Dec. 27, 1966 K. M. GERTEIS 3,293,874

AIR CONDITIONING SYSTEM WITH REHEATING MEANS

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FIG. 1

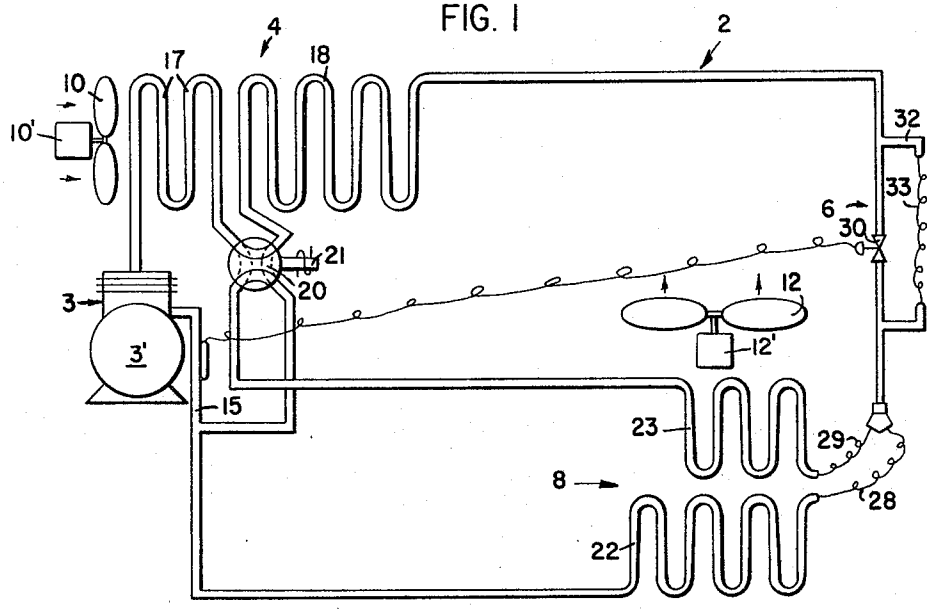



FIG. 2

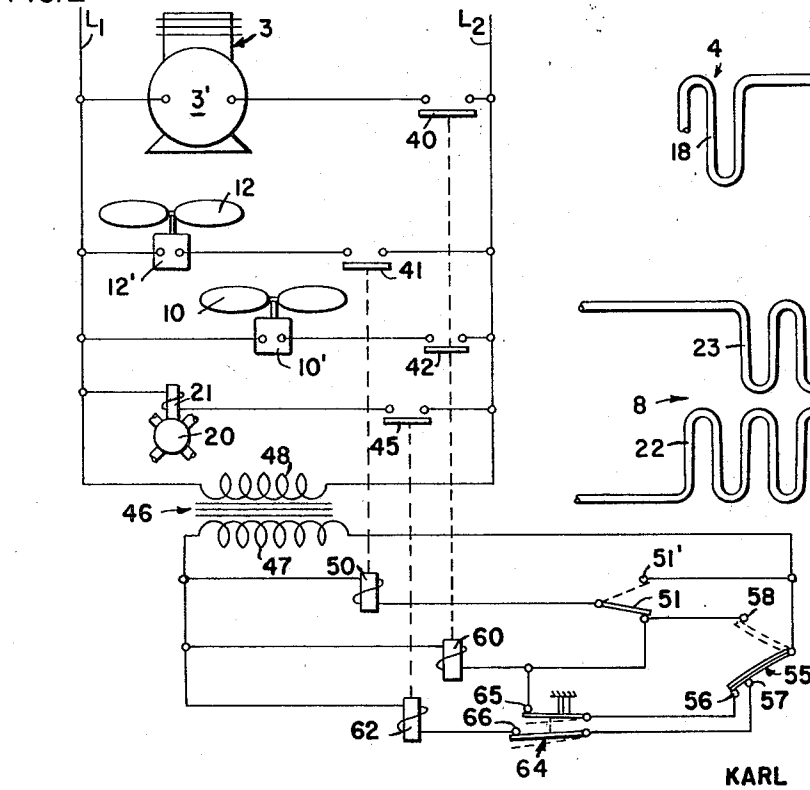
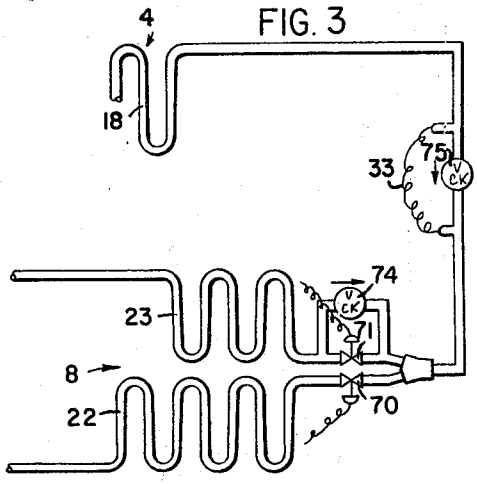



FIG. 3

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# AIR CONDITIONING SYSTEM WITH REHEATING MEANS

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This invention relates to air conditioning apparatus and, more particularly, to an air conditioning apparatus incorporating reheating means to provide air conditioned in both temperature and humidity.

Air conditioning units, such as room coolers, during periods of high humidity and relatively low temperatures may not maintain the humidity of the space being conditioned at a comfortable level since to do so would require excessive sensible cooling of the air being conditioned, which the controlling thermostat, responsive to sensible temperature conditions of the space conditioned, prevents. While the unit may operate cyclically under the control of the thermostat to cool the air, the percentage of moisture removed is inadequate and the relative humidity of the space being conditioned remains high.

One way of obtaining the proper balance between humidity and sensible heat removal is to reheat the air prior to discharge into the area being conditioned. Although numerous arrangements for reheating the conditioned air are known to the prior art, for example, electric resistance heating, most are not practicable with room coolers due to cost, complexity, etc.

It is a principal object of the present invention to provide an improved air conditioning apparatus incorporating means to reheat the conditioned air.

It is a further object of the present invention to provide a refrigeration system having valve means adapted at a predetermined humidity condition to route relatively hot gaseous refrigerant from the outdoor coil directly to a downstream part of the indoor coil to reheat the conditioned air.

It is an object of the present invention to provide an improved refrigeration system particularly useful with room-type coolers wherein a portion of the indoor and outdoor coils are combined to form a composite system condenser, the indoor coil condenser part serving to reheat the conditioned air stream while the remaining indoor coil part functions as a system evaporator.

This invention relates to a conditioning apparatus comprising in combination a compressor, a condenser, expansion means, and an evaporator arranged in a closed refrigeration system; fan means for bringing air to be conditioned into heat exchange relation with the evaporator for discharge into the space being conditioned whereby upon actuation of the compressor the apparatus cools the air; the condenser comprising first and second serially connected heat exchange coil parts; the evaporator comprising first and second heat exchange coil parts arranged to provide parallel refrigerant flow paths; valve means adapted when actuated to connect the condenser first coil part in series with the evaporator first coil part and the condenser second coil part with the suction side of the compressor whereby the evaporator first coil part functions as a condenser and the apparatus cools and heats the air; and control means for the apparatus including means responsive to a predetermined humidity condition in the space to actuate the valve means.

Other objects and advantages will be apparent from the ensuing description and drawings in which:

FIGURE 1 is a diagrammatic view showing the improved air conditioning apparatus of the present invention;

FIGURE 2 is a circuit diagram illustrating the control arrangement for the improved refrigeration system; and



FIGURE 3 is a diagrammatic view showing a modified form of the air conditioning apparatus of the present invention.

Referring to FIGURE 1 of the drawings, there is shown the air conditioning apparatus 2 of the present invention. Air conditioning apparatus 2 includes compressor 3, condenser 4, refrigerant metering means 6 and evaporator 8 interconneced with one another to form a closed refrigeration system. Refrigerant passing through condenser 4, which may be air cooled, is condensed by air discharged thereover by fan 10. Air to be conditioned is brought into heat exchange relation with evaporator 8 by means of fan 12, the conditioned air thereafter flowing into the area being conditioned. Gaseous refrigerant from evaporator 8 passes through line 15 to compressor 3.

Condenser 4 is circuited into two heat exchange coil sections 17, 18. Condenser coil sections 17, 18 are serially connected with one another by a suitable valve, such as four-way valve 20. Valve 20 preferably includes a solenoid operator 21 therefor effective, when energized, to position valve 20 in the dotted line position of FIGURE 1 of the drawings.

Evaporator coil 8 is circuited into two heat exchange coil sections 22, 23. Evaporator coil section 23, which may function as a reheat coil, usually has less heat exchange capacity than coil section 22. Evaporator coil section 23 is connected through reversing valve 20 with line 15 and the suction side of compressor 3. Evaporator coil sections 22, 23 are each connected through refrigerant metering means, capillaries 28, 29 respectively, with the downstream side of refrigerant metering means 6 and with each other. Evaporator coil section 23 is positioned downstream of coil section 22. Coil section 23 may, however, be disposed adjacent coil section 22.

Refrigerant metering means 6 comprises thermal-type expansion valve 30. Conduit 32, having a suitably sized capillary 33 therein bypassing expansion valve 30, may be provided. It is understood that expansion valve 30 is closed to the reverse flow of refrigerant from evaporator 8 to condenser coil section 18. Where used, bypass conduit 32 permits the controlled flow of refrigerant from coil section 23 to coil section 18 during the reheat cycle, as will be more apparent hereinafter.

In FIGURE 2 of the drawings, drive motor 3' of compressor 3 is connected through contactor 40 across power leads $L_1$, $L_2$. Leads $L_1$, $L_2$ connect with a suitable source of electrical energy (not shown).

Indoor fan motor 12' is connected through switch 41 across leads $L_1$, $L_2$. Outdoor fan motor 10' is connected through switch 42 across leads $L_1$, $L_2$. Solenoid 21 of valve 20 is connected through switch 45 across leads $L_1$, $L_2$.

Series connected indoor fan relay 50 and fan selector switch 51 are connected across the secondary winding 47 of stepdown transformer 46 through contact 58 of thermostat 55. Control relay 60 is connected across transformer winding 47 through thermostat contact 58. Primary winding 48 of stepdown transformer 46 is connected across leads $L_1$, $L_2$. Selector switch 51 may be manually moved to the dotted line position shown in FIGURE 2 to close contact 51' and effect continuous operation of indoor fan 10 independent of thermostat 55. Closure of contact 51' by switch 51 energizes relay 50, which in turn closes switch 41 to complete an energizing circuit to indoor fan motor 12'.

Thermostat 55 comprises any suitable commercially available two-stage thermostat adapted to control operation of the air conditioning apparatus 2 in response to cooling demands of the area being conditioned. At the occurrence of a relatively low cooling demand within the area being conditioned, thermostat 55 closes con-

tacts 56, 57. Where the cooling demand is high, thermostat 55 closes contact 58.

Closure of contact 58 by thermostat 55 completes an energizing circuit to control relay 60 and, through fan selector switch 51, to indoor fan relay 50. Control relay 60, when energized, closes contactor 40 to energize the compressor drive motor 3' and switch 42 to energize outdoor fan motor 10'.

Relay 62 is series connected with contact 57 of thermostat 55 through humidistat 64. Humidistat 64, which is conventional, closes contacts 65, 66 thereof at a predetermined humidity condition within the space being conditioned to ready the apparatus for operation on the reheat cycle, as will be more apparent hereinafter. Relay 62, when energized, closes switch 45 to complete an energizing circuit to solenoid 21 of valve 20.

Relay 50 and switch 51, and control relay 60 are connected through contact 65 of humidistat 64 to contact 56 of thermostat 55. Switching relay 62 is connected through contact 66 of humidistat 64 with thermostat contact 57.

At a predetermined high cooling demand of the space being conditioned, thermostat 55 closes contact 58 to complete emergizing circuits to control relay 60 and, through fan selector switch 51, to indoor fan relay 50. Control relay 60 closes contactor 40 to energize compressor drive motor 3' and switch 42 to energize outdoor fan motor 10'. Relay 50 closes switch 41 to energize indoor fan motor 12'.

Refrigerant discharged from compressor 3 passes through condenser coil sections 17, 18, series connected by reversing valve 20. The stream of outdoor air generated by fan 10 condenses the refrigerant flowing through coil sections 17, 18, the condensed refrigerant passing through expansion valve 30 and capillaries 28, 29 to evaporator coil sections 22, 23. Refrigerant in coil sections 22, 23 extracts heat from the air discharged thereover by fan 12. Vaporized refrigerant from coil section 22 flows directly to line 15 and compressor 3, while refrigerant from coil section 23 flows through valve 20 to line 15 and compressor 3. Conditioned air from coil sections 22, 23 flows into the area being conditioned.

Since contacts 56, 57 of thermostat 55 are open, humidistat 64 is neutralized and no reheating of the conditioned air stream by the conditioning apparatus 2 occurs.

Where the cooling demand imposed upon conditioning apparatus 2 is relatively low, thermostat 55 closes contacts 56, 57 to ready the apparatus for operation on the reheating cycle in response to the dehumidification demands of the space being conditioned as sensed by humidistat 64.

At a predetermined high humidity condition within the spaced conditioned, humidistat 64 closes contacts 65, 66 to complete, through thermostat 55, energizing circuits to relays 50, 60 and 62. Relays 50, 60 energize compressor 3, outdoor fan 10 and indoor fan 12, as described heretofore. Relay 62 closes switch 45 to energize solenoid 21 which moves valve 20 to the dotted line position of FIGURE 1 of the drawings to connect condenser coil section 17 directly with evaporator coil section 23 and condenser coil section 18 with line 15.

Refrigerant from compressor 3 passes through condenser coil section 17, reversing valve 20, reversing valve 20, evaporator coil section 23, capillary 29 and capillary 28 into coil section 22. Refrigerant in the condenser and evaporator coil sections 17, 23, respectively, is condensed by air from fans 10, 12, respectively, while refrigerant flowing through coil section 22 is evaporated, cooling the air passing thereover. Coil section 23 warms or reheats the relatively cool conditioned air from coil section 22. The vaporized refrigerant in coil section 22 returns through line 15 to compressor 3. The conditioning apparatus 2 accordingly functions to first cool then reheat the air stream generated by fan 12, the conditioned air thereafter passing to the area being conditioned.



Where used, capillary 33 is sized to allow condenser coil section 18 to function, to a limited degree, as an evaporator during the reheat cycle. This is useful where conditions encountered during the reheat cycle are such that evaporator coil section 22 alone is unable to maintain the surface temperature thereof above the frost point.

In the modification shown in FIGURE 3 of the drawings, wherein like numerals refer to like parts, capillaries 28, 29 are replaced by thermal-type expansion valves 70, 71, respectively. To permit condensed refrigerant in coil section 23 to flow through expansion valve 70 into coil section 22, a check valve controlled bypass 74 is provided for expansion valve 71. Where capillary 33 is used to permit controlled operation of coil section 18 as an evaporator during the reheat cycle, a check valve controlled bypass 75 is provided.

During cooling cycle operation of the modified system illustrated in FIGURE 3, condensed refrigerant from condenser 4 passes through check valve controlled bypass 75 and expansion valve 70, 71 into evaporator coil sections 22, 23, respectively. Refrigerant from coil sections 22, 23 returns to compressor 3 in the manner described.

During operation of the modified system on the reheat cycle, condensed refrigerant from coil section 23 passes via check valve controlled bypass 74 and expansion valve 70 into coil section 22. Vaporized refrigerant from coil section 22 returns to compressor 3, as described heretofore. Capillary 33, when used, feeds controlled amounts of condensed refrigerant into condenser coil section 18. Check valve controlled bypass 75 is closed to the flow of refrigerant from coil section 23 into coil section 18. Control of the modified system shown in FIGURE 3 is exercised in the manner shown and described.

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

I claim:

1. In a conditioning apparatus, the combination of a compressor, a condenser, expansion means, and an evaporator arranged in a closed refrigeration system; fan means for bringing air to be conditioned into heat exchange relation with said evaporator for discharge into the space being conditioned whereby upon actuation of said compressor said apparatus cools said air; said condenser comprising first and second serially connected heat exchange coil parts; said evaporator comprising first and second heat exchange coil parts arranged to provide parallel refrigerant flow paths; valve means adapted when actuated to connect said condenser first coil part in series with said evaporator first coil part and said condenser second coil part with the suction side of said compressor whereby said evaporator first coil part functions as a condenser and said apparatus cools and heats said air, and control means for said apparatus including means responsive to a predetermined humidity condition in said space to actuate said valve means.

2. The apparatus according to claim 1 in which said expansion means includes a thermal-type expansion valve operatively connecting said condenser with said evaporator and first capillary type refrigerant metering means between said evaporator first and second coil parts.

3. The apparatus according to claim 2 in which said expansion means includes second capillary-type refrigerant metering means bypassing said thermal-type expansion valve, said second capillary-type metering means permitting condensed refrigerant from said evaporator coil first part to flow to said condenser coil second part so that said condenser coil second part may function as an evaporator while said apparatus cools and heats said air.

4. The apparatus according to claim 1 in which said expansion means includes a thermal-type expansion valve for each of said evaporator first and second coil parts; and first check valve controlled means for bypassing refrigerant around the expansion valve for said evaporator coil first part while said apparatus cools and heats said air.

5. The apparatus according to claim 4 in which said expansion means includes capillary-type refrigerant metering means between said condenser coil second part and the expansion valves for said evaporator first and second coil parts to accommodate flow of condensed refrigerant from said evaporator first coil part to said condenser second coil part while said apparatus cools and heats said air so that said condenser second coil part may function as an evaporator; and second check valve controlled means for bypassing refrigerant around said capillary-type refrigerant metering means while said apparatus cools said air.

6. The apparatus according to claim 1 in which said valve means comprises a four-way valve serially connecting said condenser first coil part with said condenser second coil part and said evaporator first coil part with the suction side of said compressor.



7. The apparatus according to claim 1 in which said evaporator first coil part is disposed downstream of said evaporator second coil part, said control means being adapted at a first temperature condition to actuate said compressor and fan means whereby said apparatus cools; said control means being adapted at a second temperature condition in response to said predetermined humidity condition to actuate said compressor and fan means and said valve means whereby said apparatus both cools and reheats said air.

**References Cited by the Examiner**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 2,172,877 | 9/1939 | Parcaro | 62—173 |
| 3,026,687 | 3/1962 | Robson | 62—173 |
| 3,139,735 | 7/1964 | Malkoff | 62—173 |


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