

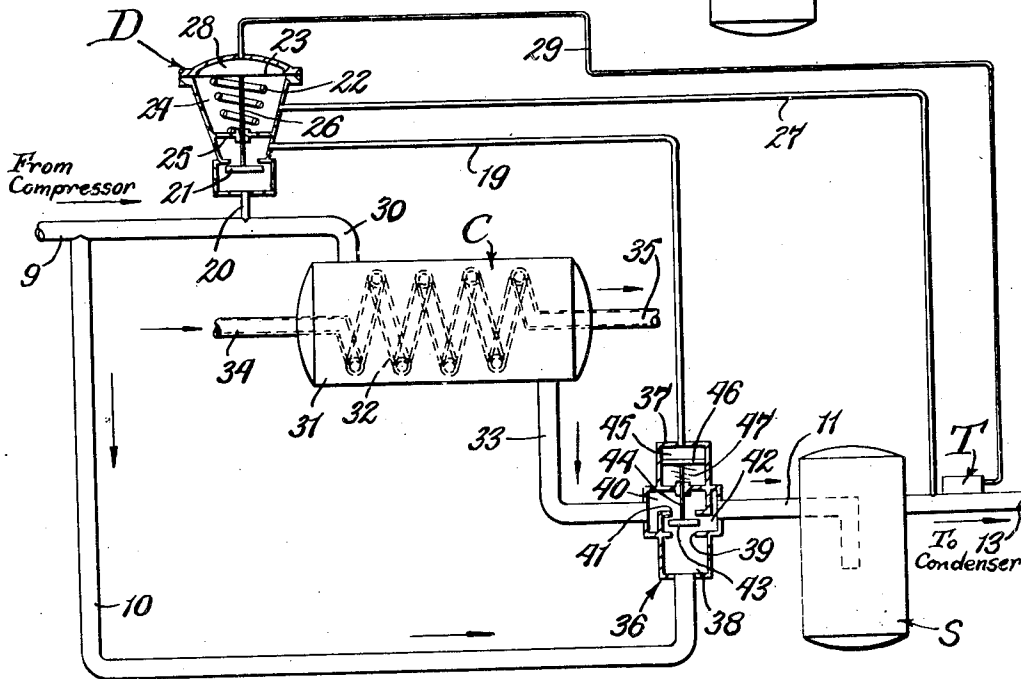
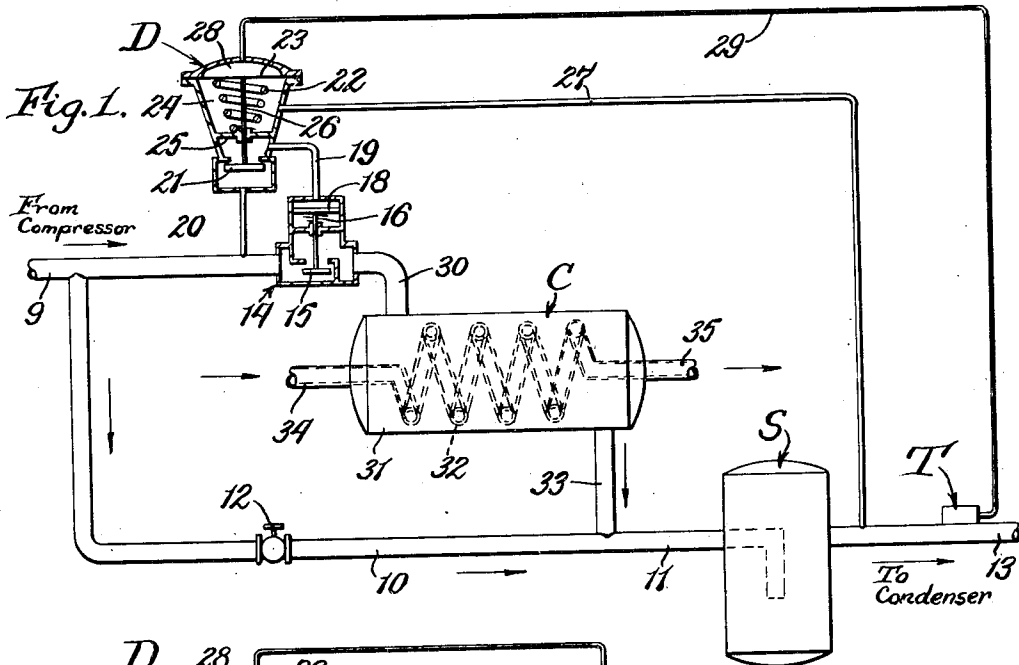
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W. KALS
APPARATUS FOR SEPARATING OIL
FROM REFRIGERANT VAPORS

2,476,044

Filed Dec. 26, 1946

2 Sheets-Sheet 1



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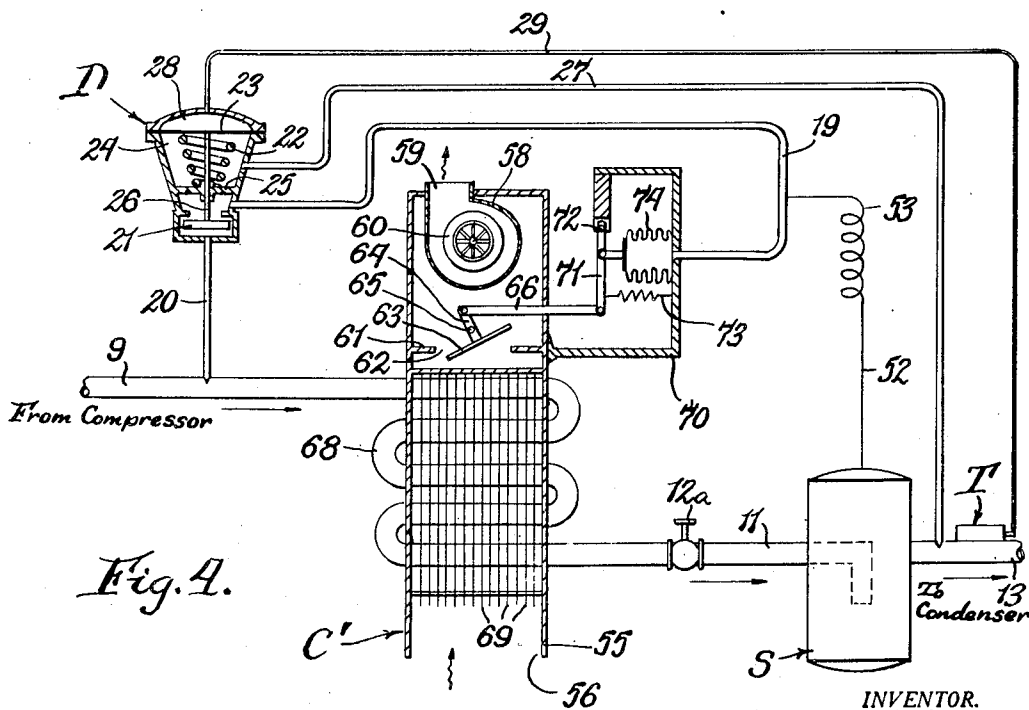
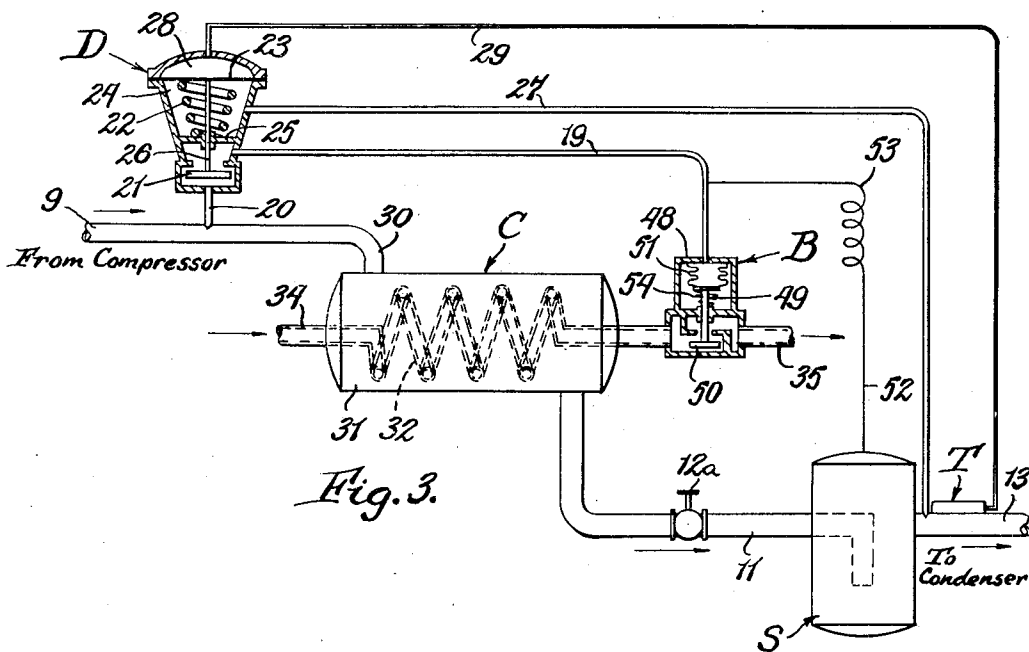
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UNITED STATES PATENT OFFICE

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APPARATUS FOR SEPARATING OIL FROM REFRIGERANT VAPORS

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This invention relates to apparatus for separating oil from refrigerant vapors and more particularly to a superheat control for such oil separation which insures that the refrigerant vapors admitted to the oil separator are at the optimum temperature for oil separation, this being slightly above the condensation temperature thereof and this temperature, of course, changing with the changing condensing pressures of the refrigerant vapors.

In a compressor-condenser-expander refrigeration system, the superheated compressed refrigerant vapor discharged by the compressor carries with it a part of the oil used to lubricate the compressor. This oil is carried from the compressor with the compressed and superheated refrigerant vapor partly in vapor form and partly in the form of finely dispersed drops. The amount of oil so carried over from the compressor depends on the type and construction of the compressor, and also on the kind of refrigerant used. Modern high speed refrigerating compressors will usually discharge a greater amount of oil than the older slow speed type, although some compressors, which are badly worn, will usually pump considerable quantities of oil.

If oil is not properly separated from the refrigerant vapor, it will be carried to the expansion coil or evaporator where it generally causes trouble if in any quantity. With Freon F-12, oil raises the boiling point 1° F. for each 5% of oil present. Not only does the oil so reduce the temperature difference between the refrigerant in the evaporator and the fluid to be cooled, but it also lowers the Freon film heat transfer coefficient.

Freon evaporators are more seriously affected by the presence of oil since oil will mix with liquid Freon. For this reason, a Freon expansion coil is usually fed at the top and is provided with a gravity oil return to the compressor crank case. Further, the gas velocity through the expansion coil is usually kept above 1200 feet per minute. In so called flooded evaporators, which are filled with liquid Freon, oil is not returned to the compressor, but loads up the evaporator with continuously increasing oil concentration. In flooded ammonia evaporators the oil and the liquid ammonia separate so that the oil can be drained off. Even in this case, however, efficient oil separation prior to liquification of the refrigerant is of great value as it reduces the need for servicing the evaporator.

A part of the oil passing through the evaporator is liable to congeal in the expansion coil. The

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coating of oil thus built up on the inner surfaces of the expansion coil not only reduces the heat transfer efficiency of the coil but in time this coating is apt to cake on the expansion coil surfaces so as to permanently impair the heat transfer, this reduction in heat transfer efficiency being progressive.

The usual oil separator installed in the compressor discharge line does not successfully trap the oil because a portion of the oil is present in vapor form and the oil separator depends on impingement of oil drops and hence does not remove the oil vapors. For this reason the superheated refrigerant vapor is frequently precooled before entering the oil separator in order to condense the oil vapor. However, without control, such precooling may cause partial condensation of the refrigerant vapor so that liquid refrigerant as well as liquid oil is trapped in the oil separator. This is particularly harmful in the case of Freon since liquid oil and liquid Freon will mix in the oil separator tank and this mixture cannot be returned to the compressor crank case without causing trouble there.

It is one of the principal objects of the invention to provide means for removing the maximum amount of oil from superheated compressed refrigerant vapor thereby to prevent the oil from being carried into the evaporator.

Another aim is to provide such means for removing the oil from superheated compressed refrigerant vapor which is under accurate control to effect the maximum amount of oil separation under all operating conditions.

Another aim is to effect such control by maintaining a fixed amount of superheat, that is, a fixed temperature difference between the superheated vapor and saturated vapor, at the outlet of the oil separator.

Another aim is to provide such control which is adapted to the use of any cooling medium to precool the refrigerant vapors.

Another object is to accomplish the above with simple and trouble-free apparatus which will stand up under conditions of severe and constant use without requiring adjustment or repair.

Other objects and advantages will appear from the following description and drawings in which:

Fig. 1 is a diagrammatic representation of the compressed refrigerant vapor line between the compressor and condenser of a compressor-condenser-expander refrigeration system and showing the same equipped with an oil separator and control embodying the present invention.

Figs. 2-4 are views similar to Fig. 1, and showing modified forms of the invention.

In the form of the invention shown in Fig. 1, the numeral 9 represents the outlet line direct from the compressor (not shown) of a compressor-condenser-expander refrigeration system and conducting the oil-bearing compressed superheated refrigerant vapors therefrom. This outlet line 9 is connected by a branch or by-pass line 10 with the inlet 11 of an oil separator S of any suitable construction, this branch line 10 also being shown as having a restriction such as a hand valve 12. This restriction is preferably of an order to provide a substantial impedance to the flow of refrigerant vapor through the by-pass or branch line 10. The outlet line 13 from the oil separator leads to the condenser (not shown) of the refrigeration system.

The outlet line 9 direct from the compressor connects with a piston valve 14, the movable valve head 15 of which is shown as seating in the direction of flow of the refrigerant vapor and the valve being normally closed by a helical compression spring 16 acting against the piston 18 of the piston valve. The piston chamber of this piston valve is connected by a control line 19 with the outlet of a normally closed diaphragm valve D. The inlet of this diaphragm valve is connected by a line 20 with the compressor outlet line 9 and its movable valve head 21 is shown as seating in the direction of flow of the refrigerant vapor from the compressor outlet line 9 and as being urged toward its closed position by a helical compression spring 22 acting against the diaphragm 23 of the diaphragm valve. The helical compression spring 22 is confined within a chamber 24 which is isolated from the vapors controlled by the valve by a partition 25 in which the valve rod 26 between the movable valve head 21 and diaphragm 23 is slidingly fitted. The chamber 24 is connected by an equalizing line 27 with the line 13 from the oil separator S. The chamber 28 on the opposite or upper side of the diaphragm 23 is connected by a line 29 with a thermostatic bulb T which is in thermal contact with the line 13 leading to the condenser, as by being clamped to this line or immersed in the vapors flowing therein. The line 29 is preferably in the form of capillary tubing and the thermostatic bulb T is partially charged with liquid refrigerant of the same kind as that handled by the refrigeration system. Thus, if Freon F-12 is used in the refrigeration system, the thermostatic bulb T will also be partially charged with Freon F-12.

The outlet from the piston valve 14 is connected by a line 30 with the shell 31 of a cooler C containing a precooling coil 32 through which a cooling medium of any suitable form flows. The outlet from the shell 31 of the cooler C is connected by a line 33 with the inlet line 11 leading to the oil separator S, this connection being beyond the restriction or hand valve 12. The inlet and outlet connections for the precooling coil C are designated at 34 and 35, respectively. It will be seen that the part of the superheated refrigerant gas passing through the shell of the cooler C is cooled.

In the operation of the form of the invention shown in Fig. 1, the purpose is to maintain a fixed amount of superheat in the refrigerant vapor leaving the oil separator S through the line 13. The saturation temperature of the refrigerant will vary with the prevailing vapor pressure and therefore the present control is designed to compensate for these pressure variations to maintain the vapor temperature in the line 13 from the oil

separator S a fixed number of degrees above the saturation temperature.

To this end the thermostatic bulb T is partially charged with liquid refrigerant of the same kind as is used in the refrigerating system. The vapor pressure exerted by the liquid charge in this bulb will always equal the saturation pressure at the bulb temperature, since liquid will always be present in this bulb. Since this bulb is clamped to or inserted in the line 13 conducting the refrigerant vapor from the oil separator S, the thermostatic bulb T will assume the temperature of the refrigerant vapor passing through this line 13. The vapor over the liquid charge inside of the thermostatic bulb T is always saturated, and if the vapor in the line 13 is saturated as well, the pressures exerted by the vapor in the thermostatic bulb T and the vapor in the line 13 will be equal since the temperatures are equal due to the intimate thermal contact between the thermostatic bulb T and the line 13. If the vapor in the line 13 becomes superheated its pressure will remain unchanged, but the vapor pressure exerted by the bulb will become greater because it will correspond to the saturation pressure at the higher temperature obtaining in the line 13.

Since the unchanged pressure of the line 13 is now applied to the underside of the diaphragm 23 through the equalizing line 27 and the higher vapor pressure of the thermostatic bulb T is now applied to the upper side of this diaphragm through the tubing 29, it will be seen that under this condition the diaphragm 23 is moved downwardly to open the movable valve head 21 of the diaphragm valve D when this pressure difference between lines 29 and 27 is sufficient to overcome the force of the compression spring 22 acting against the diaphragm 23. This opening of the movable valve head 21 admits the refrigerant vapor from the line 9 through the line 20, diaphragm valve D, and control line 19 to the cylinder of the piston valve 14, this moving its piston 18 downwardly to open its movable valve head 15. This permits the refrigerant vapor from line 10 to flow through the piston valve 14, line 30, shell 31 of the cooler C and line 33 into the inlet line 11 of the oil separator S. Conversely, if the diaphragm valve 21 closes and the flow of refrigerant to the cylinder of the piston valve 14 is shut off, the piston valve will gradually move to its closed position since the refrigerant vapor from its cylinder is permitted to bleed into the line 30 through the usual orifices (not shown) provided in a piston valve of this type.

In passing the cooling coil 32 of the cooler C, this refrigerant vapor is cooled. At the same time the impedance offered by the restriction or hand valve 12 will reduce the flow of refrigerant vapor through the branch or by-pass line 10. Hence a greater amount of precooled vapor will be mixed with a smaller amount of uncooled by-passed vapor so as to reduce the superheat of the mixture at the location of the thermostatic valve T.

In this manner the vapor pressure in the thermostatic bulb T is brought into balance with the vapor pressure in the oil separator outlet line 13 plus the force of the spring 22 so that the equilibrium of forces acting on both sides of the diaphragm valve 23 is restored.

It will be seen that this equilibrium is determined by the force of the compression spring 22 and that hence by making the force of this compression spring adjustable an adjustable forced amount of superheat can be maintained in the line 13. The setting of the restriction or hand

valve 12 should be such that with the piston valve 14 in fully open position a preponderance of the refrigerant vapor will pass through the cooler C and only a small amount of the refrigerant vapor will bleed through the by-pass line 10. Conversely, when the piston valve 14 is nearly closed, the restriction or hand valve 12 should not excessively increase the discharge pressure or head at the compressor outlet. Since the nearly closed position of the piston valve 14 will coincide with a low condensing pressure, due to the low temperature of the coolant for both the condenser and the precooler, the increase of this head pressure or discharge pressure due to the restriction or hand valve 12 will be of little consequence.

This restriction or hand valve 12 must, however, be fixed and tamper-proofed so that the branch or by-pass line 10 cannot be completely closed at any time.

It will be seen from the form of the invention shown in Fig. 1 that the control is essentially that of proportioning the relative amounts of refrigerant vapor flowing directly through the cooler C to the oil separator S and through the bypass line 11. It will also be understood that any other usual valve arrangement for regulating the proportions of vapor flowing through the main line and the bypass line could be used, such as three-way valves provided at the juncture of the lines 9 and 10 or at the juncture of the lines 33 and 10.

This form of the invention is illustrated in Fig. 2 in which the three-way valve, designated at 36, is arranged at the juncture of the lines 33 and 10, the body 37 of this three-way valve being shown as having a bottom chamber 38 connected with the line 10 and having an outlet opening surrounded by an upwardly facing valve seat 39, a side chamber 40 connected with the line 33 and having an outlet opening surrounded by a downwardly facing valve seat 41, and a chamber 42 between the valve seats 39 and 41 and connected with the line 11 leading to the oil separator S. A valve head 43 on a vertical valve rod 44 works in the chamber 42 between the two valve seats 39 and 41 so as to seat against one seat or the other, this valve rod extending upwardly through a vertical slideway in the valve body into a piston chamber or cylinder 45. A piston 46 is arranged in this cylinder and is fast to the upper end of the valve rod 44, this piston being biased upwardly by a spring 47. The piston is moved downwardly by pressure from the control line 19 which connects with the cylinder 45 above the piston 46. In other respects the form of the invention shown in Fig. 2 is identical to that shown in Fig. 1 and hence this description is not repeated.

In the operation of the form of the invention shown in Fig. 2, a preponderating vapor pressure in the thermostatic bulb T, caused by a rise in superheat of the refrigerant vapor passing through the line 13, will open the diaphragm valve D to admit refrigerant vapor into the control line 19 and cylinder 45 thereby moving the piston 46 downwardly against the resistance of the spring 47. This movement of the piston 46 causes the valve head 43 to be moved away from the seat 41 and toward the seat 39. This movement of the valve head thereby restricts the flow of refrigerant vapor from the line 10 directly to the line 11 leading to the oil separator S and increases the proportion of refrigerant vapor passing from the cooler C and through the line 33 to the oil separator S. Since a greater proportion of the refrigerant vapor now passing

through the three-way valve 36 into the oil separator S has been cooled in its passage through the cooler C, the superheat in the line 13 is reduced to the setting of the spring 22 of the diaphragm valve D as with the form of the invention shown in Fig. 1.

In the form of the invention shown in Fig. 3, all of the refrigerant vapor from the compressor outlet line 9 passes through the cooler C to the inlet line 11 of the oil separator S, the line 11 being shown as provided with the restriction or hand valve 12a. The form of the invention shown in Fig. 3 also has the thermostatic bulb T in thermal contact with the line 13 leading from the oil separator to the condenser, this connecting in the same manner with the diaphragm valve D which is connected with the lines 9 and 19 in the same manner as with the form of the invention shown in Figs. 1 and 2, this description therefore not being repeated and the same reference numerals being applied. However, the control line 19 connects with a bellows valve B which is shown as arranged in the line 35 through which the cooling medium passes from the cooling coil 32 of the cooler C. This bellows valve B can be of any suitable form and is shown as having a casing 48 slidably supporting a valve rod 49 carrying a movable valve head 50 which seats upwardly to close the valve, and the control line 19 connects with the interior of the bellows 51 which, when expanded, moves the valve head 50 downwardly to open the valve. In addition, a capillary line 52, containing a capillary coil 53, connects the control line 19 with the oil separator S, this capillary coil 53 providing a high impedance in the capillary line 52. The bellows valve B is rendered normally closed by a helical compressor spring 54.

In the operation of the form of the invention shown in Fig. 3, a preponderating vapor pressure in the thermostatic bulb T, caused by a rise in superheat of the refrigerant vapor passing through the line 13, will open the diaphragm valve D to admit refrigerant vapor pressure into the bellows 51 of the bellows valve B and thereby move its movable valve head 50 downwardly to open this valve. In consequence a greater amount of cooling medium is permitted to flow through the coil 32 of the cooler C so as to cool the refrigerant vapor passing through the shell 31 of this cooler to a greater degree. Since the refrigerant vapor is cooled to a lower temperature before being admitted to the oil separator S, the superheat in the line 13 is reduced to the setting of the spring 22 of the diaphragm valve D as with the other forms of the invention shown. The form of the invention shown in Fig. 3 thereby provides a very accurate control of the amount of the superheat in the refrigerant vapor passing from the oil separator S and can be used to regulate the temperature of the refrigerant vapor passing through the oil separator S to a temperature slightly above the condensation temperature thereof regardless of the head pressure in the refrigeration system.

With the construction shown in Fig. 3 the capillary line 52 with its capillary coil 53 is necessary because without this line the prevailing pressure in the line 19 would be sealed therein with the closing of the diaphragm valve D. To overcome this condition and permit closing of the bellows valve B under the influence of its spring 54 when the diaphragm valve D shuts off, the line 52, together with its capillary coil, connects the control line 19 to a point, such as the oil separator S, where a slightly lower pressure prevails than the pilot pressure in line 9, due to the

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pressure drop of the restriction or hand valve 12a. By this connection, when the diaphragm valve D is closed, the pressure within the bellows B is reduced to the slightly lower pressure of the vapor in the oil separator S so that the bellows valve B moves toward its closed position under the influence of its spring 54.

The form of the invention shown in Fig. 4 illustrates a modification in which a forced draft of air is used as the cooling medium in the precooler and in which a damper control is provided for regulating the amount of cooling effected, the system being in other respects similar to that shown in Fig. 3. The cooler C¹, which corresponds to the cooler C in the other forms of the invention, is shown as comprising a rectangular casing 55 which is open at its bottom, as indicated at 56, to provide an air inlet. A fan housing 58 is mounted in the upper part of the casing 55, the inlet of this fan housing being in communication with the interior of the casing so as to exhaust air therefrom, the discharge 59 of the fan housing being shown as directed upwardly through the top of the casing 55. The fan housing houses a fan wheel 60 which can be of any suitable form to effect such movement of the air. Within the casing 55 is arranged a horizontal partition 61 having an opening 62, the effective size of which is controlled by a damper 63. This damper is shown as having an arm 64 which is pivotally mounted on the casing at 65, the extreme end of the arm 64 being connected to a link 66 which extends through the side of the casing 55. The outlet line 9 from the compressor connects with a serpentine coil 68, the horizontal runs of which are arranged in the lower part of the casing 55 and which can be provided with fins or extended surfaces 69 to improve heat transfer. As with the form of the invention shown in Fig. 3, the outlet from the serpentine coil 68 connects with the inlet line 11 of the oil separator S.

For actuating the damper 63, a bracket 70 is shown as secured to the side of the casing 55 and as carrying a depending lever arm 71 which is pivoted at its upper end to this bracket 70, as indicated at 72, and is pivotally connected at its lower end to the outer end of the link 66. A spring 73 between the lower end of this lever arm 71 and the bracket 70 normally holds the damper 63 in its closed position and to move the damper 63 toward its open position a horizontal bellows 74 is mounted on the bracket 70 and has its outer end connected with the central part of the lever arm 71.

Upon introducing pressure in the bellows 74 it will be seen that, through the lever arm 71 and link 66, the damper 63 will be rotated counterclockwise, as viewed in Fig. 4, to open this damper. This pressure is supplied from the control line 19 which connects with the diaphragm valve D in the same manner as in the form of the invention shown in Fig. 3, the other parts of the control system being identical to the form of the invention shown in Fig. 3 and this description hence not being repeated.

In the operation of the form of the invention shown in Fig. 4, a preponderating vapor pressure in the thermostat bulb T, caused by a rise in the superheat of the refrigerant vapor passing through the line 13, will cause the diaphragm valve D to admit refrigerant vapor pressure from line 9 and through the control line 19 into the bellows 74 and thereby expand this bellows. This moves the lever arm 71 to the left, as viewed in

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Fig. 4, thereby to rotate the damper 63 about its pivotal mounting 65 counterclockwise or toward its open position. In consequence, a greater amount of air is drawn upwardly through the casing 55 by the fan wheel 60, this air being drawn upwardly through the inlet 56 of the casing 55 past the serpentine coil 68, through the opening 62 and into the scroll or fan housing 58, from which it is discharged through the outlet 59 of this fan housing. The refrigerant vapor passing through the coil 68 is thereby cooled to a lower temperature before being admitted to the oil separator S, thereby to reduce the amount of superheat in the vapor leaving through the line 13. By this means this superheat can be accurately controlled to provide a temperature within the oil separator slightly above the condensation temperature of the refrigerant vapor regardless of variations in head pressure in the refrigerating system.

As with the form of the invention shown in Fig. 3, a capillary tube 52 with a capillary coil 53 connects the control line 19 with the oil separator S so as to maintain, when the diaphragm valve D is closed, a slightly lower pressure in the bellows 74 than the pilot pressure of the refrigerant gas in the line 9, this insuring accuracy of control since otherwise the fluid sealed within this bellows by the closing of the diaphragm valve D would remain at the same pressure thereby preventing closing of the damper 63 even when the diaphragm valve D shuts off.

From the foregoing it will be seen that the present invention provides a very simple and trouble-free control system which insures the maintenance of a fixed amount of superheat at the outlet of the oil separator and can therefore be used to maintain, within the oil separator, the optimum temperature for oil separation regardless of the changes in the head pressure of the refrigerating system.

I claim:

1. In refrigerating apparatus having an oil separator, means for conducting a stream of superheated oil bearing refrigerant vapor from a compressor and in vapor form through said oil separator, and means for conducting a stream of a cooling medium in heat exchange relation to said stream of oil bearing vapor before entering said oil separator, the combination therewith of means controlling the amount of superheat in the refrigerant vapor leaving said oil separator, comprising a bulb in thermal contact with the refrigerant vapor leaving said oil separator and containing a volatile liquid, a valve actuated by the pressure of the vapor generated by said volatile liquid and having its inlet connected with said stream of refrigerant vapor after leaving said compressor, and valve means actuated by the pressure of said refrigerant vapor at the outlet of said valve and controlling the amount of heat exchange between said stream of refrigerant vapor and stream of cooling medium to control said amount of superheat in the refrigerant vapor leaving said oil separator.

2. In refrigerating apparatus having an oil separator, means for conducting a stream of superheated oil bearing refrigerant vapor from a compressor and in vapor form through said oil separator, and means for conducting a stream of a cooling medium in heat exchange relation to said stream of oil bearing vapor before entering said oil separator, the combination therewith of means controlling the amount of superheat in the refrigerant vapor leaving said oil separator, com-

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prising a bulb in thermal contact with the refrigerant vapor leaving said oil separator and containing a volatile liquid, a valve actuated by the pressure of the vapor generated by said volatile liquid and having its inlet connected with said stream of refrigerant vapor after leaving said compressor, and valve means actuated by the pressure of said refrigerant vapor at the outlet of said valve and controlling the amount of one of said streams brought in thermal contact with the other of said streams thereby to control said amount of superheat in the refrigerant vapor leaving said oil separator.

3. In refrigerating apparatus having an oil separator, means for conducting a stream of superheated oil bearing refrigerant vapor from a compressor and in vapor form through said oil separator, and means for conducting a stream of a cooling medium in heat exchange relation to said stream of oil bearing refrigerant vapor before entering said oil separator, the combination therewith of means controlling the amount of superheat in the refrigerant vapor leaving said oil separator comprising a bulb in thermal contact with the refrigerant vapor leaving said oil separator and containing a volatile liquid, a diaphragm valve having its inlet connected with said stream of refrigerant vapor leaving said compressor, a line connecting said bulb with said diaphragm valve to actuate said diaphragm valve in response to the pressure of the vapor generated by said volatile liquid in said bulb, a piston valve controlling the amount of one of said streams brought in thermal contact with the other of said streams, and a control line connecting the outlet of said diaphragm valve with the piston chamber of said piston valve, thereby to actuate said piston valve in response to the movement of said diaphragm valve.

4. In refrigerating apparatus having an oil separator, means for conducting a superheated stream of oil bearing refrigerant vapor from a compressor and in vapor form through said oil separator, a cooler, means for conducting a part of said stream of superheated oil bearing vapor through said cooler before entering said oil separator, and a bypass line conducting the other part of said stream of refrigerant vapor around said cooler, the combination therewith of means controlling the amount of superheat in the refrigerant vapor leaving said oil separator, comprising a bulb in thermal contact with the refrigerant vapor leaving said oil separator and containing a volatile liquid, a valve actuated by the pressure of the vapor generated by said volatile liquid and having its inlet connected with said stream of refrigerant vapor after leaving said compressor, and valve means actuated by the pressure of said refrigerant vapor at the outlet of said valve and controlling the proportions of said stream of refrigerant vapor passing through said cooler and through said bypass line thereby to control said amount of superheat in the refrigerant vapor leaving said oil separator.

5. In refrigerating apparatus having an oil separator, means for conducting a superheated stream of oil bearing refrigerant vapor from a compressor and in vapor form through said oil separator, a cooler, means for conducting a part of said stream of oil bearing vapor through said cooler before entering said oil separator, and a bypass line conducting the other part of said stream of refrigerant vapor around said cooler, the combination therewith of means controlling the amount of superheat in the refrigerant vapor

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leaving said oil separator, comprising a bulb in thermal contact with the refrigerant vapor leaving said oil separator and containing a volatile liquid, a diaphragm valve having its inlet connected with said stream of refrigerant vapor leaving said compressor, a line connecting said bulb with said diaphragm valve to actuate said diaphragm valve in response to the pressure of the vapor generated by said volatile liquid in said bulb, a piston valve controlling the proportions of said stream of refrigerant vapor passing through said cooler and through said bypass line, and a control line connecting the outlet of said diaphragm valve with the piston chamber of said piston valve, thereby to actuate said piston valve in response to the movement of the said diaphragm valve.

6. In refrigerating apparatus having a cooler, an oil separator, means for conducting a stream of superheated oil bearing refrigerant vapor from a compressor in succession and in vapor form through said cooler and oil separator, and means for conducting a stream of a cooling medium through said cooler, the combination therewith of means controlling the amount of superheat in the refrigerant vapor leaving said oil separator, comprising a bulb in thermal contact with the refrigerant vapor leaving said oil separator and containing a volatile liquid, a valve actuated by the pressure of the vapor generated by said volatile liquid and having its inlet connected with said stream of refrigerant vapor after leaving said compressor, and valve means actuated by the pressure of said refrigerant vapor at the outlet of said valve and controlling the amount of said stream of cooling medium conducted through said cooler, thereby to control said amount of superheat in the refrigerant vapor leaving said oil separator.

7. In refrigerating apparatus having a cooler, an oil separator, means for conducting a stream of superheated oil bearing refrigerant vapor from a compressor in succession and in vapor form through said cooler and oil separator, and means for conducting a stream of a cooling medium through said cooler, the combination therewith of means controlling the amount of superheat in the refrigerant vapor leaving said oil separator, comprising a bulb in thermal contact with the refrigerant vapor leaving said oil separator and containing a volatile liquid, a diaphragm valve having its inlet connected with said stream of refrigerant vapor in advance of said cooler, a line connecting said bulb with said diaphragm valve to actuate said diaphragm valve in response to the pressure of the vapor generated by said volatile liquid in said bulb, a bellows valve controlling the amount of said stream of cooling medium conducted through said cooler, and a control line connecting the outlet of said diaphragm valve with the bellows chamber of said bellows valve, thereby to actuate said bellows valve in response to the movement of said diaphragm valve.

8. In refrigerating apparatus having an oil separator, means for conducting a stream of superheated oil bearing refrigerant from a compressor and in vapor form through said oil separator, and means for conducting a stream of air in heat exchange relation to said stream of oil bearing refrigerant vapor before entering said oil separator, the combination therewith of means controlling the amount of superheat in the refrigerant vapor leaving said oil separator, comprising a bulb in thermal contact with the refrigerant vapor leaving said oil separator and containing a vola-

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tile liquid, a valve actuated by the pressure of the vapor generated by said volatile liquid and having its inlet connected with said stream of refrigerant vapor after leaving said compressor, a damper in said stream of air, and means actuated by the pressure of said refrigerant vapor at the outlet of said valve and controlling said damper thereby to control said amount of superheat in the refrigerant vapor leaving said oil separator.

9. In refrigerating apparatus having a cooling coil, an oil separator, means for conducting a stream of superheated oil bearing refrigerant vapor from a compressor in succession through said cooling coil and oil separator, and means for conducting a stream of air over said cooling coil to absorb heat therefrom, the combination therewith of means controlling the amount of superheat in the refrigerant vapor leaving said oil separator, comprising a bulb in thermal contact with the refrigerant vapor leaving said oil separator and containing a volatile liquid as said re-

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frigerant vapor, a diaphragm valve having its inlet connected with said stream of refrigerant vapor in advance of said cooling coil, a line connecting said bulb with said diaphragm valve to actuate said diaphragm valve in response to the pressure of the vapor generated by said volatile liquid in said bulb, a damper in said stream of air, a bellows operatively connected to said damper to actuate the same, and a control line connecting the outlet of said diaphragm valve with said bellows thereby to actuate said damper in response to the movement of said diaphragm valve.

WALTER KALS.

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