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VOLUMES OF COLD LIQUEFIED HYDROCARBONS

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Filed Aug. 7, 1953

4 Sheets-Sheet 1

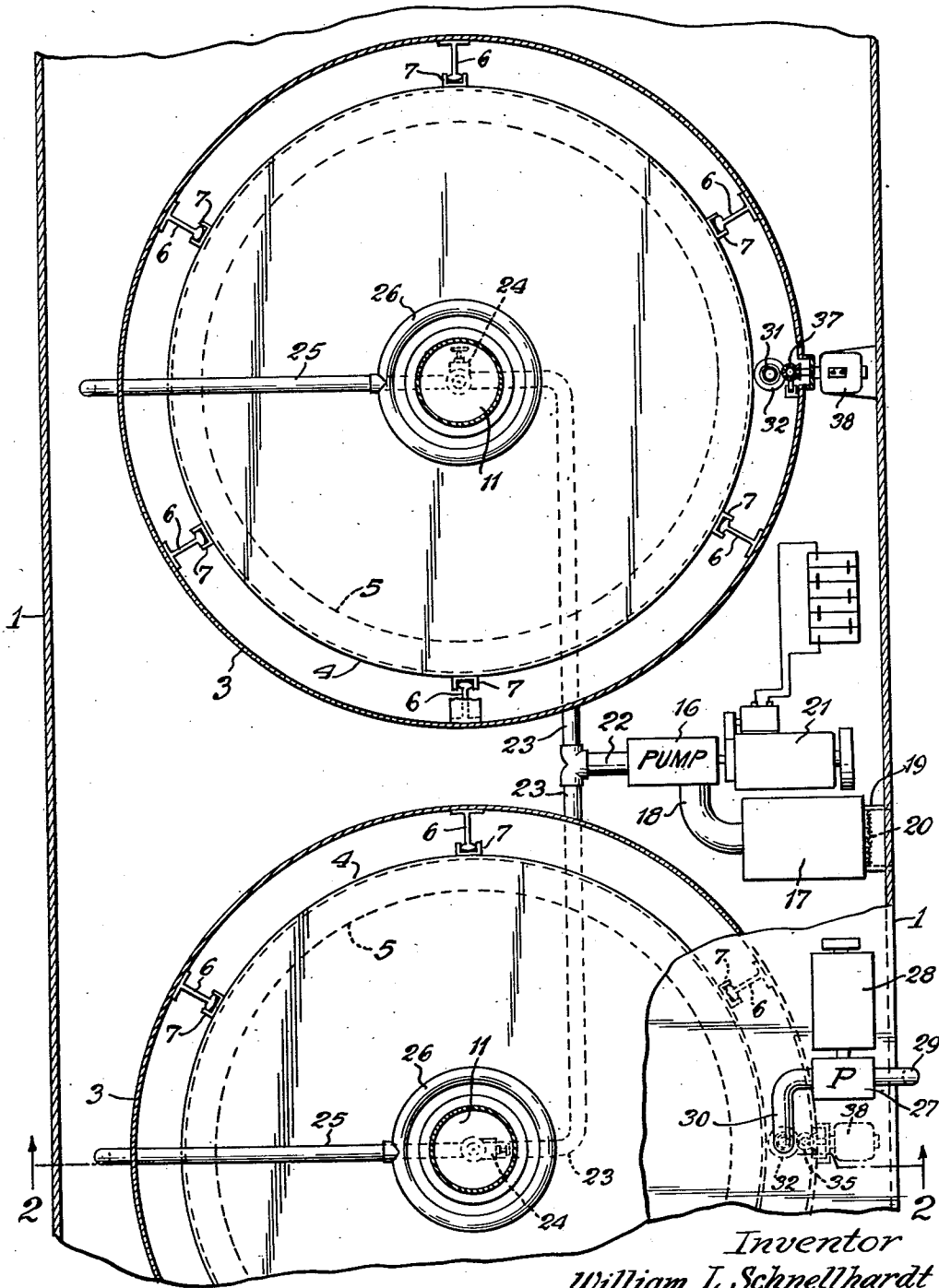


Fig. 1

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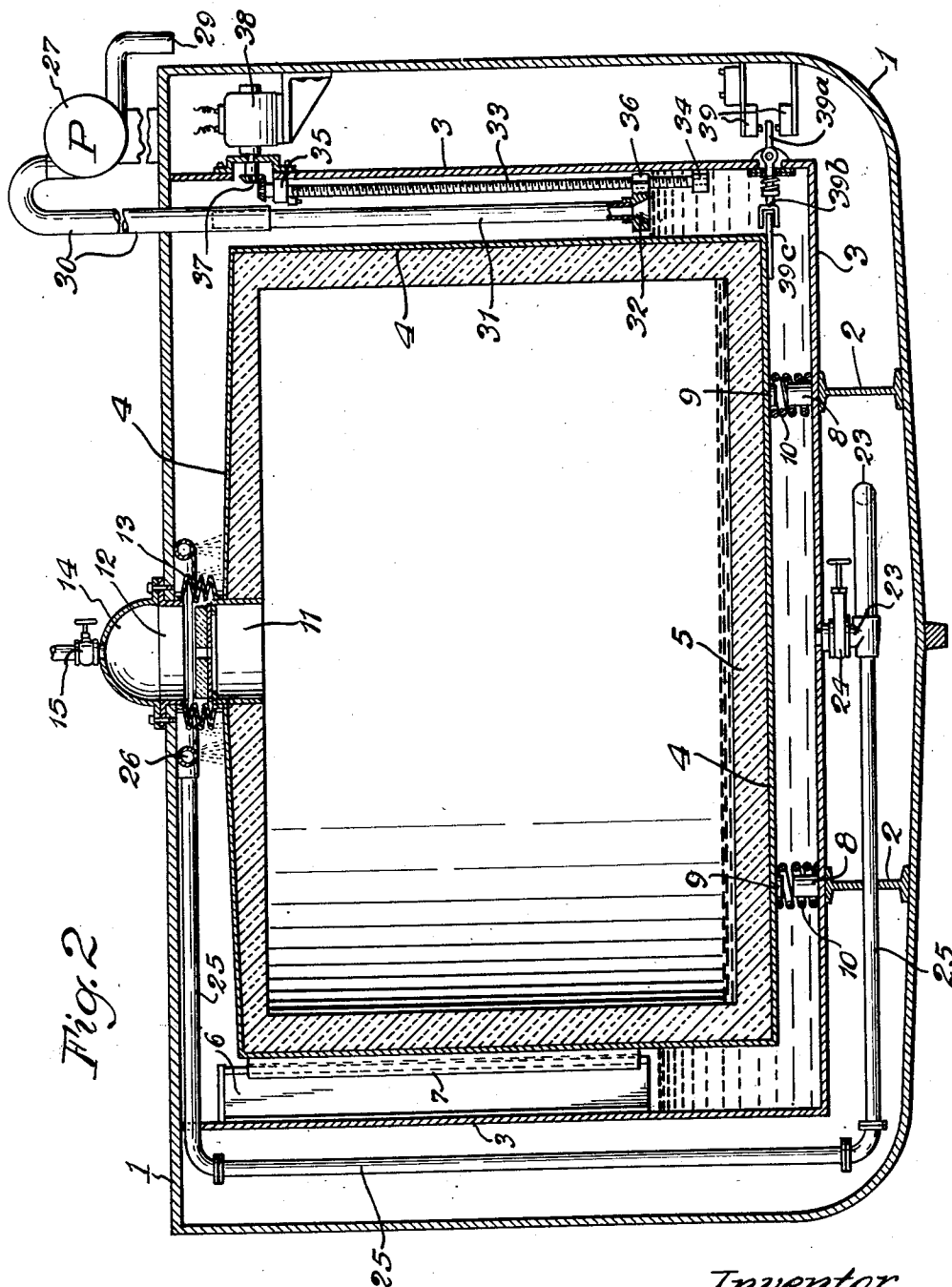
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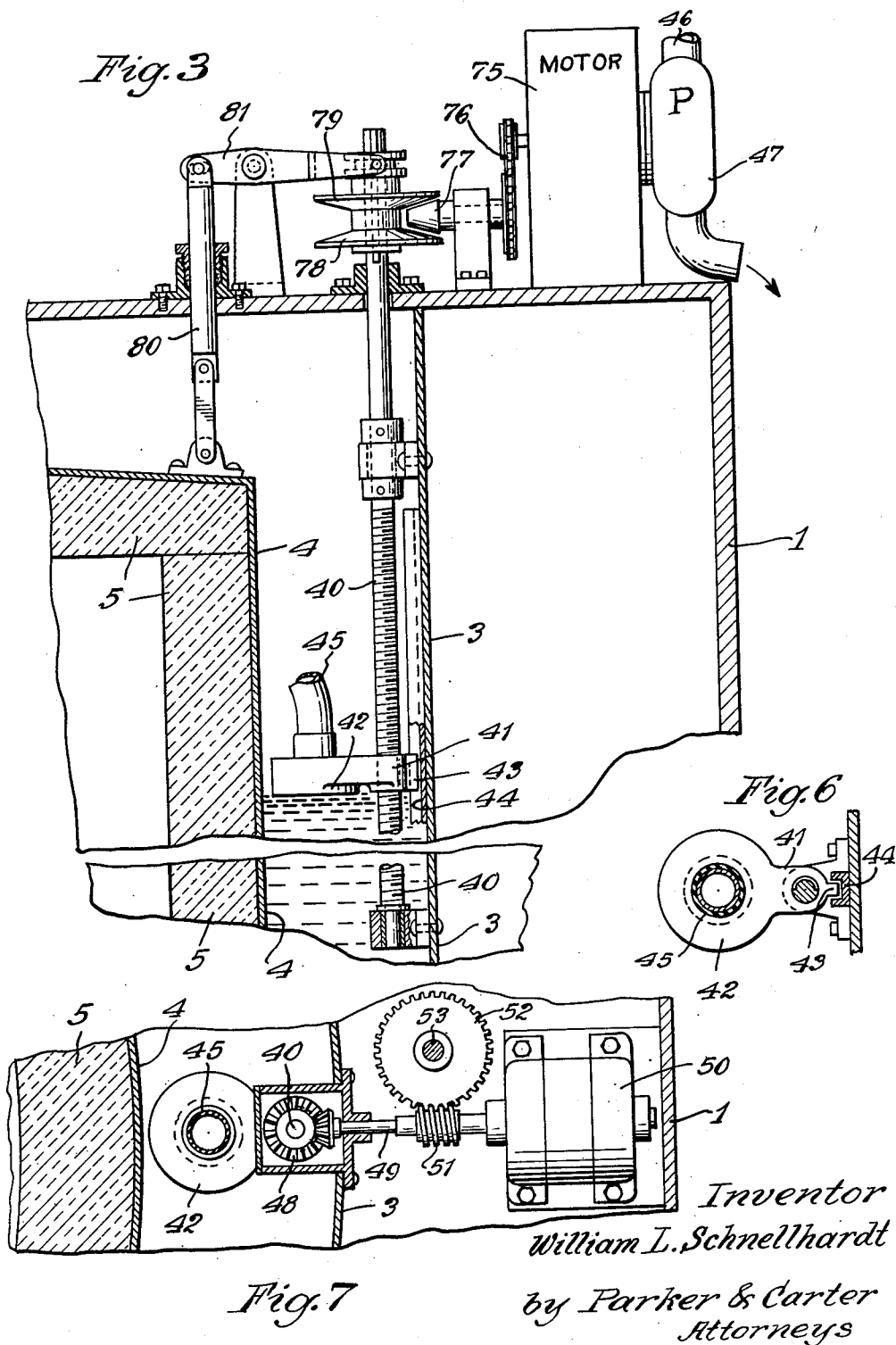
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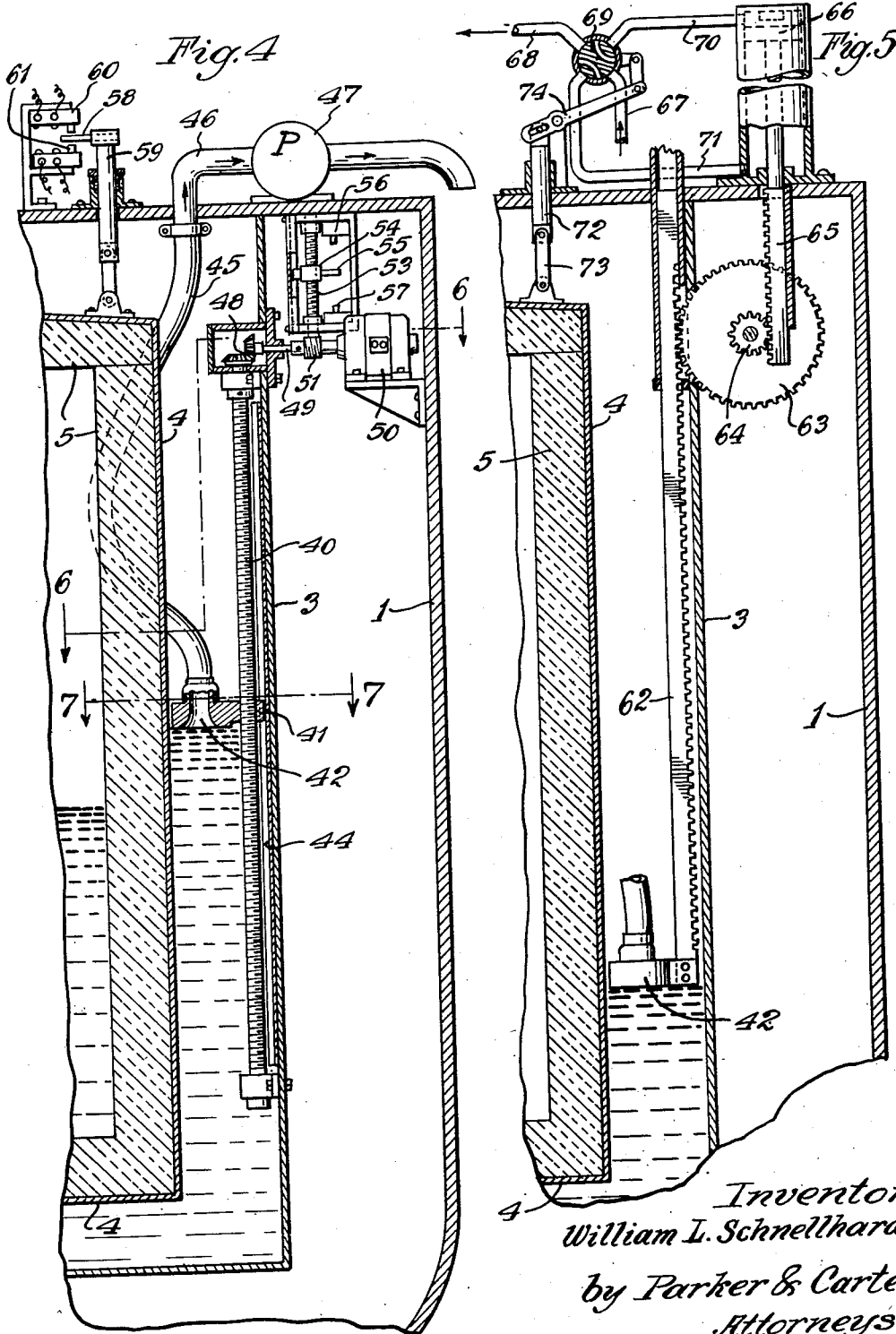
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MEANS FOR STORING AND CONVEYING LARGE VOLUMES OF COLD LIQUEFIED HYDROCARBONS

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11 Claims. (Cl. 62—1)

My invention relates to improvements in means for storing and conveying large volumes of extremely cold, liquefied hydrocarbons and the like and has for one object to provide means for floating and positioning in a liquid containing, temperature maintaining, tank a receptacle adapted to contain liquefied cold hydrocarbon.

Another object of my invention is to provide positive means for maintaining the flotation of said vessel in the supporting tank whereby variations in the weight of the vessel and contents will automatically be reflected in the variations in the weight and volume of water or other liquid in which the floating vessel floats whereby the hydrocarbon containing vessel will always be supported in the liquid and insulated thereby from stresses and strains which might otherwise cause leakage or breakage of the hydrocarbon containing vessel.

Other objects will appear from time to time throughout the specification and claims.

My invention is illustrated more or less diagrammatically in the accompanying drawings, wherein

Figure 1 is a horizontal section through a barge adapted to contain a plurality of shipping tanks for hydrocarbons and the like;

Figure 2 is a section along the line 2—2 of Figure 1;

Figure 3 is a detail section similar to the section of Figure 2, showing a modification;

Figure 4 is a section similar to the section of Figure 2 showing a further modification.

Figure 5 is a similar section showing a still further modification;

Figure 6 is a section along the line 6—6 of Figure 4;

Figure 7 is a section along the line 7—7 of Figure 4.

Like parts are indicated by like characters throughout the specification and drawings.

1 is the hull of a barge or ship. Supported within the hull by any suitable means such as beams 2 is a cylindrical water tank 3. There may be one or more of these tanks. The upper deck of the ship serves as a roof for the tank 3. Floating in a water bath in the tank 3 is the insulated gas tank 4. It contains interior insulating lining 5 at top, bottom and sides and is movably positioned within the tank 3 by rails 6 loosely engaging channels 7 so that a limited angular movement of tank 4 in tank 3 is permitted. The two tanks are generally concentric and the inner floating gas tank is free to rise and fall throughout a limited travel in response to change in displacement of the inner tank and the depth of the water bath. 8 indicates buffers extending upwardly from the floor of the tank 3 adapted to be contacted by stop pads 9 on the bottom of the floating tank 4 in an emergency. Springs 10 may also be interposed between the fixed tank 3 and the floating tank 4 to cushion any blow which might result from excess displacement of the floating tank 4.

The floating tank 4 being closed at its bottom and sides is centrally apertured at 11 in register with an aperture 12 in the roof of the fixed tank 3. Flexible bellows 13 joins the two tanks and the dome 14 overlies the opening

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or port 12. A duct 15 communicating with the dome 14 may be used to supply liquid hydrocarbon to the gas tank 4 or to withdraw vaporized hydrocarbon therefrom as the case may be.

16 is a pump adapted to draw water from the filter 17 through intake duct 18. Water may be supplied to the filter 17 from the outside of the barge through the intake port 19 or from the hold of the barge as desired. 21 is a motor driving the pump 16. The pump supplies water under pressure to the main 22. The main 22 has a plurality of branches 23 which conduct water to each of the tanks 3, controlled by valves 24 so that flotation water may be fed preferably from the river or ocean in which the barge floats or from the bilge of the barge, to each of the fixed tanks adjacent the center of the bottom thereof.

Each branch 23 has an extension 25 which passes upwardly around the fixed tank 3 to an annular spray ring 26 which discharges water against the roof of the floating tank 4, whence it runs down around the sides of the tank so that the water bath in the fixed tank 3 supports and floats the gas tank and the gas tank is also enclosed in a sheet of flowing water.

When the floating or gas tank is empty it is light and but little water is needed in the fixed tank 3 to float it. As the floating tank is filled, its displacement increases and more water must be supplied. Then as the barge moves from the loading point to point of discharge there is a continuous evaporation and escape of the hydrocarbon from the floating tank and therefore the displacement of the tank falls and so the depth of the water must be lowered. Automatic means are therefore required at all times to control the water bath to maintain the gas tank in floating equilibrium independent of changes in its displacement.

It is also important to maintain so far as is possible, the temperature of the area immediately surrounding the floating tank at a constant point. While as the barge travels for example, from Texas to Chicago along the inland waterway, radical changes in atmospheric temperature may be met, the changes in the temperature of the water in which the barge floats will be much less extreme. Therefore, it is desirable to subject the outer surfaces of the floating tank with its liquefied cold hydrocarbon contents to variation in water temperature rather than to variation in air temperature, hence the desirability of maintaining some measure of continuous circulation of the water about the gas tank.

The pump 16 furnishes water to the bath and gas tank, preferably drawing it from the river or ocean as the case may be at the prevailing temperature level. The capacity of the pump 16 is adequate to supply the maximum requirement and control means are provided for addition to and withdrawal from the bath of such amount of water as will maintain the water level at the point required to float the floating tank.

Referring particularly to Figures 1 and 2, 27 is a pump driven by a motor 28, there being at least one such pump for each water tank. The pump discharges through the duct 29 and is provided with a flexible suction connection 30 leading to a suction pipe 31 provided with an intake funnel 32 between the adjacent walls of the tanks 3 and 4. There may be one or more intake funnels and associated parts.

33 is a lead screw mounted in bearings 34, 35. A nut 36 engages the screw and carries the funnel 32. Opposing mitre gears 37 provide a driving connection between the screw 33 and the motor 38 so that rotation of the screw may move the funnel 32 up and down as desired. 39 is a suitable switch assembly adapted to be actuated by a lever 39a extending inwardly through the

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walls of the tank 3 and forked at 39b to engage a finger 39c on the tank 4. Suitable wiring connections lead from the switch 39 to the motor 38 so that the motor may be actuated in forward or reverse direction to rotate the screw 33 and move the intake funnel up and down in consonance with the up and down movement of the floating tank 4.

Referring to the modified form shown in Figure 4, in this case the screw 40 extends through a nut 41, which carries the funnel 42, a lug 43 on the nut 41 engages the channeled track 44 so that rotation of the screw may raise and lower the funnel 42 and rotation of the funnel and nut is prevented by engagement of the lug 43 with channel 44. 45 is a flexible hose extending from the funnel 42 to the intake 46 of the pump 47. The screw 40 is rotated by the mitre gears 48 driven by shaft 49 by motor 50. The shaft 49 carries a worm 51 in mesh with a worm wheel 52 which drives the screw 53. Nut 54 on the screw 53 carries a finger 55 which may engage either one of the limit switches 56, 57 to shut off return from motor 50 to prevent excess movement of the funnel 42. The finger 58 carried by the plunger 59 connected to the tank 4 is associated with the switches 60, 61 so that, depending on which ever one of the switches is closed by the finger 58, the motor 50 will be started to move the funnel 42 and keep it adjacent the level of the liquid.

It will be understood, of course, that the capacity of the pump withdrawing water from the bath will normally be greater than the capacity of the pump supplying water to the bath because water must continuously circulate through the bath and the pump removing the water has as its function to operate when necessary to remove sufficient water to maintain the liquid level correct to float the gas tank.

In the further modified form of Figure 5, the funnel 42 is carried by the rack 62 in mesh with a gear 63, which in turn is driven by a smaller gear 64 engaged by a rack 65 actuated by the hydraulic piston 66. Hydraulic fluid circulating through pipes 67, 68 controlled by a valve 69 may in consonance with the position of the valve, apply hydraulic pressure through pipes 70 or 71 to either phase of the piston to move the funnel 42 up or down. The plunger 72 connected by links 73 to the tank 4 engages a lever 74 to control the position of the valve 69.

In the modified form shown in Figure 3, the screw 40 is actuated by a mechanical connection from a pump motor 75 through a reduction chain 76 to drive a friction wheel 77 which may be in engagement with one or other of friction discs 78, 79. The plunger 80 actuates the lever 81 in consonance with movement of the tank 4 to engage one or other or both of the discs 78 with the friction wheel 77 so that the funnel may move up and down as needed.

By this arrangement there will always be a continuous inflow of water from the surface of the body of water in the fixed tank so that there will always be a circulation of the water in the space between the inner wall of the fixed tank and the outer wall of the floating tank and there will always be a supply of such water to the bottom and to the top of the two tanks so that the temperature conditions at the periphery of the inner floating tank will always be that of the water in which the barge is floating.

It would, of course, be possible to have all the water enter or leave the water bath at the bottom or at the top of the tank but if this were done, circulation of the water in the bath might be inadequate to maintain proper temperature conditions. By the arrangement shown where water always enters the bath at the bottom adjacent the center of the gas tank and is always drawn off from the top of the bath, there is assured a continuous circulation of cold water from the bottom of the tank upwardly toward the top of the liquid level so that there will always be a uniform circulation.

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The various mechanisms shown for insuring that independent of the level of the liquid the warm water from the top of the bath is always removed and replaced by cold water from the lower portion of the bath is of value in that depending on circumstances, different types of mechanism may be used, the essential thing being that accurate control of the position of the water removing funnels be maintained at all times.

Since it is of the greatest importance that the water in the bath floating the gas tank be constantly circulated and since it is of the utmost importance that the temperature about the floating tank be maintained as nearly as possible uniform throughout, the current or flow of water from the bottom of the bath is centrifugal to all sides of the floating tank and thence vertical to the surface so that there can be no dead pockets where the heat exchange would be abnormal. Of course, a relatively small proportion of the bath water reaches the bath at the surface but it is merely that thin film of water which impinges on the top of the gas tank, flows radially centrifugally and then vertically down along the cylindrical walls.

If desired, the output of the two pumps can be controlled by any conventional means, either by valving or by changes in the pump output. However, this can be dispensed with because if the discharge funnel or aperture, and there may be one or more, is automatically maintained immediately adjacent the surface of the bath and if the discharge pump in consonance with decrease in displacement of the gas tank removes water from the bath at a rate such that the funnel or discharge port is above the liquid level, no further discharge will take place until the intake pump has raised the level of the bath.

On the other hand, if increase in displacement of the gas tank raises the depth of the bath, no harm will be done and the capacity of the discharge pump being greater than the capacity of the intake pump, the discharge pump will lower the level of the bath with respect to the position of the exhaust aperture or funnel until a balance is resumed.

I claim:

1. A tank adapted to contain a water bath, a gas tank floating freely therein, means for continuously supplying water for temperature control and suspension of the gas tank, to the water tank at the bottom central portion thereof, and means for withdrawing water from the surface of the bath, said means including an intake funnel adjacent the surface of the bath and automatic means for moving the funnel vertically to maintain it at the surface of the bath independent of variation in the level of said surface, control means for the means for moving the funnel responsive to the displacement of the gas tank in the bath.

2. A tank adapted to contain a water bath, a gas tank floating freely therein, means for continuously supplying water for temperature control and suspension of the gas tank, to the water tank at the bottom central portion thereof, and means for withdrawing water from the surface of the bath, said means including an intake funnel adjacent the surface of the bath and automatic means for moving the funnel vertically to maintain it at the surface of the bath independent of variation in the level of said surface, control means for the means for moving the funnel responsive to the displacement of the gas tank in the bath, means for withdrawing water through said funnel, the maximum capacity of said withdrawal means being greater than the capacity of the supply means.

3. A tank adapted to contain a water bath, a gas tank floating freely therein, means for continuously supplying water for temperature control and suspension of the gas tank, to the water tank at the bottom central portion thereof, and means for withdrawing water from the surface of the bath, said means including an intake funnel adjacent the surface of the bath and automatic means for moving the funnel vertically to maintain it at the surface of the bath independent of variation in the level of

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said surface, said funnel moving means including a motor, electric controls therefor, limit switches, means responsive to the position of the floating tank for actuating said switches to control the motor and a drive means between the motor and the funnel.

4. A tank adapted to contain a water bath, a gas tank floating freely therein, means for continuously supplying water for temperature control and suspension of the gas tank, to the water tank at the bottom central portion thereof, and means for withdrawing water from the surface of the bath, said means including an intake funnel adjacent the surface of the bath and automatic means for moving the funnel vertically to maintain it at the surface of the bath independent of variation in the level of said surface, said funnel moving means including a motor, electric controls therefor, limit switches, means responsive to the position of the floating tank for actuating said switches to control the motor and a drive means between the motor and the funnel, the drive means including a support for the funnel, a screw in threaded relationship with said support and means parallel with the screw for holding the funnel against angular movement with respect to the screw.

5. Means for storing liquid hydrocarbons at substantially atmospheric pressure and at temperatures substantially below atmospheric comprising in combination: an outer tank adapted to contain a liquid, an inner tank spaced from said outer tank and adapted to contain the liquefied hydrocarbon, means for restraining lateral movement between said tanks while permitting limited substantially unopposed relative vertical movement therebetween, a conduit connected with the space within said inner tank and extending out of said outer tank, and means for maintaining in the space between said tanks, a constantly replenished body of a liquid, whose freezing point is above the temperature of the liquefied hydrocarbon, in such amount as to just buoyantly support said inner tank, such last named means comprising: means for delivering to said body of liquid a stream of such liquid at least a portion of which enters such body substantially below its liquid level, and means for withdrawing liquid from adjacent the liquid level of said body at a rate adjustably controlled in response to the extent to which said inner tank settles in said body of liquid.

6. A structure as defined in claim 5 characterized further in that the delivery of liquid to said body is at a substantially constant rate.

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7. A structure as defined in claim 5 characterized further in that said inner tank is provided with thermal insulation on all of its faces.

8. A structure as defined in claim 5 characterized further in that said inner tank is prismatic and provided with thermal insulation on all of its faces.

9. A structure as defined in claim 5 characterized further in that said inner tank is prismatic and provided with thermal insulation on all of its faces on its inner periphery.

10. Means for storing liquid hydrocarbons at substantially atmospheric pressure and at temperatures substantially below atmospheric comprising in combination: an outer tank adapted to contain a liquid, an inner tank spaced from said outer tank and adapted to contain the liquefied hydrocarbon, means for restraining lateral movement between said tanks while permitting limited substantially unopposed relative vertical movement therebetween, a conduit connected with the space within said inner tank and extending out of said outer tank, and means for maintaining in the space between said tanks, a constantly replenished body of a liquid, whose freezing point is above the temperature of the liquefied hydrocarbon, in such amount as to just buoyantly support said inner tank, such last named means comprising: means for delivering to said body of liquid a stream of such liquid at least a portion of which enters such body substantially below its liquid level and a portion of which flows downwardly over said inner tank, and means for withdrawing liquid from adjacent the liquid level of said body at a rate adjustably controlled in response to the extent to which said inner tank settles in body of liquid.

11. A structure as defined in claim 10 characterized further in that the delivery of liquid to said body is at a substantially constant rate.

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