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COMPUTER REFRIGERATION SYSTEM

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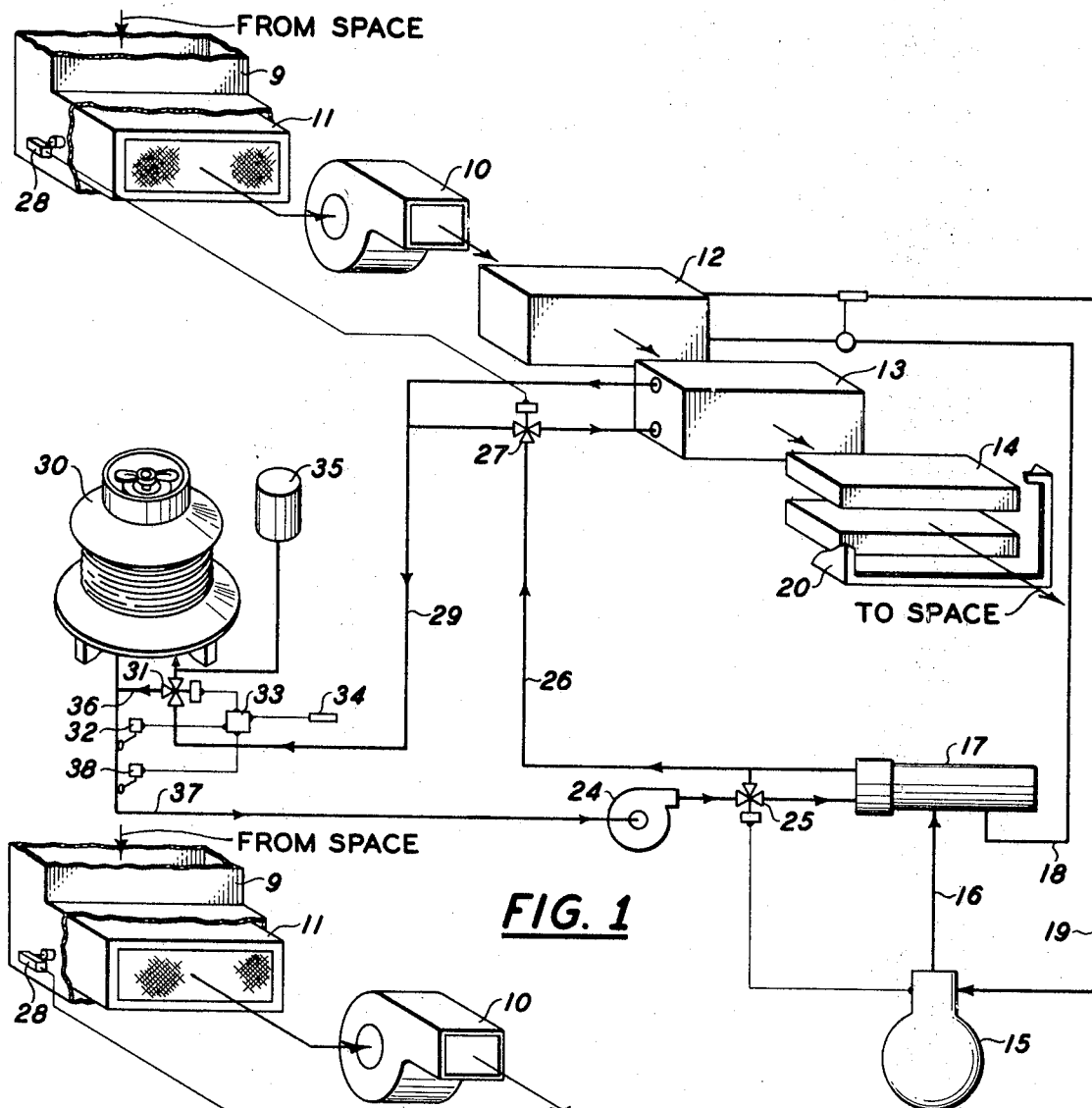


FIG. 1

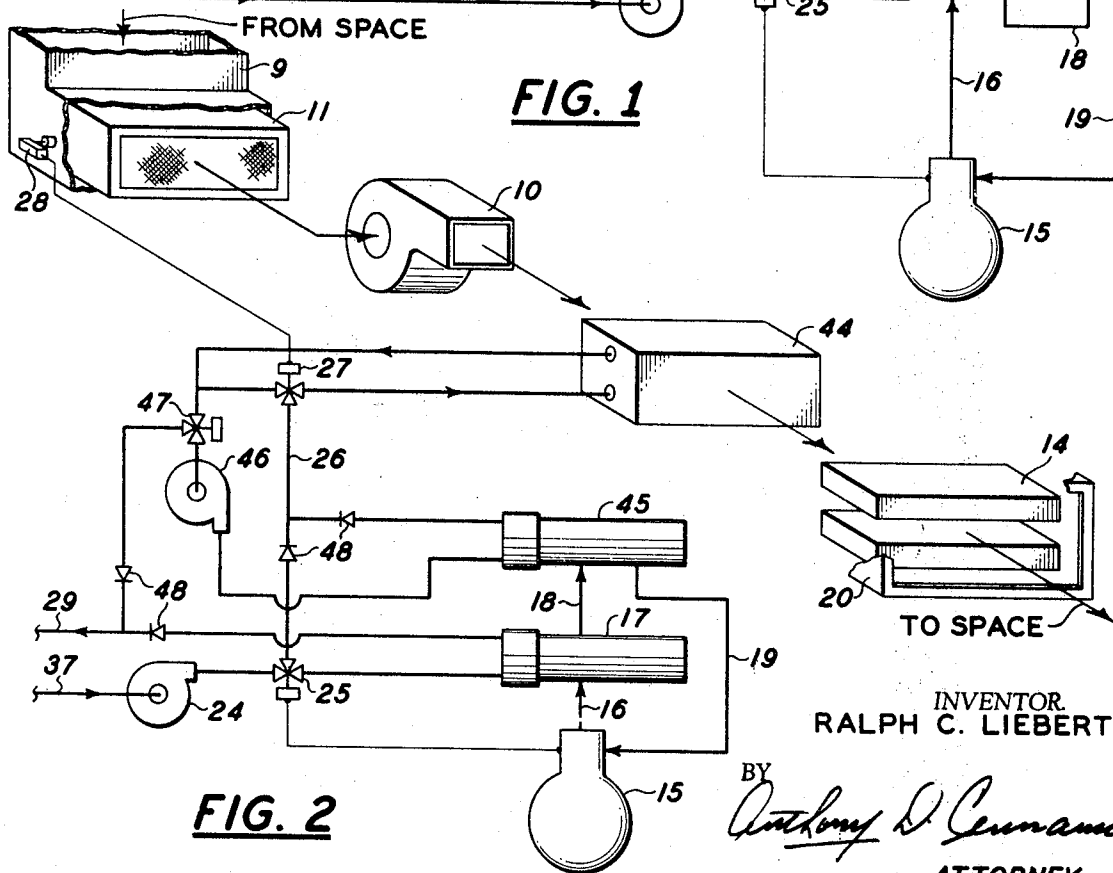


FIG. 2

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COMPUTER REFRIGERATION SYSTEM

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5 Claims

ABSTRACT OF THE DISCLOSURE

The invention relates to an air conditioning system having a filtered air flow directed sequentially past two heat exchange coils. The first coil is operated when the outdoor weather is warm and comprises a direct expansion evaporator coil. The second coil is operated in the alternative for reheat or cooling such that when the evaporator coil is operative for cooling, a liquid heated from the refrigeration condenser is circulated thereto to reheat the air passing from the evaporator coil. When the evaporator coil is inoperative, the same liquid is cooled by an outdoor located heat exchanger and circulated to the second coil to effect air cooling.

This application is a continuation of Ser. No. 526,169, filed Feb. 9, 1966, now abandoned.

It is not uncommon in industrial or commercial air-conditioning installations whether for process, comfort, or specialized industrial needs to encounter a requirement for year-round cooling in order to offset a continuous, high internal heat generation summer and winter. Exemplifying such a need is the spaces containing a computer which are being placed in commercial and industrial locations with an ever increasing frequency. Because of the high heat emission rate from the computer it is necessary to continuously air cool the space in which it is situated in order to protect the equipment and render the space comfortably tolerable for the working personnel. It is usual in such installations to circulate large volumes of air with a relatively small temperature differential of about 15–20 degrees between the space and the air discharge temperature from an air-conditioning unit.

The technique commonly employed to effect year-round air cooling is to utilize a refrigeration condensing unit with associated components when the outdoor temperature is relatively warm and to introduce increasing amounts of outdoor air as the outdoor temperature drops below the space temperature. When the outdoor temperature drops to or below the temperature at which the cooled air from the air-conditioning unit is discharged into the space, e.g., 60° F., it is common to pump down the refrigeration unit and maintain cooling by controlled mixing of outdoor and recirculated air. Where dehumidification is required, the control point is varied to meet the particular requirement and an external heat source such as steam, hot water, or electricity is supplied to a reheat air coil to maintain required temperature conditions. Still another, much less economical solution, has been to employ refrigeration year-round.

While such prior systems, utilizing outdoor air have worked well, it has been found that where a computer installation is located remotely spaced relative to a source of outside air, the extensive duct work and the building volume occupied thereby extending for long distances, render the system impractical and economically unsound. That is, the large volume of building space occupied or consumed by the duct work passing through floors and the like and which could otherwise be utilized more gainfully, has rendered such system so virtually prohibitive

as to restrict the choice of site at which the computer can be placed. This has been particularly true where there is a multiplicity of computer installations in various different locations scattered throughout the building and each one requires the vast duct work associated therewith in order to maintain temperature conditions.

Now in accordance with the instant invention there have been discovered a novel air-conditioning system in which up to approaching 100% recirculated air can be utilized for year-round cooling while the economic saving afforded by capitalizing on cool outdoor temperatures is still retained. This enables limiting the duct work to only the immediate area surrounding the conditioned space as to eliminate or to substantially reduce duct size connections to the outdoors. This therefore permits a wider location choice for the computer installation anywhere within the building structure without concern of long duct runs which have previously imposed a handicap on the choice of location.

Thus it is an object of the invention to provide a novel air-conditioning system for year-round space cooling.

It is a further object of the invention to provide a novel air-conditioning system for year-round space cooling capable of capitalizing on cool outdoor air temperatures without extensive duct runs to the outdoors as has been common in the prior art.

It is a still further object of the invention to provide a novel air-conditioning system for year-round cooling that is not dependent on nearness to an outdoor air source as to afford greater flexibility of location choice for a computer.

These and other objects are attained in accordance with the invention hereof by an air-conditioning system operable in either of two embodiments. In a first embodiment, adopted for accurate humidity control, a filtered air flow is always directed sequentially past two heat exchange coils. The first coil is operated when the outdoor weather is warm and comprises a direct expansion evaporator coil. The second coil is operated in the alternative for reheat or cooling such that when the evaporator coil is operative for cooling, a liquid heated from the refrigeration condenser is circulated thereto to reheat the air passing from the evaporator coil. When the evaporator coil is inoperative, the same liquid is cooled by an outdoor located heat exchanger and circulated to the second coil to effect air cooling. Thus, when the conditioned air is being cooled by the evaporator coil, waste heat is supplied from the condenser for reheat by the second coil. In the alternative, as the outdoor temperature drops and the first coil becomes inoperative, the second coil is supplied with a chilled coolant to maintain the required air discharge temperature. In either cycle, operation is economically optimum and is effected without the need of direct introduction of outdoor air into the space. Since the need for outdoor air is eliminated, the duct work associated with such prior systems can likewise be eliminated. Where desired, a minimum quantity of outdoor air can be utilized in order to maintain freshness in the system.

A second embodiment is adopted for cooling without the humidity control feature of reheat. This permits operation with a single heat exchange coil to which chilled cooled liquid is supplied for summer operation while the outdoor heat exchanger chills the liquid for winter operation.

Further objects and features of the invention will become apparent by reading the following description in connection with the drawings which schematically illustrate the system hereof in the different embodiments.

Referring now to FIG. 1 of the drawings there is shown the system hereof in a first embodiment as operatively adapted and which can conveniently be furnished and

substantially contained in a commercial package type unit or fabricated and assembled on-site as is commonly known. The air flow is induced by a supply fan 10 that draws the air from the space via a duct 9 through a filter 11 for discharge through a direct expansion evaporator refrigeration coil 12. The air leaving the latter coil then passes through a reheat or winter cooling second coil 13, as will be described, and then travels past an optionally required humidifier 14 before being discharged via duct 20 into the conditioned space.

In order to operate the system in a first cycle, when the outdoor temperature is above the required air discharge temperature (leaving fan 10) and down to within approximately 15° below thereof (e.g., 45° F.), a refrigeration compressor 15 is operatively connected with the direct expansion coil 12 in a refrigeration system that includes a hot gas line 16 connected to condenser 17, a liquid line 18 from the condenser to the coil, and a suction line 19 from the coil back to the compressor. The suction line temperature is maintained through controlled compressor operation suitable for the requirement of temperature and/or humidity.

When coil 12 is operative at a suction temperature to effect dehumidification of the air, coil 13 is operative as a reheat coil. The source of heat thereto is supplied by a circulating liquid, preferably comprising an anti-freeze solution as will be understood, contained in a closed pipe loop that includes a circulating pump 24 and a pressure actuated diverting valve 25. When the compressor 15 is operating, the center port of valve 25 is closed and liquid circulated by the pump passes directly through the opposite side port in heat exchange relation through the condenser 17 and then into pipe 26 toward coil 13. When the compressor 15 is inoperable, as will be described, the center port of valve 25 is opened and the opposite side port is closed permitting the liquid to completely bypass the condenser 17, thus maintaining proper heat passage on the refrigeration compressor 15.

Controlling liquid flow through coil 13 is a modulating type diverting valve 27 responsive to the demands of reversible thermostat 28 having its sensing bulb in return air duct 9. The thermostat controls the valve in a manner to permit increasing quantities of liquid to pass through coil 13 in response to an insufficient temperature determined in the return air duct. This, therefore, provides sufficient reheat for the discharge temperature required and the remainder of the liquid is bypassed about the coil to a pipe conduit 29 which carries the recombined liquid to an outdoor located heat exchanger 30. The latter heat exchanger can comprise an evaporative condenser or the like, or a suitable closed coil type heat exchange unit as is known in the art such as an air cooled condenser. Connected to the piping in the vicinity of the heat exchanger is an expansion tank 35.

In order to maintain a constant temperature of liquid entering condenser 17, the flow of liquid to heat exchanger 30 is controlled via a modulating diverting valve 31 under control of an immersion stat 32. The valve is effective to proportion the flow between that passing through the heat exchanger 30 to be cooled and that bypassing the heat exchanger 30 via pipe conduit 36 generally as a function of outdoor temperature. Both flows are then recombined in conduit 37 returning the liquid to the condenser 17. Valve 31 is connected through a summer-winter controller 33 permitting controlled operation for either the summer or winter cycle. A typical set of operating conditions as exemplifying the warm weather operation, would have the outdoor temperature at approximately 95° F. The mixed liquid in conduit 37 is supplied to the condenser 17 at approximately 105° F. while the liquid in conduit 26 being supplied to the reheat coil 13 is at approximately 115° F.

As the outdoor temperature drops to approximately 40° F., as sensed by the temperature bulb 34 of summer-winter controller 33, the refrigeration equipment is

pumped down and the temperature of liquid in conduit 37 is placed under control of an immersion stat 38. This latter stat is effective to control valve 31 in order to effect a liquid temperature in conduit 37 for supply to coil 13 capable of cooling the air supply to the required discharge temperature. Since the indoor air is normally dry at that time of year, dehumidification and reheat are unnecessary.

In this operational mode, valve 25 is set to permit complete flow bypass of the condenser 17 and the liquid solution passes directly to valve 27 and coil 13 which is now operative as a cooling coil. Valve 27, likewise as before, proportions the flow either to the coil or into conduit 29. It is controlled by duct thermostat 28 in a manner whereby the valve port connecting to the coil is proportionately opened as the need for cooling increases and is proportionately closed as the need for cooling decreases. Since the action of thermostat 28 in this mode is to increase coil flow on temperature rise, its operation is reverse from that of the summer cycle during which flow is increased on temperature drop to effect a greater degree of reheat.

The liquid flow in conduit 29 as before, approaches valve 31 and as a function of outdoor temperature, is proportioned between heat exchanger 30 or into bypass conduit 36. The recombined flow in conduit 37, which is maintained at a constant temperature, e.g., 45° F., is then circulated to the coil 13. As the outdoor temperature drops to for example below zero, the flow through heat exchanger 30 will decrease to a minimum.

Where humidification is necessary during the cold winter months, there is provided a humidifier 14 such as the spray or pan type electrically heated. In a preferred embodiment, the humidifier comprises a pan type heated by an overlying infrared lamp (not shown) of a type marketed by the Humidair Corporation of St. Charles, Illinois.

In FIG. 2 there is illustrated the second embodiment hereof to the extent that it structurally differentiates from the system of FIG. 1. In accordance with this latter embodiment, the capability of humidity control is not provided for and only a single chilled coil 44 is utilized to maintain year-round cooling of the space.

For warm outdoor weather operation there is provided a refrigeration system as before but including a liquid chiller 45 for chilling liquid supplied to diverting valve 27 and coil 44. The chilled liquid is continuously circulated by means of a pump 46 receiving the coil return via the side port of diverting valve 47. At the same time condenser 17 is cooled by liquid coolant being recirculated by means of pump 24 to heat exchanger 30.

For cold outdoor weather operation, pump 46 is inoperative and the center ports of valves 25 and 47 are opened. In this relation pump 24 circulates the liquid directly between valve 27 and heat exchanger 30 as in FIG. 1. Check valves 48 assist in the prevention of back-flow in the different piping during operation of the respective cycles.

By the above description there is disclosed a novel air-conditioning system capable of year-round cooling for maintaining space temperature and humidity conditions. The system is unique in its operation and is substantially more economical to install and to operate than prior systems utilized for similar purposes. It offers the distinct advantage of eliminating long runs of massive ducts as has been utilized heretofore. By virtue of its compactness, and economical savings, increased flexibility is afforded in selecting space requiring such year-round cooling.

Since many changes can be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the drawings and specification shall be interpreted as illustrative and not in a limiting sense.

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What is claimed is:

1. An air-conditioning system for year-round cooling comprising in combination:

- (a) blower means circulating air to a temperature controlled space;
- (b) a first heat exchange coil interposed in the air path effected by said blower means;
- (c) mechanical refrigeration means connected to said first coil and including a compressor and a condenser and operative when energized to maintain said first coil at a refrigerated temperature sufficient to cool the air circulating therepast to a predetermined temperature;
- (d) a second heat exchange coil interposed in the air path effected by said blower on the discharge side of said first coil;
- (e) circulating means connected to said second coil supplying a heated liquid, such as an antifreeze solution, thereto for effecting air reheat when said refrigeration means is operative and supplying a cooled liquid for effecting air cooling when said refrigeration means is inoperative; and
- (f) a heat exchanger in relation with an external source of cooler or outdoor air prior to being supplied to said coil and at a temperature at least about 15 degrees below the temperature of said space, said heat

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exchanger being coupled to the second heat exchange coil.

2. The system according to claim 1 in which the heated liquid supplied by said circulating means is heated by being passed in heat exchange relation with the condenser of said refrigeration means prior to being supplied to said second coil.

3. The system according to claim 1 in which said first coil is cooled by direct expansion refrigeration.

4. The system according to claim 1 including control means sensitive to ambient outdoor temperature about the conditioned space for switching the space air cooling media between said first and second heat exchange coils.

5. The system according to claim 1 wherein the heat exchanger is connected to an expansion tank.

References Cited

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