July 28, 1959 C. R. PATON 2,896,428

AIR CONDITIONING APPARATUS

Filed Dec. 3, 1954 4 Sheets-Sheet 1

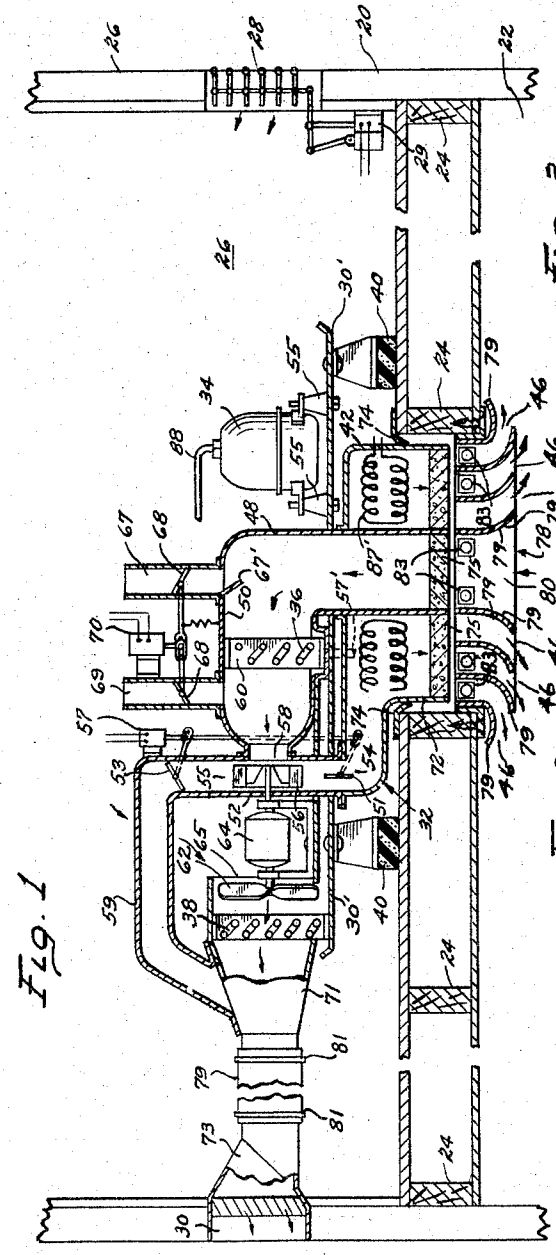


FIG. 1

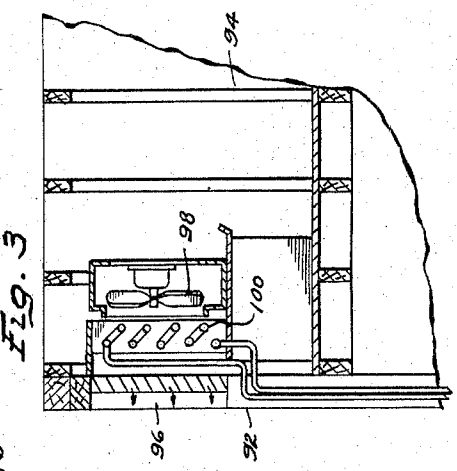


FIG. 3

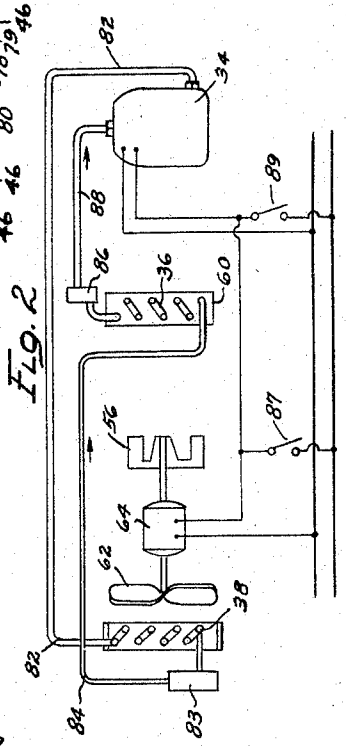


FIG. 2

INVENTOR.
CLYDE R. PATON.
BY
Wallace P. Lamb
ATTORNEY.

July 28, 1959 C. R. PATON 2,896,428

AIR CONDITIONING APPARATUS

Filed Dec. 3, 1954 4 Sheets-Sheet 2

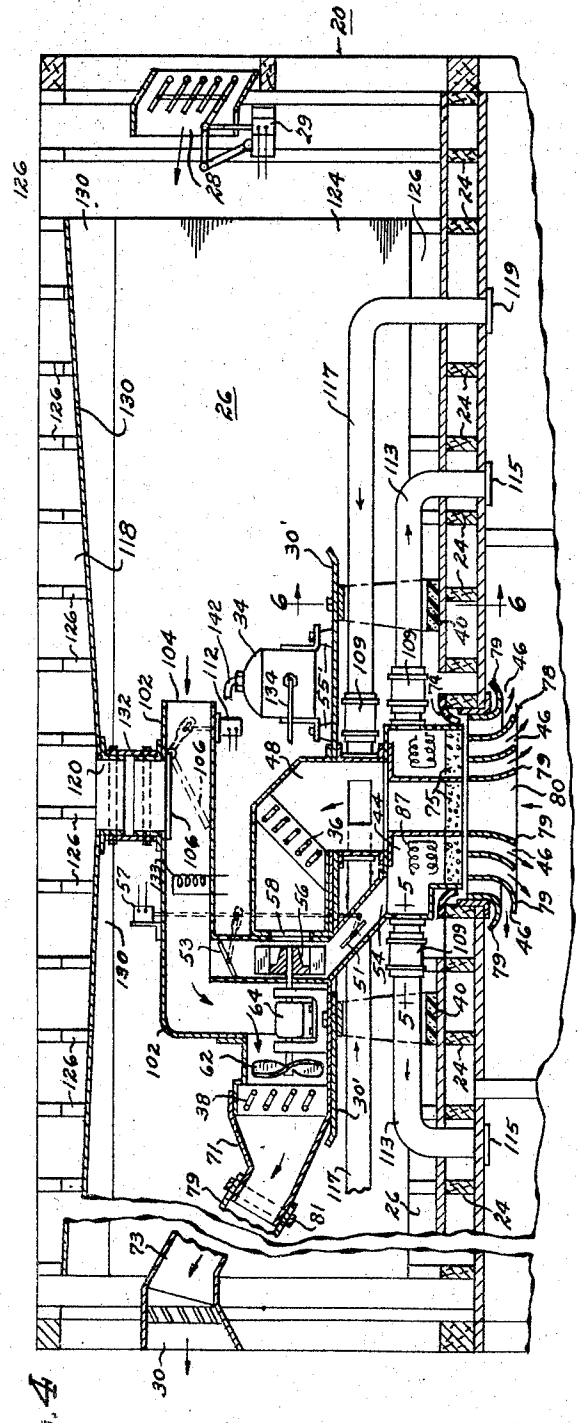


Fig. 4

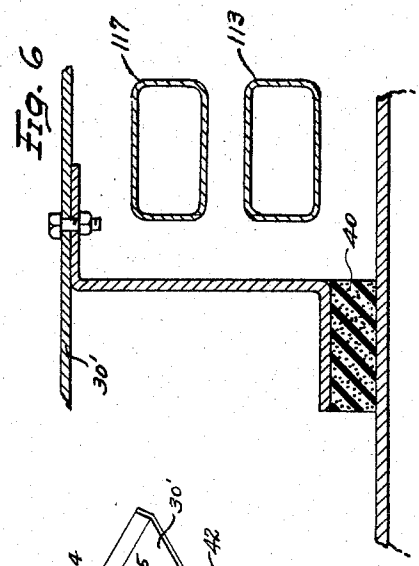


Fig. 6

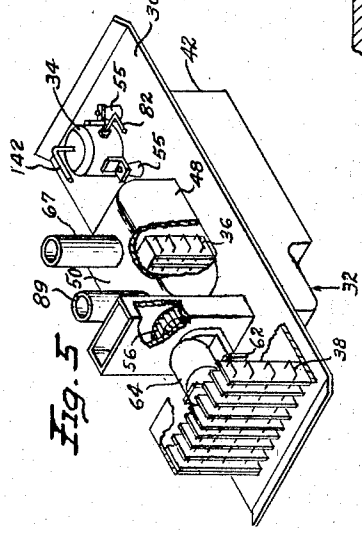


Fig. 5

INVENTOR.
CLYDE R. PATON.
BY
Wallace P. Lamb
ATTORNEY.

July 28, 1959 C. R. PATON 2,896,428

AIR CONDITIONING APPARATUS

Filed Dec. 3, 1954 4 Sheets-Sheet 3

Fig. 7

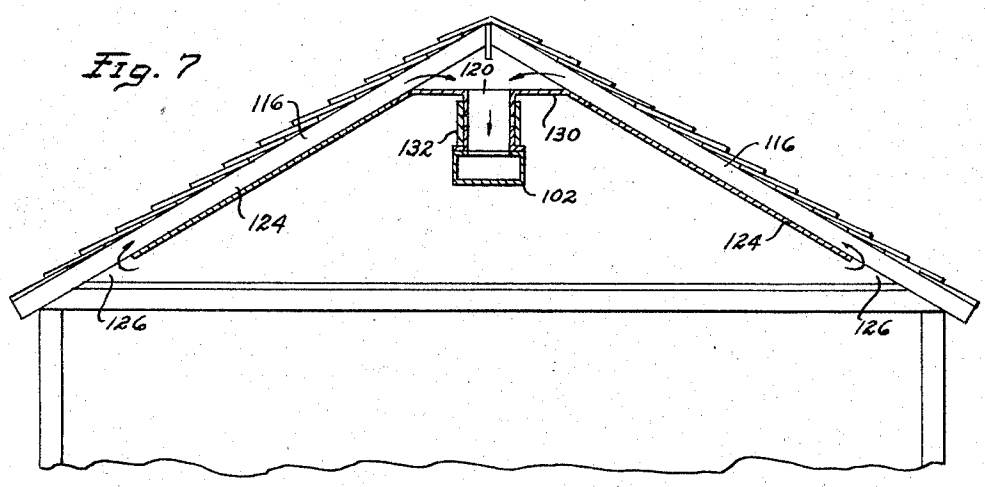


Fig. 9

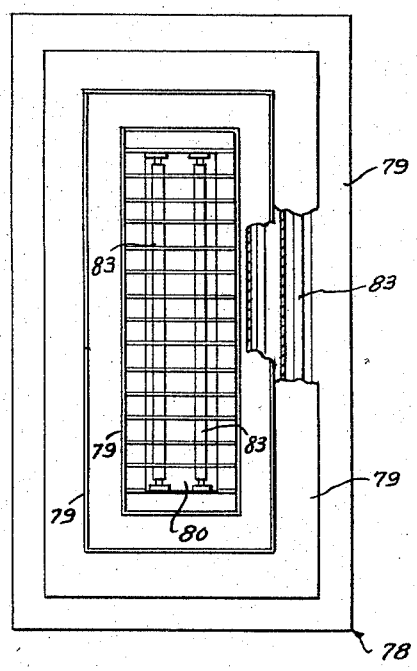
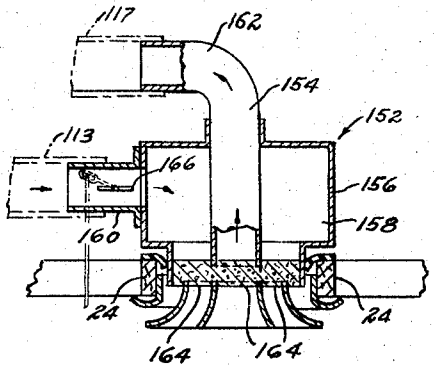


Fig. 8



INVENTOR.
CLYDE R. PATON
BY
Wallace P. Lamb
ATTORNEY.

July 28, 1959 C. R. PATON 2,896,428

AIR CONDITIONING APPARATUS

Filed Dec. 3, 1954 4 Sheets-Sheet 4

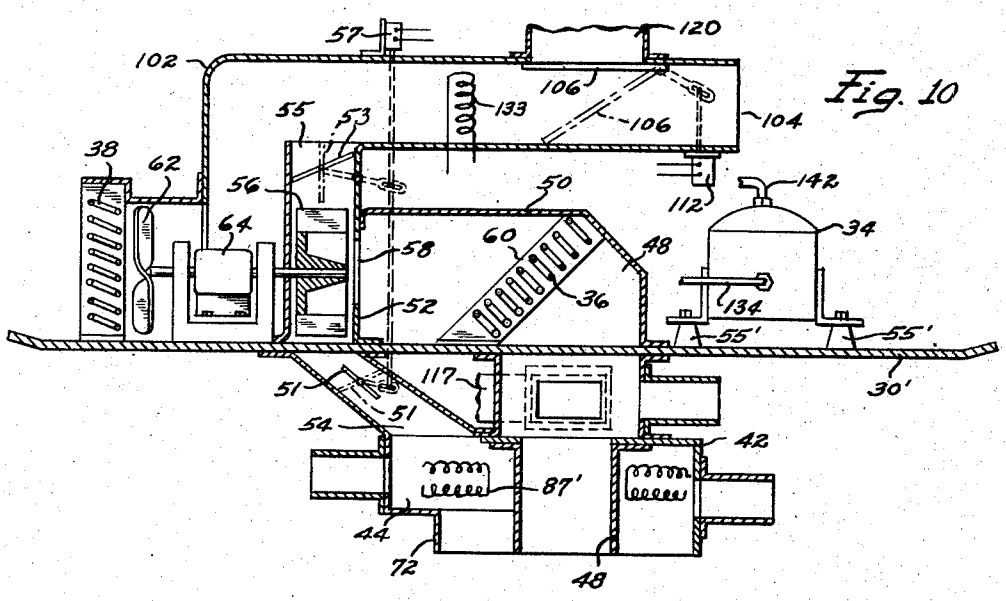


Fig. 10

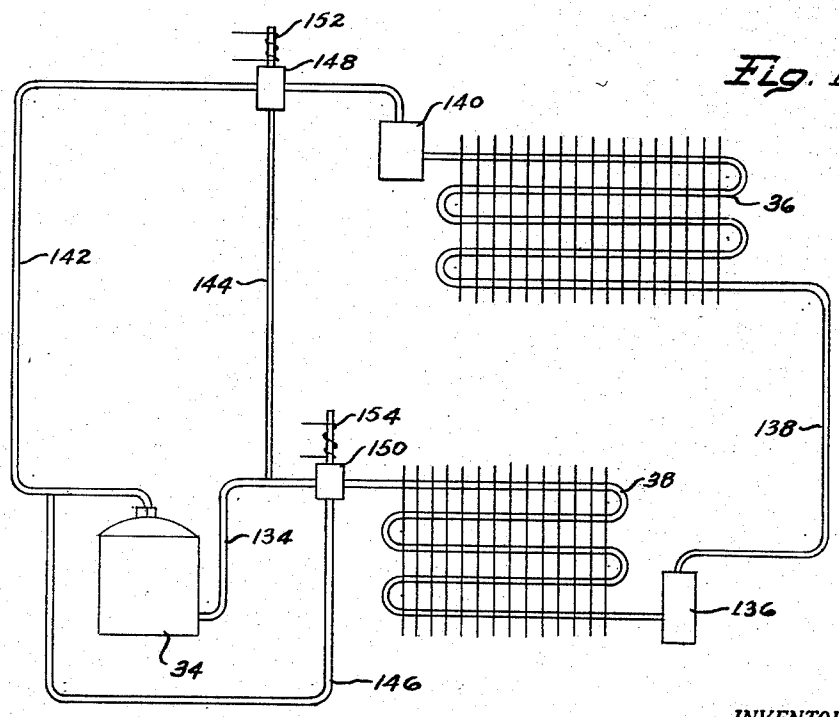


Fig. 11

INVENTOR.
CLYDE R. PATON.
BY
Wallace P. Lamb
ATTORNEY.

United States Patent Office

2,896,428

Patented July 28, 1959

2,896,428

AIR CONDITIONING APPARATUS

Clyde R. Paton, Birmingham, Mich.

Application December 3, 1954, Serial No. 472,955

1 Claim. (Cl. 62—409)

This invention relates generally to air conditioning apparatus and particularly to ceiling installed air conditioning apparatus.

There has long been a need for an air conditioning system which is both efficient in operation and can be readily installed in the ceiling of a room or other space to cool and/or heat one or more rooms or spaces without being conspicuous or otherwise detracting from the appearance or functions of the house. For example, some people are opposed to the window box type of air conditioner because, among other reasons, said installations are unsightly and in addition render the window useless as such. Then again, the practice of converting heating systems for summer air conditioning plants is not feasible for homes that have hot water or steam systems because of the expense of conversion, the expense of operation, and the inefficiency of such systems.

Accordingly, it is an object of my invention to provide an improved air conditioning system which is efficient in operation and can be readily installed in the ceiling of a room or other space to be cooled.

Another object of the invention is to provide a ceiling installed refrigerating system having a refrigerant condenser arranged to be air cooled by a fan such that the fan may, if desired, be operated without the refrigeration system to circulate fresh air as an attic exhaust fan through a room or rooms of a building on days when cooling by refrigeration isn't necessary for comfort.

Another object of the invention resides in the provision and arrangement of an air cooled condenser cooled by an attic exhaust fan irrespective of where the remainder of the refrigerating apparatus is located.

Another object of the invention resides in a ceiling installed refrigeration air conditioning system, the units of which are in at least partial balanced arrangement on a common support both to effect balance and expedite installation.

Another object of the invention is to provide an improved air conditioning apparatus of a construction and arrangement in a building or house such that the apparatus is readily controlled to effect either refrigeration air conditioning or air ventilating of the building or house for optimum comfort.

In connection with the next preceding object, a specific object resides in my effecting a cooperative relationship between air flow ducts, an attic exhaust and condenser cooling fan, and a room air recirculating blower such that at the will of an operator, either the blower acts on the air of a room to obtain forced draft refrigeration air conditioning or both the blower and fan together operate to effect forced draft ventilation, as desired.

Another object of the invention is to provide for heating a room of a building or house with a reversed refrigerating system, or heat pump which will function efficiently in extremely cold climates where evaporators exposed to substantially outdoor temperatures, normally tend to become so cold that the vaporization function and

therefor the heating function either becomes insignificant or ceases entirely.

The above object is obtained by a novel arrangement for introducing extraneous heat to the evaporator to effect continued vaporization therein and resultant heat of condensation at the condenser heater.

More specifically, it is an object to utilize as the above mentioned extraneous heat for the evaporator, the radiant heat leakage to the attic from the room being heated together with solar heat stored in the roof of the building or house.

Another specific object relative to my heat pump system invention is to provide a novel arrangement for conducting and inducing heat flow to the evaporator.

Another object of my invention resides in a novel construction of a ceiling mounted hot air heating system employing a reversible refrigerating system or heat pump together with an air duct system having forced air draft conveying extraneous heat to the evaporator to insure continued evaporation of refrigerant therein.

Another object of the invention is to provide a reversible refrigerating air conditioning-heat pump system having an improved arrangement for heating a room and for insuring continued evaporation at the evaporator by utilizing extraneous heat such as the solar heat in the building roof, and heat leakage through the room ceiling for conduction to the evaporator.

Another object of the invention is to provide supplementary electrical heating elements in a reversible air conditioning system to provide adequate heat during intervals when sufficient heat is not otherwise available in order to secure satisfactory heating capacity in frigid climates or when solar heat in the building roof is not available.

Other objects of the invention will become apparent from the following detail description, taken with the accompany drawings in which:

Fig. 1 is a vertical sectional view of my improved ceiling installed air cooling apparatus;

Fig. 2 is a diagrammatic view of a refrigerating system of the air conditioning apparatus;

Fig. 3 is a vertical section of a modification of my air conditioning apparatus;

Fig. 4 is a vertical sectional view of another modification of my air conditioning apparatus;

Fig. 5 is an isometric view of the apparatus proper shown removed from Fig. 1;

Fig. 6 is another enlarged detail sectional view, taken along line 6—6 of Fig. 4;

Fig. 7 is a vertical sectional view of a building including the apparatus of Fig. 4, to illustrate the heating function thereof;

Fig. 8 is a vertical sectional view of an air intake-discharge fixture;

Fig. 9 is a bottom view of an air intake-discharge fixture having parts broken away and in section;

Fig. 10 is an enlarged vertical sectional view of the air conditioning apparatus proper of Fig. 4, and

Fig. 11 is a diagrammatical view of the refrigerating system used in the air conditioning apparatus of Fig. 4.

Referring to the drawings by characters of reference, and first to Fig. 1, this view shows my air conditioning apparatus installed in a building 20 to air condition a single room 22, the building having the usual ceiling joists 24 which also give support for the floor of an attic 26. As is common, opposite walls of the attic are provided with louvered air vents 28 and 30 of which vent 28 is the inlet and vent 30 the outlet in the present arrangement. The inlet vent 28 is provided with movable louvers which are operated by a solenoid 29 to open and/or close the vent 28 for a purpose to be hereinafter explained.

The apparatus comprises, in general, a support or

platform 30', an air duct structure 32, and a refrigerating or cooling system, including a motor compressor unit 34, a heat exchanger or refrigerant evaporator 36, and a heat exchanger or refrigerant condenser 38. The refrigerating system and the air duct structure 32 are both mounted on the support 30' which in turn is mounted on the attic floor. The platform 30', duct structure 32 and the refrigerating system collectively comprise the air conditioning apparatus proper. This is a unitary structure which may be fabricated and assembled at a plant for installation as a unit. Soft rubber pads 40 or mountings of other suitable vibration absorbing material, are preferably provided between the feet of the support 30' and the attic floor to decrease vibration transmission to the ceiling.

The duct structure 32 has a duct 42 which provides a plenum chamber 44 having cold air outlets 46, adjacent the ceiling to discharge cold air into room 22. Extending upwardly through the plenum chamber 44 is a room air intake duct 48 which extends upwardly through the support 30' and then extends horizontally, as at 50, wherein I locate the refrigerant evaporator 36. The duct 50 continues to the inlet of a blower housing 52 which has a downwardly directed outlet 54 discharging into the plenum chamber 44. The housing 52 may be of the scroll type to house a wheel type blower 56 having an air intake 58 at the side or at the blower hub, and a pair of spaced outlets 54, 55 substantially tangential to the periphery of the blower wheel. The outlets 54, 55 are controlled respectively by a pair of valves or dampers 51, 53 which are operated together by a common operator, such as a solenoid 57. As shown, the valves 51, 53 are arranged such that when one is open the other is closed and vice-versa. It will be seen that when the valves 51, 53 are in the positions shown, operation of the blower 56 will draw room air up through duct 48 over the evaporator 36 to cool the air and will discharge the cooled air to the plenum chamber 44 for discharge into the room 22 through outlets 46. The valves 51, 53 are reversed when the apparatus is operated to effect air ventilation of the room which is hereinafter described in detail. The evaporator 36 extends to the sides of the duct 50 and to the top and bottom thereof so as to present a large cooling surface to the air passing in contact therewith. The evaporator 36 may be of conventional type having the usual conduit bent in sinuous form and provided with fins 60 to give extended heat transfer surface with the air. A drain pipe 57' leads from a well beneath evaporator 36 to carry away condensate.

In order to expedite installation of ceiling mounted air conditioning apparatus and also to effect balance on the support 30', I arrange the motor compressor unit 34 at one side of duct 50 or near one end of support 30' and the condenser 38 at the other end of the support. In order to decrease transmission of audible vibrations originating within the motor-compressor unit to the support 30', I provide soft mountings 55', such as sponge rubber, between the unit and support 30' to absorb vibrations. Mounted on the support 30' between the blower 56 and the condenser 38, I provide forced draft means or a fan 62, and this fan and the blower 56 may be both driven by a single electric motor 64 disposed therebetween. The fan 62 is arranged to serve the dual function of (1) cooling the condenser 38 during operation of the air conditioning system, and (2) cooling the attic and room 22 as an exhaust fan on days when refrigeration is not desired.

Leading from the air discharge side of condenser 38 is a duct section 71 communicating with a second duct section 73 which leads to the attic vent 30. Duct sections 71, 73 have adjacent ends which are spaced apart to avoid transmission of audible vibrations from the air conditioning apparatus to the building, and said sections are connected together by a vibration insulator section 79. The insulator section 79 may be made of any suitable fabric or other material and the sections may be connected together by clamps 81, or other suitable means.

In the top of duct 50, I provide a pair of air passages 67 and 69 to establish, under certain conditions, communication between duct 50 and the attic. The passages 67, 69 are located in spaced relation along duct 50, passage 67 being anterior to the evaporator 36 and passage 69 being posterior to the evaporator with respect to direction of air flow over the evaporator. The passages 67, 69 are extended by short, upright ducts communicating at their lower ends with duct 50 and having their upper ends open to the attic. In each of the passages 67, 69 is a valve or damper 68 to open and/or close the passages to air flow therethrough. These dampers 68 are either both closed, or both open. A solenoid 70 may be provided to operate the dampers 68 together through suitable arms so that said operation may be conveniently initiated by a push button switch (not shown) located conveniently in room 22 or some adjacent convenient point. During operation of the air conditioning system, it will at times be desirable to exhaust some of the recirculated or stale air and add some fresh air to the circulating duct system. This is done by opening dampers 68 to establish open communication between duct 50 and the attic. When this occurs, stale air is exhausted to the attic through duct 67 under the influence of fan 62, exhausted air being directed into passage 67 by a baffle 67'. At the same time, fresh air entering vent 28 is taken into the duct system through passage 69 under the influence of blower 56 and thus is mixed with the air circulated through the room and duct system. When air refrigeration is not required for comfort in room 22, but air circulation is desirable, the passages 67, 69 function to establish communication between room exhaust duct 50 and fan 62. This function of the system requires that a door or window of room 22 be opened to allow entrance of outside air; that the attic intake 28 be closed; that dampers 68 be open; and that the refrigerating system be shut down. Under the above conditions, fan 62 will draw fresh outside air into room 22, up through duct 48, through duct 50, out of both of the passages 67, 69 to the attic and discharge through outlet 30 under action of fan 62 to maintain air circulation through the room 22. If desired, increased circulation of air may be had by energizing solenoid 57 to open valve 53 and close valve 51. This results in blower 56 being connected through duct 59 to outlet 30 whereby the blower is coacting with fan 62 to effect room air circulation.

The lower end of the plenum chamber 44 is preferably reduced, as at 72, to fit loosely between an adjacent pair of the ceiling joints 24, and on the upper edges of said joists I provide centering members 74 for the duct structure 32. As indicated, the centering members 74 are strips of material secured to the joists or attic floor having their lower edges free and being sufficiently resilient so as to engage at all times, the reduced lower portion of the plenum chamber. These resilient members 74 thus act to center the duct structure as an inexpensive means of preventing contact between and resultant transmission of vibration from the apparatus to the ceiling. This is important to quiet operation as ceiling structures, in general are so constructed as to amplify audible vibrations.

Removably held in the plenum chamber outlets and the room air intake are filters 75 to filter dust, dirt and other foreign matter from the air. The filters 75 may be made of fiber glass or of any other suitable filter material. By locating the filters 75 at or near the ceiling, it will be understood that said filters may be removed for cleaning or replacement from the room, thus avoiding an arrangement which would require that the filters be reached from the attic. Fitted in the ceiling opening is a cold air deflector and grille 78 which may be held in place by bayonet slots or any other suitable quick release means. The grille 78 is preferably a rectangular frame structure com-

posed of a number of rectangular louver or vane type sleeve 79 spaced apart to form a room air intake 80 and a number of the cold air discharges or outlets 46. As shown in Fig. 1 the intake 80 is centrally disposed in communication with intake duct 48, and the outlets 46 are on opposite sides of the intake 80 in communication with the plenum chamber 44. Lower edge portions of the vanes 79 are curved outwardly to deflect the cold heavier air laterally to effect good distribution of the cold air throughout room 22. Also, the curved vanes 79 conceal light fixtures 83 which may be of the fluorescent or other type. One or more of the light fixtures may be mounted in the grille intake 80 to effect direct lighting, and other of the fixtures may be mounted in the grille discharge passages to effect lateral or indirect light against the ceiling.

With reference to the refrigerating system, the outlet of compressor 34 is connected by a conduit 82 to the inlet of condenser 38 which has its outlet connected to a receiver 83 which in turn is connected by a small diameter metering tube 84 to the inlet of the evaporator 36. A refrigerant accumulator 86, wherein vaporous refrigerant is separated from the liquid, connects to the outlet of evaporator 36, and a return or suction line 88 connects the accumulator 86 to the intake of the motor-compressor unit 34. In operation, liquid refrigerant from the condenser 38 is delivered to the evaporator 36 by the small diameter tube 84 which meters the liquid refrigerant supplied such that just sufficient refrigerant is delivered to the evaporator to keep the evaporator completely refrigerated. After expansion and accompanying absorption of heat in the evaporator 36, the vaporous refrigerant is returned to and by the compressor to be again compressed thereby and then liquified in the condenser and the cycle repeated.

Operation

To operate the apparatus for refrigeration air conditioning of room 22, a switch 89 is closed which effects operation of both the refrigeration system and motor 64 which drives fan 62 and blower 56. The louvers of attic vent 28 must be open, as shown to allow fan 62 to draw in outside air for cooling condenser 38 and ventilating the attic 26, and valve 51 must be open and valve 53 closed, as shown. Also, valves 68 are normally closed during the refrigeration air conditioning of room 22. The blower 56 operates to circulate room air over the evaporator 36 and return the cool air to the room to cool the same. In detail, the blower 56 draws relatively warm air from the room 22 upwardly through duct 48 over the evaporator 36 where the air is cooled and whence the air is taken into the blower housing and forced downwardly into the plenum chamber 44, through filters 75 and discharged back into the room through the grille outlets 46. When it is desired to add fresh air to the room air circulating system, solenoid 70 is energized to open valves 68. This allows some of the stale recirculated air to exhaust through passage 67 to the attic and allows other fresh air flowing from inlet 28 under the influence of fan 62 and blower 56 to be drawn by blower 56 through passage 69 into the room circulating duct system.

When refrigeration air conditioning of room 22 is not necessary for comfort, but it is desired to ventilate the room and also attic 26, it is only necessary to close the louvers of air inlet 28, open valves 68, close valve 51 and open valve 53 and open a window or door of room 22. Also, refrigeration is discontinued by opening switch 89, and a switch 87 is closed to energize motor 64 so as to operate blower 56 and fan 62. With the air vent 28 closed and valves 68 open, the fan 62 and the blower 56 draw air into room 22 from the said open window or door, up through duct 48, through passages 67, 69 into the attic to the fan, and through the blower housing and duct 59 for discharge by the dual fan-blower action through attic air outlet 30. It will be seen that both fan 62 and blower 56 cooperate to draw fresh air into the room and that together the fan and blower will effect a high capacity of air flow through the room.

The refrigerating system may be reversed to function as a heating system during cold weather, and reversal of the system may be effected in the well known manner hereinafter described in connection with Fig. 11. When the system is reversed for heating operation, the heat exchanger 36 then functions as a condenser, and the heat exchanger 38 functions as an evaporator. During the heating operation, the blower 56 draws room air up through intake duct 48 over the condenser 36 where the heat of condensation is given up to the air; the heated air then flowing through the blower housing into the plenum chamber and discharging into the room through the air outlets 46. In order that my apparatus may be used successfully as a heating plant in climates ranging from mild southern climates to severe cold climates, I provide a supplementary heater 87 for use in providing adequate heat during intervals when sufficient heat is not otherwise available in order to secure satisfactory heating capacity of the system in frigid climates. The heater 87 is preferably of the electric type and is preferably located in the plenum chamber 44, as shown.

Referring now to Fig. 3, I have shown a fragment of a building 92 having a space 94 normally unused or unoccupied such as an attic, provided with a louvered air outlet 96. The attic 94 also preferably has a fresh air intake which may be a louvered opening or window in the attic or other part of the building so that an exhaust fan 98 may be used to draw fresh air through the attic to cool the same. The fan 98 is located near the outlet 96 to discharge air therefrom and between the fan 98 and the outlet 96, I provide a refrigerant condenser 100 of a refrigerating apparatus, used in the building. While I have shown and described the refrigerant condenser 100 as being between the outlet 96 and the fan 98, it will be understood that the condenser may be located on the intake side of the fan or in any other position such that the forced flow of air passes over and cools the condenser. The units of the refrigerating apparatus, other than the condenser 100, may be located anywhere in the building.

In Fig. 4, I have shown a modification of my air conditioning system of Fig. 1, and since the systems are similar, like parts have been given like numerals to avoid repetitious description. The air duct system of the modification differs from that of Fig. 1 in having a duct 102 which extends horizontally above duct 48 having one end open, as at 104, to the fresh air intake 28 and the other end connected to the intake side of the housing of exhaust fan 62. A valve or damper 106 is provided in duct 102 to open and/or close the duct to air flow. Posterior to the damper 106, the blower housing discharges into duct 102 under control of valve 52. For convenience, damper 106 may be actuated by a solenoid 112 and the solenoid may be controlled by a suitable switch (not shown) which may be mounted on a conveniently located control panel in the living quarters of the building.

In Fig. 10, the air conditioning apparatus of the modification is shown removed from the building to illustrate how this apparatus is provided as a unitary structure. In general, the unitary structure comprises the support or platform 30', the duct structure, the refrigeration-heating system and controls 57 and 112. It will be seen that the apparatus may be fabricated and assembled at the factory and be shipped to sites of installations ready to install as a prefabricated structure. In summer when the system is being used for refrigeration air conditioning, the system operates substantially as the previously described system of Fig. 1 with the exception that the modification is adapted to cool several rooms of the building. To this end, I provide cold air supply ducts 113, leading from the plenum chamber 44 to air inlets 115 in

the several rooms, and provide warm air return ducts 117 from outlets 119 in the rooms to the air conditioner return duct 48. The room inlets 115 and outlets 119 may be located in the ceilings or walls of the rooms and be covered with suitable grilles. In order to avoid transmission of vibrations from the apparatus to the ceiling via the duct runs 102, 106, I connect each of said ducts 102 to plenum chamber 44 and ducts 106 to duct 48 by vibration insulator duct sections 109. The duct sections 109 may be of soft fabric or other insulating material and may be clamped or otherwise attached to the adjacent ends of the metal duct sections.

As is well known, in reversible refrigerating systems, generally known as heat pump systems, if the evaporator is subjected to substantially outdoor temperature such as the temperature of an attic or other unheated space, that the evaporator may cool down, in severely cold climates, to the point where the rate of evaporation is inefficient to maintain desired heating capacity for the room or space being heated. To insure against this occurring, I provide an inexpensive means for delivering extraneous heat to the evaporator to aid refrigerant vaporization and consequently add heat to the system for transfer at the condenser to room air. By extraneous heat, I mean heat from a source externally of the apparatus. I use as the said extraneous heat the heat loss by radiation through the ceiling or ceilings of heated rooms and the solar heat stored in the roof and conduct the heat to the evaporator. To accomplish these objectives, I provide a heat absorbing air duct system, comprising, a plurality of roof ducts 116, a hot air header 118, and a header outlet duct 120. The roof ducts 116 extend upwardly between adjacent rafters 122 substantially from the ceiling to the roof peak where the ducts 116 discharge into the header 118 whence the warm air is drawn down into duct 102 through duct 120.

To form the roof ducts 116, I attach sheet material 124 to the under edges of the rafters 122 preferably to cover a substantial portion of the underside of the roof. The sheet material 124 terminates sufficiently above the ceiling to provide air inlets 126 near the ceiling on the attic side thereof. In order to contain or trap heat in the ducts 116, the sheet material 124 is of the heat reflector type, such as sheet aluminum or foil to reflect the heat toward the underside of the roof which is preferably provided with a blackened or nonreflecting surface.

The header 118 may be formed by a portion of the roof at the peak thereof and by sheet material 130 attached to the roof. As shown, the header 118 extends substantially coextensive with the roof ridge rail, the sheet material 130 being attached to outer rafters and being spaced below the intermediate rafters so that all of the utilized roof ducts 116 discharge into the header. The header 118 is connected to duct 102 by duct sections which includes an intermediate vibration insulator section 132 to prevent transmission of audible vibrations from the apparatus to the roof. The section 122 may be made of soft fabric or other noise absorbing material.

A heater 133 is provided to supply heat to the evaporator 38 on occasions when sufficient heat for desired efficiency of the apparatus is not attainable from the roof ducts. In the present arrangement heater 133 is located in duct 102, but may be located in any other suitable place to supply heat to the evaporator 38 to effect efficient evaporation therein. For example, if desired, the heater 133 could be mounted adjacent or on the evaporator 38.

With reference to the cooling and/or heating system shown diagrammatically in Fig. 11, the refrigerating system includes heat exchanger 38 functioning as a refrigerant condenser and heat exchanger 36 functioning as a refrigerant evaporator. The motor-compressor unit 34 is connected by a conduit 134 to the inlet of condenser 38 which has an outlet connected to a receiver 136. From the receiver 136, liquid refrigerant is conducted through a small diameter metering tube 138 to the evaporator 36 wherein heat absorption vaporizes the refrigerant and the vaporous refrigerant passes to an accumulator 140 whence the vaporous refrigerant is drawn back through a return line 142 to and by the unit 34 and the cycle repeated.

On heating operation of the system, the heat exchanger 36 now functioning as a condenser or heat dissipater receives liquid refrigerant from motor-compressor unit 34 through conduit 134 and a small diameter metering tube 144, and from the condenser 36 refrigerant passes through metering tube 138 to element 136 which functions as a receiver. From receiver 136, the liquid refrigerant enters and expands in heat exchanger 38 which functions as an evaporator, and vaporous refrigerant returns to the motor-compressor unit through return conduit 146. The numerals 148 and 150 designate double acting valves adapted to change the system from cooling to heating and vice-versa. These valves 148, 150 may be operated by solenoids 152 and 154 which may be controlled by suitable manual switches (not shown). It will be seen that valve 150 is in conduit 134 anterior to heat exchanger 38 and that return line 146 is also connected to valve 150. Thus, when cooling is desired, the valve 150 is operated to open conduit 134 and close conduit 146, and conversely when heating is required valve 150 is operated to close conduit 134 and open return conduit 146. Similarly, valve 140 is in both conduit 142 and conduit 144 so that on cooling, valve 148 opens return line 142 and closes conduit 144, and conversely on heating, valve 148 opens feed line 144 and closes return conduit 142.

Assuming that valves 148, 150 are in position for cooling operation of the system, the system operates as follows: Gaseous refrigerant from the motor-compressor unit 34 passes through conduit 134 and valve 150 into condenser 38 wherein the gas is condensed and conducted to the receiver 136. From the receiver 136 the liquid refrigerant is metered through tube 138 to the evaporator 36 wherein expansion and absorption of ambient heat vaporizes the refrigerant which passes to the accumulator 140 whence vaporous refrigerant returns through valve 148 and return line 142 to the compressor and the cycle repeated. In operation of the refrigerating system, motor 64 will be operating the blower 56 and the fan 62, attic vent 28 must be open, damper 106 must be in the raised or full line position closing duct 120 and opening duct 102 to the attic and valves 51, 53 must be in the full line positions shown. Operation of the blower 56 draws relatively warm air up through duct 48 over the cold evaporator 36 to cool the air which is then returned through duct 54 and plenum chamber 44 for discharge back into the room through filters 75 and grille outlets 46. At the same time, fan 62 draws air in through attic vent 28 and duct 102 and discharges the air over the condenser to dissipate the heat of condensation, and exhausts through attic vent 30. Also by my arrangement, fan 62 cools the attic by ventilation or air movement therethrough and thus contributes to the lowering of the house temperature. On days when refrigeration is not required for comfort, sufficient cooling may be had by operating only the blower 56 and fan 62.

On other days it will be desirable to cool the room or rooms of the house by forced air ventilation. When this is desired, attic vent 28 is closed, valves 51, 53 are moved to the dot and dash positions and a door or window is opened in the living quarters. The exhaust fan 62 and blower 56 now coact and draw air in through the open window or door, up through duct 48, duct 108, duct 102 and exhausts from attic vent 30. Thus, in warm weather, when refrigeration is not necessary for comfort, the condenser cooling fan 62 and blower 56 may be utilized together as an air exhaust means to effect fresh air circulation through the rooms.

When it is desired to operate the heat exchange sys-

tem to heat the rooms, valves **148** and **150** are operated to change the direction of flow of the refrigerant and thus convert the refrigeration system to a heat pump system. The heat pump system operates as follows: Gaseous refrigerant from the motor-compressor unit **34** passes through conduit **134** and metering tube **144** to valve **148** and then through receiver **140** to heat exchanger **36** which now functions as a condenser. From the condenser **36** liquid refrigerant passes through metering tube **138** to the receiver **136** and then into heat exchanger **38** which now functions as an evaporator. From the evaporator **38** vaporized refrigerant is drawn back to the motor-compressor **34** through valve **150** and conduit **146** and the cycle repeated.

During the reverse action of the refrigerating system, damper **106** is in the position shown in dot and dash lines closing duct **102** to attic air and opening said duct to the hot air header **118** at the underside of the roof and valve **52** is closed and valve **51** is open. The fan **62** now draws air from the attic, through inlets **126**, up the roof ducts **116**, into the hot air header **118**, down the header discharge into duct **102**, over the evaporator **38** and out the exhaust vent **30**. As previously mentioned the air drawn into the roof ducts **116** will contain radiant heat from the ceiling and this heat and the solar heat stored in the roof is conducted to the evaporator to effect continued vaporization therein in cold climates. The air heated by heater **36**, is delivered by the blower **56** to the plenum chamber **44** whence the air passes into the room through filters **75**, some of the air flowing through ducts **102** to other rooms to be heated, and colder air from said rooms returning by ducts **106** to the intake **48**. In extremely cold weather, efficient operation of the evaporator **38** and therefor the heating system may be assured by the use of extraneous heat for the evaporator, such as the heat produced by the electric heater **87**. This heater may be located in plenum chamber **44** and may be energized when desired to supplement the condenser heat output.

In order that the rooms of the house, outlying from the air conditioning apparatus may have a single grille for both the air intake and air discharge, a duct grille terminal **152** of the type shown in Fig. 8 may be used. The duct terminal **152** is similar to the main duct structure at the air conditioning apparatus in comprising a room air intake duct **154** surrounded by an outlet duct **156** providing a plenum chamber **158**. The outlet duct **156** and the plenum chamber **158** have short connecting sections **160**, **162** for connection respectively to the air supply and return runs **113**, **117**. A one piece air filter **164** is provided in the intake and outlet and a grille, similar to the grille of Fig. 4 is provided to give a pleasing appearance, to direct air outwardly to all parts of the room and to provide a light fixture. The one piece air filter **164** is held between the lower edge of air intake duct **154** and the upper edges of the grille. It will be seen that by arranging the filter immediately above the grille access thereto for replacement may be readily had from the room by merely removing the grille. Each of the outlying air discharge-intake units **152** (Fig. 8) is provided with a damper **166** in the inlet adapted for individual manual adjustment so that the cooling and/or heating of the several rooms may be selective.

From the foregoing description, it will now be understood that I have provided an improved ceiling installed air conditioning apparatus in which I provide an air cooled condenser cooled by an attic exhaust fan with an arrangement such that the exhaust fan may be operated in conjunction with the refrigerating system to not only cool the condenser, but to also cool the attic or, if desired, may be operated alone at times when refrigeration isn't necessary to comfort. Also, I have provided a condenser-exhaust fan arrangement in which the condenser and attic exhaust fan for cooling the same are remote from the remainder of the refrigerating apparatus. In addition, I have provided an improved reverse cycle refrigerating apparatus for heating in winter in which I provide a novel arrangement for utilizing ceiling radiant heat and solar heat from the roof of the building or an electric heater or all three to supply heat to the evaporator to insure continued vaporization of refrigerant even during severely cold weather so as to effect efficient heating of the room.

While I have shown and described my invention in detail, it will be understood that the invention is to be limited only by the spirit and scope of the appended claim.

What I claim is:

In a combination cooling and ventilating system for either cooling a room or ventilating the room, a duct within a closed space without the room, said duct having an air inlet and an air outlet communicating with the room, a cooling element within said duct between the inlet and outlet thereof, a blower within said duct between said cooling element and said outlet, a heat dissipating element without said duct operatively connected to said cooling element, an exhaust fan without said duct inducing air flow over said heat dissipating element and discharging the air to outside atmosphere, an air exhaust from said duct on the outlet side of said blower and communicating with said fan, a valve controlling said duct outlet, a valve controlling said exhaust, one of said valves being open when the other is closed, means operable to actuate said valves, an exhaust air passage in said duct in communication with said fan, said exhaust air passage on the anterior side of said cooling element with respect to direction of air flow, a baffle within said duct directing air flow to said passage, an intake air passage in said duct on the posterior side of said cooling element and communicating with the intake of said blower, a valve controlling said exhaust air passage, a valve controlling said intake air passage, said exhaust and inlet passage valves either being both open or both closed, and means operable to actuate said exhaust and inlet passage valves.

References Cited in the file of this patent

UNITED STATES PATENTS

1,706,213	Cordley	Mar. 19, 1929
2,182,569	Peo	Dec. 5, 1939
2,257,221	Bell	Sept. 30, 1941
2,363,839	Demuth	Nov. 28, 1944
2,466,383	Cody	Apr. 5, 1949
2,475,841	Jones	July 12, 1949
2,523,332	Riehl	Sept. 26, 1950
2,619,812	Burgess	Dec. 2, 1952
2,638,757	Borgerd	May 19, 1953
2,664,720	Borgerd	Jan. 5, 1954
2,682,757	Borgerd	July 6, 1954
2,691,488	Ghai	Oct. 12, 1954
2,722,107	Gay	Nov. 1, 1955
2,760,353	Kuhlenschmidt	Aug. 28, 1956
2,779,572	Holman	Jan. 29, 1957

FOREIGN PATENTS

547,436	Great Britain	Aug. 27, 1942