

[54] SUPERHEAT CONTROL SYSTEM

[76] Inventor: **Raymond F. Stevens**, Cider Mill
Road, Tolland, Conn. 06084

[22] Filed: **Aug. 12, 1974**

[21] Appl. No.: **496,336**

[52] U.S. Cl. **62/209; 62/83; 62/227**

[51] Int. Cl.² **F25B 49/00**

[58] Field of Search 62/129, 208, 209, 227,
62/83

[56] **References Cited**

UNITED STATES PATENTS

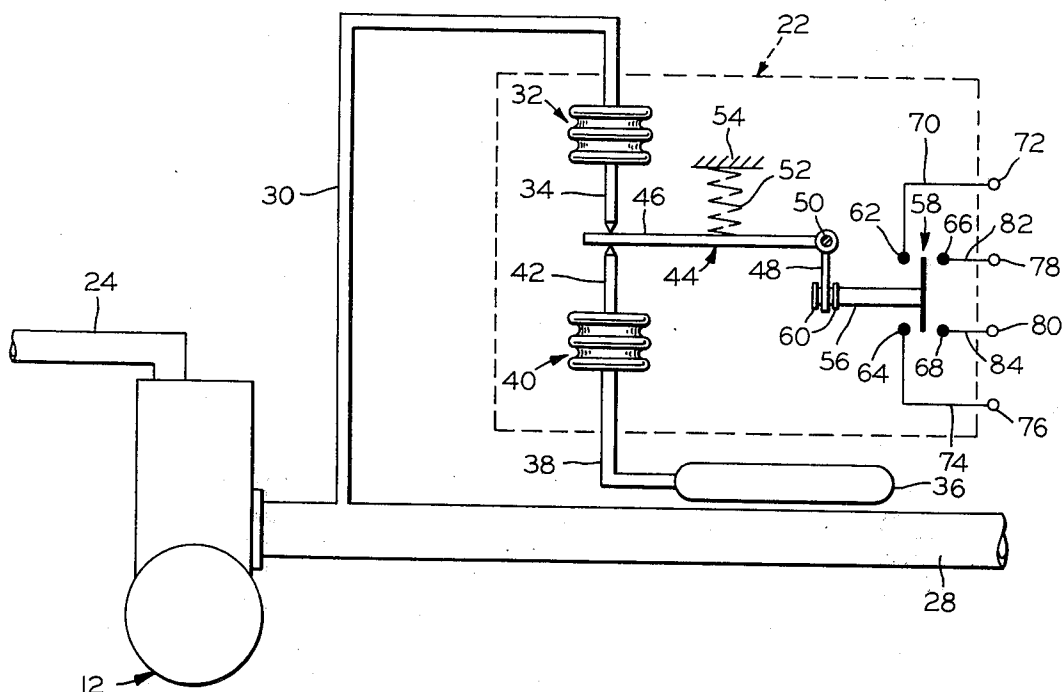
3,130,558 4/1964 Gardner 62/209

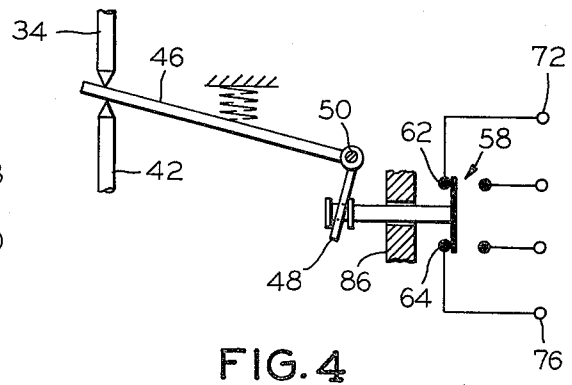
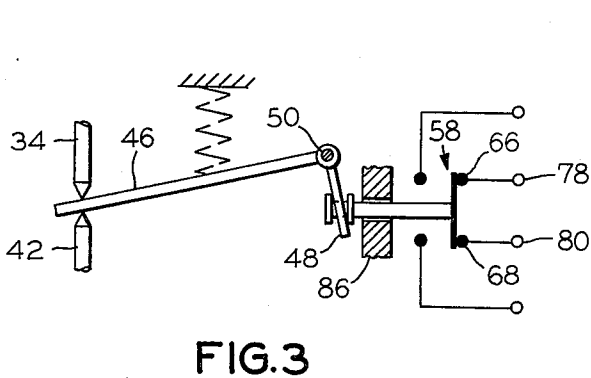
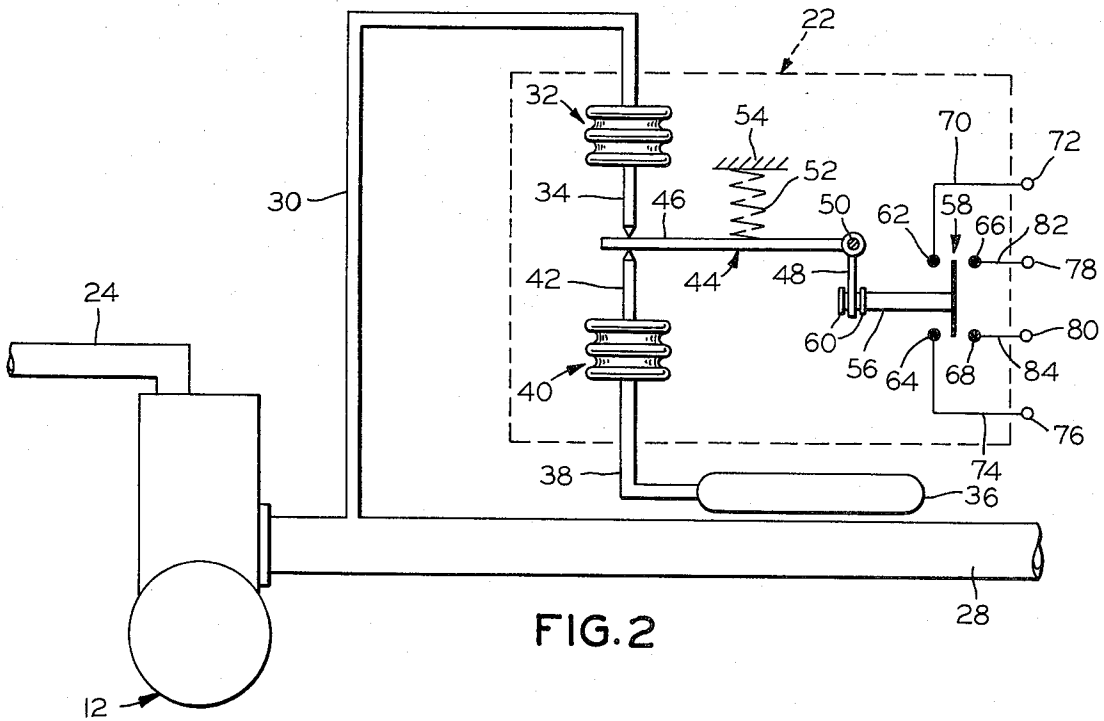
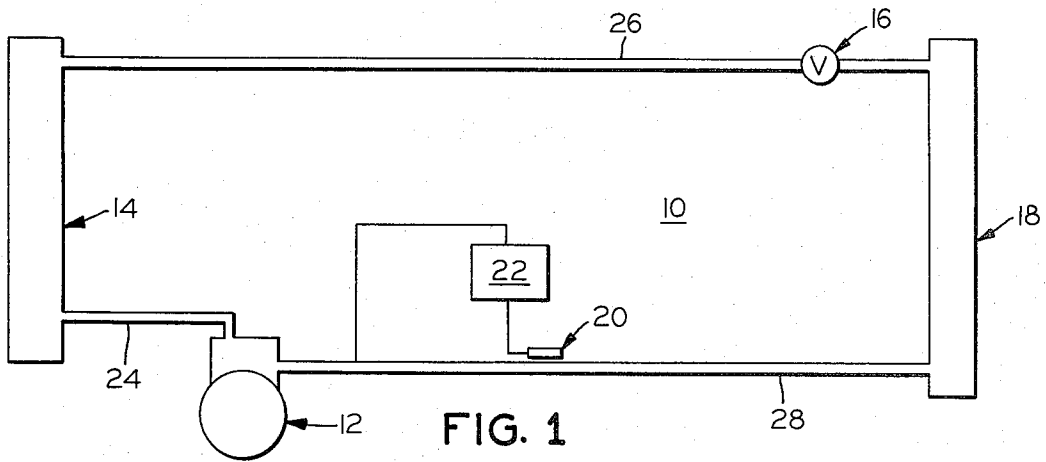
Primary Examiner—William E. Wayner

[57] **ABSTRACT**

A superheat control for a refrigeration system in which a switch is operated to provide a control function. The switch is operated by a pivoted arm with the arm being acted on by a first bellows on one side and a second bellows on the opposite side. The first bellows is responsive to the suction pressure to the compressor while the second bellows is responsive to the suction temperature.

5 Claims, 4 Drawing Figures





SUPERHEAT CONTROL SYSTEM

BACKGROUND OF THE INVENTION

By definition, refrigeration is a process involving the removal of heat from an area where it is not wanted and the transfer thereof to a place where it is found not to be objectionable. In the basis cycle of mechanical refrigeration, a low temperature, low pressure refrigerant vapor enters the compressor where it is compressed to a high pressure, high temperature vapor which is piped to a condenser. In the condenser, the vapor is condensed to form a high pressure liquid with the heat of compression being removed therefrom during this process. The high pressure liquid refrigerant is then supplied to the inlet of an expansion valve which functions to meter the flow of refrigerant to an evaporator, the latter being connected to the outlet of the expansion valve. Since the pressure internally of the evaporator is considerably lower than that of the liquid refrigerant at the expansion valve inlet, the refrigerant flashes into a vapor of low temperature and absorbs heat from the medium surrounding the evaporator. The refrigerant vapor leaving the evaporator is then supplied to the suction side of the compressor to complete the cycle.

It has long been established that there exists a definite relationship between the pressure and temperature of a refrigerant at any given boiling point. In what is referred to as a saturated condition, refrigerant vapor will have the same temperature as the liquid under the same pressure. Inasmuch as refrigeration compressors are designed to handle only vapor, they can suffer serious mechanical damage when subjected to the destructive hydraulic forces of liquid refrigerant. To minimize the possibility of such damage, compressor manufacturers recommend that the refrigerant vapor entering the compressor be superheated to ensure that only vapor will pass through the compressor. Although this refrigerant vapor is superheated, there is essentially no increase in its pressure in the superheated condition versus the pressure thereof when in the saturated condition.

While the refrigerant expansion valve performs the function of metering the refrigerant in such quantity as to satisfy the evaporator cooling demand under normal conditions, the expansion valve does not respond fast enough to sudden changes in the evaporator cooling load, or during periods of low load condition, or restricted air flow across the evaporator. Consequently, under such circumstances, the refrigerant leaving the evaporator will have no superheat. Rather, the refrigerant will be in a saturated state thereby including both vapor and liquid refrigerant whose deleterious effect within the compressor is widely known in the art.

There has thus existed a need to provide a means which would be operable to sense the pressure of superheat in the refrigerant vapor being returned to the compressor. Moreover, a need has been evidenced to provide such a means which possesses the ability to respond to the sensing of an abnormal superheat condition in the refrigerant being returned to the compressor to actuate an electrical switch to effect a control operation upon the occurrence of a predetermined loss of superheat and before a saturated condition develops. Also, it is desirable that such a means be capable of optionally being provided with an alarm circuit which is operable to alert an operator that a loss of superheat is occurring. In addition, should the condition not be

remedied, the means should be effective in view of a further loss of superheat to shut down the compressor before any significant damage can be done thereto by liquid refrigerant reaching the latter.

Accordingly, it is an object of the present invention to provide a superheat control system which is particularly adapted for employment in a refrigeration system.

It is another object of the present invention to provide such a superheat control system which is operable to sense the presence of superheat in the refrigerant vapor being returned to the compressor.

A further object of the present invention is to provide such a superheat control system which is operable to effect a control function when a predetermined loss of superheat in the refrigerant vapor being returned to the compressor is sensed to have occurred.

A still further object of the present invention is to provide such a superheat control system which embodies an alarm circuit that is operable to alert an operator that a loss of superheat is occurring.

Yet another object of the present invention is to provide such a superheat control system which is effective in the presence of a continued loss of superheat in the refrigerant vapor being returned to the compressor to shut down the compressor before any significant damage can be done thereto by liquid refrigerant reaching the latter.

Yet still another object of the present invention is to provide such a superheat control system which is easily installable in a refrigeration system, and is compatible with the presently available components that are commonly found embodied in a refrigeration system.

SUMMARY OF THE INVENTION

It has now been found that the foregoing and related objects can be readily attained in a superheat control system which is particularly suited to be operatively connected in circuit relation with a compressor in a refrigeration system for purposes of sensing the superheat condition of the refrigerant being fed to the compressor and in turn to utilize this sensing to effect a control function. The superheat control system includes a compressor which is connected by first conduit means to the inlet of a condenser. The outlet of the condenser is in turn connected by second conduit means through an expansion valve to the inlet of an evaporator. To complete the refrigeration cycle, the outlet of the evaporator is connected by third conduit means to the suction side of the compressor. The superheat control system further includes sensing means operable for sensing the superheat condition of material flowing through the third conduit means. For this purpose, the sensing means is supported in juxtaposed relation to the third conduit means intermediate the ends thereof. The sensing means is operatively connected to safety switch means whereby the switch means is capable of being actuated by the sensing means in response to sensings made by the latter. The switch means when actuated in turn is operable to cause a control function to be effected when an abnormal superheat condition is sensed to exist in the third conduit means.

In accord with the preferred embodiment of the invention, the sensing means includes a pipe having one end thereof connected to the third conduit means and the other end to a first pressure sensitive bellows whereby refrigerant flowing through the third conduit means is drawn into the pipe and is fed to the first bel-

lows with the pressure of the refrigerant supplied to the first bellows being the same as the pressure of the refrigerant in the third conduit means. The sensing means further includes a sensing bulb which is charged with a suitable refrigerant. The bulb is supported in juxtaposed relation to the third conduit means adjacent to but spaced from the suction side of the compressor. One end of the bulb is connected to a capillary tube with the other end of the latter being connected to a second pressure sensitive bellows. The bulb functions to sense the temperature of the refrigerant in the third conduit means and to transform this sensing into a pressure which in turn is applied through the second bellows to an operating arm included in the switch means. The latter operating arm is spring biased in the opposite direction by a combination of forces consisting of a spring force and a pressure force which is derived from pressure supplied to the first bellows through the aforementioned pipe which is connected to the third conduit means. The operating arm is operatively connected to a switch whereby to be capable of effecting a suitable control function in response to a sensing by the bulb that an undesired condition exists with respect to the superheat condition of the refrigerant being supplied to the compressor.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram of a refrigeration system embodying therewithin a superheat control system constructed in accordance with the present invention;

FIG. 2 is a schematic diagram on an enlarged scale of the sensing and switch means of a superheat control system constructed in accordance with the present invention;

FIG. 3 is a schematic diagram of the switch means of a superheat control system constructed in accordance with the present invention illustrating the switch means occupying a first operating position thereof; and

FIG. 4 is a schematic diagram of the switch means of a superheat control system constructed in accordance with the present invention illustrating the switch means occupying a second operating position thereof.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENT

Referring now to the drawings and more particularly FIG. 1 thereof, there is illustrated therein a refrigeration system, generally designated by reference numeral 10, embodying therewithin a superheat control system constructed in accordance with the present invention. More specifically, there is depicted in FIG. 1 a refrigeration system including a compressor 12, a condenser 14, a metering device 16, an evaporator 18, sensing means 20 and switch means 22. The compressor 12, the condenser 14, the metering device 16 and the evaporator 18 are all fluidically interconnected in a conventional manner by means of suitable conduit means. To this end, the outlet of the compressor 12 is connected by conduit 24 to the inlet of the condenser 14. Conduit 26 functions to connect the outlet of the condenser 14 to the metering device 16 and therethrough to the inlet of the evaporator 18. The outlet of the evaporator 18 is connected by means of conduit 28 to the suction side of the compressor 12. In accord with the illustrated embodiment of the refrigeration system 10, the metering device 16 comprises a conventional expansion valve.

The compressor 12, the condenser 14, the expansion valve 16 and the evaporator 18 function in the refrigeration system 10 in the same manner as do such components in a conventional refrigeration system. Namely, a low temperature, low pressure refrigerant vapor enters the compressor 12 where it is compressed to a high pressure, high temperature vapor. The latter is fed through conduit 24 to the condenser 14 wherein the vapor is condensed to produce a high pressure liquid and during which process the heat of compression is removed therefrom. From the outlet of the condenser 14, the high pressure liquid refrigerant is then supplied through conduit 26 to the intake side of the expansion valve 16. The latter functions to meter the flow of refrigerant through the conduit 26 to the evaporator 18 which is connected in fluid flow relation to the outlet side of the expansion valve 16. Since the pressure internally of the evaporator 18 is considerably lower than that of the liquid refrigerant at the inlet of the expansion valve 16, the refrigerant flashes into a vapor of low pressure and absorbs heat from the medium surrounding the evaporator 18. The refrigerant vapor leaving the evaporator 18 is then supplied through conduit 28 to the suction side of the compressor 12 to complete the refrigeration cycle. Inasmuch as the compressor 12, the condenser 14, the expansion valve 16 and the evaporator 18 are each of conventional construction and the mode of operation thereof is well-known to those skilled in the art, it has not been deemed necessary for purposes of obtaining an understanding of the present invention to illustrate the drawings and to describe in detail herein the nature of the internal construction of the aforementioned four components.

Referring now to FIG. 2 of the drawings, there will be set forth a description of the superheat control system portion of the refrigeration system 10. There is included in the superheat control system portion the sensing means 20 and the switch means 22, the latter being operatively connected to the former. The sensing means 20 is operable to sense the superheat condition of the refrigerant flowing through the conduit 28 to the suction side of the compressor 12. The switch means 22 on the other hand is actuatable by the sensing means 20 in response to a sensing by the latter that an abnormal superheat condition exists in the refrigerant flowing from the evaporator 18 to the compressor 12.

With regard more specifically to the sensing means 20, the latter includes a pipe 30, one end of which communicates with the conduit 28 at a location along the length of the latter which is in relatively close proximity to the inlet of the compressor 12. The other end of the pipe 30 is operatively connected through the use of a suitable fitting (not shown) of conventional construction to one side of a first pressure sensitive bellows 32. Consequently, as the refrigerant flows through the conduit 28, a quantity thereof is drawn into the pipe 30 and is fed to the bellows 32. Moreover, it will be readily understood that the pressure of the refrigerant which is drawn into the pipe 30 and which is received by the bellows 32 will be at the same pressure as the refrigerant flowing in conduit 28. As depicted in FIG. 2 of the drawings, the other side of the bellows 32 has operatively connected thereto a member 34, for a purpose yet to be described.

The sensing means 20 in addition includes a bulb 36. The latter bulb 36 is charged with a suitable refrigerant. More particularly, the bulb 36 contains a quantity of

refrigerant of the same class as that employed in the refrigeration system 10. In this regard, in accord with the preferred embodiment of the invention the bulb 36 is charged with a quantity of the refrigerant which is commonly referred to by those skilled in the art by the designation R-22. The bulb 36 is attached through the use of any suitable conventional form of fastening means (not shown) to one end of a capillary tube 38. The other end of the capillary tube 38 is in turn operatively connected by means of a suitable fitting (not shown) of conventional construction to one side of a second pressure sensitive bellows 40. The bellows 40 has the other side thereof operatively connected to a member 42 of relatively short length, for a purpose yet to be described. Consequently, the bulb 36, the capillary tube 38 and the bellows 40 are all in fluid communication with each other whereby refrigerant is capable of flowing within and between all three of these components, and with the pressure of the refrigerant being the same in all three components, namely, the bulb 36, the capillary tube 38 and the bellows 40.

Referring again to FIG. 2 of the drawings, the switch means 22 will now be described. As depicted therein, the switch means 22 includes an operating arm 44 which is generally L-shaped in configuration. The latter configuration is provided by a first arm portion 46 of relatively long length and a second arm portion 48 of relatively short length which together function to give the operating arm 44 the aforescribed configuration. The arm portions 46 and 48 are rigidly affixed together so as to be movable as a unit. In accord with the illustrated embodiment of the operating arm 44, the arm portions 46 and 48 are formed integrally with each other, however, it is to be understood that if so desired the arm portions 46 and 48 could take the form of separate members which are thereafter fastened together. The operating arm 44 is pivotably mounted on a suitable pivot pin 50, the latter in turn being suitably supported for this purpose on a support element (not shown). The free end of the operating arm 44 has bearing thereagainst on one side thereof the free end of the member 34 which is operatively connected to the first bellows 32 and on the other side thereof the free end of the member 42 which is operatively connected to the second bellows 40. In addition, intermediate the ends of the arm portion 46 of the operating arm 44 there is provided a spring 52 one end of which engages the arm portion 46 on the same side thereof as the member 34. The other end of the spring 52 bears against a fixed support, schematically depicted at 54 in FIG. 2 of the drawings. The spring 52 is therefore operable to apply a biasing force to the operating arm 44. As will be described more fully hereinafter, the operating arm 44 is caused to pivot about the pivot pin 50 when the combined force being applied by the member 34 and the spring 52 against one side of the arm portion 46 and the force being applied on the other side of the arm portion 46 by the member 42 are not in balance.

Insofar as concerns the other arm portion, namely, the arm portion 48 of the operating arm 44, the free end thereof is operatively connected to one end of a movable contact member 56 of a multipole electrical switch 58. More specifically, the free end of the arm portion 48 is mechanically connected to the free end of the movable contact member 56. In this regard, in accord with the illustrated embodiment of the invention, the free end of the arm portion 48 is preferably pro-

vided with a through hole (not shown) formed therein so as to be suitably dimensioned to permit the free end of the contact member 56 to be passed therethrough. In addition, a pair of washer-like members 60 of enlarged diameter are suitably positioned adjacent the free end of the contact member 56 whereby as depicted in FIGS. 2-4 of the drawings when the arm portion 48 is received on the contact member 56 the former is held captive between the pair of members 60. It will therefore be readily apparent that by virtue of the mechanical connection which exists between the arm portion 48 and the contact member 56, when the operating arm 44 is caused to pivot about the pivot pin 50 the pivotal movement thereof is transformed into a longitudinal movement of the contact member 56 whereby the latter is movable either between the position thereof shown in FIG. 2 of the drawings to the position thereof illustrated in FIG. 3 on the one hand or to the position thereof depicted in FIG. 4 on the other hand.

As best understood with reference to FIGS. 2-4 of the drawings, the electrical switch 58 includes a first pair of contacts 62 and 64, and a second pair of contacts 66 and 68. Contact 62 is connected by means of conductor 70 to a terminal 72 while contact 64 is connected by conductor 74 to a terminal 76. Similarly, the contacts 66 and 68 are connected to terminals 78 and 80, respectively, by means of conductors 82 and 84, respectively. The four terminals 72, 76, 78 and 80 are connected in electrical circuit relation with suitable alarm and/or control circuits (not shown) whereby as will be described more fully hereinafter when either of the pair of contacts are in a closed condition an electrical circuit is completed between either the terminals 72 and 76 or the terminals 78 and 80. More specifically, as shown in FIG. 3 of the drawings when the force being exerted on the operating arm 44 by the member 34 and the spring 52 exceeds that being exerted thereagainst by the member 42, the arm portion 46 of the operating arm 44 is caused to pivot in a downwardly direction, as viewed with reference to FIG. 3 about the pivot pin 50. In turn, the arm portion 48 pivots in an upwardly direction as viewed with reference to FIG. 3 causing the contact member 56 to move to the right whereupon the contact member 56 moves into engagement with the contacts 66 and 68 thereby causing an electrical circuit to be completed between the terminals 78 and 80. In a similar manner, as shown in FIG. 4 of the drawings when the force being exerted on the operating arm 44 by the member 42 exceeds that being exerted thereagainst by the member 34 and the spring 52, the arm portion 46 of the operating arm 44 is caused to pivot in an upwardly direction as viewed with reference to FIG. 4 about the pivot pin 50. Consequently, the arm portion 48 pivots in a downwardly direction as viewed with reference to FIG. 4 causing the contact member 56 to move to the left whereupon the contact member 56 engages the contacts 62 and 64 thereby completing an electrical circuit between the terminals 72 and 76.

There will now be set forth a description of the manner in which the refrigeration system 10 equipped with a superheat control system in accord with the present invention is intended to perform. For this purpose, reference will be had hereinafter to a refrigeration system in which typical pressures are employed. Moreover, it will be assumed that the refrigerant used in the refrigeration system 10 is the refrigerant R-22. With a refriger-

ant vapor pressure of 60 p.s.i. in the conduit 28, the pressure sensitive bellows 32 will likewise have a pressure of 60 p.s.i. applied thereto by virtue of the fact that the bellows 32 is in fluid flow communication with the conduit 28 through the pipe 30. Consequently, there is an initial force corresponding to this 60 lb. pressure being applied to the pivotably mounted operating arm 44 by the member 34. With an assumed loading force of 2 p.s.i. being provided by the spring 52 acting against the arm portion 46 of the operating arm 44, there is a combined force equivalent to 62 p.s.i. acting to move the operating arm 44 in a downwardly direction as viewed with reference to FIG. 2 of the drawings. It is conventional practice in refrigeration systems that the refrigerant being supplied to the suction side of the compressor be at a superheat of approximately 10°. Therefore, since the sensing bulb 36 also contains the refrigerant R-22 and since the equivalent saturated temperature of R-22 refrigerant at 60 p.s.i. is approximately 34°F., a 10° superheat means that the actual temperature of the 60 p.s.i. vapor within the conduit 28 will be 44°F. With the sensing bulb 36 being supported in engagement with the outer wall of the conduit 28, the refrigerant within the bulb 36 will be under the influence of a 44°F. temperature which will reflect an equivalent bulb pressure of approximately 74.5 p.s.i. Moreover, since the bulb 36 is connected to the pressure sensitive bellows 40 by means of the capillary tube 38, there will be a pressure of approximately 74.5 p.s.i. applied within the bellows 40. Therefore, inasmuch as the opposing force being exerted against the operating arm 44 by the member 42, i.e., a force equivalent to 74.5 p.s.i. is greater than the force being applied thereto by the member 34 and the spring 52, i.e., a force of 62 p.s.i., contact member 56 will occupy the position thereof which is depicted in FIG. 4 of the drawings wherein the contacts 62 and 64 are in a closed condition thereby being effective to complete an electrical circuit between the terminals 72 and 76. The latter terminals 72 and 76 could be connected in turn in circuit relation with some form of visual indicator means whereby when the contacts 62 and 64 are in a closed condition, a green light indicating a normal operating condition would be illuminated. On the other hand, if so desired, the terminals 72 and 76 could be connected in circuit relation with the control circuit of the compressor 12 whereby the latter is operable only when the contacts 62 and 64 are in a closed condition. Assuming now that there occurs a decrease in the superheat of the vapor flowing in the conduit 28, a corresponding decrease will be produced in the pressure of the refrigerant within the sensing bulb 36 and thereby a change in the forces being exerted against the arm portion 46 of the operating arm 44. For example, should the superheat of the refrigerant vapor flowing through the conduit 28 to the compressor 12 decrease to a value of approximately 1°F., the pressure of the refrigerant in the bulb 36 will be at a level which is at or near equilibrium with the vapor pressure in the conduit 28 and the bellows 32. Consequently, the loading force of the spring 52 bearing against the arm portion 48 will be effective to cause the operating arm 44 to pivot about the pivot pin 50 to substantially the position thereof illustrated in FIG. 3 of the drawings whereupon the contact member 56 engages the contacts 66 and 68 thereby completing an electrical circuit between the terminals 78 and 80. The latter terminals 78 and 80 could in turn

for example, be connected in circuit relation with a suitable alarm circuit whereby when the contacts 62 and 64 are in a closed condition a suitable audible alarm is caused to be sounded and/or a visual alarm could be produced such as the illumination of a red warning light whereby the operator's attention is drawn to the fact that the refrigeration system 10 is malfunctioning. On the other hand, if the terminals 72 and 76 are connected in circuit relation with the control circuit of the compressor 12 whereby an electrical circuit must be completed between the terminals 72 and 76 in order for the compressor 12 to operate, when the contact member 56 has been caused to move to the right in the manner depicted in FIG. 3 of the drawings as a result of the decrease in the superheat of the refrigerant vapor flowing through the conduit 28, the contact member 56 is disengaged from the contacts 62 and 64 thereby opening the electrical circuit between the terminals 72 and 76 which in turn is effective to stop the operation of the compressor 12. Another circuit arrangement which might be utilized for example, is to have the terminals 72 and 76 connected in circuit relation with an alarm means whereby under normal conditions when the contacts 63 and 64 are in a closed condition the aforementioned alarm means is inoperable, however, when a decrease in superheat occurs whereby the contact member 56 moves to the position thereof shown in FIG. 2 of the drawings, the alarm means is actuated to draw the operator's attention to the fact that something is wrong in the refrigeration system 10. Moreover, if a continued loss of superheat occurs whereby the contact member 56 continues to move to the right wherein it engages the contacts 66 and 68 as shown in FIG. 3 of the drawings, the terminals 78 and 80 could be connected in circuit relation with the control circuitry of the compressor 12 whereby when the circuit is completed to the terminals 78 and 80 through the closing of the contacts 66 and 68, the compressor 12 is caused to shut down. Obviously, the terminals 72, 76, 78 and 80 of the switch 58 can be connected in circuit relation with a variety of different forms of electrical circuits whereby different functions are produced depending on which pair of contacts are in a closed condition. Therefore, it is deemed sufficient to merely note that the switch 58 and more particularly the contact member 56 thereof is capable of occupying any of three different operating positions, namely, a first position as shown in FIG. 2 of the drawings wherein the contact member 56 is out of engagement with both the first pair of contacts 62 and 64 and the second pair of contacts 66 and 68, a second position as illustrated in FIG. 3 of the drawings wherein the contact member 56 is in engagement with the second pair of contacts 66 and 68, or a third position as depicted in FIG. 4 of the drawings wherein the contact member 56 is in engagement with the first pair of contacts 62 and 64.

Although only one embodiment of a superheat control system constructed in accord with the present invention has been described hereinabove and illustrated in the drawings, it is to be understood that modifications in the construction thereof may be made thereto by those skilled in the art without departing from the essence of the invention. In this connection, some of the modifications which can be made in the superheat control system have been alluded to hereinabove while others will become readily apparent to those skilled in the art when exposed to the present description and il-

illustration of the construction of the superheat control system. For example, obviously a variety of different types of refrigerant could be employed in the refrigeration system 10 and the bulb 36 other than the refrigerant R-22, without departing from the essence of the invention. In this regard, of course, it might be found to be necessary if some other refrigerant were to be substituted for the refrigerant R-22 to adjust the amount of biasing force being exerted against the arm portion 46 by the spring 52. Consequently, it is therefore desirable that the spring 52 be made adjustable. In addition, although the switch 58 as described hereinabove comprises a multipole switch which has three different operating positions, obviously the switch 58 could take some other form without departing from the essence of the invention. Likewise, the operating functions being controlled through the switch 58 could obviously take some form other than that which has been specifically described hereinabove without departing from the essence of the invention. Also, although in accord with the preferred embodiment, the contact member 56 is guided in its longitudinal movement by some form of guide means, the latter being schematically depicted in FIGS. 3 and 4 of the drawings by the means designated therein by reference numeral 86, obviously if so desired this means could be eliminated or could take some other form from that depicted in the drawings without departing from the essence of the invention.

Thus, it can be seen that the present invention provides a novel and improved superheat control system which is particularly adapted for employment in a refrigeration cycle. Moreover, in accord with the present invention a superheat control system has been provided which is operable to sense the presence of superheat in the refrigerant vapor being returned to the compressor. The superheat control system of the present invention is operable to effect a control function when a predetermined loss of superheat in the refrigerant vapor being returned to the compressor is sensed to have occurred. Furthermore, in accord with the present invention a superheat control system is provided which embodies an alarm circuit that is operable to alert an operator that a loss of superheat is occurring. Also, a superheat control system has been provided in accord with the present invention which is effective in the presence of a continual loss of superheat in the refrigerant vapor being returned to the compressor to shut down the compressor before any significant damage can be done thereto by liquid refrigerant reaching the latter. Finally, in accord with the present invention a superheat control system has been provided which is easily installable in a refrigeration cycle, and is compatible with the presently available components that are commonly found embodied in a refrigeration cycle.

I claim:

1. In a refrigeration system having a compressor, a condenser connected in fluid flow relation with the compressor by first conduit means, an expansion valve and an evaporator both being connected in fluid flow relation by second conduit means with the condenser, and with the evaporator being further connected in fluid flow relation with the compressor by third conduit means whereby refrigerant is made to flow from the compressor to the condenser, from the condenser to the expansion valve and therethrough to the evaporator, and from the evaporator back to the compressor to complete a refrigeration cycle, the improvement of a

superheat control system embodied within the refrigeration system operable for sensing the superheat of the refrigerant flowing to the compressor and for performing a control function in response thereto, said superheat control system comprising:

- a. first pressure sensing means operable to establish a reference pressure, said first pressure sensing means including pipe means connected at one end thereof to the third conduit means in fluid flow relation therewith at a point along the length of the third conduit means adjacent to but spaced from the compressor and so as to comprise the sole fluid flow connection with the third conduit means between the point of connection of said pipe means with the third conduit means and the point of connection of the third conduit means with the compressor, said pipe means being operable to draw thereto from the third conduit means refrigerant at the same pressure and temperature conditions as the refrigerant entering the compressor from the third conduit means, said first pressure responsive means comprising a first pressure sensitive bellows expandable by the refrigerant received therewithin so as to thereby operate to establish a reference pressure therewithin corresponding to the pressure of the refrigerant within said first pressure sensitive bellows and therefore also to the pressure of the refrigerant entering the compressor from the third conduit means, said first pressure sensitive bellows including a first member connected thereto so as to be movable therewith in accordance with the expansion and contraction of said first pressure sensitive bellows;
- b. second pressure sensing means operable to establish a pressure correlated to the superheat of the refrigerant entering the compressor from the third conduit means, said second pressure sensing means including a sensing means having fluid therein supported in juxtaposed relation to the surface of the third conduit means adjacent to the point of connection of said pipe means with the third conduit means, said sensing means being operable to sense the superheat of the refrigerant flowing in the third conduit means and to establish by means of the fluid within said sensing means a pressure correlated to the sensed superheat, tube means having one end thereof connected to said sensing means for receiving fluid therefrom, and second pressure responsive means comprising a second pressure sensitive bellows having one end thereof connected to said tube means so as to receive fluid therefrom at a pressure corresponding to the pressure of the fluid within said sensing means, said second pressure sensitive bellows being expandable by the fluid received therewithin so as to thereby operate to establish a pressure therewithin correlated to the superheat of the refrigerant entering the compressor from the third conduit means as sensed by said sensing means, said second pressure sensitive bellows including a second member connected thereto so as to be movable therewith in accordance with the expansion and contraction of said second pressure sensitive bellows, said second pressure sensitive bellows being physically unconnected to said first pressure sensitive bellows so that the fluid within said second pressure sensitive bellows acts solely on said second pressure sensitive bellows and

the refrigerant within said first pressure sensitive bellows acts solely on said first pressure sensitive bellows; and

c. switch means including a switch having at least one pair of contacts, at least one pair of terminals connected in electrical circuit relation with said pair of contacts and connectible in electrical circuit relation with an external electrical circuit for purposes of performing a control function, a contact member supported for movement between a first position and a second position relative to said pair of contacts, operating means mounted for movement between a first position and a second position operatively connected to said contact member for imparting movement thereto, said operating means comprising an elongated pivotably mounted lever arm having one end thereof mechanically connected to said contact member, said lever arm adjacent the other end thereof having said first member of said first pressure sensitive bellows in engagement therewith for applying a first force thereto in one direction corresponding to the reference pressure and also having said second member of said second pressure sensitive bellows in engagement therewith for applying a second force thereto in the opposite direction corresponding to the pressure correlated to the superheat of the refrigerant entering the compressor from the third conduit means wherein when said first force being applied to said lever arm by said first member of said first pressure sensitive bellows acting thereagainst exceeds said second force being applied to said lever arm by said second member of said second pressure sensitive bellows said lever arm is moved by the differential force being applied thereto to said first position thereof causing said contact member to occupy said first position thereof relative to said pair of contacts and when said first force being applied to said lever arm by said first member of said first pressure sensitive bellows is less than said second force being applied to said lever arm by said second member of said second pressure sensitive bellows said lever arm is moved by the differential force being applied thereto to said second position thereof thereby causing said contact member to occupy said second position thereof relative to said pair of contacts.

2. In a refrigeration system as set forth in claim 1 wherein said pipe means comprises a length of pipe having one end thereof open to the third conduit means and the other end thereof open to said first pressure sensitive bellows.

3. In a refrigeration system as set forth in claim 2 wherein said sensing means comprises a sensing bulb, and said tube means comprises a capillary tube having one end open to said sensing bulb and the other end thereof open to said second pressure sensitive bellows.

4. In a refrigeration system as set forth in claim 3 wherein said switch means includes a second pair of contacts, a second pair of terminals connected in electrical circuit relation with said second pair of contacts and connectible in electrical circuit relation with an external electrical circuit for purposes of performing a control function, and said contact member is movable between a third position and a fourth position relative to said second pair of contacts.

5. A superheat control system operable for sensing the superheat of a refrigerant flowing in a conduit to the suction side of the compressor and for performing a control function in response to a predetermined sensing of superheat level comprising:

a. first pressure sensing means operable to establish a reference pressure, said first pressure sensing means including pipe means connected at one end thereof to the conduit in fluid flow relation therewith at a point along the length of the conduit adjacent to but spaced from the compressor and so as to comprise the sole fluid flow connection with the conduit between the point of connection of said pipe means with the conduit and the point of connection of the conduit with the compressor, said pipe means being operable to draw thereinto from the conduit refrigerant at the same pressure and temperature conditions as the refrigerant entering the compressor from the conduit, said first sensing means further including first pressure responsive means connected to the other end of said pipe means so as to receive therefrom the refrigerant drawn into said pipe means, said first pressure responsive means comprising a first pressure sensitive bellows expandable by the refrigerant received therewithin so as to thereby operate to establish a reference pressure therewithin corresponding to the pressure of the refrigerant within said first pressure sensitive bellows and therefore also to the pressure of the refrigerant entering the compressor from the conduit, said first pressure sensitive bellows including a first member connected thereto so as to be movable therewith in accordance with the expansion and contraction of said first pressure sensitive bellows;

b. second pressure sensing means operable to establish a pressure correlated to the superheat of the refrigerant entering the compressor from the conduit, said second pressure sensing means including a sensing means having fluid therein supported in juxtaposed relation to the surface of the conduit adjacent to the point of connection of said pipe means with the conduit, said sensing means being operable to sense the superheat of the refrigerant flowing in the conduit and to establish by means of the fluid within said sensing means a pressure correlated to the sensed superheat, tube means having one end thereof connected to said sensing means for receiving fluid therefrom, and second pressure responsive means comprising a second pressure sensitive bellows having one end thereof connected to said tube means so as to receive fluid therefrom at a pressure corresponding to the pressure of the fluid within said sensing means, said second pressure sensitive bellows being expandable by the fluid received therewithin so as to thereby operate to establish a pressure therewithin correlated to the superheat of the refrigerant entering the compressor from the conduit as sensed by said sensing means, said second pressure sensitive bellows including a second member connected thereto so as to be movable therewith in accordance with the expansion and contraction of said second pressure sensitive bellows, said second pressure sensitive bellows being physically unconnected to said first pressure sensitive bellows so that the fluid within said second pressure sensitive bellows acts solely on said

13

second pressure sensitive bellows and the refrigerant within said first pressure sensitive bellows acts solely on said first pressure sensitive bellows; and
c. switch means including a switch having at least one pair of contacts, at least one pair of terminals connected in electrical circuit relation with said pair of contacts and connectible in electrical circuit relation with an external electrical circuit for purposes of performing a control function, a contact member supported for movement between a first position and a second position relative to said pair of contacts, operating means mounted for movement between a first position and a second position operatively connected to said contact member for imparting movement thereto, said operating means comprising an elongated pivotably mounted lever arm having one end thereof mechanically connected to said contact member, said lever arm adjacent the other end thereof having said first member of said first pressure sensitive bellows in engagement therewith for applying a first force thereto in one direction corresponding to the reference pressure and also having said second member of said second pressure sensitive bellows in engage-

25

30

35

40

45

50

55

60

65

14

ment therewith for applying a second force thereto in the opposite direction corresponding to the pressure correlated to the superheat of the refrigerant entering the compressor from the conduit wherein when said first force being applied to said lever arm by said first member of said first pressure sensitive bellows acting thereagainst exceeds said second force being applied to said lever arm by said second member of said second pressure sensitive bellows said lever arm is moved by the differential force being applied thereto to said first position thereof causing said contact member to occupy said first position thereof relative to said pair of contacts and when said first force being applied to said lever arm by said first member of said first pressure sensitive bellows is less than said second force being applied to said lever arm by said second member of said second pressure sensitive bellows said lever arm is moved by the differential force being applied thereto to said second position thereof thereby causing said contact member to occupy said second position thereof relative to said pair of contacts.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,913,347
DATED : October 21, 1975
INVENTOR(S) : Raymond F. Stevens

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 10, line 21, after "means," insert the following:

-- said first sensing means further including first pressure responsive means connected to the other end of said pipe means so as to receive therefrom the refrigerant drawn into said pipe means, --

Signed and Sealed this

twenty-fourth Day of February 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks