

Aug. 25, 1942.

A. H. EBERHART

2,293,718

AIR CONDITIONING APPARATUS

Filed Oct. 12, 1938

4 Sheets-Sheet 1

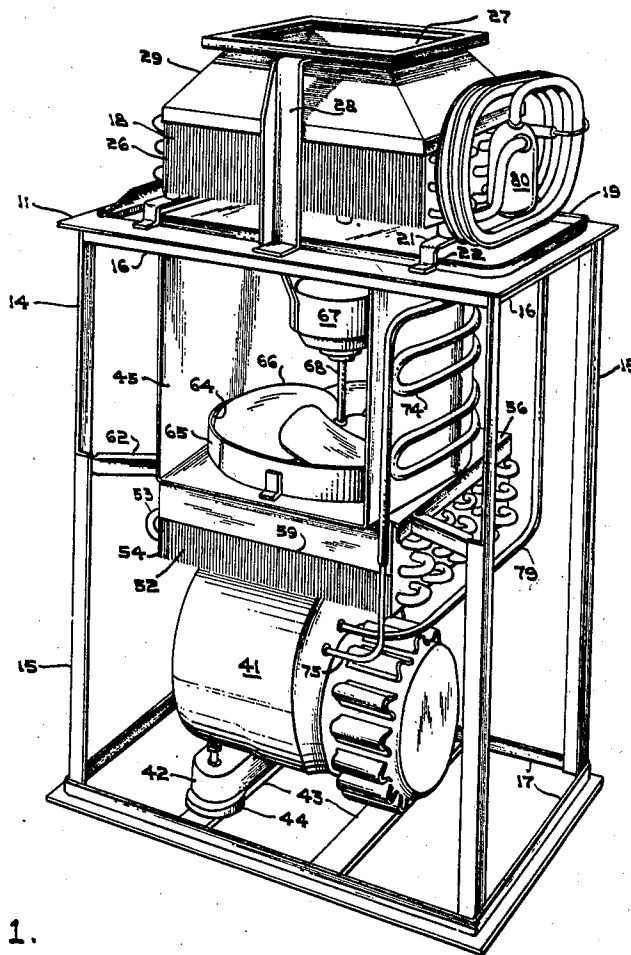


FIG. 1.

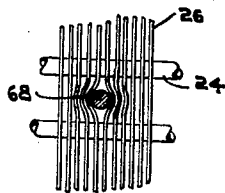


FIG. 2.

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4 Sheets-Sheet 2

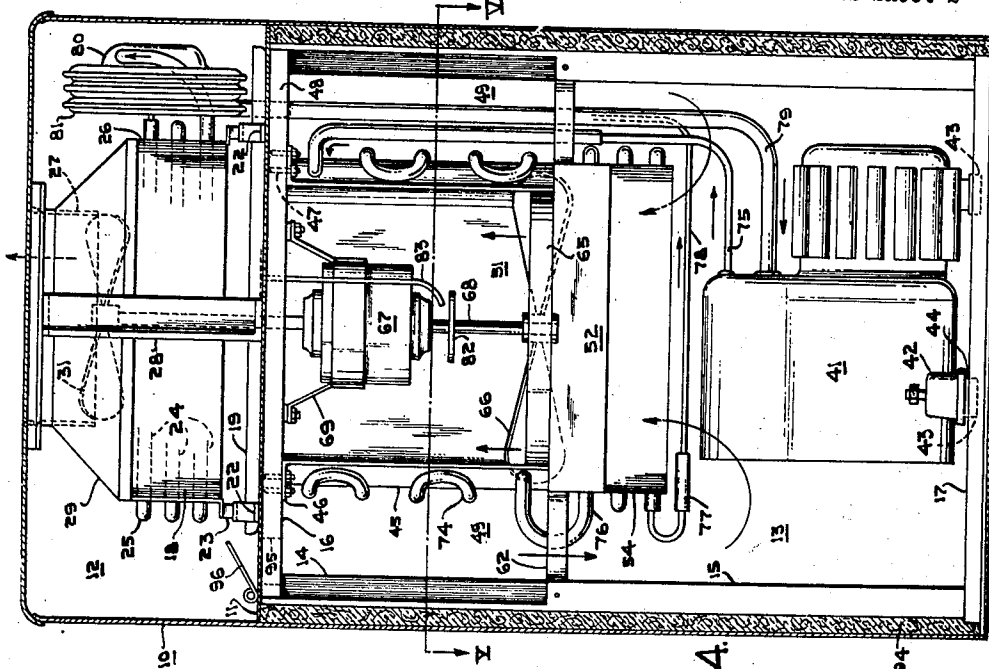


Fig. 4.

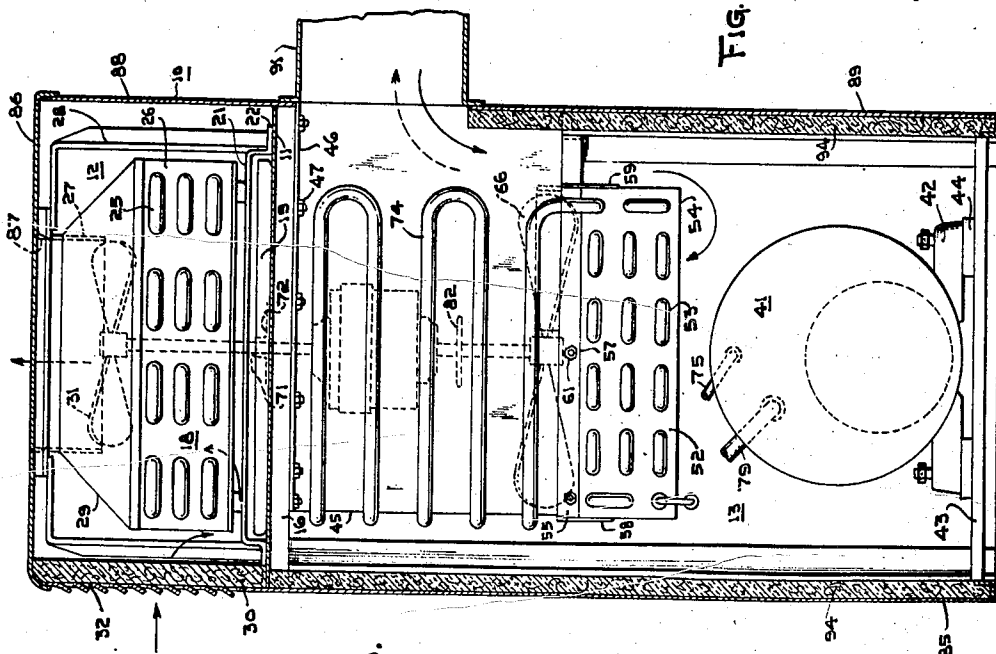


Fig. 3.

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4 Sheets-Sheet 3

FIG. 5.

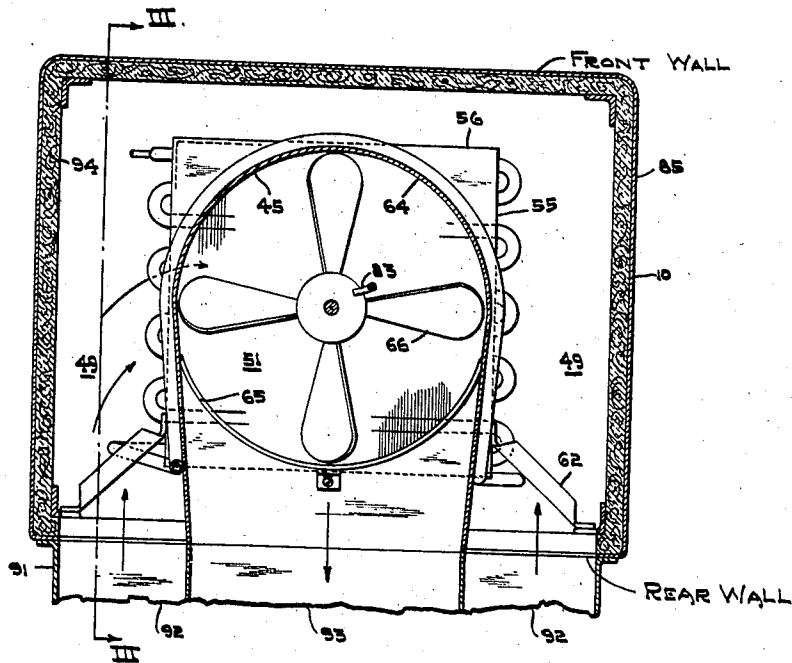
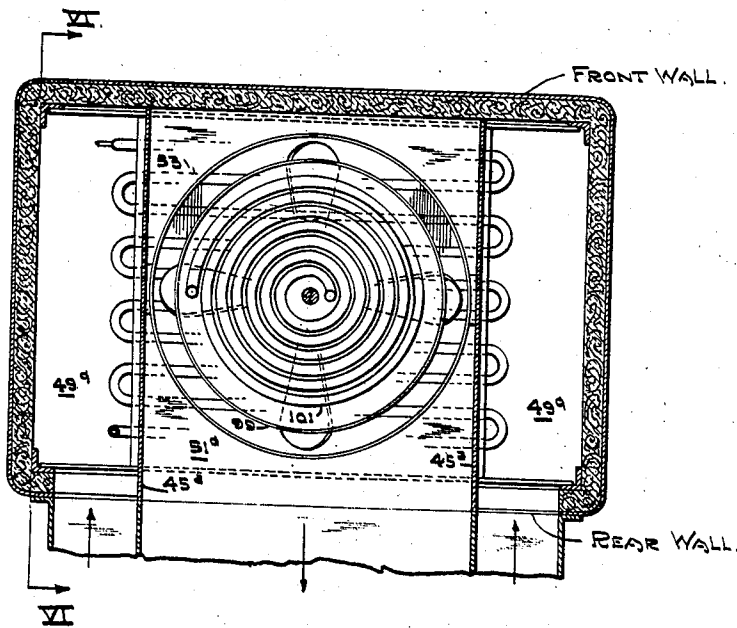


FIG. 8.

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4 Sheets-Sheet 4

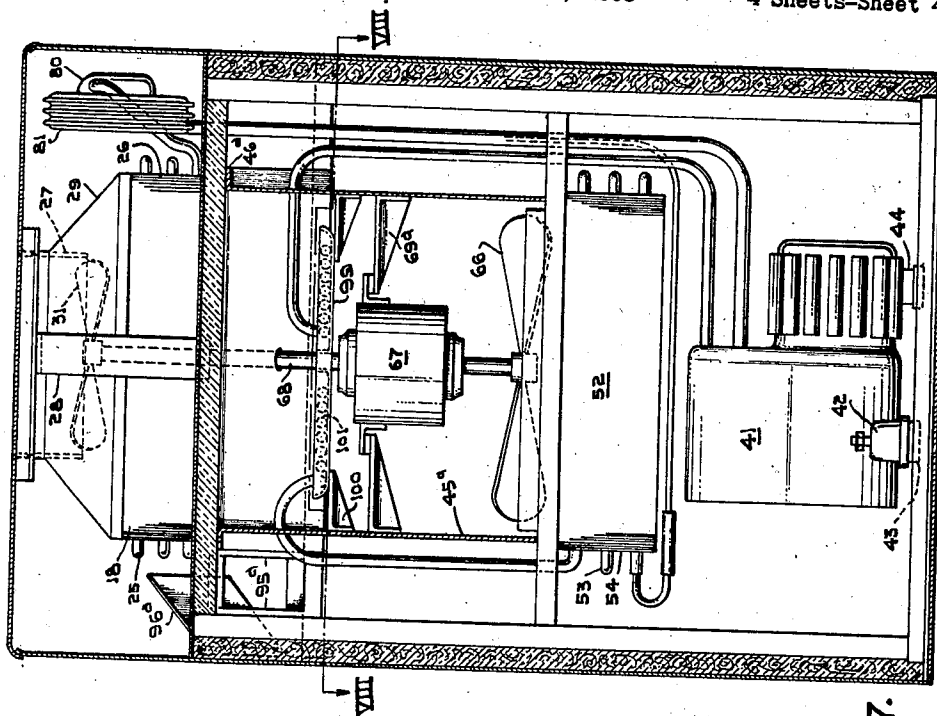


FIG. 7.

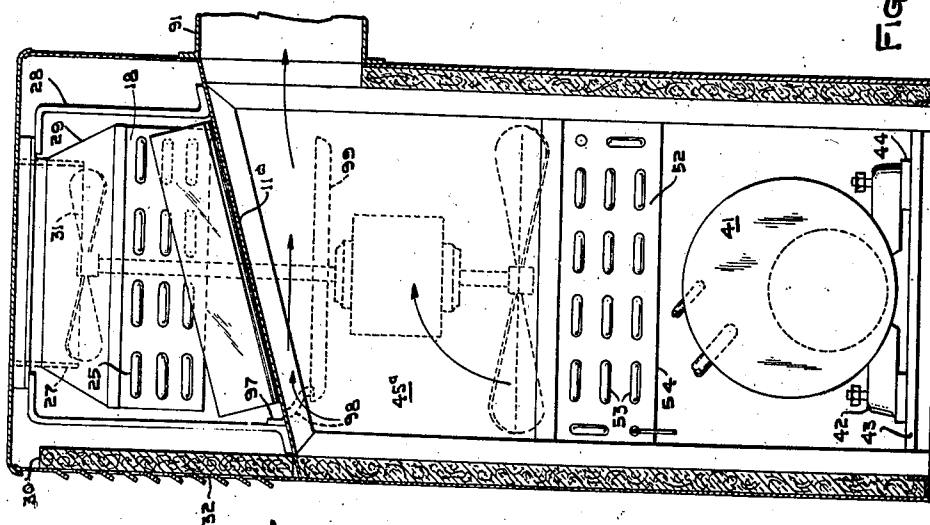


FIG. 6.

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UNITED STATES PATENT OFFICE

2,293,718

AIR CONDITIONING APPARATUS

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Application October 12, 1938, Serial No. 234,511

5 Claims. (Cl. 62-140)

My invention relates to air conditioning apparatus, more particularly to a self-contained unit air conditioner, and it has for an object to provide improved apparatus.

A further object is to provide a suitable construction of unit air conditioner that may be manufactured at low cost.

A further object is to provide a unit air conditioner of simplified construction.

Another object is to provide an air cooled, self-contained room cooler in which heat leakage from the air heated by the condenser to the room air is minimized.

These and other objects are effected by my invention as will be apparent from the following description and claims taken in connection with the accompanying drawings, forming a part of this application, in which:

Fig. 1 is a perspective view of one embodiment of unit air conditioner, with the cabinet removed, as seen from the rear;

Fig. 2 is a fragmentary view of a detail;

Fig. 3 is a side elevation, parts of the cabinet being in section along the line III-III of Fig. 5;

Fig. 4 is a rear elevation, with the rear wall and the window duct removed;

Fig. 5 is a horizontal sectional view taken along the line V-V of Fig. 4;

Fig. 6 is a side elevation, with parts of the cabinet in section along the line VI-VI of Fig. 3, of a second embodiment;

Fig. 7 is a rear elevation, with the rear wall and window duct removed, of the second embodiment; and,

Fig. 8 is a horizontal sectional view taken along the line VIII-VIII of Fig. 7.

Referring to the first embodiment shown in Figs. 1 to 5, the air conditioning apparatus is enclosed in a casing 10. A horizontal partition 11, which may be of sheet metal, divides the interior of the casing into an upper compartment 12 containing the air cooling apparatus and a lower compartment 13 containing the refrigerant liquefying apparatus.

The apparatus is supported by a frame 14, which includes vertical angle irons or corner posts 15 extending to the partition 11, longitudinal and transverse angle irons 16 connecting the upper ends of the corner posts, and longitudinal and transverse angle irons 17 connecting the lower ends of the corner posts.

The partition 11 may, as shown, rest directly on the top of the frame 14, or heat insulating

material may be interposed therebetween, if desired.

The air cooling apparatus in the upper compartment 12 comprises an evaporator 18. A drip pan 19, resting on the partition 11, is disposed beneath the evaporator 18 for collecting condensate forming thereon. The evaporator is supported on the partition 11 and spaced upwardly therefrom by means of straps 21 which extend over the drip pan and which have feet 22 secured to the partition 11 beyond the drip pan. Rubber mountings 23 are preferably interposed between the evaporator and the straps 21 to avoid transmission of noise therebetween.

The evaporator 18 is disposed horizontally and comprises a plurality of straight, parallel tubes 24 disposed horizontally, as shown on the drawings. The adjacent ends of the tubes are connected by U-bends 25 to provide suitable refrigerant passages. The tubes 24 are provided with vertical fins or plates 26 providing extended heat transfer surfaces therefor. Preferably, the plates 26 extend across the entire group of tubes, as shown in Fig. 3, the plates being formed with openings through which the tubes extend. Good metallic contact between the plates and the tubes is provided in order to effect good heat conduction.

A fan shroud 27 is mounted above the evaporator by means of two brackets 28 mounted on the partition 11 and disposed on the front and rear sides of the evaporator. A cloth duct member 29 extends from the evaporator 18 to the fan shroud 27 to provide flow of air from the former to the latter.

A propeller fan 31 is disposed in the shroud 27 and effects flow of air upwardly through the evaporator, the duct member 29 and the fan shroud 27. This fan will be described later. The casing is provided with an inlet opening 32 for admitting air from the room in which the apparatus is disposed. A filter 30 is preferably provided as shown in Fig. 3, to filter the air entering through the inlet opening 32.

The refrigerant liquefying apparatus in the lower compartment 13 includes a motor compressor unit 41, which is preferably of the enclosed type. It may be mounted in any suitable manner; for example, it may be provided with brackets or feet 42 resting on angle irons 43 extending between and connected to the longitudinal angle irons 17 of the frame 14. Rubber mountings or other suitable mountings 44 are preferably interposed between the feet 42 and the angle irons 43 for minimizing trans-

mission of vibration from the motor compressor unit to the frame.

A vertical partition 45, made of rust-resisting sheet metal, is suspended from the horizontal partition 11, in any suitable manner, for example, it may be provided with a horizontal flange 46 connected to the horizontal partition 11 by bolts 47 extending through heat insulating material 48. As shown in Fig. 5, the partition 45 is of horse-shoe form in horizontal section and forms a division between inlet passages 49 and an outlet passage 51. The end portions of the partition extend to and terminate at the rear wall of the casing 10.

A condenser 52 is carried by the partition and disposed immediately beneath the same. The condenser is disposed horizontally and includes straight parallel tubes 53 disposed horizontally. Fins or plates 54 are preferably attached to the tubes to provide extended heat transfer surfaces therefor.

A casing member 55 partially encloses the upper portion of the condenser and includes a top wall 56, end flanges 57, a front flange 58 and a rear flange 59 bent downwardly from the respective edges of the top wall 56. The top wall 56 is secured to the lower edge of the partition 45, as by soldering, and the condenser is preferably removably attached to the casing member 55, as by bolts 61 extending through the end flanges 57 and the plates 54. The vertical partition 45 and the condenser 52 may be braced laterally by braces 62 extending between the end flanges 57 and the corner posts 15.

The top wall 56 of the casing member is formed with a circular fan opening 64. A fan shroud member 65 is attached to the top wall 56 along the rear half of the opening 64, while the adjacent portion of the partition 45 serves as a shroud for the front half of the opening. A fan 66, of the propeller type, is disposed in the opening 64 immediately above the condenser, for effecting flow of air over the latter.

A motor 67 having a vertical shaft 68 is provided for driving the fans 31 and 66, and is preferably mounted on the underside of the partition 11 by means of brackets 69. The motor shaft 68 is extended upwardly through the drip pan 19 and the evaporator 18, and the fan 31 is mounted thereon, as shown in Figs. 3 and 4. The drip pan 19 is formed with an opening 71 to accommodate the shaft, and with a flange 72 around the opening to prevent the escape of condensate therethrough. The portions of the evaporator plates or fins 26, which would otherwise interfere with the shaft 68, are bent away from each other, as shown in Fig. 2, to provide an opening through which the shaft extends. It will be noted, therefore, that the shaft extends between adjacent tubes and between adjacent plates or fins of the evaporator. The lower end of the shaft 68 is extended downwardly and the fan 66 is mounted thereon as is apparent from the drawings.

The evaporator, the compressor and the condenser are connected in a refrigerant circuit in a manner generally similar to any compression system. The circuit, however, includes tubing 74 attached to the partition 45, as by soldering, and containing high temperature compressed refrigerant gas. The inlet end of the tubing 74 is connected to the compressor discharge through a conduit 75. The outlet end of the tubing 74 is connected to the condenser 52 through a connecting conduit 76. The outlet of the condenser

is connected through a refrigerant liquid strainer 77 to the inlet of the evaporator by a long tube of restricted bore, sometimes referred to as a capillary tube, and indicated at 78. The capillary tube serves as an expansion device for reducing the pressure of the refrigerant. The outlet of the evaporator is connected to the inlet of the compressor by a suction line or conduit 79, which may have an accumulator 80 intercalated therein near the evaporator for the purpose of retaining any unvaporized refrigerant that may be discharged from the evaporator. The capillary tube 78 and the suction line 79 are arranged in heat transfer relation, as shown at 81, to provide for transfer of heat from the condensed refrigerant leaving the condenser to the vaporized refrigerant flowing from the evaporator to the compressor.

An atomizer 82 is mounted on the shaft 68 below the motor 67, and a tube 83 is adapted to convey condensate from the drip pan 19 to the top of the atomizer 82, from which it is thrown against the partition 45.

The casing 10 may be of any suitable construction. For example, it may comprise a member 85 providing the front and side walls of the casing, a top wall member 86 having an outlet opening 87 registering with the fan shroud 27, and upper and lower rear wall members 88 and 89, respectively.

A horizontal duct member 91 is removably attached to the rear of the casing and has inlet passages 92 communicating with the inlet passages 49, and an outlet passage 93 communicating with the outlet passage 51. As shown in Figs. 3 and 4, the height of the edges of the partition 45 at the rear wall, and the height between the partition 11 and the top wall 86 is considerably greater than the height of the duct member 91. It is possible, therefore, to vary considerably the height at which the duct member 91 may be attached to the casing. While the duct member 91 is not necessarily vertically slidable, nevertheless, it is possible when constructing each unit to position the duct at a suitable height by suitably conforming the rear wall thereto, without altering any of the apparatus within the unit. For example, the upper portion 88 of the rear wall may be supplied of sufficient height to extend between the top wall of the casing and the duct member when the latter is in the lowermost position, and the lower portion 89 may be supplied of sufficient height to extend between the duct member 91 and the bottom of the casing when the duct member is at the uppermost position. Then, when the duct member 91 is positioned at the desired height, the excess portions of one or both of the rear wall portions 88 and 89 may be cut off. On the other hand, if desired, a vertically slidable connection between the duct member 91 and the rear wall may be provided.

Operation

The motor 67 drives both of the fans 31 and 66. The evaporator fan 31 draws air inwardly through the inlet 32 and the filter 30, upwardly over the surfaces of the evaporator, and through the cloth duct member 29, and discharges the same through the shroud 27 and the discharge opening 87 upwardly into the room or other enclosure in which the unit is placed. The fan 66 operates to induce flow of air inwardly through the inlet passages 92 of the duct member 91, the inlet passages 49 within the lower compartment

13 of the unit, over the surfaces of the motor compressor unit 41, then upwardly over the surfaces of the condenser 52, past the fan 66, upwardly through the passage 51 and then outwardly through the upper portion of said passage 51 and the outlet passage 93 in the duct member 91.

The vaporous refrigerant is compressed by the motor compressor unit 41, raising the temperature thereof to a high value. It is then conveyed through the tubing 74, in which it serves to heat the partition 45. It then flows through the condenser in which it is transformed to the liquid state. The condensed refrigerant then flows through the tube 78, in which its pressure is reduced. During the first portion of its travel through the tube 78, the condensed refrigerant gives up a portion of its heat to the vaporized refrigerant, thereby increasing the cooling capacity of the refrigerant. The reduced pressure refrigerant then enters the evaporator 18 in which it serves to extract heat from air flowing over the surfaces of the evaporator and in which the liquid refrigerant is vaporized. The vaporized refrigerant then flows through the suction conduit, in a portion of which it receives heat from the refrigerant in the tube 78 and then enters the motor compressor unit to be recompressed.

The moisture condensed from the air by the evaporator 18 drops to the drip pan 19 and is collected thereby. Thence it flows by gravity through the tube 83 to the atomizer 82, from which it is thrown by centrifugal force and/or air currents to the partition 45. On the latter, it receives heat supplied from the high temperature refrigerant gas in the tubing 74 and it is vaporized and carried off in the stream of air discharged from the fan 66. The latter air has had its temperature raised by the heat extracted from the condenser 52 so that it has high moisture absorbing capacity. The moisture is, therefore, discharged from the unit along with the condenser air stream.

The wall portions enclosing the lower compartment 13 are preferably provided with heat insulating material, as shown at 48 and at 94, to minimize leakage of heat from the incoming condenser air stream to the air in the room.

In order to provide for change of air in the enclosure in which the air conditioning apparatus is enclosed, there is preferably provided an opening 95 in the horizontal partition 11. An adjustable door 96 is preferably provided for controlling the flow of air through said opening. The direction of flow of air through this opening depends upon the proportions of the several air passages, the size of the filter 30, etc. Preferably, the apparatus is designed for flow of air downwardly therethrough so that room air is drawn into the condenser air stream and withdrawn therewith from the enclosure. Such withdrawal results in infiltration of outdoor air into the enclosure to replace the withdrawn air.

Figures 6, 7 and 8

In Figs. 6, 7 and 8, I show a second embodiment in which the partition 11a between the upper and lower compartments is inclined rearwardly. Two flat vertical partitions 45a are substituted for the horseshoe partition 45 of the first embodiment. The partitions 45a extend between the front and rear walls and are suspended from the partition 11a by means of flanges 46a at their inclined upper edges. They form divisions between inlet passages 49a and an outlet pas-

sage 51a generally similar to the first embodiment. The condensate formed on the evaporator is collected directly on the partition 11a, which is made of a rust-resisting metal and provided with a flange or dam 97 to form a sump. From the latter, the condensate is drained by gravity through a tube 98 to a pan 99, which is mounted beneath the partition 11a by brackets 100 secured to the partitions 45a. The pan 99 is provided with a flanged opening through which the motor shaft 68 extends, as shown in Fig. 7.

A length of tubing 101, wound spirally, is placed on the bottom of the pan and heats the condensate received therein. The tubing 101 is connected between the compressor outlet and the condenser inlet, similarly to the tubing 74 of the first embodiment, so that compressed refrigerant gas at relatively high temperature flows therethrough.

The motor 67, driving the evaporator fan 31 and the condenser fan 66, is mounted on brackets 69a secured to the partitions 45a. In other respects, the second embodiment of Figs. 6, 7 and 8 may be, as shown, similar to the first embodiment of Figs. 1 to 5.

In the operation of the second embodiment, a portion of the condenser air stream flows around the front edge and over the top of the pan 99, and evaporates the condensate contained therein. The vaporization is facilitated by the heat supplied from the refrigerant gas flowing through the tubing 101. In other respects, the operation of this embodiment is the same as that of the first embodiment. Any suitable provision, such as the addition of the atomizer 82 of Figs. 1 to 5, may be made for disposing of any excess condensate which is not evaporated in the pan 99 and which overflows the same.

One advantage of the second embodiment is that a greater height of air filter 30 may be provided. Also, improved flow of air to the bottom of the evaporator 18 is provided. The increased height of the rear edge of the partition 11a increases the range through which the window duct 91 may be adjusted.

While I have shown my invention in several forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:

1. In a unit air conditioner, the combination of a housing, a partition providing an evaporator compartment and a machine compartment in the housing, an evaporator disposed in said evaporator compartment, partition means in said machine compartment including opposed vertical wall portions and forming an air passage in said machine compartment between said opposed vertical wall portions, said housing having an outlet opening adjacent the upper end of the machine compartment and communicating with the upper end of said passage and inlet openings disposed on opposite sides of the outlet opening and communicating with the upper end of the machine compartment outside of said passage, a condenser and a compressor disposed in said machine compartment, and air translating means disposed in said machine compartment and effecting flow of air inwardly through said inlet openings, downwardly through the machine com-

partment outside of said air passage, through said passage, and outwardly through said outlet opening, said air also flowing in contact with the surfaces of said condenser.

2. In a unit air conditioner, the combination of a housing, a partition providing an upper compartment and a lower compartment in the housing, partition means extending downwardly from said partition and including opposed vertical wall portions, said partition means forming an air passage in said lower compartment between said opposed vertical wall portions, a condenser extending horizontally between said vertical wall portions adjacent the lower ends thereof, said housing having an outlet opening adjacent the upper end of the lower compartment and communicating with the upper end of said passage and inlet openings disposed on opposite sides of the outlet opening and communicating with the upper end of the lower compartment outside of said passage, and a propeller blower disposed in said air passage and operating to effect flow of air inwardly through said inlet openings, downwardly through the lower compartment outside of said air passage, upwardly over the surfaces of said condenser and through said passage, and outwardly through said outlet opening.

3. In a self-contained unit air conditioner, the combination of a housing structure having a partition dividing the same into an upper cooling compartment and a lower machine compartment, an evaporator in said cooling compartment, partition walls suspended from said partition in spaced relation to two vertical walls of the machine compartment and defining a vertical air passage on at least two sides thereof, a condenser disposed across said air passage adjacent the lower end thereof, a fourth vertical wall of said machine compartment having an outlet opening communicating with the upper end of said air passage and two inlet openings disposed on opposite sides of said air passage and outlet opening, a fan disposed in said air passage above the condenser for effecting flow of air upwardly through said passage, whereby air admitted through said inlet openings flows downwardly along the inside of three vertical walls of the machine compartment to the underside of the condenser, and upwardly through the condenser and said air passage to said outlet opening.

4. In a unit air conditioner, the combination of a housing, a first partition dividing the housing

into an upper and a lower compartment, partition means extending downwardly from said first partition and including opposed vertical wall portions extending to and terminating at the rear wall of the housing, said partition means providing a vertical air passage between said vertical wall portions, a condenser extending between said opposed wall portions adjacent the lower edges thereof, a blower disposed in said passage above the condenser for effecting flow of air upwardly over the condenser and through the air passage, a horizontal duct member having one air passage adapted to communicate with the first-mentioned air passage and other passages disposed at the same level as said one passage and adapted to communicate with the lower compartment outside of the first-mentioned air passage and on opposite sides thereof, the height of those portions of the first-mentioned air passage and of said lower compartment which are adapted to communicate with the passages in the duct member being substantially greater than the height of said duct member so as to provide latitude in the height at which the duct member may be disposed, and said housing being constructed and adapted so that the duct member may be attached thereto at varying heights to adapt the same for window sills of various heights.

5. In a self-contained unit air conditioner, the combination of a casing, a partition dividing the casing into an upper compartment and a lower compartment, an evaporator disposed in the upper compartment for cooling and dehumidifying air, partition means in the lower compartment providing a vertical air passage therein, a horizontal condenser extending entirely across said air passage adjacent the lower end thereof, a propeller fan and driving motor disposed in said passage above the condenser, a pan disposed in said passage above said fan and motor, means for draining moisture condensed by said evaporator to said pan, means for conveying high temperature refrigerant in heat transfer relation to the moisture in said pan to supply heat for vaporization thereof, said fan being adapted to effect flow of air downwardly through the lower compartment and upwardly over the surfaces of said condenser and through said passage and over the top of said pan to vaporize the moisture contained therein.

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