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REVERSIBLE HEAT PUMP SYSTEM

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Fig. 1.

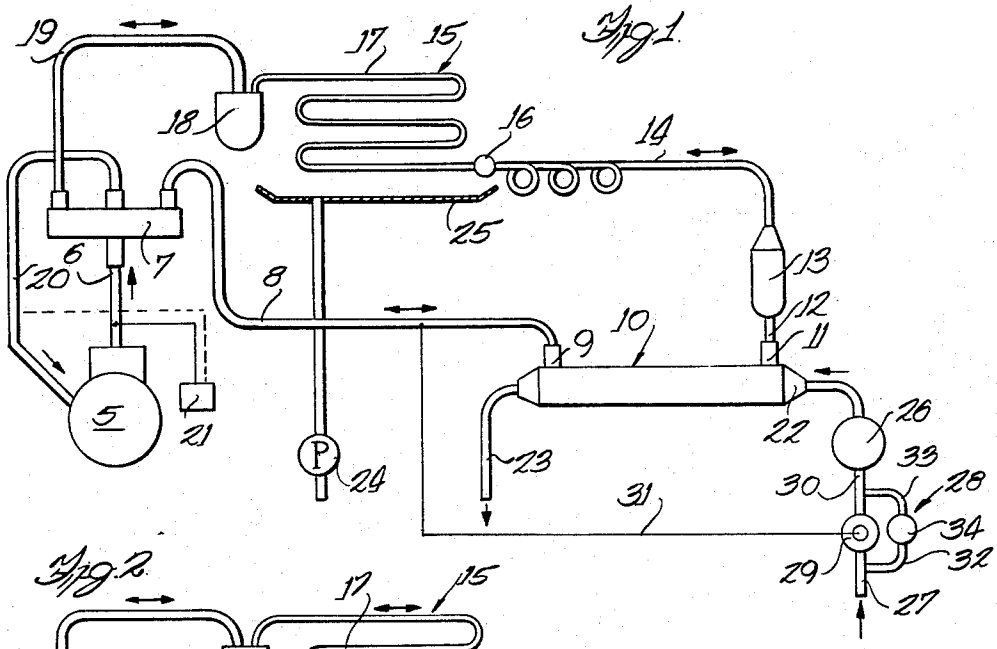


Fig. 2.

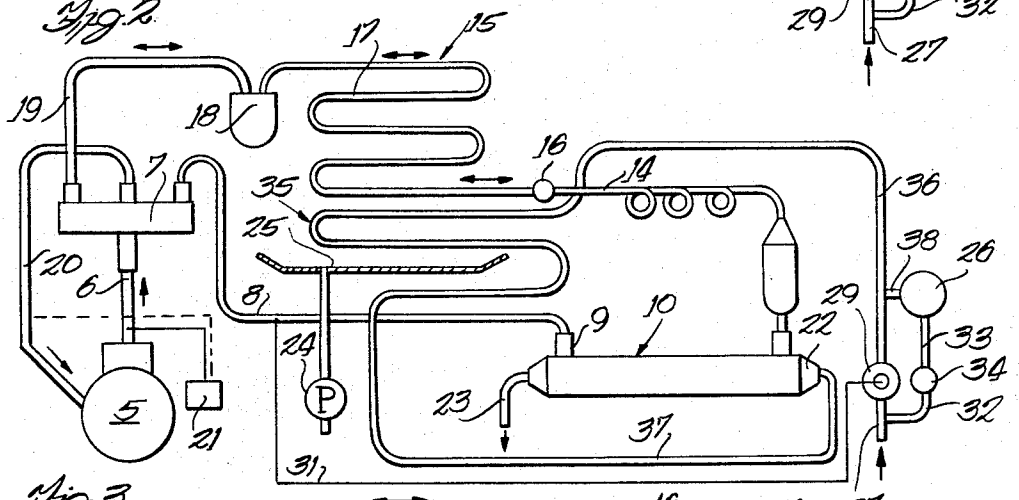
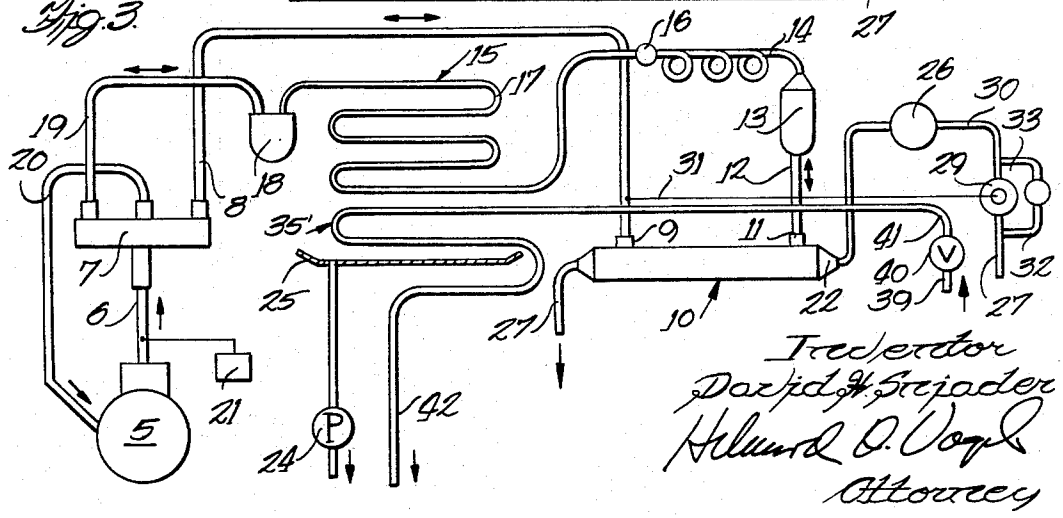


Fig. 3.



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REVERSIBLE HEAT PUMP SYSTEM

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6 Claims. (Cl. 165—29)

This invention relates to thermostatically controlled heat pumps which operate reversibly to heat or cool room air. More in particular this invention relates to an air conditioner operable thermostatically to cool a room and alternately to heat a room under the control of a thermostat.

In conventional water-cooled air-conditioning systems the water, during the warm season, enters the condenser somewhere between 60–85° F. and discharges approximately 25° F. above inlet temperature. If the same air conditioner is operated in reverse cycle the heat pump then delivers heat to the room which heat is extracted from the condenser water. In such operation the water discharging from the condenser is about 25° F. below the inlet water temperature. Now during the winter months, particularly in northern areas such as Chicago, Illinois, water temperatures often drop to 35–38° F. Since during heat pump cycle operation the system extracts heat from the flowing condenser water, unless a high flow rate of condenser water is employed the heat extracted would result in freezing of the water in the condenser. Once freezing of the water in the condenser occurs no further water flow is possible and thus the heat pump could no longer extract heat.

In order to overcome the above described difficulties it is a prime object of the present invention to provide means for controlling the temperature of the inlet water to the condenser during operation on heat pump cycle.

Another important object of the invention is to provide an auxiliary water coil adjacent the evaporator coil for the purpose of augmenting the function of the evaporator coil.

Still another important object of the invention is to provide means for automatically elevating the temperature of inlet water to the condenser during heat pum operation.

A yet further object of the present invention is to pro-

These and other important objects inherent in the in-

augment a heat pump.

vide means for employing a central hot water source to

vention will be more readily understood from preferred embodiments of the invention described in the ensuing description, the appended claims, and the annexed drawings wherein:

FIGURE 1 is a schematic drawing illustrating a reversible cycle heat pump with automatic means for elevating the temperature of the water entering the condenser according to this invention;

FIGURE 2 is another form of the invention which interposes an auxiliary water coil adjacent the evaporator which further increases the efficiency of the system; and

FIGURE 3 is a variation of the system of FIGURE 2 wherein the auxiliary water coil employs a secondary source of hot water.

With continued reference to the drawings the numeral **5** in FIGURE 1 indicates an electrically energized refrigerant gas compressor of conventional construction. The compressor **5** discharges liquified compressed refrigerating

gas through line **6** to an electrically opearted reverse cycle valve **7** of conventional design. When the system is operated for cooling a room or rooms (i.e., air conditioning) the reversing valve **7** comunicates line **6** with port **9** of water medium heat exchanger or condenser **10** through line **8**. The liquified compressed refrigerant is cooled by the water condenser **10** and discharges as cooled liquified compressed refrigerant through port **11** of condenser **10** and enters a conventional strainer **13** through line **12**. From the strainer **13** the cooled liquified compressed refrigerant passes through line **14** to evaporator indicated at **15** through the orifice **16** thereof. As the cooled liquified compressed refrigerant passes through orifice **16** of evaporator **15** a large pressure drop occurs so that the liquid refrigerant vaporizes to the gas phase thereby lowering the temperature of the gas due to absorption of heat. The cold gas flows through the coil **17** of the evaporator **15** which absorbs heat from room air driven thereacross by a conventional electric fan (not shown). The refrigerant gas with heat thus absorbed from the room is conducted to an accumulator **18** as indicated in FIGURE 1. From accumulator **18** the refrigerant gas communicates with the inlet side of compressor **5** through line **19**, reverse cycle valve **7**, and line **20**. The relief valve **21** is interposed between lines **6** and **20** to prevent excessive pressure being developed by the compressor **5**.

During room cooling cycle (air conditioning) just described most of the heat absorbed from the room by the evaporator **15** is discharged into the condenser **10**. In order to remove this heat, cold water enters port **22** and discharges from the condenser **10** to drain through line **23**. Thus the temperature in line **23** is elevated from that of the inlet water at port **22**.

Now when the above described system is operated in reverse cycle the reverse cycle valve **7** connects line **6** with line **19** and thus the hot liquified refrigerant being discharged from the compressor **5** is conducted into the evaporator coil **15** which heat is discharged into the room by the room air circulating fan (not shown) moving the room air across the coil **17**. In effect this removes heat from the liquified refrigerant thus heating the room. The thus cooled liquified refrigerant passes through orifice **16** into line **14**, strainer **13**, line **12** and into the condenser unit **10** through line **11**. Between the orifice **16** and port **11** the pressure drop causes the liquified refrigerant to vaporize which results in a sharp temperature drop as is well known. The inlet water entering the port **22** of condenser **10** is thus cooled and the temperature of the inlet water is sharply reduced (usually about 25° F.) in the drain line **23**.

It will be appreciated from the above that during reverse cycle operation for heating the room the evaporator **15** actually functions as a heat exchanger in the same manner as the condenser **10** during room cooling cycle. But for simplicity in description the unit **10** will be referred to as a condenser and the unit **15** will be referred to as an evaporator although both are heat exchangers.

Up to this point a conventional reversible cycle heat pump has been described which may be operated for cooling a room when the temperature of the room is above a predetermined upper limit and reverses to deliver heat in the event the temperature of the room air is below a lower predetermined limit. Conventional thermostatic

control means for electrically shifting the reverse cycle valve **7** and energizing the compressor **5** are employed. The water pump **24** is merely a conventional means for removing condensate water from the collecting tray **25** which is condensed from the room air during room cooling cycle operation.

The prime novel feature of the present invention resides in the combination of water heating means with the above described reversible heat pump whereby water entering the port **22** of condenser **10** is thermostatically controlled to a predetermined minimum temperature during heat cycle operation. This is accomplished by interposing a thermostatically controlled water heater **26** in the inlet water line **27** from a primary source of cooled water. The conventional heater **26** may heat the water by electrically heated elements, gas or other means. Thus, during the colder months when the inlet water source entering line **27** reaches a predetermined minimum temperature, say 70° F., the heater functions to heat the inlet water temperature. If desired the thermostat of the water heater may be electrically interconnected with the room thermostat so that when heat is called for the thermostat control of the water heater **26** is energized when the room thermostat energizes the reverse cycle valve **7** to room heating cycle. The inlet water temperature at port **22** of condenser **10** is thus controlled to a predetermined minimum. From this it becomes apparent that during winter months' operation on heat cycle, the water in the condenser **10** will not freeze. Further, the water heater **26** provides the system with a source of heat which heat is transferred from the condenser **10** to the evaporator **15**.

In order to prevent unnecessary flow of water through the condenser **10** during periods when the system is not operating, i.e., when the room temperature thermostat is satisfied and thus neither calls for heating nor cooling, a conventional valve system, generally indicated at **28**, is employed. Valve **29** is interposed between inlet water line **27** and line **30** as shown in FIGURE 1. The valve **29** is operated by a control duct **31** communicatively connected to line **8**. When the system is operating on room cooling cycle the pressure in line **8** is high which high pressure opens valve **29** to admit water therethrough to condenser **10**. However, when the system is operating on room heating cycle the pressure in line **8** is low and thus valve **29** remains closed. In order to provide water flow to the condenser unit **10** during room heating cycle operation a by-pass line **32, 33** with a solenoid operated valve **34** is interposed therebetween is employed. The solenoid valve **34** is energized to the open position when the reverse cycle valve **7** is energized to shift to the heat cycle operation position.

FIGURE 2 is a modification of the above described system. In essence it provides a secondary coil indicated at **35** positioned adjacent the evaporator coil **15** wherein the coil **35** is connected in series relation with the water heater **26** and condenser unit **10**. Thus inlet water entering line **27** during cooling cycle operation passes through pressure operated valve **29** into line **36**, through coil **35** and thence into port **22** of condenser **10** through line **37**. Since, during warm months, inlet water temperature **27** is usually well below room temperature, the coil **35** functions to absorb some heat from the room and yet remain sufficiently cool to function for further heat absorbing in the condenser unit **10**. In this arrangement the hot water heater **26** is interposed in the by-pass system **28**. Thus during room heating cycle inlet water from line **27** passes through line **32**, energized solenoid valve **34**, through line **33**, hot water heater **26** to line **36** through line **38**. From this it is apparent that hot water from heater **26** is conducted directly to the secondary coil **35** through line **36** wherein some of the heat from the hot water is absorbed directly into the room from coil **35** and adritional heat is extracted from the hot water by the condenser unit **10** before discharge to drain line **27**. In this arrangement part of the heat absorbed by the room air is furnished directly by the water heater **26** and the balance of heat is furnished indirectly through the heat pump heating cycle operation.

The modification shown in FIGURE 3 is similar to that shown in FIGURE 2 except that the secondary coil **35'** is connected to a central hot water source, such source being common in hotels and apartment buildings. The central hot water source enters through line **39**, shut-off valve **40** which may be of a solenoid type energized under thermostat control, and line **41**. The discharge flow may be discharged to drain through line **42** as shown in FIGURE 3 or alternately connected to flow through the condenser **10** as shown in FIGURE 2.

In general the capacity of a heat pump system is chosen for cooling a room to a temperature of a few degrees below outside temperatures (usually about 15° F.). However, the same heat pump operating on the heating cycle could only raise the room temperature about the same number of degrees Fahrenheit during the cold months. Thus where the system is quite adequate for room cooling, the same system may well be inadequate when the outside temperature is, say 10° F. The systems of FIGURES 2 and 3 permit utilization of lower capacity heat pumps and yet provide sufficient heat when outside temperatures are extremely low. On the other hand the system of FIGURE 1 is quite adequate where outside temperatures seldom are below 50° F. Of course, if an adequate capacity heat pump is used sufficient to heat the room adequately when outside temperatures are extremely low then the secondary coil **35** or **35'** would be unnecessary.

Having thus described preferred embodiments of the invention it can be seen that the objects of the invention have been fully achieved and it must be understood that modifications thereof may be made which do not depart from the spirit of the invention nor from the scope thereof as defined in the appended claims.

What is claimed is:

1. A heat pump system for selectively heating and cooling a room comprising, in combination, a refrigerant compressor, a reverse cycle valve, an evaporator coil for selectively heating and cooling the air within said room and a heat exchanger connected in operative relation, said exchanger including a water medium heat exchange means, and a water heating means communicatively connecting a source of cooled water to the inlet side of the water medium heat exchange means for heating said water only during operation of said system for heating said room, and a secondary coil positioned adjacent to said evaporator coil, said secondary coil being interposed in series relation between the discharge side of said water heating means and the said inlet side of said heat exchanger whereby said secondary coil is heated by said water heating means only during operation of said system for heating said room.

2. A heat pump system according to claim **1** wherein said water heating means is thermostatically controlled.

3. A heat pump system for selectively heating and cooling a room comprising, in combination, a refrigerant compressor, a reverse cycle valve, an evaporator coil disposed within said room and a heat exchanger connected in operative relation, said exchanger including a water medium heat exchanger means, and a water heating means communicatively connecting a primary source of cooled water to the inlet side of said water medium heat exchange means for heating said water only during operation of said system for heating said room, and a secondary coil positioned adjacent said evaporator coil, said secondary coil being connected serially to the water inlet side of said heat exchanger and to the discharge side of said water heating means and said primary source, and valve means for connecting said primary source of water with said secondary coil during operation of said system for cooling said room and alternately connecting said

water heating means in series relation with said secondary coil during operation of said system for heating said room.

4. The invention according to claim 1 and means including valve means for bypassing said water heating means during the room cooling cycle of the system.

5. The invention according to claim 4 and means for thermostatically controlling the heating of said water heating means.

6. The invention according to claim 4 and said valve means being of a pressure operated type, and means for connecting the valve means to one side of the heat exchanger for response to the pressures at the heat exchanger.

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