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REFRIGERATING APPARATUS

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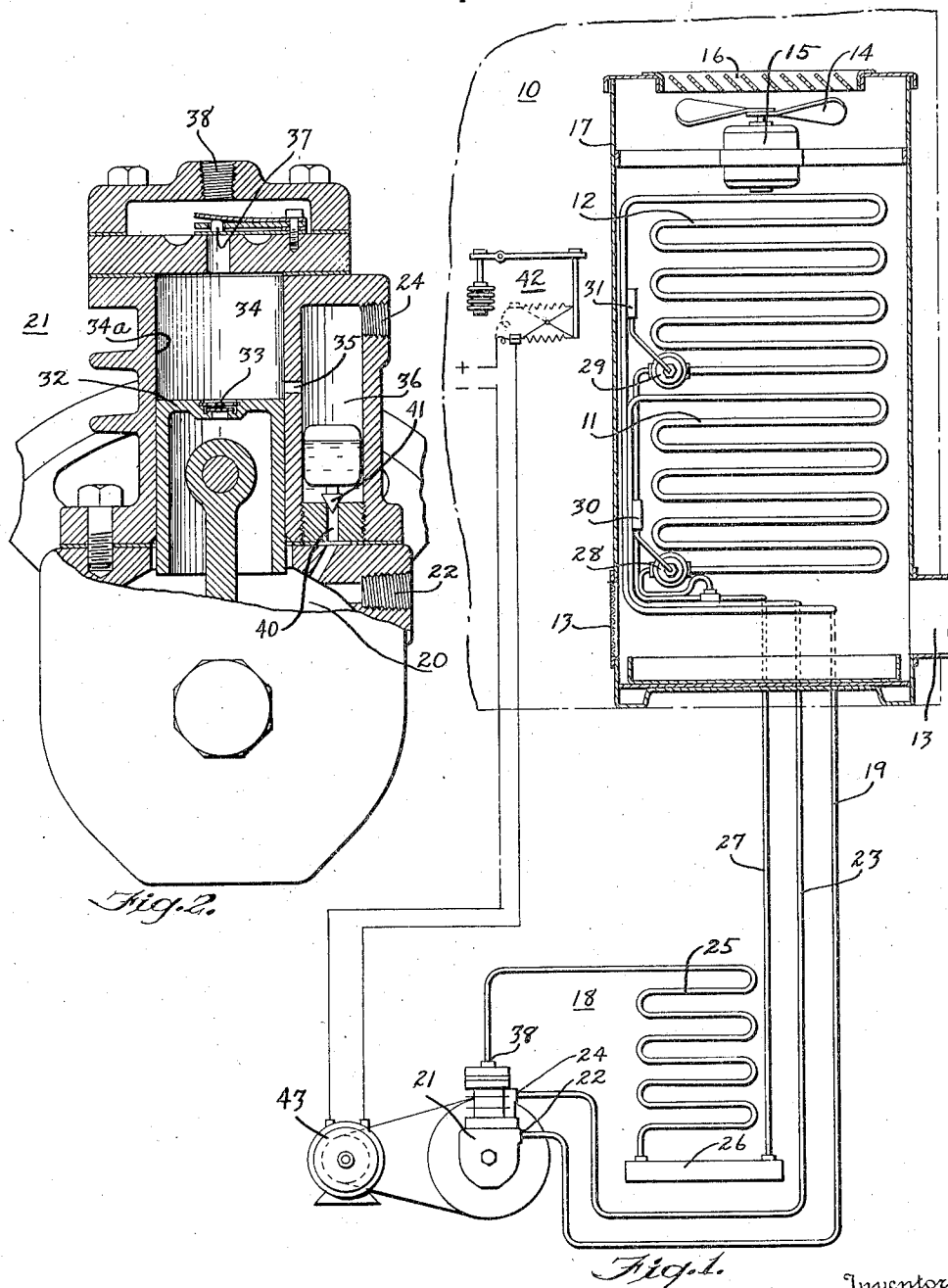


Fig. 1.

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REFRIGERATING APPARATUS

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11 Claims. (Cl. 62—115)

This invention relates to refrigeration.

An object of this invention is to provide an improved method and apparatus for conditioning air or the like in which a portion of the heat is removed from the air by a refrigerant evaporating at a relatively high temperature and in which another portion of the heat is removed from the air by a refrigerant evaporating at a relatively lower temperature in a manner to enhance very materially the efficiency and economy of operation.

It is another object of this invention to provide a method and apparatus for conditioning air or the like by thermal exchange with two or more evaporators maintained at different refrigerant pressures and utilizing the refrigerant from the higher pressure evaporator or evaporators to aid in relieving the vaporized refrigerant from the lower pressure evaporator or evaporators.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing, wherein a preferred form of the present invention is clearly shown.

In the drawing:

Fig. 1 is a diagrammatic representation of an apparatus embodying features of my invention; and

Fig. 2 is a view, partly in elevation and partly in cross-section, of a compressor for use in the apparatus shown in Fig. 1.

In practicing my invention, air or the like for the enclosure 10 is thermally contacted with two or more evaporators 11 and 12 preferably causing the air to flow in series relationship in thermal contact with the evaporators. The air to be conditioned may enter through an inlet 13 either from the enclosure 10, or from outside of the enclosure, or both, and is caused to flow in thermal contact with the evaporators 11 and 12 under the impulse of the fan 14 driven by a motor 15, the air being discharged into enclosure 10 through the outlet 16 of casing 17 which contains the evaporator and the fan.

The evaporators 11 and 12 are connected with a refrigerant liquefying unit 18 in such a manner that the evaporator 11 is maintained at a relatively high evaporator pressure or temperature and the evaporator 12 is maintained at a relatively low evaporating pressure or temperature. To this end the evaporator 12 is connected through a suction line 19 with a low pressure portion or crank case 20 of the compressor 21 through the compressor low pressure inlet 22. The evaporator 11, which is to be maintained at

a relatively high evaporating pressure with respect to the evaporator 12, is connected through the suction line 23 with the inlet 24 of the compressor 21 in such a manner that the vaporized refrigerant from the evaporator 11 is utilized to aid in compressing and relieving the vaporized refrigerant from evaporator 12. The refrigerant from evaporators 11 and 12 is co-mingled and compressed in the compressor 21 and is discharged into the condenser 25 where it is relieved or stored in the liquid refrigerant receiver 26 from whence it flows through the liquid refrigerant line 27 to the evaporators 11 and 12, flowing through the automatic expansion valves 28 and 29 respectively. The automatic expansion valve 28 preferably is of the type which automatically opens and admits liquid refrigerant into the evaporator 11 when the pressure therein is reduced below a predetermined pressure limit. However, the suction line 23 near the outlet of the evaporator 11 is in thermal contact with a thermostatic bulb 30 which is connected with the control or diaphragm of valve 28 in such a manner that when the liquid refrigerant tends to "spill over" from the evaporator 11 the valve 28 is throttled notwithstanding the fact that the pressure therein may be below the predetermined limit heretofore described.

The valve 29 is an automatic valve preferably similar to the valve 28 and is provided with a thermostatic bulb 31 in thermal contact with the suction line 19 near the outlet of the evaporator 12. The calibration of the valve 29 is such that it opens at a predetermined lower pressure limit than the valve 28, and the thermostatic bulb 31 tends to throttle the valve 29 if the evaporator 12 tends to "spill over".

The compressor 21 is constructed so that the vapors from the evaporator 11 are utilized to aid in compressing the vapors from evaporator 12. Thus, if compressor is of the reciprocating piston type, the piston 32 is provided with an intake or check valve 33 such that, on the down stroke, vapors from the low pressure portion of the crankcase 20 enter the compression chamber 34 in the cylinder 34a. When the piston 32 reaches the lower limit of the stroke or is near the lower limit, it uncovers a port 35 which connects the compression chamber 34 with the oil separating chamber 36, which is connected with the suction line 23 through the inlet 24 to the evaporator 11. When this occurs, the relatively high pressure vapor from the evaporator 11 flows through the port 35 into the compression chamber 34 and, because of its higher pressure, partially com-

presses the vapors from the evaporator 12. Thereafter the piston 32 completes the compression of co-mingled vapors to a condensing pressure by the upward stroke, and the vapors are discharged through the check valve 37 through the compressor outlet 38 into the condenser 25.

In the type of compressor shown in Fig. 2, lubricant for the compressor is generally maintained in the lower part or sump of the crankcase 20 from which it is splashed to the moving parts of the compressor. It is desirable to return to the crankcase any lubricant which is carried into the evaporators. The lubricant which goes to the evaporator 12 and is returned through the suction line 19, naturally separates and falls into the lower part or sump of the crankcase. The lubricant which flows to the evaporator 11 and returns through the line 23 is separated from the refrigerant vapor in the separator chamber 36. Here the lubricant is permitted to flow through the passage 40 into the crankcase 20 through the medium of an automatic oil pressure reducing valve such as float valve 41 which opens as the lubricant level in the chamber 36 rises above a predetermined point.

Means are provided for controlling the compressor 21 or its compressing action in accordance with conditions produced by either or both the evaporators 11 and 12. Thus thermostatic switch 42, responsive to either, or both, the dry bulb or wet bulb temperature of the air in compartment 10 starts and stops the motor 43 which drives the compressor 21, and maintains the desired conditions in the compartment 10.

From the above it will be seen that a portion of the heat from the air is removed in the evaporator 11 at a relatively high temperature, and thus a substantial portion of the refrigerating load is performed under a relatively short evaporator-condenser temperature gradient. The final low temperature of air only needs to be imparted by the evaporator 12. This mode of operation greatly increases the efficiency and cost of operation, and greatly increases the refrigerating or air conditioning capacity of the system.

While the form of embodiment of the invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. Refrigerating apparatus comprising a relatively high pressure evaporator, a relatively low pressure evaporator, a compressor having a low pressure portion connected to said relatively low pressure evaporator and to a lubricant sump, said compressor having a piston and compression chamber and means for causing flow of refrigerant vapor from said relatively low pressure evaporator into said compression chamber during the suction cycle of said piston, a lubricant separator connected to said relatively high pressure evaporator and to said compressor and having a pressure reducing valve connected to said lubricant sump, means causing flow of refrigerant vapor from said relatively high pressure evaporator to said compression chamber near the end of the suction cycle of said piston, and condensing means connected to said compressor and said evaporators.

2. Refrigerating apparatus comprising a first evaporator, a second evaporator, a compressor having a crank case connected to said second evaporator, said compressor having a cylinder and reciprocating piston having an intake valve con-

nected to said crankcase, an oil separator connected to said first evaporator and having an automatic oil pressure reducing means connected to said crankcase, an inlet port in said cylinder covered and uncovered by said piston and connected to said first evaporator, and condensing means connected to said compressor and evaporators.

3. Refrigerating apparatus comprising a first evaporator, a second evaporator, a compressor having a crank case connected to said second evaporator, said compressor having a cylinder and reciprocating piston having an intake valve connected to said crankcase, an oil separator connected to said first evaporator and having a float controlled oil valve connected to said crankcase, an inlet port in said cylinder covered and uncovered by said piston and connected to said first evaporator, and condensing means connected to said compressor and evaporators.

4. Refrigerating apparatus comprising a first evaporator, a second evaporator, a compressor having a crank case connected to said second evaporator, said compressor having a cylinder and reciprocating piston having an intake valve connected to said crankcase, an oil separator connected to said first evaporator and having an automatic oil pressure reducing means connected to said crankcase, an inlet port in said cylinder covered and uncovered by said piston and connected to said first evaporator, condensing means connected to said compressor and evaporators and means automatically responsive to conditions produced by at least one of said evaporators for controlling the operation of said compressor.

5. Refrigerating apparatus comprising a first evaporator, a second evaporator, means for thermally contacting said evaporators in series with an air stream to be conditioned, a compressor having a crankcase connected to said second evaporator, said compressor having a cylinder and reciprocating piston having an intake valve connected to said crankcase, an oil separator connected to said first evaporator and having an automatic oil pressure reducing means connected to said crankcase, an inlet port in said cylinder covered and uncovered by said piston and connected to said first evaporator, and condensing means connected to said compressor and evaporators.

6. A refrigerating apparatus comprising a relatively high pressure refrigerant evaporator, a relatively low pressure refrigerant evaporator, a compressor withdrawing refrigerant vapor and lubricant from said second named evaporator, said compressor having means for withdrawing refrigerant vapor and lubricant from said first named evaporator and partially compressing the vapor from said second named evaporator with the vapor from said first named evaporator, said compressor having means for completely compressing said vapors to a condensing pressure, means for separating the lubricant from the vapor from one of said evaporators and mixing it with lubricant from the other of said evaporators before compression, and means for condensing the compressed vapors and introducing the condensate thus formed into said evaporators.

7. A refrigerating apparatus comprising a relatively high pressure refrigerant evaporator, a relatively low pressure refrigerant evaporator, a compressor withdrawing refrigerant vapor and lubricant from said second named evaporator, said compressor having means for withdrawing refrigerant vapor and lubricant from said first

named evaporator and partially compressing the vapor from said second named evaporator with the vapor from said first named evaporator, said compressor having means for completely compressing said vapors to a condensing pressure, means including a float controlled valve for separating the lubricant from the vapor from one of said evaporators and mixing it with lubricant from the other of said evaporators before compression, and means for condensing the compressed vapors and introducing the condensate thus formed into said evaporators.

8. A refrigerating apparatus comprising; a relatively high pressure refrigerant evaporator; a relatively low pressure refrigerant evaporator; a compressor having a crankcase, cylinder and piston, said piston having a valved connection with said crankcase, said cylinder having a relatively high pressure intake connected to said high pressure evaporator, said crankcase having a relatively low pressure intake connected to said low pressure evaporator, an oil separator for said high pressure intake, and means automatically introducing separated oil from said separator to said crankcase; and means for condensing the compressed vapors and introducing the condensate thus formed into said evaporators.

9. Refrigerating apparatus comprising a relatively high pressure evaporator, a relatively low pressure evaporator, a compressor having a crankcase, cylinder and piston, said piston having a valved connection with said crankcase, said cylinder having an intake connected with said high pressure evaporator, said crankcase having

an intake connected to said low pressure evaporator, an oil separator for said high pressure intake, means automatically introducing separated oil from said separator to said crankcase, and condensing means connected to said compressor and said evaporators.

10. Refrigerating apparatus comprising a relatively low pressure evaporator, a relatively low pressure evaporator, a compressor having a crankcase, cylinder and piston, said piston having a valved connection with said crankcase, said cylinder having a high pressure intake connected with said high pressure evaporator, said crankcase having a low pressure intake connected with said low pressure evaporator, an oil separator for said high pressure intake, a float controlled valve automatically introducing separated oil from said separator to said crankcase, and condensing means connected to said compressor and said evaporators.

11. Refrigerating apparatus comprising evaporator means, a compressor having a crankcase, cylinder and piston, said piston having a valved connection with said crankcase, said cylinder having a high pressure intake connected with said evaporator means, said crankcase having a low pressure intake connected with said evaporator means, an oil separator for said high pressure intake, means automatically introducing separated oil from said separator to said crankcase, and condensing means connected to said compressor and said evaporator means.

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