Aug. 24, 1943. L. E. PERRINE 2,327,451

AIR CONDITIONER

Filed Oct. 27, 1941 2 Sheets-Sheet 1

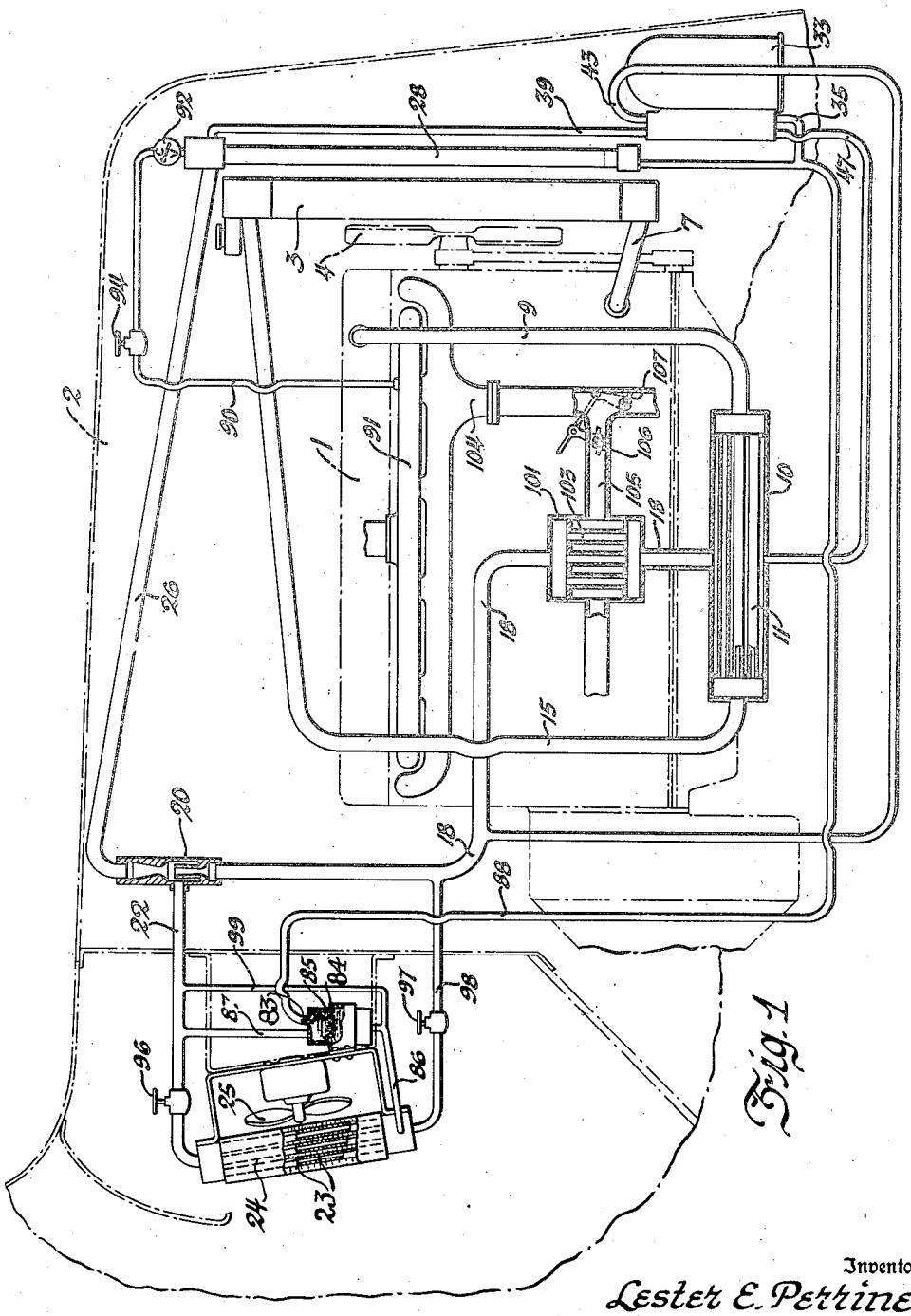

Fig. 1

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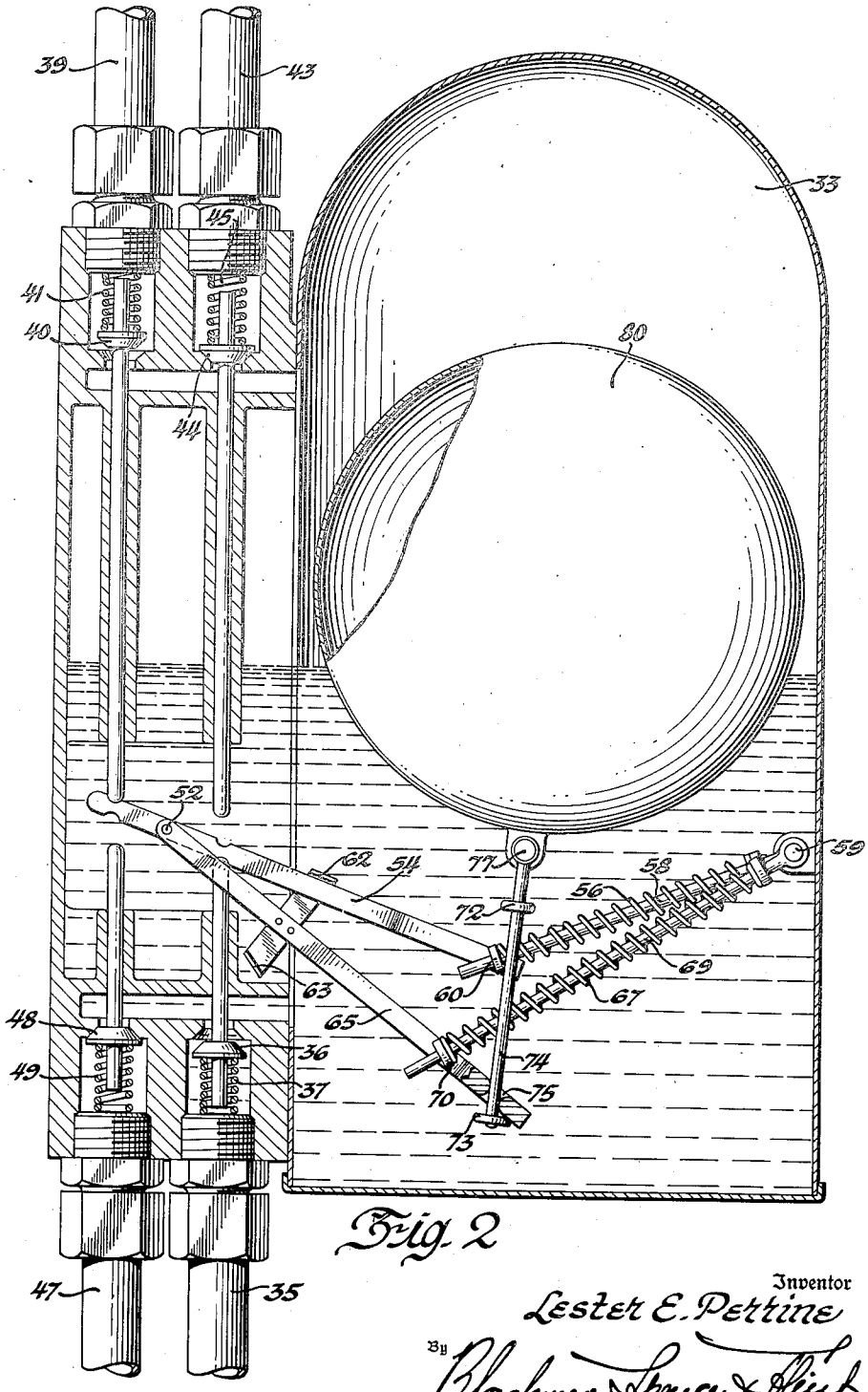

Fig. 2

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AIR CONDITIONER

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7 Claims. (Cl. 257—7)

This invention relates to a heat exchange system and more especially to a cooling system which is particularly suitable for air conditioning a motor vehicle.

The principal object of the invention is a cooling system of simple construction, having a minimum of moving parts, which is comparatively cheap to make, easily installed in a limited space, and which will require a minimum of attention.

A more specific object of the invention is a cooling system of a kind in which a jet of refrigerant vapor through an injector lowers the pressure above the refrigerant in an evaporator, thereby evaporating the refrigerant therein at a lowered temperature.

Another object of the invention is a cooling system in which heat for vaporizing refrigerant to produce vapor under pressure for the injector is obtained from the engine cooling water of the vehicle.

A still further object of the invention is a means whereby the evaporator may be arranged to work as a heat radiator in cold weather.

The above and other objects of the invention will be apparent as the description proceeds.

According to the invention, a refrigerant liquid is vaporized in a boiler, and passes thence through an injector to a condenser, the injector having a suction line through which the vapor jet of the injector draws a vacuum above the refrigerant liquid in an evaporator if cooling is required, thereby evaporating the refrigerant in said evaporator and lowering its temperature. If heating is required, some of the vapor from the boiler is passed through the refrigerant liquid in the evaporator to heat it, the injector drawing condensed vapor from the evaporator instead of refrigerant vapor. Air blown through the evaporator can accordingly be cooled or heated to be used for cooling or heating purposes.

The drawings show the application of the invention to a motor vehicle for cooling or heating the air therein as may be desired.

In the drawings

Figure 1 shows the system associated with the engine under the hood of a conventional automobile.

Figure 2 is an enlarged sectional view of the part 33 of Figure 1.

Referring more particularly to Figure 1, a conventional water cooled internal combustion engine 1, disposed under the hood 2 at the front end of an automobile (not otherwise shown), furnishes the power for driving the automobile. Included in the engine water cooling system is a conventional radiator 3, and a fan 4 driven by the engine, for drawing air through the core of the radiator.

From the bottom of the radiator 3, water passes through a pipe 7 to the engine water jacket and cooling passages (not shown), where it takes up heat from the engine. The heated water from the engine is carried through a pipe 9 to a boiler 10 in which there are water tubes 11 surrounded by a refrigerant liquid. From the boiler 10 the water is returned by a pipe 15 to the uppermost part of the radiator 3 to be cooled. Thermo-siphon circulation of the water may be augmented in the conventional way by an engine water pump (not shown).

The hot water circulated through the boiler evaporates the refrigerant at a vapor pressure which is that of the refrigerant at the particular temperature to which it is heated, and in the process, the latent heat of evaporation of the refrigerant abstracts a considerable amount of heat from the engine water cooling system, reducing the heat therein and thereby reducing the capacity for cooling which would otherwise be required of the engine water cooling system.

The high pressure refrigerant vapor from the boiler is conducted through a pipe 18 to an injector 20 of well known principle so arranged that the energy of the vapor jet therethrough draws a high vacuum in a suction line 22 and, when cooling is required, in the space above the level of refrigerant liquid in the pipe 23 of the core of a conventional heat exchanger constituting an evaporator 24, to which the suction line 22 is connected. The reduced pressure on the refrigerant liquid in the evaporator causes it to boil at a temperature lower than that of the boiler or the atmosphere, so that air blown through the core of the evaporator by an electric fan 25 is cooled, and can be used to cool the occupants of the vehicle.

The jet of vapor through the injector recompresses the vapor from both the evaporator and the boiler in forcing it through a pipe 26 to a heat exchanger constituting a condenser 28, with the result that the temperature in the condenser is higher than that of the evaporator or atmosphere, and the condenser is enabled to dissipate its heat load to the atmosphere. As shown, the condenser 28 is in front of the engine radiator 3 where it is cooled by air drawn through the cores of both the condenser and the engine radiator by the fan 4, and by impact when the vehicle is in motion.

From the condenser the refrigerant liquid may be returned to the boiler by any suitable means, but as shown this is preferably an automatic device consisting of a sealed tank 33 (the details of which are shown in Figure 2) between the bottom of the condenser 28 and the boiler 10, and provided with an inlet 35 for liquid refrigerant from the condenser, an outlet 39 for vapor to the condenser, an inlet 43 for vapor from the boiler, and an outlet 47 for liquid refrigerant to the boiler; said inlets and outlets being respectively

provided with valves 36, 40, 44 and 48, resiliently closed by springs 37, 41, 45, and 49, respectively.

Fulcrumed at 52 within the tank 33, is a valve operating lever 54, which is adapted in one position concurrently to open the valves 36 and 40, and in another position concurrently to open the valves 44 and 48.

The lever 54 is resiliently urged towards one position or the other by a helical spring 56 which, with the lever 54, constitutes an "over center" toggle; the spring 56 being guided by a rod 58 pivoted at 59 within the tank and extending through the eye of a swivel 60 on the lever 54.

The toggle 54, 56 is moved over center by one or the other of the arms 62, 63 of a lever 65, fulcrumed at 52, and forming one link of another "over center" toggle of which the other link is a helical spring 67 guided by a rod 69 pivoted at 59 within the tank, and extending through the eye of a swivel 70 on the lever 65.

The toggle 65, 67 is moved over center in one direction or the other by one or the other of the collars 72, 73 at the opposite ends of a link 74 extending through a hole 75 in the end of the lever 65 and pivotally connected at 77 to a float 80.

The arrangement is such that when the level of liquid refrigerant in the tank 33, and hence the float, is low, the valves 36 and 40 are open as shown, so that liquid refrigerant from the condenser 28 runs into the tank through the inlet 35 as vapor above the liquid in the tank is vented to the condenser through the outlet 39; as the liquid level in the tank rises and the float reaches a predetermined height, the valves 36 and 40 are closed and the valves 44 and 48 are opened so that boiler vapor pressure is admitted through the inlet 43 and liquid refrigerant flows from the tank 33 through the outlet 47 to the boiler 10.

It will be appreciated that the liquid refrigerant flows by gravity from the condenser into the tank 33 in the first part of the cycle, and thence, in the second part of the cycle, into the boiler 10 when sufficient vapor therefrom has passed into the tank 33 to establish boiler pressure and temperature therein, and that therefore the liquid level in the boiler may be governed by the relative height of the tank 33.

The tank 33 is preferably constructed of thin spun metal for rapid heat dissipation so that the refrigerating liquid is not vaporized as it enters the tank.

The spring 41 of the vent valve 40 being stronger than the spring 37 of the liquid refrigerant inlet valve 36, the latter will function as a safety valve during the periods in which the valves 44 and 48 are opened by the valve operating lever 54 and the valves 40 and 36 are normally closed. The valve 36 then limits the maximum pressure in the boiler by opening when the boiler pressure through valve 44 is sufficent to overcome the pressure of the spring 37 and permitting liquid refrigerant to be forced back through pipe 35 into the condenser.

The refrigerant liquid in the evaporator 24 is maintained at the required level by means of a float valve 83 actuated by a float 84 in a float chamber 85, the lower part of which is connected to the lower part of the evaporator by a pipe 86; the float chamber being subjected to the same vacuum as the evaporator through a pipe 87 connected to the suction line 22 of the injector which draws refrigerant from the bottom of the condenser into the float chamber through a pipe 88, whenever the liquid refrigerant in the evaporator 24 and the float chamber 85 falls below the level indicated in Figure 1 and the float valve 83 is open.

Since all vapor in the system flows towards the condenser, any inert gases stagnate at the top of the condenser, from which they may be purged at suitable intervals by the use of engine inlet manifold vacuum when the engine is operating at small throttle openings if the vapor pressure in the condenser at normal operating temperatures is sufficiently high, or by heating the condenser if the refrigerant used has too low a vapor pressure for this to be done.

The need for a separate vacuum pump is thus eliminated and the system is adapted to use refrigerants of low vapor pressure and very high latent heat for energy, such as water, alcohol or benzine, which tolerance to small leaks, permitting connection of the parts by rubber hose and clamps, and the use of light weight, high efficiency cores in the evaporator and condenser.

As shown, when, for example, alcohol having a vapor pressure of approximately 11 inches of mercury (18 inches of vacuum) is used, the system is purged of inert gases through a pipe 90 between the top of the condenser 28 and the engine inlet manifold 91; there being a check valve 92 in the pipe 90 to prevent reverse flow into the condenser, and a valve 94 which may be opened manually or automatically in any desired way, periodically to purge the system.

In order that the system may be used for heating as an alternative cooling, the suction line 22 is provided with a valve 96 which can be manually closed to cut off the space above the refrigerant liquid in the evaporator, from the vacuum produced by the injector, while heated vapor from the boiler is conducted from pipe 18, through a manually controlled valve 97 in a pipe 98, into the refrigerant liquid in the evaporator thereby raising its temperature for use as a heat radiator. Excess refrigerant liquid or heated vapor cooled and condensed by the refrigerant liquid and by the air to be heated which is impelled through the core of the evaporator by the fan 25, is withdrawn from the evaporator by the injector vacuum in the suction line, through a small bore bypass pipe 99 from below the level of liquid in the evaporator to a point in the suction line between the valve 96 and the injector, thereby maintaining circulation in the system.

For higher efficiency and a greater degree of cooling or heating, the energy available from the saturated refrigerant vapor from the boiler may be increased by superheating the vapor before it reaches the injector 20. To this end a superheater 101 is interposed in the vapor pipe 18 between the boiler and the injector, there being vapor tubes 103 in the superheater, which are heated by exhaust gases from the engine exhaust manifold 104 through a pipe 105 controlled by valves 106 and 107.

The system described is to a large extent self-regulating and requires a minimum of attention, the degree of cooling or heating actually obtained being mainly dependent on the amount of air impelled through the evaporator by the fan 25 which is controlled by a simple switch.

I claim:

1. In a cooling system including a boiler, an evaporator, and a condenser for a refrigerant, and an injector between the boiler and the condenser through which a jet of vapor from said boiler is passed to the condenser, said injector having a suction line to said evaporator above the level of liquid refrigerant therein, through

which a vacuum is drawn on the refrigerant liquid in said evaporator to lower its temperature, automatic means for returning liquid refrigerant from the condenser to the boiler including a tank with an inlet for liquid refrigerant from the condenser, an outlet for vapor to the condenser, an inlet for vapor from the boiler, and an outlet for liquid refrigerant to the boiler, valves for said inlets and outlets, said valves opening outwardly of said tank against the pressure of the spring means normally holding them closed, and means responsive to the level of liquid refrigerant in the tank for opening the first two of said valves while the other two valves are closed and vice versa, respectively to permit liquid refrigerant from the condenser to flow into the tank when the liquid level therein falls below a predetermined height and to permit liquid refrigerant from the tank to flow into the boiler when the liquid level in the tank rises above a predetermined height, the spring of said outlet valve for vapor to the condenser being stronger than the spring of said inlet valve for liquid refrigerant from the condenser, whereby during the periods when the inlet valve for vapor from the boiler and the outlet valve for liquid refrigerant to the boiler are open and the outlet valve for vapor to the condenser and the inlet valve for liquid refrigerant from the condenser are normally closed, the inlet valve for liquid refrigerant from the condenser will function as a safety valve limiting the maximum pressure in the boiler by opening when the boiler pressure through the inlet valve for vapor from the boiler is sufficient to overcome the pressure of the spring of the inlet valve for liquid refrigerant from the condenser, and permitting liquid refrigerant to be forced back therethrough into the condenser.

2. In a motor vehicle driven by an engine with water jacket cooling passages and a radiator for dissipating heat from the engine cooling water to the atmosphere, in combination, a boiler, an evaporator and a condenser for refrigerant liquid, and an injector through which a jet of vapor from said boiler is passed to the condenser and draws a vacuum on the refrigerant liquid in said evaporator to lower its temperature for cooling the interior of the vehicle, said boiler being heated by engine cooling water heated in the engine water jacket and passing through the boiler on its way to the radiator, the heat required to be dissipated by the radiator being thereby reduced to the extent of the heat removed from said engine cooling water in heating and vaporizing the refrigerant in said boiler.

3. The combination according to claim 2 in which the condenser is before the radiator in the path of air forced therethrough by impact when the vehicle is in motion, the extent to which the effectiveness of the radiator is reduced by this disposition of the condenser being compensated for by the heat removed from said engine cooling water in heating and vaporizing the refrigerant in said boiler.

4. In a motor vehicle driven by an engine, in combination, a boiler, an evaporator, and a condenser for refrigerant liquid, an injector through which a jet of vapor from said boiler is passed to the condenser, said injector having a suction line to said evaporator above the level of liquid refrigerant therein through which a vacuum is drawn on the refrigerant liquid in said evaporator to lower its temperature for cooling the interior of the vehicle, an inlet manifold for said engine, the pressure in said inlet manifold being sub-atmospheric, a tube between the top of the condenser and the inlet manifold, and valve means in the tube through which any inert gases in the refrigerant system may be periodically purged therefrom into the inlet manifold.

5. In a motor vehicle driven by an engine, in combination, a boiler, an evaporator and a condenser for refrigerant liquid, an injector through which a jet of vapor from said boiler is passed to the condenser, said injector having a suction line to said evaporator above the level of liquid refrigerant therein through which a vacuum is drawn on the refrigerant liquid in said evaporator to lower its temperature for cooling the interior of the vehicle, a superheater between the boiler and the injector, and means whereby the vapor from the boiler is superheated by the heat of the engine exhaust.

6. In a motor vehicle driven by an engine, in combination, a boiler, an evaporator and a condenser for refrigerant liquid, an injector through which a jet of vapor from said boiler is passed to the condenser, said injector having a suction line to said evaporator above the level of liquid refrigerant therein through which a vacuum is drawn on the refrigerant liquid in said evaporator to lower its temperature for cooling the interior of the vehicle, a valve in the suction line between the evaporator and the injector, a pipe for the flow of vapor from the boiler into the bottom of the evaporator and a valve in said pipe, and a bypass pipe from the evaporator below the level of the liquid therein to a point in said suction line between the first mentioned valve and the injector; whereby when said first mentioned valve is closed and said second mentioned valve is open, heated vapor will flow into the refrigerant liquid in said evaporator thereby raising its temperature for use as a heat radiator, the heated vapor condensed in said evaporator being withdrawn therefrom through said bypass pipe by the injector vacuum in the suction line.

7. In a motor vehicle driven by an engine, in combination, a boiler, an evaporator, and a condenser for refrigerant liquid, an injector through which a jet of vapor from said boiler is passed to the condenser, said injector having a suction line to said evaporator above the level of liquid refrigerant therein through which a vacuum is drawn on the refrigerant liquid in said evaporator to lower its temperature for cooling the interior of the vehicle, a valve in the suction line between the evaporator and the injector, a pipe for the flow of vapor from the boiler into the bottom of the evaporator and a valve in said pipe, and a bypass pipe from the evaporator below the level of the liquid therein to a point in said suction line between the first mentioned valve and the injector; whereby when said first mentioned valve is closed and said second mentioned valve is open, heated vapor will flow into the refrigerant liquid in said evaporator thereby raising its temperature for use as a heat radiator, the heated vapor condensed in said evaporator being withdrawn therefrom through said bypass pipe by the injector vacuum in the suction line, and means being provided for impelling air to be heated through said evaporator.

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