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L. F. WHITNEY

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MULTIPLE STAGE EJECTOR IN REFRIGERATION SYSTEM

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2 Sheets-Sheet 1

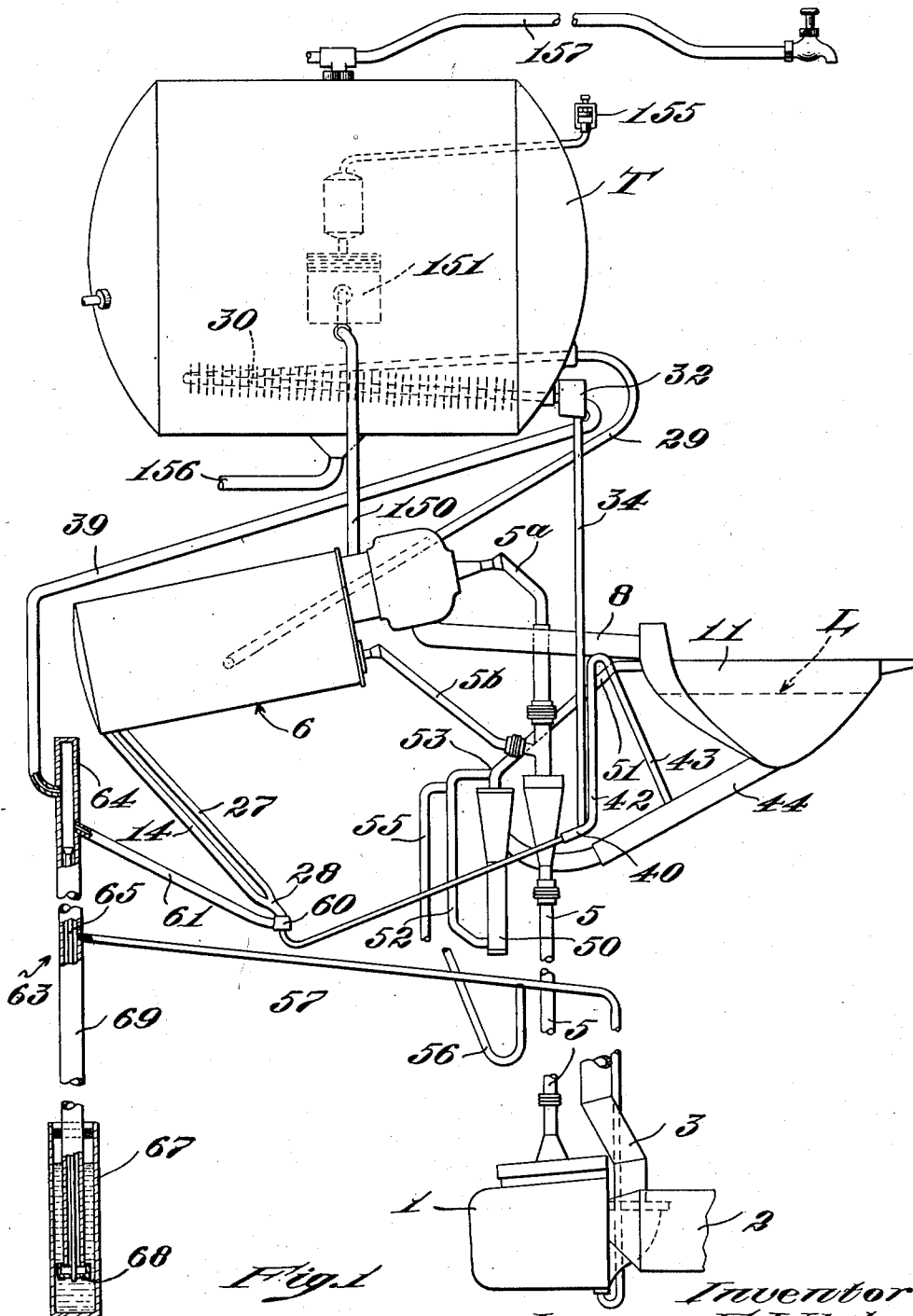


Fig. 1

Inventor
Lyman F. Whitney
by Roberts, Cushman & Groves
Attys

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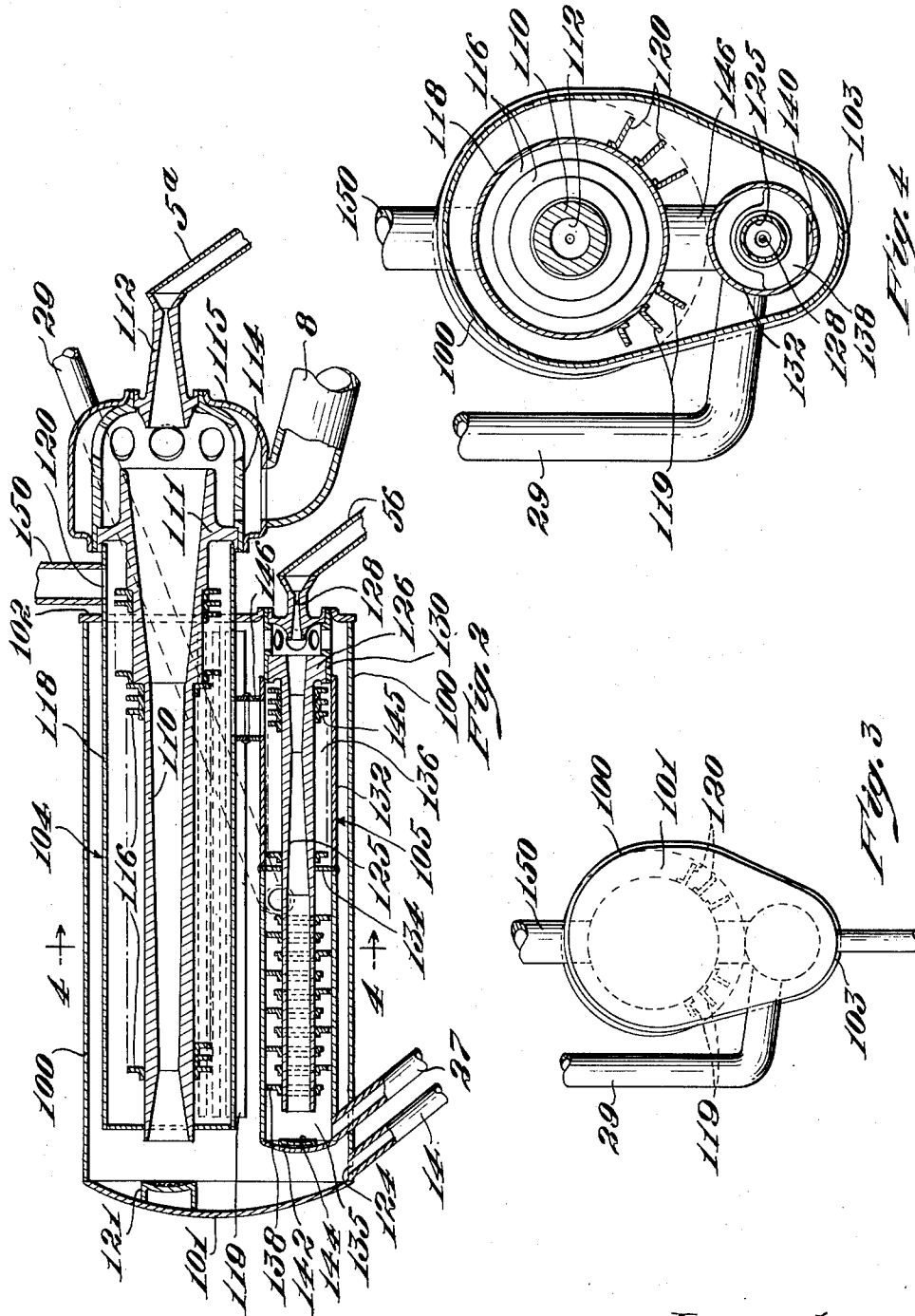
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by Robert Cushman & Groves
Atty's

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MULTIPLE STAGE EJECTOR IN REFRIG-
ERATION SYSTEM

Lyman F. Whitney, Cambridge, Mass., assignor,
by mesne assignments, to Stator Company, a
corporation of Massachusetts

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This invention relates to an improved refrigeration system of the type shown in United States Patent No. 2,174,300 granted to me September 26, 1939.

Such systems usually employ water as a refrigerant and mercury as a propellant, and while water and mercury are immiscible under ordinary conditions, under certain operating conditions fine particles of mercury become suspended in the water to form a mud-like sludge, as is more fully explained in my above-mentioned patent. Such sludge tends to impede circulation and provision must be made to minimize its formation, to remove and break up accumulations of such sludge, and to return the mercury component to the boiler or propellant circuit without impairing the operating efficiency of the refrigerating system. To this end the system shown in my above-mentioned patent has proved successful, but it will be noted that the arrangement is relatively complicated, bulky and expensive. Moreover, since such systems are also used to provide a supply of hot water, provision must be made to transfer the heat of condensation of the propellant and refrigerant fluids to a suitable water supply, as shown for example in United States Patents No. 2,174,302, granted to me September 26, 1939.

It is, of course, highly desirable to operate such systems so as to maintain a high refrigeration efficiency and heat transfer, and yet prevent the objectionable accumulation of mercury sludge.

The principal objects of the present invention are to simplify the above systems and to provide a compact, multiple stage ejector unit embodying means for eliminating sludge and means for transferring or dissipating heat, which unit is efficient and reliable in operation and relatively inexpensive to manufacture and install.

Further objects relate to various features of construction and will be apparent from a consideration of the following description and the accompanying drawings wherein:

Fig. 1 is a diagrammatic view of a refrigerating system embodying the present invention;

Fig. 2 is a longitudinal section view through the multiple stage ejector unit;

Fig. 3 is an end elevation of the ejector unit; and

Fig. 4 is an enlarged section on the line 4—4 of Fig. 2.

Referring to Fig. 1, the refrigerating system shown therein comprises a boiler 1 having a suitable heater such as a gas burner assembly 2 and a draft-inducing flue 3, only a portion of which is shown. Mercury vapor passes from the boiler 1

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through a riser pipe 5 to the branches 5^a and 5^b which are connected respectively to the first and second stage aspirators of my improved multiple stage ejector unit 6. The first stage aspirator is connected by a vapor duct 8 to the cooler or evaporator 11 which contains a body of aqueous refrigerant containing a suitable antifreeze agent. Vapor is drawn through the duct 8 to the mixing chamber of the first stage aspirator (hereinafter more fully described) and the mixed propellant mercury vapor and the refrigerant vapors are passed through the aspirator where the refrigerant is compressed and the mercury is condensed.

The condensed mercury flows from the first stage aspirator into a drain 14 while the compressed vapor passes to the second stage aspirator into which a second stream of mercury vapor flows from the line 5^b, this latter propellant stream causing a further compression of the refrigerant vapor in the second stage aspirator. A drain 27 receives the condensed mercury from the second stage aspirator and the two drains 14 and 27 converge at the Y 28. The compressed refrigerant passes upwardly from the second stage aspirator through duct 29 to the refrigerant condenser 30. The condenser 30 may be of any suitable form and is here shown as being disposed within a water tank or reservoir T, as in my prior Patent No. 2,174,302 granted September 26, 1939.

A chamber or drum 32 is preferably located at the end of the condenser 30 which is remote from the inlet of the pipe 29 and one end of a pipe 39 communicates with the chamber 32 so as to receive non-condensable gases therefrom. The lower portion of this chamber is connected with a drain or refrigerant return pipe 34 through which the condensed refrigerant passes on its way back to the cooler 11.

The lower end of the pipe 34 is connected to an inclined tube 40, the upper end of which has a vertical continuation 42 which extends above the level of the liquid L in the cooler 11. The pipe section 42 has a connection with a downwardly extending pipe 43, the lower end of which is connected with a drain duct 44 communicating with the lower part of the cooler 11. The lower part of the cooler 11 is formed with walls which incline downwardly toward the drain 44 so that accumulations of mercury sludge in the cooler 11 may pass directly into the drain 44.

The lower part of the duct 44 provides a shallow trap communicating with a drum or chamber 50. The duct 44 has a relatively large diameter to permit the movement of the heavy sludge therethrough and the drum 50 extends

downwardly a substantial distance below its connection with the trap defined by the duct 44. The upper part of the drum 50 is connected by vapor duct 51 to the low-pressure portion of the system, i. e., the upper part of the cooler 11. An upwardly inclined duct 52 extends upwardly from the lower part of the drum 50 and is connected at 53 with the vapor duct 51. Slightly below the top of drum 50 is a spill-over duct 55, the lower part of which provides a trap 56 connected to a mercury return 57 which is connected with the boiler 1.

When sludge accumulates in the cooler 11, it forms a mud-like deposit on the lower walls of the cooler and since the cooler is provided with downwardly sloping walls, this heavy, mud-like deposit can drain into the drum 50. Since the drum 50 is connected to the low-pressure portion of the system and is in a relatively warm location, the more volatile element of the heavy sludge, i. e., the aqueous refrigerant, is evaporated and drawn into the first stage mixing chamber through the duct 3, while the mercury residue flows into the line 52 and thence into the spill-over 55 to the mercury return 57. Since the drum 50 extends a substantial distance below the spill-over connection into the line 55, any sludge in the lower part of the drum is subjected to a substantial liquid head which results in a tendency to squeeze refrigerant out of the sludge so that the mercury may coalesce.

The Y 28 which connects the drains 14 and 27 communicates with a small drum or chamber 60 to which the lower end of the inclined pipe 40 is also connected, while an upwardly inclined duct 61 extends from this chamber 60 to a chamber 64 constituting a part of the purger assembly 63. The chamber 64 receives non-condensable gases through the pipe 39 and a drop tube 65 of restricted internal diameter extends downwardly therefrom. Globules of condensed mercury spilling over from the duct 51 entrain bodies of the non-condensable gases in the tube 65, compressing the gases as they move downwardly through the tube. The lower end of the tube 65 is immersed in a body of mercury in the well 67, the upper surface of this liquid propellant being exposed to atmosphere. A return duct 69 is circumposed about the tube 65 and is connected to the mercury-return pipe 57, there being a very small pressure-equalizing vent between the upper part of the duct 69 and chamber 64. A deflector 68 prevents gas from rising into the duct 69 from the lower end of the drop tube 65.

The arrangement of the spill-over connection between the tube 61 and chamber 60 determines the level of the mercury in the trap defined by the lower parts of the ducts 34 and 42. The condensed mercury received from the drains 14 and 27 passes into the chamber 60 and from the latter may pass to the spill-over connection, thus being received by the purger. From the purger the mercury flows from the pipe 57 back to the boiler 1, the height of the mercury in the pipes 57 and 69 being sufficient to balance the boiler pressure.

During normal operation of the system the trap defined by the pipes 61 and 40 is constantly receiving condensed mercury from the drains 14 and 27, and the spill-over connection between pipe 61 and chamber 64 definitely limits the height of mercury in the pipe 27. Thus, a mercury column of constant height is automatically maintained in the leg 61 of the trap while the total static pressure in this leg of the trap is

provided by the mercury column plus the condenser pressure thereabove. This static pressure is balanced in the opposite leg of the trap by the mercury in the tube 40 below its connection with the duct 34, and by the liquid columns in the respective branches 34 and 42 of this leg, as well as the pressures above these respective columns. The liquid heads in the branches 34 and 42 are provided by bodies of condensed mercury and aqueous refrigerant, as explained more fully in Patent No. 2,174,300 granted to me September 26, 1939, to which reference may be had for a more complete description of the operation of the system.

In accordance with the present invention, the first and second stage aspirators and their associated parts constitute a unit which comprises an elongate housing 100 of generally ovoid cross section having a closed rear end 101 and a front end 102 formed with vertically spaced openings which receive the first and second stage aspirators 104 and 105, respectively. The floor or bottom wall 103 slopes slightly from the front toward the rear so that condensate accumulating therein runs toward the rear wall.

The aspirator 104 may be of the same general design as shown in my prior Patent No. 1,756,802 granted April 29, 1930, comprising an elongate funnel 110 the enlarged end 111 of which is in spaced axial alignment with a nozzle 112 connected with the branch 5^a of the riser 5. The space between the nozzle and funnel constitutes a mixing chamber surrounded by a perforate casing 114 which is disposed within a dome-like closure or cap 115 which is formed with an enlarged opening to receive the vapor duct 8. Throughout the major portion of its length the funnel 110 is provided with heat-dissipating fins 116 and a jacket 118 surrounds the funnel, this jacket having a plurality of longitudinally extending fins 119 along its lower wall portion and an opening 120 formed in its upper wall outside the housing 100. Opposite the discharge end of the funnel 110 is a deflector plate 121 carried by the end wall 101 of the housing. The lower wall of the housing is provided with a drain opening 124 which is connected with the line 14.

The aspirator 105 is generally similar to the aspirator 104 and comprises an elongate funnel 125 having an intake end 126 in spaced alignment with a nozzle 128 connected to the branch line 5^b of riser 5. A sleeve 130 extends about the space or mixing chamber between the nozzle and funnel, and this sleeve is formed with spaced perforations or inlets so as to provide a communication between the interior of the housing and the mixing chamber. A jacket or casing 132 surrounds the funnel and at approximately the center of the jacket is a partition 134 (Fig. 2) which divides its interior into two sections 135 and 136.

A series of baffles 138 fit about the outlet end of the funnel within the chamber or section 135 and the lower ends of alternate baffles are cut so as to provide segmental openings 140 (Fig. 4) to permit condensate to run toward the closed end 142 of the jacket. The closed end of this jacket carries a deflector plate 144 and is formed with a drain opening to which the line 27 is connected. The upper end of the chamber 135 between partition 134 and the baffles is provided with an opening to which the vapor line 29 is connected, and the lower end of the chamber is

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provided with a discharge opening to which the drain pipe 27 is connected.

The intake end of the funnel within the section 136 carries a series of heat-dissipating fins 145 and the upper part of this chamber is provided with an enlarged opening directly connected with a similar opening in the floor of the jacket 118 by a short duct 146. The interiors of the jacket 118 and the chamber 136 are filled with alcohol or other similar liquid which receives heat from the gases passing through the funnels and transmits the same by way of a pipe 150 which connects the opening 120 in the jacket 118 with a condenser 151 located in a hot water supply tank T.

The tank T is provided with a connection 155 leading to the condenser 151 by means of which the alcohol circuit may be initially evacuated so that the alcohol therein may vaporize at a relatively low temperature (around 176° F.) when the temperature of the water around the condenser 151 is 170° F. The tank T is also provided with an inlet line 156 for receiving incoming water from the supply main, and a hot water supply line 157 is connected with the upper part of the tank, as in my prior Patent No. 2,174,302 granted September 26, 1939, to which reference may be had for a more complete description of this part of the system.

In operation, mercury vapor discharged from the nozzle 5^a aspirates water vapor through the duct 8 and carries it through the funnel 110, compressing it and discharging the compressed hot vapor into the interior of the housing 100. A substantial amount of heat is absorbed by the alcohol in the jacket 118, and any condensed mercury falls to the bottom of the housing 100 and eventually passes into the drain pipe 14. The compressed water vapor and any uncondensed mercury is drawn into the second stage aspirator and carried through the funnel 125 which results in further compressing the water vapor which, after passing about the baffles 138, is discharged into the duct 29. The condensed mercury accumulating in the bottom of the chamber 135 flows through the openings 140 into the drain 27. Heat from the second stage aspirator is absorbed by the alcohol in the section 136 and circulates upwardly through the jacket 118 and duct 150 into the condenser 151 where alcohol vapors are condensed and thus give up their heat to the water in the tank T, as is more fully described in my above-mentioned Patent No. 2,174,302.

While I have shown and described one desirable embodiment of the invention, it is to be understood that this disclosure is for the purpose of illustration and that various changes and modifications may be made without departing from the spirit and scope of the invention as set forth in the appended claims.

I claim:

1. In a refrigeration system of the type having a refrigerant fluid circuit including a vapor duct and a condenser duct, a propellant fluid circuit including a pressure line and a return line, and a cooling fluid circuit, a multiple stage ejector unit comprising a housing of elongate cross-section, a first stage ejector connected with said vapor duct and with said pressure line and ex-

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tending within the upper part of said housing, a second stage ejector connected with said pressure line and extending within the lower part of said housing, jackets about the ejectors having a connection with said cooling fluid circuit, the first stage ejector discharging into the interior of said housing and the second stage ejector having a vapor inlet communicating with the interior of said housing so as to receive vapors discharged by the first stage ejector, a connection between the outlet of the second stage ejector and said condenser duct, and return means from the outlet of said second stage ejector and the interior of said housing to said return line.

2. In a refrigeration system of the type having a refrigerant fluid circuit including a vapor duct and a condenser duct, a propellant fluid circuit including a pressure line and a return line, a multiple stage ejector unit comprising a housing, a first stage ejector connected with said vapor duct and with said pressure line and extending within one part of said housing, a second stage ejector connected with said pressure line and extending within another part of said housing, a casing surrounding the discharge end portion of said second stage ejector, the first stage ejector discharging into the interior of said housing and the second stage ejector having a vapor inlet communicating with the interior of said housing so as to receive vapors discharged by the first stage ejector, a connection between said casing and said condenser duct, and return means from said casing and the interior of said housing to said return line.

3. In a refrigeration system of the type having a refrigerant fluid circuit including a vapor duct and a condenser duct, and a propellant fluid circuit including a pressure line and a return line, a multiple stage ejector unit comprising a housing, a first stage ejector connected with said vapor duct and with said pressure line and extending within one part of said housing, a deflector plate carried by said housing opposite the discharge end of said ejector, a second stage ejector connected with said pressure line and extending within another part of said housing, the first stage ejector discharging into the interior of said housing and the second stage ejector having a vapor inlet communicating with the interior of said housing so as to receive vapors discharged by the first stage ejector, a connection between the outlet of the second stage ejector and said condenser duct, a second deflector plate disposed opposite the discharge end of said second ejector, and return means from the outlet of said second stage ejector and the interior of said housing to said return line.

LYMAN F. WHITNEY.

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