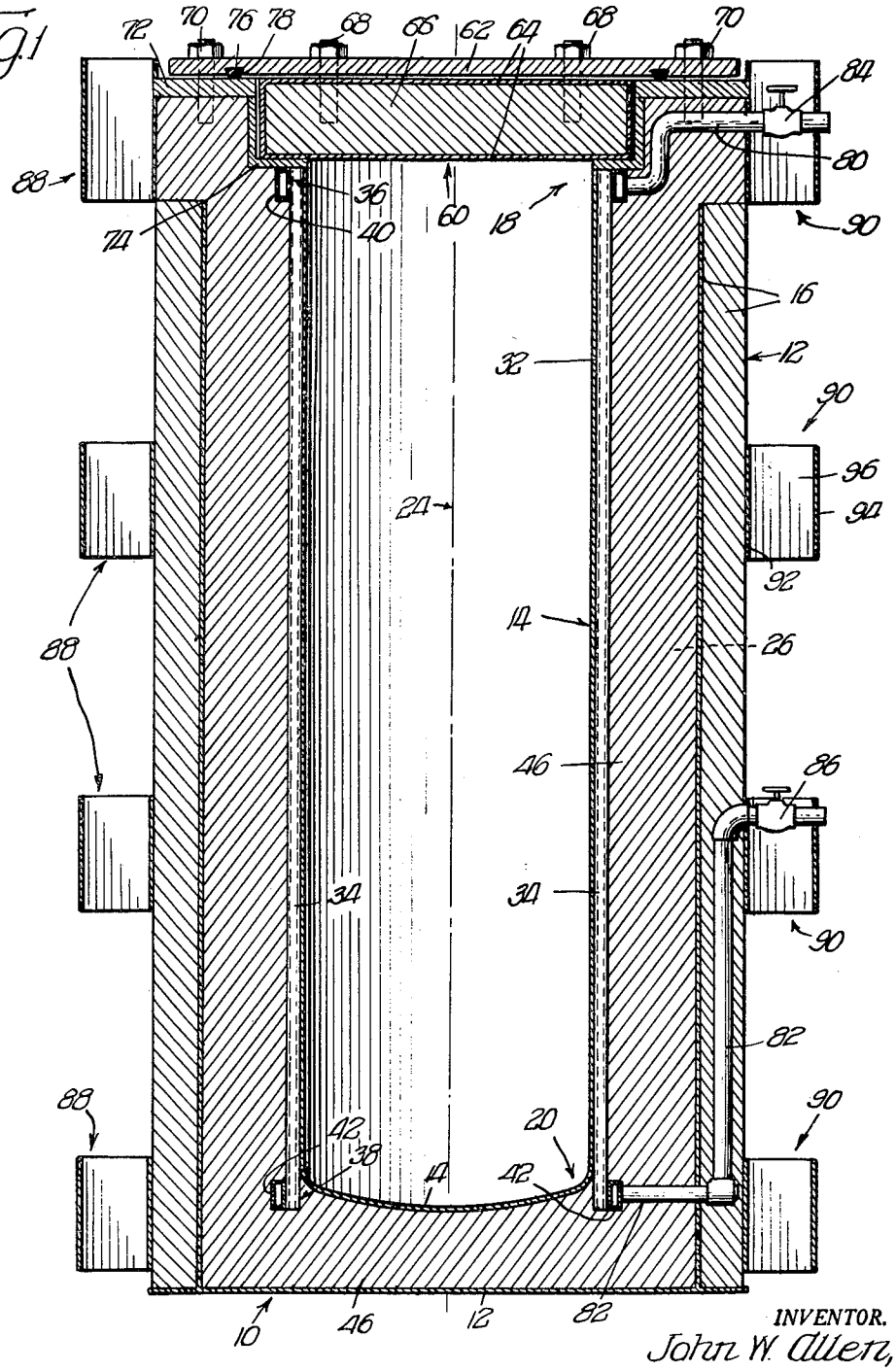
OR 3,113,215

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CASK CONSTRUCTION FOR RADIOACTIVE MATERIAL

Filed Feb. 27, 1961 4 Sheets-Sheet 1

Fig. 1



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CASK CONSTRUCTION FOR RADIOACTIVE MATERIAL

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Fig. 2

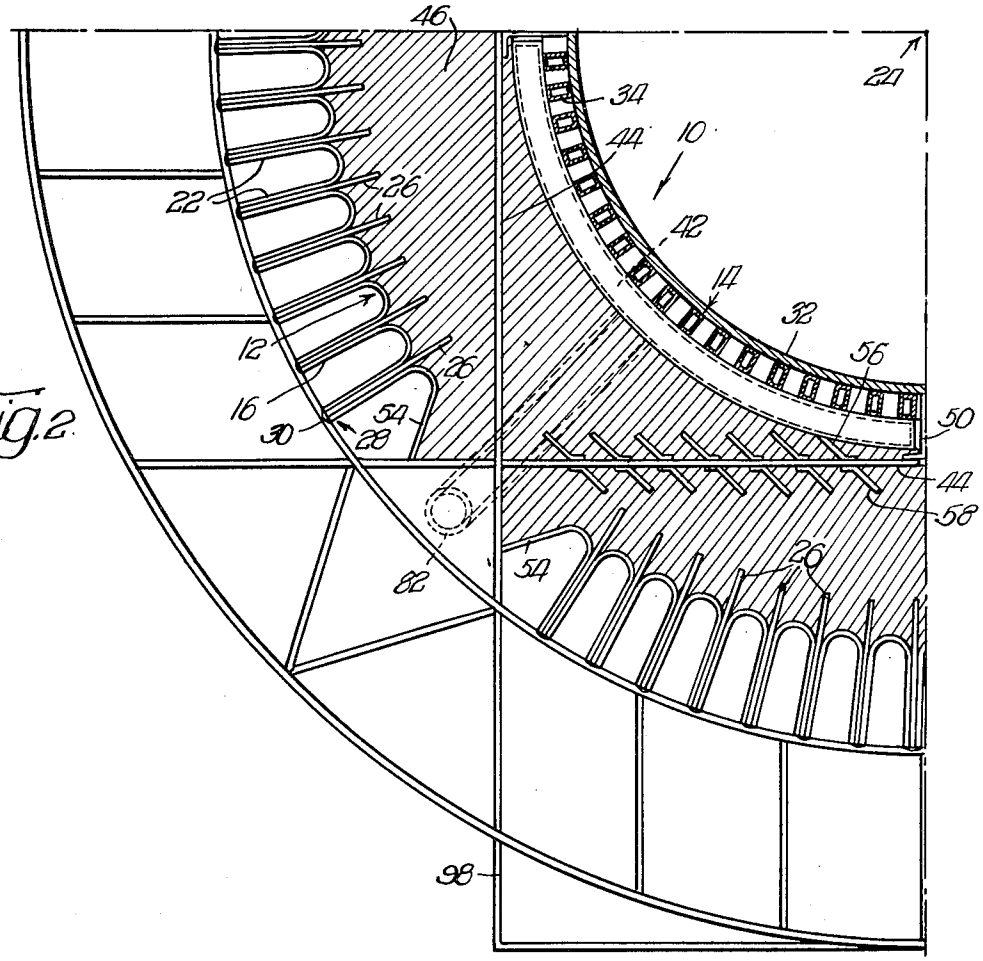
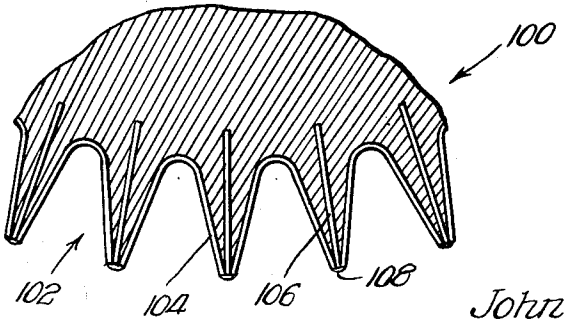


Fig. 3



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CASK CONSTRUCTION FOR RADIOACTIVE MATERIAL

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Fig. 4

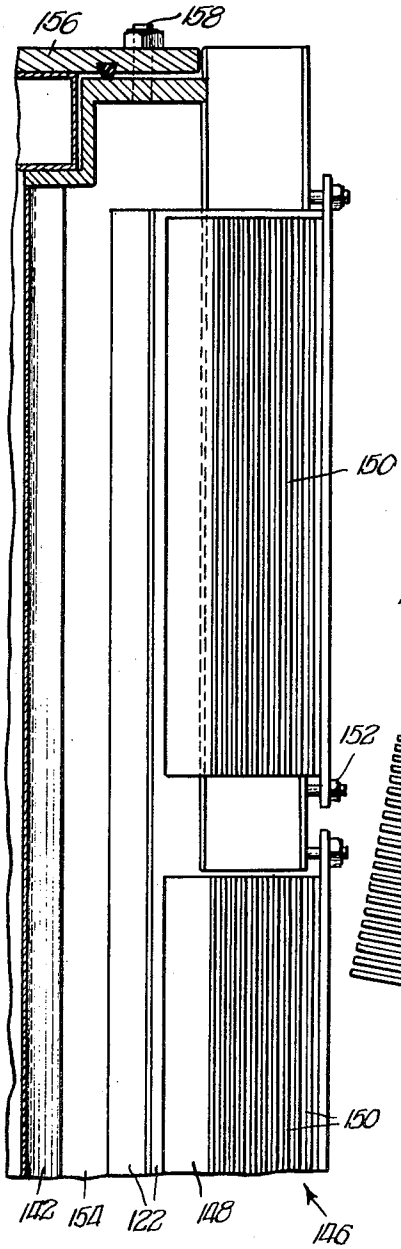
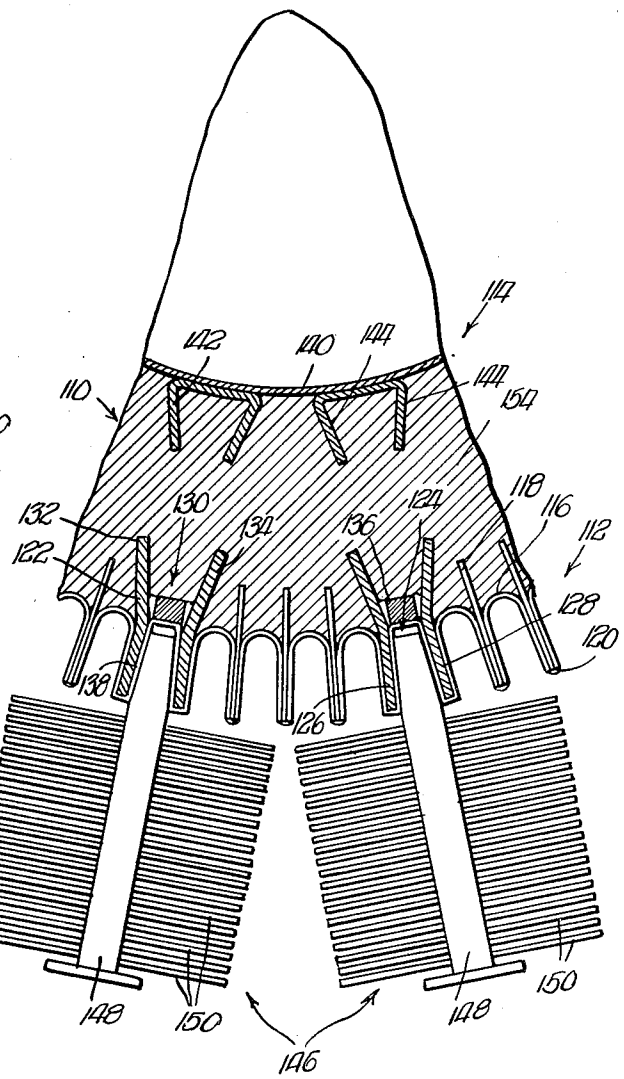


Fig. 5



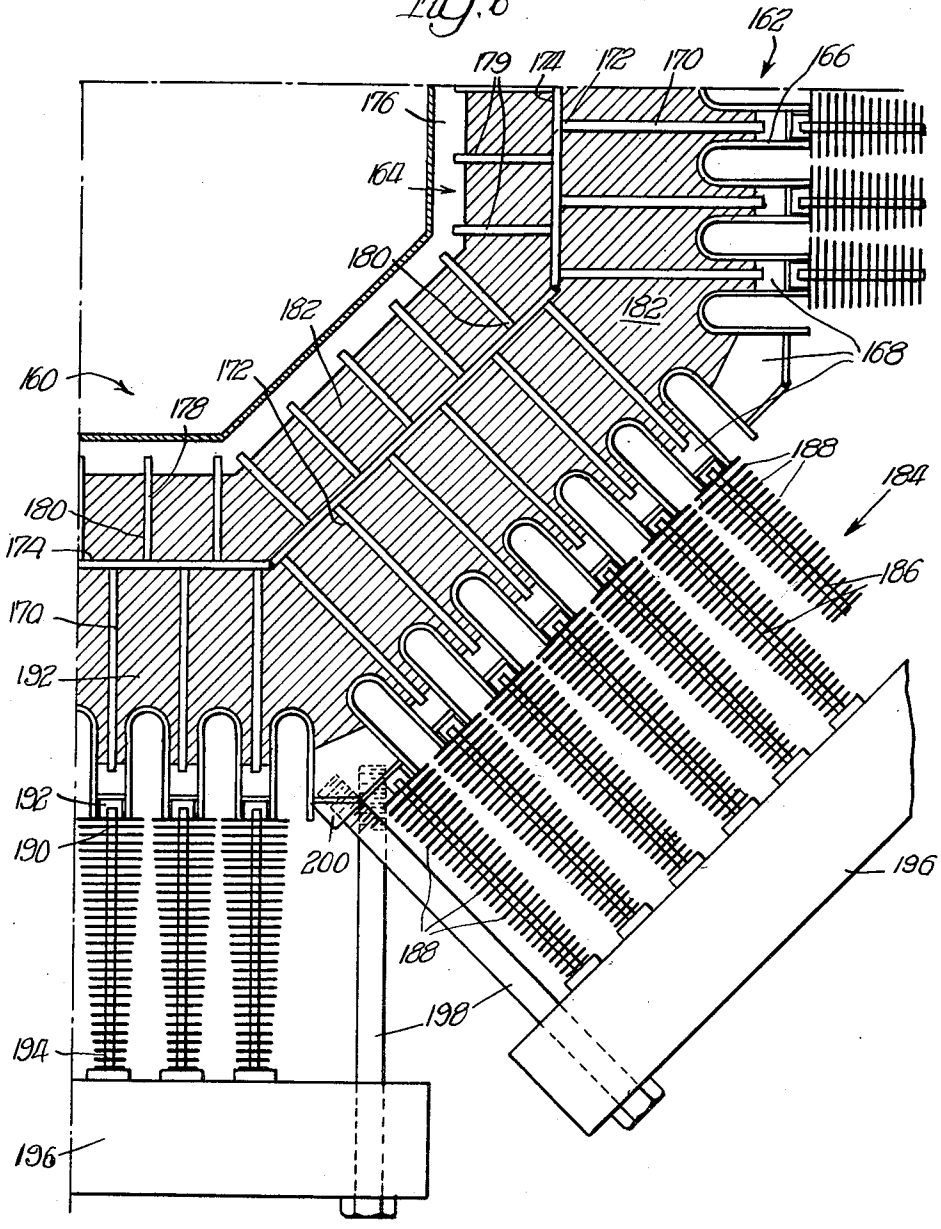
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Fig. 6



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CASK CONSTRUCTION FOR RADIOACTIVE MATERIAL

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10 Claims. (Cl. 250—108)

This invention relates to casks for transporting radioactive materials; more particularly it relates to casks or containers of minimal dimensions and weight, yet having high strength for transporting intensely radioactive matreials which are exothermic and which may encounter temperatures from heat generated internally of several hundred degrees Fahrenheit during transport. More specifically the invention relates to a cask, suitable for the shipment of intensely radioactive materials which may be exothermic, constructed so as to have very high thermal conductivity to condut the heat from said casks to the ambient air as rapidly as possible.

Such casks may be carried in a truck or on a flat car and transported to its destination through populated areas and it is necessary that the cask provide ample shielding to prevent exposure to the general public of radiation and heat burns, and yet provide rapid thermal conductivity to release the heat generated within the container. Hence it is an object of the present invention to provide a cask comprising a composite structure incorporating the best features of various materials for the construction of a suitable radiation shielding container, of minimal weight and high thermal conductivity and suitable for transporting intensely radioactive materials safely.

The invention comprises briefly a minimum dimension container adapted for transporting intensely radioactive materials, having inner and outer shells in spaced relation, high radiation-shielding material between the shells, the shells being constructed of finned sections to provide high thermal conductivity, the outer shell having attached banks of fins to provide additional thermal conductivity, and the radiation being attenuated by passing transversely through the high density shielding material members or the finned sections. The outer liner consists of bent plates welded together to give a fin surface for heat dissipation to the surrounding air. The space between the outstanding flanges is filled with high heat-conductive material to improve the efficiency of the fins. The space is filled with lead, as the main portion of the lead inside the liner is poured. A strip of aluminum or copper, brazed to the liner material, or held in place by the lead, is used to improve the heat conduction. The liner is constructed of stainless steel to provide a non-corrosive surface which is easy to decontaminate.

Referring now to the accompanying drawings forming part of this application and wherein like reference characters indicate like parts:

FIGURE 1 is a central longitudinal cross sectional view of the preferred form of cask.

FIGURE 2 is a transverse sectional view through a portion of the cask of FIGURE 1, showing a high conductive strip brazed to the fin material.

FIGURE 3 is a fragmental view, similar to FIGURE 2, showing the conductive strip lead-bonded to the fins.

FIGURE 4 is a side elevational view of a portion of a cask showing a modified auxiliary fin arrangement.

FIGURE 5 is a horizontal sectional view through the cask of FIGURE 4.

FIGURE 6 is a partial cross section through a cask having auxiliary cooling fins of slightly different arrangement.

Referring now more particularly to the drawings, FIGURES 1 and 2 illustrate a preferred construction of a cask indicated generally by the reference **10**. The cask

or container **10** comprises an outer shell **12** and an inner shell **14** in spaced relation from said outer shell. The cask may be of any suitable configuration although a cylindrical configuration is illustrated in this embodiment.

The outer shell **12** is constructed of a plurality of fins **16** each extending from the upper end **18** of the cask to the bottom end **20** and being of a U-shaped construction with legs **22** extending radially with relation to the center line **24** of the cask **10**. The fins **16** are spaced apart from each other by means of conducting strips **26**. The outer extremities **28**, both of the fin legs **22** and of the strips **26**, are joined together in any suitable manner such as by the welds **30** so as to present a corrugated or fin surface construction to the outer shell **12**.

The inner shell **14** is constructed of a liner **32** to which are attached a plurality of longitudinally-extending fluid conducting pipes **34** mounted radially around the liner and in spaced relation to each other. The pipes **34** are interconnected at their upper and lower extremities **36**, **38** and extend from upper and lower annular pipes **40**, **42**.

The outer and inner shells **12**, **14** are spaced apart by means of structural braces **44** and a suitable filler **46** which may be poured into the space **48** formed between the shells. The braces **44** are spaced from the internal liner **32** by means of suitable supporting structure **50** and are connected to the outer shell **12** by suitable welding **52** to the distorted fins **54**. Secondary fins **56**, **58** may be mounted on the braces **44** to aid in longitudinal heat conduction.

A removable lid **60** is provided at the top of the cask **10**, which is always carried in a vertical position, as shown in FIGURE 1. The lid **60** is constructed of an outer head **62** and an inner head **64**, the latter being of a hollow construction and filled with a suitable filler **66** similar to the filler **46** between the outer and inner shells **12**, **14** of the cask **10**. The outer head **62** and the inner head **64** of the lid **60** are secured together by means of suitable bolts **68**. The lid **60** may be removably fastened to the top of the cask **10** by means of bolts **70** and seats on a recessed contour which provides a pressure seal between the cask walls and the lid **60**. In this regard, the outer head **62** seats on a flange **72** and the inner head **64** seats on a step flange **74**. Suitable gaskets **76**, constructed of resilient material, are provided in recesses **78** in the outer head **62**, which gaskets **76** engage the flange **72**. The lid **60** may be provided with a conventional pressure release check valve (not shown), if so desired, having an adjustable pressure release mechanism connecting the interior of the cask with the ambient atmosphere, through an indirect channel to prevent the escape of unattenuated radiation, when the pressure within the cask exceeds the preset release valve.

In order to increase the heat dissipation of the cask, a natural convection liquid circulating system is provided and comprises a plurality of pipes **34** positioned within the wall of the cask **10** and next to the internal liner **32**. The pipes **34** are interconnected by means of annular pipes **40**, **42** and communicate by way of conduits **80**, **82** to an external series of pipes (not shown) for dissipating the heat to the ambient atmosphere. This circulating system may be regulated by means of valves **84**, **86** located externally of the outer shell **12** on the conduits **80**, **82**. When the liquid circulating cooling system is not in operation, the pipes **34** act as internal fins for transferring heat from the internal liner **32** to the filler **46** and thence to the intermediate fins **16** of the outer shell **12** and to the ambient atmosphere.

Structural supports for the cask are supplied by external annular ring construction **88** which comprises a plurality of annular members **90**, each having an internal wall **92**, and an external wall **94**, spaced from the internal wall **92** by means of ribs **96**. Supported trunnions **98** for carry-

ing the cask 10 extend through the external ring construction 38. Conduits 80, 82 and their valves 84, 86 are located within the structure of the external ring construction 38 for protection from possible damaging contact during transportation of the cask 10, as shown in FIGURE 1.

The outer shell 12 is preferably made of a strong structural material to impart strength to the cask 10. The fins 16 are made of a low conductive material, such as stainless steel, while the conductnig strips 26 are made of a high-conductive material, such as copper or aluminum. The conductivity of stainless steel is only about nine B.t.u. per hour per degree Fahrenheit per foot, while the conductivity of aluminum is one hundred twenty, and copper is two hundred twenty. The internal liner 32 is composed of stainless steel; and the pipes 34, the annular tubes 40, 42 and the conduits 80, 82 are made of high-conductive material such as copper. The fillers 46, 66 are composed of high radiation-shielding material, such as lead, which may be poured between the outer and inner shells 12, 14 and into the hollow inner head 64 of the lid 60. The pipes 34 are brazed to the liner 32, as are the conducting strips 26 to the fins 16.

It will be seen that the fin construction 16 of the outer shell 12 presents a large corrugated surface to the lead filler 46. This is necessary since it is impractical to obtain a 100% true metallic bond between the lead filler 46 and the stainless steel fins 16. The resulting air gap between the lead and the steel presents a heat barrier which is reduced in proportion to the area of this gap. The fin construction 16, illustrated in FIGURES 1 and 2, provides a large area both to the air gap between the lead and the steel and also to the ambient atmosphere. The fins 16 have a rounded configuration which is smooth and devoid of rough welds and, therefore, facilitates cleaning during decontamination. The welds 30, at the outer extremities 28 of the fins 16 and conducting strips 26, do not transfer heat, so do not require full fusion welding. These welds are also much more accessible during fabrication of the cask for the welding operation and are ground smooth to present an easy surface to clean. The corrugated fin construction 16 also provides expansion capabilities to provide for expansion of the lead filler 46 due to its increased temperature and high coefficient of expansion.

A modification of my invention for cask construction for transporting thermally hot intensely radioactive material is illustrated in FIGURE 3 in which the cask is shown generally by the reference 100 and is comprised of an internal shell (not shown), similar to that illustrated in FIGURES 1 and 2, and an external shell 102 having a plurality of radially aligned V-shaped fins 104 spaced apart by means of conducting strips 106. The fins 104 and conducting strips 106 are outwardly joined together by means of suitable welds 108.

A third embodiment of my invention is illustrated in FIGURES 4 and 5, in which the cask is shown generally by the reference 110 and is comprised of outer and inner shells 112, 114 in spaced relation from each other. The outer shell 112 is constructed of a plurality of radially aligned U-shaped fins 116 spaced apart by means of conducting strips 118, said fins 116 and conducting strips 118 being outwardly joined together by means of suitable welds 120. Intersticed between groups of the fins 116 and conducting strips 118 are a plurality of H-shaped wedge-receiving fins 122 having a radially outwardly-facing recess 124, formed between the radially outwardly-extending legs 126, 128, and an inwardly-oriented recess 130, formed between the inwardly-extending askew legs 132, 134. The legs 126, 132 and 128, 134 of the fins 122 are spaced apart by means of post 136. These conducting fins 122 are internally seated within and brazed to a liner 138 which forms an M-shaped extension of the fins 116. The inner shell 114 is constructed of a liner 140 to which are brazed a plurality of radially-aligned internal fins 142, which have legs 144 directed to dissipate heat toward the recess 130 of the conducting fins 122 of the outer shell 112. Adapted to seat within the recesses 124 of the wedge-receiving fins 122 are a series of external fins 146 each constructed of a supporting wedge member 148 from which extend a plurality of closely-spaced fin blades 150. The auxiliary fins 146 may be removably mounted to the cask 110 by means of suitable bolts 152. Between the outer and inner shells 112, 114 is poured a suitable radiation-shielding filler 154. A removable lid 156 is mounted on the top of the cask 110 by means of suitable bolts 158.

In this embodiment, the internal liner 140 and outer shell fins 116 are constructed of stainless steel, the internal fins 142, conducting strips 118 and conducting fins 122 are made of copper, and the auxiliary fins 146 are made of aluminum, while the filler 154 is lead.

A fourth embodiment of my invention is illustrated in FIGURE 6, in which the cask is shown generally by the reference 160. The cask 160 is hexagonal in configuration and is comprised of an outer shell 162 spaced apart from an inner shell 164. The outer shell 162 is constructed of a plurality of U-shaped fins 166, made of a low-conductive material, such as stainless steel, said fins 166 being spaced apart by means of structural blocks 168, also made of stainless steel. Imbedded in the structural blocks 168 are inwardly-extending conducting strips 170, made of a high-conductive material, such as copper. The innermost extremities 172 of the conducting strips 170 are structurally supported and brazed to braces 174, also made of a high heat-conductive material, such as copper. The inner shell 164 is constructed of an internal liner 176, made of a low-conductive material such as stainless steel, to which is attached a plurality of internal fins 178 of high heat-conductive material, such as copper. The outer extremities 180 of the internal fins 178 are structurally supported by and brazed to the braces 174. A suitable high radiation-shielding material, such as lead, is poured into the space between the outer and inner shells 162, 164 to form a filler 182. Auxiliary removable fins 184 are mounted externally on the cask 160, and each comprises a supporting member 186 from which extends a plurality of closely-spaced fin blades 188. The inner end 190 of the supporting members 186 is mounted in a flat surface contact 192, made of a soft material, such as soft copper, for intimate contact with the structural blocks 168 of the outer shell 162. The outer end 194 of the supporting members 186 is mounted in a frame 196 which is bolted by means of suitable bolts 198 into threaded recesses 200 in the outer shell 162. The auxiliary fin construction 184 is made of a high heat-conductive material, such as aluminum or copper. It will be seen that intimate engagement between the auxiliary fins 184 and the outer shell 162 may be obtained by exerting pressure between the soft contact surface 192 and the structural members 168 of the outer shell 162, thereby insuring efficient pick-up of heat from the cask 160.

The auxiliary fin construction 146 and 184 is made up of high-conductive material, such as copper or aluminum and is removable from the cask 10 before the cask is lowered into the loading or unloading pool. These loading pools may contain radioactive particles that would lodge into the space between closely spaced fins and that would be extremely difficult to clean from the fins. Therefore, by providing removable fins, such a contamination problem may be avoided.

The foregoing specification, specific examples and descriptions of my invention and the methods of utilizing it are intended as illustrative of the invention, the scope of which is limited only by the following claims.

What is claimed is:

1. An apparatus for transporting exothermic radioactive material comprising a cask, said cask having walls constructed of an outer shell and an inner shell spaced from said outer shell, a radiation-shielding filler between said outer and inner shells, said inner shell including a

plurality of heat-conductive fins for dissipating heat through said cask wall, said outer shell having a fin-like construction, said fin-like construction including a plurality of U-shaped fins spaced apart by high heat-conductive strips radially aligned with relation to the center line of said cask, and an auxiliary heat-conductive fin assembly removably mounted on said outer shell, whereby a large surface is exposed to the ambient atmosphere for dissipating heat from the cask.

2. An apparatus for transporting exothermic radioactive material comprising a cask, said cask having walls constructed of an outer shell and an inner shell spaced from said outer shell, a radiation-shielding filler between said outer and inner shells, said outer and inner shells having a heat-conductive fin-like construction for dissipating heat from said cask, and an auxiliary heat-conductive fin assembly removably mounted externally on said outer shell, whereby a large heat-conductive surface is exposed to the ambient atmosphere.

3. An apparatus for transporting exothermic radioactive material comprising a cask, said cask having walls constructed of an outer shell and an inner shell spaced from said outer shell, a radiation-shielding filler between said outer and inner shells, said outer and inner shells having a heat-conductive fin-like construction for dissipating heat from said cask, said outer shell having a plurality of radially-aligned fins and a plurality of radially-aligned conducting strips, each being intersticed between said fins and associated with the radiation-shielding filler, said inner shell being constructed of an internal liner and a plurality of longitudinally-extending fluid conducting pipes mounted radially around said liner and in spaced relation from each other, a removable lid for said cask, means for fastening said lid to said cask, and structural supports mounted on said outer shell for carrying said cask.

4. An apparatus for transporting exothermic radioactive material comprising a cask, said cask having walls constructed of an outer shell and an inner shell spaced from said outer shell, a radiation-shielding filler between said outer and inner shells, said outer and inner shells having a heat-conductive fin-like construction for dissipating heat from said cask, said outer shell having a plurality of radially-aligned fins each of U-shaped construction and a plurality of radially-aligned conducting strips, each being intersticed between said fins and associated with said radiation-shielding filler, said inner shell being constructed of an internal liner and a plurality of longitudinally-extending fluid conducting pipes mounted radially around said liner and in spaced relation from each other, said pipes being interconnected at their upper and lower extremities, a removable lid for said cask, means for fastening said lid to said cask, and structural supports mounted on said outer shell for carrying said cask.

5. An apparatus for transporting exothermic radioactive material comprising a cask, said cask having walls constructed of an outer shell and an inner shell spaced from said outer shell, a radiation-shielding filler between said outer and inner shells, said outer and inner shells having a heat-conductive fin-like construction for dissipating heat from said cask, said outer shell having a plurality of radially-aligned fins each of V-shaped construction and a plurality of radially-aligned conducting strips, each being intersticed between said fins and associated with said radiation-shielding filler, said conducting strips being lead-bonded to said fins, said inner shell being constructed of an internal liner and a plurality of longitudinally-extending fluid conducting pipes mounted radially around said liner and in spaced relation from each other, a removable lid for said cask, means for fastening said lid to said cask, and structural supports mounted on said outer shell for carrying said cask.

6. An apparatus for transporting exothermic radioactive material comprising a cask, said cask having walls

constructed of an outer shell and an inner shell spaced from said outer shell, a radiation-shielding filler between said outer and inner shells, said outer and inner shells having a heat-conductive fin-like construction for dissipating heat from said cask, said outer shell having a plurality of radially-aligned fins spaced apart by radially-aligned conducting strips brazed thereto, said conducting strips being associated with the radiation-shielding filler, and a plurality of wedge-receiving fins intersticed between groups of said fins, said inner shell having an internal liner and a plurality of internal fins brazed thereto and spaced apart from each other, a removable lid for said cask, means for fastening said lid to said cask, structural supports mounted on said outer shell for carrying said cask, and auxiliary heat-conducting fin assemblies adapted to be removably mounted externally on said outer shell, each auxiliary fin assembly having wedge members engaging said wedge-receiving fins.

7. An apparatus for transporting exothermic radioactive material comprising a cask, said cask having walls constructed of an outer shell and an inner shell spaced from said outer shell, a radiation-shielding filler between said outer and inner shells, said outer and inner shells having a heat-conductive fin-like construction for dissipating heat from said cask, said outer shell having a plurality of radially-aligned fins each of U-shaped construction spaced apart by radially-aligned conducting strips brazed thereto and associated with the radiation-shielding filler, and a plurality of wedge-receiving fins each of H-shaped construction intersticed between groups of said fins, said inner shell having an internal liner and a plurality of internal fins brazed thereto and spaced-apart from each other, a removable lid for said cask, means for fastening said lid to said cask, structural supports mounted on said outer shell for carrying said cask, and auxiliary heat-conducting fin assemblies adapted to be removably mounted externally on said outer shell, each auxiliary fin assembly having wedge members engaging said wedge-receiving fins.

8. An apparatus for transporting exothermic radioactive material comprising a cask, said cask having walls constructed of an outer shell and an inner shell spaced from said outer shell, a radiation-shielding filler between said outer and inner shells, said outer and inner shells having a heat-conductive fin-like construction for dissipating heat from said cask, said outer shell having a plurality of radially-aligned fins spaced apart from each other, structural blocks spacing said fins, radially-aligned conducting strips extending inwardly from said structural blocks into said radiation-shielding filler, said inner shell having an internal liner and a plurality of internal fins secured thereto and spaced apart from each other, a removable lid for said cask, means for fastening said lid to said cask, structural supports mounted on said outer shell for carrying said cask, and auxiliary heat-conducting fin assemblies adapted to be removably mounted externally on said outer shell, each auxiliary fin assembly having a supporting member, fin blades extending therefrom, a flat surface contact and means for biasing said flat surface contact into intimate engagement with said structural block of said outer shell.

9. An apparatus for transporting exothermic radioactive material comprising a cask, having an outer shell and an inner shell, high radiation-shielding material between said outer and inner shells, said outer shell having a fin-like construction, said fin-like construction including a plurality of U-shaped fins joined together at their meeting edges with radially-aligned conducting strips having an inner portion associated with said high radiation-shielding material, whereby one surface is exposed to the ambient atmosphere and the other surface is exposed to the shielding material.

10. An apparatus for transporting exothermic radioactive material comprising a cask, said cask having walls constructed of an outer shell and an inner shell spaced from said outer shell, a radiation-shielding filler between

said outer and inner shells, said outer and inner shells having a heat-conductive fin-like construction for dissipating heat from said cask, said outer shell having a plurality of radially-aligned fins each of U-shaped construction spaced apart by radially-aligned conducting strips brazed thereto, said conducting strips associated at their inner edges with the radiation-shielding filler, a plurality of wedge-receiving fins intersticed between groups of said fins, said inner shell having an internal liner and a plurality of internal fins connected thereto and spaced apart from each other, said internal fins being directed towards said wedge-receiving fins, a removable lid for said cask, means for fastening said lid to said cask, means associated with said outer shell for carrying

said cask, and auxiliary heat-conducting fin assemblies adapted to be removably mounted externally on said outer shell, each auxiliary fin assembly having wedge members designed to engage with said wedge-receiving fins.

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