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LOW WEIGHT CONTAINER FOR RADIOACTIVE MATERIALS

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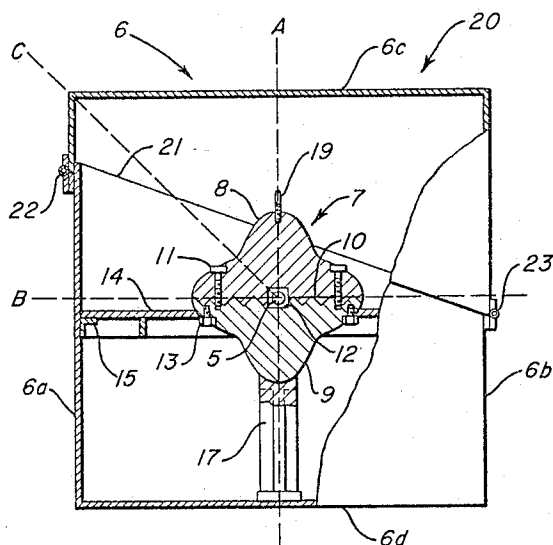


Fig. 1.

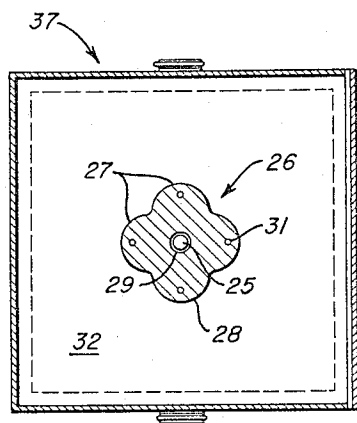


Fig. 2.

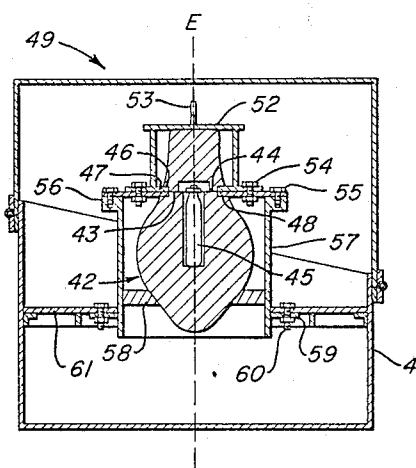


Fig. 4.

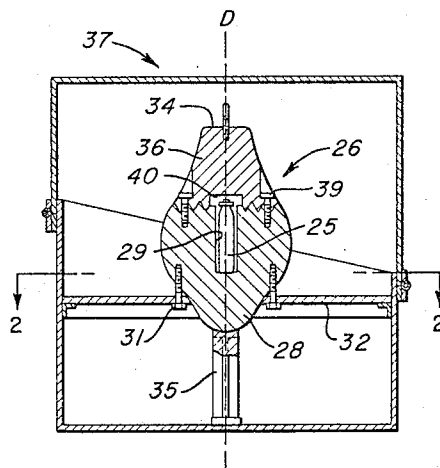


Fig. 3.

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1

2,743,372

LOW WEIGHT CONTAINER FOR RADIOACTIVE MATERIALS

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This invention relates to containers for radioactive materials. It is particularly, although not exclusively, concerned with shielding containers which are readily portable as distinguished from those which are permanently installed. Immediately perceived requirements of portable containers of the class described are minimum exterior dimensions, minimum weight and container configuration that will facilitate transporting and storage, as well as being convenient in use.

It has been found that the standard cubical shipping container for radioactive materials when provided with wall type interior shielding such as sheets of lead, for example, is so heavy due to the necessary thickness of the sheets that expedited shipment, as by aircraft due to the short half-life of the radioactive material as Na^{24} , is not commercially feasible due to weight limitations. The foregoing coupled with the dimension limitations of air freight shipment adds also to the difficulties of loading and unloading.

With the increasing use of radio-isotopes by industry the importance of the problem and an insistent need for its solution have been recognized. The evolution of the container of this invention resulted from vigilant attention to the most salient factors dictated by both theoretical considerations and practical use.

Accordingly, it is a principal object of this invention to provide a cubical container assembly of minimum outside dimensions for the safe transportation and storage of radioactive materials.

Another object of the invention is the provision of a dual container assembly in which an outer cubical container encloses an inner, centrally disposed container for radioactive material, the latter being so shaped as to provide a value of radioactivity that varies within permissible limits on the outer surface of the cubical container.

A further object of the invention is to provide a dual container assembly for generally spherical sources of radiation which will insure a more nearly constant radiation level on the surface of the outer container and one that will require a minimum of material.

An additional object of the invention is to provide a dual container assembly of improved design for generally spherical sources of radiation carried in a standard cylindrical container which will insure a more nearly constant radiation level on the surface of the outermost container.

A still further object of the invention is to provide a dual container assembly for radioactive material which is characterized by rigid yet readily separable relation of the inner and outer containers.

Another object of the invention is to provide for a generally spherical source of radiation, a cubical container assembly which is so shaped internally and externally as to provide a limited level of radiation upon all outer surfaces of the container when the radiation source is disposed at the center of the latter.

Additional objects and advantages of the invention will

2

be apparent from a consideration of the following specification and accompanying drawings, and wherein:

Figure 1 is a central section taken on a plane parallel with one wall of one form of our cubical container assembly;

Figure 2 shows a modified form of the invention and is a sectional view of Figure 3 taken on line 2—2 of the latter;

Figure 3 is a vertical, centrally taken, sectional view of a form of the invention also shown in Figure 2 and particularly useful for shielding radioactive materials retained in cylindrical receptacles; and

Figure 4 is a vertical, centrally taken, sectional view of a modified form of the invention shown in Figs. 2 and 3 and likewise accommodating an innermost cylindrical receptacle.

The principle of the invention in its simplest form will be most easily understood from a consideration of Fig. 1 to which attention is now directed.

In this figure is shown a source of radioactivity 5 which can be considered as generally spherical and located at the intersection of the central axes A and B of the cubical outer container 6, of which opposite side walls 6a, 6b, and top and bottom walls 6c and 6d, respectively, appear in this figure. Accordingly, the distance from source 5 to the outer surface of container 6 will vary from a minimum where any of such axes intersects a wall, as 6a, to a maximum where a diagonal, as C, intersects the vertex of any one of the four trihedral container angles, i. e., at the corner of the cubical container. Therefore, the problem of designing a centrally immobilized, inner container 7 so that the radiation monitored from the source 5 at various points over the outer surface of container 6 will be at a safe and relatively constant level is governed by the reference points of maximum and minimum radiation as just described and the pattern of variation encountered therebetween.

The cross sectional outline of the inner container 7 in the central plane of symmetry (Fig. 1) may be ascertained in various ways, in all of which it will be necessary to obtain the location of the inner container boundary through an included radial angle of only 45 degrees from the point radiation source (center of cube 6) and one side of which angle coincides with an axis of symmetry of the container and the other side is a diagonal to the intersection of the top wall 6c and adjacent side wall 6a, for example. Since the outer container is a cube, it is evident that the inner container 7 will have three mutually perpendicular axes of symmetry passing through the cube center and that such container therefore will be a solid obtained by revolving the central section 7 about either the horizontal axis B or the vertical axis A of Fig. 1 with identical results.

The boundary of the inner container 7 will, of course, be such as to interpose a greater wall thickness of the shielding material, e. g., uranium metal, along axis B than along diagonal C and the optimum curvature may be calculated in accordance with the inverse square law along various angularly separated radii between axis B and diagonal C having first determined the necessary thickness of container 7 along axis B to provide a safe radiation level at the intersection of such axis and side wall 6a. Since the source 5 is disposed at the center of cube 6, the sectional outline of container 7 may be readily plotted both in the two dimensions of Fig. 1 and also in the third dimension normal thereto. It will be appreciated that the distance from source 5 to a corner of the cube 6 is greater than that from the source 5 to the container along the diagonal C in the plane of the paper and theoretically the thickness of container 7 in the direction of each corner may be further decreased

if the necessary calculations are deemed justifiable by the saving in weight and material.

It will be readily appreciated that empirical methods of contour determination of container 7 are feasible. For example, by use of a stack of thin sheets of shielding material disposed perpendicular to the radius being probed and with a suitable survey meter located at the surface of the cubical container intersection with such radius, the necessary thickness of shielding material along such radius will be found.

Container 7 is preferably made as an upper half 8 and a lower half 9 joined along mating zigzag and concentric surfaces 10 extending generally in a horizontal plane to eliminate stray radiation through the necessary closure and maintained in assembled relation by suitable means such as screws 11. The assembled sections 8 and 9 define an innermost cubical receptacle 12 for the radioactive material and also constitute a rigid unit with respect to the outer container 6 by being fastened as by bolts 13 to a suitable central shelf 14 which is apertured to receive the lower portion 9 of the container 7. Shelf 14 may be made of steel welded to wall brackets 15 of the outer container 6 and serves to center the container 7 as well as support the latter. Through the provision of a sturdy central post 17 of the I beam type, support of container 7 is also derived directly from the bottom wall 6d to which it is suitably anchored.

For convenient access to the interior of outer container 6 and to the eye bolt 19, which is provided in the top half 8 of container 7 to facilitate its removal, a three dimensional hinged lid as 20 is preferred. Thus, the lid 20 includes not only the top 6c of the outer cubical container 6 but also an appreciable portion of the side walls as well and provides a marginal overlap with the container body. The latter feature operationally is facilitated by having the plane of the container opening 21 disposed at an angle to the container bottom 6d. Spaced hinges 22 unite lid 20 with side wall 6a, while on the container's opposite side 6b a central hinge 23 having a selectively removable hinge pin serves to lock the outer unit for shipping purposes.

In actual practice it has been found that inner containers of the contour shown in Figure 1 are difficult to produce by machining of the usual shielding materials employed, such as uranium metal and tungsten. Accordingly, a modified version of the invention but involving the same principles is shown in Figures 2 and 3. Herein, the innermost receptacle 25 is shown as cylindrical and customarily is identical in size and shape with those inserted in the pile at Oak Ridge, Tennessee, radioactive material of short half-life being more expeditiously prepared for rapid shipment by using the same container in which the material was irradiated.

In general, the same method of calculating the thickness and contour of the inner container 26 in Figs. 2 and 3 is followed as we employed in arriving at the configuration of the container 7 of Fig. 1 and depending on the shielding effectiveness of the material used. The similarity of the section contour of Fig. 2 to that of Fig. 1 will be noted. In the interest of simplicity, the bases of the oppositely directed projections or cusps 27 do not follow the theoretical data precisely but are broader to follow a standard geometric figure (i. e., a circle) and since the projections themselves are semispheres, machining to the final shape of Figs. 2 and 3 is much easier and cheaper despite the additional material required. Sufficient number of transverse sections spaced along the vertical axis D will be plotted to delineate a solid figure having a vertical section as shown in Fig. 3.

The other constructional features of the embodiment of Figs. 2 and 3 follow, in general, those of Figure 1. The two portions (upper and lower) of the inner container are united along concentric and corrugated mating surfaces extending generally in a horizontal plane. The lower and major container portion 28 is cylindrically

bored to provide a vertical, central recess 29 for the cylindrical receptacle 25 and is fastened securely as by bolts 31 to a centrally apertured shelf 32 rigidly secured as by welding to the lateral walls of an outer cubical container similar to that of Fig. 1. Central supporting post 35 in Fig. 3 serves the same purpose as post 17 of Fig. 1.

The upper portion 36 of container 26 is flat-topped as at 34 to facilitate further interior bracing within the outer cubical 37 by structural members (not shown) depending from the lid of cubical 37 and adapted to engage such flattened portion when the lid is in closed position. A recess 40 centrally of the corrugated surface of upper portion 36 accommodates the customary cap of cylindrical receptacle 25 to simplify removal of the latter while screws 39 constitute convenient fastening means for the upper and lower portions of container 26. The container assembly of Figs. 2 and 3 is especially useful for innermost cylindrical receptacles which are entirely filled with radioactive material.

It has been found that there are many instances in radio-isotope distribution of the cylindrical containers being only partially filled with material due to various factors. Due to short half-life and other obvious reasons repackaging of the radioactive material to substitute a much smaller but adequate immediate container as a substitute for the standard cylinder or "can" removed from the pile, as earlier mentioned, is not feasible. Accordingly, a present requirement is for a container assembly of minimum weight and cubical dimensions and capable of accommodating a standard cylindrical pile "can" having only a small quantity (i. e., of height no greater than the diameter of the "can") of radioactive material therein. Fig. 4 discloses in vertical section through its vertical axis of symmetry such a container assembly.

It will be seen that there is a similarity in outline between the shielding container 42 of Fig. 4 and container 26 of Fig. 3. However, in the interest of simplified manufacture, although at the cost of added weight, the container has the pear-shaped form of a solid of revolution about vertical axis E so that a transverse section corresponding to Fig. 2 will be a circle and not include spaced protuberances. Also, the mating surfaces 43, 44 of the respective container portions may be finished flat instead of corrugated as in Figs. 1-3 since the cubical containers are always maintained top side up and the disposition of the active material at the bottom of the can 45 renders the corrugations unnecessary. A peripheral groove 46, however, is provided in the oppositely disposed surfaces of the respective container portions into which a pair of superposed, centrally apertured collars 47, 48 may extend for the full depth of said groove to lock not only the portions of container 42 together but also said container in the cubical outer container 49 as clearly shown in Fig. 4.

To accomplish the foregoing purpose additional structure as now described may be provided. Upper collar 47 may include an integrally fabricated cap 52, the top portion of which extends horizontally in close retaining relation with the flat upper end of the upper container body. An eye bolt 53 welded to such cap enables the upper container body to be removed following withdrawal of the means such as bolts 54 which maintain collar 47 in assembly with collar 48. The latter for more convenient operation is of greater diameter for attachment as by bolts 55 to an upper, thickened wall portion 56 of an intermediate cylinder 57. The latter extends below the container 42 and in its lower portion has integrally supported as by welding, an inner seating ring 58, having an inclined surface facing container 42 to accurately seat the same in supporting relation. Circumferentially of cylinder 57 is provided an outer ring 59, bolted at 60 to a square shelf 61 which is suitably united to the lateral walls 4 of cubical container 49.

5

Thus, it will be seen that the container assembly of Fig. 4 although not theoretically ideal as to thickness accomplishes a marked reduction in weight and insures adequate safety for shipping personnel. Since screws of uranium metal or tungsten are quite difficult to produce and substitute materials would constitute a serious radiation pervious path, the external clamping means for the two portions of container 42 is much superior to that employed in Figs. 1-3. In the event the container assembly is overturned while in transit, the radioactive material will be spread to other portions of the can 45 and the wall thickness of container 42 being less along straight lines to the former, there will be lessened protection to nearby personnel. Such risk is deemed to be more than offset by the saving in material and weight in the routine shipment of such container assemblies by aircraft.

While the salient features of the present invention have been described in detail with respect to one embodiment it will, of course, be apparent that numerous modifications may be made within the spirit and scope of the invention and it is not desired to limit the invention to the exact details shown except insofar as they may be defined in the following claims.

What is claimed is:

1. A shielded container assembly for the transport of highly radioactive materials comprising a cubical outer container, a closed, inner container for radioactive material and a closed, intermediate container rigidly mounted in said outer container and enclosing said inner container, said intermediate container being made of shielding material of wall thickness which varies approximately as the inverse square of the distance from the center of the outer container to the outer wall thereof.

2. A shielded container assembly for the transport of highly radioactive materials comprising a cubical outer container, a closed, inner container for radioactive material and a closed, intermediate container rigidly mounted in said outer container and enclosing said inner container, said intermediate container being made of shielding material of wall thickness which is a maximum along major axes of said outer container and a minimum along diagonals to the corners thereof.

3. A shielded container assembly for the transport of highly radioactive materials comprising a cubical outer container, a closed, inner container for radioactive material and a closed, intermediate container rigidly mounted in said outer container and enclosing said inner container, said intermediate container being composed of a body portion and a cover portion made of shielding material of such variable wall thickness as to insure at various, randomly chosen points on the outer surface of the outer container, an approximately level radiation indication.

4. The combination of elements as recited in claim 3 and wherein the body portion and the cover portion are provided with mating surfaces including concentric grooves and ridges to prevent excessive radiation transmission along said surfaces.

6

5. The combination of elements as recited in claim 3 and wherein said outer container includes a cover portion hinged to a lower body portion in peripheral overlapping relation.

6. A shielded container assembly for the transport of radioactive materials comprising a cubical outer container, a closed, pear-shaped, intermediate container of shielding material rigidly mounted in said outer container, and a closed, inner container for radioactive material disposed in said intermediate container.

7. The combination of elements recited in claim 6 and wherein said inner container is of cylindrical shape and said intermediate container is cylindrically bored to receive the same.

8. The combination of elements recited in claim 6 and wherein said intermediate container is formed of a lower portion substantially surrounding said inner container and a top portion resting on said lower portion.

9. A shielded container assembly for the transport of radioactive materials comprising a cubical outer container, a pear-shaped intermediate container of shielding material including a closure of substantial thickness disposed in said outer container, and means between said containers for maintaining said closure in place and said intermediate container in rigid relation with respect to said outer container, and an inner container for radioactive material disposed in said intermediate container.

10. The combination of elements recited in claim 9 and wherein said cover and intermediate container are peripherally grooved to accommodate said means.

11. The combination of elements recited in claim 9 and wherein said means includes a seat for the base of said intermediate container and a top portion for exerting clamping pressure on said cover.

12. A pear-shaped container for radioactive material, said container being made of uranium metal and consisting of a body portion and a cover portion unattached to but adapted to rest on said body portion.

13. A shielded container assembly for the transport of radioactive materials comprising a cubical outer container of rigid but relatively thin walled construction, a pear-shaped intermediate container of relatively thick-walled shielding material including a closure of substantial thickness disposed in said outer container, and separable means between said container for maintaining said closure in place and said intermediate container in rigid relation with respect to said outer container, and an inner container for radioactive material disposed in said intermediate container.

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