March 9, 1943. A. B. NEWTON 2,313,391

REFRIGERATING SYSTEM

Filed Sept. 28, 1940 2 Sheets-Sheet 1

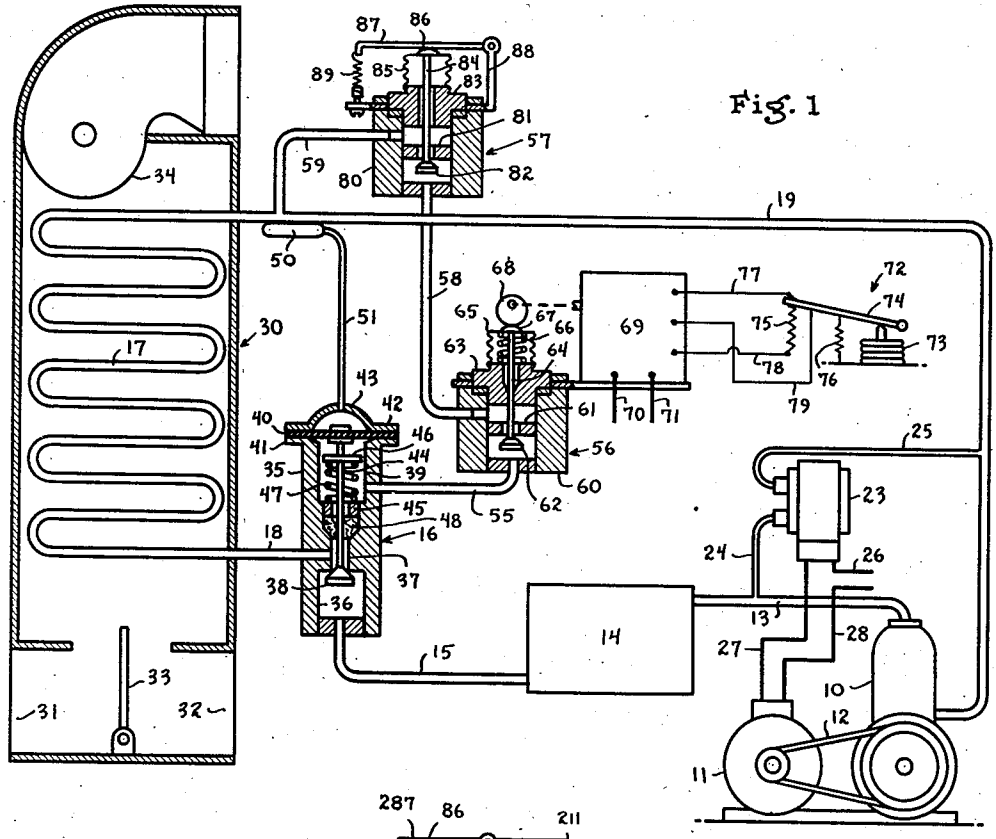


Fig. 1

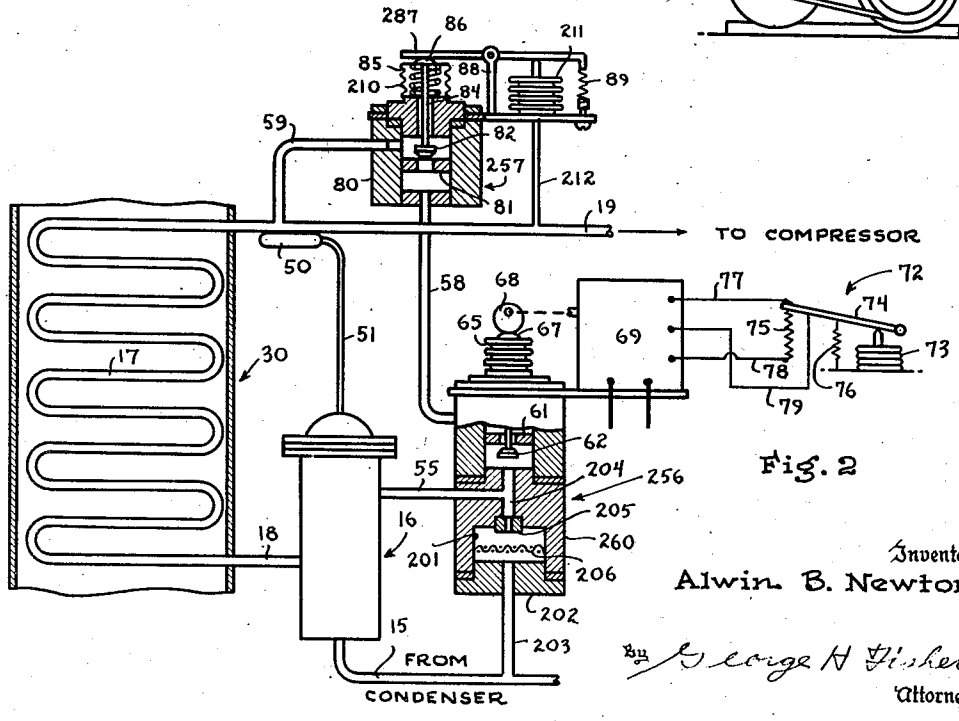


Fig. 2

Inventor
Alwin B. Newton.
By George H. Fisher
Attorney

March 9, 1943. A. B. NEWTON 2,313,391

REFRIGERATING SYSTEM

Filed Sept. 28, 1940 2 Sheets-Sheet 2

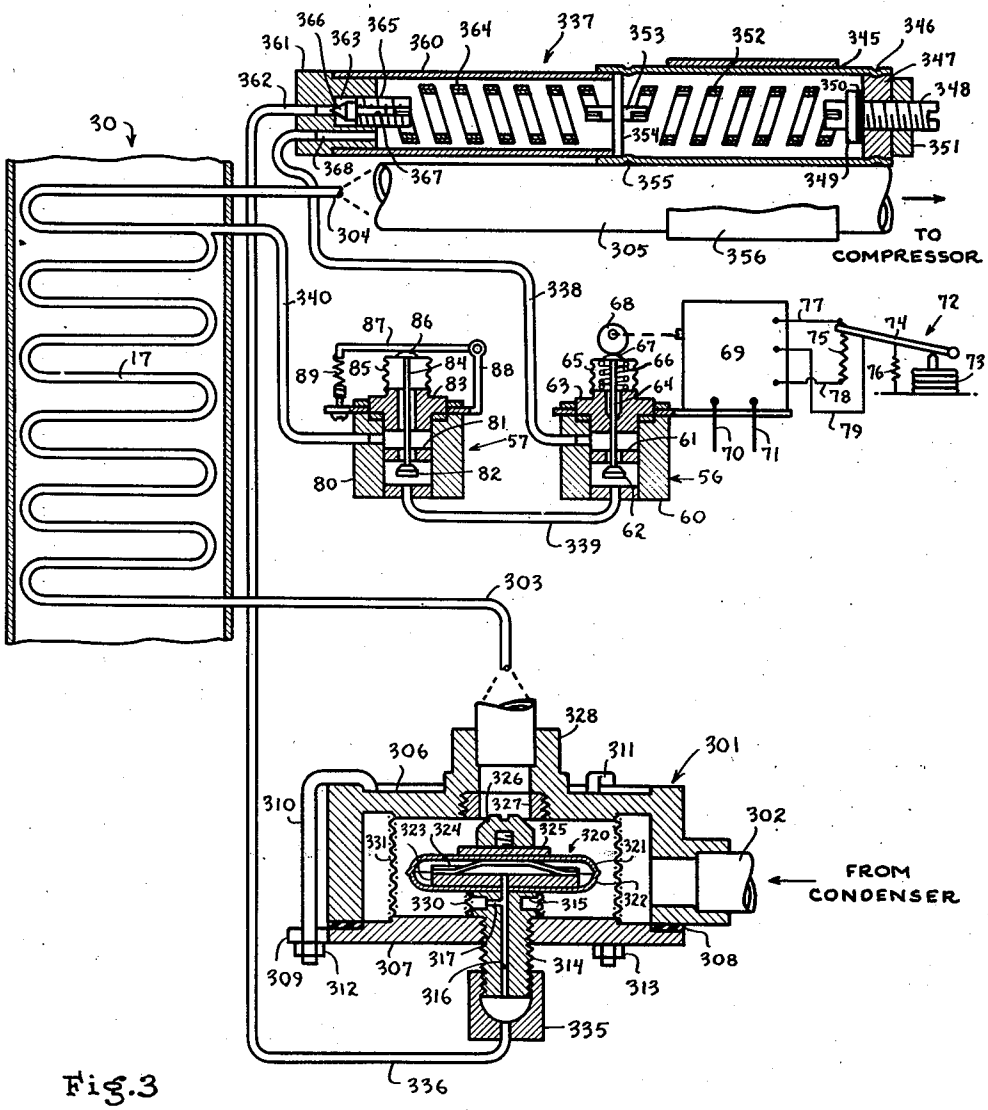


Fig. 3

Inventor
Alwin B. Newton

By George H Fisher
Attorney

Patented Mar. 9, 1943

2,313,391

UNITED STATES PATENT OFFICE

2,313,391

REFRIGERATING SYSTEM

Alwin B. Newton, Minneapolis, Minn., assignor to Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., a corporation of Delaware

Application September 28, 1940, Serial No. 358,781

12 Claims. (Cl. 62—8)

The present invention relates to refrigeration, more particularly to systems of the compression type and it is especially concerned with improved means for preventing high evaporator pressures and consequent heavy loads on the compressor.

The invention disclosed herein is an improvement of the refrigerating systems having superheat control disclosed in my prior applications as follows: Serial No. 243,843 filed December 3, 1938; Serial No. 286,594, filed July 26, 1939, and Serial No. 300,400 filed October 20, 1939. My prior applications show various arrangements for controlling the superheat at the outlet of an evaporator. These arrangements include superheat valves having an equalizer connection, which is a pipe for communicating pressure to the pressure responsive element of the valve, and which may be connected to the evaporator at points having different pressures to vary the superheat to be maintained. These prior arrangements also comprehend a pressure operated expansion valve controlled by a small pilot valve which may be responsive to temperature or superheat.

My present invention comprehends the provision of an additional small valve responsive to evaporator pressure which may be located in the equalizer connection or may act as a supplemental pilot valve to cause the main valve to restrict the flow of refrigerant to the evaporator when evaporator pressure is relatively high, that is under heavy load conditions, to avoid placing unduly great loads on the compressor. This additional valve is therefore normally inactive, its object being to control the pressure acting on the main valve so as to cause the main valve to move toward closed position when the evaporator pressure rises to relatively high values for the reason just pointed out. In this way a very small valve may be used to limit the load placed on the compressor but which valve is inoperative to increase the rate of refrigerant supply beyond the demands of the valves normally in control.

For a complete understanding of my invention and appreciation of the specific manner of attainment of its objects and advantages, reference may be had to the following detailed description and annexed drawings wherein:

Figure 1 represents diagrammatically a refrigerating system embodying one form of my invention;

Figure 2 represents a modified form of the invention, and

Figure 3 represents a second modified form of the invention.

Referring to Figure 1 of the drawings, numeral 10 designates generally the compressor of a compression type refrigeration system. The compressor is driven by an electric motor 11 through a belt 12. The compressor discharges through a pipe 13 into a condenser 14 of usual type. The condenser is connected by a pipe 15 to an expansion valve 16 of the superheat control type and the outlet of the expansion valve 16 is connected to an evaporator coil 17 by a pipe 18. The outlet of the evaporator coil 17 is connected to the suction side of the compressor by a pipe 19.

The compressor motor 11 is controlled by a controller 23 which is identical with the controller disclosed in detail in the application of Albert L. Judson and Carl G. Kronmiller Serial No. 196,447, filed March 17, 1938. Briefly referring to the controller 23, it includes pressure responsive elements responsive to discharge and suction pressure of the compressor, these elements being connected to the discharge pipe 13 and suction pipe 19 by tubes 24 and 25, respectively. The controller 23 embodies switching mechanism which controls the compressor motor 11 through the wires 26, 27 and 28. The operation of the controller 23 is to start the compressor at a predetermined high suction pressure and to stop it at a predetermined relatively lower suction pressure and also to shut down the compressor in the event of occurrence of a relatively high head or discharge pressure.

The evaporator coil 17 forms part of an air conditioning unit designated generally at 30, the unit 30 comprising a longitudinal passageway for air having openings 31 and 32 at its lower portion whereby fresh and recirculated air may be admitted in regulatable quantities for passage over the coil 17. The proportions of fresh and recirculated air may be varied by adjustment of a damper 33. A continuous circulation of air may be enforced through the unit 30 by means of a motor driver fan 34.

The expansion valve 16 includes a body 35 having an inlet chamber 36 to which the pipe 15 from the compressor is connected. Within the body of the valve is a longitudinal throat 37 the lower end of which forms a seat for a valve member 38. The pipe 18 leading to the evaporator 17 is connected to an intermediate portion of the throat 37. The upper part of the valve body 35 forms a chamber 39 which is sealed by a flexible diaphragm 40, the edges of which engage a flange 41 at the upper part of the valve body, the edges of the diaphragm being secured between the flange 41 and a flange 42 on a bulged valve cover 43, the cover being secured to the valve body in any

suitable manner. Numeral 44 designates a valve stem, one end of which is connected to the valve member 38 and the other end of which is suitably secured to the central portion of the diaphragm 40. The valve stem 44 passes through an annular ring 45 within the valve body 35 and near its upper end it carries a disk 46. Interposed between the disk 46 and ring 45 is a coil spring 47 which normally urges the valve stem in an upward direction so as to urge the valve member 38 against its seat. Numeral 48 designates suitable packing around the valve stem 44 between ring 45 and the upper end of throat 37.

The space between the valve cover 43 and the diaphragm 40 is connected to a temperature responsive bulb 50 filled with volatile liquid by means of a tube 51. The bulb 50 is disposed in intimate thermal contact with the outlet of the evaporator coil 17 so as to be responsive to the temperature thereof. The liquid in the bulb 50 vaporizes and develops a pressure proportional to the temperature at the evaporator outlet which is communicated to the chamber on the upper side of diaphragm 40 by tube 51 and acts to urge the diaphragm downwardly.

Pressure on the downstream side of the valve 16 may pass through the packing 48 and ring 45 around the valve stem and into the chamber 39 below the diaphragm 40 so that the lower side of the diaphragm is exposed to pressure within the upper part of the body 35 of the expansion valve. Packing 48 of course limits the flow of refrigerant into chamber 39.

The expansion valve structure as so far described corresponds to superheat control valves well known in the art wherein evaporator pressure acts to urge the expansion valve in closing direction and a pressure corresponding to the temperature of superheated refrigerant at the outlet of the evaporator tends to urge the valve in opening direction. The arrangement of my invention however includes additional structure which will now be described.

Numeral 55 designates a pipe leading from the chamber 39 of valve 16 to a control valve 56. The outlet of the control valve 56 is connected to an additional control valve 57 by a pipe 58 and the outlet of the valve 57 is connected to the suction pipe 19, that is, the pipe leading from the outlet of the evaporator coil 17, by a pipe 59. The connections from the chamber 39 of valve 16 to the evaporator outlet form an equalizer connection for the expansion valve 16 which in itself is a structural detail known in the art.

The valve 56 comprises a casing 60 having an internal partition 61 which has an opening therethrough forming a valve seat for a valve member 62. The upper part of the casing 60 is closed by a suitable member 63 and the stem 64 of the valve member 62 extends through the member 63 and is connected to a collapsible bellows 65, one end of which is secured to the member 63. Within the bellows 65 is a coil spring 66 which acts against the bellows 65 to expand it and to urge the valve stem 64 in closing direction of the valve. On the exterior of the bellows 65 is a knob 67 against which bears a cam 68 which is in the form of an eccentric disk driven by a proportioning motor 69 of the type disclosed in detail in the patent of D. G. Taylor No. 2,028,110. The proportioning motor 69 is supplied with electrical power by wires 70 and 71 and is controlled by a proportioning controller designated at 72. The proportioning controller comprises a temperature responsive bellows 73 filled with a volatile liquid so that it expands and contracts in accordance with the temperature affecting the bellows. The bellows has a stem at its movable end which bears against a pivoted arm 74 which forms a slider cooperating with an electric resistance 75. A coil spring 76 normally urges the arm 74 in a counter-clockwise direction. The ends of the resistance 75 are connected to the proportioning motor 69 by wires 77 and 78 and the arm 74 is connected to the proportioning motor by a wire 79. When the temperature is above a predetermined value, the slider 74 is at the upper end of the resistance 75 as shown on the drawing and the valve 56 is wide open under these circumstances. When the temperature affecting the controller 72 falls below a predetermined value the slider 74 moves downwardly over the resistance 75 causing the motor 69 to operate in a direction to rotate the cam 68 so that it permits the bellows 65 to expand, moving the valve member 62 towards its seat. As the temperature affecting the controller 72 falls, the valve 56 continues to close and becomes fully closed at a predetermined temperature affecting the controller 72, the operation of the proportioning motor 69 in response to the controller 72 being the same as that described in detail in the above referred to Taylor patent.

The valve 57 comprises a casing 80 having an internal partition 81 with an opening therethrough forming a valve seat for a valve member 82. The upper part of the casing 80 is closed by a suitable member 83 having an opening therethrough, through which extends a stem 84 connected to the valve member 82, the upper end of the stem 84 being connected to a collapsible bellows 85 corresponding to that of the valve 56. The bellows 85 has a knob 86 at its movable end and a pivoted lever arm 87 normally engages this knob, the lever arm 87 being pivoted to an arm 88 at one end and being connected at its other end to a coil spring 89 which normally urges the lever 87 in a counter-clockwise direction tending to collapse the bellows 85 and urge the valve member 82 away from its seat. Pressure from within the evaporator coil 17 is free to pass through the pipe 59 into the casing 80 and through the closure member 83 around the valve stem to the interior of the bellows 85. When the pressure within the bellows 85 builds up sufficiently, it is operative to expand the bellows 85 against the force of spring 89 so as to move the valve member 82 against its seat, that is, to closed position.

When the control valves 56 and 57 are in open position there is free communication between the chamber 39 of valve 16 and the outlet of the evaporator and under these circumstances the expansion valve 16 functions in a known manner to maintain a constant degree of superheat at the outlet of the evaporator by maintaining a constant difference between the pressure in chamber 39 and the pressure corresponding to the temperature at bulb 50. There is a given pressure drop through the evaporator coil 17 and with the interior of the chamber 39 in free communication with the oultet of the evaporator the pressure within chamber 39 is lower than it would be if this chamber were exposed to pressure at the inlet of the evaporator. The packing 48 permits a slight amount of leakage around the valve stem 44 from the evaporator inlet into chamber 39 and the equalizer connection. Thus normally there is a small flow of refrigerant from the evaporator inlet through the equalizer connection

through the evaporator outlet. The equalizer connection therefore forms a bleed circuit from the chamber 39 and the function of the control valve 56 is to close off the equalizer connection progressively in response to falling temperature affecting the controller 72 so that as valve 56 closes there is more and more restriction in the equalizer connection causing refrigerant from the inlet of the evaporator to accumulate underneath the diaphragm and to build up a pressure tending to urge valve 16 in closing direction. Thus as valve 56 moves towards closed position valve 16 also moves towards closed position so that refrigerant is admitted to the evaporator at a lower rate and a relatively higher degree of superheat is maintained at the outlet of the evaporator. In other words, the controller 72 and control valve 56 act to control the refrigerating capacity of the evaporating coil 17.

In systems of the type disclosed wherein the capacity of the evaporator is controlled by controlling the superheat at the outlet of the evaporator, there may be times when the cooling load is relatively heavy and under these conditions the evaporator pressure may rise to a relatively high value. Under these circumstances, the compressor is withdrawing relatively dense refrigerant from the evaporator at relatively high pressure, or in other words, it is withdrawing a relatively large weight of refrigerant, that is, the compressor is pumping refrigerant at a high rate such that the compressor motor may become overloaded. Under these circumstances, it is desirable to provide means for reducing the evaporator pressure by restricting the rate of admission of refrigerant to the evaporator. To provide for securing this result, the control valve 57 moves towards closed position when the evaporator pressure rises to a predetermined value at which the bellows 85 is expanded, overcoming the spring 89. As the control valve 57 closes it cuts off the equalizer connection in the same manner as the control valve 56 does when it closes. The effect of this is to cause the pressure to build up underneath the diaphragm 40, in the same manner as when the control valve 56 closes. Thus under heavy load conditions when the compressor motor may become overloaded, the expansion valve is moved towards a fully restricted condition so as to decrease the rate of admission of refrigerant to the evaporator coil so that a relatively higher degree of superheat is maintained at the outlet. In this manner, a very small and inexpensive valve may be employed to prevent the compressor motor from becoming overloaded by reducing the rate of admission of refrigerant to the evaporator coil. This valve under normal operating conditions is open and does not interfere with the superheat control valve or the control by the temperature responsive controller 72.

Referring to Figure 2 of the drawings, the system is essentially the same as that of Figure 1, like numerals designating like elements in the two figures. The embodiment of Figure 2 may include the compressor, condenser, and controller 23 of Figure 1, these parts of the system not being shown on Figure 2. The control valve 256 of Figure 2 is like the valve 56 of Figure 1 except that it provides for metering refrigerant from the high side of the system into the equalizer connection. Its casing 260 has an internal chamber 201 and the lower part of the casing 260 is closed by a member 202. The chamber 201 is in communication with the condenser by means of a branch pipe 203 connected to the pipe 15. The chamber 201 communicates with the inlet side of the valve 62 by means of a chanel 204 having a metering orifice member 205 at its lower end. The pipe 55 from the valve 16 is connected to the channel 204. Numeral 206 designates a filtering screen within the chamber 201. From the foregoing, it will be apparent that high pressure refrigerant may be bled through the metering orifice member 205 into the equalizer connections so that when either of the control valves in the equalizer connection is closed, high pressure refrigerant will bleed through the metering orifice and pipe 55 into the chamber below the diaphragm of valve 16 so as to fully close the valve. This arrangement is described in detail in my prior application referred to above Serial No. 286,594, filed July 26, 1939. In some systems the pressure drop through the evaporator may not be sufficient to provide for complete modulation of the expansion valve, that is to fully closed position. By providing for communication of high pressure refrigerant to the chamber below the diaphragm sufficient pressure will always be available so that the valve may always be modulated to fully closed position if desired.

The control valve 257 of the present embodiment corresponds to the valve 57 of the previous embodiment and operates in the same manner. However, in the present embodiment there is a coil spring 210 within the bellows 85 which urges the bellows in opening direction of the valve. A lever 287 is pivoted near its mid point, one end end of the lever bearing against the knob 86 of the bellows 85 and the other end of the bellows being urged in a counter-clockwise direction by the coil spring 89. Numeral 211 designates a pressure responsive bellows, the interior of which is connected to the suction pipe 19 by a pipe 212. The movable end of the bellows 211 carries a stem acting on the lever arm 287 urging it in a counter-clockwise direction tending to collapse the bellows 85 so as to move the valve in closing direction. Similarly to the operation in the previous embodiment when the pressure within the evaporator and within the pipe 19 rises to a relatively high value, the bellows 211 expands collapsing the bellows 85 and moving the valve 257 to closed position.

The operation of the embodiment of Figure 2 is the same as that of Figure 1 except for the differences pointed out above. Whenever either of the control valves 256 or 257 is fully closed, flow through the equalizer connection is cut off entirely. Under these circumstances, the lower side of the diaphragm within the expansion valve 16 is subjected to the pressure of the high side refrigerant bled through the metering orifice member 205 and through the pipe 55. This high pressure refrigerant accumulating within the chamber 39 serves to fully close the expansion valve. When the flow through the equalizer connection is modulated by either of the control valves, higher pressure is available for closing the expansion valve 16 than is available in the arrangement of Figure 1 wherein high side refrigerant is not metered into the equalizer connection. As pointed out in my prior applications, the arrangement of Figure 2 provides for modulation from zero percent to one hundred percent capacity of the evaporator coil while with the arrangement of Figure 1 normally modulation from approximately 60 per cent to 100 per cent of coil capacity only may be obtained. In Figure 2, as in Figure 1, when the evaporator pres-

sure rises above a predetermined relatively high value the valve 257 cuts off flow through the equalizer connection causing the expansion valve to move towards fully restricting position so that a relatively higher superheat is maintained at the outlet of the evaporator.

Referring to Figure 3 of the drawings, I have shown a system which is like the one disclosed in my prior application referred to above, Serial No. 300,400. The embodiment of Figure 3 includes a compressor and a condenser as in the previous embodiments but which have not been shown on Figure 3, the outlet of the condenser being connected to a pressure operated expansion valve 301 by a pipe 302. The outlet of the expansion valve 301 is connected to an evaporator 17 by a pipe 303 and the evaporator has an outlet pipe 304 which is connected to the suction side of the compressor. A portion 305 of the outlet pipe of the evaporator is shown enlarged for purposes which will presently become apparent.

The expansion valve 301 comprises a generally cylindrical casing 306, the lower part of which is closed by a plate 307, there being a gasket 308 interposed between the plate 307 and the adjacent portions of the casing 306 so as to make the interior of the casing 306 fluid tight. The plate 307 has suitable ears as shown at 309 through which extend hook bolts 310 and 311 having hooks which engage the upper part of the casing 306 and which have nuts 312 and 313 engaging their opposite ends. Numeral 314 designates a screw-threaded nipple member which engages the central part of the plate 307 in screw-threaded relationship. The portion of the nipple 314 within the casing 306 is of slightly larger diameter and it has an annular grooove 315 communicating with a longitudinal orifice 316 in the nipple 314 by means of a transverse channel orifice 317. Secured to the portion of nipple 314 within the casing 306 is an expansible and contractable cell 320 formed by two flexible diaphragms 321 and 322 secured together at their edges. Within the cell 320 is a metal disk 323 of suitable thickness to prevent the cell from completely collapsing so as to avoid overstressing of the diaphragms. Interposed between the disk 323 and the upper diaphragm 321 is a spring member 324 in the form of a spider having a number of fingers which normally urges the cell into expanded position. Secured to the upper diaphragm 321 is a disk 325 having a stud to which is secured a valve head 326. The valve head 326 cooperates with a seat formed by a removable seat member 327 in screw-threaded relationship with the upper part of the casing 306. The outlet of the valve is formed in a boss 328 to which is connected the outlet pipe 303. The orifice 316 extends through the lower diaphragm 322 and disk 323 to the interior of the cell 320. Numeral 330 designates a screen surrounding the portion of the nipple 314 within the casing 306 and covering the groove 315 so that refrigerant entering the groove 315 must pass through the screen. Numeral 331 designates a ring-shaped screen member disposed within the casing 306 so that refrigerant entering through the inlet pipe 302 must pass through the screen 331 before it can come in contact with the cell 320.

Refrigerant which enters the casing 306 is free to pass through the groove 315 and the orifices 317 and 316 to the interior of the cell 320 and the cell 320 expands and contracts in accordance with the pressure of the refrigerant developed therewithin and accordingly moving the valve head 326 toward or away from its seat. A cap 335 engages the nipple 314 in screw-threaded relationship exterior of the casing 306 and a bleed pipe 336 is connected to the cap 335. The pipe 336 is connected to a pilot valve 337 which, as presently described is of the superheat control type. The outlet of the valve 337 is connected by a pipe 338 with a control valve 56 which is the same as the valve 56 of the previous embodiments. The outlet of the valve 56 is connected to a control valve 57 which is the same as the valve 57 of the previous embodiment by a pipe 339. The outlet of the valve 57 is connected to an intermediate point of the evaporator 17 by a pipe 340. As shown on the drawing, the pipe 340 is connected to one of the last passes of the evaporator 17 but it is to be understood that it might be connected to other intermediate points of the evaporator or to the outlet.

From the foregoing, it is apparent that high pressure refrigerant is metered into the interior of the cell 320 and that this refrigerant is bled off from the interior of the cell through the control valves 337, 56 and 57 to the evaporator 17. The valves 56 and 57 operate to control the bleed connection in the same manner as the valves 56 and 57 control the flow through the equalizer connection of the previous embodiments. The valve 57 is responsive to pressure in the bleed connection and closes in response to rise in pressure therein and the valve 56 is operated by the proportioning motor 69 and the controller 72 as in the previous embodiments.

Superheat control valve 337 comprises a tube 345 having a detent 346 at one end which secures an end plug 347 in position. A screw 348 extends through the end plug 347 and near its inner end the screw 348 has a shoulder 349, and between the shoulder 349 and the end plug 347 is a fiber washer or disk 350 to prevent leakage of fluid from within the tube 345 around the screw 348. A lock nut 351 may be provided on the screw 348 external of the tube 345 so that screw 348 may be locked in any adjusted position. The inner end of the screw 348 is slotted so as to receive the end of a helical bimetal element 352 within the tube 345. The opposite end of the bimetal element 352 is engaged in a slot in the end of a pin 353. Pin 353 extends through a disk 354 at the end of the tube 345 which is held in position by a detent 355. The tube 345 is attached securely to the portion 305 of the outlet pipe of the evaporator by a metal strap 356 or other suitable clamping means so that the tube 345 and the portion 305 of the outlet pipe are in intimate thermal engagement whereby the bimetal element 352 is responsive to the temperature of superheated refrigerant in the outlet pipe of the evaporator.

The pilot valve mechanism 337 includes another tube 360, the end of which is telescoped within the tube 345 and its end being in abutting relationship with the disk 354. The opposite end of the tube 360 is closed by an end plug 361 having a bore 362 to which the pipe 336 is connected, and a counterbore 363. Within the tube 360 is another helical bimetal element 364, the right end of which engages in a slot at the end of pin 353 and the left end of which is engaged in a slot in a screw-threaded member 365 which engages the counterbore 363 in screw-threaded relationship. The member 365 carries a valve head 366 which engages with the bore 362. The member 365 has a longitudinal groove

367 so that refrigerant entering through the bore 362 can pass through the groove into the tube 360. There is another bore 368 in the end plug 361 to which is attached the pipe 338.

The valve head 366 is slightly scored so that at least a small amount of refrigerant can always pass through the pipe 336 and the bore 362 and groove 367 to the interior of tube 360. When the valves 56 and 57 are in wide open position, the interior of the tube 360 is in communication with the evaporator by means of the pipes 338, 339 and 340 and the said valves. Thus, the pressure within the tube 360 is substantially the same as that within the evaporator and the temperature within the tube 360 is the vaporization temperature corresponding to the pressure existing at the time within the evaporator. The temperature affecting the bimetal element 364 therefore corresponds to the pressure within the evaporator and the bimetal element 364 therefore operates the valve head 366 responsively to the pressure within the evaporator. The bimetal elements 364 and 352 act in opposition, the bimetal element 364 acting to move the valve member 366 towards its seat when the temperature affecting that element rises and the bimetal element 352 acting to move the valve member 366 away from its seat when the temperature affecting that element rises. When element 364 moves valve member 366 towards its seat, the rate of bleed from within the interior of cell 320 is reduced tending to cause the pressure therewithin to increase and move the valve member 326 towards its seat to restrict the flow of refrigerant to the evaporator. When the bimetal element 352 moves the valve member 366 away from its seat, the rate of bleed from the interior of the cell 320 is increased causing the pressure within the cell to be reduced so that the expansion valve 301 tends to open. Thus it can readily be seen that the pilot valve mechanism 337 controls the expansion valve 301 in accordance with the degree of superheat existing at the outlet of the evaporator 17 inasmuch as the elements 364 and 352 control the expansion valve 301 in accordance with the pressure within the evaporator and the temperature of the superheat at the outlet, increasing evaporator pressures tending to close the expansion valve and increasing temperatures of refrigerant at the outlet of the evaporator tending to open the expansion valve. Or, in other words, a constant difference is maintained between the temperature of saturated refrigerant in the evaporator and superheated refrigerant at the outlet.

The degree of superheat to be maintained may be readily adjusted manually by adjusting the screw 348 to adjust the bimetal elements and the position of the valve head 366.

In normal operation when the control valves 56 and 57 are wide open the pilot valve mechanism 337 controls the superheat at the outlet of the evaporator. As in the previous embodiments however, the capacity of the evaporator may be controlled by the control valve 56. As the temperature affecting the controller 72 tends to fall, moving the slider 74 downwardly over the resistance 75 the valve 56 will move in closing direction tending to obstruct the flow of refrigerant from within tube 360 to the evaporator so that the pressure within the tube 360 will build up to a value higher than the pressure in the evaporator. The pressure within the tube 360 will be higher than the pressure within the evaporator depending upon how far towards closed position the valve 56 is moved. As the pressure within the tube 360 is increased the temperature of the refrigerant therein will correspondingly increase, the vapor within the tube at all times being saturated of course. As the temperature affecting element 364 increases, valve member 366 is moved towards its seat tending to restrict the rate of bleed from within the cell 320. Thus the pressure within cell 320 will increase causing the valve 301 to move towards closed position. From the foregoing it will be seen that as valve 56 is moved towards closed position the temperature affecting element 364 is increased and the pilot valve mechanism 337 will maintain a higher degree of superheat at the outlet of the evaporator. In other words, the valve 56 is effective to control the capacity of the evaporator but the pilot valve mechanism 337 at all times is in control of the superheat at the outlet and maintains the degree of superheat at a constant value which is determined by the valve 56.

As in the previous embodiments, under certain circumstances there may be heavy cooling loads and the pressure within the evaporator will be relatively high tending to place a heavy load on the compressor motor. At these times it is desirable to reduce the capacity of the evaporator by restricting the admission of refrigerant thereto. When the evaporator pressure rises to a predetermined value, the bellows 85 is expanded against the force exerted by spring 89 moving the control valve 57 towards closed position. This action of the control valve 57 will cause the pressure within tube 360 to be increased in the same manner as when the valve 56 moves towards closed position as described above. Thus as the valve 57 closes in the same manner as described above when valve 56 closes the pressure within the cell 320 will build up causing the valve 301 to restrict the flow of refrigerant to the evaporator. If the pressure in the evaporator rises to a given relatively high value causing the valve 57 to completely close, the bleed from within the cell 320 is entirely cut off and the high pressure being metered to the interior of the cell 320 causes the pressure therewithin to build up to such a value as to completely close the expansion valve 301. Thus it is to be seen that the control valve 57 serves to limit the evaporator pressure and to thus limit the capacity of the evaporator and the load which may be placed upon the compressor motor. Normally, however, the valve 57 is in open position and it does not interfere with the control of the expansion valve by the superheat control valve 337 and the temperature responsive valve 56.

From the foregoing, one skilled in the art will appreciate that I have provided a very convenient system wherein a small and inexpensive valve serves to limit the capacity of an evaporator so as to prevent the compressor motor from becoming overloaded. This small supplemental valve is normally inactive and does not interfere with the control of the system from the other control valves which are normally in control.

In the system of Figure 3 float operated pilot valves might be substituted for the valve 337 so as to control the refrigerant supply in accordance with the accumulation of refrigerant in the high or low side of the system. In all the embodiments, a proportioning controller responsive to evaporator pressure might be used in lieu of the pressure responsive valve, this controller be-

ing connected parallel with the controller 72 as to also control valve 56.

In the form of the invention shown in Figure 1 it is within the purview of my invention to provide communication between the inlet of the evaporator and chamber 39 by means of a separate pipe connection. With such a pipe connection the relative effectiveness of the communication between chamber 39 and the inlet and the outlet of the evaporator might be varied by means of a three way valve as in my prior application Serial No. 243,843 referred to above.

hTe embodiments of my invention which I have disclosed are representative of various forms which it may take. Many modifications and changes may be made in the invention and its scope is to be determined not in accordance with my disclosure but only by the claims appended hereto.

I claim as my invention:

1. In a refrigerating system, in combination, an evaporator of a type having a pressure drop between its inlet and outlet, an expansion valve of the superheat control type having a pressure responsive element, means connecting said element and a portion of said evaporator wherein the pressure is lower than at the inlet so as to subject said element to said lower pressure, valve means in said connecting means, and an element responsive to evaporator pressure for maintaining said valve open for all normal evaporator pressures but closing said valve when said evaporator pressure reaches a value indicating that the cooling load is excessive so that the pressure responsive element of said expansion valve is less subject to said lower pressure as said valve means closes off the connecting means.

2. In a refrigerating system, in combination, an evaporator of a type having a pressure drop between its inlet and outlet, an expansion valve of the superheat control type having a pressure responsive element, means connecting said element and a portion of said evaporator wherein the pressure is lower than at the inlet so as to subject said element to said lower pressure, means providing relatively restricted communication between said element and a portion of said evaporator at relatively higher pressure, and valve means in said connecting means having an element responsive to pressure within said connecting means for closing off said last means as the pressure therein increases so that the pressure responsive element of said expansion valve is less subject to said lower pressure as said valve means closes off the connecting means.

3. In a refrigerating system, in combination, an evaporator of a type having a pressure drop between its inlet and outlet, a pressure operated expansion valve having a pressure responsive element, means connecting said element to a portion of said evaporator wherein the pressure is lower than at the inlet so as to expose said element to said lower pressure, said pressure urging said valve in closing direction, a valve in said connecting means, and means responsive to evaporator pressure for maintaining said valve open for all normal variations in evaporator pressure but closing off said connecting means as the evaporator pressure increases above a value indicating an excessive cooling load so that as evaporator pressure increases above such value said element is exposed progressively less and less to said lower pressure causing said expansion valve to move progressively in closing direction irrespective of temperature conditions.

4. In a refrigerating system, in combination, an evaporator of a type having a pressure drop between its inlet and outlet, a pressure operated expansion valve having a pressure responsive element, means connecting said element to a portion of said evaporator wherein the pressure is lower than at the inlet so as to expose said element to said lower pressure, said pressure urging said valve in closing direction, a valve in said connecting means, means responsive substantially to evaporator pressure for maintaining said valve open for all normal variations in evaporator pressure but closing off said connecting means as the evaporator pressure increases above a value indicating an excessive cooling load so that as evaporator pressure increases above such value said element is exposed progressively less and less to said lower pressure causing said expansion valve to move progressively in closing direction irrespective of temperature conditions, and an additional temperature responsive valve in said connecting means for controlling said expansion valve.

5. In a refrigerating system, in combination, an evaporator, of a type having a pressure drop between its inlet and outlet, a pressure operated expansion valve having a pressure motor, means connecting said motor and a portion of said evaporator wherein the pressure is lower than at the inlet, so as to expose said motor to said lower pressure, said pressure tending to move said valve in closing direction, means providing restricted communication between said motor and the upstream side of the expansion valve, a valve in said connecting means responsive substantially to evaporator pressure for closing off said connecting means as evaporator pressure increases whereby pressure accumulates in said motor tending to cause expansion valve to move proportionately in closing direction as evaporator pressure increases, and a valve in said connecting means of a superheat control type responsive to superheat at the outlet of the evaporator controlling said connecting means to control said expansion valve in accordance with superheat.

6. In a refrigerating system, in combination, an evaporator of a type having a pressure drop between its inlet and outlet, a pressure operated expansion valve having a pressure motor, means connecting said motor and a portion of said evaporator wherein the pressure is lower than at the inlet so as to expose said motor to said lower pressure, said pressure tending to move said valve in closing direction, means providing restricted communication between said motor and the upstream side of the expansion valve, a valve in said connecting means responsive substantially to evaporator pressure for closing off said connecting means as evaporator pressure increases to cause said expansion valve to move proportionately in closing direction as evaporator pressure increases, a valve in said connecting means of a superheat control type responsive to superheat at the outlet of the evaporator controlling said connecting means to control said expansion valve in accordance with superheat, and an additional valve responsive to temperature conditions controlling the pressure affecting said pressure motor.

7. In a refrigerating system, in combination, refrigerant supply means, an evaporator and an expansion valve controlling the supply of refrigerant to the evaporator, said expansion valve having pressure responsive operating means, means for conveying pressure from the upstream

side of said valve to said operating means and means for bleeding pressure from said operating means to the downstream side of the valve, pilot valve means controlling the pressure applied to said pressure responsive operating means, and means responsive to evaporator pressure for maintaining said pilot valve means in a position to permit said expansion valve to open wide under all normal evaporator pressures, said evaporator responsive means being arranged to control the pressure on said pressure responsive operating means to cause closure of said expansion valve when said evaporator pressure increases to a value indicating an excessive load on said refrigerant supply means.

8. In a refrigerating system, in combination, refrigerant supply means, an evaporator, and an expansion valve controlling the supply of refrigerant to the evaporator, said expansion valve having pressure responsive operating means, means for conveying pressure from the upstream side of said valve to said operating means and means for bleeding pressure from said operating means to the downstream side of the valve, pilot valve means controlling said bleeding means, said pilot valve means being responsive substantially to evaporator pressure and having means whereby flow through said bleeding means is permitted by said pilot valve means for all normal evaporator pressures but is cut off at predetermined relatively high evporator pressures causing pressure to build up in said operating means, said relatively high evaporator pressures being indicative of an excessive load on said refrigerant supply means, and said operating means being arranged to close said expansion valve when the pressure builds up in said operating means.

9. In a refrigerating system, in combination, refrigerant supply means, an evaporator, and an expansion valve controlling the supply of refrigerant to the evaporator, said expansion valve having pressure responsive operating means, means for conveying pressure from the upstream side of said valve to said operating means and means for bleeding pressure from said operating means to the downstream side of the valve, pilot valve means controlling the pressure applied to said pressure responsive operating means, said pilot valve means being responsive to evaporator pressure and being constructed and arranged to so control the pressure applied to said operating means as to cause said expansion valve to close in response to relatively high predetermined evaporator pressures which indicate an excessive load being placed on the refrigerant supply means and to permit said expansion valve to open for all normal evaporator pressures, and additional temperature responsive valve means controlling the pressure applied to said operating means for controlling said expansion valve.

10. In a refrigerating system, in combination, refrigerant supply means, an evaporator, and an expansion valve controlling the supply of refrigerant to the evaporator, said expansion valve having pressure responsive operating means, means for conveying pressure from the upstream side of said valve to said operating means and means for bleeding pressure from said operating means to the downstream side of the valve, pilot valve means controlling the pressure applied to said pressure responsive operating means, said pilot valve means being responsive to evaporator pressure and being constructed and arranged to so control the pressure applied to said operating means as to cause said expansion valve to close in response to relatively high predetermined evaporator pressures to prevent excessive load being placed on the refrigerant supply means, and valve means responsive to the superheat at the outlet of the evaporator controlling the pressure applied to said operating means for normally controlling said expansion valve.

11. In a refrigerating system, in combination, refrigerant supply means, an evaporator, a main valve in control of the flow of refrigerant from said supply means to said evaporator for maintaining a constant superheat at the outlet of said evaporator, a pressure motor in control of said main valve, a pilot valve in control of the pressure to which said pressure motor is subjected, means responsive to the load on the refrigerating system in control of said pilot valve, and a second pilot valve in control of the pressure to which said pressure motor is subjected, said second pilot valve being responsive to the pressure in the evaporator and being operative only upon a pressure in the evaporator indicative of an excessive cooling load on said refrigerant supply means to control the pressure of said pressure motor in a manner to increase the superheat maintained by said main valve.

12. In apparatus of the character described, in combination, means forming a refrigerating system including a source of refrigerant and an evaporator, valve means comprising an expansion valve adapted to maintain a constant superheat at the outlet of the evaporator for all normal evaporator pressures by controlling the admission of refrigerant thereto, and means responsive to a relatively high evaporator pressure indicative of an excessive cooling load operatively connected with said expansion valve for increasing the superheat maintained thereby.

ALWIN B. NEWTON.