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(71) Applicant *(for all designated States except US)*: **EMERSON NETWORK POWER, ENERGY SYSTEMS, NORTH AMERICA, INC.** [US/US]; 4350 Weaver Parkway, Warrenville, IL 60555 (US).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **LEON, Eduardo** [US/US]; 4350 Weaver Parkway, Warrenville, IL 60555 (US). **COWLING, Matthew** [US/US]; 4350 Weaver Parkway, Warrenville, IL 60555 (US). **RAYYAHIN, Bisher, J.** [US/US]; 4350 Weaver Parkway, Warrenville, IL 60555 (US). **SIMMONS, Bryan, D.** [US/US]; 4350 Weaver Parkway, Warrenville, IL 60555 (US).

(74) Agents: **THOMAS, Michael, J.** et al.; Harness, Dickey & Pierce, P.L.C., 7700 Bonhomme, Suite 400, St. Louis, MO 63105 (US).

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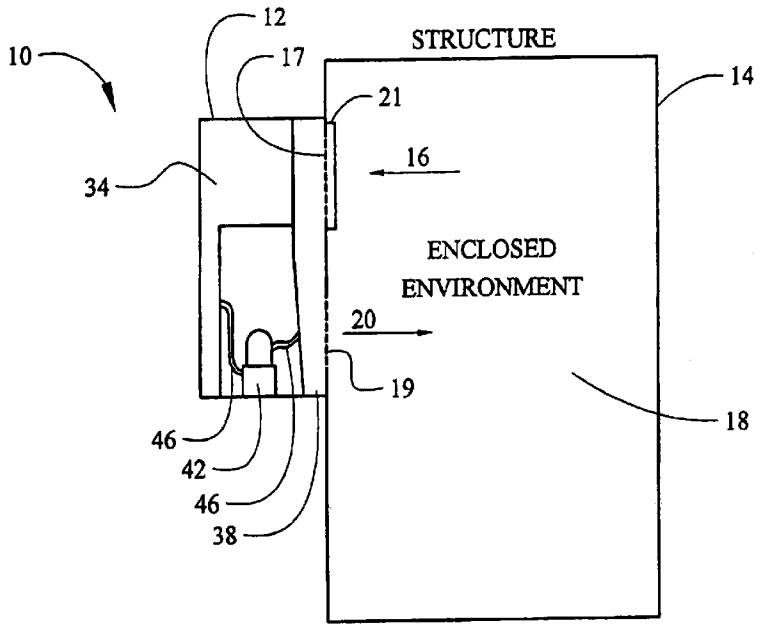
(54) **Title:** AN AIR MOVER COVER FOR A DIRECT CURRENT AIR CONDITIONING SYSTEM



(57) **Abstract:** An evaporator air mover cover for a direct current (DC) powered variable capacity air conditioning system having a housing enclosing an evaporator assembly. The housing defines an air intake opening for intaking air from an enclosed environment into the evaporator assembly. The evaporator air mover cover includes a single piece seamless structure positioned over the air intake opening for covering at least a portion of the air intake opening. Further, the evaporator air mover cover allows air from the enclosed environment to flow through the air intake opening and into the evaporator assembly.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

AN AIR MOVER COVER FOR A DIRECT CURRENT AIR CONDITIONING SYSTEM

GOVERNMENT RIGHTS

[0001] This invention was made with Government support under contract DE-FC26-04NT42106, awarded by the United States Department of Energy. The Government may have certain rights in this invention.

FIELD

[0002] The present disclosure relates to direct current (DC) air conditioning systems including an air mover cover for such systems.

BACKGROUND

[0003] The statements in this section merely provide background information related to the present disclosure and may not constitute prior art.

[0004] Direct current (DC) environmental temperature control systems (ETCSs), also referred to as air conditioning systems, are often used to control the temperature within enclosed environments where alternating current (AC) ETCSs are not feasible, desirable or reliable. For example, in environments enclosed by structures that are remotely located where AC power is not available or conveniently accessible, or where a backup air conditioning system is necessary in case AC power is interrupted, or where a DC air conditioning system is more desirable than an AC air conditioning system. Generally, DC air conditioning systems have a capacity suitable for efficiently controlling the temperature of environments enclosed by smaller

structures or buildings. For example, DC air conditioning systems are very suitable for controlling the temperature within utility sheds, portable or mobile structures, and electronics cabinets and utility or equipment structures such as cellular wireless communication electronic cabinets and battery backup closets.

[0005] Such smaller structures can be located in a wide variety of outdoor locations that present a myriad of rigorous exterior environmental conditions that affect the temperature within the structures. That is, the structures can be exposed to a wide range of external temperatures, e.g., -30°C to 55°C, varying solar loads and various forms of precipitation that can all affect the internal environmental temperature. In the case of equipment cabinets, temperature control requirements can be stringent in order to prevent damage to the often expensive and not terribly rugged equipment inside. Thus, employment of DC air conditioning systems is often desirable for actively controlling the temperature enclosed environment of such smaller structures. And in many cases, efficiency, consistency and reliability are critical necessities of the DC air conditioning system.

[0006] Typically, DC air conditioning systems include a condenser assembly and an evaporator assembly both of which are positioned within a housing. In operation, the evaporator assembly receives air from an enclosed environment through a first opening in the housing, and an air mover pushes the air across a heater or an evaporator heat exchanger to condition the air (i.e., to heat or cool the air) before outputting the air through a second opening in the housing into the enclosed environment.

[0007] In some known designs, an air mover cover may be mounted over the first opening to allow air into the evaporator assembly. Typically, these covers are made of sheet metal having edges which are sealed together by using a sealant, such as a room temperature vulcanizing sealant, or by welding the edges together. These seals or welds are time consuming to apply, costly and prone to failure. Over time these seals and/or welds may deteriorate, which may compromise the effectiveness of the evaporator assembly.

SUMMARY

[0008] According to one aspect of the present disclosure, an evaporator air mover cover for a direct current (DC) powered variable capacity air conditioning system having a housing enclosing an evaporator assembly. The housing defines an air intake opening for intaking air from an enclosed environment into the evaporator assembly. The evaporator air mover cover includes a single piece seamless structure positioned over the air intake opening for covering at least a portion of the air intake opening. Further, the evaporator air mover cover allows air from the enclosed environment to flow through the air intake opening and into the evaporator assembly.

[0009] According to another aspect of the present disclosure, a direct current (DC) powered variable capacity air conditioning system having a housing defining an air intake opening, and an evaporator assembly enclosed in the housing and positioned adjacent the air intake opening for receiving air from an enclosed environment. The system further includes an air mover cover comprising a single piece seamless structure and positioned over the

air intake opening for covering at least a portion of the evaporator air mover. The air mover cover allows air from the enclosed environment to flow through the air intake opening and into the evaporator assembly.

[0010] According to yet another aspect of the present disclosure, a direct current (DC) powered variable capacity air conditioning system having a housing defining an air intake opening, and an evaporator assembly including a plurality of components enclosed in the housing and positioned adjacent the air intake opening. The system further includes an evaporator air mover cover having a transparent panel positioned over the air intake opening for covering at least a portion of the evaporator assembly including at least a portion of the components. The portion of the components is visible through the transparent panel.

[0011] According to still another embodiment of the present disclosure, a direct current (DC) powered variable capacity air conditioning system having a housing defining an air intake opening, and an evaporator assembly enclosed in the housing and positioned adjacent the air intake opening. The system further includes an evaporator air mover cover including a guard and a screen having at least one edge, the evaporator air mover cover defines a second opening. The evaporator air mover cover is positioned over the air intake opening for covering at least a portion of the evaporator air mover. The guard is positioned at least partially around the second opening, the screen is positioned over the second opening, and the at least one edge of the screen is positioned on the guard for preventing the at least one edge from being exposed.

DRAWINGS

[0012] The drawings described herein are for illustration purposes only and are not intended to limit the scope of the present disclosure in any way.

[0013] Fig. 1 is a block diagram of a direct current (DC) powered variable capacity air conditioning system (VCACS) including an evaporator air mover cover according to various embodiments, connected to a structure enclosing an environment to be thermally conditioned by the variable capacity air conditioning system.

[0014] Fig. 2 is an exploded perspective view of a portion of the VCACS illustrating various components of the VCACS, in accordance with various embodiments of the present disclosure.

[0015] Fig. 3 is a front view of an evaporator air mover cover according to various embodiments of the present disclosure.

[0016] Fig. 4 is a perspective view of the evaporator air mover cover of Fig. 3.

[0017] Fig. 5 is a front view of the VCACS according to various embodiments of the disclosure.

[0018] Fig. 6 is a front view of a screen according to various embodiments of the present disclosure.

[0019] Fig. 7 is a side cross-sectional view of the evaporator air mover cover of Fig. 1.

[0020] Fig. 8 is a blown up view of section A, shown in Fig. 7, illustrating a guard for an evaporator air mover cover according to various embodiments of the present disclosure.

DETAILED DESCRIPTION

[0021] Further areas of applicability of the present disclosure will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating various preferred embodiments, are intended for purposes of illustration only and are not intended to limit the scope of the disclosure. Additionally, the features, functions, and advantages of the present disclosure can be achieved independently in various embodiments or may be combined in yet other embodiments.

[0022] Fig. 1 illustrates a direct current (DC) powered variable capacity air conditioning system 10 having an evaporator air mover cover 21 according to one or more embodiments described below. The DC variable capacity air conditioning system (VCACS) 10 is connected to a wall of a structure 14 enclosing an environment 18 to be thermally conditioned by the DC VCACS 10. The DC VCACS 10 can operate using any suitable DC power supply (not shown) such as one or more DC batteries or a converted alternating current (AC) supply. The structure 14 can be any building, shed, cabinet, closet, portable or mobile structure, or any other structure enclosing an environment desirous of being thermally controlled by the DC variable capacity air conditioning system 10. For example, the structure 14 can be an electronics and/or equipment cabinet, such as a cellular wireless communication electronics cabinet or battery backup closet, where it is important to maintain the enclosed environment 18 at a desired temperature to prevent damage to the enclosed components and/or systems. The VCACS

10 is configured to provide heating and cooling to maintain a substantially constant temperature of the enclosed environment 18 of the structure 14. The VCACS 10 and the structure 14 can comprise a telecommunication station, e.g., a wireless telecommunication station, wherein the structure 14 is a telecommunication electronics and equipment cabinet, e.g., a wireless telecommunication electronics and equipment cabinet.

[0023] The VCACS 10 generally includes a housing 12 enclosing a condenser assembly 34, an evaporator assembly 38 including an evaporator shroud 32 and a variable speed compressor 42 connected to the condenser and evaporator assemblies 34 and 38 via refrigerant lines 46. The housing 12 defines an air intake opening 17 for intaking air from the enclosed environment 18 into the evaporator assembly 38 (indicated generally by an arrow 16), and an air output opening 19 for outputting air from the evaporator assembly 38 into the enclosed environment 18 (indicated generally by an arrow 20). The evaporator air mover cover 21, described in more detail below, is positioned over the air intake opening 16.

[0024] Referring to Fig. 2, in various embodiments, the evaporator assembly 38 includes an evaporator heat exchanger 50, a heating mechanism 54, an evaporator air mover 58 and a circuit board 62, all of which are mounted to the evaporator shroud 32. The evaporator air mover 58 can be rotationally mounted to an evaporator air mover mounting plate 66, which can then be mounted to the evaporator shroud 32. The evaporator air mover 58 can be a radial fan, an axial fan or a turbine, a variable speed backward-curved impeller, or any air mover suitable for moving varying capacities of air. Furthermore, the heating mechanism 54 can be any suitable heat producing

mechanism such as an open wire resistive heater, radiator type heater, a chemical reaction type heater, or any other heating device.

[0025] The housing 12 (from Fig. 1) can include a housing panel 70 and a housing hood 74. The housing panel 70, in various embodiments, is mounted over the evaporator air mover 58, evaporator heat exchanger 50, heating mechanism 54 and circuit board 62 and coupled to the evaporator shroud 32 and/or a housing hood 74. The housing panel 70 includes the air intake opening 17 and a plurality of grated or finned apertures that generally form the air output opening 19. In various embodiments, the evaporator air mover cover 21 can be positioned over the housing panel 70, thereby covering at least a portion of the air intake opening 17.

[0026] The evaporator air mover cover 21, in various embodiments is formed or fabricated as a single piece, seamless structure. For example, the evaporator air mover cover 21 can be molded using thermal forming or injection molding, cast, stamped or pressed to form a single piece structure without folded edges or joint seams.

[0027] In addition, the evaporator air mover cover 21 can be fabricated from any suitable material such as any suitable plastic polymer or composite including clear polycarbonate, any suitable reinforced polyurethane or epoxy resin or any other material suitable for fabricating a single piece seamless evaporator air mover cover 21.

[0028] Referring now to Figs. 3-5 and 7, the evaporator air mover cover 21, in various embodiments includes an inlet ring 48 defining an opening 52, a panel 53, a guard 56 and a terminal block cover 90.

[0029] The opening 52 allows air from the enclosed environment 18 to flow through the air intake opening 17 and into the evaporator assembly 38. Although the opening 52 is circularly shaped, the opening 52 may be other suitable shapes (e.g., ovals or rectangles) to allow air to flow through the air intake opening 17 and into the evaporator assembly 38 without departing from the scope of this disclosure. Additionally, the evaporator air mover cover 21, in various embodiments may include a plurality of openings that generally form the opening 52 and allow air to flow through the air intake opening 17 and into the evaporator assembly 38 without departing from the scope of this disclosure.

[0030] The inlet ring 48 surrounds the opening 52 and includes a radiused surface 51, as best seen in Figs. 4 and 7. The radiused surface 51 increases the pressure at which air enters into the evaporator assembly 38 and consequently the volume flow rate of air through the evaporator assembly 38.

[0031] In various embodiments, the inlet ring 48 can be formed integrally with the evaporator air mover cover 21. However, in various other embodiments, the inlet ring 48 can be a separate part that is mounted to the evaporator air mover cover 21, or the evaporator air mover cover 21 may not include the inlet ring 48, without departing from the scope of this disclosure.

[0032] In various embodiments, the evaporator air mover cover 21 includes a screen 56 that can be mounted to the evaporator air mover cover 21. The screen 56 covers the opening 52 and prevents debris from entering the evaporator assembly 38. The screen 56 also prevents human contact with the evaporator air mover 58, thereby preventing potential injury.

[0033] The screen 56, in various embodiments, is a coarse metal screen, such as a hardware cloth having edges 64 as illustrated in Fig. 6. However, the screen may be formed from other suitable materials, such as plastic, without departing from the scope of this disclosure.

[0034] In various embodiments, the evaporator air mover cover 21 can include a guard 68 covering the edges 64. The guard 68 provides protection from injury by edges 64 that can be sharp or jagged due to manufacturing processes. Fig. 8 is a blown up view of section A, shown in Fig. 7, illustrating the guard 68. As shown in Fig. 8, the guard 68 includes a bump portion 72 joining a flat portion 76 in a generally orthogonal relationship. Additionally, a recess 77 is formed at the joinder of the bump portion 72 and the flat portion 76. The edges 64 are positioned against the flat portion 76 within the recess 77. As a result, the edges 64 are covered by the guard 68, which prevents the edges 64 from being exposed, thereby preventing potential injury.

[0035] As best shown in Fig. 5, in various embodiments, the panel 53 can be transparent and positioned over the air intake opening 17 for viewing portions of the evaporator assembly 38, such as the circuit board 62, having a plurality of components 82 positioned in the evaporator assembly 38.

[0036] The components 82 of the circuit board 62 may be various electrical elements, including one or more status indicators 86. The status indicators may be light emitting diodes (LEDs) indicating the status of one or more elements of the VCACS 10. For example, the status indicators 86 can indicate whether the evaporator air mover 58 is operating properly, or whether

the evaporator assembly 38 is properly heating or cooling the enclosed environment 18.

[0037] The components 82 can also include a DC power supply bus, a processor and/or an electronic storage device and can include one or more status indicators. Furthermore, the components 82 can be used to control one or more elements of the VCACS 10, including, for example, the evaporator assembly 38 and/or the condenser assembly 34.

[0038] The evaporator air mover cover 21 can include, in various embodiments, the terminal block cover 90 for covering a terminal block 94 having a plurality of conductive connectors 96. The terminal block 94 can connect a direct current power supply (not shown) to one or more elements of the VCACS 10 including, for example, the evaporator assembly 38 including the circuit board 62, and the condenser assembly 34. The terminal block cover 90 covers the conductors 96 and protects the conductors 96 from being inadvertently short-circuited.

[0039] As best seen in Fig. 5, the evaporator air mover cover 21 can be mounted to the housing panel 70. In various embodiments, the evaporator air mover cover 21 can be removed from the housing panel 70 thereby allowing access to the evaporator air mover 58 for servicing or replacing the evaporator air mover 58.

[0040] Although various embodiments noted above describe the evaporator air mover cover 21 as being a separate part from the housing panel 70, it should be understood that in various embodiments the evaporator air mover cover 21 and the housing panel 70 can be integrally formed as a single, unitary structure without departing from the scope of this disclosure.

[0041] Additionally, although various embodiments noted above describe the evaporator air mover cover 21 as defining an opening 52, it should be understood that the present disclosure is not so limited. For example, the air mover cover 21 may not include an opening, but instead may be positioned over the air intake opening 17 such that a portion of the air intake opening 17 is exposed, thereby allowing air to flow from the enclosed environment 18 through the air intake opening 17 and into the evaporator assembly 38.

CLAIMS

What is claimed is:

1. An evaporator air mover cover for a direct current (DC) powered variable capacity air conditioning system having a housing enclosing an evaporator assembly, the housing defining an air intake opening for intaking air from an enclosed environment into the evaporator assembly, the evaporator air mover cover comprising:

a single piece seamless structure positioned over the air intake opening for covering at least a portion of the air intake opening, the evaporator air mover cover allowing air from the enclosed environment to flow through the air intake opening and into the evaporator assembly.

2. The evaporator air mover cover of claim 1 wherein the evaporator air mover cover defines an opening.

3. The evaporator air mover cover of claim 1 wherein the evaporator air mover cover further comprises an inlet ring.

4. The evaporator air mover cover of claim 1 wherein the inlet ring is formed integrally with the evaporator air mover cover.

5. The evaporator air mover cover of claim 1 wherein the evaporator air mover cover includes a transparent panel positioned over the

air intake opening for viewing a plurality of components enclosed in the housing.

6. The evaporator air mover cover of claim 1 further comprising a screen having at least one edge, the screen positioned over an opening defined by the evaporator air mover cover.

7. The evaporator air mover cover of claim 6 wherein the screen is hardware cloth.

8. The evaporator air mover cover of claim 6 further comprising a guard, wherein the at least one edge of the screen is positioned on the guard for preventing the at least one edge from being exposed.

9. The evaporator air mover cover of claim 8 wherein the guard includes a flat portion and a bump portion, the at least one edge of the screen positioned against the flat portion.

10. The evaporator air mover cover of claim 9 wherein the screen includes a plurality of edges, each edge is positioned on the flat portion of the guard.

11. The evaporator air mover cover of claim 1 wherein the evaporator air mover cover is configured for covering a terminal block mounted to the housing.

12. The evaporator air mover cover of claim 1 wherein the single piece seamless structure is a molded piece of plastic.

13. A direct current (DC) powered variable capacity air conditioning system comprising:

a housing defining an air intake opening,

an evaporator assembly enclosed in the housing and positioned adjacent the air intake opening for receiving air from an enclosed environment, and

an air mover cover comprising a single piece seamless structure and positioned over the air intake opening for covering at least a portion of the evaporator air mover, the air mover cover allowing air from the enclosed environment to flow through the air intake opening and into the evaporator assembly.

14. The system of claim 13 wherein the evaporator air mover cover defines an opening.

15. The system of claim 13 wherein the evaporator air mover cover further comprises an inlet ring.

16. The system of claim 15 wherein the inlet ring is formed integrally with the evaporator air mover cover.

17. The system of claim 13 wherein the evaporator air mover cover has a transparent panel positioned over the opening for viewing a plurality of components enclosed in the housing.

18. The system of claim 13 wherein the evaporator air mover cover of claim 1 further comprising a screen having at least one edge, the screen positioned over an opening defined by the evaporator air mover cover.

19. The system of claim 18 wherein the screen is hardware cloth.

20. The system of claim 18 wherein the evaporator air mover cover further comprises a guard, wherein the at least one edge of the screen is positioned on the guard for preventing the at least one edge from being exposed.

21. The system of claim 20 wherein the guard includes a flat portion and a bump portion, the at least one edge of the screen positioned against the flat portion.

22. The evaporator air mover cover of claim 21 wherein the screen includes a plurality of edges, each edge positioned on the flat portion of the guard.

23. The system of claim 13 wherein the evaporator air mover cover is configured for covering a terminal block mounted to the housing.

24. The system of claim 13 wherein the single piece seamless structure is a molded piece of plastic.

25. A direct current (DC) powered variable capacity air conditioning system comprising:

a housing defining an air intake opening,

an evaporator assembly including a plurality of components enclosed in the housing and positioned adjacent the air intake opening, and

an evaporator air mover cover having a transparent panel positioned over the air intake opening for covering at least a portion of the evaporator assembly including at least a portion of the components, the portion of the components being visible through the transparent panel.

26. The system of claim 25 wherein the plurality of components are mounted to a circuit board.

27. The system of claim 25 wherein the plurality of components include at least one status indicator.

28. The system of claim 27 wherein the status indicator is a light emitting diode.

29. The system of claim 25 wherein the plurality of components control one or more elements of the system.

30. The system of claim 25 wherein the evaporator air mover cover comprises a single piece seamless structure.

31. The system of claim 31 wherein the single piece seamless structure is a molded piece of plastic.

32. A direct current (DC) powered variable capacity air conditioning system comprising:

a housing defining an air intake opening,

an evaporator assembly enclosed in the housing and positioned adjacent the air intake opening,

an evaporator air mover cover including a guard and a screen having at least one edge, the evaporator air mover cover defining a second opening,

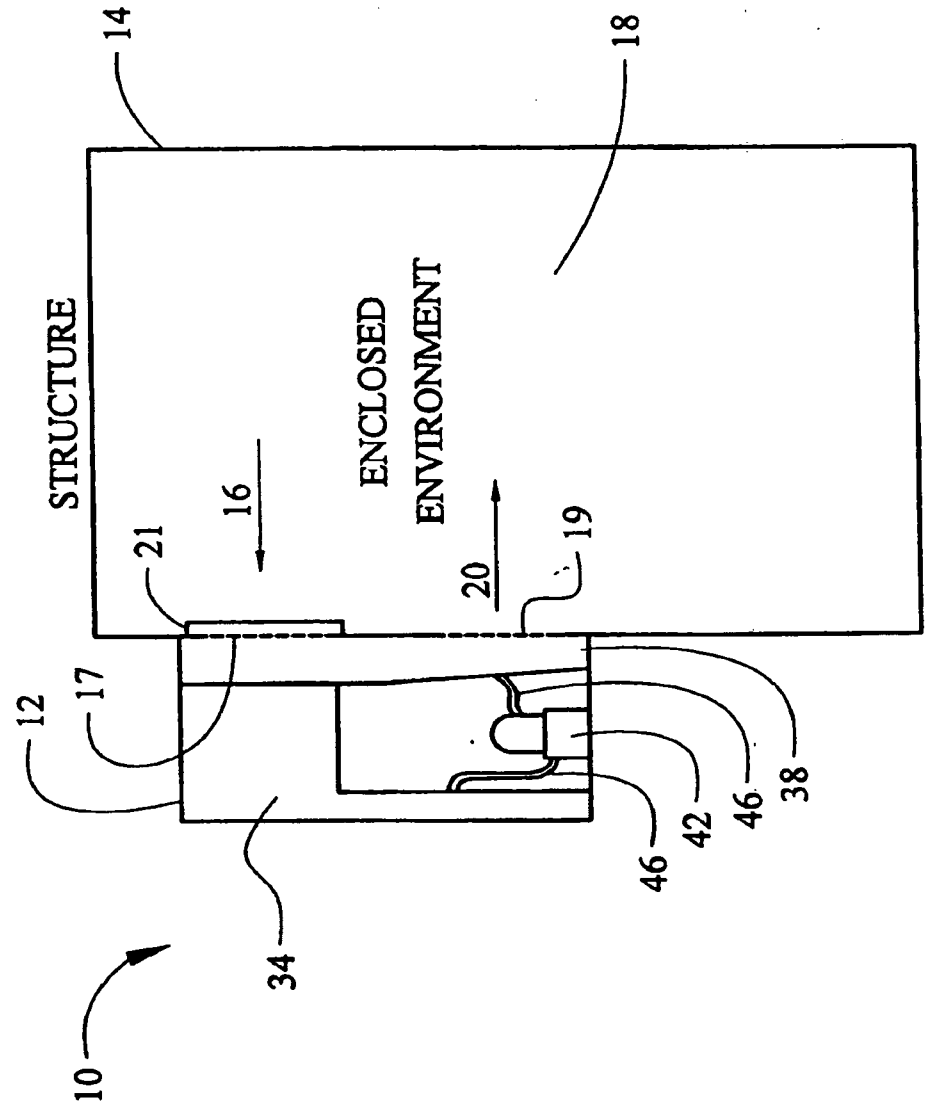
the evaporator air mover cover positioned over the air intake opening for covering at least a portion of the evaporator air mover, the guard positioned at least partially around the second opening, the screen positioned over the second opening, and the at least one edge of the screen positioned on the guard for preventing the at least one edge from being exposed.

33. The system of claim 33 wherein the guard includes a flat portion and a bump portion, the at least one edge of the screen positioned against the flat portion.

34. The system of claim 35 wherein the screen includes a plurality of edges, each edge positioned on the flat portion of the guard.

35. The system of claim 32 wherein the system further includes a terminal block having a plurality of conductive connectors mounted to the housing, the evaporator air mover cover positioned adjacent the terminal block for covering the terminal block.

36. The system of claim 32 wherein the evaporator air mover cover is removably mountable to the housing for allowing access to the evaporator air mover.


14
18
STRUCTURE
ENCLOSED
ENVIRONMENT
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21
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34
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Fig. 1

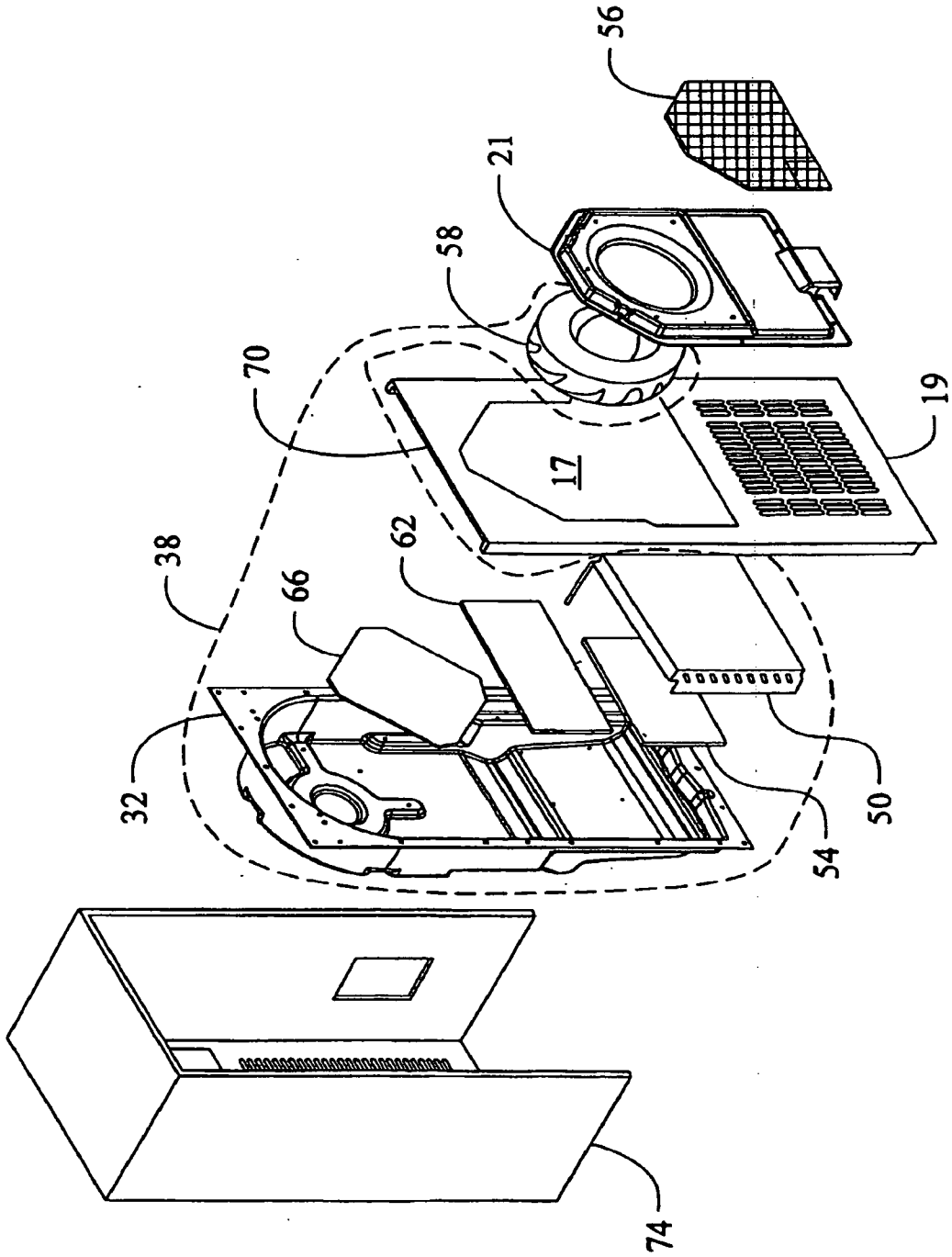

Fig. 2

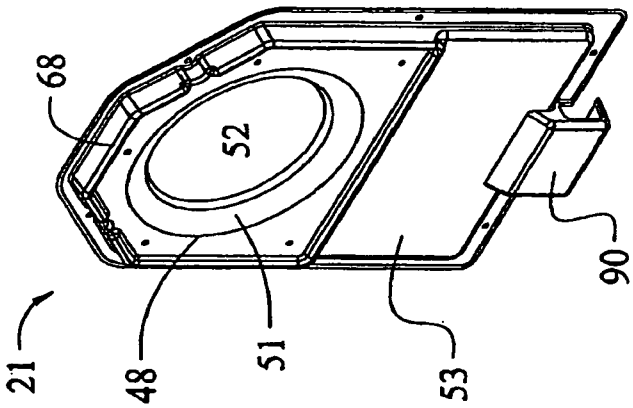

Fig. 4

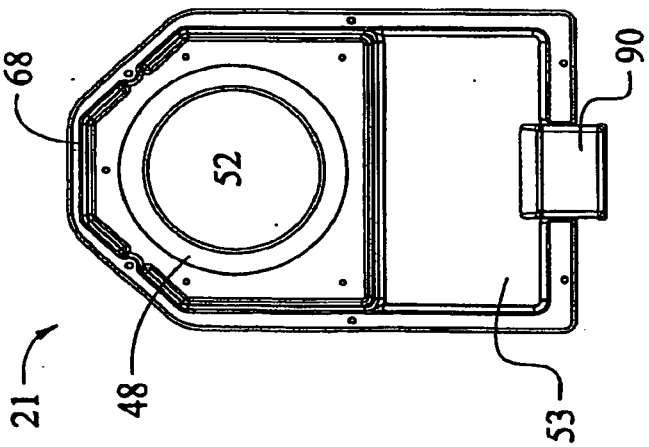

Fig. 3

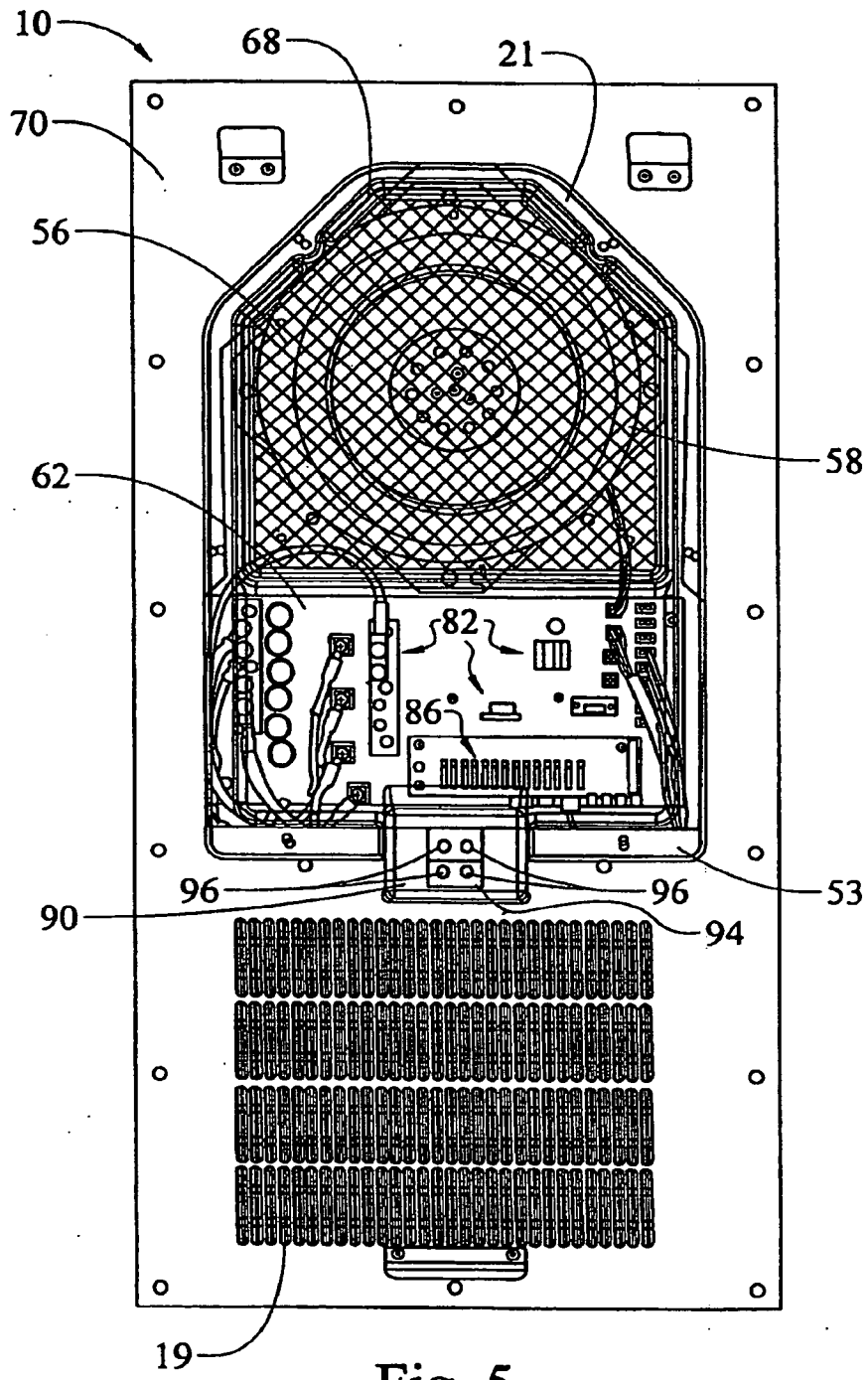

Fig. 5

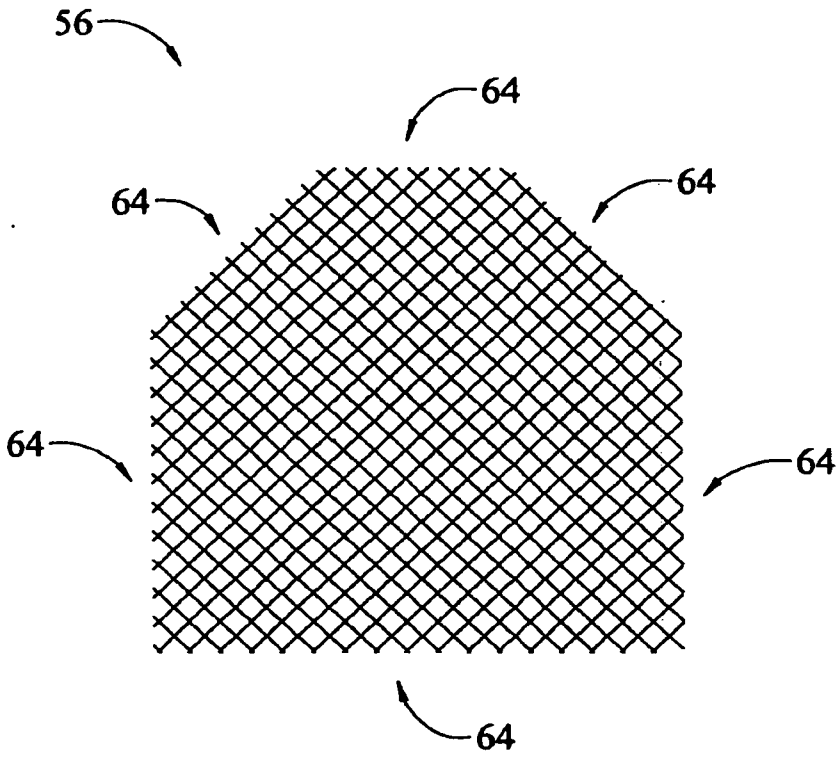

Fig. 6

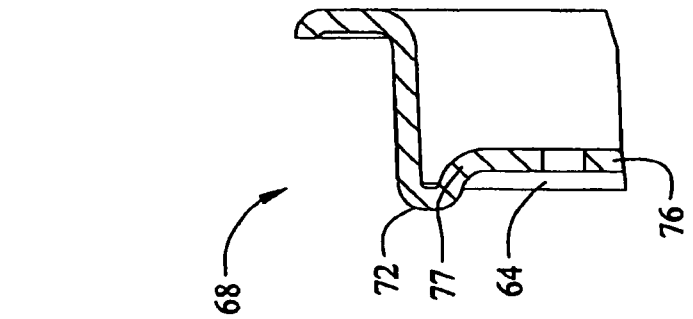

Fig. 8

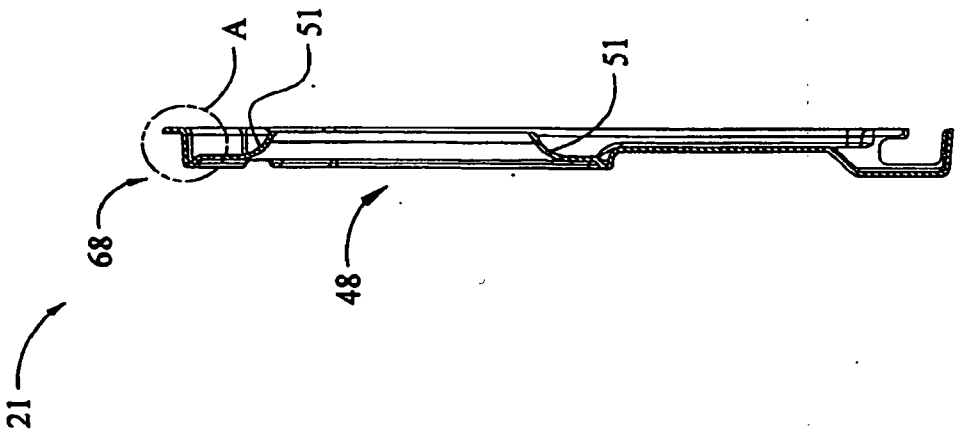

Fig. 7