June 19, 1956 J. F. LYNCH 2,750,764

UNITARY REFRIGERATING AND HEATING SYSTEMS

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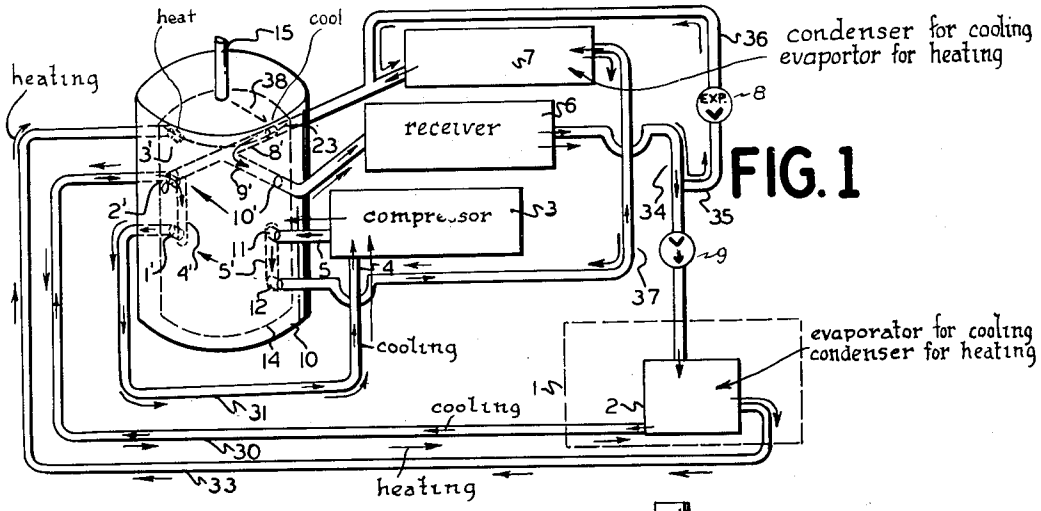


FIG. 1

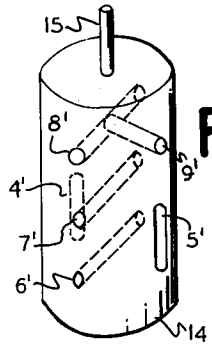


FIG. 2

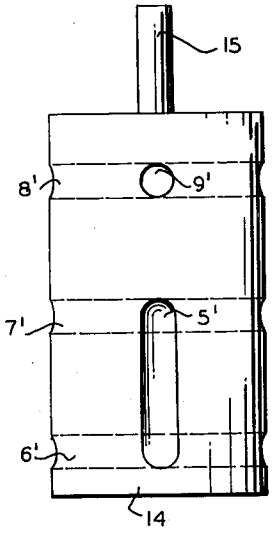


FIG. 3

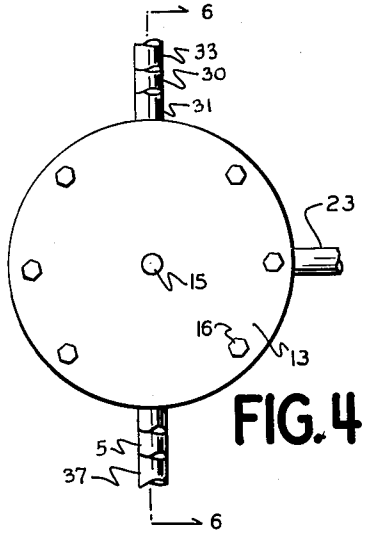


FIG. 4

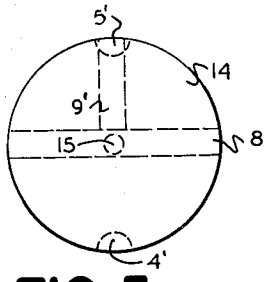


FIG. 5

INVENTOR.
Joseph F. Lynch
BY
Ezekiel Wolf
his Attorney

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FIG. 6

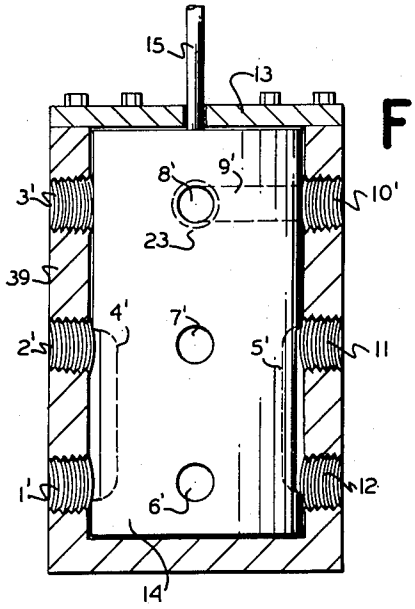
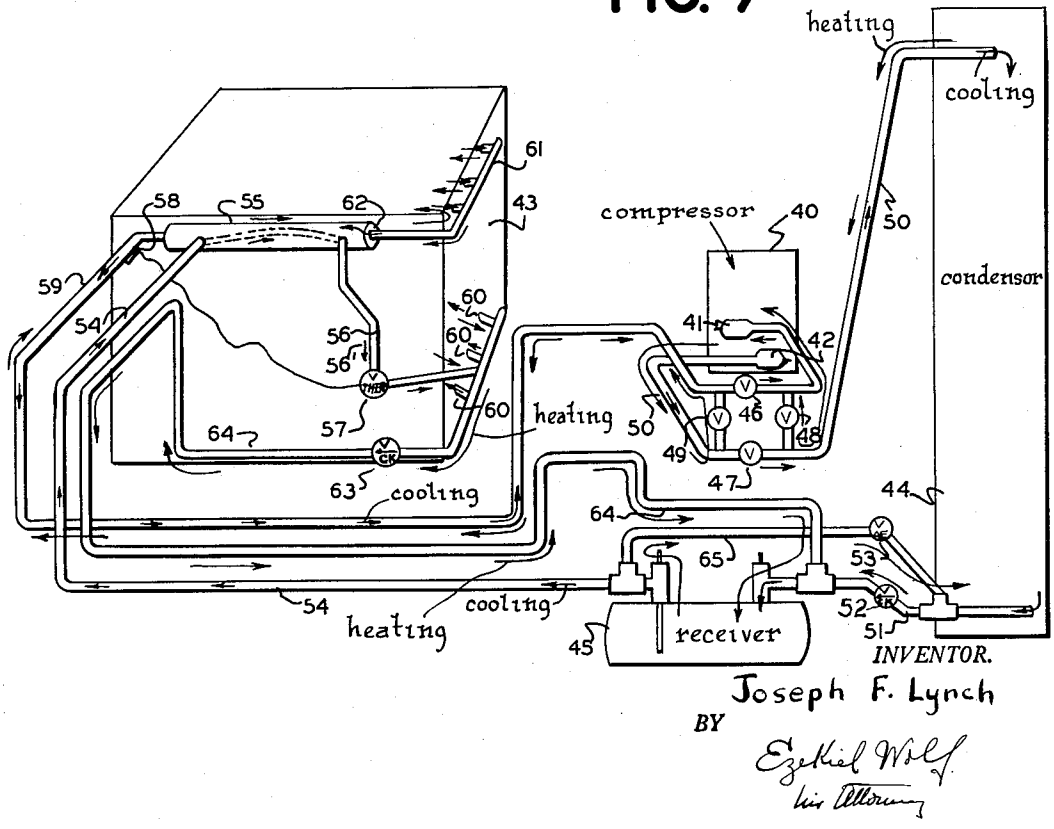


FIG. 7



INVENTOR.
Joseph F. Lynch
BY
Ezekiel Wolf
his Attorney

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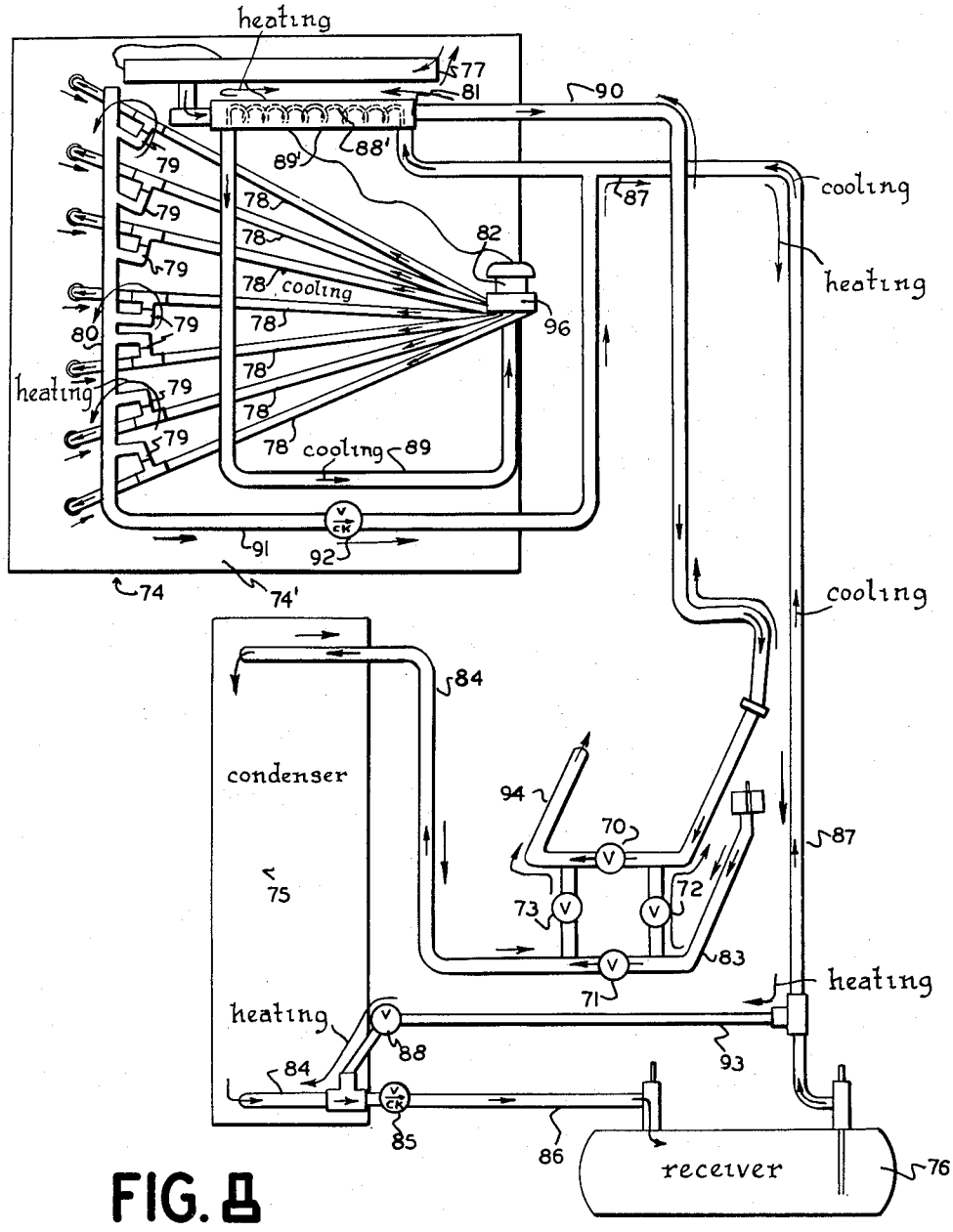


FIG. 8

INVENTOR.
Joseph F. Lynch
BY Ezekiel Wolf
his Attorney

United States Patent Office

2,750,764

Patented June 19, 1956

2,750,764

UNITARY REFRIGERATING AND HEATING SYSTEMS

Joseph F. Lynch, Cambridge, Mass., assignor of one-half to New England Trailer and Body Manufacturing Co., Medford, Mass., a corporation of Massachusetts

Application April 2, 1951, Serial No. 218,774

2 Claims. (Cl. 62—129)

The present invention relates to a refrigerating and cooling system which may be manually or otherwise controlled for keeping a storage chamber, house or any other enclosed space under desired temperature conditions.

The present invention is an improvement over the prior art principally in the compactness of the system, the use of the same units for dual purposes, the simplicity of operation by a single valve control if desired, and the simplicity of the system and the interconnections of the parts.

The invention will be better understood and its advantages over the prior art more fully appreciated in reading the specifications set forth below when taken in connection with the drawings illustrating an embodiment thereof in which:

Figure 1 shows schematically the system of the present invention illustrating more particularly the connection of the single valve control system.

Figure 2 shows the valve core of Figure 1 in perspective.

Figure 3 shows the valve core in plan elevation.

Figure 4 shows the front end view of the valve of Figure 1 with its connecting tubes.

Figure 5 shows an end view of the valve core as viewed from the lower end of Figure 2.

Figure 6 shows a section through the valve taken substantially on the line 6—6 of Figure 4.

Figure 7 shows a diagrammatic view of a modified system using a group of four valves, and

Figure 8 shows a further modification of the system of Figure 7.

In the arrangement indicated in Figures 1 to 6, inclusive, the various units may wherever it is possible be standard elements known in the art. Standard units used in the present system include compressors, condensers, evaporators, receivers, expansion valves, check valves, thermostatic and multiple thermostatic expansion valves with thermal bulb control, automatic expansion valves and heat exchangers. In Figure 1 within the compartment or chamber designated by the broken line 1 is an evaporator unit 2 which in the cooling cycle takes out the heat from the compartment and, therefore, is colder than the compartment, and in the heat cycle supplies heat to the compartment and therefore under these conditions is warmer than the compartment. Outside of the compartment there is a compressor 3 which has a suction inlet 4 and a pressure outlet 5. The system also includes a receiver 6 which acts as a receiver or storage reservoir for the circulating fluid; a condenser 7; an expansion valve 8 and a one-way valve 9 which is a restrictor in that the flow of liquid through it is restricted. The control valve is indicated at 10. The system may employ any of the common refrigerating liquids such as "Freon 12" which is a dichlorodifluoro methane or other methane compounds which change from liquid to gas in absorbing heat and from gas to liquid in giving off heat, some of which are known under other "Freon" numbers.

The choice of the proper refrigerant depends upon the temperature range of heating and cooling, the pressure one desires to use, and the ability of the fluid to operate in

the cycle with the proper operating units. With refrigerants of the "Freon" type, the gases are compressed and then the heat withdrawn until a liquid results. The liquid is then allowed to expand in the system under which conditions it again acquires heat, therefore cooling the surrounding medium and thereafter the gas is drawn again through the compressor to begin the cycle anew.

The system of Figure 1 will be traced through both its cooling and its heating cycle wherein the chamber or compartment of a truck trailer, room, or other similar space may be properly heated or cooled depending upon the requirements of the system. Assume that the refrigerant has been compressed in the compressor 3 and that it is delivered through the high pressure line 5 to the port 11 of the valve 10. The valve 10 will be in such a position by rotation of the valve handle or stem 15 so as to permit the liquid to flow through the slot 5' along the side of the core and out through the port 12 to the condenser 7. From the condenser 7 the gas which is now turned into liquid through the extraction of its heat would be sent through the port 23, through the passage 8' and the passage 9', out through the port 10' to the receiver 6. From the receiver 6 the cold liquid will pass through the one-way restrictor valve 9 into the evaporator 2 which is in the compartment 1 where the liquid will take on the heat of the compartment and pass out of it, over the line 30 to the port 2', through the slot 4' in the face of the core and out through the port 1' over the line 31 into the suction side 4 of the compressor. This completes the cooling cycle of the system.

When it is desired to supply heat to the compartment 1, it is only necessary to turn the valve stem 15 a quarter of a turn in which case a heating cycle is established for the compartment 1. In this case the passages 6', 7', and 8' in the core 14 will be aligned respectively with the port openings 1' and 12, 2' and 11, and 3' and 10' and permit the liquid or gas to flow as indicated below. Under such conditions when the compressed hot gas is pumped out of the high side 5 of the compressor 3, it will enter into the port 11, pass through the passage 7' of the core, out through the port 2' and over the line 30 into the evaporator 2. The hot gas will be cooled in the evaporator giving off their heat and will flow out over the line 33 which is the only place that the gas can go, since the valve 9 precludes its passage to the receiver. From the line 33, the condensed liquid will pass into the valve at the port 3', go through the passage 8' in the core, and then out through the port 10' into the receiver 6. The liquid will flow out of the receiver 6 over the line 34 but not into the evaporator, since this is under high pressure. It will, however, pass through the line 35 through the expansion valve 8 from the high pressure side to the low pressure side, over the line 36 and into the condenser 7, since the port 23 is closed because of the position of the valve core. In the condenser the liquid will expand and pick up heat, cooling the surrounding medium and pass out over the line 37 to the port 12 where it will go through the passage 6' in the core and out through the port 1' over the line 31 to the suction end of the compressor 3.

When the valve core is in the position shown in Figure 1 with the arrow 38 directed to the legend "cool," the evaporator in the compartment 1 will have cooled refrigerant liquid flowing through it which will take up heat and cool the compartment.

In the heating cycle the arrow 38 will be in a 90° position from the position of Figure 1, directed to the legend "heat" and in this condition of the valve, the hot gases pumped from the compressor will enter the evaporator as such and give off heat to the surrounding medium as the result of which the condensed gases tend to flow out

of the evaporator as a liquid. The evaporator in this case serves as a condenser.

While Figures 1 to 6 inclusive show a single valve for accomplishing the desired result, the same results may be accomplished by two sets of valves operated together or independently. Before going into the operation of the system employing separate valves, the construction of the valve in the system of Figures 1 to 6 should be noted.

The core 14 may be cylindrical with three diametric parallel passages 6', 7', 8' extending through the core and a right angle radial passage 9' connected to the passage 8'. The core is surrounded by a shell 39 within which the core may be rotated by the stem or handle 15. The shell has three sets of diametrically opposite ports 1' and 12, 2' and 11 and 3' and 10' which are all in the same plane and positioned on the same level as passages 6', 7' and 8' and 9' respectively with an additional port 23 radially positioned at right angles to the ports 3' and 10' for cooperating with the passages 8' and 9'. Additional slots 4' and 5' are formed in the sides of the core 14 radially 90° from the passages 6' and 7' and extending longitudinally of the core, the slot 4' extending between the position of the ports 1' and 2' and the slot 5' extending between the position of the ports 12 and 11 when the core is rotated to the position shown in Figure 6.

As indicated in Figure 6, the shell in which the core 14 is turned comprises a hollow cylinder closed at one end with a top plate 13 through which the stem 15 of the core extends. The plate 13 is attached around its periphery by means of bolts 16. The core 14 should be fitted closely to the cylinder so that the port connections will be entirely sealed off unless the passageways are aligned with them.

In the modification of the system of Figure 7, a compressor 40 draws the vapor or gas through the suction inlet 41 and discharges it through the suction outlet 42. Within the compartment or cabinet to be heated or cooled is the evaporator 43 which may be of a standard type if desired and which is shown somewhat diagrammatically in the figure. The units outside of the compartment comprise the condenser 44 and the receiver 45. Other than the valves and controls these are the only elements in the system. As indicated this figure has four manual control valves 46, 47 and 48, 49, the valves 46 and 47 being operated together in an off and on position, and the valves 48 and 49 being similarly operated in the opposite position depending upon the cycle desired.

When it is desired to cool the compartment, the valves 46 and 47 will be kept opened and the valves 48 and 49 will be closed. In this arrangement the cooling cycle may be traced as follows: Over the discharge line 50, through the valve 47 to the condenser 44 where the heat will be extracted from the compressed gases which will leave the condenser at the lower end as a liquid; over the line 51 through the check valve 52 from which it enters the receiver 45. The liquid cannot go through the automatic expansion valve 53, since it is flowing in the wrong direction for the operation of this valve.

From the receiver 45, the liquid flows out over the liquid line 54, through the heat exchanger 55 situated in the evaporator, then over the line 56, through the thermostatic expansion valve 57 which is also a one-way valve and which is operated by the control bulb 58 situated in the suction and discharge line 59 going to the evaporator. The thermo bulb 58 controls the action of the thermostatic expansion valve in the usual manner to maintain the proper control for allowing the desired flow of cooling liquid to enter the evaporator. After flowing through the thermostatic valve 57, the liquid will pass out into the evaporator through the nozzles 60 of which there may be any desired number. The liquid will then evaporate in the evaporator 43 and take on heat therein to cool the surrounding medium after which it will be drawn through the line 61 which now acts as a suction line, pass through the tube 62 of the heat exchanger which acts to cool the liquid and heat the gases going through the heat exchanger. The gases will then be drawn through the line 59 which acts as a suction line in this operation, pass through the valve 46 and enter into the compressor 40 over the suction inlet 41. In this operation of the system, the evaporator will cool the inside compartment and the condenser will heat the outside.

In the reverse operation of the system, the valves 46 and 47 are closed and the valves 48 and 49 are open. Under these circumstances the evaporator will act as the heating member and the condenser as the cooling member. The system may be traced as follows: The compressed gases will be pumped out of the compressor 40 over the line 50 through the valve 49 which is now open but not the valves 46 and 47 which are closed, over the suction line 59 which is now the high pressure line, through the tube 62 of the heat exchanger 55, through the tube 61 and out of the outlets connected thereto into the evaporator but in this case the medium will be a hot compressed gas. The gases will give off their heat in the evaporator thus heating the surrounding medium in the compartment and will be drawn out of the evaporator as a liquid at the bottom through the outlets 60 through the check valve 63 and the line 64. The liquid cannot pass through the thermostatic expansion valve since this is set for one-way passage. From the line 64, the liquid will return to the receiver 45 since the check valve 52 is set in the opposite direction. From the receiver 45, the liquid will flow over the line 65 but not over the line 54 since this line is closed by the thermostatic expansion valve. The pressure in the evaporator is higher than the pressure in the line 54 under which condition the flow in the direction of the arrow 56' cannot take place. The liquid will therefore flow through the line 65, through the automatic expansion valve 53 into the condenser 44 where heat will be picked up by cooling the external medium, and the refrigerant now a gas will be drawn out of the condenser over the line 50, pass through the valve 48 which is now open and through suction inlet 41 of the compressor 40. In this case the evaporator 43 will act as the heating unit and the condenser 44 as the cooling unit.

It will be seen from this description that merely by controlling the four valves 46, 47, 48, and 49, the compartments within which the evaporator is contained may be either heated or cooled as desired.

In the arrangement shown in Figure 8, a system somewhat similar to that of Figure 7 is indicated. Here there are four control valves similar to those of Figure 7, 70, 71, 72, and 73, an evaporator 74, a condenser 75, and a receiver 76. The evaporator 74 is a modification of the usual type. It employs within the compartment 74' a group of coils not shown, each of which has a connection to the manifold 77. These coils within the compartment are connected respectively each to one of the lines 78 externally of the compartment, each of which in turn have T connections 79 to a manifold connection 80. A heat exchanger 81 similar to that described in connection with Figure 7 is also used in this arrangement. The lines 78 all radiate from what may be called an input manifold 96 which is provided with a multiple thermostatic expansion valve 82.

The system may now be traced in a fashion similar to the system of Figure 7. The cooling cycle for the compartment will be obtained when valves 70 and 71 are open and 72 and 73 are closed. From the compressor, not shown, the gases will be pumped over the line 83, through the valve 71, the line 84, to the condenser 75 and will leave the condenser over the line 84 through the check valve 85, the line 86, and enter the receiver 76. The condensed gases will flow over the liquid line 87 but not through the thermo or automatic expansion valve 88 which will be closed, through the coils 88' of the heat exchanger 81, out over the line 89 and into the input

manifold 96 in which the multiple thermostatic expansion valve is situated. The liquid refrigerant will then flow out over the lines 78 into the evaporator, through the coils of the evaporator, into the manifold 77 and outward through the tube 89' of the heat exchanger, through the suction line 90, through the valve 70, into the compressor. This is the cooling cycle and the coils in the evaporator will act to absorb heat and cool the surrounding medium.

In the heating cycle, when the valves 70 and 71 are closed and the valves 72 and 73 open, the system will be traced as follows: The hot gases will be sent over the line 83, through the valve 72 which is now opened, over the line 90, into the cylinder 89' of the heat exchanger. The gases will then flow through the manifold 77 into the coils of the evaporator where they will now be condensed and give off heat, and outward from these coils over the line 78 to the T connections 79. The liquids will not flow beyond this because of the thermostatic expansion valve 82. From the T connection 79 the liquids will flow into the manifold 80, over the line 91, through the check valve 92 and into the liquid line 87. The liquid will not recirculate through the coils 88' and the line 89 because of the pressure in the lines 78 but will be carried through the line 87 over the liquid branch line 93, through the thermal or automatic expansion valve 88, into the condenser 75 where the liquid will evaporate or take on heat cooling the surrounding medium and out over the line 84 through the valve 73 and into the compressor over the line 94. The receiver under normal conditions always builds up a pressure in both cycles in all cases and this pressure is in part maintained because of the check valve 85 which prevents the refrigerant from flowing into the condenser 75.

It will be seen from the description of the above invention that heating and cooling of the compartment is obtained through the same system by simple valve controls using the same unit for both heating and cooling. Temperature ranges for this purpose are such that compartments in trucks can be used for a refrigerator or for keeping materials from freezing when shipped in cold weather.

Having now described my invention, I claim:

1. A cooling and heating system for an enclosed compartment including a unit designated as an evaporator serving as such in a cooling cycle and as a condenser in a heating cycle, a unit designated as a condenser outside said compartment serving as a condenser in said cooling cycle and as an evaporator in a heating cycle, a compressor unit having a discharge line and a suction line, line connection means and valve control means for sending a refrigerant fluid in the cooling cycle through the condenser, through a receiver, through said evaporator and back to said compressor suction line and in reverse order in the heating cycle, said evaporator having three lines thereto comprising two liquid lines and a single line used for both discharge from and suction to the compressor and valve means and connecting lines for using either one but not both of said liquid lines dependent upon whether said single line is used for discharge or suction.

2. A cooling and heating system for an enclosed compartment comprising a unit designated as evaporator within a compartment and units designated as compressor, receiver and condenser outside the compartment, valve means and tubes connecting said units in a series cycle of compressor, condenser, receiver, evaporator and compressor, including means for interchanging the position of the condenser and evaporator for changing from a cooling cycle to a heating cycle for the compartment, an expansion valve connected in the system with its high pressure side in the output line of the receiver, a second expansion valve having its low pressure side connected to the input line of the condenser, said valve means including a cylindrical valve having an inner solid cylinder and an external closely fitting concentric cylindrical shell, said two cylindrical elements adapted to be turned with respect to one another, said inner cylinder having three diametrically extending passages spaced longitudinally of the cylinder axis with a radial branch extending at right angles from the center of one passage to the circumference of the cylinder and a pair of longitudinal port channels in said cylinder wall at 90° from the other two passages, said cylindrical shell having ports diametrically opposite adapted to align with the ends of said three passages in said cylinder in one position and a further port adapted to align with said radial branch in a second position.

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