OR 3,754,140

United States
Beierle

3,754,140
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[54] **TRANSPORT CASK FOR RADIOACTIVE MATERIAL**

[75] Inventor: **Frederick P. Beierle**, Prosser, Wash.

[73] Assignee: **Chem.-Nuclear Systems, Inc.**, Bellevue, Wash.

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[52] **U.S. Cl.** **250/507**
[51] **Int. Cl.** **G21f 5/00**
[58] **Field of Search** ..... 250/108 R, 108 WS

[56] **References Cited**
UNITED STATES PATENTS

3,391,280	7/1968	Bonilla et al.	250/108 R
2,773,459	12/1956	Sechy	250/108 WS
3,229,096	1/1966	Bonilla et al.	250/108 R
3,056,028	9/1962	Mattingly	250/108 WS

Primary Examiner—James W. Lawrence
Assistant Examiner—Davis L. Willis
Attorney—Wells, St. John & Roberts

[57] **ABSTRACT**

A cask assembly for the transport of radioactive material comprising a shielded cylindrical cask slidably received within a cask overpack. The assembly is supported on the bed of a truck within an encircling cradle. The overpack comprises inner and outer cylindrical shells filled by directionally oriented honeycomb material designed to withstand external forces without rupture of the protective cask or containment vessel.

5 Claims, 7 Drawing Figures

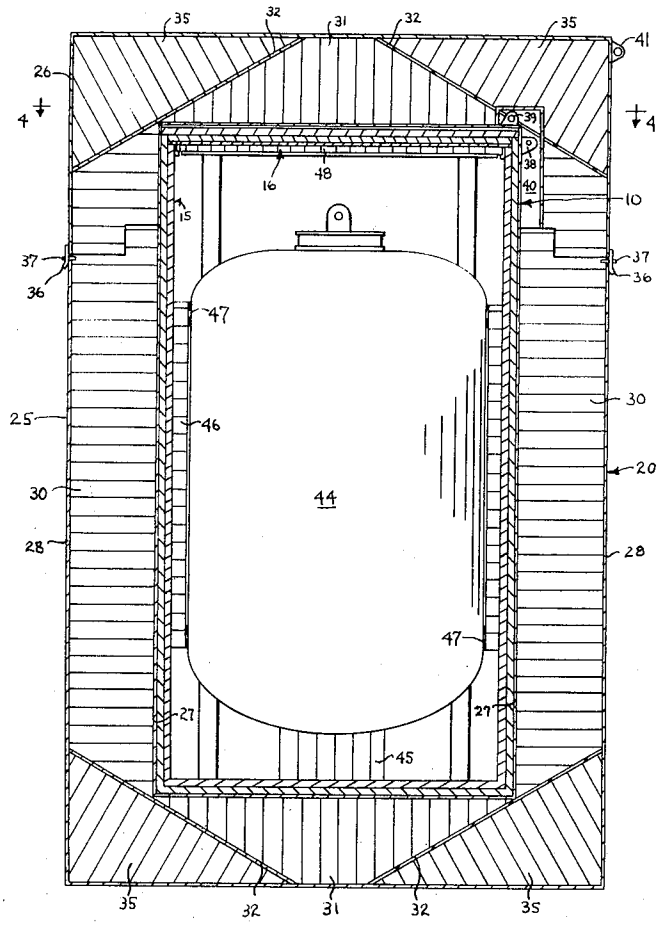

FIG. 1

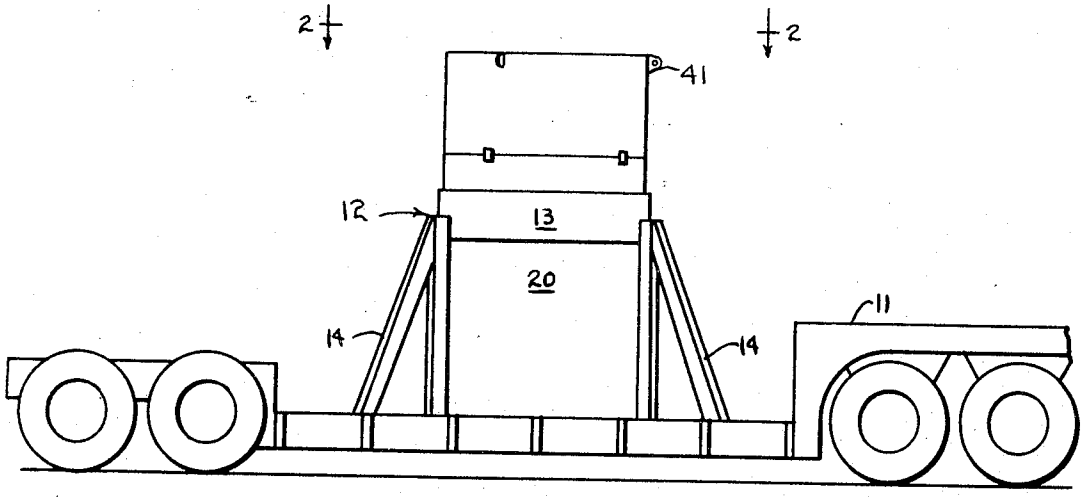

FIG. 2

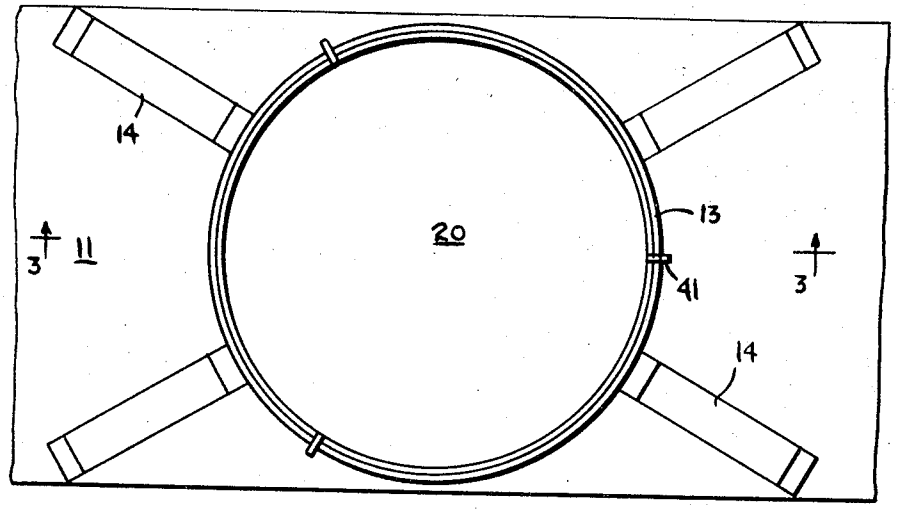

FIG. 3

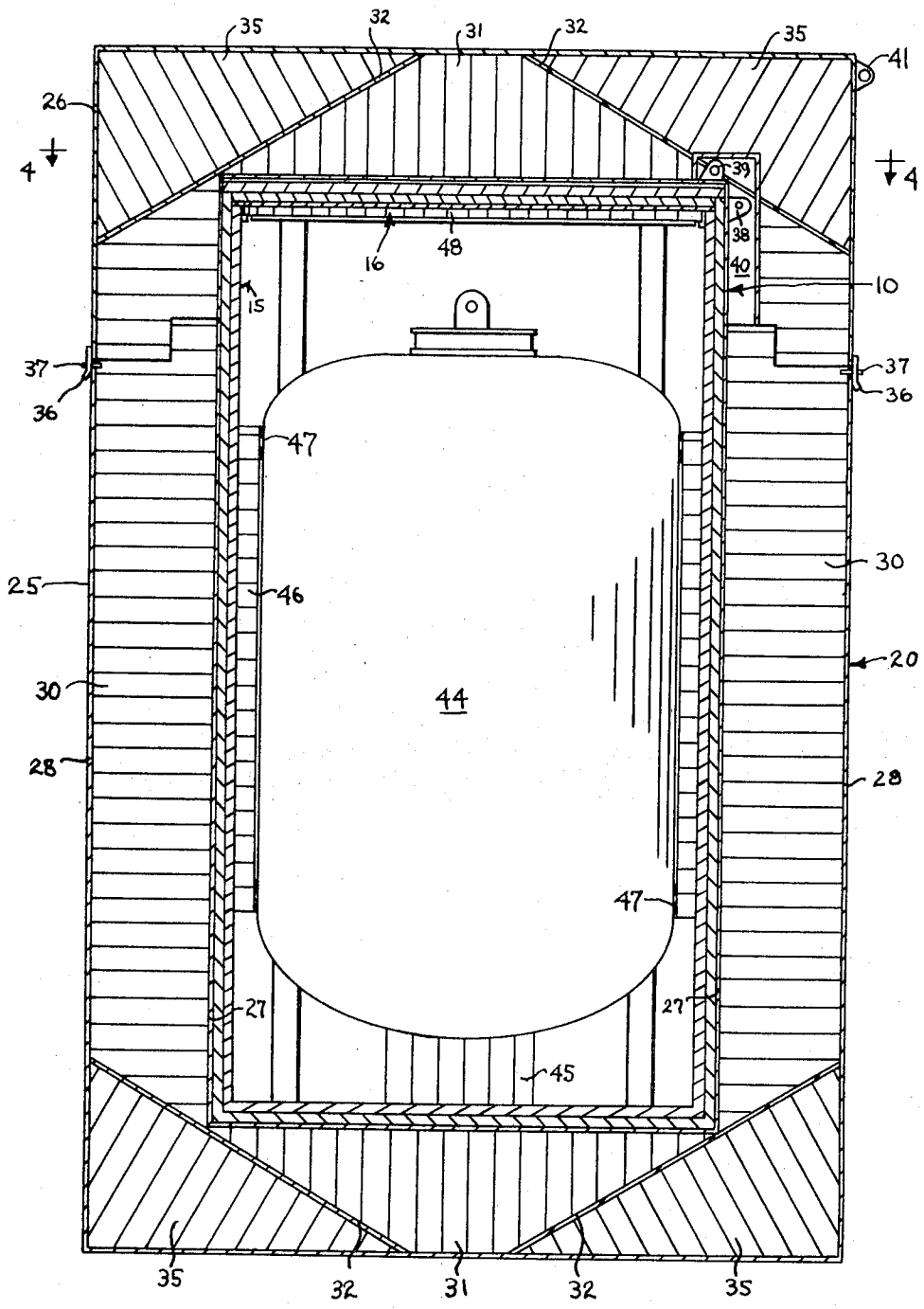
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FIG. 4

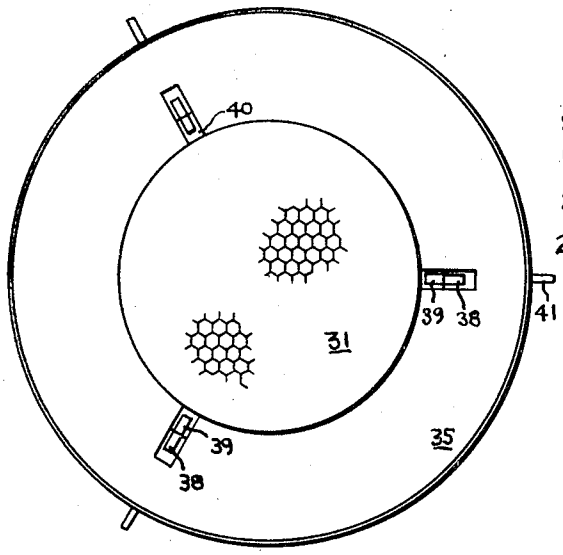


FIG. 5

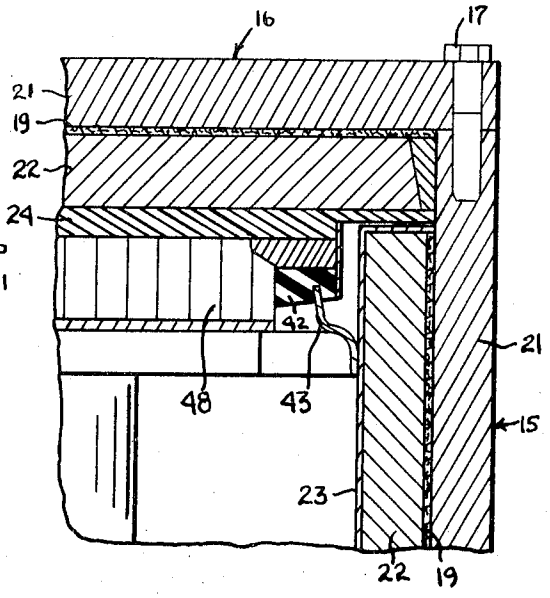


FIG. 7

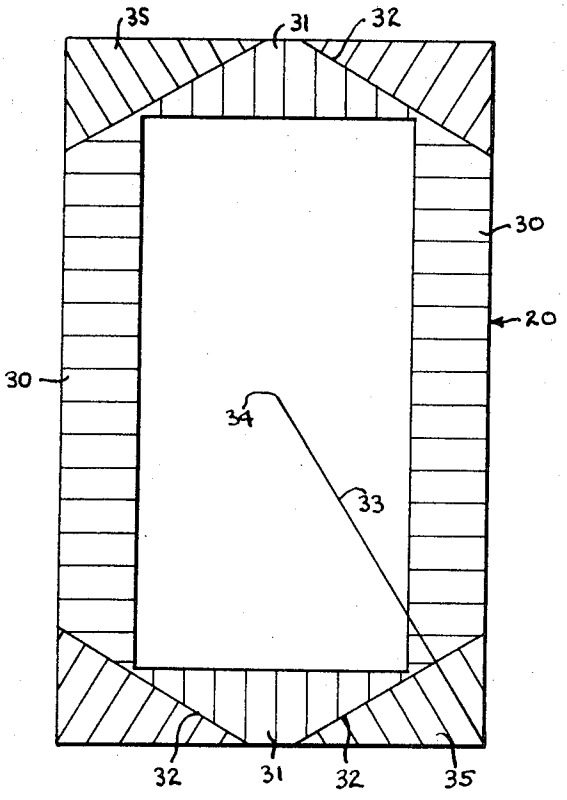
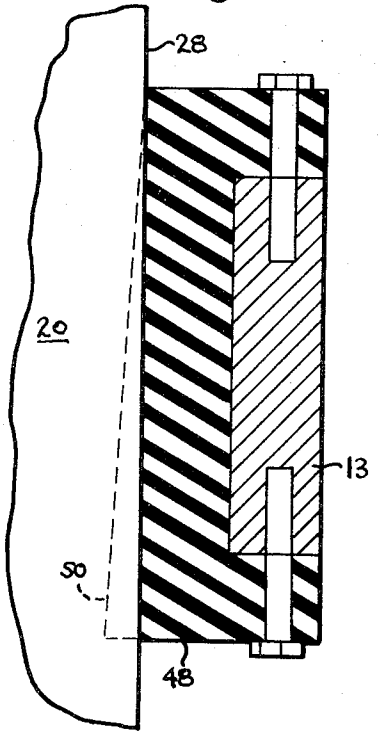


FIG. 6



TRANSPORT CASK FOR RADIOACTIVE MATERIAL

BACKGROUND OF THE INVENTION

The present assembly has been designed for highway transport of radioactive materials, such as solid, liquid or gaseous waste. The growing use of nuclear reactors for power purposes necessitates the transport of radioactive waste materials in considerable volume to remote disposal sites. It is essential that the radioactive material be transported within a package designed within the weight limits applicable to highway transport vehicles and capable of safely containing the material in the event of any accident. The design of the present cask assembly is such that it alone is capable of withstanding any normal impact load to which the assembly might be subjected during highway transport, the cask being freely carried within an upright cradle on a truck bed. It does not require any fixed anchorage to the truck bed. It includes a separable sealed cask that serves as a containment vessel and an overpack designed to absorb impact forces without rupture of the sealed cask.

The particular design of the cask overpack utilized honeycomb material as a lightweight compressible filler with directionally oriented cells for maximum energy absorption. U. S. Pat. No. 3,056,028 discloses a neutron shielding structure that includes honeycomb material, but it is not directed to the problem of energy absorption in a transporting cask assembly. Other patents noted of interest are U. S. Pat. Nos. 3,056,028, 3,229,096, 3,414,727, 3,432,666 and 3,483,381.

SUMMARY OF THE INVENTION

The invention described herein relates to a cask assembly including an inner containment vessel or cask and an outer double-walled vessel or cask overpack. The cask comprises a body including radioactive shielding material and a removable lid with a compressible sealing arrangement interposed between the lid and body. The cask overpack comprises a double-walled vessel that completely encloses the cask in an enlarged cylindrical configuration. The inner and outer walls are spaced by directionally oriented honeycomb material designed to withstand internal and external forces in compression so as to prevent accidental rupturing of the cask.

It is a first object of this invention to design a transport cask for radioactive materials which in itself is capable of withstanding foreseeable forces to which the cask might be subjected without danger of loss of containment of the radioactive material.

Another object of this invention is to provide such a cask assembly capable of use within the normal weight limits applicable to highway vehicles.

Another object of this invention is to provide a two-piece cask assembly wherein the radioactive containment vessel can be readily separated from the cask overpack for loading and handling purposes.

Another object of this invention is to provide such a cask assembly which does not place any reliance upon anchorage to a vehicle for structural integrity or physical protection of the material being transported. To the contrary, the present cask is not fixed to the vehicle, and is free to separate from the vehicle should it be overturned. The design of the cask is such as to be capable of withstanding impact without external protection of any sort.

These and further objects will be evident from the following disclosure, taken also with the accompanying drawings which illustrate a preferred form of the invention. It is to be understood that the details of the preferred construction are only illustrative and that modifications might be made within the scope of this disclosure.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation view of the cask mounted on a transport truck;

FIG. 2 is an enlarged top view of the cask assembly and cradle shown in FIG. 1;

FIG. 3 is an enlarged vertical sectional view taken through the cask along line 3—3 in FIG. 2;

FIG. 4 is a sectional view through the cask assembly as seen along line 4—4 in FIG. 3, taken at a reduced scale;

FIG. 5 is an enlarged fragmentary sectional view showing the inner cask seal details; and

FIG. 6 is an enlarged fragmentary view showing the upper portion of the cradle assembly as seen along line 6—6 in FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The drawings illustrate a preferred form of the invention, designed specifically for transporting radioactive materials, such as resins contaminated with radioactive materials for waste disposal purposes. The cask assembly has been designed to meet applicable highway standards for safe transport of such materials and to be capable of transporting large quantities of materials within present weight limits.

The cask assembly comprises an inner cylindrical cask **10** and an outer cask overpack **20**, also of cylindrical shape. The cask overpack **20** and the cask **10** received therein are held in place on a conventional flatbed trailer **11** by means of a cradle **12**. The cradle **12** comprises a rigid circular ring **13** that encircles the outside walls of cask overpack **20** and which is supported on the trailer **11** by four upright standards **14**. The cask assembly is not rigidly anchored to the flatbed trailer **11** and is capable of falling from its normal location within cradle **12** should the trailer **11** be accidentally upset. The cask assembly is designed to be independently capable of withstanding all normal physical impact forces to which it might be subjected.

Cask **10** serves as a sealed containment vessel for materials received therein. It is in the form of a right cylinder with external attachments. Cask **10** is preferably constructed in the form of a double-walled lead-filled configuration with inner surfaces of stainless steel and an outer structural steel shell with a thermal shield sandwiched between the steel and lead sections. It basically includes a cylindrical body **15** open at one axial end, and a removable end cover or lid **16** normally held in place by a plurality of bolts **17** spaced about its circular periphery. The body **15** and lid **16** of cask **10** are constructed of substantially identical layers of material. Each includes a relatively thick outer shell **21** of carbon steel suitable for structural use. The shell **21** is formed about a core of lead **22** for radioactive shielding purposes. A thermal barrier is interposed between the lead at **22** and the outer shell **21** in the form of a continuous

layer of asbestos **19**. The purpose of this layer **19** (FIG. **5**) is to prevent melting of the lead or thermal injury to the cask contents if subjected to fire. Other suitable materials, such as wood, may be substituted to provide a suitable thermal barrier or to meet required specifications for such of such articles. The inner shell of body **15** is completed by a relatively thin layer of stainless steel **23**. A structural layer of steel **24** protects the lead core of lid **16**. Lid **16** comprises a round recessed plug-type cover sealed by a specially designed resilient seal as discussed below.

The cask overpack **20** contains substantial amounts of directionally oriented honeycomb type material designed to withstand all anticipated external impact loads to which the assembly might be subjected. The cask overpack **20** is a totally enclosed vessel comprising a hollow steel shell containing honeycomb material arranged to present maximum impact resistance to the direction of impact. The overpack **20** comprises a cylindrical body **25** and cover **26** of identical construction, which cooperatively receives cask **10**. They are constructed of an inner steel shell **27** and an outer steel shell **28**. The radially spaced cylindrical walls of shells **27, 28** are separated by a cylindrical wrap of honeycomb material **30** having the cells thereof oriented radially with respect to the upright center axis of the cask assembly. The end walls of shells **27, 28** which are axially separated, are spaced by sheets of honeycomb material **31** in the shape of a frustrum of a cone. The large base of the frustrum is substantially identical in diameter to the diameter of the end walls of inner shell **27**. The opposite parallel surface of each sheet **31** is circular and of smaller diameter than such end walls. The conical surface **32** about each sheet **31** is at a right angle to a line drawn between the outer corner of the cask overpack (indicated at **33** in FIG. **7**) and the design center of gravity of the loaded cask assembly (indicated at **34** in FIG. **7**). The end surfaces of the cylindrical wrap of honeycomb material **30** which are indicated at **35** in FIG. **3**, are formed as a continuation of the surfaces **32**.

The remaining space between the shells **27, 28** is filled by two annular rings **35** of honeycomb material oriented with the cells thereof substantially parallel to the line connecting points **33, 34** in FIG. **7**. The rings **35** are designed to provide maximum impact absorption within the vessel should it be dropped on the external corners of the cask overpack **20**.

The cover **26** is selectively secured to the body **25** of the overpack **20** by external overlapping flanges **36** which protrude along body **25** and which are selectively secured thereto by a plurality of bolts **37**.

The cask **10** is defined to be removed from the overpack **20** for loading and unloading purposes, while the overpack **20** will normally remain in place within cradle **12** except for repair purposes. The lifting of cask **10** is accomplished by three radial steel lugs welded to the upper rim of the outer shell **21**. The removable lid **16** is similarly provided with three lugs **39** angularly aligned with the respective lugs **38** (FIG. **4**). The honeycombed material within the overpack cover **26** are suitably relieved at **40** to provide clearance for the reception of lugs **38, 29**. In addition, lifting lugs **41** are provided along the top rim of the overpack cover **26** to facilitate removal of the cover **26**.

The seal provided between lid **16** and body **15** in the cask **10** is shown in detail in FIG. **5**. It comprises an annular ring **42** molded of a compressible resin, such as polyurethane, or foam rubber that is engaged by an annular ring **43** of stainless steel fixed to the inner surface of the cask layer **23** and extending toward the open end of the cask body **15**. The projecting edge of ring **43** is concentric with the ring **42**. The compression of ring **42** insures a gas-tight seal capable of withstanding considerable deformation of the vessel while maintaining the seal intact. By coice of proper material, the seal can be designed to withstand short time temperatures of an elevated nature without destroying its sealing capability.

Case **10** can be designed to provide effective radioactive shielding capability within present standards for transport purposes. As an example, in a cask having external dimensions of approximately **110** inches in length and 58 inches in diameter, the lead cover **22** and outer shell **21** are both 2 inches thick. The contemplated load within cask **10** is mounted within an overpack **20** having a shell spacing of approximately 15 inches at the cylindrical sides and approximately 13 inches at the axial ends.

The lugs **38** and **39** are each designed so as to be more weak than the structural shell to which they are secured. Thus, any structural failure due to lifting forces applied to the lugs will occur in the lugs and will not result in rupture of the structural components of the cask **10**.

FIG. **3** illustrates the use of the cask assembly for carrying radioactive waste in the form of solid resin in a conventional storage pot **44**. The pot **44** is fixed within the interior of cask **10** by a lower block of honeycomb **45** and a surrounding cylindrical wrap of honeycomb **46** spaced slightly from the sides of pot **44** by two annular rings of rubber cushion material shown at **47**. The upper platform of pot **44** is engaged by a sheet of honeycomb **48** on the inner surface of the cask lid **16**. These yieldable elements within cask **10** compliment the peculiar shape of pot **44** and hold it immobile and spaced from the inner walls of cask **10**.

The cask assembly is not fixed to the trailer **11**. It sits tightly within cradle **12**, being surrounded by the horizontal ring **13**. As seen in FIG. **2**, the cask assembly is surrounded by a ring **29** of rubber belting or other suitable compressible material wedged between ring **13** and the outer shell **28** of overpack **20**. The ring **29** is radially compressed and is preferably riveted and glued to the inner surface of ring **13** so as to remain in place when overpack **20** is removed from cradle **12**.

FIG. **6** shows a modification of the cradle support in which compressed rubber blocks are substituted for the full ring **29**. At each standard **14** is a wedged block of rubber **48** which fits tightly between ring **13** and the outer shell **28** of the cask overpack **20**. As shown in FIG. **6**, each block **48** is tapered in thickness and has an original configuration illustrated by dashed lines at **50**. The blocks **48** or ring **29** attenuate vibration between the trailer **11**, cradle **12** and the cask assembly.

The cask **10** is designed to serve as a shielding container to maintain the containment of radioactivity under all anticipated conditions. The cask assembly can be fabricated of all-welded construction except for the heavily bolted lid and cover and is therefore not substantially affected by vibration incident to travel. Because the cask is constructed of metal, it is not disturbed by exposure to water spray. The overpack **20** has been designed to accomodate and absorb the forces resulting from impact of the cask assembly due to any

foreseeable accident without disrupting the integrity of the inner cask **10.**

While shown specifically designed to carry the pot **44,** the cask assembly can further be utilized to handle other waste materials requiring radioactive shielding during transport. The cushioning materials shown within cask **10** are subject to variation in order to conform to the size and shape of the load carried thereby.

Minor changes might be made in the specific details illustrated in the drawings and described above. Therefore, only the following claims are set out as definitions of the invention.

Having thus described my invention, I claim:

1. A cask assembly for the transport of radioactive materials while supported on a vehicle bed free of restraining attachment to the vehicle, comprising:

a rigid cylindrical cask having walls containing radioactive shielding material, said cask being formed of an integral body open at one axial end and a complimentary lid removably fixed thereto;

sealing means operatively interposed between the lid and body of said cask;

a rigid circular cylindrical cask overpack, comprising:

a double-walled cylindrical vessel totally enclosing said cask including inner walls complimentary to said cask, outer walls spaced from the inner walls, and honeycomb material interposed between the inner and outer walls thereof having cell orientations substantially perpendicular to the respective directions of maximum impact exposure of the walls and corners of the vessel;

said vessel including a removable lid assembly at one axial end thereof for permitting entry and removal of the cask.

2. A cask assembly as set out in claim **1** wherein said vessel comprises cylindrical inner and outer shells including radially spaced cylindrical walls aligned along a central axis and a pair of axially spaced end walls perpendicular to said axis and extending across said respective ends of said cylindrical walls;

a cylindrical wrap of honeycomb material interposed between the cylindrical walls of said inner and outer shells with the cells thereof oriented radially with respect to the axis of the walls;

sheets of honeycomb material interposed between the axially spaced end walls of said inner and outer shells with the cells thereof oriented perpendicular to said end walls;

and annular rings of honeycomb material located between the corners of the inner and outer shells at the respective ends thereof, said annular rings each having the cells thereof aligned substantially parallel to the sides of a cone having the designed center of gravity of the loaded cask assembly as its apex and the respective outer shell end wall as its base.

3. A cask assembly as set out in claim **1** wherein the double-walled vessel comprises cylindrical inner and outer shells including radially spaced cylindrical walls aligned along a central axis and axially spaced end walls perpendicular to said axis and extending across the respective ends of said cylindrical walls:

a sheet of honeycomb material interposed between the spaced end walls of the inner and outer shells at each of the respective ends of the vessel, each sheet being in the form of a truncated cone aligned along said central axis and having one circular end thereof corresponding in diameter to the inner end wall abutted thereby, the remaining circular end being of small diameter and abutting the outer end wall;

a cylindrical wrap of honeycomb material interposed between the cylindrical walls of the inner and outer shells of the vessel and abutting said cylindrical walls in an area extending along the length of the cylindrical walls of the inner vessel, the end surfaces of said cylindrical wrap being formed as continuations of the conical sides of the sheets honeycomb material at the respective vessel ends;

and annular rings of honeycomb material filling the remaining space between said inner and outer vessels at the corners thereof.

4. The cask assembly as set out in claim **3** wherein the cells of said annular rings are aligned substantially parallel to the sides of a cone having the designed center of gravity of the loaded cask assembly as its apex and the respective outer shell end wall as its base.

5. The cask apparatus as set out in claim **4** wherein the conical surfaces presented along the sides of the sheets of honeycomb material at the vessel ends and along the end surfaces of the cylindrical wrap of honeycomb material are perpendicular to the alignment of the cells of honeycomb material forming said annular rings.

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