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Quick

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[54] AIR-COOLED CONDENSER ARRANGEMENT

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[51] **Int. Cl.** **F25b 39/04**

[58] **Field of Search** 62/183, 181, 184, 507, 508

[56] **References Cited**

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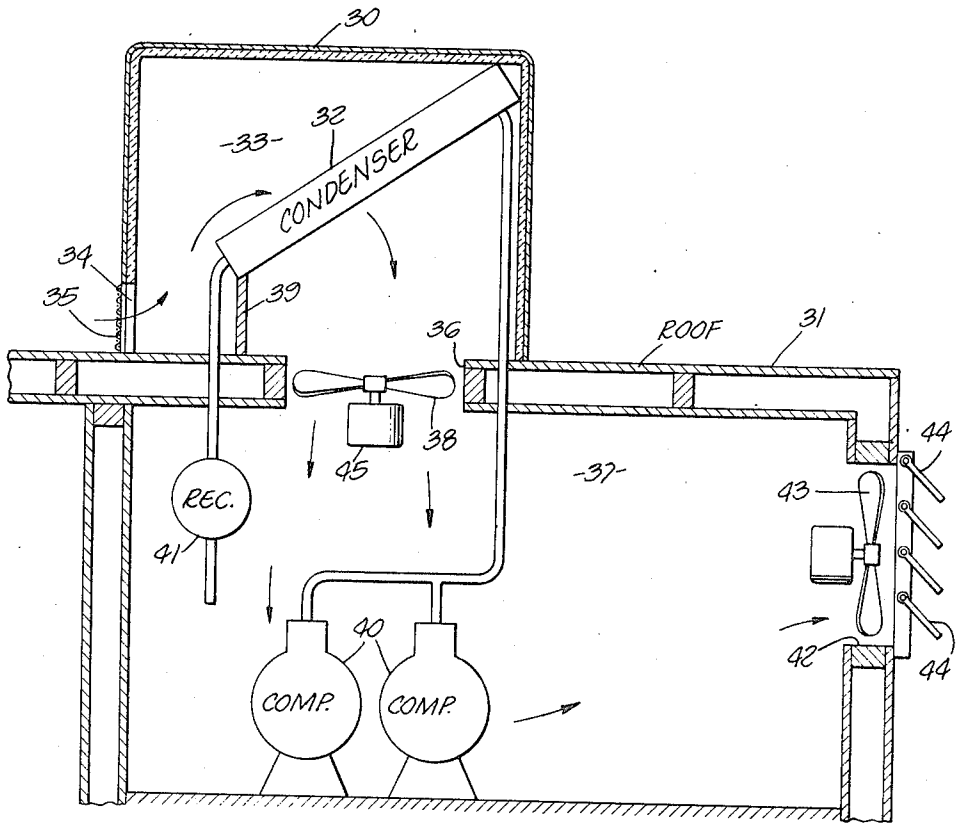
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[57] **ABSTRACT**

An air-cooled condenser arrangement for refrigeration systems to control the extremes of condensing temperatures wherein the condenser coil is mounted in the upper portion of an enclosed and insulated housing with the air inlet and outlet for the housing both positioned below the level of the condenser coil to inhibit undesirable air circulation through the condenser coil as a result of wind or the stack effect of heated air rising from the coil and a fan or blower at the outlet controls the air flow through the condenser.

13 Claims, 2 Drawing Figures



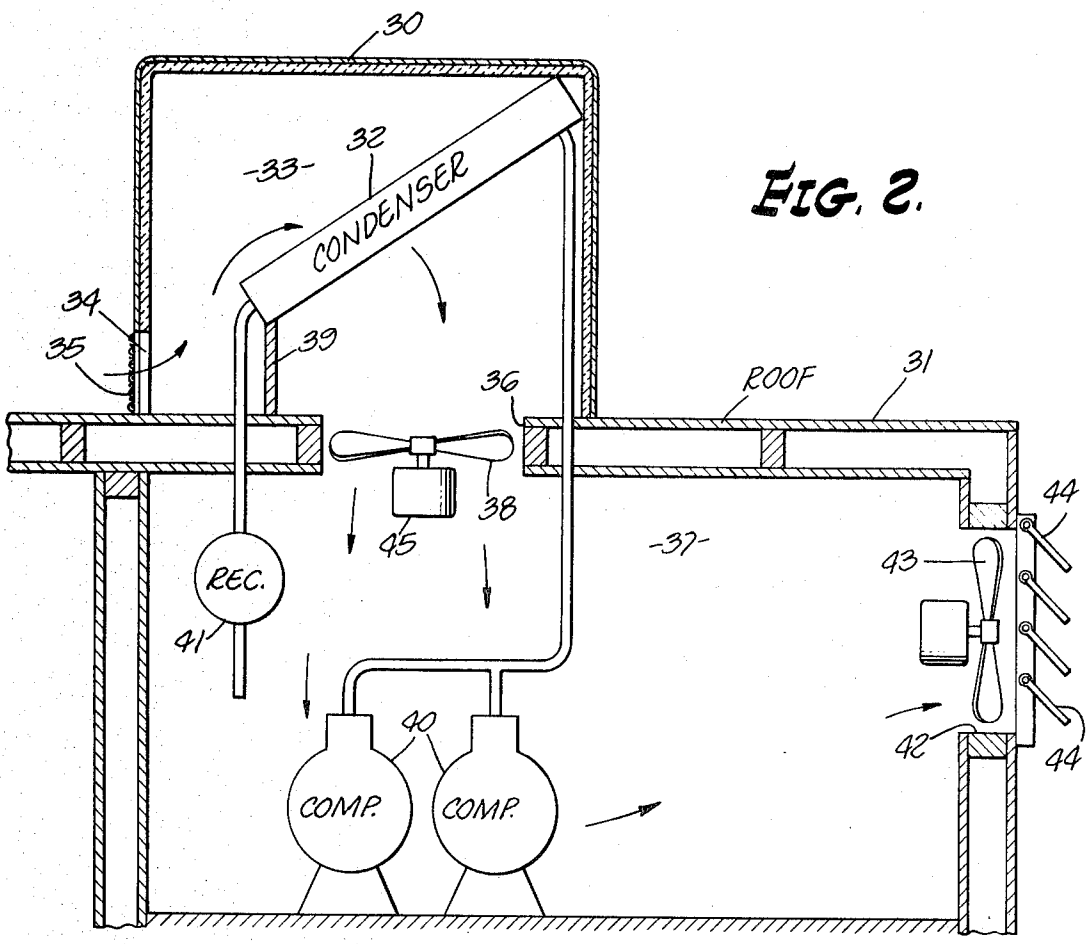


FIG. 2.

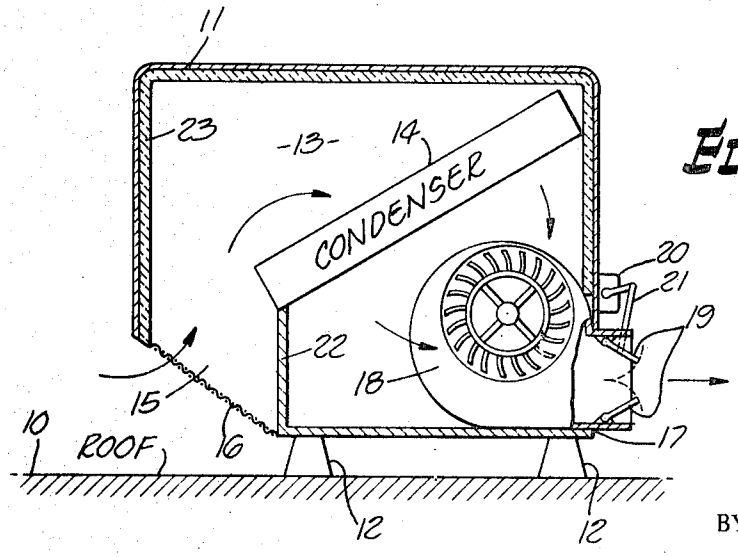


FIG. 1.

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AIR-COOLED CONDENSER ARRANGEMENT

This invention relates to air-cooled condensers provided with refrigeration systems and in particular is directed to condensers used with refrigeration systems such as in supermarkets and the like where it is desirable to control the condensing temperature within certain limits in spite of extreme ambient conditions.

Air-cooled condensers are used in many refrigeration systems and often are located on the roof of the building in which the refrigeration is being used. Supermarkets are typical of such installations. There are two generally conventional arrangements for air cooled condensers, one is with the condenser coil positioned horizontally and the air is passed upwardly therethrough and the other is with the condenser coil oriented vertically and the air is passed horizontally therethrough. Each type has certain desirable characteristics such as the low silhouette that is possible with the horizontal condenser coil.

However heretofore conventional air-cooled condenser arrangements, both horizontal and vertical types, have various disadvantages For example, in hot summer weather air cooled condensers are relatively inefficient and require the circulation of a large volume of air therethrough due to the ambient air temperature and the radiant heating of the condenser coil by the sun since the coil is usually exposed. Another and more important problem with air cooled condensers occurs in the cold winter weather when the condenser tends to operate too efficiently thereby condensing the refrigerant at temperatures and pressures far too low for the requirements of the system. In part this results from the fact that the size of the condenser coil must be selected on the basis of the maximum condensing requirements under the most adverse conditions, i.e., in the hottest summer weather whereby the coil is grossly oversized for the requirements of winter weather. Furthermore the air circulating fan arrangement is also designed for the highest demands of the hottest summer days to accomplish the necessary high volume of air circulation but necessarily results in allowing excessive air circulation in winter. As a result it is usually necessary to provide some form of head pressure control on the condenser such as to flood a substantial portion of the condenser with liquid refrigerant during winter operation to reduce the overall efficiency of the coil but this necessitates charging the system with a large amount of expensive refrigerant that is not otherwise needed in the system.

Moreover in systems using other than flooding of the condenser coil for head pressure control, the conventional air circulating arrangements under various conditions allowed enough air to flow through the condenser coil to cause excessive cooling and undesirably low condensing temperatures and pressures. For example with the type having a vertically oriented condenser coil the normal air flow path is horizontally through the condenser and therefore any appreciable wind in the winter time will cause air to flow through the condenser coil even though the fan is not operating. Even the use of dampers that are closed in cold weather has been found to be less than completely effective due to natural air leakage through such dampers in the face of extreme wind conditions. With arrangements of the type having the condenser coil oriented horizontally, the heat produced by the coil causes a natural chimney or stack effect in which the heated air rises from the coil drawing cold air in through the normal inlet thereby causing air circulation even without operation of the fan. Thus with either type conventional air-cooled condenser arrangement the natural winter conditions cause excessive air circulation and cooling.

Another advantage of heretofore conventional air cooled arrangements is the noise produced. Most conventional arrangements employ propeller-type fans which will produce the large volume of air flow required during summer operation for the lowest possible cost and yet such fans produce substantial noise. Thus in a supermarket installation in a residential area it is often necessary to provide expensive sound deadening arrangements. Moreover the large openings required by propeller-type fans further complicate the problem of inhibiting undesirable air flow passed the fan during winter operation as mentioned above. A further requirement of systems have centrally located compressors, as is now common with supermarket systems, is to ventilate the compressor room and this also varies with ambient conditions.

Accordingly by this invention there is provided an air cooled condenser arrangement wherein the condenser coil is enclosed in the upper portion of a housing with the air inlet and outlet located in the lower portion of the housing and air circulating means provide controlled air circulation therethrough whereby undesirable air circulation through the condenser coil such as by wind or stack effect is minimized.

An object of this invention is to provide a novel air cooled condenser arrangement for refrigeration systems requiring controlled condenser temperatures wherein the condenser coil is enclosed in an insulated housing in a manner to preclude natural air circulation therethrough and controllable air-circulating means provides the sole source of air flow through the condenser coil.

Another object of this invention is to provide an air cooled condenser arrangement for large central refrigeration systems with compressors located in a room requiring ventilation wherein the condenser coil is positioned in a housing with the air flow therethrough caused by an air-circulating means and such air is discharged into the compressor room for accomplishing the desired room ventilation.

Still another object of this invention is to provide a novel form of air-cooled condenser arrangement wherein the condenser coil is positioned in the upper portion of an enclosed and insulated housing, inlet and outlet openings are positioned entirely below the condenser coil, and a squirrel cage type blower with modulating dampers is mounted in the outlet for causing controlled air flow through the condenser coil.

Other and more detailed objects and advantages will appear from the following description and the accompanying drawings wherein:

FIG. 1 is a sectional elevation of one form of the air-cooled condenser arrangement of this invention.

FIG. 2 is a sectional elevation of another form of the air-cooled condenser arrangement of this invention wherein ventilation of the compressor room is also accomplished.

Referring more particularly to FIG. 1, the arrangement of this invention is illustrated in an embodiment of the type that normally would be mounted on the roof 10 of a building. For convenience of illustration the refrigeration system and the conventional piping and the like is omitted from FIG. 1. The housing 11 may be provided with supports 12 for mounting on the roof 10 in a slightly raised position. The housing 11 may be of any convenient construction such as sheet metal and framing to produce a completely enclosed upper portion 13 in the housing. The condenser coil 14 for the refrigeration system is mounted in this upper portion 13 of the housing and the coil would be of the conventional air-cooled type comprising tubing and cooling fins. Although it is not essential to this invention, it is preferred that the condenser coil 14 be positioned at an angle to both the horizontal and vertical, as shown in the drawing, whereby a relatively low silhouette for the housing is possible without sacrificing desired air circulation characteristics.

An air inlet 15 is provided in the lower portion of the housing 11 and may be of the type that faces downwardly at an angle and may be covered by a wide mesh screen 16 to prevent objects and trash from being drawn into the housing. An outlet 17 is provided in the housing 11 on the opposite side from inlet 15. Air-circulating means, preferably a squirrel cage type blower 18, is mounted in housing 11 and associated with the outlet opening 17. Discharge dampers 19 are mounted in the outlet 17 and are movable between a position completely closing the outlet 17 and an open position. The movement of dampers 19 is controlled by a modulating motor 20 through linkage 21 in a relatively conventional fashion. Modulating motor 20 is controlled in response to variations in the head pressure on the condenser coil 14 for moving dam-

pers 19 to an open position upon the occurrence of high head pressure and closing dampers 19 upon the occurrence of excessively low head pressure.

Appropriate partitions, such as wall 22 cooperate with the condenser 14 and housing 11 to cause the path of air circulation to proceed from inlet 15 upwardly, then laterally and downwardly through condenser 14, and finally to pass out through outlet 17. As illustrated in FIG. 1, partition 22 prevents wind from blowing directly through the housing between the inlet 15 and outlet 17. Moreover the entire condenser coil 14 is positioned above the level of inlet 15 and outlet 17 whereby air heated by the condenser 14 will be trapped in the upper portion 13 of the housing 11 when the blower 18 is off and dampers 19 are closed. This warm air buildup in housing 11 causes the condensing temperature and pressure to rise as desired. Preferably the housing 11 is insulated, such as with insulating material 23, both for allowing this warm air buildup in winter and minimizing heat transfer into the housing 11 from the sun in summer time. The use of the squirrel cage type blower 18 greatly reduces the air noise caused during operation and permits the use of a smaller outlet opening 17 and more efficient dampers 19 than would otherwise be possible with conventional propeller-type fans.

Referring now to FIG. 2, a modified embodiment of this invention is shown wherein the additional advantage of ventilating the compressor room is obtained. Again the air-cooled condenser arrangement includes an enclosing housing 30 which in this instance may be mounted directly on the roof 31 if desired. The condenser coil 32 is mounted in the upper portion 33 of the housing and completely above the location of inlet opening 34. Again a screen 35 may be used to cover opening 34. The outlet opening 36 from the housing also comprises an opening through the roof 31 of the building and may be in direct communication with the compressor room 37 as shown or in communication by reason of appropriate ducting. An air-circulating means, here shown as a propeller-type fan 38 is mounted in outlet 36 to draw the air into the housing 30 through inlet 34, then through condenser 32, and discharge such air into the compressor room 37. Again appropriate partition walls such as partition 39 in housing 30 cause this indirect air flow path. The compressor room 37 contains the refrigeration system compressors 40 and other equipment such as receiver 41 and the room requires substantial ventilation. For example in the summer the usual requirement is approximately 10 cubic feet of air per minute for each rated horsepower of the compressors. An exhaust outlet 42 is provided and may include exhaust fan 43 to assist in moving the air through the compressor room. Conventional dampers 44 are provided on exhaust opening 42 for preventing a back draft of air into the compressor room.

In order to provide the proper rate of air circulation passed condenser coil 32 in the embodiment of FIG. 2, the motor 45 for fan 38 may be of a variable speed type with the speed controlled in proportion to the condenser head pressure, i.e., the higher the pressure the higher the fan speed. It is preferred that the motor 45 and fan 38 be controlled to operate at a slow speed under even the lowest condenser head pressures, which speed merely counteracts the stack effect due to the heat generated in the compressor room 37 in cold weather but would not cause any significant air circulation through condenser coil 32 under such conditions. By the arrangement of FIG. 2 the compressor room is ventilated as required in any such installation and in fact the magnitude of ventilation would vary with the weather conditions in the direct ratio desired since less ventilation is required in winter than summer. Again it is to be noted that the embodiment of FIG. 2 avoids the wind and stack effects that normally cause excessively low head pressures in winter.

Having fully described my invention in connection with two typical embodiments it is to be understood that my invention is not limited to these embodiments but rather is of the full scope of the appended claims.

I claim:

1. An air-cooled condenser arrangement for a refrigeration system requiring controlled heat exchange in the condenser, comprising, an enclosed housing having upper and lower portions, said housing having an inlet opening and an outlet opening both located in the lower portion of said housing, a condenser coil mounted in the upper portion of said housing, air-circulating means mounted at said housing outlet opening for controllably discharging air from said housing, said housing having partition means for causing said air circulating means to draw air into said housing through said inlet opening and then through said condenser coil before the air is discharged through said outlet opening, said inlet opening and outlet opening being entirely below said condenser coil and separated horizontally by at least said partition means for preventing condenser coil cooling by reason of either heated air rising from said condenser coil and out through said housing, and means controlling said air-circulating means for causing the air to circulate at a rate related to the head pressure in the condenser coil for condensing the refrigerant within a desired range of head pressures.

2. The condenser arrangement of claim 1 wherein said air circulating means comprises a squirrel cage type blower having a discharge outlet connected to said housing outlet opening, and dampers are provided with one of said openings.

3. The condenser arrangement of claim 2 wherein said dampers are associated with said outlet opening and are movable between an open position and a position completely closing said outlet opening, and said controlling means move said dampers in proportion to the pressure in said condenser coil.

4. The condenser arrangement of claim 1 wherein at least said upper portion of said housing is thermally insulated.

5. An air-cooled condenser arrangement for a refrigeration system requiring controlled heat exchange in the condenser, comprising, an enclosed housing having upper and lower portions, said housing having an inlet opening and an outlet opening both located in the lower portion of said housing, a condenser coil mounted in the upper portion of said housing, air circulating means mounted at said housing outlet opening for controllably discharging air from said housing, said housing having partition means for causing said air circulating means to draw air into said housing through said inlet opening and then through said condenser coil before the air is discharged through said outlet opening, said inlet opening and outlet opening being below said condenser coil and separated horizontally by at least said partition means for preventing condenser coil cooling by reason of either heated air rising from said condenser coil and out through either opening or wind passing horizontally directly through said housing, the refrigeration system including compressors located in an enclosed room, and said outlet opening being connected to said room for ventilating said room with the air discharged by said air circulating means.

6. The condenser arrangement of claim 5 wherein said air circulating means includes a variable speed fan having means for controlling the speed in relation to the head pressure in said condenser coil.

7. The condenser arrangement of claim 6 wherein controlling means causes operation of said fan at a slow speed even upon the occurrence of very low head pressures for preventing substantial air circulation through said condenser coil by stack effect from said room.

8. The condenser arrangement of claim 5 wherein an exhaust fan is provided in said room remote from the connection of said outlet opening from causing circulation through said room.

9. An air-cooled condenser arrangement for a refrigeration system requiring controlled heat exchange in the condenser, comprising, an enclosed housing having upper and lower portions, said housing having an inlet opening and an outlet opening both located in the lower portion of said housing, a condenser coil mounted in the upper portion of said housing at a small angle to the horizontal with the lower end located nearer said inlet than outlet, air circulating means mounted at said

housing outlet opening for controllably discharging air from said housing, said housing having partition means for causing said air circulating means to draw air into said housing through said inlet opening and then through said condenser coil before the air is discharged through said outlet opening, and said inlet opening and outlet opening being below said condenser coil and separated horizontally by at least said partition means for preventing condenser coil cooling by reason of either heated air rising from said condenser coil and out through either opening or wind passing horizontally directly through said housing.

10. An air-cooled condenser arrangement for a refrigeration system, comprising, a housing having spaced inlet and outlet openings located in a lower portion of said housing, a condenser coil mounted in said housing above the level of said inlet and outlet openings, said housing having means for causing air to flow therethrough from said inlet opening through said condenser coil in heat exchange relation to said outlet opening air circulating means to said outlet opening for causing controlled air flow through said housing, and means controlling said air circulating means for causing the air to circulate at a rate related to the head pressure in the condenser coil for condensing the refrigerant within a desired range of head pressures.

11. The condenser arrangement of claim 10 wherein damper means are provided in said outlet opening for controlling the rate of airflow and are closable for stopping all air flow through said outlet opening.

12. The condenser arrangement of claim 10 wherein the refrigeration system includes compressors positioned in a room adjacent the condenser arrangement and said outlet opening is connected to said room for ventilating the room.

13. An air-cooled condenser arrangement for a refrigeration system requiring controlled heat exchange in the condenser, comprising, an enclosed housing having upper and lower portions, said housing having an inlet opening and an outlet opening both located in the lower portion of said housing, a condenser coil mounted in the upper portion of said housing, air circulating means mounted in said housing and cooperating with means in said housing for causing air to be drawn into said housing through said inlet opening and then through said condenser coil before the air is discharged through said outlet opening, and means controlling said air circulating means for causing the air to circulate at a rate related to the head pressure in the condenser coil for condensing the refrigerant within a desired range of head pressures.

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