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AIR CONDITIONING CONDENSATE HANDLING APPARATUS AND METHOD

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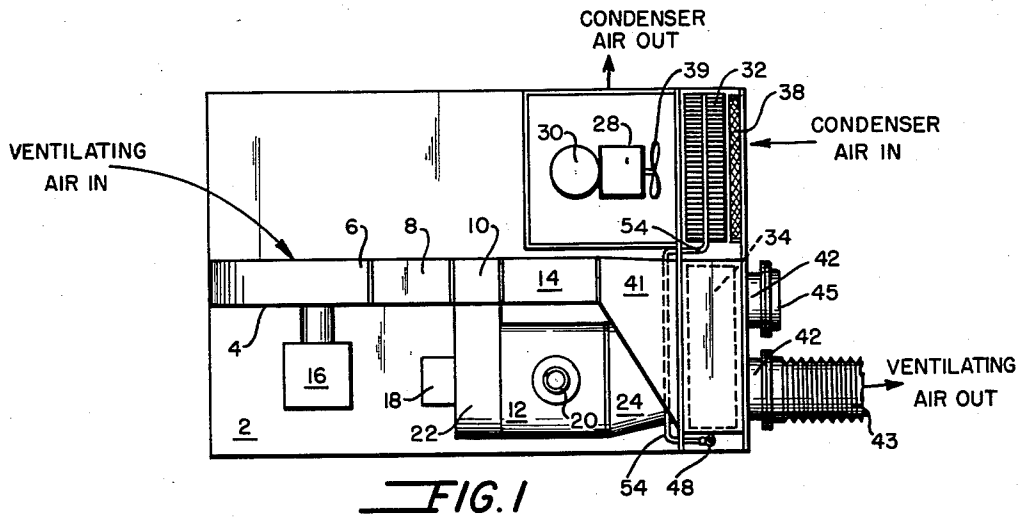


FIG. 1

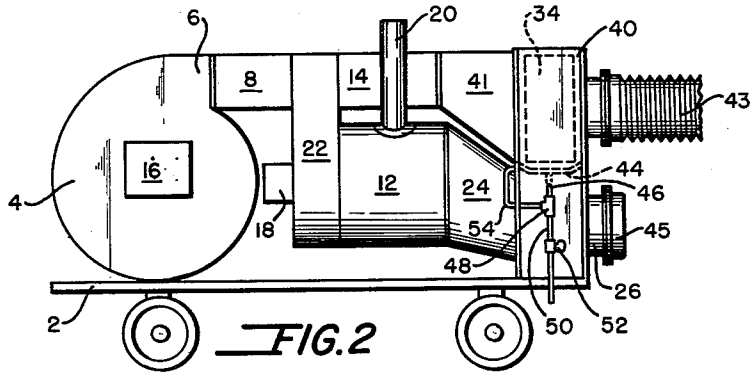


FIG. 2

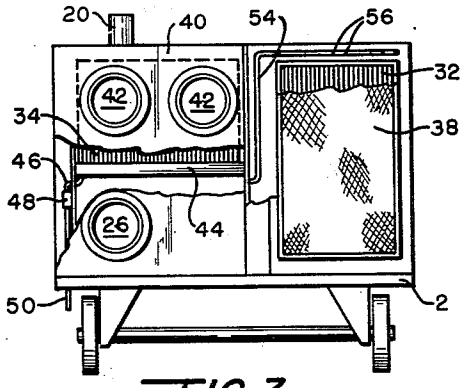


FIG. 3

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AIR CONDITIONING CONDENSATE HANDLING APPARATUS AND METHOD

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This invention relates generally to air conditioning and relates particularly to an apparatus and a method for conducting atmospheric moisture received from a heat absorbing portion of a refrigeration system to an elevated position where the moisture is used to absorb heat from the heat liberating portion of the refrigeration system.

One object of the invention is the provision of an arrangement for moving condensate from a lower position to a higher position without the use of conventional devices such as pumps or slinger rings.

The invention is not universally applicable to refrigeration systems and, in fact, may be said to be rather limited in its application. However, within the bounds of its application, it provides a novel approach to the problem of simply and effectively handling moisture condensed from the air by a heat absorbing element, and which is to be conducted to the heat liberating element for use in obtaining the conventional evaporative condensing effect.

The invention will be described herein as embodied in a portable, ground support, all-weather air conditioner adapted to provide high pressure ventilating air to advanced series military aircraft. The temperature of such ventilating air may be required to be anywhere within a range of say, 40–200° F., depending upon ambient air temperatures. The ventilating air is required to be delivered to the aircraft under a relatively high pressure, such as, say, 40 inches water gauge, to obtain proper distribution of the ventilating air through the relatively high resistance internal passages of the aircraft. To obtain ventilating air temperatures within the lower portion of the temperature range when ambient temperature is above the desired temperature, a conventional mechanical refrigeration system including an evaporator and condenser may be used. The moisture condensed on the evaporator is fed to the condenser for distribution thereover to obtain an evaporative condensing effect in accordance with conventional practice. However, in accordance with the invention, the force used to convey the condensate from a position underlying the evaporator to an elevated position along the upper edge of the condenser is derived from the difference in static pressure existing in the plenum or casing in which the evaporator is disposed, this pressure being created by the ventilating air blower, and the atmospheric pressure existing at the condensate outlet along the top edge of the condenser.

Thus it will be appreciated that while the invention is relatively simple in concept, it provides an advantageous arrangement as embodied in such an air conditioner. For example, no mechanical force need be directly imparted to the condensate to effect its movement from the lower elevation to a higher elevation. No slinger rings need be provided on the condenser air fan, and the condensate does not need to be fed into the condenser fan for entrainment in the condenser fan air flow. The condenser fan may be arranged to draw air through the condenser rather than blow it through. However, a blow-through arrangement may be used if desired, and the condensate may be fed to a position where it drops onto the condenser fan and is broken up and entrained in the condenser air flow.

Since the inventive concept is relatively simple and will be readily understood by those skilled in the art, and

various changes within the scope of the invention may be made in structure without departing from the spirit of the invention, the embodiment of the invention shown in the drawing is to a large degree diagrammatic in nature and is shown by way of example primarily.

In the drawing:

FIGURE 1 is a partly diagrammatic top view, broken in part, of an all weather air conditioner embodying the invention;

FIGURE 2 is a side view of the apparatus of FIGURE 1, this view also being partly diagrammatic; and,

FIGURE 3 is a partly broken end view of the apparatus of FIGURES 1 and 2.

The ground support air conditioner shown in the drawing is adapted to provide heated ventilating air, cooled ventilating air, or both at the same time, in accordance with need of the served aircraft. The apparatus is preferably mounted on a trailer bed 2 for mobility, and a housing (not shown) encloses the apparatus in normal operation. Suitable openings are provided in the housing to permit access to controls and the like, and to admit air flow as required.

The ventilating air system basically includes a high pressure blower providing a source of ventilating air which may be heated or cooled or both, an air heating branch to which any part of the ventilating air may be directed, and an air cooling branch through which the rest of the ventilating air is passed.

The high pressure blower is designated 4 and receives ambient air which passes into its inlet as indicated by the arrow in FIGURE 1. If desired an air filter may filter the ventilating air before it enters the blower inlet. The blower outlet 6 is connected by duct 8 to an air switching section 10 which contains a butterfly damper (not shown) for regulating the proportions of air directed into the heater 12 and alternatively into the air cooling branch duct 14. The blower 4 is driven by gasoline engine 16 which is also a source of power for certain accessory items (not shown) used in operating and controlling the heater.

The combustor and heat exchanger of heater 12 may be of the general character described in Hubbard U.S. Patent 2,758,591, but is here shown with a separate combustion air blower unit 18. Since this type of heater is indirect-fired, it has a stack 20 through which combustion gases are discharged separately from the ventilating air. Whatever ventilating air is taken into the air heating branch from the switching section 10 passes to the heater by a way of scroll-shaped transition 22. The heated ventilating air is discharged from the heater into an oblique cone frustum transition 24 connected to a heated air outlet duct connector 26 (FIGURES 2 and 3).

The mechanical refrigeration portion of the apparatus includes an engine 28, a refrigerant compressor 30, a refrigerant condenser 32, a refrigerant evaporator 34, and other conventional mechanical refrigeration system components not shown. The compressor and engine are located in a separate compartment as shown with the condenser extending across the air inlet to the compartment. Preferably an air filter 38 extends across the inlet upstream from the condenser. Condenser air is drawn into the compartment as shown by the arrow in FIGURE 1, through the filter and condenser, by a condenser fan 39 driven by the engine unit 28, the heated air from the condenser being discharged out through a louvered side outlet in the compartment 36 as indicated by the so-identified arrow.

The evaporator 34 is mounted in the upper portion of a box-shaped casing 40 to which the cold air branch 14 of the ventilating air duct is connected by means of transition 41. A pair of cold air outlet duct connectors 42 are ar-

ranged to receive ventilating air cooled by its passage through the evaporator 34, and are adapted to have connected thereto flexible ducts 43 (only one shown) which extend to the aircraft to be served. Those duct connectors not having flexible ducts connected thereto are capped with dish-shaped covers 45.

A condensate drip pan 44 underlies the bottom edge of the evaporator 34 in a position to receive moisture condensed from the ventilating air onto the evaporator surface and dripping therefrom. This pan may serve as the bottom wall of the chamber or plenum in which the evaporator is mounted, or a separate bottom wall below the pan may be provided. In any case, the plenum formed in the upper part of the casing 40 and in which the evaporator and pan are situated should be substantially air tight, save for the ventilating air inlet and outlet, so that a high static pressure may be maintained in the chamber.

To drain the condensate from the pan 44, an S-shaped tube 46 has one end connected to the pan and extends through a side wall of the casing 40 with its other end connected to a T 48. A condensate dump line 50 having a valve 52 therein is connected to one port of the T, and another conduit 54 for conveying the condensate to the condenser is connected to the other port of the T and passes from the T generally horizontally around behind the casing between the heated air and cold air branch transitions 24 and 41, then upwardly between the condenser and evaporator, and then horizontally over the upper edge of the condenser. The portion of conduit 54 extending over the condenser is provided with a series of holes 56 through which condensate drips onto the condenser surface.

As an example of the operation of the apparatus, assume that cooling air only is to be provided to a served aircraft when the ambient temperature and humidity is such that some moisture will be extracted from the ventilating air by condensation on the evaporator surface. A cover 45 is placed over the heated air outlet duct connector 26 and one or both of the cooled air outlet duct connectors 42 are connected by flexible ducts 43 to the aircraft to be served. If only one duct is to be used as shown in FIGURES 1 and 2, the cover 45 is secured on the other cooled air duct connector. The damper in the air switching section 10 of the ventilating air duct is set to direct all of the air from blower 4 into the cooling air branch 14.

The blower engine is started and run at a rate which develops a static air pressure in the plenum in which the evaporator 34 is located of, say, 40 inches water gauge. The refrigeration system engine is also operated to provide power for the refrigeration system. As moisture from the ventilating air passing through the cooling branch condenses on the cold evaporator surface it drips into pan 44. Since the static air pressure in the plenum in which the pan and evaporator are located is about 40 inches water gauge, this difference in pressure between the plenum and atmosphere is sufficient to elevate the condensate a distance of about 40 inches. This pressure forces the condensate from the pan 44 through tube 46, through the T 48 into conduit 54 (assuming that valve 52 in the dump line 50 is closed), and then through the conduit 54 for discharge through holes 56 in that part of the conduit overlying the condenser. It is noted that if desired the condensate may be discharged onto the condenser fan rather than being dripped onto the condenser; in this case the condenser fan is arranged for blow-through operation and the filter is appropriately relocated.

It will thus be appreciated that the force for moving the condensate from the drip pan 44 to an elevated position overlying the condenser is obtained from the static air presure generated by the ventilating air blower, and the use of any kind of pumps or slingers which physically contact the condensate to elevate it are unnecessary.

It will of course be apparent that the invention as described herein can be embodied only in those air conditioning systems: having a ventilating air blower generating

a static air pressure, in terms of inches water gauge, equal to or greater than the difference in inches elevation between the place where the condensate is accumulated and the location at which the condensate is to be discharged; and where a high resistance to air flow is exerted by the space to be conditioned so that the relatively high static pressure in the plenum in which the evaporator and condensate drip pan are located can be developed and maintained. However, within these limitations the invention provides an effective arrangement for handling condensate.

The invention claimed is:

1. In air cooling apparatus wherein condensate accumulated from a heat absorbing surface is conducted upwardly for distribution over a heat liberating surface; means forming a chamber in which said heat absorbing surface is situated, said chamber having an air inlet and an air outlet; condensate collecting means in said chamber underlying said heat absorbing surface and subject to the static air pressure existing in said chamber; pipe means providing a passage for said condensate from said collecting means to a relatively elevated discharge position adjacent said heat liberating surface; and means for supplying air to be cooled to said chamber at a rate developing a static pressure in said chamber at least equal, in inches water gauge, to the differential in height in inches between said condensate collecting means and said elevated discharge position adjacent said heat liberating surface, whereby condensate from said heat absorbing surface is forced by said chamber static pressure through said pipe means to said discharge position.

2. In air conditioning apparatus of the character described: means defining an enclosed air flow path for the flow of air to be conditioned for delivery to a source of relatively high resistance to said air flow; a refrigerant evaporator disposed across said path to cool and dehumidify said air passing therethrough; condensate collecting means underlying said evaporator; a refrigerant condenser having an upper edge at an elevated height relative to said condensate collecting means; pipe means having an inlet connected to receive said condensate from said collecting means and having condensate outlet means along said upper edge of said condenser; and means for supplying air to said air flow path under a static pressure at said evaporator at least equal, in inches water gauge, to said height in inches of said condenser upper edge relative to said condensate collecting means whereby condensate from said collecting means is forced by said static pressure to flow through said pipe means to said condensate outlet means.

3. In an air conditioning system: means defining a passage for the flow of air to be conditioned; a refrigeration evaporator extending across said air flow passage; condensate collecting means underlying said evaporator for receiving moisture condensed from said air upon said evaporator; a refrigeration condenser disposed with its upper edge elevated relative to the level of said condensate collecting means; condensate pipe means having a first branch connected to said condensate collecting means and extending upwardly to a discharge position at a height substantially level with said condenser upper edge, and a second branch connected to said condensate collecting means and extending downwardly therefrom to a dump position below said condensate collecting means, said second branch having a valve therein; and high pressure ventilating air blower means operable to force air through said air passage at a rate developing a static air pressure at said condensate collecting means at least equal, in terms of inches water gauge, to the difference in elevation in inches between said condensate collecting means and said discharge position.

4. The method of forcing condensate from a condensate collecting location underlying a refrigerant evaporator to an elevated discharge location adjacent a refrigerant condenser surface comprising: imposing a static air pressure upon said condensate at said collecting location at least

equal, in inches water gauge, to the difference in elevation in inches between said condensate collecting location and said condensate discharge location.

5. The method of furnishing motive power for conveying accumulated condensate received from a heat absorbing surface in a chamber to a relatively elevated discharge position adjacent a heat liberating surface comprising: forcing air to be cooled by said heat absorbing surface into said chamber at a rate imposing a static air pressure, in inches water gauge, upon said condensate at least equal to the difference in height in inches between the location at which said condensate is accumulated and said elevated discharge position.

6. The method of elevating moisture condensed upon the heat absorbing portion of a refrigeration system disposed across the air flow passage of a relatively high air pressure ventilating system comprising: gathering said moisture in a zone underlying said heat absorbing portion; subjecting said zone to a static air pressure at least equal, in terms of inches water gauge, to the height in inches said moisture is to be elevated to a discharge position.

References Cited in the file of this patent

UNITED STATES PATENTS

2,119,958	Newill	June 7, 1938
2,145,380	Weiland	Jan. 31, 1939
2,289,035	Neeson	July 7, 1942
2,941,381	Eberhart	June 21, 1960