

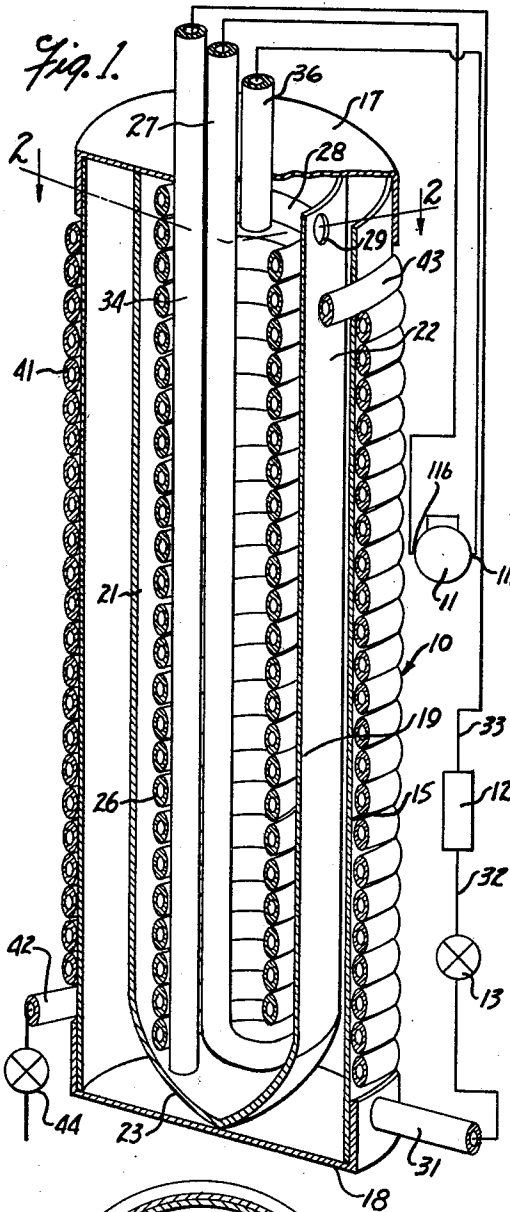
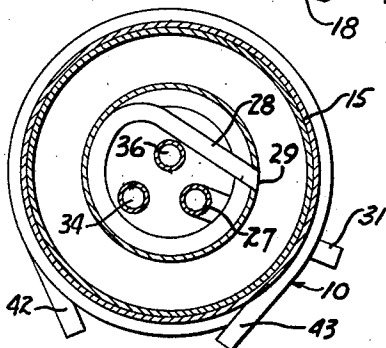
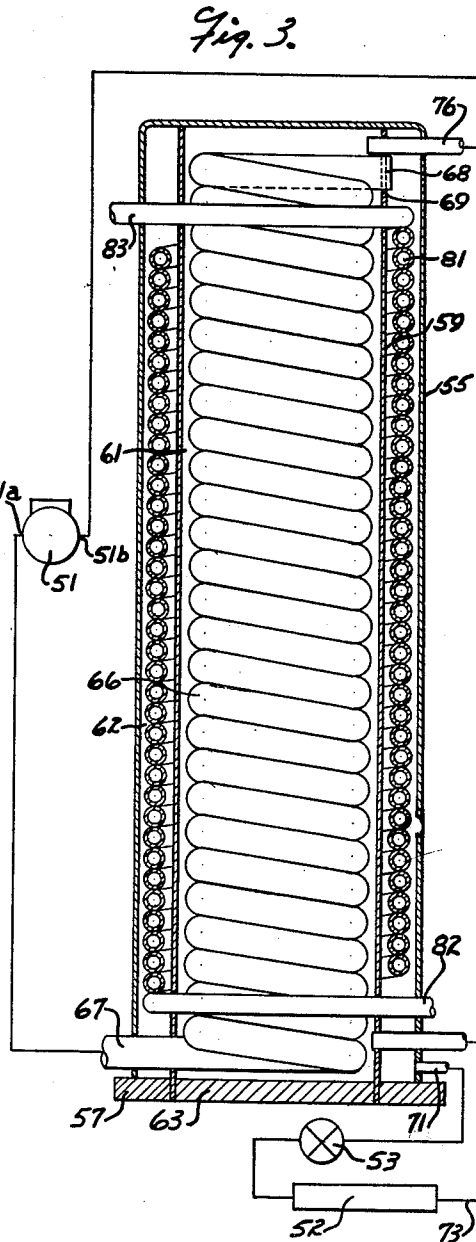
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REFRIGERATION SYSTEM INCLUDING CONDENSER HEAT EXCHANGER

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REFRIGERATION SYSTEM INCLUDING
CONDENSER HEAT EXCHANGER

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This invention relates to improvements in refrigerating apparatus and particularly to a condenser and heat exchanger unit for a refrigerating apparatus.

Heat exchangers have heretofore been provided to prevent the passage of liquid refrigerant back to the compressor, and to also pre-cool the hot refrigerant leaving the compressor. The heat exchanger passes the partially saturated gas leaving the evaporator in heat exchange relation to the hot gas leaving the compressor to heat and completely saturate the gas before it returns to the compressor and, conversely, to pre-cool the hot gas leaving the compressor. The heat exchanger, however, only removes a small portion of the heat in the gas leaving the compressor and it has heretofore been in the general practice to provide a separate condenser to cool and condense the compressed refrigerant prior to passage to the evaporator, and a receiver or accumulator to hold the excess liquid refrigerant necessary to accommodate the changing loads on the refrigerating apparatus.

An important object of this invention is to provide a combination heat exchanger and condenser for a refrigerating apparatus in which the several functions of the heat exchanger and condenser are combined in a single unit and in such a manner as to provide a compact overall construction so arranged as to substantially avoid frosting and sweating of the parts of the refrigerating apparatus outside the evaporator.

Another object of this invention is to provide an improved combination heat exchanger and condenser of the water cooled type, and which is so constructed as to avoid freeze ups of the condensing water.

Yet another object of this invention is to provide a combination heat exchanger and condenser which also functions as an accumulator or receiver to eliminate the necessity of a separate receiver.

A further object of this invention is to provide a combination heat exchanger-condenser and accumulator in accordance with the foregoing object, and which avoids excess accumulation of lubricating oil in the receiver.

These, together with various other objects and advantages of this invention will be appreciated as the same becomes better understood by reference to the following detailed description when taken in connection with the accompanying drawings wherein:

FIG. 1 is a perspective view of the combination heat exchanger-condenser-accumulator, with parts broken away and shown in section to illustrate details of construction and with the remainder of the refrigerating system shown diagrammatically to illustrate its connection thereto.

FIG. 2 is a transverse sectional view taken on the plane 2—2 of FIG. 1.

FIG. 3 is a longitudinal sectional view through a modified form of heat exchanger and condenser unit.

The condenser and heat exchange unit designated generally by the numeral 10 is adapted for use in a refrigerator system including a compressor 11, an evaporator 12 and an expansion control 13. The combined heat exchanger and condenser unit is arranged to pass the partially saturated gas leaving the evaporator in heat exchange relation with the hot compressed gas leaving the compressor to both completely saturate the gas before it enters the compressor and to pre-cool the hot gases which leave the compressor. Complete saturation of the gas before it enters the compressor is desirable in order to prevent damage to the compressor as may occur if slugs

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of liquid refrigerant are fed thereto, and to also minimize sweating and frosting of the suction lines and generally improve the overall efficiency of the refrigerating apparatus. The condenser and heat exchange unit is also arranged to condense the gaseous refrigerant prior to its supply to the evaporator.

The condenser and heat exchange unit 10 in general includes an outer casing 15, advantageously in the form of an upright preferably cylindrical sleeve, having end walls 17 and 18, herein shown in the form of flanged caps which are soldered or otherwise attached to the outer casing in sealed relation therewith. An inner shell or sleeve 19 is disposed within the casing 15 in spaced relation thereto and is closed at opposite ends to define an inner heat exchange chamber 21 within the shell and an outer condenser chamber 22 between the shell and casing. As shown, the inner shell 22 has its upper end soldered or otherwise sealingly attached to the upper end wall 17 of the outer casing. The lower end of the inner shell is closed as by a preferably cup-shaped end wall 23.

A heat exchange jacket, advantageously in the form of a helical coil 26, is disposed in the inner heat exchange chamber 21, in spaced relation to the walls thereof and has a compressed gas refrigerant inlet line 27 connected to the outlet side 11b of the compressor 11. The inlet line 27 conveniently extends from the lower end of the coil upwardly through the upper wall 17 of the outer casing, and the outlet end 28 of the heat exchange coil is connected to an outlet opening 29 in the inner shell, and in sealed relation with the inner shell. The outlet opening 29 of the heat exchange coil is disposed adjacent the upper end of the condenser chamber 22 and the heat exchange coil thus discharges the gas into the outer condenser chamber. A condensed refrigerant outlet line 31 is connected to the outer condenser chamber 22 adjacent its lower end and is connected to an expansion control, such as capillary tube or an expansion valve 13. The refrigerant from the expansion control is fed through a line 32 to the evaporator 12.

The gas leaving the evaporator is frequently in a partially saturated condition and contains small bubbles of unexpanded liquid refrigerant. In order to completely saturate this gas, before it enters the compressor, the refrigerant return line 33 is connected to a tube 34 which extends into the heat exchange chamber 21. The tube 24 preferably extends to a point adjacent the bottom wall 23 of the inner shell, to discharge the partially saturated gas into the bottom cup shaped end wall 23 of the heat exchange chamber and thereby agitate any oil which may tend to collect in the lower end of the heat exchange chamber to prevent excessive accumulation of oil in that chamber. The tube 34 conveniently is attached to the upper wall 17 of the outer casing in sealed relation therewith and extends downwardly in the heat exchange chamber. A suction return line 36 communicates with the heat exchange chamber adjacent its upper end and, as shown, extends through the upper wall 17 in sealed relation therewith. The suction return line 36 is connected to the inlet side 11a of the compressor 11.

The condensing chamber 22 is arranged to be liquid cooled and, in the embodiment of FIGS. 1 and 2, the water cooling jacket is disposed externally of the condensing chamber to minimize the possibility of cross flow between the water lines and the refrigerant lines, in the event of a rupture in either of the lines. The water jacket is advantageously in the form of a helical coil designated 41, disposed around the outside of the casing 15, and has water inlet and outlet lines 42 and 43, respectively. The flow of water through the cooling jacket may be controlled in any desired manner as by a manual or automatic flow regulating valve 44. As is conventional, the automatic type flow regulating valves are operated in

response to the pressure at the high pressure side of the refrigerating apparatus so that, when the compressor is stopped, the pressure gradually decreases and allows the valve to close and shut off flow of cooling water. As soon as the compressor is again started, the rise of the high side pressure opens the valve and permits water flow to resume.

From the foregoing it will be seen that the partially saturated refrigerant from the evaporator is passed into and through the inner heat exchange chamber 21, while the hot gas from the compressor is passed from line 27 through the heat exchange coil 26. The hot gas passing through the coil 26 heats the partially saturated gas in the heat exchange chamber 21 to completely saturate the same before it is returned to the inlet of the compressor. In addition, the hot gas from the compressor is pre-cooled so that less cooling water is required to condense the vapor in the condenser chamber 22. The pre-cooled gas is discharged into the upper end of the condenser chamber and is cooled by the water cooling coils 41. Since the gas in the condenser chamber 22 is at a moderately high temperature, there is no danger of freezing the water in the cooling coils 41. Moreover, since the heat exchange is disposed inside the condenser chamber, there is no sweating or frosting in the heat exchange portion of the unit. The inner shell 19 which forms the heat exchange chamber is advantageously made sufficiently large as to also function as a receiver or accumulator to store the excess refrigerant necessary to accommodate the fluctuating loads on the refrigerating apparatus. In this manner, the function of a heat exchanger, condenser and accumulator or receiver are all combined in a single compact unit.

A modified form of heat exchange and condenser units is illustrated in FIG. 3. In general, the unit includes an upright preferably cylindrical casing 55 having an upper end wall 56 and a lower closure plate 57. As shown, the upper end wall is formed integrally with the casing and the lower end of the casing is sealed by soldering to the plate 57. An inner shell 59 is disposed in the outer casing in spaced relation thereto to define an inner heat exchange chamber 61 inside the shell and an outer condenser chamber 62 between the shell and casing. The inner shell is conveniently closed as by soldering to the upper wall 56 of the outer casing and the lower end of the shell is closed by a plug 63. The inner shell is also sealed to the plate 57 to close the lower end of the condenser chamber 62. A heat exchange coil 66 is disposed in the inner shell in spaced relation to the walls thereof and has a refrigerant inlet 67 communicating with its lower end and a refrigerant outlet 68 at its upper end. As shown, the refrigerant inlet line 67 extends through the shell and outer casing adjacent the lower end thereof and is connected to the outlet 51a of a compressor 51. The outlet line 68 from the heat exchange coil extends through an opening 69 in the shell and communicates with the condenser compartment 62 adjacent the upper end of the latter. A condensed refrigerant outlet 71 communicates with the condenser compartment 62 adjacent the lower end of the latter and extends through an expansion control such as a capillary tube or expansion valve 53 to the evaporator 52. The partially saturated gas from the evaporator is fed through a line 73 to the lower end of the condenser compartment and, as shown, the line 73 extends through the casing and shell adjacent the lower end of the latter. The fully saturated gas from the heat exchange compartment is passed through a line 76 back to the inlet 51b of the compressor.

In this embodiment, the liquid cooling jacket is in the form of a coil 81 which is disposed inside the condenser chamber 62 to be immersed in the refrigerant therein. Cooling water is supplied to the coil through water inlet and outlet lines 82 and 83 which, as shown, extend through openings in the outer casing and are sealed thereto as by soldering or the like. Advantageously, the

cooling water is fed into the lower end of the cooling coil adjacent the condensed refrigerant outlet 71 and then passes upwardly to outlet conduit 83 adjacent the upper end of the unit. With this arrangement, the cooling water flows opposite the direction of flow of refrigerant in the condensing chamber so that the coolest water is located adjacent the outlet and the warmer water is discharged adjacent the upper end of the condensing chamber where the refrigerant is hottest. The operation of the heat exchange and condensing unit of FIG. 3 is generally the same as that of the preceding embodiment and further description is deemed unnecessary. As discussed in connection with the preceding embodiment, the inner heat exchange chamber is made sufficiently large to function as an accumulator or receiver to hold the excess refrigerant necessary to accommodate fluctuating loads on the refrigerating apparatus.

I claim:

1. In combination with a refrigeration system having a compressor and evaporator, a condenser-heat exchanger unit including a casing having spaced inner and outer shells defining an inner heat-exchange chamber and an outer condenser chamber surrounding at least a major portion of said heat-exchange chamber and separated therefrom by a heat conductive wall, means defining a tortuous heat exchange passage immersed in said inner heat-exchange chamber in heat exchange relation with the fluid in the heat-exchange chamber and having a high pressure refrigerant inlet connected to the outlet of said compressor and a high pressure refrigerant outlet communicating with said outer condenser chamber to pass refrigerant thereto, a low pressure refrigerant inlet communicating with said inner heat-exchange chamber and connected to the outlet of said evaporator to pass the partially saturated refrigerant from the evaporator to the heat-exchange chamber, a low pressure refrigerant outlet line communicating with said heat-exchange chamber adjacent the upper end thereof and connected to the suction side of the compressor for returning the saturated vapor to the compressor, a condensed refrigerant outlet line communicating with said condenser chamber adjacent the lower end thereof and connected to the inlet of the evaporator to pass condensed refrigerant thereto, and means defining a liquid cooling jacket disposed in heat exchange with said outer condenser chamber, said liquid cooling jacket having a cooling liquid inlet and outlet for passing cooling liquid through the cooling jacket and thereby cool the refrigerant in the condenser chamber.

2. The combination of claim 1 wherein said cooling jacket comprises a coil immersed in said outer condenser chamber.

3. The combination of claim 1 wherein said cooling jacket comprises a coil disposed around the outside of said outer shell in heat-exchange relation therewith.

4. In combination with a refrigeration system having a compressor and evaporator, a combination condenser-heat exchanger unit including casing means defining a heat-exchange chamber and a condenser chamber surrounding at least a major portion of the heat exchange chamber and separated therefrom by a heat conductive wall, means defining a tortuous heat exchange passage spaced from said heat conductive wall and immersed in the inner heat-exchange chamber in heat exchange relation with the fluid in said heat-exchange chamber and having a high pressure refrigerant inlet connected to the outlet of said compressor and a high pressure refrigerant outlet communicating with said condenser chamber adjacent the upper end of the latter, a low pressure refrigerant inlet line communicating with said heat exchange chamber and connected to the outlet of said evaporator to pass the partially saturated refrigerant from the evaporator to the heat-exchange chamber, a low pressure refrigerant outlet line communicating with said heat-exchange chamber adjacent the upper end thereof and connected to the suction side of the compressor for returning the saturated

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vapor to the compressor, a condensed refrigerant outlet line communicating with said condenser chamber adjacent the lower end thereof for passing condensed refrigerant to the evaporator, and means defining a liquid cooling jacket disposed in heat exchange relation with said condenser chamber, said liquid cooling jacket having a cooling liquid inlet and outlet for passing cooling liquid through the jacket to thereby cool the refrigerant in the condenser chamber.

5. The combination of claim 4 wherein said low pressure refrigerant inlet line communicates with said condenser chamber adjacent the lower end thereof to agitate the fluid in the heat exchange chamber.

6. The combination of claim 5 wherein said cooling

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jacket comprises a coil immersed in said condenser chamber.

7. The combination of claim 5 wherein said cooling jacket is disposed externally of said condenser chamber in heat exchange relation therewith.

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