A refrigerant system includes a compressor, an evaporator, an expansion valve, an accumulator or equivalent, one or more earth loops, and auxiliary heat removal means. The auxiliary means comprises a fan and fan coil and the fan forces air between multiple tubes of the fan coil to remove unwanted heat from the hot vapor exiting the compressor.
REFERGERANT-TO-AIR DEVICE

This application claims the benefit of U.S. Provisional Patent Application Ser. No. 61/717,353, filed on Oct. 23, 2012 the contents of which are herein incorporated by reference their entirety.

The present invention relates to the field of a refrigerant-to-air device that works in conjunction with earth-coupled heat pumps, to dissipate a portion of the heat otherwise intended to be rejected to the earth.

FIG. 1 is a diagram of the components, the refrigerant circuit, and the electrical connections.

In FIG. 1, the parts are numbered as follows:

- Compressor
- Auxiliary Cooling Module (ACM)
- Electronic Motor Control Unit (EMCU)
- Refrigerant conduits
- Expansion Valve or Liquid Flow Control
- Evaporator
- Accumulator or Active Charge Control
- Temperature Sensor
- Pressure Sensor
- Wiring from temperature sensor to EMCU
- Wiring from pressure sensor to EMCU
- Power cable from the EMCU to blower

Surface of Earth.

In FIG. 2, the parts are numbered as follows:

- Fan coil
- Inlet manifold
- Outlet manifold
- Refrigerant tubing
- Refrigerant outlet

Fan coil arrangement
- Fan motor
- Fan blades
- Side view of fan coil outlet manifold
- Fan coil outlet.

In FIG. 3, the parts are numbered as follows:

- Refrigerant-to-water heat exchanger
- Water circulating pump
- Underground water loop

In FIG. 5, the parts are numbered as follows:

- Power cable from wattage sensor to EMCU
- Power inlet cable
- Wattage sensor
- Wiring from wattage sensor to EMCU
- Power cable from wattage sensor to compressor

The operation of the system is as follows:

The unwanted heat is absorbed by the refrigerant in the evaporator. The refrigerant is then drawn through Active Charge Control (ACC) and on to the compressor. The hot compressed vapor then leaves the compressor through conduit and the heated vapor proceeds onward to earth loop, where the remaining heat is dissipated within the earth, where the vapor is condensed back to liquid refrigerant. The liquid then flows via conduit to the Liquid Flow Control (LFC), which regulates the amount of refrigerant required by the evaporator. The refrigerant then flows on to the evaporator via conduit to complete the cycle. The LFC and the ACC work in concert to regulate the condenser (earth loop) and to be fully condensing and the evaporator fully wetted, such that all inactive liquid refrigerant resides in the ACC, and an optimum amount of refrigerant is in active circulation under all operating conditions, and the ACC provides storage for inactive liquid refrigerant to provide for all operating conditions, plus any desired amount of reserve refrigerant charge.

Pressure sensor transmits a pressure signal via wiring to the Electronic Motor Control Unit (EMCU), or temperature sensor transmits a temperature signal via wiring to the EMCU. The purpose of the EMCU is to turn the fan motor on or off and modulate the electrical power that enters the EMCU by power entrance cable and then flows from the EMCU via power cable to a fan within the ACM. Within the EMCU is an electronic control (not shown), that uses pressure or temperature signals to regulate the speed of the fan motor by controlling the amount of electrical power that flows on to the fan within the ACM. The electronic control modules are off-the-shelf modules that are generally readily available, leaving no need to describe the details of such modules. The amount of power delivered to the fan may vary from zero (off) to full power, thus allowing the ACM to remove the optimum amount of unwanted heat from the hot vapor, to achieve a predictable system capacity and efficiency. Improving efficiency by use of the ACM can allow fewer earth loops for a given system capacity, which can result in a reduced overall system cost.

Alternatively, the LFC may be replaced with other expansion devices such as a capillary tube, TXV (Thermostatic expansion valve), or a fixed orifice, and the ACC may be replaced with a liquid/vapor separator such as an accumulator. For a system with these refrigerant controls, it is necessary to calculate a fixed refrigerant charge for the system, the amount of charge that will provide the best average efficiency as the systems operates through the whole range of operating conditions.

With reference to FIG. 2, the fan coil receives hot vapor at inlet manifold, then the hot vapor flows through multiple tubes, where air blowing between the tubes absorbs and removes heat. The tubes may be finned (not shown) for maximum heat removal. The vapor flows from the tubes into outlet manifold and exits the fan coil at exit stub.

FIG. 3 is a side view of Fan and Fan coil viewed from the exit manifold side of the Fan coil. The fan motor rotates the fan blades, to force air through the fan coil (FIG. 2). The refrigerant vapor exits the fan coil at exit stub.

With reference to FIG. 4, another embodiment of the invention dissipates the unwanted heat into the earth by way of a heat exchanger and water loop circuit. In this configuration, the hot vapor leaving the ACM is conveyed via conduit to the primary side of heat exchanger, wherein the vapor is condensed back to liquid and the liquid refrigerant proceeds via conduit to the expansion valve, to complete the cycle. The unwanted heat is transferred to the secondary side of the heat exchanger. A water loop circuit consists of the secondary side of the heat exchanger, a...
circulating pump 32, and underground water loop 33. The pump 32 circulates water, or glycol or some other liquid through the circuit, thereby transferring the unwanted heat into the earth 28.

Yet another embodiment of the invention is shown in FIG. 5. All the components in FIG. 4 remain, and components 34, 35, 36, and 37 are added. In FIGS. 1 and 4, the function of holding the compressor output temperature and/or pressure to or below a desired limit, is provided by automatically or manually controlling the speed of the fan motor 51. The configuration of FIG. 5 further provides the function of automatically controlling the fan to a speed that results in the lowest power consumption incurred by the system. Power for the system enters through power cable 34, and proceeds through wattage sensor 35 to the EMCU 27 via electric power cable 26, and to the compressor 10, via power cable 37. Wattage sensor 35 then sends a signal representing the total power usage to the EMCU via wiring 36.

With this configuration, the EMCU is set to maintain a fan speed that gives the lowest system wattage input. When the pressure and/or temperature sensor reaches the desired limit, the EMCU will then respond to control the fan such that the desired limit is not exceeded. When the pressure and temperature are below the set limit, the AMCU will adjust the fan speed to a speed that reduces the total wattage to the system to a minimum, but not to a speed that allows the temperature or pressure to rise above the desired limits.

What is claimed is:

1. A refrigerant system including a compressor, an evaporator, an expansion valve, an accumulator, and a Liquid Flow Control (LFC), an Active Charge Control (ACC), an ACM, and an EMCU, and one or more of a refrigerant earth loop or a water earth loop, wherein the ACM and EMCU serve to prevent the temperature or pressure from exceeding the desired limit, and wherein the LFC serves to maintain the condenser, herein consisting of the earth loop(s), in a fully condensing condition, and wherein the ACC serves to maintain the evaporator in a “fully wetted” condition, with the result that the LFC and ACC, working in concert to collect and store all inactive, non-circulating liquid refrigerant within the ACC, to provide that the optimum amount of refrigerant is in active circulation under all operating conditions, which in turn provides improved system efficiency.

5. A refrigerant system comprising a compressor, an evaporator, an expansion valve, an accumulator, an Auxiliary Cooling Module (ACM), a heat exchanger, a pump, and one or more water loops buried within the earth, and further comprising a conventional electronic control module (ECMU) to automatically control the speed of the fan in the ACM to modulate the amount of heat to be removed, and wherein a pressure sensor and/or a temperature sensor mounted on the hot vapor conduit leaving the compressor sends pressure and/or temperature signals to the ECMU, to regulate the electrical power input to the fan in the ACM in response to the pressure or temperature signals, to regulate the amount of heat removed by the Auxiliary Cooling Module, to thereby prevent exceeding the desired pressure or temperature limit.

6. The system of claim 5 wherein the expansion valve is an LFC and the Accumulator is an ACC, and wherein the LFC and ACC work in concert to require all non-circulating liquid refrigerant to be stored in the ACC, to provide that an optimum amount of refrigerant is in active circulation within the full range of operating conditions.

7. The system of claim 3, further comprising wattage minimizing means, wherein said means consist of wattage sensor which measures the total wattage consumed by the system, and wherein the signal from the sensor is connected to the ECMU, and the ECMU is set to adjust the fan speed to minimize the total wattage drawn by the system, while preventing the compressor outlet conduit temperature or pressure from exceeding a desired limit.

8. The system of claim 4, further comprising Wattage minimizing means, wherein said means consist of wattage sensor which measures the total wattage consumed by the system, and wherein the signal from the sensor is connected to the ECMU, and the ECMU is set to adjust the fan speed to minimize the total wattage drawn by the system, while preventing the compressor outlet conduit temperature or pressure from exceeding a desired limit.

9. The system of claim 5, further comprising Wattage minimizing means, wherein said means consist of wattage sensor which measures the total wattage consumed by the system, and wherein the signal from the sensor is connected to the ECMU, and the ECMU is set to adjust the fan speed to minimize the total wattage drawn by the system, while preventing the compressor outlet conduit temperature or pressure from exceeding a desired limit.

10. The system of claim 6, further comprising wattage minimizing means, wherein said means consist of wattage sensor which measures the total wattage consumed by the system, and wherein the signal from the sensor is connected to the ECMU, and the ECMU is set to adjust the fan speed to minimize the total wattage drawn by the system, while preventing the compressor outlet conduit temperature or pressure from exceeding a desired limit.