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 APPARATUS FOR UNLOADING COLD LOW TEMPERATURE
 BOILING LIQUIDS FROM STORAGE RESERVOIR
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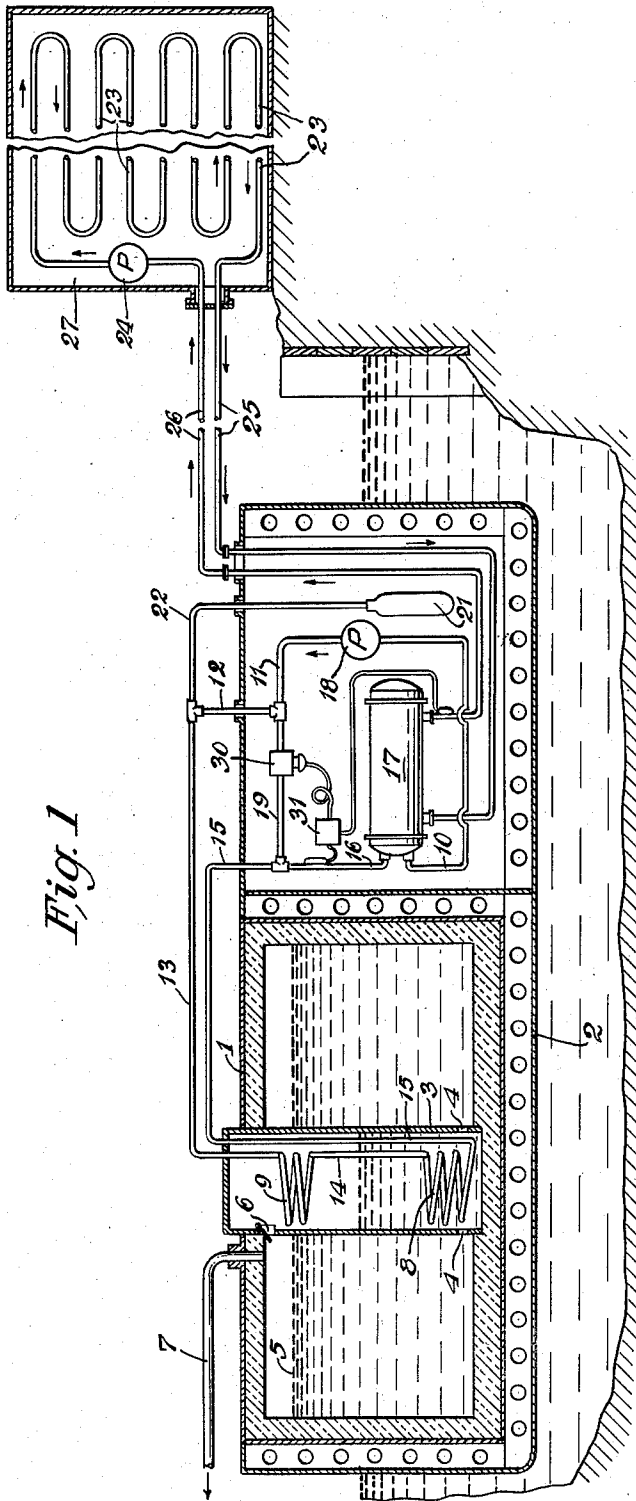


Fig. 1

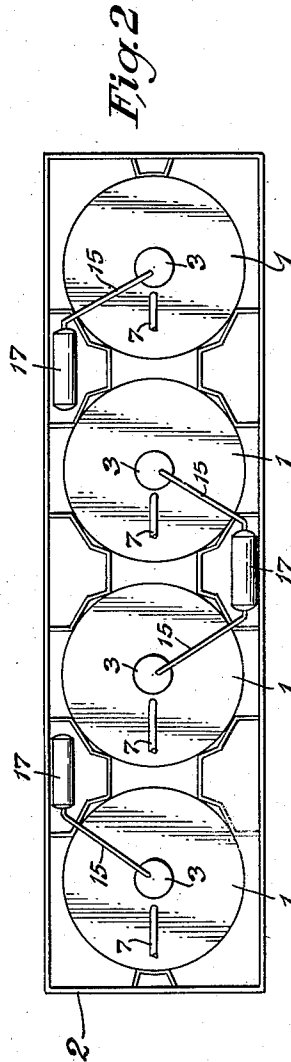


Fig. 2

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APPARATUS FOR UNLOADING COLD LOW TEMPERATURE BOILING LIQUIDS FROM STORAGE RESERVOIR

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4 Claims. (Cl. 62-52)

My invention relates to apparatus and method for unloading cold low temperature liquids from storage reservoirs and is illustrated diagrammatically in connection with the unloading of such a cold liquid as liquefied methane from a transport vessel or barge to point of use.

My invention is illustrated diagrammatically in the accompanying drawings wherein—

Figure 1 is a cross section in part elevation through a barge and associated elements embodying my invention;

Figure 2 is a plan view on a reduced scale showing a modification of the barge of Figure 1 with plural tanks.

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

An insulated tank 1, and there may be a plurality of them, carried on any suitable vehicle for land or water transport is adapted to be filled with a cold boiling liquid at low pressure and temperature for example natural gas at atmospheric pressure and -258° F. The barge 2 illustrates such a vehicle. A gas and liquid tight boiler 3 is located in the tank 1, extending preferably from top to bottom thereof. Ports 4 at the bottom of the boiler are open to the tank below the level 5 of the liquid contained therein. A valve controlled port 6 above the level of the liquid permits flow under controlled pressure, from the boiler of the gas dome or space above the liquid at the top of the tank 1, from which extends a gas discharge pipe 7.

A closed eutectic heat transfer circuit on the barge 2 includes evaporator coils 8 and superheater coils 9 in the boiler joined in series by the pipes 10 to 16 inclusive with the primary heat exchanger 17 and pump 18. The eutectic is circulated by the pump 18 through the circuit including the heat exchanger 17, the superheater coils 9, the evaporator coils 8 and back to the heat exchanger 17.

The by pass duct 19 joins the pipes 11 and 16 and is controlled by the valve 30 to vary the relative proportions of the eutectic passing through the coils in the boiler and through the by pass. 21 is a surge tank floating on the closed eutectic circuit and connected thereto by the pipe 22.

A heat source suggested by the coils 23 is joined in series with a pump 24 and the heat exchanger 17 by pipes 25 and 26. Heat may be supplied from any suitable source to the coils 23 to warm the heat transfer fluid for heat exchange in the heat exchanger 17. For example, 27 may illustrate a cold storage chamber containing the coils 23 which cool the chamber and extract heat therefrom for transfer ultimately to the boiler coils. Any other source of heat, however, may equally well be used, for example, the water in which the barge 2 floats, in which case the coils 23 might be immersed in the water.

Assuming the loaded tank in transit, the liquid level in the tank 1 and boiler 3 will be the same. Gas evaporated from the liquid by ambient heat will be discharged through pipe 7 for use as fuel for propulsion or for other use or disposal as the case may be. The pump 18 will be idle and the eutectic in the system will be at rest.

When the tank reaches its destination, the pipes 25

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and 26 will, by any suitable connections, assuming that the coil 23 is on shore, be joined in series with the coil 23 and warm heat exchange fluid will circulate through the heat exchanger 17. The pump 18 will go into operation and the eutectic heated at 17 will circulate through coils 8 and 9 to vaporize the liquid in the boiler 3. Gas pressure will as a result build up in the boiler for discharge through the valve controlled port 6. As pressure rises the level of the liquid in the boiler will fall to expose superheater coil 9 to gas rather than liquid.

At this time coil 8 serves as the vaporizer and coil 9 as the superheater and superheated gas will be discharged from the boiler to the gas dome for discharge through duct 7 for any desired use.

The rate at which heat is supplied to the boiler and superheater coils is controlled by control of the flow of eutectic through the by pass 19 by the control valve 30 actuated by the control box 31 which in turn is responsive to the temperatures of the outgoing heat exchange fluid on its way from heat exchanger 17 to the coil 23 on the one hand and of the eutectic on its way to the heat exchanger 17 from the boiler.

As an illustration, heat may be added at 12 to 10,000 B.t.u. per minute per million cubic feet per day of methane in gaseous phase evaporated and superheated to -20° F. This heat must come from the heat source 27 and the heat exchange liquid might take the form of brine with 20° F. temperature drop circulated at the rate of 64.6 gallons per minute or might take the form of water with 20° F. temperature drop at 60.0 gallons per minute or might be supplied by steam with 1180 B.t.u. per pound heat drop at the rate of 508 pounds per hour.

The point here is that if the gas vaporized from the liquid hydrocarbon or other cold boiling liquid is to be used on shore as gas, under circumstances such that the short installation is not equipped to handle and vaporize or boil the cold boiling liquid, the heat source can be made available on shore in the form of a boiler or in a refrigerating chamber or an ice plant as the case may be and a heat source transfer liquid can be circulated from shore to the heat exchange eutectic or medium on the barge so that circulation of the heat source transfer medium can be relied upon in consonance with the circulation of the eutectic circulating only on the vehicle to provide the heat necessary to vaporize the cold boiling liquid on the vehicle or barge and discharge it in gaseous phase for use ashore.

I have referred to a barge but it might be an ocean-going ship and even under some circumstances it might take the form of a tank car, the point being that there is associated with the insulated tank containing the cold boiling liquid, heat exchange means which travel with the tank and so are always in proper relationship with the liquid so that the introduction of heat to the heat exchange means enables the heat exchange means to transfer heat to the liquid to vaporize it.

I claim:

1. In combination a ship, a thermally insulated container within the ship having a cargo of a liquefied gas maintained at a subatmospheric temperature, a first heat exchanger immersed in the cargo of liquefied gas in the said container, a second heat exchanger on the ship outside of said container, passages connecting the inlet of the first heat exchanger with the outlet of the second heat exchanger and the outlet of the first heat exchanger with the inlet of the second heat exchanger to provide a complete circuit, means for circulating a heat transfer medium through said heat exchangers and interconnecting passages at an adjustably controlled rate for controlling the amount of heat introduced into the liquefied gas for the vaporization thereof, passages in communication with said

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second heat exchanger for connection with a third heat exchanger on-shore for circulation of a second heat exchange medium therethrough to transfer heat from shore to the first heat exchange medium through the second heat exchanger and to make use of the refrigeration available from the liquefied gas for on-shore refrigeration, and means for controlling the rate of circulation of the second heat exchange medium between the on-shore heat exchanger and the second heat exchanger on ship, means in communication with the passages for bypassing the second heat exchanger, and means for controlling the amount of heat exchange medium bypassed in response to the temperature of the second heat exchange medium issuing from the second heat exchanger.

2. The combination as claimed in claim 1 which includes a superheater in the container in the space above the level of the liquefied gas for heating vapors released by the first heat exchanger from the liquid while simultaneously extracting some of the refrigeration therefrom, said superheater being in series between the first heat exchanger and the second heat exchanger for the flow of heat exchange medium sequentially from the second heat exchanger through the superheater to the first heat exchanger.

3. The combination as claimed in claim 1 which includes passage means in communication with the upper

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portion of the container above the liquid level for transporting released vapors from the container to shore.

4. The combination as claimed in claim 2 in which the superheater and the first heat exchanger are arranged with the superheater above the heat exchanger within a single housing having openings in the lower portion for the free flow of liquefied gas into the housing for immersion of the first heat exchanger therein and having openings in the upper portion of the housing beyond the superheater for flow of vapors released by the first heat exchanger past the superheater and into the upper portion of the container above the level of the liquefied gas contained therein.

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