Jan. 5, 1965 D. G. LANNI 3,164,111

BOMB SHELTER

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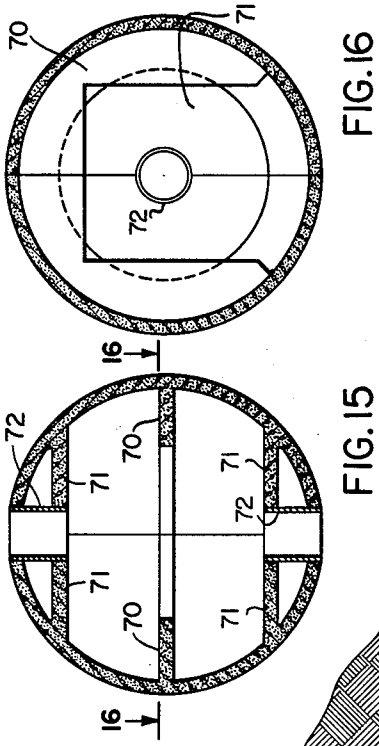

FIG. 16

FIG. 15

FIG. 1

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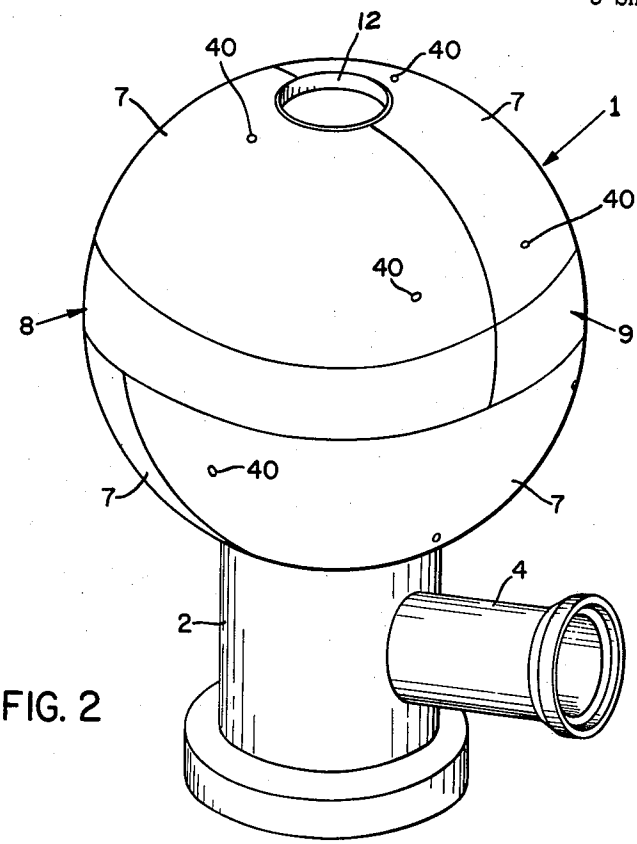

FIG. 2

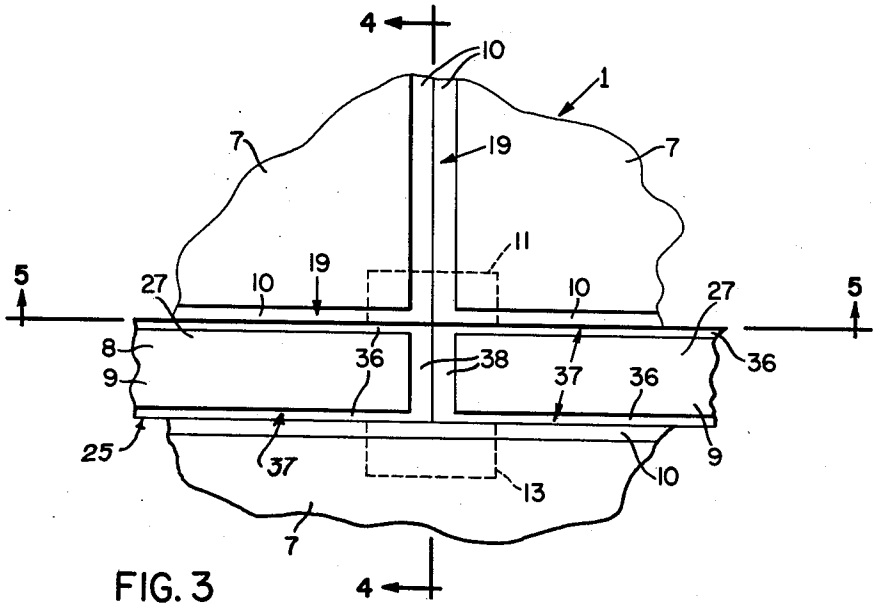

FIG. 3

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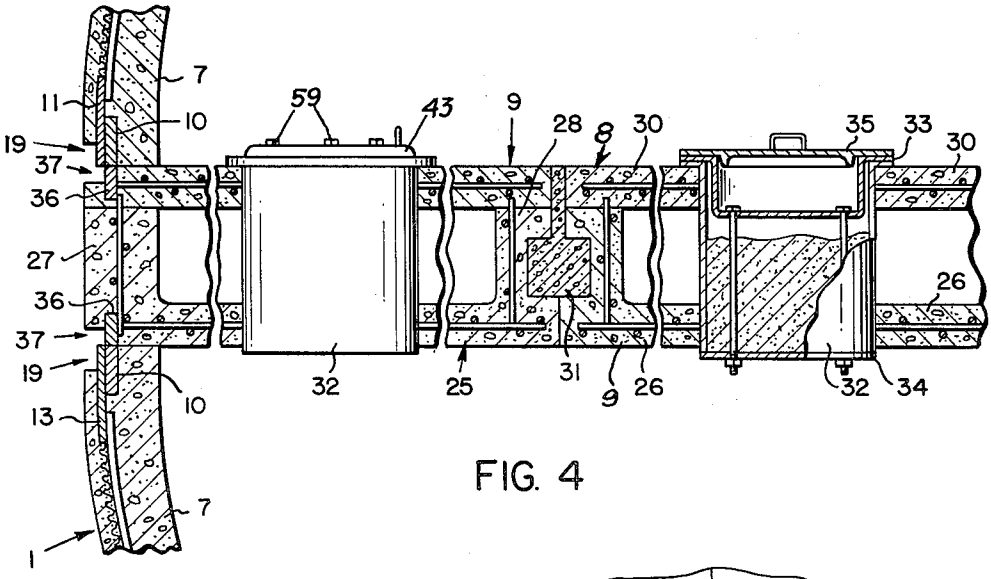

FIG. 4

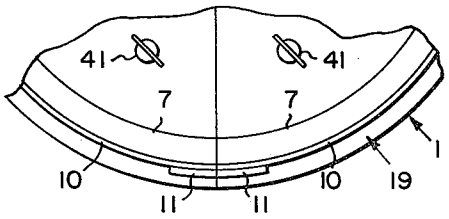

FIG. 5

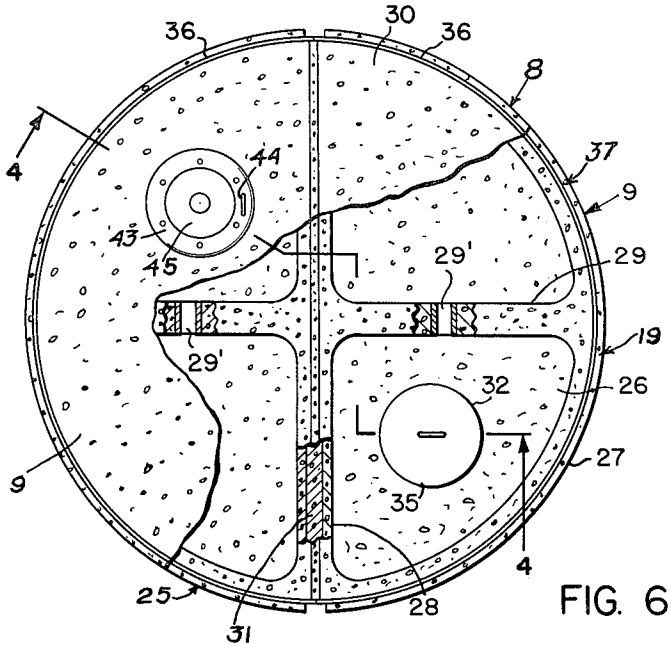

FIG. 6

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FIG. 7

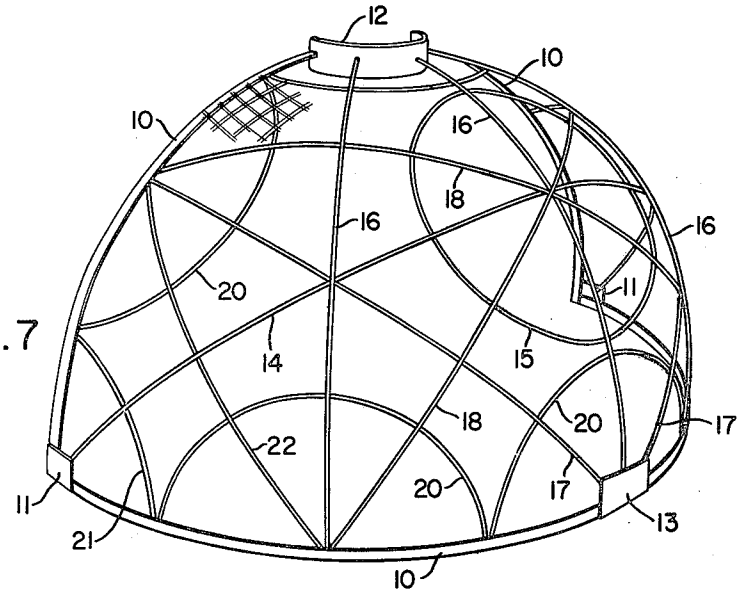
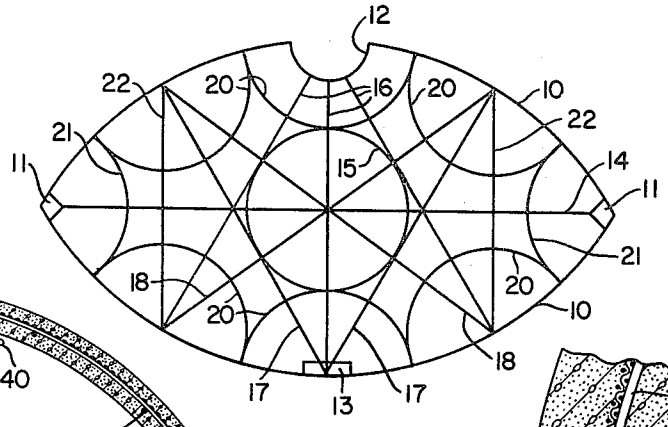


FIG. 8



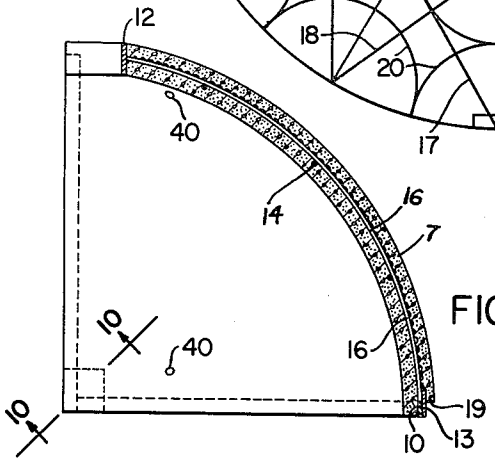


FIG. 9

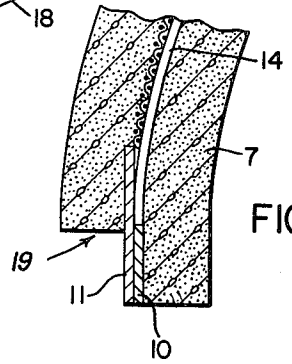


FIG. 10

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FIG. 11

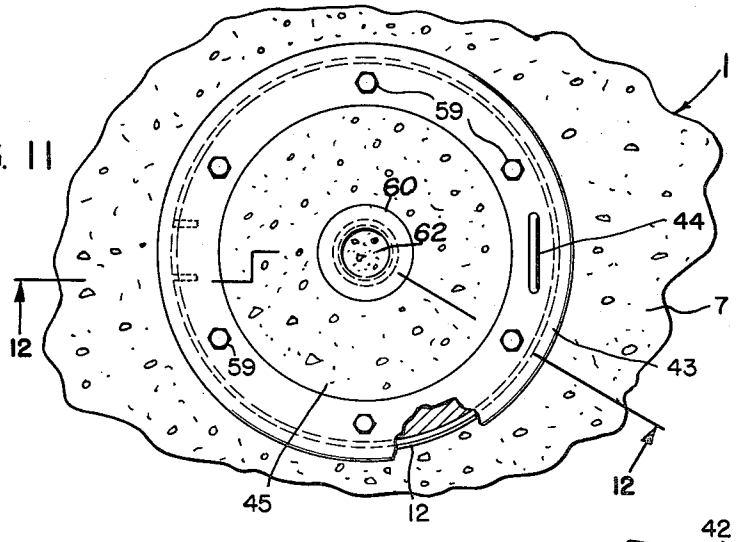

FIG. 13

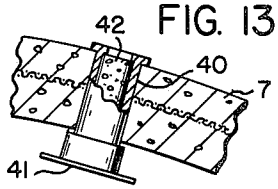

FIG. 12

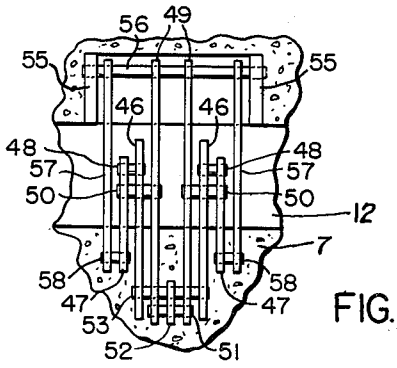

FIG. 14

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3,164,111
BOMB SHELTER

Daniel G. Lanni, 251 Bonnie Brae Ave., Rochester, N.Y.

Filed July 13, 1962, Ser. No. 209,685
5 Claims. (Cl. 109—1)

This invention relates to improvements in bomb shelters to protect human beings and the like from the effects of the blast as well as radiation produced by nuclear bombs.

An object of the invention is to provide a generally improved and more satisfactory shelter of this kind.

Another object is to provide a bomb shelter which is substantially spherical in shape and constructed of two or more segments or sections rigidly assembled together to form the casing. The casing sections are constructed to provide shielding against radiation from nuclear explosions as well as to provide a substantially spherical structure in which frame members imbedded in cemetitious material cooperate to distribute stresses in all directions throughout the walls of the casing for equalizing external pressures applied to the casing walls.

Still another object is to provide partially spherical casing sections constructed with steel frame members extending about the marginal portions of each section having a plurality of curved or arcuate steel bars interconnecting opposite portions of the marginal frame members in a plurality of different angular relations in order to provide for stress distribution in cooperation with the cementitious wall structure in which the frame members and bars are cast to distribute stress in all directions in said walls, along said bars and throughout the spherical casing. Upon assembly the bars form continuous circumferential reinforcing about the sphere in all directions and have a plurality of major axes through the sphere for stress distributing cooperation.

A further object of the invention is to provide a substantially spherical casing structure having a horizontal deck or partition dividing the compartment within the casing into two sections, an upper compartment section and a lower compartment section, in which the deck or partition is used as additional shielding means for preventing radiation from affecting occupants of the lower section of the compartment when the rays come from above the upper section and vice versa. The partition or deck may also be constructed to form water compartments having a two-fold function; first, to provide a shield against some of the radiation from nuclear explosions, such as neutrons, where the neutrons travel toward one side of the deck and the occupants are at the opposite side of the deck; and second, where the water is also usable for drinking purposes by the occupants.

A still further object provides for construction of the casing in a plurality of partially spherical sections and with the deck or partition made in sections to facilitate manufacture and shipping. All of the sections will be made from steel reinforced concrete or similar cementitious material with portions of the peripheral frame members projecting outwardly beyond the outer marginal portions of the concrete. With this construction each casing section can be made in duplicate so that a plurality of sections may be assembled into substantially spherical casing forming relation by placing one edge of each casing section against the edge of another section with the metal frame members engaging one another for convenient attachment by welding, or the like, to rigidly secure adjacent sections in rigidly assembled relation. By assembling two sections as above described and then assembling additional sections in a similar manner one at a time, a casing composeed of two, four or more

sections may be conveniently manufactured, shipped and assembled at the site where the bomb shelter is to be built. After the casing sections are placed in position and welded together, the joints between the edges where the welds are made are filled with suitable joint filling material to complete the wall structure of the spherical casing. The sections will be formed with frame portions adapted to register upon assembly to provide one or more access openings to the compartment within the casing. A suitable closure may be provided for each of these openings arranged to be conveniently opened and closed by the occupants of the shelter from either the outside or the inside of the casing. The closure for the entrance opening may have suitable mechanism so the occupants within the shelter can conveniently lock the closure in closed position from within for holding it firmly in place during a nuclear explosion.

The invention further provides for the support of the spherical casing on a suitable foundation and an entrance to the bomb shelter from the lower portion in addition to the entrance at the upper portion. A tunnel arrangement communicates with and leads away from the foundation a suitable distance to a terminal housing which extends upwardly to the ground surface. A closure for the open end of the terminal housing provides convenient entrance and exit to the lower portion of the spherical bomb shelter casing through the tunnel and foundation.

These and other desirable objects may be attained in the manner disclosed as an illustrative embodiment of the invention in the following description and in the accompanying drawings forming a part hereof, in which:

FIG. 1 is a vertical cross section showing the bomb shelter constructed according to the invention to illustrate how it is buried below the surface of the ground and supported on a foundation member having a tunnel connected with a remotely located terminal casing to provide an entrance and exit into the bomb shelter from a remote location, as well as through the upper portion of the casing.

FIG. 2 shows the bomb shelter and foundation unit in perspective to illustrate how the casing when made of four sections is assembled with a partition or deck unit.

FIG. 3 is an enlarged fragmentary side elevation showing two upper sections and one lower section of the bomb shelter casing assembled with the deck or partition sections, illustrating how the marginal frame bars on adjacent edges of the partition and casing sections are assembled and welded together in casing forming relation.

FIG. 4 is a vertical fragmentary cross section taken through the central portion approximately on the line 4—4 of FIG. 3 to illustrate the assembly of portions of the casing sections with the deck unit or partition members and how the partition members are assembled together in forming the complete bomb shelter casing.

FIG. 5 is a fragmentary cross section taken approximately on the line 5—5 of FIG. 3.

FIG. 6 is a plan view of the deck unit assembled in the casing with the upper casing sections removed and with portions of the upper wall of the deck unit broken away to illustrate details of construction.

FIG. 7 illustrates the typical metal frame structure used in the construction of each partially spherical casing section in perspective.

FIG. 8 is a schematic layout diagram illustrating the arrangement of the metal bars in the metal frame for one quarter casing section.

FIG. 9 is a transverse cross section taken through the center portion of one of the casing sections to illustrate details of construction of a completed section.

FIG. 10 is a fragmentary cross section taken at the corner of one of the segments approximately on line 10—10 of FIG. 9 showing the details of construction.

FIG. 11 is a plan view of the closure for one of the entrance openings into the casing.

FIG. 12 is a fragmentary vertical cross section on an enlarged scale taken approximately on line 12—12 of FIG. 11, showing the construction of one of the closure members used for closing and shielding each entrance opening into the bomb shelter casing.

FIG. 13 is an enlarged fragmentary cross section through a portion of the casing showing the construction for providing one of the probe holes.

FIG. 14 is a detail cross section taken substantially on line 14—14 of FIG. 12 showing the hinge construction for attaching the closure to the casing.

FIG. 15 is a diagrammatic illustration in vertical cross section through a modified form of bomb shelter construction.

FIG. 16 is a horizontal cross section taken substantially on line 16—16 of FIG. 15.

The bomb shelter provided by the invention has a substantially spherical casing indicated at 1 preferably buried below the surface of the ground as shown in FIG. 1 with only a small portion of the upper part of the casing located at approximately the level of the ground. The substantially spherical casing 1 forming the bomb shelter is preferably supported on a foundation member 2 located in solid ground below the spherical casing or bomb shelter to provide a cradle like support for the casing. This foundation member 2 is preferably formed of a conduit of cylindrical, truncated conical, or other suitable shape in the form of a reinforced concrete conduit section. When the foundation member is arranged in an excavation in the ground to provide a suitable firm foundation, the casing can be easily placed in the desired position on the foundation member 2 where it will be firmly supported. The earth is replaced in the excavation made for the bomb shelter about the casing 1 and foundation member 2 in the manner illustrated in FIG. 1.

The foundation member 2 preferably has one or more openings in the side walls as indicated at 3 providing an exit-entrance opening into a tunnel construction 4 extending below the ground surface away from the lower portion of the bomb shelter to a remote location at a desired distance from the bomb shelter where it opens into the lower portion of a terminal casing 5, as shown in FIG. 1. The tunnel may be constructed of reinforced concrete pipe sections of suitable size so that people may crawl through the tunnel into the foundation member under the bottom of the bomb shelter casing. The terminal casing 5 is provided with a partition 6 having an opening formed therein to provide access to the lower portion of the casing from the open upper end located at approximately the level of the ground surface, as shown in FIG. 1. The upper end of the terminal casing 5 also has an opening to provide for entrance and exit. The terminal casing 5 may also be constructed of tubular reinforced cement pipe structures of conventional form with the upper portion of the casing 5 tapered inwardly to the open upper end forming an entrance. The invention provides the partition 6 in the terminal casing to form a radiation shield for the lower portion of the terminal casing and the tunnel. Suitable closures are removably mounted in the upper end of terminal casing 5 to close the entrance thereto and in the opening in partition 6 for closing and shielding the lower portion of the terminal casing.

The bomb shelter casing 1 is formed of a plurality of partially spherical sections 7 as illustrated in the drawing in which four casing sections 7 are assembled to form a substantially spherical casing 1 on opposite sides of a deck member indicated generally at 8 and formed of a pair of sections 9.

Each substantially spherical casing section 7 is designed to resist both inward and outward pressures and is constructed in the form of a stress distributing partially spherical cement and metal frame wall structure, as illustrated in FIGS. 7, 8, 9, and 10, for example. Each section has a stress distributing frame structure provided with the marginal frame bars 10 of substantially arcuate form arranged at substantially right angles to one another and joined at their ends to the terminal or gusset plates 11. The marginal frame bar 10 at one edge of the sections 7 has a central portion between the ends cut out to receive a substantially semi-cylindrical entrance frame bar 12 forming part of the entrance opening into the bomb shelter. This entrance frame bar 12 has its ends suitably secured by welding or the like to the adjacent ends of the marginal frame bar 10, as shown in FIGS. 7 and 8. All sections will usually be made identical.

The opposite marginal frame bar 10 has an attaching plate 13 welded in the central portion, as shown in FIGS. 7 and 8. Within this frame a series of bars are fastened to form a network of reinforcing. The bars are arcuate with a radius equal to the major radius of the sphere. They are so fastened that when the segments of the sphere are joined, substantially continuous circumferential reinforcing is provided. One possible arrangement will now be described. A central frame bar 14 of arcuate shape is located approximately in the center of the partially spherical section 7 between the marginal frame bars 10 and has the opposite ends welded to the gusset plates 11, as shown in FIG. 7. A ring 15 is suitably welded to the central portion of the central frame bar 14, as shown in FIG. 7. A plurality of tie bars 16 of arcuate shape have one end of each secured to the outer side of the semi-cylindrical entrance frame bar 12 in spaced relation and have the opposite ends extending toward the opposite marginal frame bar 10 in diverging relation, as shown in FIG. 7. The central tie bar 16 has its opposite end welded to the attaching or gusset plate 13 while the two outer tie bars 16, as shown in FIG. 7, have the opposite ends of each welded to the opposite marginal frame bar 10 at a position about one-half of the distance between the gusset plates 11 and the attaching or gusset plate 13.

A pair of tie bars 17 of arcuate form have one end of each welded to the attaching or gusset plate 13 at one end on opposite sides of the connection of the tie bar 16 thereto and extend in diverging relation to the central tie bar 16 toward the opposite marginal frame bar 10 where they have the opposite ends welded to the opposite marginal frame bar 10 at a position about one-half of the distance between the terminal gusset plates 11 and the semi-cylindrical entrance frame bar 12, as clearly shown in FIG. 7. The arcuate radial tie bars 18 have an intermediate portion of each welded to the ring 15 and to each other and the central portion of the central tie bar 16 with the opposite ends extending in arcuate radial relation from the ring 15 toward the opposite marginal frame bars 10. The opposite ends of the radial tie bars 18 are welded to the marginal frame bars 10 intermediate the ends thereof and about one-half of the distance between the entrance frame bar 12 and the attaching plate 13, respectively, and the gusset plates 11, as shown in FIG. 7 adjacent to the connections for the bars 16 and 17, respectively. It will be noted from FIG. 7 that all of the tie bars 16, 17 and 18 extend in angular relation to each other and to the central bar 14. All of these bars may be welded to each other where they cross one another in order to form a rigid stress distributing frame structure with marginal frame bars 10.

Semi-circular frame bars 20 have opposite ends welded to spaced portions of marginal frame bars 10. These bars 20 are positioned so the centers of the circles for each of the bars is located respectively at one of the centers of entrance frame 12, the gusset plate 13, and

the positions where the bars 17 and 18 are welded to frame bars 10, as clearly shown in FIGS. 7 and 8. Partially circular bars 21 are arranged at opposite ends of the frame, as shown in FIGS. 7 and 8, with the ends welded to marginal frame bars 10 adjacent to the connections for the adjacent bars 20. Bars 21 have the centers for the circle of the bars located substantially at the position where the frame bars 10 are joined and substantially at the outer corner of gusset plates 11. Supplemental arcuate bars 22 are mounted to extend across opposite end portions of the frame with the ends welded to marginal frame bars 10 adjacent to the connections of bars 17 and 18. Supplemental arcuate bars 22 have the center portions engaged with central frame bar 14 to which they are preferably welded. The central portions of partially circular bars 21 are also preferably welded to the central frame bar 14.

This frame structure, as illustrated in FIG. 7, is placed in a suitable mold lined with plastic sheet material and has concrete or other suitable cementitious material cast about the frame structure to produce a finished wall or casing section 7 having a smooth reflective outer surface for use in building the bomb shelter casing 1. This wall or casing section 7 is preferably of substantially uniform thickness in cross section and of partially spherical shape. Where four sections are used to form a bomb shelter casing 1, each section will be approximately the shape of a quarter of a sphere so that four sections 7 assembled together will provide a complete casing 1 of substantially spherical form. The smooth reflective outer surface is formed by the plastic sheet in the molding of each section 7 and forms a smooth highly reflective surface for reflecting rays of many different wavelengths including thermal rays.

When the frame members shown in FIG. 7 have a cementitious material molded thereon to form the completed section, the outer edges of the marginal frame bars 10 will project to the outer edge of each side of the section, as shown in FIGS. 9 and 10, while the wall structure is recessed as indicated at 19 in FIGS. 9 and 10, to expose the surface of the marginal frame bars 10 throughout their length. When two or more sections 7 of the substantial spherical casing are assembled, the marginal frame bars 10 will be arranged in edge to edge relation with the edges of the sections abutting in close relation. In this relation the sections may be rigidly secured together by welding the marginal frame bars 10 of adjacent sections together throughout the length of the bars. The recesses 19 in the outer face of each of the spherical sections 7 provide a sufficiently wide opening when the sections are assembled, as shown in FIGS. 3 to 5, so access to the marginal frame bars 10 may be had for welding them together to form a rigid frame structure for the assembled substantially spherical casing.

In the form of the invention illustrated, two partially spherical sections 7 are assembled together to form a unit. This unit may be mounted on foundation member 2 with the edge portion facing upwardly to form the lower portion of the shelter. A deck member 8 is then assembled on the upper edges of this lower casing unit, as shown in the drawings. Each two spherical sections 7 are applied together on opposite sides of the deck member 8 in such a way that the joint between the two upper sections will be arranged in a plane substantially ninety degrees apart from the plane of the joint between the two lower sections, as clearly indicated in FIG. 2.

The deck member 8 is formed of a pair of deck sections 9 as illustrated in the drawings. Each deck section 9 may be formed of solid steel reinforced concrete, or the like, in which case it is preferable to use iron filings or iron segments of small size throughout the deck structure of each section 9 to form a radiation shield. The deck structure, as illustrated in the drawings, shows the deck sections 9 in the form of two flat substantially semi-circular units of hollow construction. Each deck section 9 is formed of a lower deck body 25 having a bottom wall 26, an outer side wall 27 of substantially semi-cylindrical shape, an inner side wall 28 and a central partition wall 29. A top plate 30, FIG. 4, formed of reinforced concrete is molded onto the upper edges of the side walls 27 and 28 and the partition wall 29 by leaving portions of the reinforcing members in the side walls projecting above the upper edges. In this way the top plate 30 may be molded onto the lower deck body 25 to provide sealed waterproof compartments in the space between the bottom wall 26, the top plate 30 and the outer and inner side walls on opposite sides of partitions 29. A pipe 29' is mounted in each partition 29 as shown in FIG. 6 to provide communication with the compartments on each side of the partition. The deck sections 9, as shown in FIG. 4, will be formed with keyways 31 extending along the inner face of side wall 28 throughout its length from end to end thereof. The deck sections 9 may be assembled with the inner faces of the inner walls 28 slightly spaced from one another when mounted in assembled relation to from a circular deck. Cement is then forced into the space between inner walls 28 and into keyways 31 to interlock deck sections 9 together in assembled relation. The top plate 30 and the bottom wall 26 of deck sections 9 are also formed with apertures sufficiently large to provide passageways between the upper and lower compartment sections for the occupants of the bomb shelter to climb through, as shown in FIG. 4. A sheet metal tube 32 is inserted in the openings in the top plate 30 and the bottom wall 26, as shown in FIG. 4. The sheet metal tube 32 is sealed in the apertures in the top plate 30 and the bottom wall 26 to prevent leakage of water from the compartment in the deck section 9 in any suitable well known manner. A ring 33 is removably mounted over the upper end of one of the sheet metal tubes 32 and has an offset strap portion extending across the central portion thereof so it will fit and extend down into the tube 32, as shown in FIG. 4. This provides a support for a bottom plate 34 secured in assembled position on the bottom of tube 32 by a pair of bolts. This sheet metal tube may be filled with sand. A floor plate 35 is then mounted on top of this tube. This provides an emergency access opening between the top and bottom compartments in case the other tube becomes damaged or closed.

The other tube 32 will normally be used for passage of individuals in the casing between the upper and lower compartments. A closure will be used for this other tube which will be mounted at the upper end thereof and will be the same construction as that hereinafter described for closing the entrance openings into the casing.

Where the deck member 8 is used in the construction of a bomb shelter, as shown in the drawings, it will be assembled on top of the bottom pair of spherical sections 7 forming the bottom half of the bomb shelter casing by having the marginal portion of the assembled deck sections 9 seated on the edges of a pair of the assembled spherical sections 7, as shown in FIG. 4. Each deck section in being molded of concrete about a steel reinforcing framework will have a semi-cylindrical attaching bar 36 secured to the outer marginal portions of the reinforcing framework, as shown in FIGS. 3 and 4. Attaching bars 36 will be mounted in the upper and lower outer portions of the deck member 8 in the marginal portions of the top plates 30 and the bottom walls 26 and the outer side walls 27, as shown in FIGS. 3 and 4, so the outer edges will abut the outer edges of the marginal frame bars 10 of the casing sections 7. The outer edges of the deck member 8 will have the wall recessed, as indicated at 37 in FIG. 4, to expose the bars 36 to an extent sufficient to provide for welding the bars 36 and the marginal frame bars 10 throughout their respective lengths together to form a rigid assembled structure.

The bars 36 will extend entirely around the upper and lower portions of the deck member 8 and be completely welded to the outer marginal frame bars 10 of the four partially spherical sections 7 to rigidly unite the upper and lower sections 7 to the deck sections 9.

It will be understood that where the marginal frame bars 10 engage at the corners of the spherical sections 7 and with the bars 36 at the joint between the deck sections 9, there will be a pair of end bars 38 attached to the ends of the bars 36 and the reinforcing framework so that the joints at the outer side between the sections 9 alined with the joint between the sections 7 may be welded together, as clearly illustrated in FIG. 3 to form a unitary structure. Where it is found desirable, the joint between the deck esctions 9 may be offset between the joints of the sections 7.

In assembly of two duplicately constructed sections 7, the semi-cylindrical entrance frame bars 12 will be arranged in opposite complementary relation to form an entrance opening into the compartment within the casing 1. In using four duplicately constructed sections 7, as illustrated in the drawings, with two assembled in the manner described above on the top and bottom respectively, of the deck member 8, an arrangement will be provided where entrance openings are located at the top and bottom of the bomb shelter casing. The deck member 8 will also divide the bomb shelter casing into upper and lower compartment sections each of which is accessible through one of the openings in the bomb shelter casing, as well as through the openings in the deck.

The bomb shelter casing 1, as shown in the drawings, is arranged so the lower entrance opens into the interior of the foundation member 2 so that access may be had to the lower section of the bomb shelter through the foundation member 2, the tunnel 4 and the terminal casing 5 or through any suitable equivalent entrance passages that may be found desirable. The bomb shelter casing 1 will be arranged on the foundation member 2 so the deck member 8 will be ararnged in a substantially horizontal position to provide head room in both the upper and lower sections of the bomb shelter and also a deck for supporting the occupants in a comfortable position in the upper compartment section in the casing 1. When all of the sections are welded together and to the deck member 8, as herein above described, the recesses 19 and 37 provided for welding the metal frame members in forming the rigid casing structure will be filled with cement or other suitable cementitious material to complete the wall of the casing structure. The bomb shelter in assembled relation will then appear in the form illustrated in FIGS. 1 and 2. The lines shown in FIG. 2 indicate diagrammatically the position of the joints between the sections 7 and the deck member 8 for indicating the location of the joints where the sections are assembled together. These lines will not show in a completed shelter after recesses 19 and 37 are filled, and are used only for the purpose of diagrammatic illustration of the invention in this application.

A plurality of tubular pipe sections 40 are molded into each section 7 around and spaced suitably over the entire surface of the completed sphere to provide probe holes in the wall structure of the bomb shelter. Each pipe 40, see FIG. 13, has an outwardly extending flange at the outer end to seat against the outer surface of the cementitious material forming the wall of the casing and will extend through the wall of the casing in substantially radial relation and have an inner end projecting inwardly beyond the inner wall surface and threaded to receive a suitable cap 41 for closing the hole provided by the pipe. A slug 42 of concrete or the like to form a radiation shield will be slidably inserted into the pipe 40 and held in place by the cap 41 and an inwardly extending shoulder formed about the outer end of pipe 40. This provides a shield against radiation entering into the casing through the pipe 40. These probe holes formed by the pipes 40 are provided for the purpose of allowing a smaller pipe or rod to be projected outwardly through the wall of the casing 1 after a bomb blast should the casing be disoriented from its original position in order to determine the amount of earth or other material over the upper portions of the substantially spherical casing 1 and to extend a tube into the atmosphere above the ground for drawing air into the bomb shelter compartment after an explosion for either test purposes or for use in supplying air to the occupants whenever it is found that the air above ground is suitable for human use.

A suitable closure is provided for the entrance openings in the casing 1. Such a closure should provide shielding from radiation in addition to closing the entrance openings into the casing in an effective manner to withstand the pressure created by a nuclear exposion. A suitable cover for this purpose is shown in FIGS. 11 and 12. A cover ring 43 is provided with a handle 44 on the outer side. The cover ring 43 will have an open center portion and a flange extending inwardly into the opening at the upper end of the opening as well as an outwardly extending flange, as shown in FIG. 12, carrying a sealing ring for effectively sealing against the outer portion of the casing and the frame bar 12 in closed position. The cover will also include an inner plug member 45 formed of reinforced concrete of suitable thickness to extend from the outer face of the cover ring 43 to a point within the casing 1.

A hinge attaches the cover to the entrance frame bar 12, as shown in FIGS. 12 and 14. The hinge has a pair of spaced parallel supporting plates 46 mounted on frame bar 12. A pair of supporting bars 47 each have one end pivotally mounted on one of the pivot pins 48, each pivot pin being mounted on one of the supporting plates 46. A pair of cover hinge bars 49 have the central portions pivotally connected by pivot pins 50 to the intermediate portions of supporting bars 47. The lower free ends of cover hinge bars 49 are connected by control bar 51. A control link 52 has one end pivotally mounted on the intermediate portion of control bar 51 and the opposite end pivotally mounted on the intermediate portion of pivot pin 53. The pivot pin 53 has opposite ends mounted in supporting plates 46 in spaced relation below pivot pins 48 in a position spaced slightly inwardly from the vertical plane passing through the center of pivot pins 48. The control link 52 has a length between the pivot pin 53 and the control link 51 slightly less than the distance between pivot pins 48 and pivot pins 50 for a purpose to be described.

The upper ends of cover hinge bars 49, as shown in FIG. 12, above pivot pins 50 extend in angular relation toward entrance frame bar 12 at an angle of about forty degrees from the vertical center line through the center of the cover hinge bars. The upper free ends of cover hinge bars 49 are pivotally connected by a cover hinge pin 54 to cover hinge plates 55 mounted on the underside of the cover ring 43. A pair of second hinge pins 56 are mounted in cover hinge plates 55 inwardly in spaced relation to cover hinge pin 54, as shown in FIG. 12. The hinge pins 54 and 56 lie in a plane substantially parallel with the upper and lower surfaces of the cover 43. A pair of spaced substantially parallel connecting links 57 have their upper ends pivotally mounted on hinge pins 56 and extend downwardly in substantially upright relation at the outer sides of the supporting levers 47. The lower ends of connecting links 57 are pivotally attached to the outer free ends of supporting bars 47 by the hinge pins 58. The supporting bars 47 have the ends extending from opposite sides of the pivot pin 50 in angular relation in which the included angle between the opposite ends is approximately one hundred thirty-five degrees. The length of the ends of the supporting bars 47 between the pivot pin 50 and hinge pins 58 and pivot 48 is substantially equal. The distance between cover hinge pins 54 and 56 is sub-

stantially equal to the distance between pivot pin 50 and pivot 48.

This provides a hinge construction for the cover 43 which will operate in opening movement of the cover to move the cover upwardly at the hinge portion and the opposite edge until the bottom inner edge of the cover will move to a position above and clear of entrance frame bar 12. Then, further opening movement will cause the free end of the cover opposite the hinge portion to move through an arcuate path to a position above the hinge with the cover in substantially vertical position. In the start of this opening movement the cover hinge bars 49 move upwardly with and under the control of the supporting bars 47 and the control link 52. The preliminary movement will be slightly inward and substantially vertical until the hinge bars 49 reach an upwardly inclined position of about forty-five degrees. When this approximate position is reached the bottom or inner surface of the cover will be substantially above the upper outer edge of entrance frame bar 12. Further movement further raise the hinged edge of the cover and start moving it outward until it reaches the substantially vertical open position to one side of the entrance opening as indicated in dotted lines in FIG. 12. The pair of connecting links 57 and the outer ends of the supporting bars 47 cooperate in moving the cover into substantially vertical position as the several links move to the open position. In open position the cover hinge bars 49, the supporting bars 47, the control link 52 and the connecting links 57 will all move into positions extending upwardly and toward the entrance frame bar 12 to lie between and at the outer sides of the supporting plates 46 and above the upper edges of the supporting plates 46.

The inner plug member 45 is detachably secured to the under inner side of the cover ring 43 by a plurality of bolts 59 having nuts threaded on the inner ends in rigidly attaching the cover ring and plug member together.

The central portion of the plug member 45 has a pipe 60 mounted therein with an external flange extending over the outer upper surface, as shown in FIG. 12, and the inner end extending below the lower face of the plug member 45 to receive a cap 61. This provides another probe hole in the casing for use in extending a radio antenna into the air outside the casing or use as a probe hole to determine conditions outside of the casing by those occupying the bomb shelter. The entrance of radiation through the pipe 60 is controlled by means of a concrete plug 62 held in position by the cap 61 and an inwardly extending shoulder about the upper outer end of pipe 60. This plug is removed by the occupants inside the casing or bomb shelter upon removal of the cap for exploratory purposes and is then replaced when replacing the cap 61, in the same manner followed in using the other probe holes.

The cover with the assembled cover ring 43 and the inner plug member 45 will be latched in closed position by the occupants of the bomb shelter. A latch bar 65 has one end pivotally mounted on the inner end of one of the bolts 59 at the opposite side of the cover from the hinge, as shown in FIG. 12. This latch bar has an inwardly extending portion from the end mounted on the bolt 59 terminating in an outwardly extending portion for engaging under the inner edge of the entrance frame bar 12. The other end of the latch bar 65 forms a handle for manually rotating it into and out of latching position. When the latch bar 65 is extended toward the center of the cover it will not interfere with opening movement of the cover as above described.

It will be understood that covers constructed as herein described will be used to cover both the top and bottom entrance openings to the bomb shelter casing and will also be used in the opening in the deck 8 providing access between the upper and lower compartments in the casing through the tube 32 not provided with the cover 35. One of these covers may be used in place of the ring 33, bottom plate 34 and cover 35 if desired. However, where the cover 35 is used, it is not intended to normally use this tube 32 for access purposes except when the cover over the other tube 32 becomes jammed or otherwise inoperative. Then, occupants in the upper compartment can remove the cover 35, unscrew the bolts holding the bottom plate 34 to the ring 33. The bottom plate 34 with the sand filler will drop into the lower compartment. The ring 33 is removed from the tube 32 and then the access opening is clear for passage to the lower compartment. Occupants of the lower compartment remove the bolts holding the bottom plate 34 and let the sand drop into the bottom compartment. They can then push the ring 33 and the cover 35 upwardly into the upper compartment for opening the tube 32 for passage. The cover 35, bottom plate 34 and sand provide a radiation shield when they are in position on the tube 32.

Attention is directed to the arrangement of the bars in the frame for the casing sections from which it will be understood that in the assembled spherical casing, there are approximately fifteen different axes extending in diametrical relation through the assembled spherical casing where the bars forming the frames for the assembled section intersect each other. A plurality of frame bars and tie bars, as shown in FIGS. 7 and 8 intersect and extend in angular relation to each other entirely about the spherical casing in assembled relation at each of the axes and provide stress distribution through the walls of an assembled casing in all directions. This structural arrangement also provides substantial strength to absorb and distribute compression stresses applied at any part on the outer surface and also stresses applied from the inside caused by rapid increase and decrease of exterior pressures above and below the interior pressure.

Suitable equipment such as seats or beds with food, etc., will be stored within the bomb shelter constructed as herein above described for the convenience of the persons using the shelter. Suitable valves or the like will be mounted in the bottom wall 26 and small openings with caps mounted therein may be provided in the top plate 30 so that the occupants of both the upper and lower compartments of the shelter may obtain access to obtain water from the compartments in the deck member 8. These are not illustrated in the drawing but any suitable means for obtaining the water from the compartments in the deck may be provided.

In a bomb shelter construction with the casing 1 formed of the sections 7 and the deck member 8 constructed as herein above described, the wall portions using the metal frame members, as shown in FIG. 7, will provide a stress distributing structure in assembled form. The forces of a nuclear explosion will be applied to the outside of the bomb shelter casing from substantially all directions. The forces directed against the outer wall surfaces of the casing will be distributed along and within the wall portions through the cooperation of the metal frame structure embedded in cement circumferentially around the walls in all directions for equalization. In this way this substantially spherical casing structure with its combined metal frame and cement sections can be constructed with relatively thin wall portions, approximately four inches thick for example, and provide a bomb shelter that will withstand tremendous pressure from nuclear explosions for protecting and preventing injury to the occupants within the compartment.

When the bomb shelter is located below ground, as illustrated in FIG. 1, the effects of all radiation especially neutrons entering through the upper portion of the casing 1 will be reduced in their effects upon the occupants of the lower compartment of the shelter due to the barrier or shield provided by the deck member 8 and the water within the compartment. In this way neutrons or other radiation entering into either of the compartment sections will be blocked by the deck member to further protect the occupants of the compartment on the opposite side

of the deck member. The smooth reflective outer surface also reflects many of the different rays of various wavelengths including thermal rays from all portions of the casing in further protecting the occupants from radiation.

This bomb shelter is constructed so that the concrete wall structure with embedded metal frames will effectively shield the occupants of both the upper and lower compartment sections against radiation as well as to protect them against the effects of the bomb blast through the stress distributing properties of the casing sections and the deck sections cooperating with one another to distribute stresses throughout the walls thereof for equalization. With a substantially spherical bomb shelter incorporating the invention herein above disclosed, the occupants of the shelter will be protected against the effects of large nuclear explosions in the order of fifty megatons from points just beyond the crater caused by the explosion. The bomb shelter herein above disclosed may have the earth about the shelter substantially removed by nuclear explosion while it will still protect its occupants from blast effects and thermal flash burns and against radiation to a lesser degree.

The probe holes provide openings for air induction, water piping, drainage lines and other service and emergency features so that in the event the blast is severe enough to dislocate the position of the sphere on its foundation and in the ground, the probe holes nearest to the surface can be opened and threaded lengths of pipe can easily be ejected to the surface for ventilating, air induction, testing, and the like. In addition, should the bomb blast jam the entrance doors, a probe hole pipe can be forced out of the shelter by jacking to expose a section of the concrete wall around the probe hole. A new hole may be formed by chipping out the concrete with the use of hand tools by the occupants to escape from the shelter. The spherical bomb shelter may be buried completely in the ground with the upper portion adjacent the surface of the ground, as illustrated in FIG. 1 of the drawings, or it may be buried beneath the surface of the ground with a suitable entrance or terminal casing similar to terminal casing 5 extended above the upper opening in the casing to the ground level. This is not shown in the drawing but will be obvious from the illustration of the invention and the above description.

The modified bomb shelter construction shown in FIGS. 15 and 16 is illustrated in diagrammatic form on a small scale for the purpose of illustrating how a different interior arrangement may be built into a spherical casing from that previously described. It will be understood that the casing sections will be constructed and assembled as hereinbefore described and that the deck member 8 will be omitted. Instead, for example, a pair of the casing sections 7 are constructed with integrally molded deck portions 70 extending inwardly throughout a portion of one margin thereof. When this pair of sections is assembled with the deck portions 70 positioned horizontally, they will cooperate to provide a deck in the casing in the central portion about the inner walls of the shelter casing as shown in FIG. 15. The deck portions 70 are shown as extending around about three-fourths of the inner wall of the casing. These deck portions 70 will provide either storage space or bunks for occupants to sleep on.

The two top casing sections forming the upper half of the spherical casing are constructed to correspond with casing sections 7 and have a partition wall 71 of reinforced concrete secured or molded in the upper portion thereof as shown in FIG. 15. The partition wall 71 will have the center portion formed with an opening to receive the sheet metal tube 72 to form an entrance passage into the shelter. The entrance tube 72 will fit on the inside of the entrance frame bars 12 of the upper sections and be sealed thereto and to the partition wall 71 in watertight relation.

The compartment formed at the top inside portion of the shelter casing is suitably equipped with a water inlet and outlet connection of a conventional form which are not shown. Water tanks may be placed in the compartment, if desired. The water forms a radiation shield at the top of the casing as well as, a supply of drinking water. The lower casing sections will have a partition wall 71 formed therein to form a floor at the bottom portion of the casing. An entrance tube 72 is inserted in the bottom entrance opening into the shelter casing and will extend through an alined opening in the bottom partition wall 71 forming the floor. If desired the partition wall 71 at the bottom of the casing may have a wooden or other type of floor suitably secured to the inside wall of the casing. The entrance openings will have covers applied thereto of the character hereinabove described. Other details of construction as above described, such as probe holes, will be provided in the structure illustrated in FIGS. 15 and 16, and the spherical casing may be mounted and entrances provided as above described.

It is seen from the foregoing disclosure that the above mentioned objects of the invention are well fulfilled. It is to be understood that the foregoing disclosure is given by way of illustrative example only, rather than by way of limitation, and that without departing from the invention, the details may be varied within the scope of the appended claims.

What is claimed is:

1. A bomb shelter, comprising a substantially spherical casing having walls formed of cementitious material of substantially uniform thickness to form an interior compartment, foundation means mounted below ground for normally supporting said casing in a predetermined position below ground level with the uppermost portion lying close to ground level, said foundation means being formed of a conduit providing an internal passage extending downwardly from the lowermost portion of the casing, entrance means at the uppermost and lowermost portions of the casing providing access to the interior compartment from above ground level and to the lowermost portion through said foundation means, tunnel means extending from said foundation means a substantial distance away from said casing and foundation means forming a passage providing access through said foundation means to the lowermost portion of said casing, a terminal housing at the outer end of said tunnel means formed with a passage communicating with said tunnel means at one end and opening at the ground level at the other end, and closure means controlling access at the ground level opening, and substantially horizontal deck means mounted in the intermediate portion of said casing dividing said compartment into upper and lower sections, whereby said entrance means, foundation means, tunnel means, terminal housing and closure means provide access to both upper and lower sections of said compartment from spaced locations at ground level and protect said sections from radiation, said casing and deck means having stress distributing cooperation for distributing stresses applied to the outer side of said casing through said walls and deck means in all directions parallel to the surfaces thereof for equalization therein, and said casing cooperates with said deck means in providing a radiation shield for occupants of one section of said casing from radiation directed toward said casing and the opposite side of said deck means.

2. A bomb shelter as claimed in claim 1 wherein said deck means comprises spaced floor members and connecting wall portions forming a chamber therein adapted to contain water as a radiation shield and for consumption by the occupants of the compartment sections, and means providing access to each compartment section.

3. A bomb shelter comprising a substantially spherical casing formed with a compartment therein and having casing walls formed for shielding and protecting occu-

pants of the casing from the effects of nuclear explosions, said casing being formed with an entrance to provide access to said compartment, closure means for said entrance, a plurality of small passages formed in said casing walls opening in said compartment at the inner ends, extending in angular relation to each other and opening at the outer sides of said casing to form probe holes, said probe hole passages being spaced at intervals throughout all sides of said spherical casing so that in any position to which said casing may be displaced as a result of an explosion, at least one of said probe holes will extend approximately upwardly from the top of the displaced casing, and closure means for each of said small passages detachably mounted on said casing wall at the inner side thereof in said compartment.

4. A bomb shelter of the character claimed in claim 3 wherein a plurality of pipe sections are mounted in said casing wall to form said passages, cap members are detachably mounted on the inner ends of said pipe sections to close the passages therein, and radiation shield plugs are detachably mounted in said pipe sections.

5. A bomb shelter structure comprising a subterranean hollow foundation having an access passageway leading laterally outwardly therefrom, a substantially spherical shelter body separate from and resting on top of said foundation, a body of earth surrounding said spherical shelter body and substantially covering the same except at the extreme top thereof, a first personnel passageway extending upwardly through substantially the extreme top of said spherical body for access to the outer atmosphere above ground level, means manually displaceable from within said body for sealing said first personnel passageway in an airtight manner, a second personnel passageway extending downwardly through substantially the extreme bottom of said spherical body for access into the space within said hollow foundation, means manually displaceable from within said body for sealing said second personnel passageway in an airtight manner, a pair of vertically spaced substantially horizontal partitions

extending substantially diametrically across said spherical body to divide it into upper and lower personnel compartments of approximately equal size, said horizontal partitions being watertight so that the space between them may be used for storage of water, means forming a personnel passage through said partitions in watertight relation to the space between them, a multiplicity of relatively small probe holes extending approximately radially through the walls of said spherical body at intervals throughout all sides thereof so that in any position of displacement and disorientation of said body as a result of an explosion, at least one of said probe holes will extend upwardly from approximately the then top of the displaced body, and means manually displaceable from within said body for sealing each of said probe holes in an airtight manner.

References Cited in the file of this patent

UNITED STATES PATENTS

625,258	Grow	May 16, 1899
1,367,501	Reineke	Feb. 1, 1921
1,549,240	West	Aug. 11, 1925
2,166,577	Beckius	July 18, 1939
2,223,418	Hewett	Dec. 3, 1940
2,350,981	Bescherer	June 13, 1944
2,729,966	Lutteke	Jan. 10, 1956
2,771,042	Deaton	Nov. 20, 1956
2,773,459	Sechy	Dec. 11, 1956
2,822,765	Rudinger	Feb. 11, 1958
2,897,668	Graham	Aug. 4, 1959

FOREIGN PATENTS

656,577	Germany	Feb. 9, 1938
675,737	Germany	May 16, 1939
892,511	Germany	Oct. 8, 1953

OTHER REFERENCES

Publication: "Popular Mechanics," vol. 109, March 1958.