United States Patent

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[54] **CONTROL FOR REFRIGERATION SYSTEMS**
8 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **62/212,** 62/225

[51] **Int. Cl.** **F25b 41/00**

[50] **Field of Search** 62/204, 212, 223, 224, 225, 227

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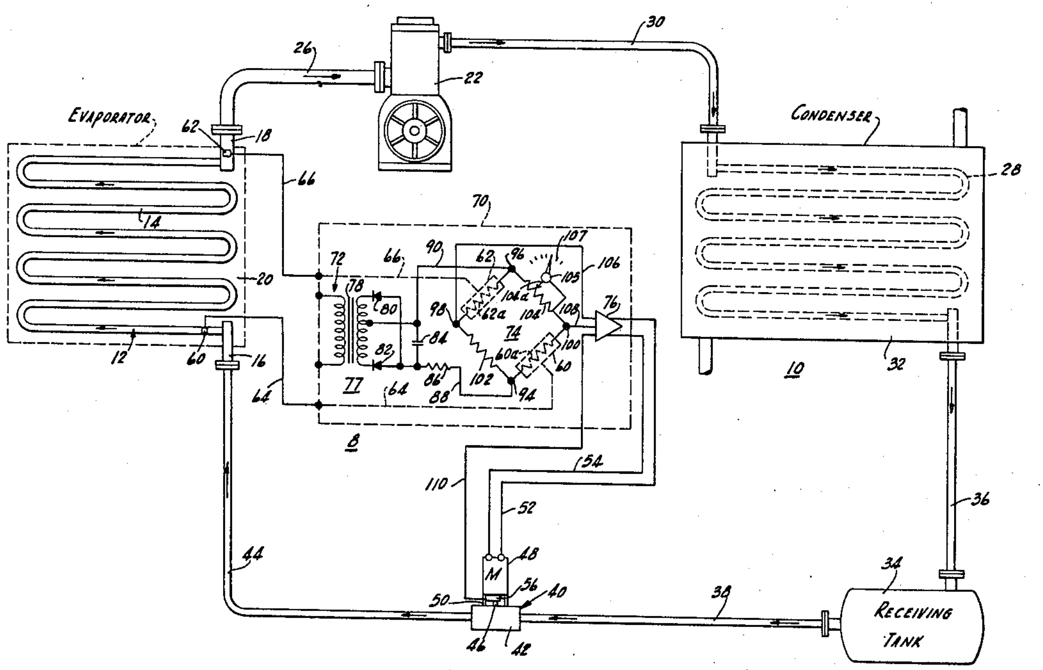
ABSTRACT: A control system for a refrigeration system employs first and second temperature sensors located in the system evaporator to control the superheat condition of the system refrigerant. One temperature sensor senses the temperature of liquid phase refrigerant in the evaporator while the other temperature sensor senses the temperature of gaseous phase refrigerant in the evaporator. The temperature sensors are connected to a differential temperature control means which regulates the system expansion valve in accordance with a desired differential temperature or superheat condition between the liquid and gaseous phase refrigerant.



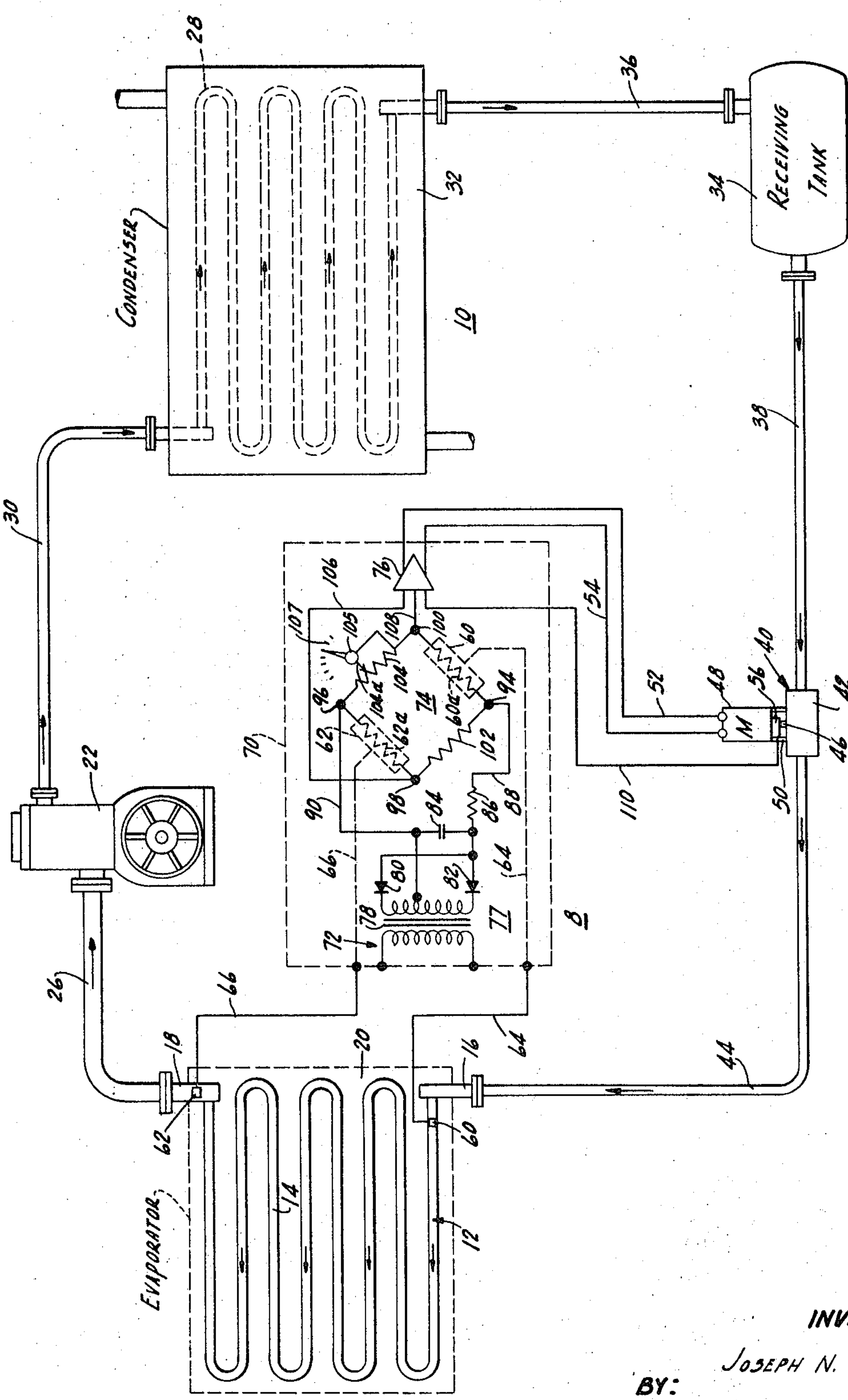


Fig. 1

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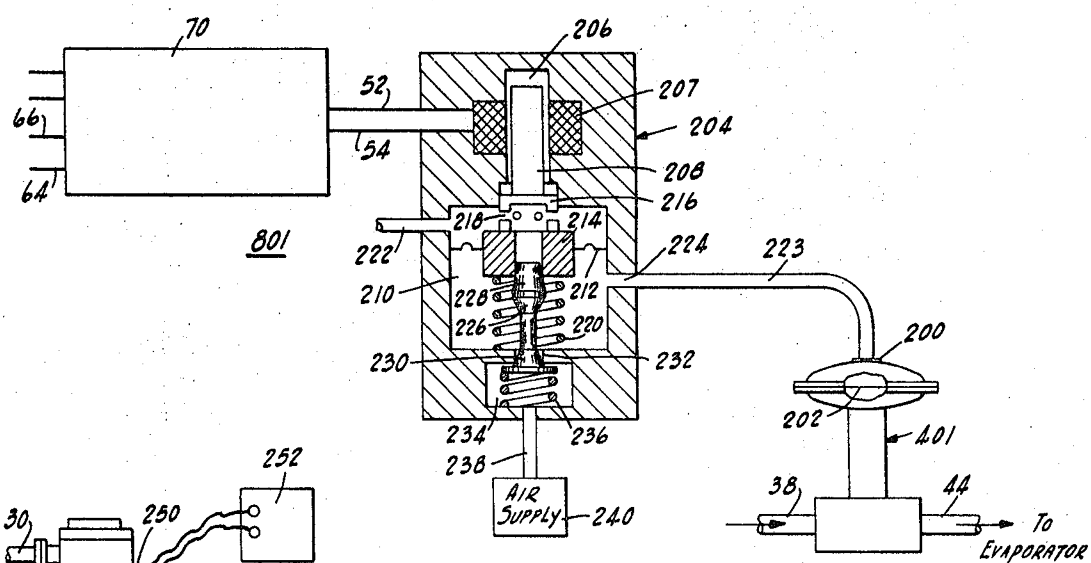

Fig. 2

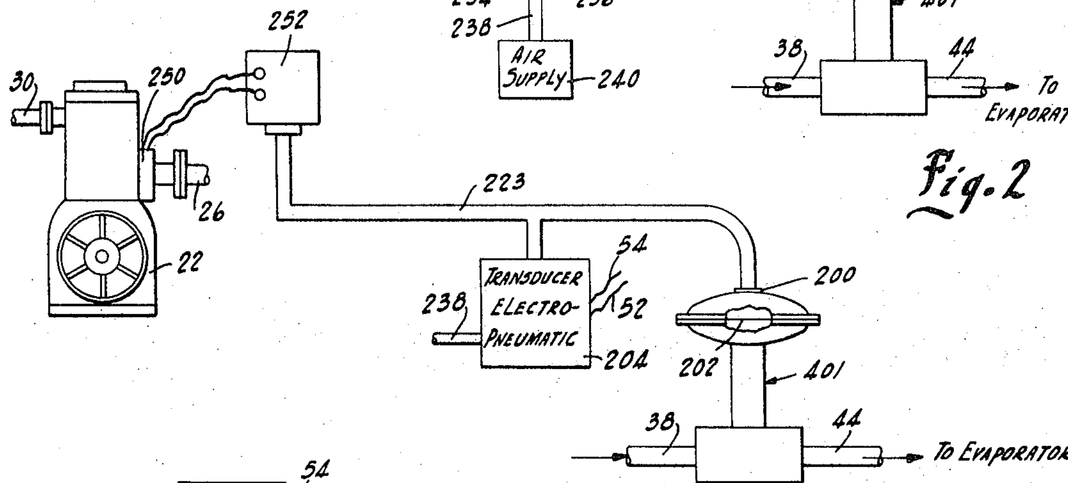

Fig. 3

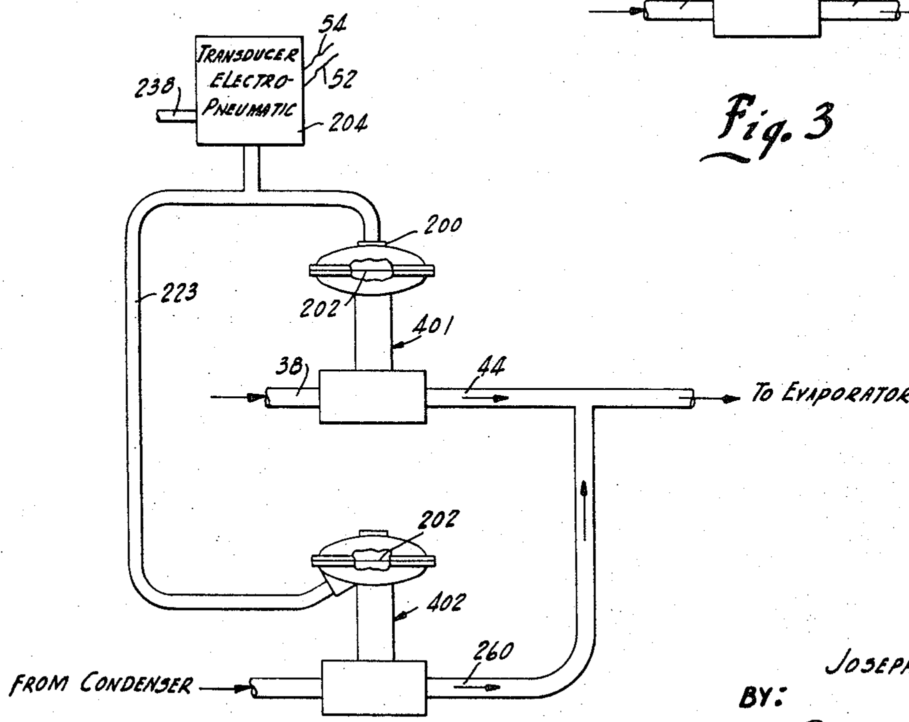

Fig. 4

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CONTROL FOR REFRIGERATION SYSTEMS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is directed to automatic controls for refrigeration systems and more particularly to such controls employing plural sensors.

2. Description of the Prior Art

Conventional refrigeration systems employ a recirculating refrigerant for removing heat from the low temperature side of the system and for discharging heat at the high temperature side. A motor driven compressor which receives low-pressure gaseous phase refrigerant and compresses it to a high pressure provides the work input necessary for the operation of the system.

The high-pressure gaseous phase refrigerant is supplied to a condenser where heat is removed from the refrigerant to convert it to a liquid. The liquid is then supplied through an expansion valve to the evaporator where the liquid receives heat from the cooling load, such as a chill room, which causes the refrigerant to revert to the gaseous form. The gaseous refrigerant is then returned to the compressor for recirculation.

The amount of heat absorbed by the refrigerant in the evaporator includes the heat of vaporization of the refrigerant; that is, the amount of heat which must be absorbed by a liquid at a given temperature to convert it to a gas at the same temperature. In addition, the gaseous refrigerant resulting from the conversion of the liquid refrigerant may absorb additional heat, which raises its temperature above the temperature of vaporization. The gaseous refrigerant in such a state is said to be superheated and the amount by which the temperature of the gas is raised above the vaporization temperature is expressed in degrees of superheat.

In many applications of refrigeration systems, such as low temperature applications, it is desired to prevent superheating of the gaseous refrigerant or to regulate the superheat of the refrigerant to a preselected magnitude. This must be accomplished by controlling the flow of liquid refrigerant into the evaporator. However, the conventional thermostatically controlled expansion valve, responsive to load temperature, normally used for this purpose is totally unsuited to controlling refrigerant superheat. Such valves, when used to control superheat, suffer, among other shortcomings, a slow response time, a wide regulating range, and a narrow load range.

In an effort to provide better control of the gaseous refrigerant superheat, devices responsive to the temperature of the refrigerant itself have been placed at the outlet of the evaporator to control the amount of liquid refrigerant entering the evaporator as a function of the temperature of the refrigerant leaving the evaporator. See U.S. Pat. No. 2,355,894 to Ray, which shows a gaseous refrigerant controlled device, and U.S. Pat. No. 3,205,675 to Matthies which shows a liquid refrigerant controlled device. While these devices represent an improvement over a thermostat, they also exhibit one or more of the shortcomings of the latter type of control.

SUMMARY OF THE PRESENT INVENTION

It is, therefore, the object of the present invention to provide an improved refrigeration system control for regulating the superheat of refrigerant in its gaseous phase existing therein.

It is a further object of the present invention to provide such a control which is particularly suitable for use in refrigeration systems operating at low temperatures and which permits regulation of low superheat conditions of the system refrigerant.

It is yet another object of the present invention to provide a control system which permits the desired amount of superheat to be directly set, and which provides accurate, stable, and rapid regulation of superheat conditions over a wide range of operating conditions.

Briefly, it is the object of the present invention to provide an improved control for regulating the superheat condition of the refrigerant in a refrigerating system responsive to the temperature differential between the temperature of the liquid phase refrigerant and the temperature of the gaseous phase refrigerant existing in the system evaporator. The control includes a valve connected to the inlet of the evaporator for metering the flow of liquid refrigerant into the evaporator in accordance with a controlling signal to the valve. A first temperature responsive sensory element is located in the inlet of the evaporator for providing a signal proportional to the temperature of the liquid phase refrigerant. A second temperature responsive element is located in the outlet of the evaporator for providing a signal proportional to the temperature of the gaseous phase refrigerant leaving the evaporator. A differential temperature control means is connected to the first and second sensory elements and is responsive to their signals for providing an output signal corresponding to the difference between the first and second signals. This output signal is provided to the controllable valve for controlling the supply of liquid refrigerant to the evaporator and the superheat of the gaseous refrigerant in accordance with the differential temperature between the temperature of the refrigerant entering the evaporator and the temperature of the refrigerant leaving the evaporator.

The output signal of the differential temperature control means may be utilized to operate other auxiliary apparatus in the refrigeration system such as a compressor unloading means or a hot gas supply valve recirculating gaseous refrigerant to the inlet of the evaporator.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic illustration of a refrigeration system employing the control of the present invention;

FIG. 2 is a schematic view of portions of the control showing another embodiment of the present invention;

FIG. 3 is a schematic diagram of portions of the control of the present invention showing the use of the control to operate compressor unloading means; and

FIG. 4 is a partial schematic diagram of the control of the present invention, showing use of the control in regulating gaseous refrigerant recirculation to the evaporator.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning now to the drawings, there is shown in FIG. **1** thereof a refrigeration system of conventional construction designated generally by the numeral **10** and the control **8** of the present invention. Refrigeration system **10** includes an evaporator **12**, comprised of a labyrinthine conduit or coil **14** which receives low temperature refrigerant in a liquid phase at inlet **16** and discharges refrigerant in a high temperature gaseous phase at outlet **18**. The refrigerant is converted from low temperature to high temperature by the absorption of heat from the space surrounding coil **14**, for example, chill room **20**.

The external power necessary for the operation of refrigeration system **10** is provided by motor driven compressor **22**. Compressor **22** takes the gaseous refrigerant discharge from evaporator **12** in conduit **26** and compresses it to a high-pressure gaseous refrigerant. The high-pressure gaseous refrigerant is supplied to condenser **28** in conduit **30** where the refrigerant is condensed to a liquid phase as by the giving off of heat to the circulating water in water jacket **32**. The liquid refrigerant in condenser **28** may be supplied to receiver **34** by conduit **36** for storage until needed by refrigeration system **10**.

The aforesaid elements form components of conventional refrigeration systems operating in accordance with the general principles of a Carnot cycle and further description is not deemed necessary.

THE CONTROL

The Control Valve

The liquid refrigerant in receiver 34 is supplied via conduit 38 to expansion or metering valve 40 which meters the flow of refrigerant to evaporator 12 in accordance with a controlling signal to the valve. Valve 40 may be responsive to controlling signals provided in various forms. An electrically operated valve is shown in FIG. 1.

Valve 40 includes a housing 42 having an inlet connected to receiver conduit 38 and outlet connected to evaporator inlet 16 via conduit 44. A valve stem 46 extends from housing 42. Housing 42 includes a means for regulating the flow of refrigerant between the inlet and outlet thereof in response to mechanical movement of valve stem 46. A vane, valve disc and seat, or other well known structure may be used for this purpose.

In the embodiment of the invention shown in FIG. 1, the mechanical movement to valve stem 46 is in the form of rotary motion. For this purpose, motor 48 is mounted on housing 42 by means of bracket 50. The output shaft of motor 48 is connected to valve stem 46 so that by rotating motor 48 valve stem 46 will be rotated to change the position of a vane in valve housing 42 or the relationship of a valve disc to a valve seat in housing 42.

Motor 48 is energized by a controlling signal provided in conductors 52 and 54. The direction of rotation may be controlled by the relative polarity of the voltage in conductors 52 and 54. A feedback signal corresponding to the actual positioning of the elements of valve 42 by motor 48 is provided by potentiometer 56 mounted on valve stem 46 and operable by the rotation of valve stem 46.

It will be appreciated that motor 48 may be in the form of a solenoid motor which provides mechanical movement to valve stem 46 in the form of raising or lowering the valve stem, if desired.

TEMPERATURE SENSORS

Temperature sensors are located in evaporator 12 for measuring the temperature of both the liquid and gaseous phase refrigerant in the evaporator. Specifically, a first temperature sensor 60 is located in the portion of evaporator 12 containing refrigerant in the liquid phase. Temperature sensor is illustratively shown in FIG. 1 as located at the inlet 16 of evaporator 12 and for this purpose temperature sensor 60 may be inserted or embedded in coil 14. While many types of sensors may be employed, the presently preferred embodiment of the invention utilizes resistive elements, the resistance of which varies as a function of its ambient temperature. Such resistive elements are commonly termed thermistors. A second temperature sensor 62 is located in the portion of refrigeration system 10 containing the gaseous phase refrigerant so as to measure its temperature. Temperature sensor 62 is illustratively shown as embedded on conduit 26 at the outlet 18 of evaporator 12. Sensor 62 may also comprise a thermistor.

CONTROL MEANS

Temperature sensors 60 and 62 are connected to differential temperature control means 70 via conductors 64 and 66, respectively. While the resistive elements of temperature sensors 60 and 62 are actually located in evaporator 12, as shown in FIG. 1 and described above, their connection to control means 70 by conductors 64 and 66 incorporates these elements in the control means. Therefore, to facilitate the analysis of the construction and operation of control means 70, the resistive elements 60a and 62a of temperature sensors 60 and 62 respectively, are shown as located in control means 70 by dotted lines. Control means 70 provides an output signal proportional to the difference between the temperature sensed by sensor 60 and by sensor 62. Control means 70 may typically include a power supply 72, an electric bridge 74, and an amplifier 76.

Power supply 72 comprises a transformer 78, the primary winding of which is connected to an available source of alternating current and the secondary winding of which is center tapped and contains diodes 80 and 82. The rectified output of the secondary winding of transformer 78 is filtered by capacitor 84 and resistor 86 to provide a direct current in conductors 88 and 90 to remaining portions of control means 70.

Electric bridge 74 of the Wheatstone type, has its input terminals 94 and 96 connected across conductors 88 and 90. Bridge 74 includes a pair of voltage dividers, each comprised of a pair of center tapped resistive elements, extending between the input terminals 94 and 96. The center tap of each voltage divider comprises an output terminal 98 and 100 of bridge 74 and the magnitude and polarity of the voltage existing between the output terminals is an indication of the relative resistance of the various resistive elements in the voltage dividers.

Considering bridge 74 in detail, conductor 88 is connected to input terminal 94. A fixed resistor 102 of a preselected magnitude is connected between input terminal 94 and output terminal 98. The resistive element 62a of temperature sensor 62 is connected between output terminal 98 and input terminal 96. Input terminal 96 is connected to conductor 90. Resistor 102 and thermistor 62a form one of the voltage dividers of bridge 74. As resistor 102 is of fixed resistive magnitude, the voltage provided at output terminal 98 will be a function of the resistance of thermistor 62a, which in turn is a function of the temperature of the gaseous refrigerant at outlet 18 of evaporator 12.

The second voltage divider of bridge 74 is formed by thermistor 60a of temperature sensor 60, which is connected between input terminal 94 and output terminal 100 and rheostat 104, which is connected between output terminal 100 and input terminal 96. The resistive portion of rheostat 104 may have the same resistance as resistor 102. The voltage provided at output terminal 100 will be a function of the resistance of thermistor 60a, which in turn is a function of the temperature of the liquid phase refrigerant entering inlet 16 of evaporator 12. The magnitude of the voltage provided at output terminal 100 by thermistor 60a may be adjusted by adjusting the position of wiper 104a of rheostat 104. The position of wiper 104a may be controlled by knob 105 and dial 107. Knob 105 and dial 107 form a means by which the degree of superheat of the gaseous refrigerant leaving evaporator 12 may be directly set, as hereinafter described.

The output signal of bridge 74 consists of the differential voltage existing between output terminals 98 and 100. This differential voltage is provided in conductors 106 and 108 connected to output terminals 98 and 100, respectively, to the input terminals of amplifier 76, where the signal is amplified, and provided to conductors 52 and 54 as the controlling signal to motor 48 of valve 40. The feedback signal from potentiometer 56 is also provided to the input of amplifier 76 via conductor 110.

A commercially available control means 70 of the type described above which may be used in the control of the present invention is one made and sold by the Electronic Construction Corp., Milwaukee, Wis., under the trade name Delta T Sensor.

OPERATION

In operation, control means 70 is energized by transformer 78 to provide a voltage across the input terminals 94 and 96 of bridge 74. The resistance of thermistor 62a in temperature sensor 62 assumes a value which is a function of the temperature of the gaseous phase refrigerant leaving the evaporator 12 at outlet 18. Thermistor 60a in temperature sensor 60 assumes a value which is a function of the temperature of the liquid refrigerant entering evaporator 12 at inlet 16. Neglecting for the moment the effects of adjustments to rheostat 104, the voltage at output terminals 98 will be a function of the resistance of thermistor 62a and the temperature of the gaseous refrigerant, while the voltage at output terminal 100 will be a function of the resistance of resistor **60***a* in the temperature of the liquid refrigerant, so that the difference in temperature between the gaseous phase and liquid phase refrigerant appears as a difference in the voltage between output terminals **98** and **100** and as a voltage signal in conductors **106** and **108** to amplifier **76**.

A control signal generated by amplifier **76** to motor **48**, responsive to the input signal in conductors **106** and **108**, causes motor **48** to operate valve **42** in a manner to reduce the temperature difference between the gaseous phase and liquid phase refrigerant. For example, if the temperature of the gaseous refrigerant leaving evaporator **12** is excessive, due to an excessive cooling load on the evaporator, the polarity and magnitude of the control signal to motor **48** is such as to cause motor **48** to rotate in a direction to open valve **40** to allow more refrigerant to enter evaporator **12** to handle the increase cooling load. The increased liquid refrigerant available in evaporator **12**, reduces the temperature of the gaseous refrigerant leaving the evaporator and the control signal of amplifier **76** is reduced. In this manner, the temperature of the gaseous refrigerant is regulated with reference to the temperature of the liquid refrigerant.

If it is desired to maintain the gaseous refrigerant leaving evaporator **12** at a condition of zero superheat, that is, at a temperature which is the same as the liquid refrigerant entering evaporator **12**, valve **40** is operated to supply sufficient liquid refrigerant to evaporator **12** to reduce the temperature of the gaseous refrigerant leaving evaporator **12** to its saturated temperature. At this point, the temperature sensed by temperature sensors **60** and **62** will be identical and the differential temperature signal provided by control means **70** will be zero. The refrigeration system is thus maintained in a condition of zero superheat.

Under many conditions, it is desired to maintain a preselected amount of superheat in the gaseous refrigerant leaving evaporator **12**. That is, it is desired to heat the gaseous refrigerant by a preselected amount above the temperature of the liquid refrigerant entering evaporator **12**. Rheostat **104** is incorporated in bridge **74** for this purpose. By adjusting the position of wiper **104***a*, the voltage at output terminal **100** may be varied independently of the resistance of thermistors **60***a* and **62***a*. The variation in the voltage at output terminal **100** varies the voltage signal in conductors **106** and **108** to amplifier **76** and the control signal to valve motor **48**. This causes motor **48** to operate valve **40** to adjust the temperature of the gaseous refrigerant leaving evaporator **12** at outlet **16** so that the gaseous refrigerant has the desired degree of superheat. For this purpose, dial **107**, which operates in conjunction with knob **105** to vary the position of wiper **104***a* of potentiometer **104** may be calibrated directly in degrees of superheat.

DESCRIPTION OF OTHER PREFERRED EMBODIMENTS

FIG. **2** shows an alternative embodiment of the control of the present invention. In the embodiment of FIG. **2**, a pneumatically actuated valve **401** is employed to meter the flow of refrigerant to inlet **16** of evaporator **12**. Valve **401** may be a diaphragm operated valve in which pneumatic pressure supplied to inlet **200** raises or lowers diaphragm **202** to operate valve **401**. The control **801** includes an electropneumatic transducer **204** which converts the electric signal in conductors **52** and **54**, generated by control means **70**, to a pneumatic signal having corresponding control pressure variations. A typical electropneumatic transducer **204** which may be used in control **801** is shown in FIG. **2**.

Electropneumatic transducer **204** includes solenoid **206**, the coil **207** of which receives the electric signal in conductors **52** and **54**. The position of plunger **208** of solenoid **206** is a function of the energization of coil **207** provided by the electrical signal from control means **70**. Cavity **210** in the body of transducer **204** contains a diaphragm **212** positioned across the cavity and containing cylindrical valve seat **214**. A spacer **216** having a plurality of vents **218** is positioned between plunger **208** and valve seat **214** to couple the former to the latter. A spring **220** biases valve seat **214** against the force exerted by spacer **216**.

An exhaust port **222** connects the upper portion of cavity **210** to the surrounding atmosphere. An output port **224** is located in the lower portion of cavity **210** to provide the output pressure to airline **223** and to pneumatically operated valve **401**. A valve stem **226** positioned in cavity **210** has a truncated conical portion **228** which closes valve seat **214** when the valve stem is in the upper position and the valve seat is in the lower position. A second conical portion **230** closes valve seat **232** between cavity **210** and chamber **234**. A spring **236** positioned in chamber **234** biases valve stem **226** upward. Supply airline **238** supplies inlet air to chamber **234** from air supply source **240**.

A commercially available electropneumatic transducer which may be employed in control system **801** as transducer **204** is made and sold by the Fisher Governor Company, Marshalltown, Iowa under the model designation type 546.

In the operation of control **801**, temperature sensors **60** and **62** and control means **70** function in the same manner as described above to provide an output signal in conductors **52** and **54** responsive to the temperature sensing of thermistors **60***a* and **62***a*.

The output signal in conductors **52** and **54** drives transducer **204**. Assume in an exemplary instance, the output signal of amplifier **76** is of a polarity to indicate that additional refrigerant is desired in evaporator **12**. The signal in conductors **52** and **54** energizes solenoid coil **207** to drive plunger **208** downward into cavity **210**. This causes spacer **216** to depress valve seat **214** and valve stem **226**. The depression of valve stem **226** increases the air flow through valve seat **232** from chamber **234**, connected to air supply line **238**, to cavity **210**, connected to airline **223**. This increases the air pressure in airline **223** and in cavity **210**. The increased air pressure in cavity **210** causes diaphragm **208** to flex upwardly, raising valve seat **214** and valve stem **226** against the downward force exerted by solenoid plunger **208**. The opposing forces on diaphragm **212** assume a state of balance so that the air pressure in airline **223** is a function of the energization of solenoid **206** by amplifier **76**. The air pressure in airline **223** operates diaphragm **202** to open valve **401** and admit more refrigerant to evaporator **12**.

In the event the output signal of amplifier **76** is of the opposite polarity, solenoid **206** is energized to withdraw solenoid plunger **208** from cavity **210**. This permits valve seat **214** to be raised off valve stem **226** by means of spacer **216** and allows the air flowing from chamber **234** into chamber **210** to escape through valve seat **214** and out exhaust port **222**, reducing the air pressure in cavity **210** and in airline **223** and closing valve **104**. The reduced pressure in cavity **210** causes diaphragm **212** to flex downward, restricting the flow of air through valve seat **214** so that the opposing forces of a diaphragm again balance when air pressure in airline **223** has reached a value proportional to the magnitude of the output signal of amplifier **76**.

Control means **70** may be employed to operate the apparatus in addition to metering valve **40**. For example, it is often desired to reduce the volume of gaseous refrigerant compressed by compressor **22** as the rate at which liquid refrigerant is metered to evaporator **12** is reduced, so as to maintain proper operating conditions in evaporator **12**. The reduction in gaseous refrigerant compressed by compressor **22** is obtained by an unloading mechanism **250** (FIG. **3**) interposed between gaseous refrigerant inlet line **26** and compressor **22** which permits compressor **22** to operate without compressing gaseous refrigerant.

To coordinate the operation of unloading mechanism **250** with the operation of the valve **40**, a sensory element is placed in the output of amplifier **76** which is responsive to the amplifier output signal. An exemplary embodiment of the above described arrangement is shown in FIG. **3** in which pneumatically operated relay **252** is connected in output airline **223** of electropneumatic transducer **204**. Relay **252** is operable by the air pressure in airline **223** so that when the pressure in the airline is such as to cause valve **401** to reduce the flow of refrigerant to evaporator **12**, relay **252** is energized to cause unloading mechanism **250** to unload compressor **22** and reduce the inlet volume.

In a similar manner, an electrically operated relay, inserted directly in the output of amplifier **76**, may be used to operate unloading mechanism **250** to unload compressor **22**.

To maintain stable operating conditions in evaporator **12**, particularly when the cooling load on the evaporator is light, it is often desired to recirculate gaseous refrigerant from the outlet **16** of evaporator **12** to the inlet of evaporator **12**. This techniques is aptly called "false loading" as it increases the effective cooling load on evaporator **12** without altering the temperature maintained in chill room **20**. An additional valve **402** may be connected to the output of control means **70**. FIG. 4 shows the use of such an additional valve in the pneumatically operated embodiment of the invention shown in FIG. 2. Valve **402** is interposed in conduit **260** which receives gaseous refrigerant from the outlet of the condenser and provides it to inlet **16** of the evaporator. Valve **402** is connected to airline **223** so as to be operable by the air pressure in such line generated by electropneumatic transducer **204**. However, valve **402** is constructed so that its operating mode is opposite to that of valve **401**. That is, the pneumatic signal in airline **223** which causes valve **401** to close, causes valve **402** to open, and vice versa. This may be easily accomplished by placing the inlet of airline **223** on the other side of diaphragm **202**, as shown in FIG. 4.

In operation, when the control signal to electropneumatic transducer **204** from amplifier **76** is such as to cause valve **401** to reduce the flow of refrigerant to evaporator **12** responsive to a reduced loading condition in the evaporator, the same signal is used to cause valve **402** to open to admit gaseous refrigerant to the inlet **16** of evaporator **12** via conduit **44** to increase the load on the evaporator and maintain stable operating conditions therein.

It will be appreciated that other modifications and changes may be made to the control the present invention and it is desired to include all such modifications and alterations as come within the true scope and spirit of the claims below.

I claim:

1. In a refrigeration system having a recirculating refrigerant and an evaporator for receiving high-pressure liquid phase refrigerant at an inlet and providing gaseous phase refrigerant at an outlet, means for controlling the superheat condition of the gaseous phase refrigerant in accordance with the differential in temperature between the inlet and outlet refrigerant in the evaporator, the control of refrigerant superheat condition being effected by regulating the admission of liquid phase refrigerant to the evaporator, said control means comprising an electrically operative valve connected to the inlet of the evaporator for metering the flow of refrigerant into the evaporator in accordance with a controlling signal thereto, a transformer having a primary winding connected to a power source, a secondary winding having a center tap terminal and a pair of output terminals and a diode connected to each of said output terminals to provide a DC current output;

a balanced thermistor circuit connected across the center tapped terminal and the output terminals of said secondary winding and including (1) a first thermistor located in the evaporator for providing a signal proportional to the actual temperature of the liquid phase refrigerant existing in the evaporator and (2) a selectively controllable rheostat and a second thermistor located in the evaporator for providing a signal set by said rheostat proportional to the gaseous phase refrigerant existing at the outlet of the evaporator, and an amplifier connected to the output terminals of the thermistors, the output of the amplifier connected to said valve for controlling the superheat condition of said gaseous phase refrigerant in accordance with the temperature differential between said thermistors.

2. A control according to claim **1**, wherein said electrically operable valve comprises a motor driven valve.

3. A control according to claim **1**, wherein said refrigerant system includes conduit means connected to the inlet of the evaporator for supplying high temperature refrigerant to the evaporator inlet when the flow of low temperature refrigerant into the evaporator from said controllable valve is reduced, and wherein said control includes a flow regulator connected in the conduit means for metering the flow of high temperature refrigerant into the evaporator in accordance with a controlling signal thereto; said differential temperature means being further connected to said flow regulator for providing said output signal as the controlling signal for operating said flow regulator to admit high temperature refrigerant into the evaporator when said output signal operates said valve to reduce the flow of low temperature refrigerant into the evaporator.

4. In a refrigeration system having a recirculating refrigerant and an evaporator for receiving high-pressure liquid phase refrigerant at an inlet and providing gaseous phase refrigerant at an outlet, means for controlling the superheat condition of the gaseous phase refrigerant in accordance with the differential in temperature between the inlet and outlet refrigerant in the evaporator, the control of the refrigerant superheat condition being effected by regulating the admission of liquid phase refrigerant to the evaporator, said control means comprising:

a valve connected to the inlet of the evaporator for metering the flow of refrigerant into the evaporator in accordance with a controlling signal thereto;

a first temperature responsive sensory element located in the evaporator for providing a signal proportional to the temperature of the liquid phase refrigerant existing in the evaporator;

a second temperature responsive sensory element located in the evaporator for providing a signal proportional to the temperature of the gaseous phase refrigerant existing in the evaporator; and

differential temperature means connected to said first and second sensory elements and responsive to said signals for providing a signal corresponding to the difference between said first and second signals;

said differential temperature means being connected to said valve for controlling the same, and including electric signal means responsive to said signals for providing an electric signal corresponding to the difference between said first and second signals, said valve being a pneumatically operable valve, and said differential temperature means further including an electropneumatic transducer connected to said signal means and interposed between said valve and a source of pneumatic pressure, said transducer converting the electric signal of said signal means into a pneumatic output signal for operating said valve.

5. In a refrigeration system having a recirculating refrigerant and an evaporator for receiving high-pressure liquid phase refrigerant at an inlet and providing gaseous phase refrigerant at an outlet, means for controlling the superheat condition of the gaseous phase refrigerant in accordance with the differential in temperature between the inlet and outlet refrigerant in the evaporator, the control of the refrigerant superheat condition being effected by regulating the admission of liquid phase refrigerant to the evaporator, said control means comprising:

a valve connected to the inlet of the evaporator for metering the the flow of refrigerant into the evaporator in accordance with a controlling signal thereto;

a first temperature responsive sensory element located in the evaporator for providing a signal proportional to the temperature of the liquid phase refrigerant existing in the evaporator;

a second temperature responsive sensory element located in the evaporator for providing a signal proportional to the temperature of the gaseous phase refrigerant existing in the evaporator; and differential temperature means connected to said first and second sensory elements and responsive to said signals for providing a signal corresponding to the difference between said first and second signals,

said differential temperature means being connected to said valve for controlling the same,

said refrigerant system includes a compressor connected to the outlet of the evaporator for compressing the gaseous phase refrigerant leaving the evaporator, said compressor having unloading means for unloading the compressor when the flow of refrigerant into the evaporator is reduced, and wherein said control includes signal responsive means coupled to said differential temperature means and said unloading means for operating said unloading means to unload the compressor when the output signal operates said controllable valve to reduce the refrigerant flow into said evaporator.

6. A control according to claim 5, wherein said temperature responsive sensory elements provide electric signals proportional to the refrigerant temperatures, and said differential temperature means includes electric signal means responsive to said signal for providing an electric signal corresponding to the difference between said first and second signals, said valve being a pneumatically operable valve, said differential temperature means further including an electropneumatic transducer connected to said signal means and interposed between said valve and a source of pneumatic pressure with said transducer converting the electric signal of said signal means into a pneumatic output signal for operating said valve, and wherein said signal responsive means comprises means responsive to the pneumatic signal of said transducer.

7. In a refrigeration system having a recirculating refrigerant and an evaporator for receiving high-pressure liquid phase refrigerant at an inlet and providing gaseous phase refrigerant at an outlet, means for controlling the superheat condition of the gaseous phase refrigerant in accordance with the differential in temperature between the inlet and outlet refrigerant in the evaporator, the control of the refrigerant superheat condition being effected by regulating the admission of liquid phase refrigerant to the evaporator, said control means comprising:

a valve connected to the inlet of the evaporator for metering the flow of refrigerant into the evaporator in accordance with a controlling signal thereto;

a first temperature responsive sensory element located in the evaporator for providing a signal proportional to the temperature of the liquid phase refrigerant existing in the evaporator;

a second temperature responsive sensory element located in the evaporator for providing a signal proportional to the temperature of the gaseous phase refrigerant existing in the evaporator; and

differential temperature means connected to said first and second sensory elements and responsive to said signals for providing a signal corresponding to the difference between said first and second signals;

said differential temperature means being connected to said valve for controlling the same;

conduit means connected to the inlet of the evaporator for supplying high temperature refrigerant to the evaporator inlet when the flow of low temperature refrigerant into the evaporator from said controllable valve is reduced; and

a flow regulator connected in the conduit means for metering the flow of high temperature refrigerant into the evaporator in accordance with a controlling signal thereto; said differential temperature means being further connected to said flow regulator for providing said output signal as the controlling signal for operating said flow regulator to admit high temperature refrigerant into the evaporator when said output signal operates said valve to reduce the flow of low temperature refrigerant into the evaporator;

said differential temperature means includes electric signal means responsive to said signals for providing an electric signal corresponding to the difference between said first and second signals, and said valve and flow regulator are pneumatically operable, and wherein said differential temperature means further includes an electropneumatic transducer connected to said signal means and interposed between said valve and flow regulator and a source of pneumatic pressure, said transducer converting the electric signal of said signal means into a pneumatic output signal for operating said valve and flow regulator.

8. In a refrigeration system having a recirculating refrigerant and an evaporator for receiving high-pressure liquid phase refrigerant at an inlet and providing gaseous phase refrigerant at an outlet, means for controlling the superheat condition of the gaseous phase refrigerant in accordance with the differential in temperature between the inlet and outlet refrigerant in the evaporator, the control of refrigerant superheat condition being effected by regulating the admission of liquid phase refrigerant to the evaporator for supplying high temperature refrigerant to the evaporator inlet when the flow of low temperature refrigerant into the evaporator from said controllable valve is reduced, said control means comprising an electrically operative valve connected to the inlet of the evaporator for metering the flow of refrigerant into the evaporator in accordance with a controlling signal thereto;

a bridge circuit including (1) a first voltage divider having an output terminal, a fixed resistance and a first thermistor located in the evaporator for providing a signal proportional to the actual temperature of the liquid phase refrigerant existing in the evaporator and (2) a second voltage divider having a selectively controllable rheostat and a second thermistor located in the evaporator for providing a signal set by said rheostat proportional to the gaseous phase refrigerant existing at the outlet of the evaporator; and an amplifier connected to the output terminals of said first and second voltage dividers and to said valve for controlling the superheat condition of said gaseous phase refrigerant in accordance with the temperature differential between said first and second voltage dividers.