Nov. 25, 1930. J. F. HOFFMAN 1,782,688

REFRIGERATING SYSTEM

Filed Aug. 1, 1927 3 Sheets-Sheet 1

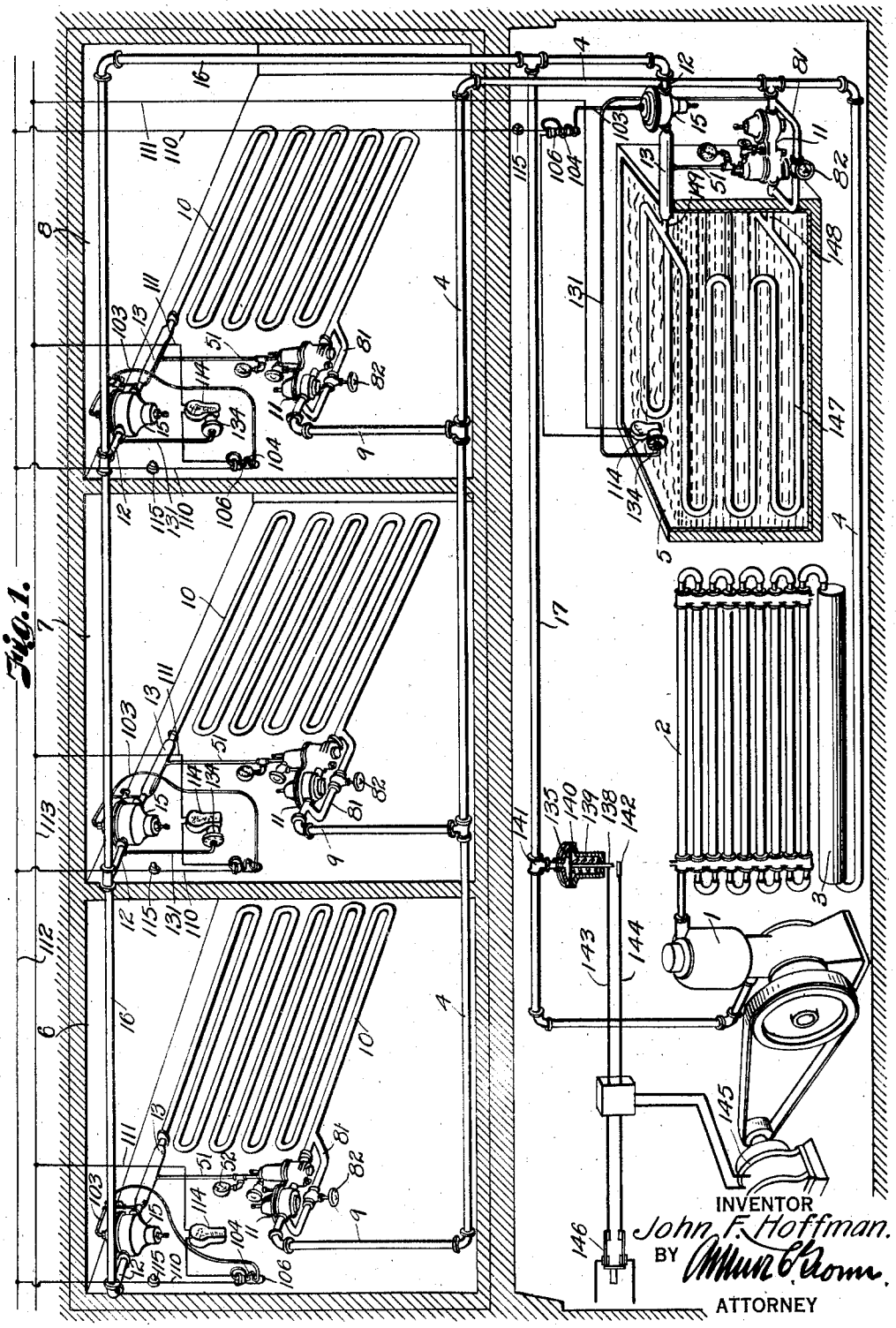


Fig. 1.

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REFRIGERATING SYSTEM

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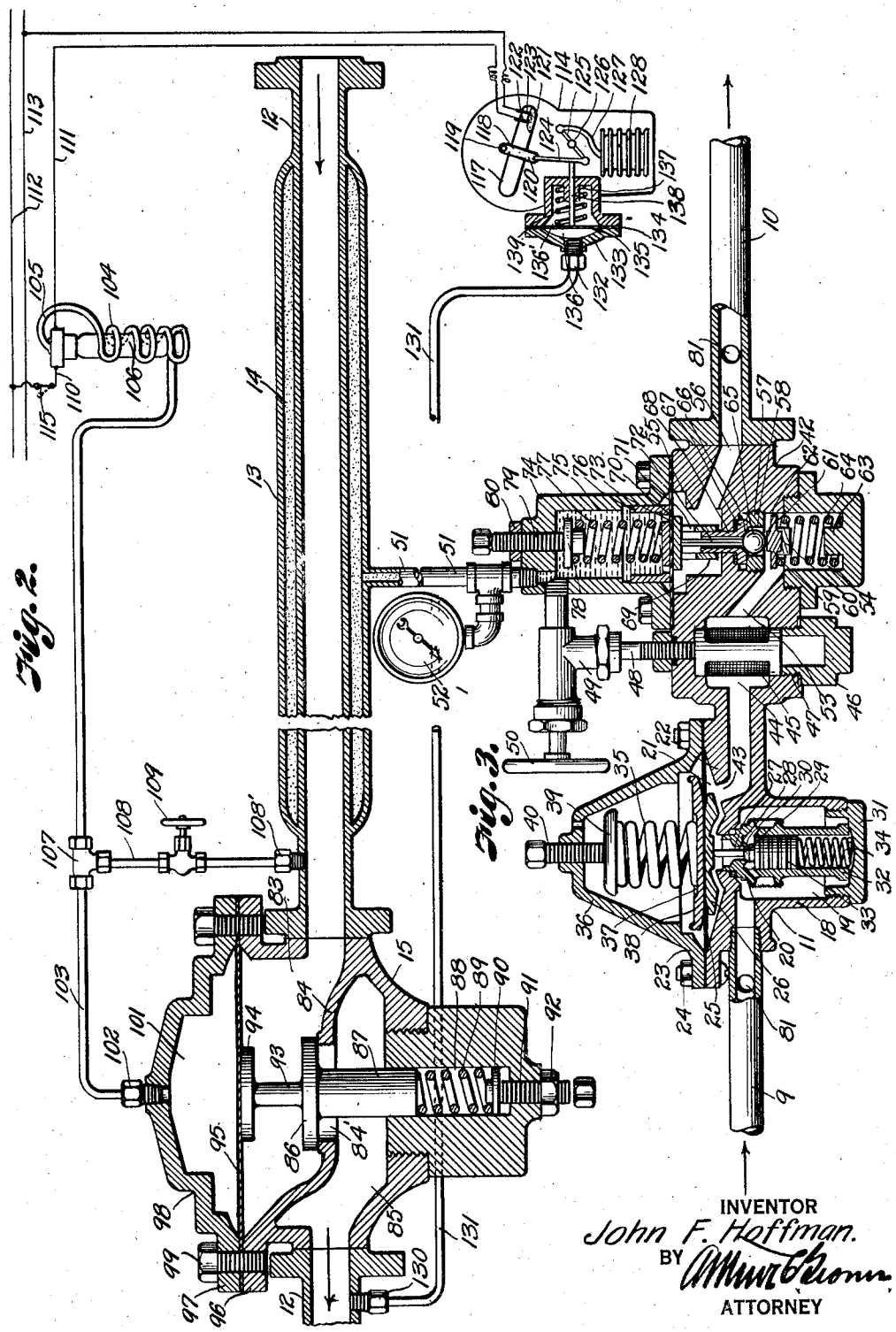


Fig. 2.

Fig. 3.

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REFRIGERATING SYSTEM

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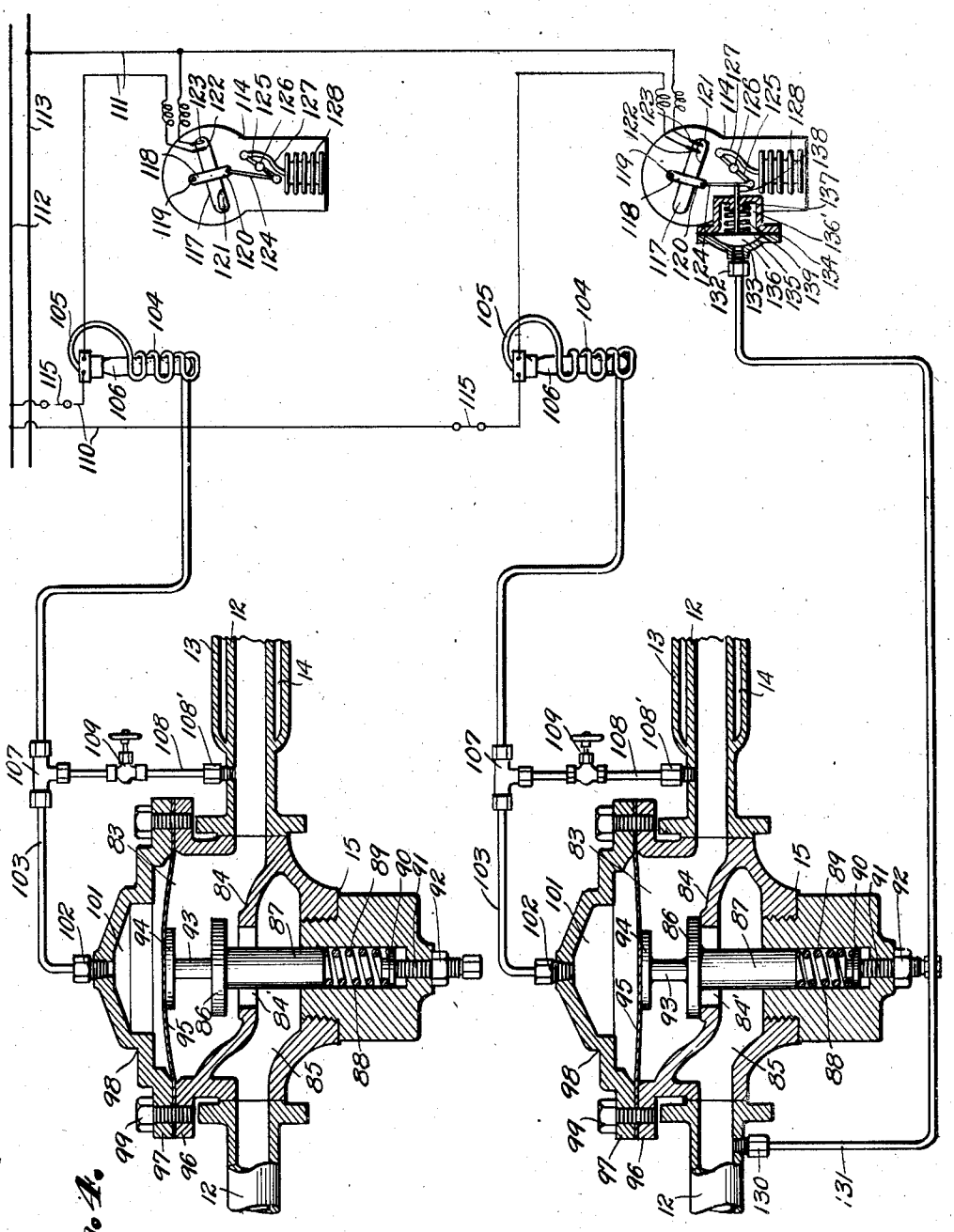


Fig. 1.

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Patented Nov. 25, 1930 1,782,688

UNITED STATES PATENT OFFICE

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REFRIGERATING SYSTEM

Application filed August 1, 1927. Serial No. 209,691.

My invention relates to refrigerating systems and more particularly to one of that class employing ammonia as a refrigeration medium and including a plurality of units for refrigeration in separate compartments wherein different temperatures are to be maintained substantially constant.

It is a principal object of my invention to individually control the units in the separate compartments whereby refrigerant may be supplied to each independently of the other and to automatically connect and disconnect the units with the source of supply in accordance with the temperature conditions in such compartments.

It is a further object of my invention to eliminate reverse cycling of the refrigerant from a unit in a compartment of higher temperature to those units in compartments of lower temperature through the low pressure line.

It is a further object of my invention to provide for major flow of refrigerant to a unit under manual control and limit automatic control to a minor flow sufficient in volume to include load fluctuations.

It is a further object of my invention to effect defrosting of the refrigerating units by reverse cycling of the refrigerating medium.

In accomplishing these and other objects of the invention I have provided a system and apparatus, the preferred form of which is illustrated in the accompanying drawings, wherein

Fig. 1 is a diagrammatic view of a refrigerating system embodying my invention, illustrating the system as including three separate cooling compartments with their refrigerating units, in combination with a source of refrigerant supply and controlling means, and including a unit for indirect refrigeration.

Fig. 2 is an enlarged vertical section of a thermostatically controlled discharge valve forming part of each of the refrigerating units, together with the thermostat controlling elements included in the unit for each low temperature compartment, illustrating the parts as they appear when the thermostat is set by pressure in the suction line to prevent regulation by varying temperature.

Fig. 3 is a vertical section of the thermostatically controlled and back pressure supply valves also included in each of the units.

Fig. 4 is a diagrammatic view of the discharge valves and controls for the coils in the high and next lower temperature compartments of a series, illustrating pressure control of the thermostat in a lower temperature compartment while the high temperature coil is charging.

Referring more in detail to the drawings:

1 designates a type of compressor commonly employed in refrigerating systems, shown as operated from an electrical motor controlled from the system, as will presently be described.

Leading from the compressor 1 is a primary condenser 2 and a receiver 3, both of ordinary construction. Leading from the receiver 3 is a supply line 4 for conducting liquid refrigerant to the various compartments served by the system and which may be tapped to supply an indirect refrigerating coil located in the tank 5, and which will be more specifically referred to following the description of the direct refrigeration.

The compartments numbered 6, 7 and 8 may be insulated compartments commonly found in cold storage warehouses or the like and here shown, for illustration, to be three in number. For further illustration it will be assumed that the temperature of the compartment 6 is to be maintained at about 38° F., the compartment 7 at about 20° F., and the compartment 8 at about 5° F.

As the mechanical construction of the refrigerating unit in each of the compartments is, except as hereafter noted, identical with those in the other compartments, but one will be referred to with the understanding that description of it applies equally to each of the others.

Leading from the line 4 within the compartment 6 is a branch supply line 9, opening to the bottom of a cooling coil 10 through a primary unit control valve mechanism, designated generally by 11 and hereinafter more

specifically described. Leaving the coil 10 at the top is an outlet branch line 12, passing through a thermostatic condenser jacket 13, containing gas, preferably and hereinafter referred to as ammonia gas, 14, whereby the primary control valve mechanism is influenced for the purposes presently mentioned.

Leaving the jacket 13 the line 12 passes into the casing 15 of the remote control back pressure valve mechanism, indicated generally by the numeral 15, and leaves said valve mechanism to enter the return or low pressure line 16 whereby the refrigerating agent is returned to the compressor through a suction line 17.

When the system has been in operation for a sufficient period to reduce the temperature of a compartment to the desired degree indicated by the setting of a thermostat within the compartment, it is necessary or desirable to interrupt flow of refrigerating agent to the cooling coil in such compartment in order to prevent accumulation of an excess of the agent within the coil. This interruption of supply is effected primarily at the valve mechanism 15 at the outlet of the coil. Continued supply of the refrigerant to the opposite end of the coil builds up a pressure within the coil which reacts on a back check valve in the supply control mechanism 11 and which is preferably of the following specific construction.

Interposed in the branch line 9 at the compressor side of said supply control mechanism is a fitting 18 comprising a vertical chamber 19 communicating through a nipple 20 with an enlarged diaphragm chamber 21, formed by the partition 22 and a cap 23 having its rim attached to the body of the fitting by suitable bolts 24 and its inner face chambered to form the upper part of the diaphragm chamber 21.

Extending across the diaphragm chamber with its periphery clamped between the flanges of the body fitting and cap is a flexible diaphragm 25, held securely within the valve case by the bolts 24 which secure the cap to the casing 5. Bearing against the under face of the diaphragm 25 is a reinforcing plate 26 carried by a valve stem 27 which extends through the bore 28 in the nipple 21 and carries a valve head 29 tapered to fit within the valve seat 30 in the lower end of the nipple 21.

The vertical chamber 19 is closed at its lower end by a screw cap 31 and seated on said cap is a cylinder 32 containing a piston 33 urged against the valve head 29 by a spring 34, which seats in the bottom of the cylinder and tends to assist in closing the valve 29 against its seat to exclude refrigerating medium from the diaphragm chamber 21.

Opposing the spring 34 at the opposite side of the diaphragm is a spring 35, housed within a dome 36 constituting part of the cap 23 and seating at its lower end in a cup 37 in a head 38 attached to the upper surface of the diaphragm. At its upper end the spring 35 bears against a plate 39 on an adjusting screw 40, which is threaded into the top of the cap dome and whereby the tension of spring 35 is regulated to predetermine the back pressure at which the valve will close the line and shut off the supply.

The principle upon which refrigerating systems of this character is dependent is the transfer of heat from the compartment to be cooled to the refrigerating agent during passage of the agent through the compartment; consequently, temperature of the agent is higher upon leaving the compartment than upon entering. The agent enters the cooling coil as a saturated vapor and transfer of heat units from the compartment to the agent transforms this vapor into a drier, gaseous condition, which is more favorable for operation of the compressor. Should the agent pass through the compartment without doing any useful work, it would leave the compartment in the same condition at which it entered and in a condition unfavorable for compressor operation. Consequently, it is desirable to eliminate this condition when it may occur.

To effect this elimination I provide the line 9 between the back pressure valve 18 and the cooling coil with a thermostatically controlled valve for diminishing the supply of refrigerating agent to the coil under the condition last above mentioned. This valve is preferably of the construction illustrated in Fig. 3 and indicated generally by the numeral 42, which designates the valve casing. The part of the line leaving the back pressure valve 18 opens from the diaphragm chamber 11 through a port 43 in the partition 22 and opens into a primary chamber 44 in the valve casing 42, containing a screened scale trap 45 for filtering the refrigerating agent in its passage to the cooling coil. The trap 45 rests on the top of a plug 46 in the bottom of the housing and normally closing a cleanout opening 47.

Leading from the top of the chamber 44 is a tube 48 connecting the chamber 44 with a fitting 49, containing a valve (not shown) operable by a hand wheel 50 to control flow of refrigerating medium from the chamber through the fitting. The fitting communicates through a conduit 51 with the condenser jacket 13 on the outlet line from the cooling coil and carries an indicator 52 for disclosing the volume of content of the jacket. It is through this connection that the thermostatic fluid is delivered to the condenser jacket under control of the valve indicated at 15.

Communicating with the chamber 44 through a bore 53 is a chamber 54, which, in turn, communicates with a chamber 55, as will presently be described, and which

chamber 55 communicates with the lower convolution of the coil 10 through a bore 56. Located within the part of chamber 54 above the port of bore 53 is a plate 57 having a central aperture 58. Located in chamber 54 below the plate 57 is a head 59, comprising a depending boss 60, an upstanding boss 61 and an annular flange 62. Seated in the bottom of the chamber 54 about an upstanding boss 63 is a spring 64, supporting the head 59 against a ball 65 within the central aperture 58 in the plate 57 and serving as a valve to control flow of the refrigerating agent from the chamber 54 to the chamber 55. The ball 65 has a seat 66 in the lower head 67 of a nipple 68 that slides in the sleeve 69 of a plate 70 in the chamber 55 and provided with lateral ports 71, whereby liquid from the chamber 54 is delivered from the nipple 68 into the chamber 55.

Located within the bore of the nipple 68 and engaging the plate 70 is a square pin 72 which serves to hold the valve ball 65 downwardly but does not interfere with flow of fluid through the nipple. The plate 70 is fixed on the lower face of a diaphragm 73, held between the top of the valve housing 42 and the valve housing cap 74. The chamber 75 in cap 74 is enlarged at its lower end to contain a spring-retaining cup 76.

Seated within the cup 76 is a coiled spring 77, the upper end of which fits over a cap plug 78 within the upper portion of the cylinder. Extending through the cylinder is a set screw 79 which bears against the cap plug 78 and carries a lock nut 80 whereby the set screw is held in any fixed adjustment to maintain a constant tension on the spring, the screw being packed and held tight to prevent displacement under pressure within the valve and to avoid leakage of the thermostatic medium whereby the diaphragm is operated to effect the automatic control.

The chamber 75 of cap 74 communicates with the condenser jacket 13 through the line 51, one branch of which leads to the chamber from the valve fitting 49 through the side of the cylinder and the other branch of which leads to the chamber from the condenser jacket through the top of the cylinder.

Extending around the supply control valves 18 and 42 is a by-pass conduit 81, provided with a hand valve 82, whereby refrigerating agent may be supplied to the coil in a major flow of substantially sufficient volume to serve the coil and any additional requirements incidental to fluctuations in load supplied under automatic regulation through the back pressure and theremostatically controlled valves.

With the construction above described, should the refrigerating agent pass freely through the cooling coil, temperature in the condenser jacket will be reduced and the contents of the jacket contracted, thereby reducing pressure in the chamber 75 so that the diaphragm 73 is expanded upwardly under tension of the spring 64 and the ball 65 urged to its seat to shut off supply of the refrigerating agent to the coil until temperature in the compartment has raised the temperature of the refrigerating medium in the coil, the thermostatic fluid in the condensing jacket again expanded and the diaphragm returned to its normal position to again open the valve and return the system to its normal operation.

Passing now to the outlet end of the cooling coil and to the remote control for the discharge valve, 83 designates a receiving chamber in the valve housing into which the refrigerating agent is delivered after its passage through the condenser jacket upon leaving the cooling coil. The chamber 83 is formed by a partition 84 having an outlet port 84′ leading to the outlet chamber 85 located in the valve housing below the partition 84 and having open communication with the branch 12 leading to the return line 16. The port 84′ is controlled by a downwardly closing plate valve 86, having a stem 87 extended through the port 84′ into a socket 88 at the bottom of the casing where it seats on a spring 89 supported by a follower disk 90 carried by a set screw 91 operable from the exterior of the casing to adjust tension of spring 89 and held in set position by a lock nut 92. The spring is of sufficient strength to normally lift the valve 86 but will yield to permit the valve to close under the conditions presently described.

Extending from the top of the valve plate is a shank 93, carrying a disk 94 which bears against the under face of a flexible diaphragm 95, extending horizontally across the valve chamber 83, with its periphery located between a flange 96 on the body of the valve casing and a flange 97 on the cap member 98; bolts 99 extending through the flanges and through the diaphragm to securely connect the parts together.

Opening into the chamber 101 in the cap member 98 above the diaphragm 95 through a nipple 102 is a tube 103, constituting the terminal of a thermostatic coil 104, which may be located at any convenient position either within or without the compartment under refrigeration for the reason that it is not dependent upon the compartment temperature but constitutes a primary control subject to a thermostat within the compartment and also to a manual control for initial setting and subsequent cutting-in and out of the refrigeration unit. The coil 104 operates on the principle of the well known Bourdon tube in that its primary end 105 is connected with an electrical heating element, such as a lamp bulb 106, with said primary end and heating element so arranged and mounted

that under relatively high temperature the end 105 will tend to straighten and move the heating element away from the coil, thereby cutting down the heating effect to maintain a predetermined constant temperature of contents of the coil, it being apparent that when the coil is inoperative the heating element will lie closely adjacent the coil so that heat is readily and quickly transferred from the element to the coil and that when the temperature rises, the element is moved away from the coil to reduce the heating effect.

Interposed in the tube 103 is a three-way fitting 107 and leading from the third outlet of the fitting is a tube 108 which opens to the return line 12 of coil 10 through a nipple 108' whereby the coil 104 is supplied with fluid from the return line, the tube 108 being controlled by a valve 109 so that when the coil 104 is filled, the connection may be broken. This connection is provided when ammonia is employed as the thermostatic fluid but I do not wish to limit myself to this particular thermostatic agent.

The heating element 106 is energized from a suitable source of electrical supply through branch lines 110—111 of a lighting or other main circuit lines 112—113. Included in the branch circuit is a thermostatic switch 114 which is located within and subject to changes in temperature of the compartment containing the cooling coil 10 and also included in the main circuit is a manual switch 115, which may be located within the compartment under refrigeration or at any other convenient place.

The thermostatic switch which I prefer to use and which is indicated generally at 114, consists of a mercury tube 117 carried by a clasp 118 which is pivotally mounted on a pin 119, above the tube and has a lower extension 120; the tube being supplied with a charge 121 of mercury and provided with contact points 122 and 123 at its right hand end (Figs. 2 and 4), which are interposed in the branch line 111 leading from the lamp 106 to the main circuit line 113. Connected with the extension 120 is a link 124 which is connected with one end of a lever 125 fulcrumed centrally on a pin 126. Connected with the opposite end of the lever 125 is an elbow link 127, which is connected with a thermostat 128, preferably of bellows type and containing a fluid expansible by heat, so that when temperature rises in the compartment containing the thermostat and the coil it serves, the thermostat expands, rocking the lever 125 to lift the link 124 and tilt the mercury tube to position for flowing the mercury charge away from the contact points and thereby opening the circuit and extinguishing the lamp, permitting contents of the coil 104 to contract and the valve 86 to open under tension of its spring.

When the compartment is cooled to the proper temperature by refrigerant flowing through the coil, the bellows thermostat contracts, shifting the mercury tube to again close the lamp circuit, expand contents of the coil 104 and force the valve 86 closed to cut off flow of refrigerant.

There is a separate thermostatic control of the character described in each of the separate compartments, each control being adjusted to maintain a given temperature within that particular compartment independently of temperature in the other compartments.

When the refrigerating liquid is released into the coils, it expands and absorbs heat from the compartments, the flow continuing until the desired temperatures have been reached in the respective compartments. It is apparent, therefore, that should refrigeration of the three compartments to be cooled respectively to 38°, 20°, and 5°, start with the compartments all at the same initial temperature, flow through the coil in the 38° compartment must be stopped while flow continues through the other two and flow through the 20° compartment stopped while it continues in the third until the latter has cooled to the desired temperature.

When the system is in operation each compartment coil is subject to its own independent conditions and must be controlled independently to maintain the compartment it serves at a constant temperature, the discharge valves of the separate coils opening and closing automatically under control of their thermostats to permit and cut off flow of the refrigerating fluid as required to maintain the temperatures in such compartments.

As the refrigerating liquid is carried back from all of the coils to the compressor through the common return line, pressure of fluid passing through the return line from a coil in a compartment of higher temperature might overcome the valve controlling flow from the coil in a compartment of lower temperature and interfere with proper refrigeration in such lower temperature compartment.

To eliminate such possibility, I provide means, preferably of the construction presently described, for retaining the discharge valve of each lower temperature coil closed while any higher temperature coil is passing refrigerant into the return line.

Tapping the branch line 12 leading from the discharge valve 15 of each lower temperature coil is the nipple 130 of a conduit 131, having a nipple 132 at its opposite end opening through the cap 133 of a pressure relay housing 134 arranged adjacent the thermostat 114 controlling such valve 15. Located within the housing 134 is a diaphragm 135 dividing the interior of the housing into the chambers 136 and 136' and fixed to the diaphragm and extending through the chamber

136 and through a guide boss 137 at the base of the housing is a pusher rod 138 adapted for engaging the link 124 of the thermostat to rock the switch 117 against the tension of bellows 128, break the circuit through the heater 106, and insure closure of the valve 15 so that should refrigerant be flowing to the return line from the coil of one of the higher temperature compartments, it will exert pressure on the switch lever 125 of the lower temperature unit and close the discharge valve of such unit while the higher temperature unit is in operation presently described. The rod is normally restrained and is returned by a spring 139 which seats in the end of the housing, surrounds the boss 137 and rod 138 and bears against the diaphragm 135.

There is a pressure relay like that described in each lower temperature compartment, but none required nor provided in the compartment of highest temperature.

As flow of refrigerant through the coils is interrupted by closure of the discharge valves while the temperatures in the compartments remain within proper ranges, I provide for interruption of operation of the compressor during such periods, preferably employing for that purpose a pressure relay 140 corresponding to those previously described and connected with the suction line 17 by a fitting 141 so that pressure in the return lines resulting from flow from any of the coils will operate the diaphragm 135 and force the pusher bar 138 into contact with a contact member 142. The bar 138 and member 142 are connected respectively with the line wires 143 and 144 of a power circuit supplying the motor 145, so that when there is pressure in the suction line, the circuit is closed and the motor energized to operate the compressor and supply refrigerant to the one or more coils through which flow is required. The power circuit may be manually controlled by a master switch 146 interposed in the circuit.

In order to maintain the several compartments at their respective temperatures, the control mechanisms are set to open the valves in the respective units when the temperatures rise above the determined degrees, the thermostat in the 5° compartment to close its heater circuit following a minimum expansion of its bellows; that in the 20° compartment only after a greater expansion, and that in the 38° only after an expansion greater than that of the thermostat in the compartment of next lower temperature. Likewise the temperatures and pressures of the refrigerant leaving the coils are progressively greater for units in higher temperature compartments, the refrigerant leaving the 38° compartment being as high as thirty pounds, so that when the coil in any higher temperature compartment opens to permit recharging, the coils of all lower temperature units will be automatically closed to prevent back cycling and the power circuit will be closed to start and continue the compressor in operation.

I preferably also include within the system an indirect cooling element; i. e., means for cooling brine which, in turn, is employed as a cooling agent for convenient distribution to other compartments or any location requiring refrigeration or for the manufacture of ice. This indirect element of the system comprises a coil 147 submerged in the brine tank 5, the coil being connected with the supply or high pressure line 4 through a branch 148 and with the return or low pressure line through a branch 149.

Located in the supply line 148 is a back pressure and thermostatically controlled valve mechanism 11 and by-pass 81 and located in the return line is a discharge valve 15, controlled by a thermostat 114 and pressure relay 134 corresponding to those previously described in connection with the direct cooling coils 10; the local thermostat controlling the last-named valve mechanism being of a type adapted for submergence in the brine in the tank 5 and connected with the circuit 112—113, as are the other corresponding thermostatic controlling elements, and which may be set to operate at any desired temperature but need not be equipped with the automatic means for controlling back flow from the suction line as are the higher temperature compartments.

Before installing a system embodying my improvements I first ascertain the capacity necessary for operating the system in order that a condenser of sufficient capacity to supply all of the units when operating at their full capacity may be provided.

Assuming installation of a system including three separate compartments in which the temperatures are to be held respectively at 38°, 20° and 5° F., and that a compressor and condenser as well as unit coils of proper capacity are included in the system, and that an indirect cooling unit is also included in the system, that all of the coils are equipped with individual thermostats, that each of the thermostats except the one in the compartment of highest temperature is equipped with a pressure relay and that the suction line is equipped with a pressure relay for controlling the motor circuit, the operation is as follows:

The hand switches controlling the local thermostat circuits in the several compartments are closed but the temperatures in the compartments being above the working degrees, the local circuits are opened by expansion of the sylphon bellows elements of the thermostats so that no current flows through the heaters 106, and the content of the tubes 103 is not expanded to a degree sufficient to expand the diaphragms in the dis-

charge valves, the springs 89 retaining the discharge valves open to provide for free flow of refrigerant through the coils to the compressor. There being no pressure in the suction line the points 139 and 142 are held out of contact and the motor is inoperative.

The system is then initially charged with refrigerant, building up sufficient pressure in the return line to operate the pressure relays, close the lower temperature coils and start the compressor. The refrigerating agent furnished to the system is compressed and condensed to liquid and the compressed liquid accumulated in the receiver at a temperature corresponding to the pressure at which it was compressed and which we will assume at 90° F. within the receiver.

The by-pass and back pressure valves of the respective units are adjusted to permit free flow of the refrigerant to the units until pressures have been built up in the units sufficient to produce the desired temperatures within the compartments, and the automatic temperature valves 42 in the supply connections to the several units are adjusted so that relatively high temperatures at the discharge ends of the units, such as are present before the refrigerant is supplied to the units when expanded, will exert pressures on the diaphragms 73 tending to open the valves and permit free flow to the units.

Under these conditions when the system is placed in operation refrigerant flows from the compressor to the several units in the system, passing in major flow through the by-passes 81.

As the unit in the compartment of highest temperature is not equipped with a pressure relay, there is no automatic closing of the discharge valve of this unit, and such valve remains open to permit free flow of refrigerant through its coil and back to the compressor.

As refrigerant continues to flow through the coil in the unit serving the compartment of highest temperature, the temperature in the compartment is lowered until the proper degree is reached, at which time the thermostat 114 will shift the mercury tube, closing the local heater circuit, thereby effecting expansion of contents of the coil 104 and expansion of the diaphragm in the discharge valve of such highest temperature unit and closing the valve against the tension of its spring, the local heating circuit remaining closed to maintain the heater in functional condition, and the discharge valve closed until rise in temperature in the compartment reverses the thermostat to again permit the valve to open and refrigerant to flow through the coil to the return line.

When the valve in the unit serving the compartment of highest temperature is closed, pressure in the return line and in the pressure relays controlling the thermostats in the compartments of lower temperatures, are relieved, permitting the pusher rods of such relays to move back under tension of their springs, thereby releasing the thermostats.

When the thermostats in the lower temperature compartments are released, the heating circuits local to such compartment are opened and contents of their coils 104 permitted to contract under influence of the lower temperatures, and the discharge valves in the units of such lower temperature compartments automatically opened so that refrigerant then flows through the coils in such compartments to the return line and back to the compressor.

As the temperature at which the refrigerant leaves the coils for the lower temperature compartments is lower than that of the refrigerant passed to the return line from the highest temperature coil, the pressure generated in the line from the coil in the compartment of next highest temperature is less than that originally present in the line, but not sufficient to affect the pressure relay in such second compartment, although sufficient to operate the pressure relay in the compartment of lowest temperature.

Consequently the thermostat in the second compartment will be unaffected by pressure of refrigerant passed to the return line from the unit in that compartment, but the thermostat in the lowest temperature compartment will be operated by its pressure relay to close its local heater circuit and close its discharge valve thereby preventing back flow of refrigerant into the coil of the lowest temperature compartment from the coil in the second compartment.

Refrigerant then flows through the coil in the second temperature compartment until the proper temperature is reached therein, when the thermostat in that compartment operates to close its local heater circuit, expand contents of the coil 104 and close the discharge valve, thereby stopping the flow of refrigerant and confining the refrigerant in the coil.

As soon as the discharge valve in the second temperature compartment has closed, pressure is relieved in the return line, the pressure relay in the lowest temperature compartment relieves its thermostat, and the thermostat shifts to break its local heater circuit and permit the discharge valve of the unit in that compartment to open, thereby permitting flow of refrigerant through the coil of that compartment and back through the line to the compressor. Flow of refrigerant continues through this coil until the temperature is lowered in its compartment to the proper degree, when the thermostat operates to close the local heater circuit and close the discharge valve.

When the discharge valve of the unit in

the compartment of lowest temperature is closed, pressure in the return line is again relieved and to an extent sufficient to permit the pressure relay on the suction line to operate and open the power circuit, thereby cutting off the compressor until temperature has risen in one or more of the compartments to a degree necessitating recharging of the coil therein.

If the compartment of lowest temperature is the one first requiring recharge, the thermostat in that compartment breaks the local heating circuit, permitting contents of its coil 104 to contract and thereby permitting the discharge valve of the unit in that compartment to open.

When the discharge valve opens refrigerant passing from the coil into the return line creates a pressure in the return line sufficient to shift the weak pressure relay controlling the motor circuit, re-establishing the motor circuit and putting the compressor in operation to deliver refrigerant through the system. The refrigerant leaving the coil in the low temperature compartment at low temperature and pressure will not disturb the pressure relay in the compartment of next highest temperature and the unit in the compartment of highest temperature having no pressure relay, the valves in the higher temperature compartments remain closed while the coil in the lowest temperature compartment is being recharged.

If, during the recharging of the lowest temperature compartment, the thermostat of the unit in one of the higher temperature compartments should operate to open the discharge valve of the unit in such higher temperature compartment, then refrigerant leaving the coil of the higher temperature unit at higher temperature and pressure than that leaving the lowest temperature coil, and at a pressure sufficient to operate the pressure relay of the low temperature compartment, the pressure relay of such lower temperature compartment will be actuated to shift the thermostat in such compartment to close the local heating circuit in that compartment and close the discharge valve of such unit, even though the charging of the coil in such unit has not been completed, thereby preventing back flow of refrigerant from a higher temperature unit into the coil of a lower temperature unit.

It is apparent, therefore, that at no time during the operation of the system can refrigerant pass from any unit of higher temperature back to a unit of lower temperature to raise the temperature of such lower temperature compartment, and that control of all of the units is automatic and individual, so that each compartment is constantly and automatically maintained at its proper individual temperature.

It is further apparent that while the compressor is operable to supply refrigerant to any or all of the units when required, it is automatically shut down except during such periods as its operation is necessary for supply.

When the system is being placed in operation the refrigerant is supplied to the several coils in a major unrestricted flow through the by-passes 81, but after the coils have been initially charged the by-pass may be cut off and further automatic charging effected through the automatic back pressure and regulating valves at the supply end of the units.

When a coil is filled and pressure built up therein to the proper degree, back pressure in the coil operates the back pressure valve and cuts off the supply of refrigerant, thereby controlling flow through the coil at both the intake and outlet ends.

As the refrigerant, in those compartments held at a temperature above the freezing point, passing from the coil to the return line, is at a temperature below that of freezing, any moisture in the compartment served by the coil will settle on and frost the coil. When the unit is automatically cut off through the thermostatic control, the liquid in the coil in a compartment held at a temperature above the freezing point rises in temperature to approach temperature of the compartment and when it passes above the freezing point, tends to melt the frost and remove the frost incrustation.

As this automatic defrosting cannot take place in a compartment held below the freezing point, I provide manually controlled means for effecting defrosting of such units. This manual control includes the by-pass about the back pressure and regulating valves at the intake end of each coil, together with the valve controlling discharge from the unit and which is normally under automatic control of the thermostat 114. When it is desired to defrost one of the low temperature coils, I open the by-pass about the back pressure and regulating valves at the intake end of the coil and open the circuit to the electrical heater 106 so that the thermostatic switch cannot effect opening of the discharge valve. With the unit set in this way, liquid from the receiver 3 is passed into the coil of the set unit and, being unable to pass on to the return line, accumulates in the coil. Being unable to expand and perform its normal refrigerating function and having entered the coil at a temperature of approximately 90°, it is apparent that this high temperature acting on the incrustation on the coil will tend to melt the frost and clean the surface.

Defrosting of any one of the units does not interfere with the normal operation of the other units as the opening of the circuit locally at any of the units will not interfere

with automatic opening and closing of the circuit through the thermostats at the other units.

It is apparent, therefore, that I have provided a refrigerating system wherein independent units served by the system may operate to maintain different temperatures in different compartments without interference one with the other, that such units are automatically controlled by local temperatures and that defrosting of the coils in higher temperature compartments is automatic and that in lower temperature compartments may be effected at will and without interference with the operation of any of the other units.

What I claim and desire to secure by Letters Patent is:—

1. In a refrigerating system, a plurality of independent cooling units, each adapted for serving a separate compartment, single supply and return lines having branches to said units, means controlling flow of refrigerant through the units, including thermostats respectively operable at different temperatures, and means responsive to pressure in the return line controlling some of said thermostats.

2. A refrigerating system, including a plurality of independent evaporator coils, each having an automatic discharge valve at its outlet end responsive to variations in temperature of a compartment served by the coil, supply and return lines, each common to all of the coils, and means local to the discharge valve of one unit and responsive to pressure supplied to the return line from another unit for controlling said valve.

3. A refrigerating system, including a plurality of independent evaporator coils, supply and return lines, each common to all of the coils, means local to each coil and responsive to variations in temperature in a compartment served by the coil, controlling flow of refrigerant through the coil, and means responsive to pressure supplied to the return line from another unit controlling said flow-controlling means.

4. A refrigerating system, including a plurality of independent evaporator coils, supply and return lines, each common to all of the coils, means local to each coil and responsive to variations in temperature in a compartment served by the coil, controlling flow of refrigerant through the coil, and means responsive to pressure supplied to the return line from another coil controlling said flow-controlling means, the temperature and pressure responsive means for the respective coils being characterized to function at different temperatures and pressures.

5. A refrigerating system, including a plurality of independent evaporator coils, each adapted for serving a separate compartment, single supply and return lines having branches to said coils, means controlling flow of refrigerant through the coils, including thermostats for the respective coils responsive at different temperatures, and means responsive to different pressures in the return line controlling the thermostats which are responsive to relatively low temperatures.

6. A refrigerating system, including a plurality of independent evaporator coils, each adapted for serving a separate compartment, single supply and return lines having branches to said coils, means controlling flow of refrigerant through the coils, including thermostats for the respective coils responsive at different temperatures, means responsive to different pressures in the return line controlling the thermostats which are responsive to relatively low temperatures, and means responsive to minimum pressure in the return line controlling flow of refrigerant through the supply line.

7. In combination with an evaporator coil, supply and return lines connected with the coil, a normally open valve in the return line, means for closing the valve, a container for expansible pressure medium in communication with said means, an electric heater for said container, a thermostat controlling said heater, and means responsive to pressure in the return line controlling said thermostat.

8. A refrigerating system, including an evaporator coil for each of a plurality of separate compartments, single supply and return lines for the coils, each coil having an individual, normally open discharge valve at its outlet end, thermostatic means local to each coil for closing the valve in response to lowering temperature, and including an electric circuit provided with a switch, and means local to each coil and responsive to pressure in the return line for actuating said switch independently of thermostatic actuation thereof.

9. A refrigerating system, including an evaporator coil for each of a plurality of separate compartments, single supply and return lines for the coils, each coil having an individual, normally open discharge valve at its outlet end, thermostatic means local to each coil for closing the valve in response to lowering temperature, and including an electric circuit provided with a switch, and means local to each coil and responsive to pressure in the return line for actuating said switch independently of thermostatic actuation thereof, the thermostatic and pressure responsive means of the several coils being characterized to operate at different temperatures and pressures for the purpose set forth.

10. A refrigerating system, including a plurality of independent evaporator coils, each having a yieldingly open discharge valve at its outlet end, single supply and return lines connected with all of the coils, thermostatic means local to each coil for closing its valve, including a local electric cir-

cuit with its switch and lever mechanism for operating the switch, and a pressure relay local to a coil and including a pusher member responsive to pressure in the return line and operable on said lever mechanism to actuate the switch.

11. A refrigerating system, including a plurality of independent evaporator coils, each having a yieldingly open discharge valve at its outlet end, single supply and return lines connected with all of the coils, thermostatic means local to each coil for closing its valve, including a local electric circuit with its switch and lever mechanism for operating the switch, and a pressure relay local to a coil and including a pusher member responsive to pressure in the return line and operable on said lever mechanism to actuate the switch, the thermostatic means for the respective coils of a series being characterized to function at temperatures in a rising scale and the pressure relays to function at pressures in a reverse scale.

12. A refrigerating system, including a plurality of independent evaporator coils, each having a yieldingly open discharge valve at its outlet end, single supply and return lines connected with all of the coils, thermostatic means local to each coil for closing its valve, including a local electric circuit with its switch and lever mechanism for operating the switch, a pressure relay local to a coil and including a pusher member responsive to pressure in the return line and operable on said lever mechanism to actuate the switch, the thermostatic means for the respective coils of a series being characterized to function at temperatures in a rising scale and the pressure relays to function at pressures in a reverse scale, a compressor, means including an electric circuit for operating the compressor, a switch controlling said circuit, and means responsive to pressure in the return line less than that required for operation of the coil relay of lowest scale for operating the switch to open the compressor circuit.

In testimony whereof I affix my signature.

JOHN F. HOFFMAN.