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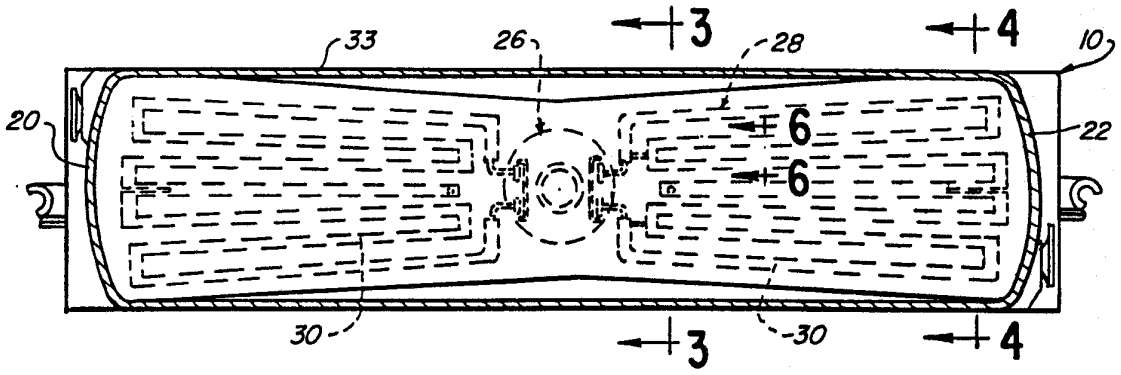
(54) Title: TANK CAR DISCHARGE VALVE HEATING UNIT



(57) Abstract

A railway car (10) heated by system through a heat exchanger (28) located at the bottom (18) of a tank (14). The heat exchanger (28) comprises pipes (53, 58, 59, 60, 61, 67, 68) running lengthwise of the car (10). Bypasses (72, 74) are provided to discharge condensate formed in the pipes between their ends to drain hot condensate into a cavity of a torus (26) sleeved about a discharge valve (114) in effective heat transfer thereto. The torus (26) includes a top wall (82) being recessed at its opposite ends to form pockets (85, 86) so as to reduce the intermediate cross-sectional area of the torus (26) for damping frothing of the condensate discharge into the torus (26) and promoting laminar flow of the condensate through the torus (26).

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"TANK CAR DISCHARGE VALVE HEATING UNIT"

Background of the Invention:

This invention relates to heated railway cars and more specifically to a novel heating unit positioned within the tank and for heating a discharge valve in an improved heat-exchange relation therewith to maintain the product in liquid state and thus assure free flow of the product during extreme freezing weather conditions.

Discussion of the prior art

The prior art is adequately discussed in my U.S. Patent 4,663,733 issued August 5, 1986 which is incorporated herein by reference, is a substantial improvement over the prior art and features a heater coil arrangement confined between a pair of complementary plates defining a perimetrically sealed envelope closed at opposite ends and supported by brackets at its lateral edges attached to the shell of the car. This patent also discloses a sump which surrounds the outlet in heat exchange relation thereto. It has been found that the arrangement of the sump and its quick discharge, although better than the prior art, fails at times to obtain adequate heat transfer to the product discharge valve requiring the application of the hot steam externally of the shell in an attempt to unfreeze the valve. Depending upon weather conditions in the frozen north it would

take hours of heating and sometimes it required hammering on the valve to clear it of the frozen product and start the product flowing.

Furthermore the structure of the heat exchangers in the prior art and the construction of the opposing plates as in applicants prior patent embracing heating coils has been costly and added undesirable excess weight to the cars.

Furthermore it has been found the disposition of the heaters is important in order to properly heat the product and control of the heating medium as it passes through the heater coils. It is desirable to extract maximum BTU's from the heating medium until it heating capability is spent before it is discharged onto the ground.

Whereas the previous devices would dump condensate at about 200 degrees or much higher temperature, the improved structure retains the condensate in the torus, and preferably discharges it at about 140 degrees which, as is obvious, is much lower than previously thereby extracting more heat in the critical area namely in the region of the discharge nozzle to provide a favorable operating temperature.

The arrangement of the heating coils is such that at their discharge ends they are of reduced cross-section and provide a constriction to the outflow of condensate and thus retain the hot

condensate in a dwell period sufficient to maximize extraction of the heat into the product without the introduction of complex controls which may be subject to breakdowns etc.

The instant arrangement has for its further object the provision of a pressure balancing arrangement between the top of the tank car above the level of the product and the housing encasing the heating coils.

These and other objects of the invention will become more readily apparent from the specification and the drawings wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a top view of the invention shown partly in horizontal section;

Fig. 2 is a vertical cross-section taken on line 2-2 of Fig. 1b;

Fig. 3 is cross-section taken substantially on line 3-3 of Fig. 1;

Fig. 4 is a cross-section taken on line 4-4 of Fig. 1;

Fig. 5 is a enlarged cross-section of a portion of Fig. 4;

Fig. 6 is a further enlarged cross-section of a portion of structure of Fig. 7;

Fig. 7 is a top plain view with parts broken away and shown in section;

Fig. 8 is a cross-section of Fig. 7;

Fig. 9 is a further cross-section;

Fig. 10 is a still further cross-section;

Fig. 11-14 are still further cross-sections through the car body;

Fig. 15 is an enlarged fragmentary plan view of the torus and surrounding structure;

Fig. 16 is a fragmentary vertical section taken substantially on line 16-16 of Fig. 15;

Fig. 17 is a vertical cross-section taken on line 17-17 of Fig. 15, and

Fig. 18 is a vertical cross-section through the torus and valve.

DESCRIPTION OF THE INVENTION:

The numeral 10 refers to a conventional railway tank car comprising a wheeled support 12 of conventional design. Storage container or tank 14 is mounted on the frame 12 by conventional structure such as by tank saddles 16. Tank 14 generally has a cylindrical configuration although the bottom 18 of the tank 14 slopes inwardly from the ends of tank heads 20 and 22 towards a discharge valve assembly generally designated 26. It is to this conventional tank car structure that the heat exchanger of this invention is mounted and which will be referred to generally by the reference numeral 28.

Heat exchanger 28 comprises heat exchanger units 30 and 30' which are identical except for being mirror images of each other. Inasmuch as units 30 and 30' are identical, only unit 30 will be described in detail with parts being indicated on unit 30' to indicate identical structure.

Heat exchanger unit 30 comprises an arcuate or downwardly sloped top plate 32 having a plurality of U-shaped channels 36 secured, as by welding, at their open top sides to the underside 37 of (Figs. 5 and 6) the plate 32 to form passageways or coils or tubes for steam and condensate. The plate or wall 32 defines with a torus wall portion 39 therebelow a thermal chamber 40 and is peripherally weld-connected to adjacent portions of the car

tank body 33 and torus as at 42. The upper end of walls 32, 32' are welded to the tank heads 20, 22, respectively to provide the closed chambers 40.

A pressure equalizer tube or pipe 44 is connected at one end to the chamber 40 through a connector 45 in a wall 33 of the tank and at its upper end is preferably connected through a fitting 46 to the space 47 at the upper portion of the tank above the lading 48.

Referring now to the heat exchanger tubing 30, 30' there are provided inlet nozzles or pipes 50, 50' which depend from the bottom of the tank at opposite sides of the outlet valve and these coupling nozzles connect to the inlet pipes 51, 51' respectively. The inlet pipes 51 and 51' are connected to the lower ends 52, 52' of the respective center tubes or inlet coil members 53, 53'.

Each center tube 53 extends diagonally upwardly from the lading discharge nozzle 55a and has an upper end with a steam splitter 54 which connects to a transverse branch portion tube 55 intermediate its ends and the end portions thereof are connected to the upper ends 56, 57 of inner circulation tubes 58, 59 which slope downwardly and are respectively connected at their lower ends to transvers tubes 63, 64 to intermediate tubes 60, 61 which ascend from their lower portions to the respective ends of the car and are thereat connected at their upper ends by short tubes 65, 66 to outer end tubes 67, 68 which slope toward the center of

the car. The lower ends of tubes 67, 68 which are connected to short transverse end tubes 69, 70 which are connected to outlet tubes 71, 71a of reduced cross-section with respect to the tubes to which they are connected to constrict the passage therethrough and reduce the flow of steam and condensate from the lower portions of tubes 60, 61 and 67, 68 which causes the steam and condensate to remain longer than usual in the heater tubes or coils so as to maximize the heat absorbshion into the product.

The disposition of the ends of the outlet tubes is of paramount importance in the provision of by-pass tubes 72, 74 which are connected between across tubes 63, 64 which extend between tubes 60, 67 and 61, 68 and the tubes 69, 70. Thus hot condensate is caused to flow into the outlet tubes from tubes 50, 61 into the outer tubes 71, 71a. In previous designs condensate and steam would be ported through the intermediate tubes 60, 61 and end or outboard tubes 67, 68. Thus the medium flowing through tubes 67, 68 is respectively cold (about 140 degrees) by the time it reaches the outlet tubes. The outflow in the present design discharges the medium, which is at a substantially higher temperature than previously, preferably about 200 degrees F. In the present invention portions the outlet tubes 71, 71a are bent downwardly and extend into a recess 70a and are connected to a wall portion 72a, of an annular chamber 73 of a torus or annulus 26.

The discharge or outlet end portions are secured with intervening portions of a plate 76 to the lower end portion of the top plate 32. The plate 76 and the chamber plate and adjacent portion of the tank wall are welded leak proof and connected to provide an integral structure.

The same construction of the torus as well as the mounting of the discharge tube end portions prevail at the opposite side of the torus which has an outer ring 80 and an inner cylindrical sleeve 81 defining the intervening cavity or chamber 73 which is defined by top and bottom integral or welded 32, 33 walls.

A single outlet tube 84 is connected through a side opening at the lower end of the chamber 73 to discharge onto the ground.

It will be observed that the steam and condensate circulating through the tubes of the heat exchanger in the advance runs and the respective return runs are connected at their lower ends to a by the by pass tubes 63, 64 which leads to the outlet tubes connected to the discharge or outlet tubes.

This feature insures that both condensate and steam invade the torus with a hot medium which normally would cool down if it all transversed through the entire length of tubing including the intermediate and outboard portions thereof.

The intermediate and outboard or end tubes are now primarily filled with hot steam which flows faster and easier therethrough than pushing a head of condensate in these tubes as occurs in the prior art.

The bypass tubes serve as separators or filter devices for separating a large proportion of the condensate from the steam.

This residual condensate is still hot about 200 degrees F and is delivered through the outlet tubes into the top of a donut shaped housing or torus 26 into a chamber 73. Inasmuch as the outlet pipes and their position at the lower end of the coils and in that tubes 72, 74 are inclined towards the center of car, the coils drain gravitationally, and the condensate being heavier than the steam, separates from the steam. Thus the intermediate and end side tubes are in the present invention heated by the steam and a large quanity of condensate does not have to be pushed ahead of the steam in the last two conduits. Experiments have shown that the combination of what drains from the intermediate tubes into the outlet tubes combined with what drains from end tubes preferably at a much higher temperature than previously at about 200 degrees whereas in the old system the temperature of the medium discharging into the outlet tubes was at a much lower temperature than previously, somewhere about 140 degrees.

The torus 26 or donut shaped vessel comprises an inner ring or tube 75 and an outer ring or tube 77. Rings 75, 77 are interconnected at their top edges 78, 80 by a plate 82 welded peripherally thereto. The inner edge of the plate 32 is welded to the top plate 82 and adjacent portions of the container wall or shell.

The top wall or plate 82 is recessed at its opposite sides to form pockets 85, 86 and the outlet tubes are bent downwardly as best seen in Figures 15 and 16 and drain in each bottom pocket wall 72 within the confines thereof.

The purpose of recessing the top of the torus is two fold. One is to obtain a low level for the outlet tubes to gravitationally drain and the second is to introduce the condensate into a constricted area 95 (Fig. 17) to congest the condensate and file the torus and maintain it filled and to obtain a greater dwell in the torus and the remaining chamber areas 96 and to maximize dissipassion of heat from the condensate and to maintain laminar flow for efficient heat transfer to the encompassing parts.

The bottom of the chamber is closed off by the wall 40 of the shell of the tank.

The lower edges of the inner and outer rings 75, 77 are weld-connected to a ring 98 which is shaped to provide good thermal conductivity. It has a frusto-conical upper end portion 100 with a large area sloping side surface 102 facing into the chamber 73 for oblation by the hot condensate. Since the chamber portions 93 of chamber 73 are of enlarged cross-sectional areas, the hot condensate is minimally agitated and thus obtains a substantially laminar flow against surface 102 thus effecting maximum heat transfer to the ring 98 which has a center bore 104 in axial alignment with the center bore 106 of the torus, the

bore 106 communicating at its upper end with the interior of the tank and providing an outlet for the product lading within the tank.

The bottom of the ring 98 has an annular recess 108 which admits a radial flange 110 of a tubular body portion 112 of a discharge valve 114 which is diagramatically shown. The make of the valve is unimportant as long as the body portion thereof is intimate tight heat transfer contact with the thermal ring 98 which in the present instance has a thick body section 116. The flange of the valve is secured within the recess in the ring by bolts 118 which extend through apertures 120 and are threaded into the body section of the ring 98 and the draw the flange against the bottom side of the ring and hold the radial edge in tight fit engagement with the annular edge of the bottom recess in the heat transfer ring. The valve is provided with an operating handle 132 (Fig. 18). The lower end of the valve housing or mounting is provided with a cap 135 threaded thereon and the discharge pipe 84 which is connected at its upper end through the tank shell to the discharge port 138 in the outer sleeve of the torus is also provided with a cap 140.

A capped inspection tube 142 is connected to the bottom of the tank and the steam inlet pipes 50, 50' are connected to the lower closed off ends of the inlet tubes of the heat exchangers. Pipes 50, 50' are provided with threaded connection, (not shown) (as is well known) for connection to the steam heater hose.

Experiments have shown that the construction herein disclosed is dramatically superior to the prior art structures in that not only is the product easily heated to readily discharge, but also the discharge valve is sufficiently heated so that it opens and closes practically effortlessly. The heating of the product from the bottom through the concave top plate of the heat exchanger obtains an extensive area of direct contact with the product and the application of the heat does not dissapate as in the prior art structures in unnecessarily heating parts which are not located in strategic ares to heat the product.

From the foregoing description it will be apparent that modifications can be made of the present invention without departing from the teachings of the invention. Also, it will be appreciated that the invention has a number of advantages, so of which have been specifically described and others are inherent in the invention. Accordingly the scope of the invention is only to be considered as set forth in the accompanying claims.

What is claimed is:

1. Heat exchanger structure for a valve of a steam heated railway car having a tank for containing pourable lading and a bottom discharge spigot having a body and a valve therefor;

means for heating the spigot for maintaining the viscosity of said lading in a pourable state,

said heating means comprising a torus encircling said spigot body in heat transfer relation therewith,

said torus having an annular chamber for receiving hot condensate therein about said spigot body and having an outlet port for discharging cooled condensate.

2. The invention according to Claim 1, and

said torus having top and bottom closures and radially spaced inner and outer rings,

wherein said inner ring is in tight thermal transfer with the body of the spigot.

3. The invention according to claim 2, and

a thermal transfer annulus connecting the bottom closure with one of said rings and having an extensive heat transfer area exposed to said chamber,

and means connecting said annulus with said spigot body in heat transfer relation thereto.

4. The invention according to claim 1, and

pockets in said top closure extending into said chamber for reducing the immediate cross-sectional area thereof for damping frothing of the condensate discharged thereinto and promoting laminar flow of the condensate through said chamber.

5. The invention according to claim 3, and

wherein said area is frusto-conical shaped.

6. The invention according to claim 2, and

car heating chambers flanking said torus and impinging against said outer ring.

7. The invention according to claim 6, and

condensate steam inlet means connected to said chamber within a region of heat transfer to associated car heater means.

8. The invention according to claim 7, and

condensate conduit means connected to said torus within said pockets,

said torus being at the lowest level of the car for gravitationlly draining the condensate thereinto.

9. The invention according to claim 2, and

said torus being positioned within the tank at the bottom thereof and said tank having longitudinal end portions sloping toward an intermediate portion of the car.

10. In a steam heated tank railway car having heating means extending from opposite ends of the car to an intervening lower portion thereof,

a discharge valve in said lower portion,

hot air means blanketing said valve in heat transfer relation thereto,

an annular collar-like element embracing said valve and comprising a circular chamber therein having an inlet connected to said heating means and an outlet for discharging steam generated condensate entered into said chamber from said heating means.

11. The invention according to claim 10,

an annulus formed as an integral part of said element and having an integral heat transfer area forming part of said chamber and having an outer heat transfer area encompassing the valve.

12. The invention according to claim 11, and

said car having an body shell and said heating means comprising a single plate subdividing said tank body into lading containing compartment and a heating chamber and said plate substending a lower portion of said tank body and peripherally weld-connected thereto and having an inner end connected with said element and adjacent portions of said shell body in he immediate proximity to said element.

13. The invention according to claim 11, and

means in said chamber for constraining turbulence in said channel of the condensate being poured thereinto.

14. The invention according to claim 13, and

said means for constructing turbulence comprising a passageway of varying cross-section in said element for conducting condensate therethrough.

15. The invention according to claim 14, and

said chamber defined in part by an annulus having a fruto-conical face exposed to said chamber for optimizing heat transfer thereat.

16. An efficient heat transfer structure for heating a discharge valve of a tank body of a railway car being heated by steam which upon cooling producers condensate,

said structure comprising an annular body confining said valve therein and having an annular chamber encircling said valve,

inlet means connected to said chamber at diametrically opposite sides thereof for conducting condensate into the chamber

and outlet means connected to said body and communicating with said chamber for draining said condensate therefrom.

17. The invention according to claim 17, and

said structure comprising means for constricting the chamber in the region of discharge of said inlet means.

18. The invention according to claim 17, and

said inlet means comprising ducts porting said condensate from opposite ends of the car.

19. The invention according to claim 18, and

said car having a bottom sloping from opposite ends of the car to said lower intermediate portion.

20. The invention according to claim 19, and

said element comprising an upper surface in direct contact with heated lading in the car.

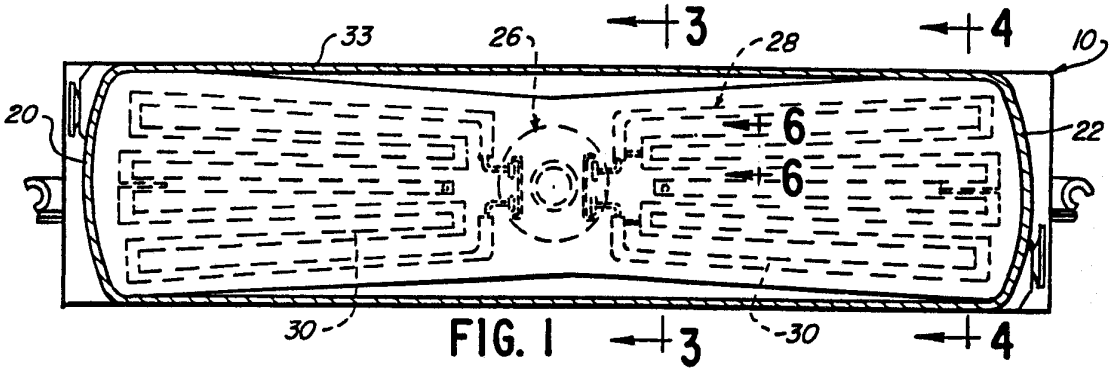


FIG. 1

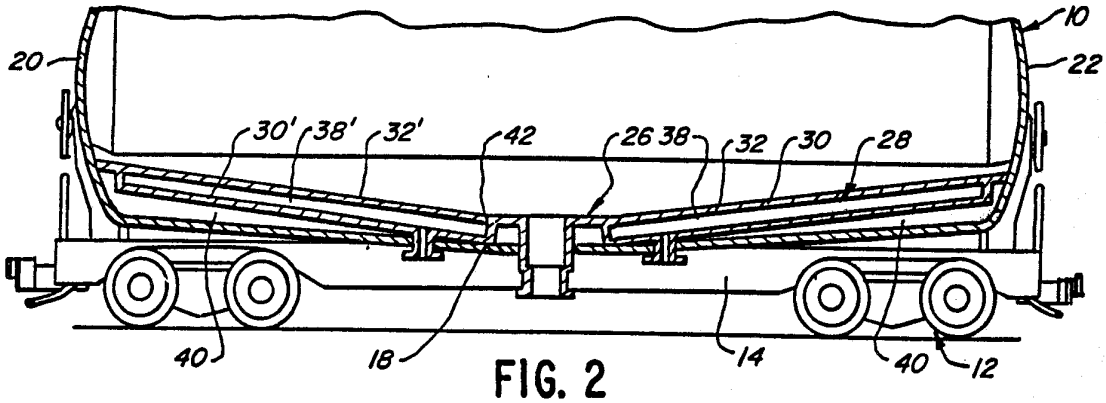


FIG. 2

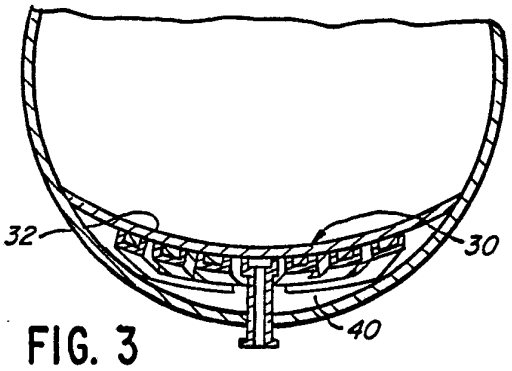


FIG. 3

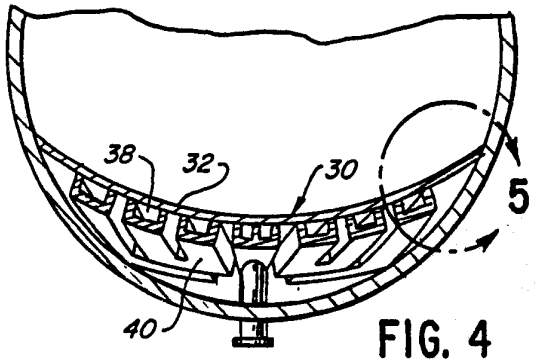


FIG. 4

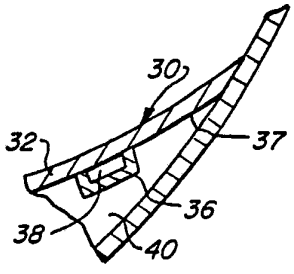


FIG. 5

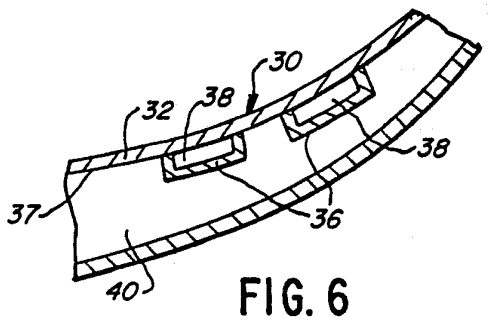


FIG. 6

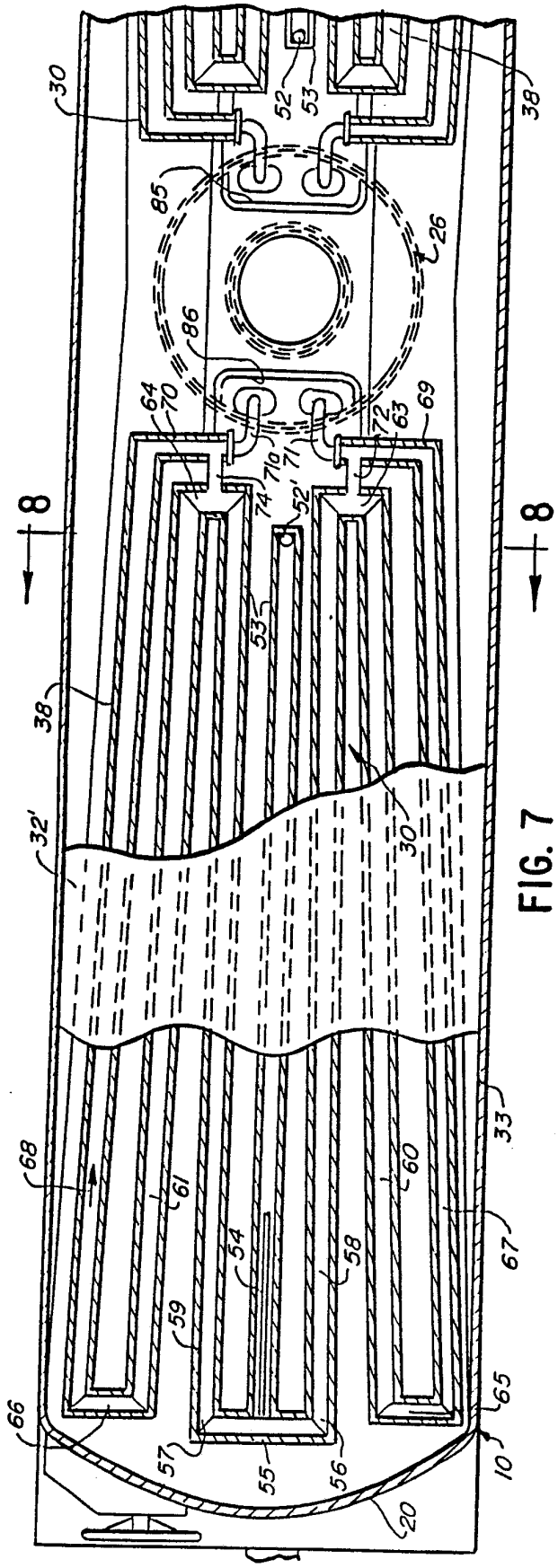


FIG. 7

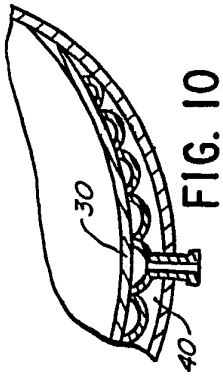


FIG. 10

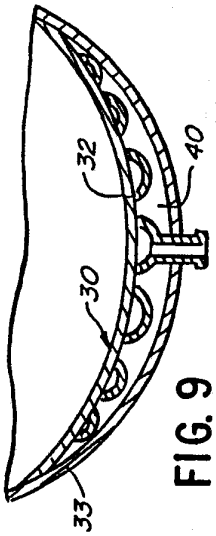


FIG. 9

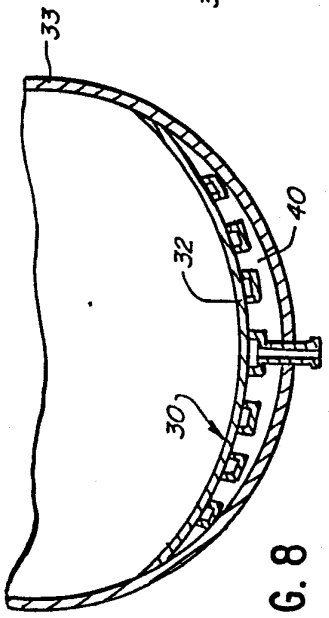


FIG. 8

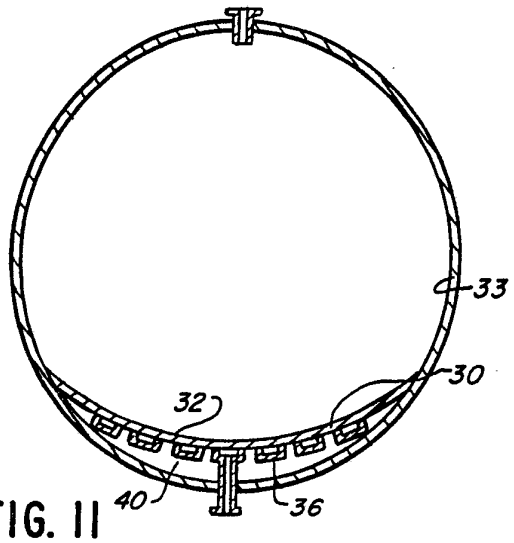


FIG. 11

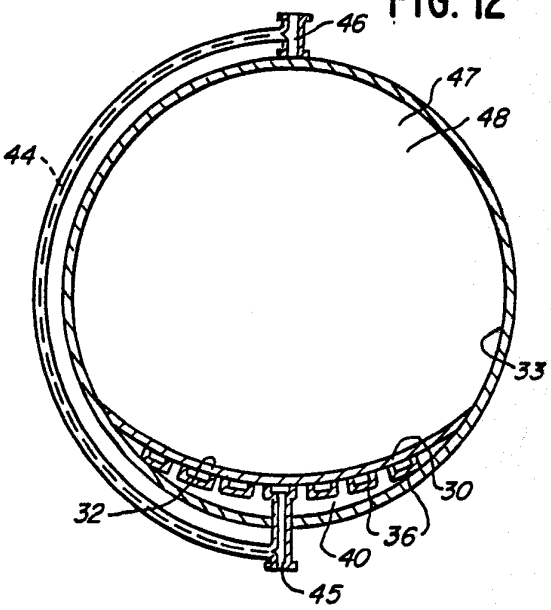


FIG. 12

FIG. 13

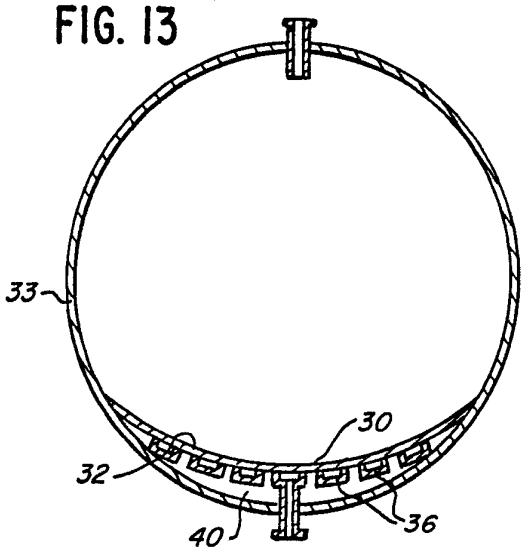
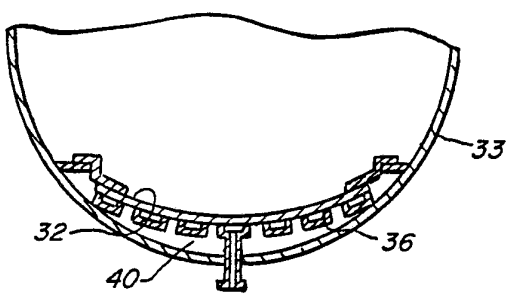


FIG. 14



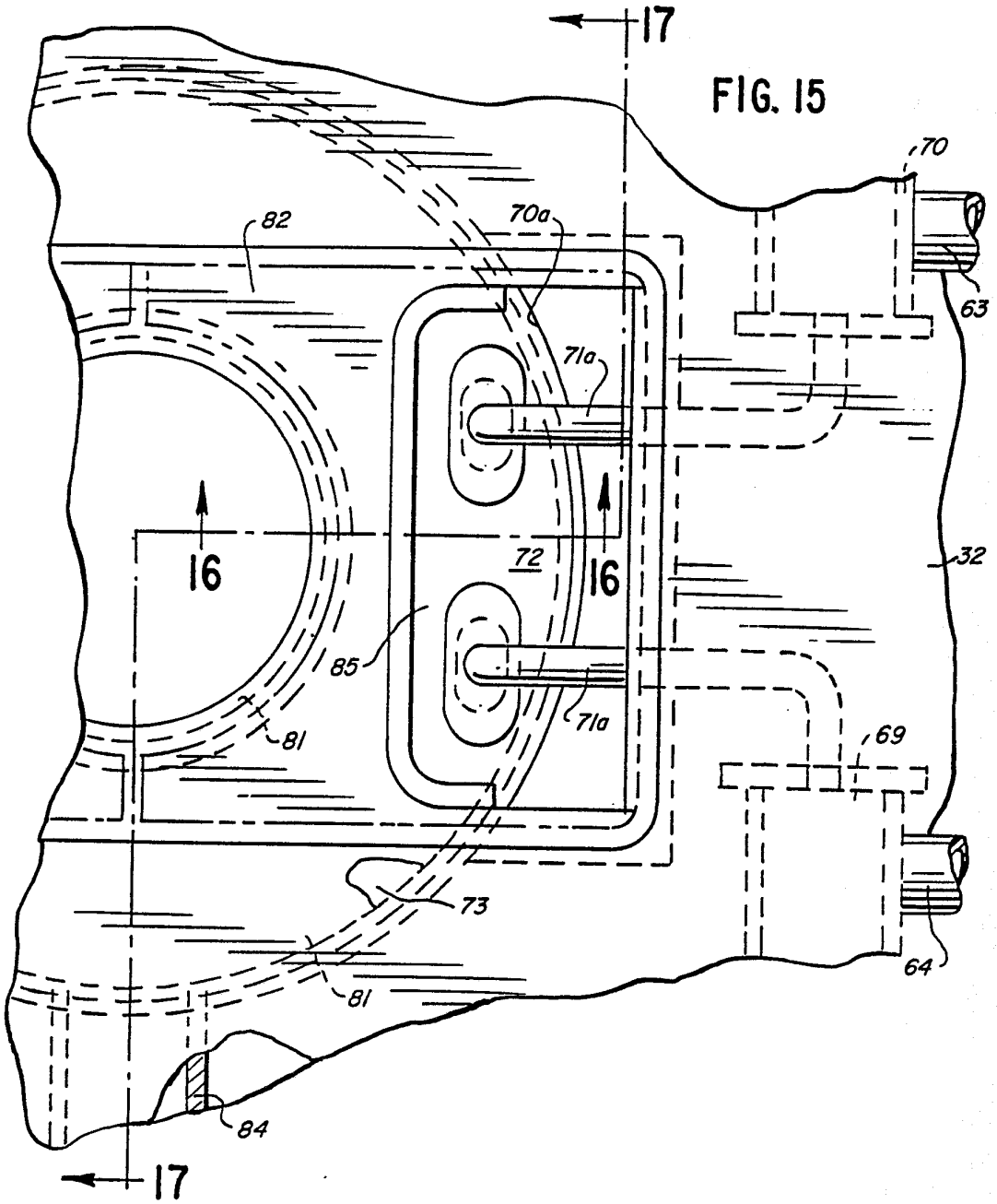

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FIG. 15

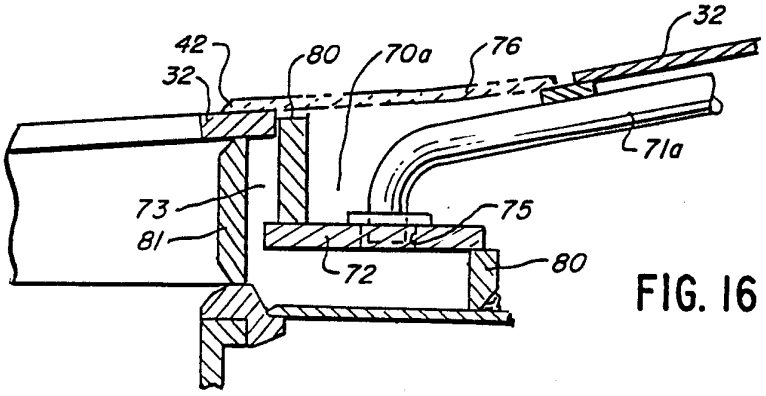
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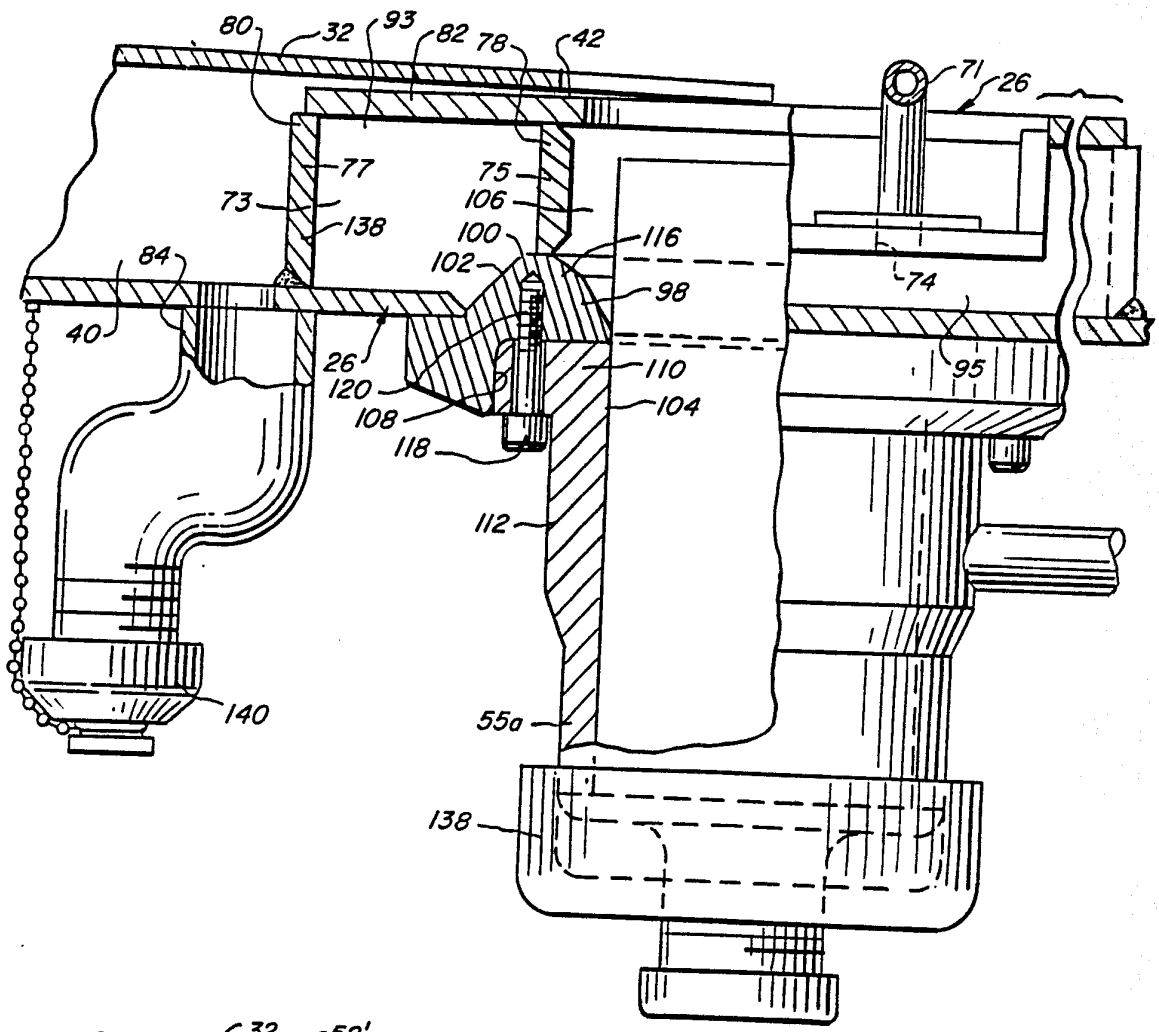
FIG. 16

FIG. 17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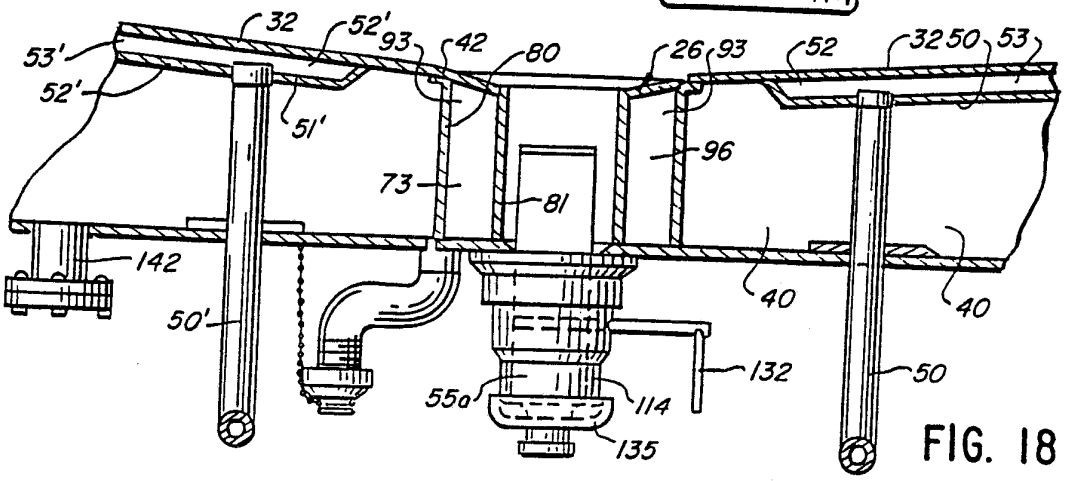
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FIG. 18

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US90/00226

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC (5) B61D 27/00; B61D 5/00

U.S. CL. 105/451

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
U.S. CL.	105/451,358,360; 165/41,170,145

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	US, A, 4,624,189 (LOEVINGER) 25 NOVEMBER 1986 (25.11.1986) (note terms 41 in Figures 2-5)	1-3;6-7;9-14; 16-20
A	US, A, 4,476,788 (LOEVINGER) 16 OCTOBER 1984 (16.10.1984)	
A	US, A, 1,370,531 (FOWLER) 08 MARCH 1921 (8.3.1921)	
A	US, A, 1,569,605 (ASH) 12 JANUARY 1926 (12.1.1926)	
A	US, A, 3,176,764 (BARBERA) 06 APRIL 1965 (6.4.1965)	
A	US, A, 3,685,458 (PRICE ET AL) 22 AUGUST 1972 (22.8.1972)	
A	US, A, 4,480,370 (LOEVINGER) 06 NOVEMBER 1984	
A	US, A, 4,530,288 (LOEVINGER) 23 JULY 1985 (23.7.1985) (continued)	

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
13 APRIL 1990	23 JUL 1990

International Searching Authority	Signature of Authorized Officer
ISA/US	for MARK T. LE Ngotho Nguyen

Form PCT/ISA/210 (second sheet) (Rev.11-87)

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	US, A, 4,603,733 (LOEVINGER) 05 AUGUST 1986 (5.8.1986)	