United States Patent

Taylor

[15] **3,653,333**

[45] **Apr. 4, 1972**

[54] HEAT-INSULATED RAILWAY TANK CARS AND A METHOD OF MAKING THE SAME

[72] Inventor: **William A. Taylor,** Sharpsville, Pa.

[73] Assignee: **General American Transportation Corporation,** Chicago, Ill.

[22] Filed: **Jan. 21, 1970**

[21] Appl. No.: **4,506**

[52] **U.S. Cl.** **105/360,** 29/455

[51] **Int. Cl.** **B61d 5/00**

[58] **Field of Search** 105/360, 358; 29/455

[56] **References Cited**

UNITED STATES PATENTS

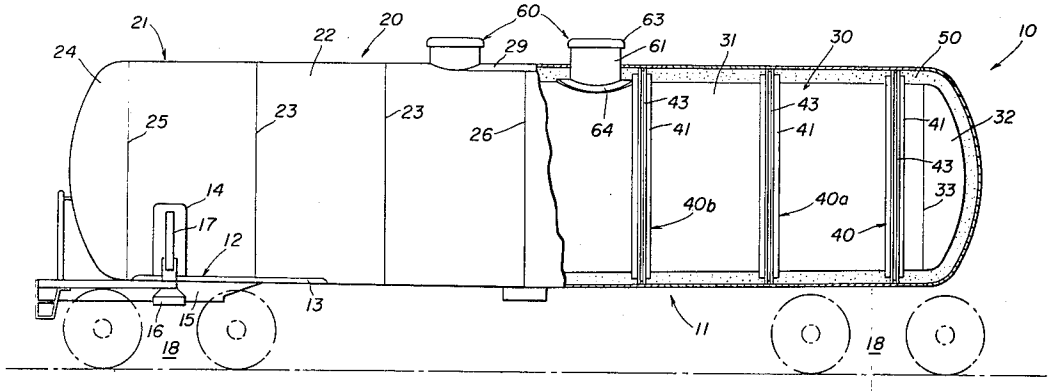
3,547,047	12/1970	Needham	105/360
3,390,644	7/1968	Krauskopf	105/358
3,172,566	3/1965	Mullin et al	105/360
3,326,141	6/1967	Graves	105/358
3,158,383	11/1964	Anderson	105/360

Primary Examiner—Arthur L. La Point
Assistant Examiner—Richard A. Bertsch
Attorney—Prangley, Clayton, Mullin, Dithmar and Vogel

[57] **ABSTRACT**

There is disclosed a heat-insulated railway tank car and a method of making the same, comprising positioning one or more barriers on an elongated inner liner, the barrier having a flexible portion and a rigid portion, sliding an elongated outer shell onto the inner liner while radially compressing the flexible portion of the barrier, the barrier thus defining separate fluid-tight compartments between the inner liner and the shell, and filling the compartments with an insulating substance.

5 Claims, 8 Drawing Figures



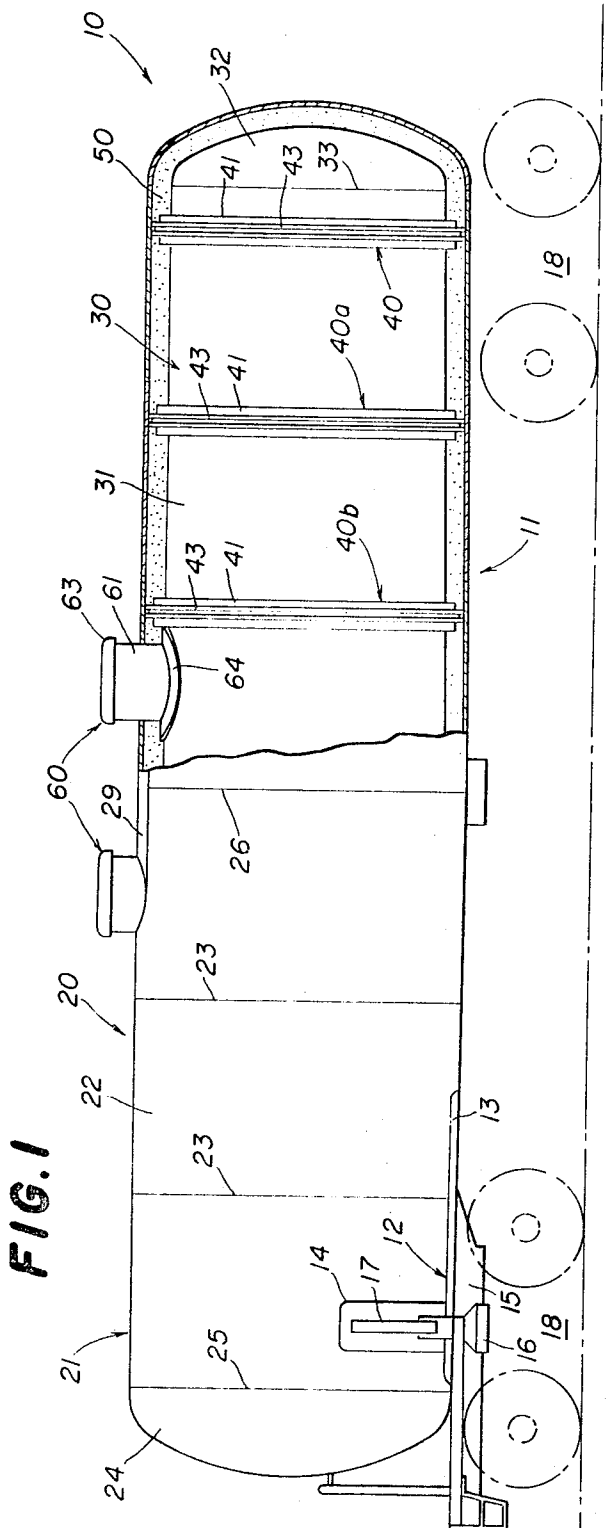


FIG. 1

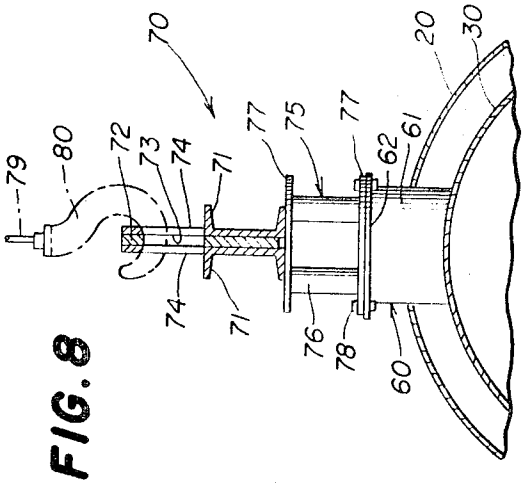


FIG. 8

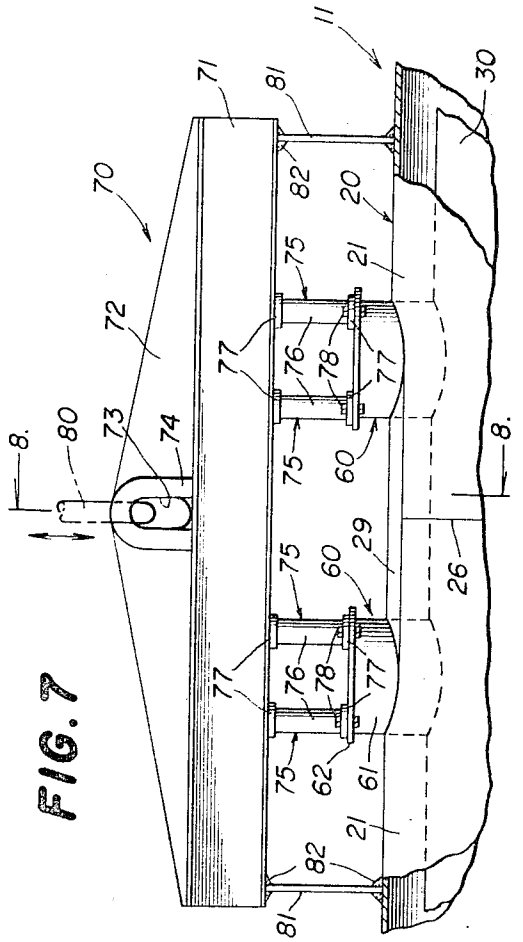


FIG. 7

INVENTOR
WILLIAM A. TAYLOR

BY
Prangley, Clayton, Mullin,
Dithmar & Vogel
ATTYS.

FIG. 2

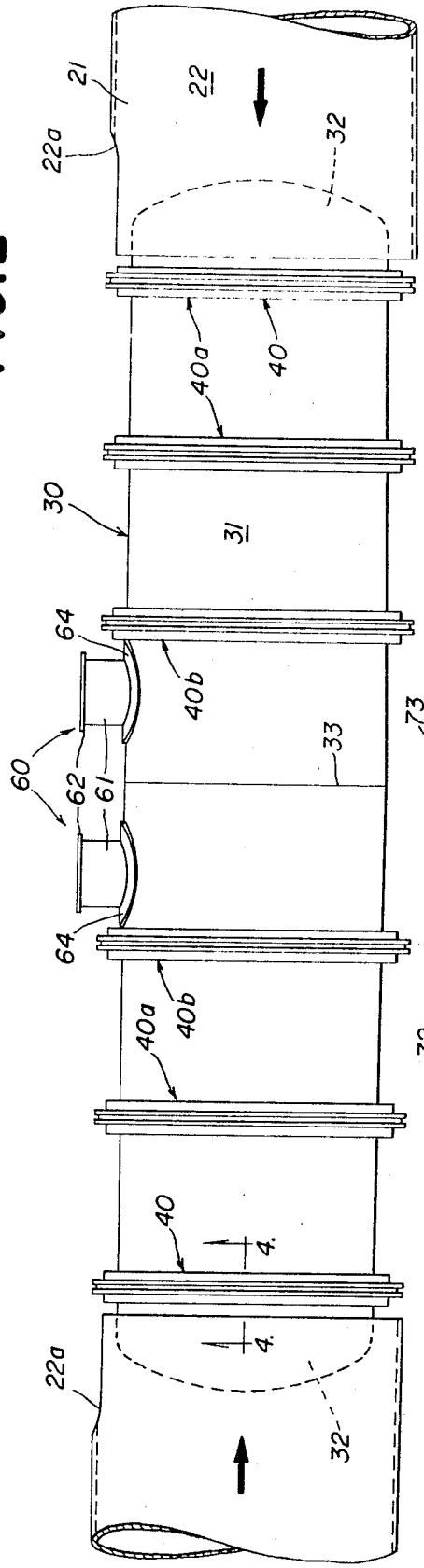

21
22
22a
32
40a
40
30
31
64
40b
60
62
61
33
64
40a
40b
40
4.
4.
22a
32

FIG. 3

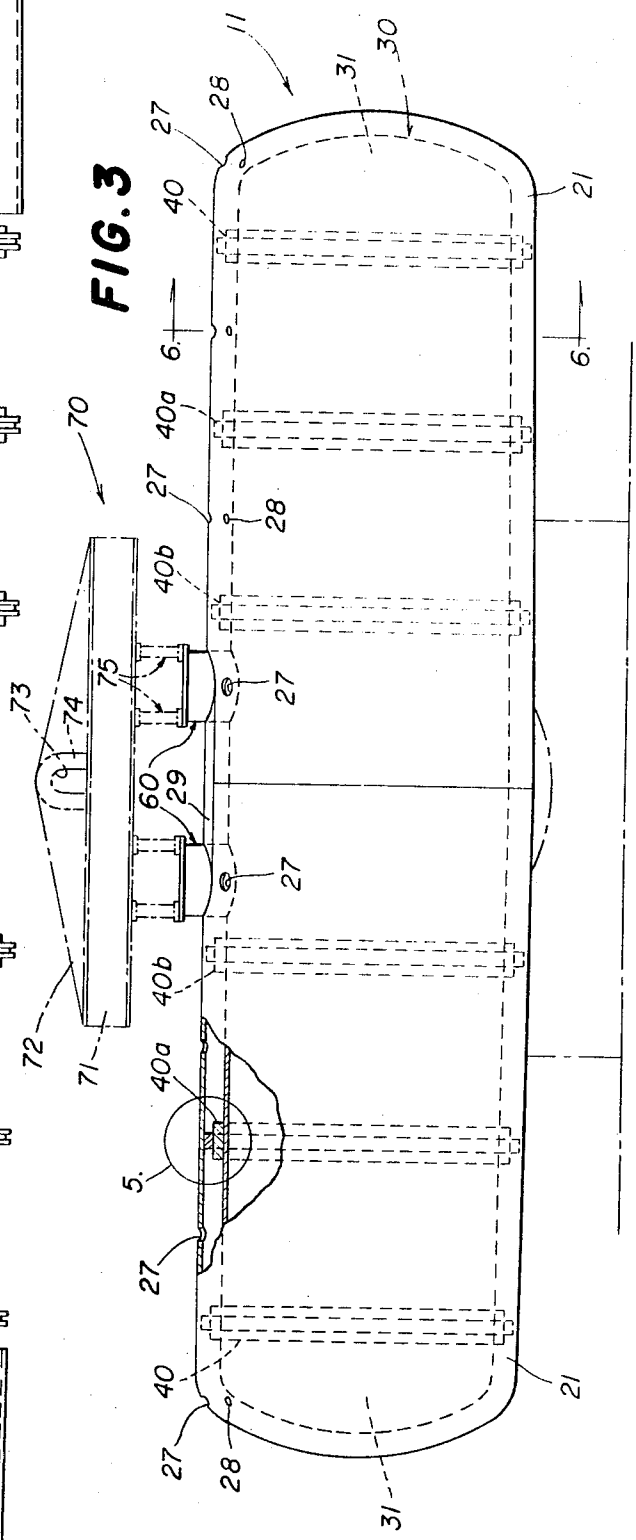

11
30
31
27
28
40
21
6.
6.
40a
70
27
28
40b
75
27
73
74
60
29
27
72
71
40b
40a
5.
27
40
21
27
28
31

FIG. 6

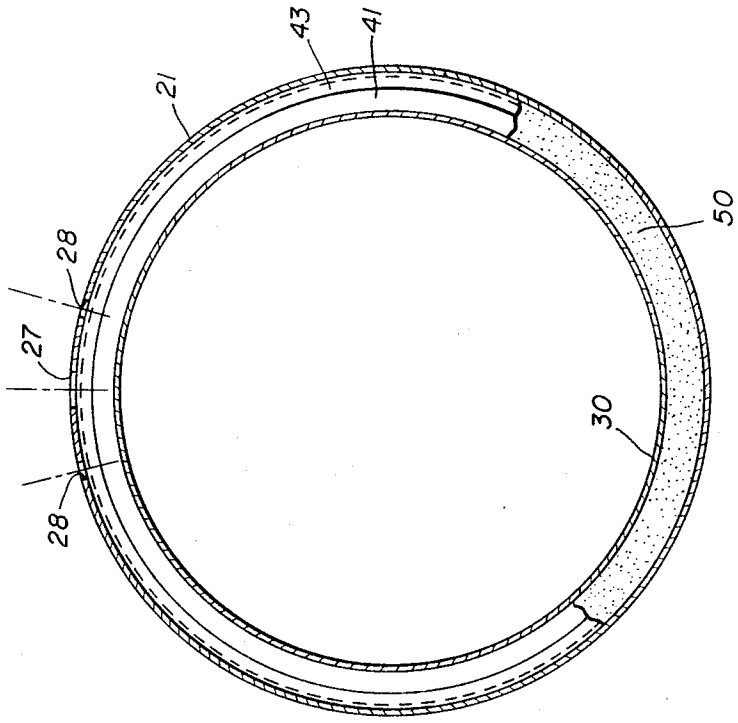


FIG. 4

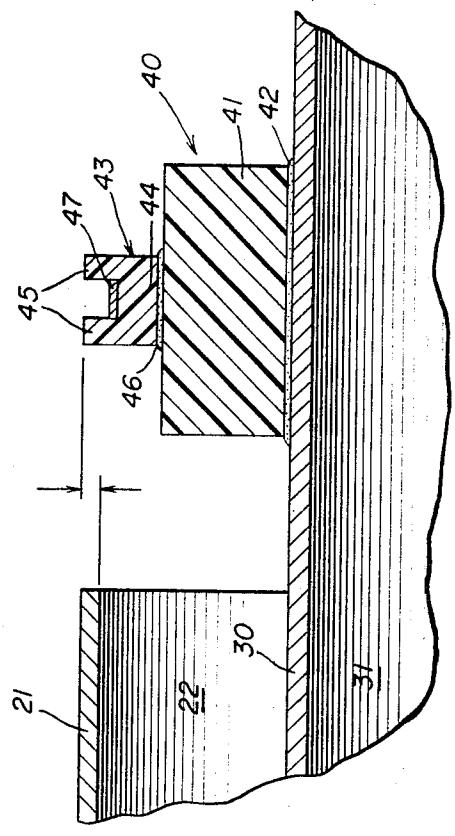
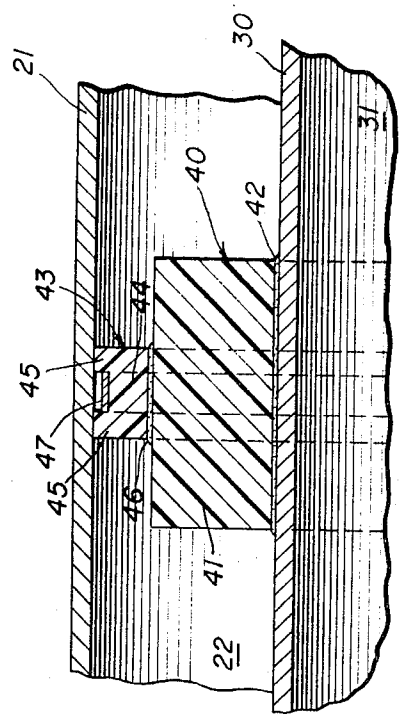


FIG. 5



HEAT-INSULATED RAILWAY TANK CARS AND A METHOD OF MAKING THE SAME

This invention relates generally to heat-insulated railway tank cars and to methods of making the same.

It is a general object of the invention to provide a railway tank car that is especially adapted to transport a variety of hot and cold ladings, and a method of making such a tank car.

Another object of the invention is to provide a method of making a railway tank car, comprising providing an elongated inner liner that has a longitudinal axis, positioning on the inner liner a barrier having a substantially rigid portion and a radially adjacent substantially flexible portion, providing an elongated outer shell having an inside radius less than the distance between the longitudinal axis and the outside surface of the barrier, sliding the outer shell onto the inner liner while radially compressing the flexible portion, the barrier thereby defining separate fluid-tight compartments between the inner liner and the shell, and filling the compartments with an insulating substance.

Another object of the invention is to provide a railway tank car, comprising an elongated inner liner having a longitudinal axis, a barrier on the inner liner and having a substantially rigid portion and a substantially flexible portion radially adjacent to the rigid portion, an elongated outer shell having an inside radius less than the distance between the longitudinal axis and the outside surface of the barrier, the elongated outer shell encompassing the inner liner and compressing said flexible portion, whereby the barrier defines separate fluid-tight compartments between the inner liner and the outer shell, and an insulating substance in the compartments.

Another object of the invention is to provide an improved method of making a railway tank car of the character described that involves a minimum number of simple steps which may be carried out in an economical manner.

Still another object of the invention is to provide an improved method of making the railway tank car, wherein the inner liner and the outer shell are maintained in a fixed relationship while the space between them is filled with an insulating substance.

A further object of the invention is to provide a railway tank car and a method of making the same, wherein there is provided a plurality of barriers disposed between the inner liner and the outer shell which define several fluid-tight compartments.

Further features of the invention pertain to the particular arrangement of the elements of the railway tank car and of the steps of the method of making the same, whereby the above-outlined and additional operating features thereof are attained.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following specifications, taken in connection with the accompanying drawings, in which:

FIG. 1 is a side elevational view of a railway tank car embodying the present invention, certain portions thereof being broken away to expose the inner liner;

FIG. 2 is a view of the inner liner of the tank car with a plurality of annular barriers thereon and with the outer shell sections being slid into place;

FIG. 3 is a side elevational view of the railway tank car with the outer shell in place and with a suspension apparatus supporting the inner liner;

FIG. 4 is a greatly enlarged view of the car in FIG. 2, along the lines 4—4 thereof;

FIG. 5 is a greatly-enlarged view of the portion of FIG. 3 in the circle labeled with the reference numeral 5, and illustrating the manner in which the outer shell compresses the flexible barrier;

FIG. 6 is an enlarged vertical section of the body of the railway tank car, this view being taken in the direction of the arrows along the line 6—6 in FIG. 3;

FIG. 7 illustrates the suspension apparatus and the manner in which it is attached to the railway tank car; and

FIG. 8 is the vertical section of the suspension apparatus and the body of the railway tank car shown in FIG. 7, taken along the lines 8—8 thereof.

Referring now to the drawings and more particularly to FIGS. 1 and 2 thereof, the railway tank car 10 there illustrated, and embodying the features of the present invention, is of the heat-insulating type and of a construction that does not include an underframe. More particularly, the railway tank car 10 comprises an elongated longitudinally extending body 11 disposed in a substantially horizontal position. The opposite lower end portions of the body 11 respectively carry two arcuate-shaped saddle plates 12 that are rigidly secured thereto, as by welding. Each of the saddle plates 12 comprises a base section 13 disposed directly below the adjacent end of the body 11, and a pair of arm sections 14 respectively disposed below the opposite side portions of the adjacent end of the body 11. In turn, two longitudinally extending and aligned stub draft sills 15 are respectively disposed below the base sections 13 of saddle plates 12 and rigidly secured thereto, as by welding. In turn, the two stub draft sills 15 are respectively carried by two laterally extending body bolsters 16 rigidly secured thereto, as by welding. Each of the body bolsters 16 carries a pair of upstanding pedestals 17 rigidly secured thereto adjacent to the opposite ends thereof, as by welding; and each of the pedestals 17 is rigidly secured to the adjacent arm section 14 of the associated saddle plate 12. Thus, each of the stub draft sills 15 is rigidly secured to the adjacent end portion of the body 11 by the adjacent saddle plate 12, the adjacent body bolster 16, and the adjacent pair of pedestals 17. The stub draft sills 15 are arranged in longitudinal alignment with each other and with the center line thereof disposed in a vertical plane passing through the longitudinal center of the body 11. The body bolsters 16 are respectively supported by truck bolsters respectively carried by wheeled trucks 18 respectively disposed therebelow, each of the body bolsters 16 being connected to the adjacent truck bolster by a center pin, not shown, so as to accommodate articulation of the truck 18 with respect to the associated body bolster 16 in a conventional manner. Also, the outer ends of the respective stub draft sills 15 are hollow and are adapted respectively to receive conventional draft gears, not shown, in a conventional manner. In view of the foregoing description of the arrangement of the stub draft sills 15 and the associated elements, it will be appreciated that the railway tank car 10 does not comprise the usual underframe; whereby the draft and buff forces are applied between the stub draft sills 15 through the body 11, without the provisions of an underframe or any other equivalent rigid auxiliary structure interconnecting the stub draft sills 15.

The body 11 of the railway tank car 10 consists of an outer shell 20 of strong rigid self-supporting structure, an inner liner 30 of fluid-tight construction, and an intermediate layer of insulating substance 50 filling the space between the inner liner 30 and the outer shell 20, the general configurations of the elements 20, 30 and 50 being similar. The outer shell 20 consists of two outer shell sections 21 that are substantial duplicates of each other, whereby the following description with respect to the left-hand shell section 21, as viewed in FIG. 1, is equally applicable to the right-hand outer shell section. Each outer shell section 21 includes three cylindrical side walls 22 that are welded together to form seams 23. Disposed on the outer end of the last of the side walls 22 is an end wall 24 which has a generally outwardly convex or bell-like configuration, and is welded to the outer end of the left-hand side wall 22 to form a seam 25.

The inner liner 30 has a welded construction and is formed of low carbon steel provided with an interior plastic coating or of suitable stainless steel for various corrosive ladings, etc. Also, the interior surface of the liner 30, when formed of stainless steel, is free of all cracks and surface irregularities, and is provided with a smooth-mirror-like finish, so as to provide a surface in contact with the contained lading that may be easily maintained in a clear, clean and sanitary condition, in order to

prevent any possible contamination of the contained lading. In the instant construction, the inner liner **30** has a tubular side wall **31** disposed in a substantially horizontal position and a pair of upstanding end walls **32** respectively disposed on the opposite ends of the side wall **31**. The side wall **31** is substantially cylindrical; and the end walls **32** are identical, each having a generally outwardly convex or bell-like configuration. There is provided a plurality of longitudinally spaced-apart annular barriers **40** secured to the inner liner **30**, the construction of which will be explained in more detail hereinafter. For the present, suffice to say that the barriers **40** are of a construction to provide a number of fluid-tight compartments between the inner liner **30** and the outer shell **20** and between adjacent ones of the barriers **40**. The insulating substance **50** then fills each of these compartments.

Finally, there is provided a pair of longitudinally spaced-apart manway structures **60** on the top of the body **11** respectively on either side of a lateral plane passing through the center thereof. Each manway structure **60** comprises an upstanding tubular manway **61** carrying a flat annular rim **62** (see FIG. **3**). Also, a cover **63** is associated with the top end of each manway structure **60** and is hingedly mounted thereon to enable it to be moved between its open and closed position with respect to the upper end of the tubular manway **61**. A substantially saddle-shaped ring **64** is carried by the top central portion of the outer shell **20** in surrounding relationship with a hole therein, through which the upstanding tubular manway **61** projects, which ring **64** is rigidly secured in place, as by welding.

Considering now the method of making the railway tank car body **11** in accordance with the present invention, and referring to FIGS. **2**, **3**, and **8**, the inner liner **30** is first assembled by securing together, by welding or the like, the various portions thereof. The two manway structures **60** are secured in place on top of the inner liner **30**, through which access may be gained to the interior. In the form of the invention shown, the inner liner **30** is constructed in such a manner that the bottom portion of the side wall **31** slopes toward the center. An outlet opening may be provided in the bottom of the side wall **31** approximately centrally thereof, whereby fluid in the liner **30** will flow naturally toward such opening.

A plurality of barriers **40** is then wrapped or placed around the inner liner **30** in longitudinally spaced-apart relationship. Referring specifically to FIGS. **4** and **5**, each barrier **40** includes an annular rigid portion **41** that has a rectangular lateral cross section and is secured to the inner liner **30** by means of an adhesive **42**. Each barrier **40** also includes a flexible portion **43** that is U-shaped in lateral cross section, the portion **43** including an annular body **44** and annular walls **45**. The flexible portion **43** is secured to the outer surface of the rigid portion **41** by means of an adhesive **46**. Finally, there is provided a strap **47** that fits within the annular wall **45** and against the body **44** to hold securely the flexible portion **43** and the rigid portion **41** at the selected position on the liner **30**.

Preferably, the adhesive **42** is applied to the exterior of the inner liner **30** and the inner surface of the rigid portion **41**. After the adhesive **42** is allowed to set, the rigid portion **41** is wrapped on the inner liner **30**. An adhesive is then applied to the outside surface of the rigid barrier **41** and also to the inside surface of the flexible portion **43**. After the adhesive is permitted to set, the flexible portion is wrapped around the rigid portion **41**. Finally, the strap **47** is placed between the annular walls **45** of the flexible portion **43** and is drawn taut. The arrangement just described causes the barrier **40** to be secured tightly to the inner liner **30**. Each of the barriers **40** is secured, one after another, in a similar manner, or if desired, the adhesive **42** can be deposited on each location on the inner liner **30**, followed by applying the adhesive **42** to the rigid portion **41**; then positioning all of the rigid portions **41** on the inner liner **30**; followed by applying adhesive to the outer surfaces of all of the rigid portions **41**, and to the inner surfaces of the flexible portions **43**; followed by positioning the flexible portions **43** in place on the outer surface of the rigid portions **41**; and finally, by affixing the straps **47** respectively to the barriers **40**.

Preparatory to assembling the outer shell **20**, the exterior of the inner liner **30** may be blasted by sand or the like to provide a good bond to the insulating substance **50** which will later be applied.

In order to support the inner liner **30** while the outer shell **20** is being slid into place, a suspension apparatus **70** is provided. The suspension apparatus **70** includes a pair of channel-shaped members **71** respectively having their flanges outwardly directed and their bight portions in spaced relationship. An elongated plate **72** is disposed between the channel-shaped members **71** and secured thereto, as by welding. A triangular portion of the plate **72** protrudes above the channel-shaped members **71** and has centrally therein an oval-shaped opening **73**. A pair of U-shaped reinforcing members are disposed upside down respectively on opposite sides of the plate **72** and secured thereto, as by welding. The suspension apparatus **70** further includes four spacer assemblies **75** secured to the channel-shaped members **71** at longitudinally spaced-apart points thereon, which points are selected to correspond to the positions of the two manway structures **60**. Each spacer assembly **75** includes a pair of laterally spaced-apart posts **76** secured at their tops and at their bottoms respectively to a pair of crossbars **77**. The top crossbar **77** of each of the four spacer assemblies **75** is secured to the outwardly directed flanges on the channel-shaped member **71**, as by welding. The bottom crossbars **77** on the two spacer assemblies **75**, toward the right, as viewed in FIGS. **3** and **7**, are secured by means of fasteners **78**, such as nuts and bolts, to the manway structure **60** toward the right, as viewed in FIG. **7**; and the bottom crossbars **77** of the spacer assemblies **75**, toward the left as viewed in FIG. **7**, are secured by similar fasteners **78** to the manway structure **60** toward the left. Finally, there is provided a cable **79** carrying a hook **80**, which cable is secured to an overhead structure (not shown). The hook **80** is slipped through the reinforcing members **74** and the opening **73** in the plate **72**, thereby to suspend the inner liner **30** for subsequent steps in its processing.

The next step involves the positioning of the outer shell **20** on the inner liner **30**. As previously stated, the outer shell **20** consists of two outer shell sections **21** which are substantial duplicates of each other. Referring to FIG. **2**, the outer shell section **21** that is to encase the left-hand portion of the inner liner **30** is placed, such that its open end is in facing relationship with the left end wall **32** of the inner liner **30**, as viewed in FIG. **2**, and such that the longitudinal axis of the outer shell section **21** is essentially colinear with the longitudinal axis of the inner liner **30**. Referring specifically to FIG. **4**, it is important to note that the outer diameter of each of the annular walls **45** of each of the barriers **40** is greater than the inner diameter of the outer shell **20**, when the barrier **40** is in an unflexed condition. Stated another way, the distance between the longitudinal axis of the inner liner **30** and the outside surface of the flexible portion **43** is greater than the inside radius of the outer shell **20**. Thus, as the outer shell section **21** on the left is being slid into place, a wiping action between the flexible portion **43** and the outer shell section **21** is created. The outer shell section **21** thus comprises radially the annular walls **45** to cause the barrier **40** to assume the condition shown in FIG. **5**. Of course, as the outer shell section **21** on the left is moved further toward the right, it encounters the second barrier **40***a*, and causes compression of the flexible portion **43** in a similar manner. It can thus be appreciated that there is defined a compartment between the first barrier **40** and second barrier **40***a* and between the outer surface of the inner liner **30** and the inner surface of the outer shell **20**, this compartment being fluid-tight by virtue of the radial compression of the annular walls **45**. The outer shell section **21** is urged further to the right until it encounters the third barrier **40**b, whereupon its flexible portion **43** is also radially compressed to define yet a second fluid-tight compartment between the second barrier

40*a* and the third barrier 40*b* and between the inner liner 30 and the outer shell section 21. When the outer shell section 21 is finally in place, as shown in FIG. 3, three fluid-tight compartments are defined, respectively between the inner liner 30 and the outer shell 20 to the left of the first barrier 40, a second compartment between the first barrier 40, and the second barrier 40*a*, and a third compartment between the second barrier 40*a* and the third barrier 40*b*.

After the left-hand outer shell section 21 is in place, the right-hand outer shell section 21 is then slid into place in a similar fashion. More particularly, the outer shell section 21 that is to encase the right-hand portion of the inner liner 30 is placed such that its open end is in facing relationship with the right end wall 32 of the inner liner 30, as viewed in FIG. 2, and such that the longitudinal axis of the outer shell section 21 is essentially collinear with the longitudinal axis of the inner liner 30. As was the case with the barrier 40 to the left, the outer diameter of each of the annular walls 45 of each of the barriers 40 toward the right is greater than the inner diameter of the outer shell 20, when the barrier 40 is in an unflexed condition. Stated another way, the distance between the longitudinal axis of the inner liner 30 and the outside surface of the flexible portion 43 is greater than the inside radius of the outer shell 20. Thus, as the outer shell section 21 on the right is being slid into place, a wiping action between the flexible portion 43 and the outer shell section 21 is created. The outer shell section 21 thus compresses radially the annular walls 45 to cause the barrier 40 to assume the condition shown in FIG. 5. As the outer shell section 21 on the left is moved further toward the right, it encounters the second barrier 40*a*, and causes compression of the flexible portion 43 in a similar manner. It can thus be appreciated that there is defined a compartment between the first barrier 40 and second barrier 40*a* and between the outer surface of the inner liner 30 and the inner surface of the outer shell 20, this compartment being fluid-tight by virtue of the radial compression of the annular walls 45. The outer shell section 21 is urged further to the left until it encounters the third barrier 40*b*, whereupon its flexible portion 43 is also radially compressed to define yet a second fluid-tight compartment between the second barrier 40*a* and the third barrier 40*b* and between the inner liner 30 and the outer shell section 21. When the outer shell section 21 is finally in place, as shown in FIG. 3, three fluid-tight compartments are defined, respectively between the inner liner 30 and the outer shell 20 to the left of the first barrier 40, a second compartment between the first barrier 40, and the second barrier 40*a*, and a third compartment between the second barrier 40*a* and the third barrier 40*b*.

Alternatively, the outer shell sections 21 may be simultaneously aligned with the respective ends of the inner liner 30 and simultaneously moved toward each other until they converge at the center line.

Each outer shell section 21 has a U-shaped opening 22*a* formed near the open end thereof, the width of that opening being slightly greater than the diameter of the tubular manway 61. The length of the opening 22*a* is approximately equal to the distance between the mid-point of the inner liner 30 and the outermost point on the tubular manway 61. The curvature of the bight portion of the opening 22*a* matches the curvature of the tubular manway 61. Accordingly, when the outer shell sections 21 are slid onto the inner liner 30, the tubular manway 61 will be located respectively in the openings 22*a*. When the outer shell sections 21 are in place, the outer ends of the tubular manways 61 will respectively abut against the curved bight portions of the openings 22*a*. To fill the gap in the outer shell 20 between the tubular manways 61, there is provided a curved cover plate 29 having a curvature to conform to the curvature of the outer shell 20, the ends being concavely curved to match the curvature of the tubular manway 61. The cover plate 29 is placed, as shown in FIG. 3, and then secured, as by welding to the outer shell 20.

After both outer shell sections 21 are in place, a bar 81 of proper length is secured temporarily to the channel-shaped members 71 at one end thereof and to the portion of the outer shell section 21 immediately therebelow, the bar 81 being secured such as by welds. Similarly, a second bar 81 is secured temporarily to the left-hand end of the channel-shaped members 71 and to the portion of the outer shell 20 immediately therebelow, such as by welds. The bar 81 effectively holds the outer shell section 21 in the desired relationship with respect to the inner liner 30. After the bar 81 is secured in place, the two outer shell sections 21 are welded together to form the seam 26. This latter step could easily have been performed prior to the connection of the bars 81. Of course, once the two outer shell sections 21 are secured together, an additional fluid-tight compartment between the third barrier of each outer shell section 21 is provided, for a total of seven compartments in all.

The uncured ingredients used to form the insulating substance 50 are then introduced through pour holes 27 which are located at longitudinally spaced-apart points in the outer shell 20. Thus, there is at least one pour hole 27 communicating with each of the seven compartments defined by the barriers 40, the inner liner 30 and the outer shell 20. Also, there is provided one or more air vents 28 communicating with each compartment to facilitate the introduction of the uncured ingredients. The ingredients once in the compartments set up rather quickly at room temperature to produce the insulating substance 50. Thereafter, the pour holes 27 and the air vents 28 are sealed by plugs, plates, or the like. The bars 81 that form part of the suspension apparatus 70 are disconnected from the outer shell 20, and then the fasteners 78 are loosened to remove the suspension apparatus 70. Thereafter, the stub draft sills 15 are welded to the saddle plates 12, the body bolsters 16 are welded to the stub draft sills 15, and the pedestals 17 are welded both to the body bolsters 16 and to the saddle plates 12, thereby to finish the principal elements of the draft structure for the railway tank car 10. Usually, the draft sills, the bolsters and the saddle plates are welded in place prior to the bringing together of the outer shell sections. Finally, the body 11 carrying the stub draft sills 15, etc. is mounted upon the associated wheel trucks 18.

In the operation of the railway tank car 10, the inner liner 30 is adapted to receive cold ladings having temperatures as low as about −50° F.; and it is undesirable to refrigerate the lading during several days of transit of the car 10; and it is required that the temperature rise of the lading be limited to several degrees F. even when the ambient temperature is as high as 100° F. Also, in the operation of the railway tank car 10, the inner liner 30 is adapted to receive hot ladings having temperatures as high as 300° F.; and it is undesirable to heat the lading during several days of transit of the car 10; and it is required that the temperature fall of the lading be limited to several degrees F. even when the ambient temperature is as low as 0° F. In order to meet this difficult specification, it is desirable that the resin forming the insulating layer 50 comprises a polyester-urethane resin of closed-cell structure entrapping substantial inert gas selected from the class consisting of a chlorine-fluorine substituted alkane; whereby this resin has a K-factor at least as low as about 0.15 B.t.u./in./sq.ft./hr./° F. in order to heat-insulate from each other the outer shell 20 and the inner liner 30.

Reverting to the inert gases specified, this class of compounds comprises $CHC1F_2$, $CHC1_2F$, $CC1_2F_2$, $CC1_3F$, $C_2C1_2F_4$ and $C_2C1_3F_3$; and of these gases $CC1_3F$ and $CC1_2F_2$ are normally preferred as a matter of efficiency and economy. The utilization of these inert gases as the blowing agent is important since a typical polyester-urethane resin blown with $CC1_3F$ has a K-factor as low as about 0.122, while a comparable typical polyester-urethane resin blown with CO_2 has a K-factor of about 0.191. For reference purposes it is noted that a comparable cellular polystyrene resin has a K-factor of about 0.220.

The following example of a polyester-urethane resin of cellular form and of closed-cell structure and blown by an inert gas of the class specified is recommended for the production

of the insulating layer **50**. This resin is produced in a conventional manner employing a well-known machine comprising tanks A and B respectively containing two portions of the ingredients, as noted below. The contents of tank A are maintained at a temperature of about 70° F. and the contents of tank B are maintained at a temperature of about 190° F; the contents of the two tanks are mixed at a rate of about 5,500 r.p.m. and in about equal parts by weight and immediately applied to the mold.

Tank A contains the ingredients in parts by weight:

	Parts
Trichloromonofluoromethane,	
"Freon-A11" (DuPont)	27
Tolylene diisocyanate,	
"70 Nacconate 4040" (Allied Chemical)	71-¾
Silicone compound, "L530"	
(Union Carbide)—	1-¼

Tank B contains the ingredients in parts by weight:
100 parts chlorinated polyester, "Hetrafoam 250"
(Durez Plastics)

In tank A the trichloromonofluoromethane is a propellant and blowing agent, and the silicone compound is an agent for controlling the cell structure of the cured polyester-urethane resin; and in tank B the chlorination of the polyester renders the cured polyester-urethane resin flame self-quenching. This polyester in tank B essentially comprises the basic reaction product of maleic anhydride and phthalic anhydride with propylene glycol; a typical formula comprising 0.5 mole maleic anhydride, 0.5 mole phthalic anhydride, and 1.1 moles of propylene glycol. A small amount of cobalt napthenate, as an accelerator, and a small amount of methyl ethyl ketone peroxide, as a catalyst, may also be added to the basic ingredients named above for the fundamental purpose of controlling the degree of prepolymerization thereof in the production of this linear polyester. Also, the chlorination of this linear polyester is normally carried out subsequent to the prepolymerization mentioned and may be omitted if the flame self-quenching characteristic noted is not desired in the ultimately produced polyester-urethane resin. However, this characteristic is highly desirable, as it increases the safety factor of the resin and contributes to chemical stability thereof when it is subjected to relatively high temperatures. This blown polyester-urethane resin after curing has a density of about 2 lbs./cu.ft.

The foregoing examples of the polyester-urethane resin are well known within themselves and form no part of the present invention; whereby these formulations have been set forth herein only by way of examples, so as positively to insure that the corresponding resins incorporated in the railway tank car **10** possess the desired chemical and physical properties that are required therein, as previously explained in conjunction with the construction and arrangement thereof. Thus, it will be readily apparent that other conventional and well-known chemical formulations of these polyester-urethane resins may be substituted in the railway tank car **10**.

In a constructional example of the railway tank car **10**: the outer shell **20** had an overall length of 627 inches; each outer shell section **21** had an overall length of 313½ inches and had an inside diameter of 115 inches at its open end and **112** inches at its closed end so that each outer shell section **21** sloped downwardly toward the mid-point of the body **11**; the inner liner **30** had an overall length of 614½ inches, an inside diameter of 102 inches at its mid-point and 99 inches at its outer extremities, whereby the bottom of the inner liner **30** slopes toward the mid-point thereof a total of 3 inches from either end; the inner liner **30** is spaced substantially uniformly inwardly of the outer shell **20**, so that the insulating substance **50** has a substantially-uniform thickness of approximately 6 5/16 inches; the rigid portion **41** of each barrier **40** is constructed of urethane foam and when viewed in lateral cross section measures 4 inches × 8 inches; each flexible portion **43** of the barriers **40** is constructed of expanded polyethylene foam wherein the radial width of the annular walls **45** when viewed in lateral cross section is 2½ inches when uncompressed and 2 5/16 inches when compressed; the distance between the outside surface of the inner liner **30** and the inside surface of the outer shell **20** is 6 5/16 inches; the distance between one end of the inner liner **30** and the center line of the adjacent barrier **40** is 69 inches; the distance between the center lines of barrier **40** and the barrier **40***a* is 93 inches; the distance between the center lines of the barrier **40***b* and the barrier **40***c* is 92 inches; the distance between the center lines of the two barriers **40***c* is 106½ inches the total amount of insulation required to make up the insulating substance **50** is 797 cubic feet; the outer shell **20** is formed with low-carbon steel, having a thickness of 7/16 inch and is of welded construction; and the inner liner **30** is formed of low-carbon steel, having a thickness of 3/16 inch and is of welded construction. Also, the interior surface of the inner liner **30** carries a substantially uniform baked phenolic coating, having a thickness in the general range 0.010 to 0.030 inch.

In view of the foregoing, it is apparent that there has been provided an improved method of making a railway tank car of the heat-insulated type and may be carried out in a simple and economical manner.

While there has been described what is at present considered to be the preferred embodiments of the invention, it will be understood that various modifications may be made therein, and it is intended to cover in the appended claims all such modifications that fall within the true spirit and scope of the invention.

What is claimed is:

1. A railway tank car comprising an elongated inner liner, an elongated outer shell encircling said inner liner and spaced therefrom, a plurality of substantially rigid annular barriers secured to the outer surface of said inner liner at longitudinally spaced-apart points thereon and each extending around the girth of said liner, a corresponding plurality of substantially flexible annular barriers disposed between said outer shell and said rigid barrier and secured respectively to the outer surface of said rigid barriers and extending therearound, the combined radial thickness of said rigid barrier and said flexible barrier in the unflexed condition thereof being greater than the radial distance between said inner liner and said outer shell, thereby to define separate fluid-tight compartments between said inner liner and said outer shell and separated one from the other by said barrier, and an insulating substance in said compartments.

2. The railway tank car set forth in claim **1**, wherein said rigid barrier is a urethane foam.

3. The railway tank car set forth in claim **1**, wherein said flexible barrier is an expanded polyethylene foam.

4. A railway tank car comprising an elongated inner liner, an elongated outer shell encircling said inner liner and spaced therefrom, a plurality of substantially rigid annular barriers secured to the outer surface of said inner liner at longitudinally spaced-apart points thereon and each extending around the girth of said liner, a corresponding plurality of substantially flexible annular barriers disposed between said outer shell and said rigid barriers and secured respectively to the outer surfaces of said rigid barriers and extending therearound, each of said flexible barriers being U-shaped in transverse cross section and including a body carrying a pair of spaced radially extending walls, the combined radial thickness of said rigid barrier and said flexible barrier in the unflexed condition thereof being greater than the radial distance between said inner liner and said outer shell, said walls being compressed by said outer shell thereby to define separate fluid-light compartments between said inner liner and said outer shell and separated one from the other by said barrier, and an insulating substance in said compartments.

5. A railway tank car comprising an elongated inner liner, an elongated outer shell encircling said inner liner and spaced therefrom, a plurality of substantially rigid annular barriers

secured to the outer surface of said inner liner at longitudinally spacedeapart points thereon and each extending around the girth of said liner, a corresponding plurality of substantially flexible annular barriers disposed between said outer shell and said rigid barriers and secured respectively to the outer surfaces of said rigid barriers and extending therearound, each of said flexible barriers being U-shaped in transverse cross section and including a body carrying a pair of spaced radially extending walls, and a band positioned between said walls and against said body and tightened securely to mount said flexible barrier upon said rigid barrier, the combined radial thickness of said rigid barrier and said flexible barrier in the unflexed condition thereof being greater than the radial distance between said inner liner and said outer shell, said walls being compressed by said outer shell thereby to define separate fluid-tight compartments between said inner liner and said outer shell and separated one from the other by said barrier, and an insulating substance in said compartments.

* * * * *