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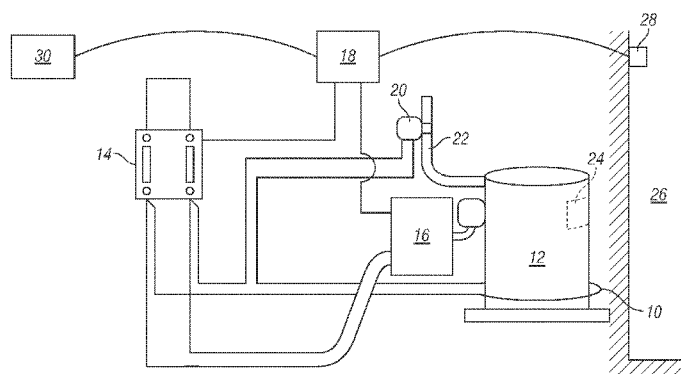


Figure 1

(57) Abstract: A control system for a crank case heater for an inverter operated compressor of a cooling system includes a contactor operably connected to the crank case heater and an inverter controller compressor and at least one compressor temperature sensor disposed at the compressor to sense a compressor temperature and an compressor internal temperature sensor. A controller is operably connected to the crank case heater and the at least one compressor temperature sensor and configured to close the contactor to energize the crank case heater independently from operation of the compressor when the at least one compressor temperature sensor senses a compressor temperature below a desired threshold.

CRANK CASE HEATER CONTROL

BACKGROUND OF THE INVENTION

[0001] The subject matter disclosed herein relates to cooling systems. More specifically, the subject disclosure relates to control of a crank case heater for a variable speed compressor of such systems.

[0002] A crank case heater is an electrical component option used on cooling systems such as air conditioners, heat pumps or chillers. In a cooling system, refrigerant always tends to migrate towards a lowest temperature portion of the system when the refrigeration system is not operating, specifically when the compressor not operating. The compressor is generally the largest thermal mass in the refrigeration system. Due to normal day to night temperature swings, the temperature around the compressor changes in split system and packaged air conditioners and heat pumps. As the temperature warms from a cold or chilly night, the compressor is often the coldest point in the system due the time it takes for the compressor to change temperatures compared to other components. Due to the inherent design of hermetic and semi-hermetic compressors, when the compressor is the coldest point in the system and when the cooling system is shut off, the refrigerant vapor will then condense in the compressor and mix with the compressor crank case oil. On the next start of the compressor the oil/refrigerant mixture tends to wash out the lubricant from the bearings in the compressor, leading to wear to the point that sometimes causes bearings in the compressor to locked up, or gall to a point resulting in an unusable compressor. To mitigate this problem, crank case heaters are often utilized to prevent the compressor from being the lowest temperature component of the system, thereby preventing migration of refrigerant to the compressor crankcase.

[0003] The crankcase heater is a resistance heater installed either in (insertion type) or around (belly band type) a compressor of a cooling system. When a voltage is applied across the crank case heater, it produces heat which migrates to the compressor to heat the compressor crank case. A typical crank case heater wired across the contactor which operates the compressor. When the contactor is in an open position as when the compressor is not operating, the crank case heater is in series with the compressor windings. Current flows through the compressor windings and powers the crank case heater. When the contactor is closed, the compressor is operating and the crank case heater is off because there is no

potential across the crank case heater. Thus, in the typical system, whenever the compressor is off, the crank case heater is operating, whether necessary or not.

BRIEF DESCRIPTION OF THE INVENTION

[0004] According to one aspect of the invention, a control system for a crank case heater for an inverter-operated variable speed compressor of a cooling system includes a contactor operably connected to the crank case heater and the inverter and at least one compressor temperature sensor located at the compressor to sense a compressor temperature. A temperature switch is located at a discharge line of the compressor, and a controller is operably connected to the crank case heater and the at least one compressor internal temperature sensor. The control is configured to close the contactor to energize the crank case heater when the at least one compressor temperature sensor senses a compressor temperature below a desired threshold.

[0005] According to another aspect of the invention, a cooling system includes an inverter operably connected to a compressor,

[0006] According to another aspect of the invention, a cooling system includes an inverter, a compressor, a crank case heater disposed at the compressor, and a contactor operably connected to the inverter and the crank case heater. At least one compressor temperature sensor is located at the compressor to sense a compressor temperature. A controller is operably connected to the crank case heater and the at least one compressor temperature sensor and configured to close the contactor to energize the crank case heater independently from operation of the compressor when the at least one compressor temperature sensor senses a compressor temperature below a desired threshold.

[0007] According to yet another aspect of the invention, a method of controlling operation of a crank case heater for a compressor of a cooling system includes sensing a compressor temperature and determining if the compressor temperature is below a desired threshold. A contactor operably connected to the inverter and the crank case heater is closed, thereby energizing the crank case heater if the compressor temperature is below the desired threshold, wherein energizing of the crank case heater is independent of operation of the compressor.

[0008] These and other advantages and features will become more apparent from the following description taken in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWING

[0009] The subject matter, which is regarded as the invention, is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other features, and advantages of the invention are apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

[0010] The Figure is a schematic of a crank case heater and compressor arrangement.

[0011] The detailed description explains embodiments of the invention, together with advantages and features, by way of example with reference to the drawings.

DETAILED DESCRIPTION OF THE INVENTION

[0012] Shown in the Figure is schematic of an embodiment of a crank case heater (CCH) 10, an inverter 16 and compressor 12 as arranged in a cooling system. In this arrangement, the compressor 12 is connected to a contactor 14 indirectly via an inverter 16. A controller is also connected to an outdoor ambient temperature sensor and an indoor temperature sensor. The inverter 16 is powered by the contactor 14 and a controller 18 is utilized to determine when to send a signal to the inverter 16 directing the inverter to power the compressor 12. Thus, the contactor 14 can be closed by a signal from a controller without necessarily supplying power to the compressor 12.

[0013] The CCH 10 is wired in series with the contactor 14 and with a discharge line temperature switch, or thermostat 20, that assesses a temperature of the compressor discharge line and is located at a discharge line 22 of the compressor 12. When it is desired to energize the CCH 10, the controller 18 sends a signal to the contactor 14 to close the contactor 14 thus applying a voltage across the CCH 10. The decision to energize the CCH 10 is based on a compressor temperature sensed by a compressor temperature sensor 24 located, for example, internal to the compressor 12, and the indoor temperature and the outdoor temperature. If the compressor temperature sensor 24 senses a compressor temperature above a desired upper limit, the contactor 14 will be opened causing the CCH 10 to not be powered. If, on the other hand, the compressor temperature sensor 24 senses a compressor temperature below a desired lower limit while the compressor 12 is not running, the thermostat 20 switch will be closed (because the compressor 12 is not running) and the CCH 10 will be powered given that the contactor 14 is closed. For example, in some embodiments, the CCH 10 will be powered if the compressor temperature sensor 24 determines that the compressor temperature is below an indoor temperature of a dwelling 26 at which the system is installed and is less than 25 degrees Fahrenheit above an outdoor ambient temperature as determined by dwelling

temperature sensors 28 and outdoor ambient temperature sensors 30 connected to the controller 18, and the thermostat 20 senses a discharge line 22 temperature below a discharge line threshold temperature.

[0014] The threshold limits are established based on physics consisting of indoor and outdoor temperature, the power of the crank case heater 10 and the thermal time constant of the compressor 12. A delta is added to the compressor temperature to ensure changing outdoor ambient do not cause the compressor 12 to become colder than the outdoor ambient. This ensures the compressor 12 is never the coldest refrigerant component in the system.

[0015] This arrangement and control method utilizes sensed temperatures to control operation of the CCH 10 rather than always operating the CCH 10 when the compressor 12 is off, and not operating the CCH 10 when the compressor 12 is on, as in the prior art. This allows for limiting the operation if the CCH 10 when the compressor is operating and also limiting the CCH 10 operation at higher outdoor ambient temperatures, when operation of the CCH may not be necessary, thus saving energy and preserving operational life of the CCH 10.

[0016] While the invention has been described in detail in connection with only a limited number of embodiments, it should be readily understood that the invention is not limited to such disclosed embodiments. Rather, the invention can be modified to incorporate any number of variations, alterations, substitutions or equivalent arrangements not heretofore described, but which are commensurate with the spirit and scope of the invention. Additionally, while various embodiments of the invention have been described, it is to be understood that aspects of the invention may include only some of the described embodiments. Accordingly, the invention is not to be seen as limited by the foregoing description, but is only limited by the scope of the appended claims.

CLAIMS:

1. A control system for a crank case heater for a compressor of a cooling system comprising:

a contactor operably connected to the crank case heater, the inverter and indirectly to the compressor;

at least one compressor temperature sensor disposed at the compressor to sense a compressor temperature;

a first temperature switch located in air space; and

a controller operably connected to the crank case heater and the at least one compressor temperature sensor and configured to close the contactor to energize the crank case heater when the at least one compressor temperature sensor senses a compressor temperature below a desired threshold; and

a second temperature switch located at a discharge line of the compressor to energize the crank case heater when a discharge line temperature is below a desired lower limit and the compressor is not operating.

2. The control system of Claim 1, wherein the controller is operably connected to the compressor.

3. The control system of Claim 2, wherein the controller is configured to energize the compressor independently of the crank case heater via the second temperature switch.

4. The control system of Claim 2, wherein the controller is operably connected to the compressor via the inverter.

5. The control system of Claim 1, wherein at least one compressor temperature sensor is disposed internal to the compressor.

6. The control system of Claim 1, wherein the first temperature switch is in an indoor ambient air space.

7. The control system of Claim 1 wherein the first temperature switch is in an outdoor ambient air space.

8. The control system of Claim 1, wherein the threshold is determined relative to the lesser of a dwelling temperature and an outdoor ambient temperature plus a differential value.

9. The control system of Claim 8, further comprising at least one dwelling temperature sensor operably connected to the controller.

10. The control system of Claim 8, further comprising at least one ambient temperature sensor operably connected to the controller.

11. A cooling system comprising:
 - a compressor;
 - an inverter
 - a crank case heater disposed at the compressor;
 - a contactor operably connected to the inverter and the crank case heater;
 - at least one compressor temperature sensor disposed at the compressor to sense a compressor temperature; and
 - a controller operably connected to the crank case heater and the at least one compressor temperature sensor and configured to close the contactor to energize the crank case heater when the at least one compressor temperature sensor senses a compressor temperature below a desired threshold; and
 - a temperature switch located at a discharge line of the compressor to energize the crank case heater when a discharge line temperature is below a desired lower limit and the compressor is not operating.
12. The cooling system of Claim 11, wherein the controller is operably connected to the inverter.
13. The cooling system of Claim 12, wherein the controller is configured to energize the compressor independent of operation of the crank case heater.
14. The cooling system of Claim 12, wherein the controller is operably connected to the compressor via an inverter.
15. The cooling system of Claim 14, wherein the inverter is connected to the contactor.
16. The cooling system of Claim 11, wherein the at least one compressor temperature sensor is disposed internal to the compressor.
17. The cooling system of Claim 11, further comprising at least one dwelling temperature sensor operably connected to the controller.
18. The cooling system of Claim 11, further comprising at least one outdoor ambient temperature sensor operably connected to the controller.
19. A method of controlling operation of a crank case heater for a compressor of a cooling system comprising:
 - sensing a compressor temperature;
 - determining if the compressor temperature is below a desired threshold;

closing a contactor operably connected to the compressor and the crank case heater, thereby energizing the crank case heater if the compressor temperature is below the desired threshold;

wherein energizing of the crank case heater is independent of operation of the compressor.

20. The method of Claim 19, further comprising deenergizing the crank case heater when the compressor temperature is above the desired threshold.

21. The method of Claim 19, further comprising deenergizing the crank case heater when the compressor discharge line temperature is above the desired threshold.

22. The method of Claim 19, wherein the threshold is determined relative to the lesser of a dwelling temperature and an outdoor ambient temperature.

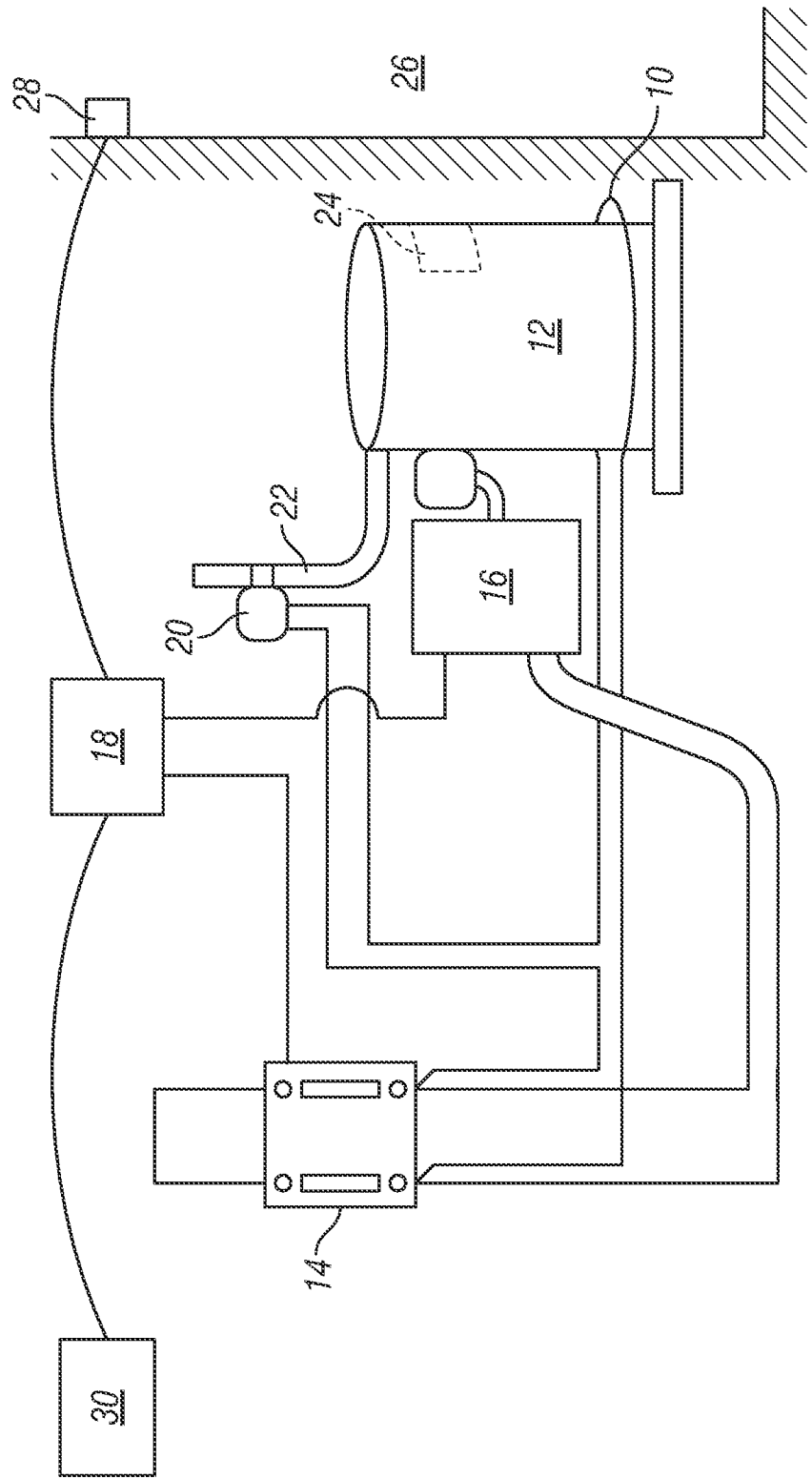


Figure 1