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DEFROSTING ARRANGEMENT FOR HEAT PUMP

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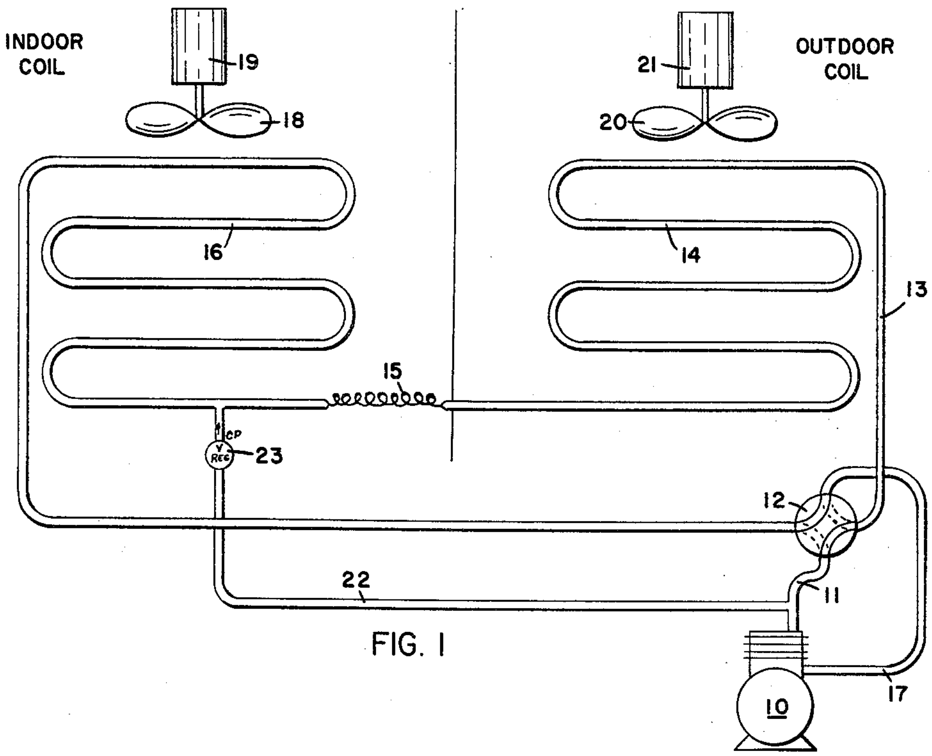

FIG. 1

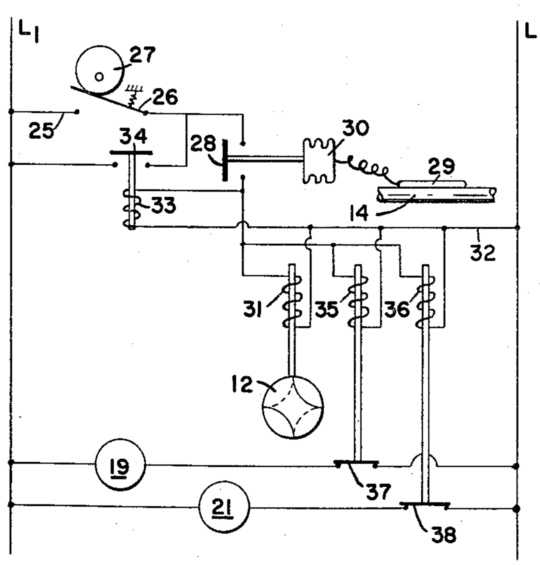

FIG. 2

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DEFROSTING ARRANGEMENT FOR HEAT PUMP

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This invention relates broadly to air conditioning equipment. More particularly, this invention relates to air conditioning equipment employing a refrigeration system operable under the reverse cycle principle. Units of this type are generally known as heat pumps and are operable to supply either cooled or warm air to an enclosure being served by the air conditioning unit.

In heat pumps of the air-to-air type, heat is extracted from one source of air and rejected to another. When the heat pump is employed to supply heated air to an enclosure, heat extracted from a source of air flowing over an outdoor heat transfer coil is rejected to a stream of air flowing over a heat transfer coil located inside the enclosure being treated. Under circumstances where the ambient temperature is substantially reduced, the amount of heat in the outdoor air is likewise relatively reduced. The heat pump operates, however, to lower the temperature of the outdoor coil sufficiently so that heat will flow from the outdoor air to the refrigerant within the coil. In reducing the temperature of the coil to a value such that a continued flow of heat will ensue, the outdoor coil may become frosted. This is true because the evaporator temperature is below the freezing point of water and moisture in the air stream flowing over the coil is deposited on the surface of the coil and frozen thereon.

Various arrangements have been suggested for periodically removing the coating of frost from the outdoor coil in a heat pump of the type under consideration so that efficient operation of the outdoor heat exchanger will continue. One of the more common arrangements proposed involves reversing the refrigerant flow so that the unit temporarily reverts to cooling cycle operation. Thus hot gaseous refrigerant flows from the compressor to the outdoor coil while the indoor coil temporarily functions as an evaporator. Such an arrangement may cause inconvenience to occupants of the enclosure if the defrosting period is of considerable duration for the reason that relatively cool air is being supplied to the enclosure under circumstances where warm air is needed to maintain comfortable conditions.

The chief object of this invention is the provision of an improved arrangement for defrosting an outdoor coil of a heat pump operating under heating conditions which includes means for temporarily loading the evaporator coil during the period that defrosting occurs. The loading of the evaporator coil occurs in the interest of reducing the defrosting period by providing a relatively high evaporator pressure during the defrosting period.

Another object of the invention is an improved method of defrosting a frost accumulating coil employed as a component in a heat pump.

Other objects and features of the invention will be apparent upon a consideration of the ensuing specification and drawings in which:

FIGURE 1 is a diagrammatic view of a heat pump equipped with the defrosting control forming the subject of this invention; and

FIGURE 2 is a schematic view of an electric circuit for use with a heat pump employing the invention.

Referring more particularly to FIGURE 1, there is shown for the purpose of illustrating this invention, an air-to-air heat pump employing a refrigeration system operable under the reverse cycle principle. In equipment of this type a first heat transfer coil is disposed within the area to be served by the heat pump and a second coil is located outside the area usually in the ambient. A compressor **10** discharges relatively hot gaseous refrigerant through discharge line **11** and four-way reversing valve **12** employed for the purpose of reversing refrigerant flow through a portion of the system in order to obtain the desired heating and cooling effects. From the reversing valve **12** which is controlled by the operation of the solenoid in a manner later to be described, the hot gaseous refrigerant flows during cooling cycle operation to an outdoor coil **14** where condensation of the liquid refrigerant occurs as ambient air is passed over the surface thereof by fan **20** driven by motor **21**.

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Liquid refrigerant formed in coil **14** flows through capillary **15** or other suitable expansion device, to an indoor coil **16** serving as an evaporator. In the indoor coil, liquid refrigerant is converted to vaporous refrigerant as it extracts heat from a stream of air delivered over the coil by fan **18** controlled by motor **19**. Vaporous refrigerant so formed flows through the reversing valve **12** to suction line **17** on into the compressor to complete the refrigerant flow cycle.

As is conventional in systems of the type described, the four-way reversing valve **12** may be actuated so that line **11** is placed in communication with the indoor coil **16** when it is desired to operate the unit on a heating cycle. Under these circumstances, heat from the refrigerant flowing in coil **16** is rejected to the air within the enclosure. The rejection of heat from the refrigerant converts the vaporous refrigerant to liquid refrigerant which flows through capillary **15** to the outdoor coil **14** which now functions as an evaporator. The vaporous refrigerant created in outdoor coil **14** as a result of heat transfer between the refrigerant and ambient air flows through the reversing valve into suction line **17**.

During the heating cycle operation described, very often the temperature of the outdoor air drops so that a heat sink of a relatively low temperature is presented. The refrigeration system acts to draw a low suction temperature and pressure so that heat may flow from the outdoor air stream to the refrigerant. In so doing, very often a coating of frost accumulates on the outdoor surface of coil **14**. An automatic defrosting system depicted in FIGURE 2 is operable to sense the collection of a predetermined amount of frost and operate to temporarily reverse the system to act on cooling cycle operation. In FIGURE 2, there is shown a control circuit adapted to function in this manner. A primary circuit consisting of conductor **25**, timer actuated switch **26**, thermal responsive switch **28** and coil **31** of solenoid **12** as well as conductor **32** functions to energize under certain circumstances, coil **31**. Periodically the timer **27** acts through a cam member to close switch **26** against the action of a spring. As the bulb **29** arranged on the outdoor coil senses a temperature below that indicated as necessity for defrost, bellows **30** forming a part of a thermal responsive system with bulb **29**, contracts and closes switch **28**. Under these circumstances, the coil **31** of the solenoid controlling reversing valve **12** is energized and moved to the position shown in FIGURE 1 permitting flow of hot gaseous refrigerant directly to the outdoor coil having a frost accumulation thereon.

In order to maintain coil **31** energized after the timer has moved to the position connecting switch **26** with line **25**, a holding circuit including coil **33** is energized. Coil **33** pulls in switch **34** so that the circuit through coil **31** is maintained energized despite the opening of switch **26** until the temperature rises in the outdoor coil indicating the absence of frost from its surface. Under these circumstances bellows **30** expands opening switch **28**. Connected in parallel with coil 31 in the defrost circuit illustrated in FIGURE 2 are coils 35 and 36 which control switches 37 and 38 regulating circuits through the fan motors 19 and 21. It will thus be appreciated that during the defrosting cycle the motors controlling the operation of fans 18 and 20 are inactive.

During the defrosting period coil 16 functions as an evaporator and inasmuch as fan 18 is inactive, it functions as an unloaded evaporator. This causes the temperature and pressure within evaporator 16 to drop to a value which in turn causes a reduction in head pressure. Thus under circumstances where it is desirable to have a relatively large body of hot gaseous refrigerant the capacity of the compressor is such that it is unable to deliver such a volume. This invention involves connecting line 22 with the compressor discharge and the indoor coil. A valve of the constant pressure type is employed in line 22 for the purpose of regulating flow therein. Valve 23 functions so that when the pressure within coil 16 drops to a predetermined value, valve 23 opens and permits the flow of a portion of the relatively high pressure discharge gas from the compressor to the evaporator coil. This has the effect of elevating the pressure and temperature of the refrigerant within coil 16 which in turn elevates the temperature and pressure of the gas being directed in line 11 to the outdoor coil. With the arrangement shown, it is possible to reduce the defrosting period and permit bulb 29 to more quickly sense a temperature high enough to indicate complete defrosting of the outdoor coil. This in turn reduces the time that coil 16 must function as an evaporator when it is desired that it function as a condenser in the interest of maintaining comfortable conditions within the area served by the heat pump.

While I have described a preferred embodiment of the invention, it will be understood that the invention is not limited thereto, since it may be otherwise embodied within the scope of the following claims.

I claim:

1. Air conditioning apparatus including a refrigeration system operable under the reverse cycle principle to supply either heated or cooled air to an enclosure, said system comprising a compressor, a first heat transfer coil located within the enclosure, a second heat transfer coil located outside the enclosure, refrigerant expansion means interposed between said coils connected to form a closed circuit for the flow of refrigerant, valve means for reversing the direction of refrigerant flow through said coils so that condensation of refrigerant occurs in said first coil, means for supplying a heat exchange medium over said first coil, means for supplying air over said second coil, defrost control means operative to temporarily reverse refrigerant flow within said circuit to supply hot gaseous refrigerant to said second coil, said defrost control means being effective to terminate operation of said air supply means, a line connecting the compressor outlet with said first coil and means responsive to a predetermined operating characteristic of said first coil regulating passage of a portion of the hot gaseous refrigerant flowing from the compressor to the first coil to raise the pressure therein and increase the loading on said coil.

2. In an air conditioning apparatus including a refrigeration system comprising a compressor, a heat rejection coil, a refrigerant expansion member and a heat absorption coil connected to form a refrigerant flow circuit, means for passing a first medium in heat transfer relation with the heat rejection coil, means for passing a second medium in heat transfer relation with said heat absorption coil, means effective to interchange the heat transfer functions of said coils so that the heat absorption coil becomes a heat rejection coil and the heat rejection coil becomes a heat absorption coil, a line connecting the compressor with one of said coils, and means regulating flow of refrigerant in said line, said means being operative when said coil is acting as a heat absorption coil to meter refrigerant to said heat absorption coil to maintain a predetermined minimum coil temperature.

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