be noted that the shelter may be of virtually any size required to house a desired quantity of personnel and equipment; however, the shape of the shelter 10 is preferably such that the exterior thereof is of an arcuate or curved configuration, of either a simple or compound curvature, whereby to best resist the pressure wave resulting from an explosion. Alternatively, it is contemplated that a relatively simple shelter may be provided by means of a pair of relatively small, easily transportable wall members, each of which may be fabricated of the aforesaid structure, these walls being adapted to be placed at a position spaced from an explosion so that personnel and the like may be positioned between the two wall members, with one of the wall members protecting the personnel from the direct blast of the explosion, and the other wall protecting the personnel from the counterblast which is produced by the air and debris rushing into the vacuum created by the initial blast. It is contemplated that the use of such pairs of wall members would be used in an area where the pressure wave would not be so great as to endanger the personnel.

A plurality of alternate embodiments of the wall structure 18 will now be described, with the various component parts or shielding layers thereof which are analogous to those layers of the wall structure 18 being designated by like numerals having alphabetical suffixes.

Referring now to FIG. 3, a wall structure 18a is shown as comprising a plurality of shielding layers 20a, 22a, 24a, 34a, 36a and 38a, all of which layers are preferably of the same construction as the analogous layers of the wall structure 18, with the exception that the layer 24, instead of comprising a pair of inner and outer tube layers, consists of inner and outer layers of spherical members or balls, generally designated by

the numeral 42. Each of the balls 42 is preferably of a hollow construction and may be inflated to an internal pressure approximately equal to the average pressure of a shock wave impinging against the wall structure 18a, or an orifice may be provided to permit air to escape. Also, the balls 42 are preferably fabricated of a polymeric material which is sufficiently flexible to permit an inward movement or retreating of a portion of the balls in response to a shock wave striking the wall structure 18a, whereby attenuation of such a shock wave is achieved in the manner hereinabove described. The balls 42 may be fixedly secured within the wall structure 18a by any suitable means, as for example, by a suitable glue or adhesive substance indicated at 44 in FIG. 3.

FIG. 4 illustrates a wall structure 18b comprising shielding layers 20b, 22b, 24b, 34b, 36b and 38b, all of which layers are identical in construction to the analogous members of the wall structure 18, with the exception that the inflatable layer 24b is provided by a plurality of resilient, inflatable tires of the type commonly found on automotive and truck vehicles, a portion of one of which is shown and designated by the numeral 46. As illustrated, the tire 46 is provided with a rim 47 and is arranged such that the radial plane thereof is coplanar with the wall structure 18b, the tire 46 being fixedly mounted by being glued or similarly retained between the resilient shielding layers 22b and 36b. The tires 46 may be arranged in any suitable manner, depending upon the degree of shock wave attenuation desired. That is, the tires 46 may be periodically spaced throughout the area between the shielding layers 22b and 36b, or alternatively, may be arranged tightly together wherein the peripheral edges thereof abut against one another, this latter arrangement, of course, providing for more effective shock wave attenuation due to the greater number of tires 46 provided between the layers 22b, 36b. The tires 46 may be tubeless or may be provided with conventional associated inflatable tubes 48 which are intended to be internally pressurized similar to the tube layers 26, 28 and balls 42, whereby the outermost walls of the tires 46 are adapted to move inwardly or retreat in response to a shock wave impinging against the wall structure 18b, as hereinabove described.

Referring now to FIG. 5, a wall structure 18c is shown as comprising shielding layers 20c, 22c, 24c, 34c, 36c and 38c which are preferably identical in construction to the analogous layers of the wall structure 18, with the exception that the outermost layer 20c, instead of being fabricated of a vulcanized elastomeric material, is replaced by a shielding layer comprising one or more inflatable tubes 50 similar to the layers 26 or 28. The tubes 50 of the layer 20c are preferably provided with some type of reinforcement means 52, for example, suitable wire or fabric, due to the fact that the tubes 50 must be interiorly pressurized to a pressure sufficient to withstand the entire force incident to a shock wave impinging against the wall structure 18c. As described in connection with the wall structure 18, the tube (s) of the layer 50 may be oriented in various ways around the exterior of the wall structure 18c, i.e., either in a coiled or circular configuration, or in the serpentine manner shown in FIG. 1.

Referring to the FIG. 6, a wall structure 18d is shown as comprising shielding layers 20d, 22d, 24d, 34d, 36d and 38d, all of which layers are identical to the analogous parts of the wall structure 18, with the exception that the outermost layer 20d is constructed of a layer of relatively thin sheet metal instead of the vulcanized elastomeric material shown in FIG. 1. With this construction, the wall structure 18d is intended to be extremely resistant to heat or any flash-fire that may occur as a result of an explosion. The outermost layer 20d is preferably provided by means of a plurality of steel plates which are adapted to move or translate inwardly due to inward translation of the inflatable layer 24d as a shock wave strikes the wall structure 18d, whereby the aforescribed shock wave attenuation characteristics are achieved.

Still another embodiment of the present invention is illustrated in FIG. 7 wherein a wall structure 18e is shown as comprising shielding layers 20e, 22e, 24e 34e, 36e and 38e. The

wall structure 18e is identical in construction to the wall structure 18, with the exception that the outermost layer 20e is provided by a multiplicity of vulcanized elastomeric spheres or balls 54 which are retained against the outermost side of the layer 22e by means of a suitable retaining member or envelope 56 which may be constructed of any suitable material such as a durable fabric or the like. As illustrated, the balls 54 are provided in at least two different sizes, with the smaller diameter of balls being arranged adjacent the outermost side of the shielding layer 22e, and the larger diameter balls being arranged outwardly from the smaller diameter balls, whereby dissimilar or mismatched rates are achieved. The balls 54 are intended to function in a manner similar to the elastomeric outermost layer of the wall structure 18; however, the wall structure 18e is preferable over the wall 18 from the standpoint of being somewhat lighter in weight per unit area, thereby providing for more convenient handling during assembly and disassembly of any shelter which may be constructed of the wall structure 18e.

Referring now to FIG. 8, another preferred embodiment of the shock shielding wall structure of the present invention is generally designated by the numeral 18g and is shown as comprising shielding layers 20g, 22g, 24g, 34g, 36g, 38g and 58. The wall structure 18g is similar to the aforescribed wall structure 18 with the exception that the outermost layer 20g is preferably in the same form as the outermost layer 20e of the wall structure 18e, i.e., comprises an exterior envelope 56g which is provided with a multiplicity of vulcanized elastomeric spheres or balls 54g. The wall structure 18g also differs from the aforescribed wall 18 in that layer 24g of the former comprises only a single inflatable layer or envelope, and that the wall 18g is provided with an additional layer 58 constructed of a suitable elastomeric material. By way of example, one construction of the wall structure 18g which has been found to be highly effective in attenuating shock waves is wherein the layer 22g is approximately 6 inches thick and is fabricated of No. 41 Rubitex, the layer 34g is approximately 1 inch thick and fabricated of No. 45 Rubitex, the layer 36g is approximately 2 inches thick and fabricated of No. 41 Rubitex, the layer 58 is approximately ½-inch thick and fabricated of vulcanized rubber of approximately 44 durometer, and the layer 24g is inflated to an internal pressure of approximately 7 p.s.i.

In operation of each of the above described wall structures 18-18g, as a shock wave impinges against the outermost layer 20 thereof, the pressure of such shock wave is attenuated to the maximum degree due to the fact that the shielding layers will be deformed inwardly in response to the shock wave striking the shelter, while a portion of the inflatable layer 24 will be moved inwardly against the resistance of the interior pressurization thereof. Accordingly, any personnel and/or equipment located within a shelter, for example, the shelter 10, which is constructed of any of the various wall structures as hereinabove described, will be protected to the maximum degree from the effects of such shock waves.

One additional embodiment of the present invention is illustrated in FIG. 9 and is shown as comprising an enclosure, generally designated 60, which is adapted to house personnel, equipment and the like. The enclosure typically consists of a lower section or floor 62, a plurality of side sections, one of which is shown herein and designated by the numeral 64, and an upper or roof section 66. In accordance with the principles of the present invention, the enclosure 60 has in surrounding relation therewith a plurality of tires of the type commonly found on automotive vehicles and which are generally designated by the numeral 68. The tires 68 are preferably provided with suitable rims 70 and internal tubes (not shown) that are adapted to be inflated to a preselected internal pressure or, alternatively, the tires 68 may be of the tubeless type and cooperate with their associated rims 70 to define inflatable chambers therewithin. As illustrated in FIG. 9, the tires 68 are oriented such that the radial planes thereof are perpendicular to the wall, floor and roof sections of the enclosure 60,

whereby shock waves traveling toward the enclosure 60 will impinge against the outermost edges of the tires. In accordance with the instant embodiment of the present invention, the tires 68 are intended to be arranged so as to completely surround the enclosure 60, with certain of the tires 68 being somewhat smaller in diameter than other of the tires 68 in order to effectively protect the enclosure 60 in the areas or voids between the larger of the tires 68. It may be noted that the tires 68 illustrated in dotted lines in FIG. 9, would be omitted in the event the enclosure 60 was of a multilevel construction, in which case the tires 68 shown in dotted lines would be arranged adjacent the uppermost and lowermost portions of such an enclosure.

In operation, the plurality of tires 68 and rims 70 are adapted to function in a manner similar to the aforescribed wall structures 18-18g, whereby to protect any personnel and/or equipment located within the enclosure 60 from the adverse effects of shock waves. In particular, as a shock wave impinges against the tires 68, the pressure of such a shock wave is attenuated by virtue of the fact that the tires 68 will be deformed or will retreat inwardly against the resistance created by the natural resilient characteristics of the tires. Simultaneously, the walls of the tires 68 will move inwardly against the resistance of the internal inflated pressure therewithin. Thus, the tires 68 have the same shock wave attenuating characteristics as the wall structures 18-18g by virtue of the resilient characteristics of the tires which is analogous to the elastomeric layers 22-34 and 36, and the retreating wall characteristics of the tires 68 which is analogous to the inflated layers 24. Accordingly, any personnel or other objects located within the enclosure 60 will be protected to the maximum degree from the effects of any shock waves in the same manner as the wall structures

18-18g.

While it will be apparent that the embodiments illustrated herein are well calculated to fulfill the objects above stated, it will be appreciated that the present invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims.

1. In a shielding device for protecting an object from an impinging shock wave, a series of adjacently oriented substantially coextensive shielding layers at least partially enclosing the object, at least one of said layers being inflatable to a predetermined internal pressure, inner layers fabricated of a relatively resilient material arranged on each side of said one layer, an outer layer adapted to be directly impinged by a shock wave, a relatively rigid layer for reinforcing the device, said outer layer comprising at least one member inflated to a preselected internal pressure, said outer layer comprising a plurality of spherical members having different resilient characteristics and said spherical members being of different sizes with the larger members being disposed outwardly from the smaller members.

2. In a shielding device for protection from an impinging shock wave, a series of adjacently oriented substantially coextensive shielding layers, at least one of said layers being inflated to a predetermined internal pressure, inner layers of relatively resilient material on opposite sides if said one layer, an outer layer adapted to be directly impinged by the shock wave and a relatively rigid layer for reinforcing the device, said one layer including a plurality of inflated spherical members, said inner layers being formed of an elastomeric material, said outer layer being formed of a vulcanized elastomeric material and said rigid layer comprising corrugated members.

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