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DEFROST CONTROLS FOR HEAT PUMPS

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Fig. 2.

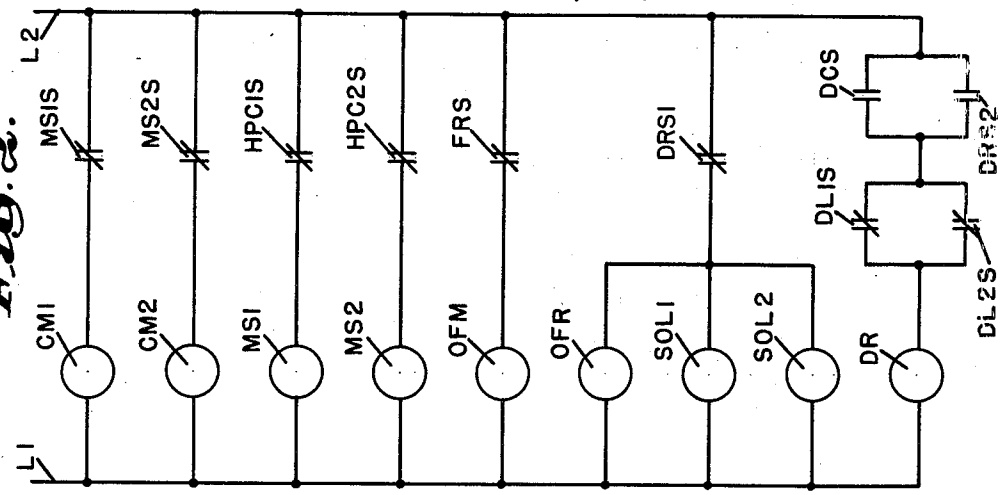
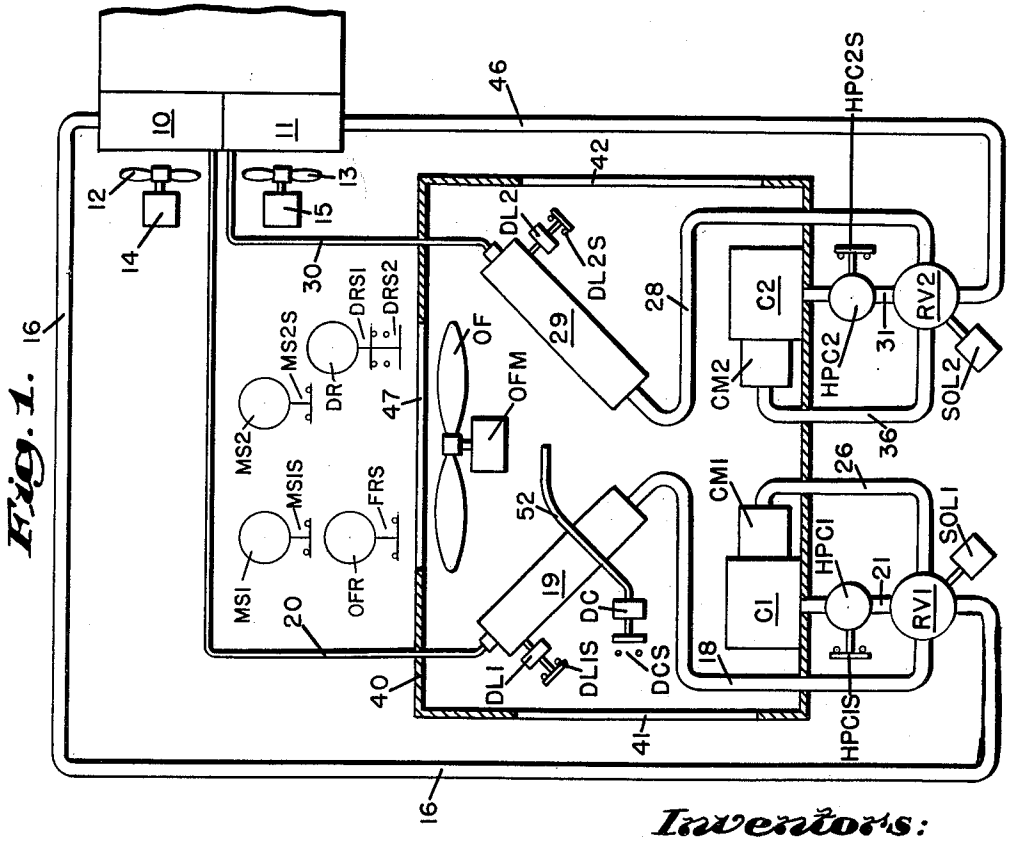


Fig. 1.



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DEFROST CONTROLS FOR HEAT PUMPS

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This invention relates to heat pumps, and relates more particularly to controls for defrosting the outdoor coils of multiple system heat pumps having a common fan or common fans for moving outdoor air over their outdoor coils.

An air conditioning system using a two system heat pump may be used for cooling indoor air in summer, and for heating indoor air in winter, one system being used for light loads, and both systems being used for heavy loads. The outdoor coils of the two systems may have a common fan or common fans for moving outdoor air over them. During indoor air heating, the indoor coils of the systems act as condenser coils, and their outdoor coils act as evaporator coils. Frost often forms on the outdoor coils when they are acting as evaporator coils at low outdoor temperatures, and for proper operation they need to be defrosted. The frost may build up differently on the two outdoor coils so that after defrosting has started, one may finish defrosting before the other. Our co-pending application, Serial No. 206,968, filed July 2, 1962, discloses controls for preventing the first system to finish defrosting from returning to normal, indoor air heating operation until the other system has finished defrosting. Our present invention is an improvement over the invention in said application in that fewer controls are required, resulting in a simpler and less expensive control system.

An object of this invention is to improve defrost controls for multiple system heat pumps.

Another object of this invention is to simplify and reduce the cost of controls for defrosting the outdoor coils of multiple system heat pumps.

This invention will now be described with reference to the annexed drawings, of which:

FIG. 1 is a diagrammatic view of a two system heat pump embodying this invention, the relays and the electrical wiring used being omitted, and

FIG. 2 is a circuit schematic showing the relays and wiring used, and showing the switches which are open and which are closed when both systems are operating to heat indoor air.

Aligned, abutting, indoor coils **10** and **11** have fans **12** and **13** respectively, driven by electric motors **14** and **15** respectively, for moving indoor air to be conditioned over the coils **10** and **11** and into the space to be served. One end of the coil **10** is connected by tubing **16** to a refrigerant reversal valve RV1 which is connected by tubing **18** to one end of outdoor coil **19**, the other end of which is connected by capillary tube **20** serving as a two-way expansion device to the other end of the coil **10**. The valve RV1 is connected by tubing **26** to the interior of electric motor CM1 of refrigerant compressor C1, which interior is connected to the suction side of the compressor C1 as is usual with hermetic compressors. The valve RV1 is connected by tubing **21** containing a high pressure cut-out HPC1, to the discharge side of the compressor C1. The valve RV1 is adjustable by solenoid SOL1 to route refrigerant from the compressor C1 through the tubing **18** to the outdoor coil **19**, and from the latter through the capillary tube **20** to the indoor coil **10** when the latter is to act as an evaporator coil, and the outdoor coil **19** is to act as a condenser coil, or to route refrigerant from the compressor C1 through

the tubing **16** to the indoor coil **10** and from the latter through the capillary tube **20** to the outdoor coil **19** when the latter is to act as an evaporator coil, and the indoor coil **10** is to act as a condenser coil.

One end of the indoor coil **11** is connected by tubing **46** to a refrigerant reversal valve RV2 which is connected by tubing **28** to one end of outdoor coil **29**, the other end of which is connected by capillary tube **30** serving as a two-way expansion device, to the other end of the coil **11**. The valve RV2 is connected by tubing **31** containing a high pressure cut-out HPC2 to the discharge side of hermetic compressor C2 which is driven by electric motor CM2. The valve RV2 is connected by tubing **36** to the interior of the motor CM2, which interior is connected to the suction side of the compressor C2. The valve RV2 is adjustable by solenoid SOL2 to route refrigerant from the compressor C2 through the tubing **28** to the outdoor coil **29** and from the latter through the capillary tube **30** to the indoor coil **11** when the latter is to act as an evaporator coil, or to route refrigerant from the compressor C2 through the tubing **46** to the indoor coil **11** and from the latter through the capillary tube **30** to the outdoor coil **29** when the latter is to act as an evaporator coil, and the indoor coil **11** is to act as a condenser coil.

The indoor coil **10**, the outdoor coil **19**, the compressor C1 and their associated components form one system of the heat pump, and the indoor coil **11**, the outdoor coil **29**, the compressor C2 and their associated components form the second system of the heat pump.

The outdoor coils **19** and **29** and the compressors C1 and C2 are supported within a cabinet having outdoor air inlets **41** and **42** in its ends, and having an air outlet **47** in its top. The coils **19** and **29** are slanted so that they diverge towards the outlet **47**, and within the space between the coils below the outlet **47** is a fan OF driven by an electric motor OFM, which draws outdoor air through the inlets **41** and **42**, passes this air over the coils **19** and **29**, and discharges this air through the outlet **47**.

The compressor motor CM1 is connected in series with normally closed switch MS1S of motor starter MS1 to A.C. electric supply lines L1 and L2. The compressor motor CM2 is connected in series with normally closed switch MS2S of motor starter MS2 to the supply lines. The motor starter MS1 is connected in series with normally closed switch HPC1S of the cut-out HPC1 to the supply lines. The motor starter MS2 is connected in series with normally closed switch HPC2S of the cut-out HPC2 to the supply lines.

The pressure cut-outs HPC1 and HPC2 are automatic resetting. They automatically reclose their switches when the abnormal pressure that has opened them decreases to normal.

The outdoor fan motor OFM is connected in series with normally closed switch FRS of fan relay OFR to the supply lines L1 and L2.

The fan relay OFR and the solenoids SOL1 and SOL2 are connected in parallel, and are connected in series with a normally closed switch DRS1 of defrost relay DR to the supply lines.

A defrost control DC is connected by tube **52** to the air between the coils **19** and **29**, and has a normally open switch DCS which closes when the air pressure between the coils **19** and **29** decreases as a result of frost having formed on either of the outdoor coils.

A defrost limit control DL1 is connected to the interior of the coil **19** so as to respond to the refrigerant pressure therein, and has a normally closed switch DL1S. A similar defrost limit control DL2 is connected to the interior of the coil **29** so as to respond to the refrigerant pressure therein, and has a normally closed switch DL2S. The switches DL1S and DL2S open when the pressures within

the coils 19 and 29 respectively, increase to normal pressures of about 220–250 p.s.i. when the frost has melted from them when they are operating as condenser coils. When the coils 19 and 29 are operating as evaporator coils, the pressures within them are insufficient to open the switches DL1S and DL2S, such pressures being, for example, at —10° F., only 16 p.s.i.

A normally deenergized defrost relay DR has a normally closed switch DRS1 and a normally open switch DRS2. The relay DR is connected in series with the switches DL1S and DL2S which are connected in parallel with each other, and the switches DCS and DRS2 connected in parallel with each other, to the supply lines L1 and L2.

Operation

In operation, it is assumed that an associated indoor thermostat which is not shown, has turned both systems of the heat pump on, and that the outdoor coils are operating as evaporator coils before substantial frost has formed on them. When substantial frost has formed on the coils 19 and 29, the resulting air pressure drop through them will cause the switch DCS to close and to energize through the normally closed switches DL1S and DL2S, the defrost relay DR which opens its switch DRS1 and closes its switch DRS2. The closing of the switch DRS2 establishes a holding circuit for maintaining the relay DR energized until both switches DL1S and DL2S open. The opening of the switch DRS1 deenergizes the relay OFR and the solenoids SOL1 and SOL2. The relay OFR opens its switch FRS which stops the fan motor OFM. The solenoids SOL1 and SOL2 adjust the reversal valves RV1 and RV2 respectively, to operate the indoor coils 10 and 11 respectively, as evaporator coils, and the outdoor coils 19 and 29 respectively, as condenser coils. The heat from the outdoor coils melts the frost thereon.

Assume that the coil 19 completes its defrosting first so that the pressure within it increases and opens the switch DL1S. The defrost relay remains energized through the still closed switches DL2S and DRS2 so that the defrosting continues. The compressor motor CM1 remains on until the rise in refrigerant pressure operates the cut-out HPC1 to open its switch HPC1S which deenergizes the motor starter MS1 and stops the motor CM1.

When the outdoor coil 29 completes its defrosting, the pressure within it increases and opens the switch DL2S, deenergizing the defrost relay DR. The latter then reopens its switch DRS2 and recloses its switch DRS1. The closed switch DRS1 reenergizes the solenoids SOL1 and SOL2 and the fan relay OFR. The solenoids SOL1 and SOL2 return the reversal valves RV1 and RV2 respectively to indoor air heating positions with the outdoor air coils 19 and 29 again operating as evaporators, and the indoor coils 10 and 11 again operating as condensers. The fan relay OFR recloses its switch FRS, restarting the outdoor fan motor OFM. The reduction in refrigerant pressure permits the cut-out HPC1 to reclose its switch HPC1S, restarting the compressor motor CM1. The two systems of the heat pump are now back in normal indoor air heating operation.

What is claimed is:

1. An air conditioning system comprising a first refrigerant compressor, a first indoor coil, a first outdoor coil, means including a first reversal valve connecting said compressor to said coils, a first solenoid for adjusting said valve to operate said outdoor coil as an evaporator coil or as a condenser coil, a second refrigerant compressor, a second indoor coil, a second outdoor coil, means including a second reversal valve for connecting said second compressor to said second coils, a second solenoid for adjusting said second valve to operate as an evaporator coil or as a condenser coil, a common fan for moving outdoor air over said outdoor coils, an electric motor for driving said fan, a defrost control responsive to air pressure drop across said outdoor coils, said control having a normally open switch which closes when there is a predetermined pressure drop across said outdoor coils, a first limit control responsive to refrigerant pressure within said first outdoor coil, said limit control having a normally closed switch which opens when there is a predetermined pressure within said first outdoor coil, a second limit control responsive to refrigerant pressure within said second outdoor coil, said second limit control having a normally closed switch which opens when there is a predetermined pressure within said second outdoor coil, said switches of said limit controls being connected in parallel, a normally deenergized defrost relay having a normally open switch connected in parallel with said switch of said defrost control and having a normally closed switch, electric supply connections, means including said switch of said defrost control and said switches of said limit controls for connecting said relay to said connections, and means including said normally closed switch of said relay for connecting said solenoids and said motor to said connections.

2. An air conditioning system comprising a first refrigerant compressor, a first electric motor for driving said compressor, a first indoor coil, a first outdoor coil, means including a first reversal valve for connecting said compressor to said coils, a first solenoid for adjusting said valve to operate said outdoor coil as an evaporator coil or as a condenser coil, a second refrigerant compressor, a second electric motor for driving said second compressor, a second indoor coil, a second outdoor coil, means including a second reversal valve for connecting said second compressor to said second coils, a second solenoid for adjusting said second valve to operate said second outdoor coil as an evaporator or as a condenser coil, a common fan for moving outdoor air over said outdoor coils, a third electric motor for driving said fan, a defrost control responsive to air pressure drop across said outdoor coils, said control having a normally open switch which closes when there is a predetermined air pressure drop across said outdoor coils, a first limit control responsive to refrigerant pressure within said first outdoor coil, said limit control having a normally closed switch which opens when there is a predetermined pressure within said first outdoor coil, a second limit control responsive to refrigerant pressure within said second outdoor coil, said second limit control having a normally closed switch which opens when there is a predetermined pressure within said second outdoor coil, said switches of said limit controls being connected in parallel, a normally deenergized defrost relay having a normally open switch connected in parallel with said switch of said defrost control, said relay having a normally closed switch, electric supply connections, means including said switch of said defrost control and said switches of said limit controls for connecting said relay to said connections, means including said closed switch of said relay for connecting said solenoids and said third motor to said connections, a first pressure cut-out responsive to refrigerant pressure from said first compressor, said cut-out having a normally closed switch, means including said switch of said cut-out for connecting said first motor to said connections, a second cut-out responsive to refrigerant pressure from said second compressor, said second cut-out having a normally closed switch, and means including said switch of said second cut-out for connecting said second motor to said connections, said switches of said cut-outs opening when the pressures from said compressors are abnormal and automatically reclosing when the pressures from said compressors return to normal.

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