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(71) **Applicant** *(for all designated States except US)*: **EMERSON NETWORK POWER, ENERGY SYSTEMS, NORTH AMERICA, INC.**; 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).

(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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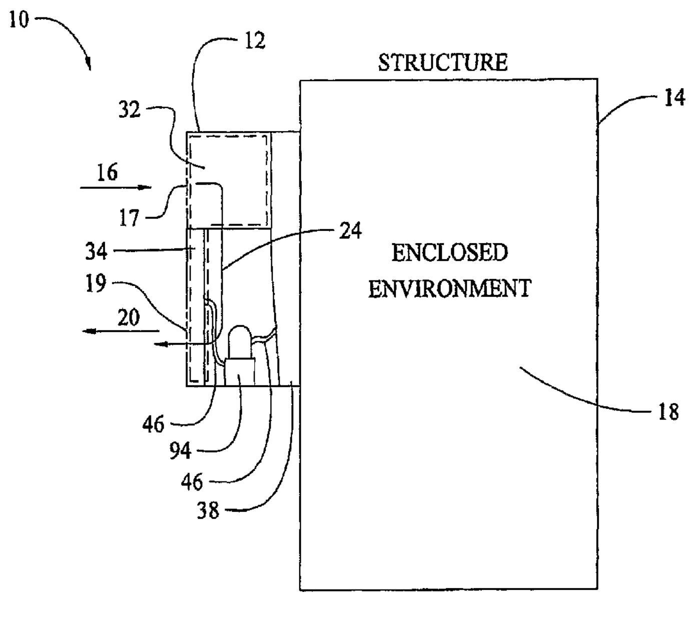
(54) **Title:** CONDENSER SHROUD ASSEMBLY FOR A DIRECT CURRENT AIR CONDITIONING SYSTEM



(57) **Abstract:** According to one aspect of the present disclosure, a condenser shroud assembly for a direct current (DC) powered variable capacity air conditioning system (VCACS), the shroud assembly includes a condenser shroud configured to support a condenser air mover of the VCACS, and a condenser shroud cover. The condenser shroud cover is mountable to the condenser shroud. Further, the condenser shroud cover defines an opening having a center axis that approximately coaxially aligns with a center axis of the condenser air mover when the condenser air mover is mounted to the condenser shroud and the condenser shroud cover is mounted to the condenser shroud.

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CONDENSER SHROUD ASSEMBLY 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 a condenser shroud assembly 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 condenser assembly receives air from an external ambient environment through a first opening in the housing, and an air mover pushes the air through the condenser assembly including across a heat exchanger before the air is output through a second opening in the housing and back into the external ambient environment.

[0007] The air mover is typically mounted on one side of a sheet metal box. On the opposite side of the box, an opening is typically formed in the sheet metal box to allow air to flow from the external ambient environment into the air mover.

[0008] As recognized by the inventors, however, mounting the air mover to, and forming an opening in, a sheet metal box has disadvantages. For example, sheet metal boxes have edges which are sealed together by using a sealant, such as a room temperature vulcanizing sealant, or by welding. These seals and 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 condenser assembly. Further, since sheet metal boxes are made by bending, folding and cutting, tolerances may build which could misalign the opening and the air mover to the extent that the sheet metal surrounding the opening may rub against the air mover, thereby damaging the air mover.

SUMMARY

[0009] According to one aspect of the present disclosure, a condenser shroud assembly for a direct current (DC) power variable capacity air conditioning system (VCACS), the shroud assembly includes a condenser shroud configured to support a condenser air mover of the VCACS, and a condenser shroud cover. The condenser shroud cover is mountable to the

condenser shroud. Further, the condenser shroud cover defines an opening having a center axis that approximately coaxially aligns with a center axis of the condenser air mover when the condenser air mover is mounted to the condenser shroud and the condenser shroud cover is mounted to the condenser shroud.

[0010] According to another aspect of the present disclosure, a direct current (DC) power variable capacity air conditioning system (VCACS) including a condenser shroud, a condenser air mover mountable to the condenser shroud, and a condenser shroud cover. The condenser shroud cover is mountable to the condenser shroud. Further, the condenser shroud cover defines an opening having a center axis that approximately coaxially aligns with a center axis of the condenser air mover when the condenser air mover is mounted to the condenser shroud and the condenser shroud cover is mounted to the condenser shroud.

[0011] According to yet another aspect of the present disclosure, a condenser shroud for a direct current (DC) power variable capacity air conditioning system (VCACS). The condenser shroud comprises a single piece seamless structure positioned adjacent an air intake opening of the VCACS. The condenser shroud directing air from the air intake opening through an air passage through a condenser assembly of the VCACS.

[0012] According to still another aspect of the present disclosure, a condenser shroud cover for a direct current (DC) power variable capacity air conditioning system (VCACS). The condenser shroud cover comprises a single piece seamless structure positioned adjacent an air intake opening of the

VCACS for directing air from the air intake opening through an air passage through a condenser assembly of the VCACS.

DRAWINGS

[0013] The drawings described herein are for illustration purposes only and are not intended to limit the scope of the present disclosure in any way.

[0014] Fig. 1 is a block diagram of a direct current (DC) powered variable capacity air conditioning system (VCACS) including a condenser shroud assembly according to various embodiments, connected to a structure enclosing an environment to be thermally conditioned by the variable capacity air conditioning system.

[0015] 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.

[0016] Fig. 3 is a side view of the VCACS illustrating a condenser air passage according to various embodiments of the present disclosure.

[0017] Fig. 4 is a front view of a condenser shroud cover according to various embodiments of the present disclosure.

[0018] Fig. 5 is a side view of the condenser shroud cover of Fig. 4.

[0019] Fig. 6 is a perspective view of the condenser shroud cover of Fig. 4.

[0020] Fig. 7 is a perspective view of a condenser shroud assembly according to various embodiments of the present disclosure.

[0021] Fig. 8 is an exploded perspective view of the condenser shroud assembly and a condenser air mover according to various embodiments of the present disclosure.

[0022] Fig. 9 is a front view of a condenser assembly according to various embodiments of the present disclosure.

[0023] Fig. 10 is a front view of a condenser shroud according to various embodiments of the present disclosure.

[0024] Fig. 11 is a perspective view of the condenser shroud of Fig. 10.

DETAILED DESCRIPTION

[0025] 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.

[0026] Fig. 1 illustrates a direct current (DC) powered variable capacity air conditioning system 10 having a condenser shroud assembly 32 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.

[0027] The VCACS 10 generally includes a housing 12 enclosing a condenser assembly 34, an evaporator assembly 38 and a variable speed compressor 94 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 an external ambient environment into the condenser assembly 34 (indicated generally by an arrow 16), and an air output opening 19 for outputting air from the condenser assembly 34 into the external ambient environment (indicated generally by an arrow 20). An air passage 24 flows through the condenser assembly 34 between the air intake opening 17 and the air output opening 19.

[0028] Referring to Figs. 2-3, in various embodiments, the condenser assembly 34 includes the condenser shroud assembly 32 that comprises a condenser shroud 50 and a condenser shroud cover 62. The condenser assembly 34 also includes a condenser air mover 54, a condenser air mover mounting plate 58, a condenser shroud cover filter 66 and a condenser heat exchanger 70. The condenser air mover 54 can be rotationally mounted to the condenser air mover mounting plate 58, which can then be mounted to the condenser shroud 50. The condenser air mover 54 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 volumes of air.

[0029] In various embodiments, the condenser shroud 50 and the condenser heat exchanger 70 are supported by a support frame 90. Additionally, a compressor 94 can be supported by the support frame 90.

[0030] A housing hood 74 is mounted over the condenser shroud 50, the condenser air mover, shroud cover and the shroud cover filter 54, 62 and 66, and the condenser heat exchanger 70, and coupled to a housing panel 78. It should be understood that although the housing hood 74 is referred to herein as a single structure, the housing hood 74 can be constructed of one or more panels, e.g., side panels, top panel and/or front panel. The housing hood 74 defines the air intake opening 17 and a plurality of grated or finned apertures that generally form the air output opening 19. An air intake cover 82, including a plurality of grated or finned apertures that generally form an air intake cover opening 86, is mounted to the housing hood 74 to cover the air intake opening 17. When the condenser air mover 54 is operating, air from the air intake opening 17 passes through the condenser shroud cover 62 and is drawn into the condenser shroud 50 from the exterior ambient environment. The condenser shroud 50 is fabricated to have an open bottom such that the condenser shroud 50 directs air from the air intake opening 17 along the air passage 24. More specifically, the condenser shroud 50 directs air through the condenser shroud 50 and downwardly such that the air flows across the condenser heat exchanger 70 and around and/or across the compressor 94 before being output back into the exterior ambient environment, via the air output opening 19. Accordingly, air flowing through the air passage 24 cools the compressor 94.

[0031] Referring now to Figs. 4-8, in various embodiments, the condenser shroud cover 62 is formed or fabricated as a single piece, seamless structure. For example, the condenser shroud cover 62 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.

[0032] In addition, the condenser shroud cover 62 can be fabricated from any suitable material such as any suitable plastic polymer or composite, any suitable reinforced polyurethane or epoxy resin or any other material suitable for fabricating a single piece seamless condenser shroud cover 62.

[0033] The condenser shroud cover 62, in various embodiments includes an inlet ring 118 defining an opening 122, and a filter support surface 126 having a plurality of fastener openings 130.

[0034] The opening 122 allows air from the external ambient environment to flow into the condenser assembly 34. Although the opening 122 is circularly shaped, the opening 122 may be other suitable shapes (e.g., ovals or rectangles) to allow air to flow into the condenser assembly 34 without departing from the scope of this disclosure. Additionally, the condenser shroud cover 62, in various embodiments can include a plurality of openings that generally form the opening 122 and allow air to flow into the condenser assembly 34 without departing from the scope of this disclosure.

[0035] The inlet ring 118 surrounds the opening 122 and includes radiused surfaces 134, as best seen in Figs. 7-8. The radiused surfaces 134 extends toward the condenser shroud 50 and increases the pressure at which air enters into the condenser assembly 34 and consequently the volume flow rate of air through the condenser assembly 34.

[0036] In various embodiments, the inlet ring 118 can be formed integrally with the condenser shroud cover 62. However, in various other embodiments, the inlet ring 118 can be a separate part that is mounted to the condenser shroud cover 62, or the condenser shroud cover 62 may not include the inlet ring 118, without departing from the scope of this disclosure.

[0037] The condenser shroud cover filter 66, in various embodiments, can be positioned on the filter support surface 126 and secured to the condenser shroud cover 62 via a plurality of fasteners (not shown) inserted into the fastener openings 130. The fasteners may be any suitable fastener including, without limitation, screws, nails, rivets or bolts.

[0038] In various embodiments, the condenser shroud filter 66 can be any suitable filter, such as a wire screen, a HEPA or a PTFE filter, for effectively preventing particulate matter such as airborne dust, dirt, leaves, grass, weeds, insects, etc. from infiltrating the condenser assembly 34. In various other embodiments, the condenser shroud filter 66 can comprise a wire screen, such as a hardware cloth and a particulate filter such as HEPA or PTFE filter.

[0039] Referring now to Figs. 7-9, the condenser shroud cover 62 can be mounted in the condenser shroud 50. In various embodiments, the condenser shroud cover 62 can be aligned with the condenser shroud 50 such that a center axis A of the opening 122 approximately coaxially aligns with a center axis of the condenser air mover 54 when the condenser air mover 54 is mounted to the condenser shroud 50 and the condenser shroud cover 62 is mounted to the condenser shroud 50. As best seen in Fig. 11, aligning the condenser shroud cover 62 and the condenser air mover 54 in this manner prevents the condenser shroud cover 62 and the condenser air mover 54 from rubbing against each other when the condenser air mover 54 is in operation.

[0040] In various embodiments, the condenser shroud 50 is formed or fabricated as a single piece, seamless structure. For example, the condenser shroud 50 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.

[0041] In addition, the condenser shroud 50 can be fabricated from any suitable material such as any suitable plastic polymer or composite, any suitable reinforced polyurethane or epoxy resin or any other material suitable for fabricating a single piece seamless condenser shroud 50.

[0042] Referring now to Figs 10-11, in various embodiments the condenser shroud 50 includes mounts 102 for supporting the condenser air mover 54 and mounting surfaces 114 for supporting the condenser shroud cover 62. The condenser air mover 54 and the condenser shroud cover 62 can be secured to the mounts 102 and the mounting surfaces 114, respectively, via a plurality of fasteners (not shown) that are inserted into fastener openings 106. The fasteners may be any suitable fastener including, without limitation, screws, nails, rivets or bolts.

[0043] In various embodiments, the condenser shroud 50 can also include a curved portion 110 that surrounds the condenser air mover 54. When air enters the condenser assembly 34 through the air intake opening 17 and the opening 122 in the condenser shroud cover 62, the condenser air mover 54 pushes the air radially away from the center of the condenser air mover 54. The air subsequently collects in, and is then channeled downwardly by, the curved portion 110 of the condenser shroud 50. The curved portion 110 allows air to flow from the air intake opening 17 downwardly through the condenser assembly 34 smoothly.

[0044] The condenser shroud cover 62, in various embodiments, can be removably mounted to the condenser shroud 50 thereby allowing access to the condenser air mover 54 for servicing or replacing the condenser air mover 54.

CLAIMS

What is claimed is:

1. A condenser shroud assembly for a direct current (DC) powered variable capacity air conditioning system (VCACS), the shroud assembly comprising:

a condenser shroud configured to support a condenser air mover of the VCACS, and

a condenser shroud cover mountable to the condenser shroud, the condenser shroud cover defining an opening having a center axis that approximately coaxially aligns with a center axis of the condenser air mover when the condenser air mover is mounted to the condenser shroud and the condenser shroud cover is mounted to the condenser shroud.

2. The condenser shroud assembly of claim 1 wherein the condenser shroud includes mounts for supporting the condenser air mover.

3. The condenser shroud assembly of claim 1 wherein the condenser shroud cover includes an inlet ring.

4. The condenser shroud assembly of claim 1 wherein the condenser shroud cover includes a mounting surface for supporting a screen.

5. The condenser shroud assembly of claim 1 wherein the condenser shroud cover includes a mounting surface for supporting filter media.

6. The condenser shroud assembly of claim 1 wherein the condenser shroud is a single piece seamless structure.

7. The condenser shroud assembly of claim 6 wherein the single piece seamless structure is a molded piece of plastic.

8. The condenser shroud assembly of claim 1 wherein the condenser shroud cover is a single piece seamless structure.

9. The condenser shroud assembly of claim 8 wherein the single piece seamless structure is a molded piece of plastic.

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

a condenser shroud,

a condenser air mover mountable to the condenser shroud,

a condenser shroud cover mountable to the condenser shroud, the condenser shroud cover defining an opening having a center axis that approximately coaxially aligns with a center axis of the condenser air mover when the condenser air mover is mounted to the condenser shroud and the condenser shroud cover is mounted to the condenser shroud.

11. The system of claim 10 wherein the condenser shroud includes mounts for supporting the condenser air mover.

12. The system of claim 10 wherein the condenser shroud cover includes an inlet ring.

13. The system of claim 10 wherein the condenser shroud cover includes a mounting surface for supporting a wire screen.

14. The system of claim 10 wherein the condenser shroud cover includes a mounting surface for supporting filter media.

15. The system of claim 10 wherein the condenser shroud is a single piece seamless structure.

16. The system of claim 15 wherein the single piece seamless structure is a molded piece of plastic.

17. The system of claim 10 wherein the condenser shroud cover is a single piece seamless structure.

18. The system of claim 17 wherein the single piece seamless structure is a molded piece of plastic.

19. The system of claim 10 wherein the condenser shroud cover is removably mountable to the condenser shroud for allowing access to the condenser air mover.

20. A condenser shroud for a direct current (DC) powered variable capacity air conditioning system (VCACS), the condenser shroud comprising:

a single piece seamless structure positioned adjacent an air intake opening of the VCACS for directing air from the air intake opening through an air passage through a condenser assembly of the VCACS.

21. The condenser shroud of claim 20 wherein the condenser shroud includes mounts for supporting the condenser air mover.

22. A condenser shroud cover for a direct current (DC) powered variable capacity air conditioning system (VCACS), the condenser shroud cover comprising:

a single piece seamless structure positioned adjacent an air intake opening of the VCACS for directing air from the air intake opening through an air passage through a condenser assembly of the VCACS.

23. The condenser shroud cover of claim 22 wherein the condenser shroud cover includes an inlet ring.

24. The system of claim 22 wherein the condenser shroud cover includes a mounting surface for supporting a wire screen.

25. The system of claim 22 wherein the condenser shroud cover includes a mounting surface for supporting filter media.

26. The system of claim 22 wherein the single piece seamless structure is a molded piece of plastic.

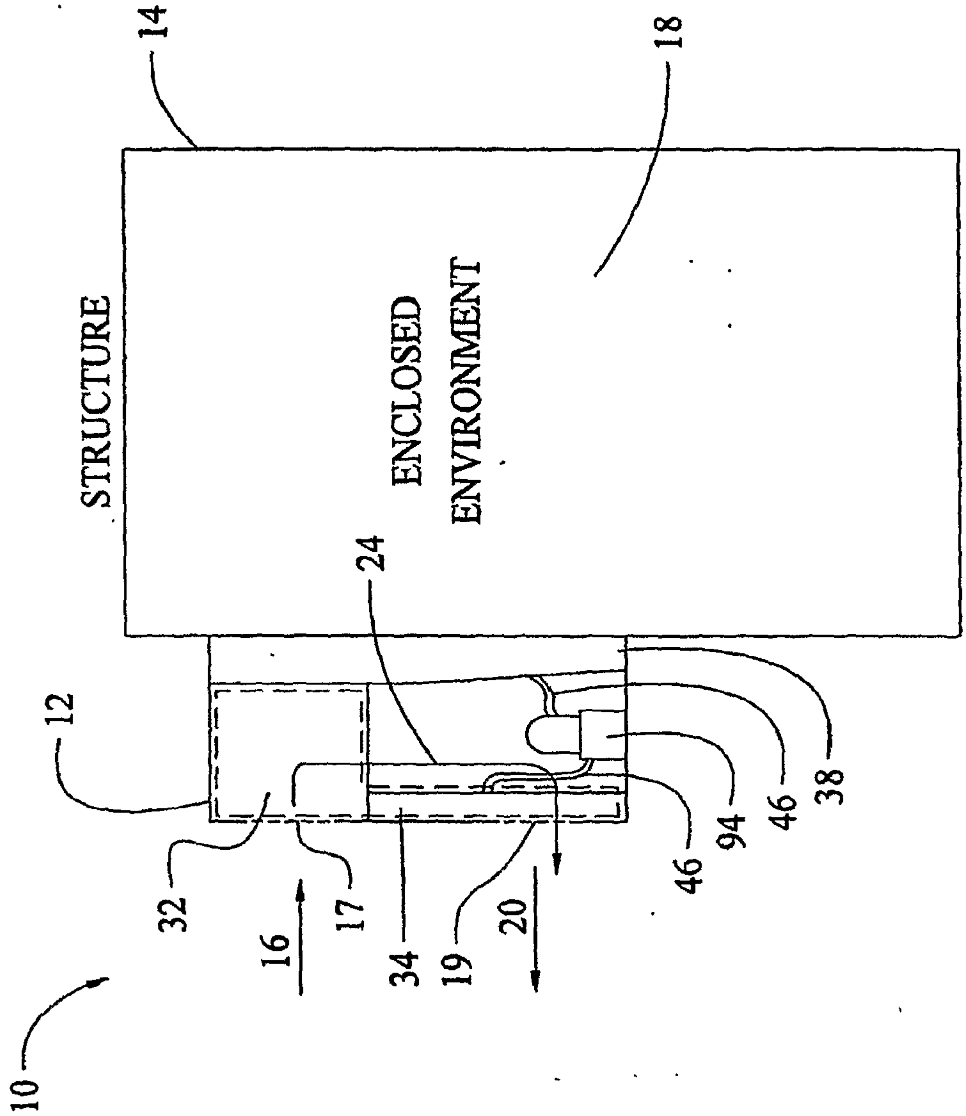
STRUCTURE
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Fig. 1

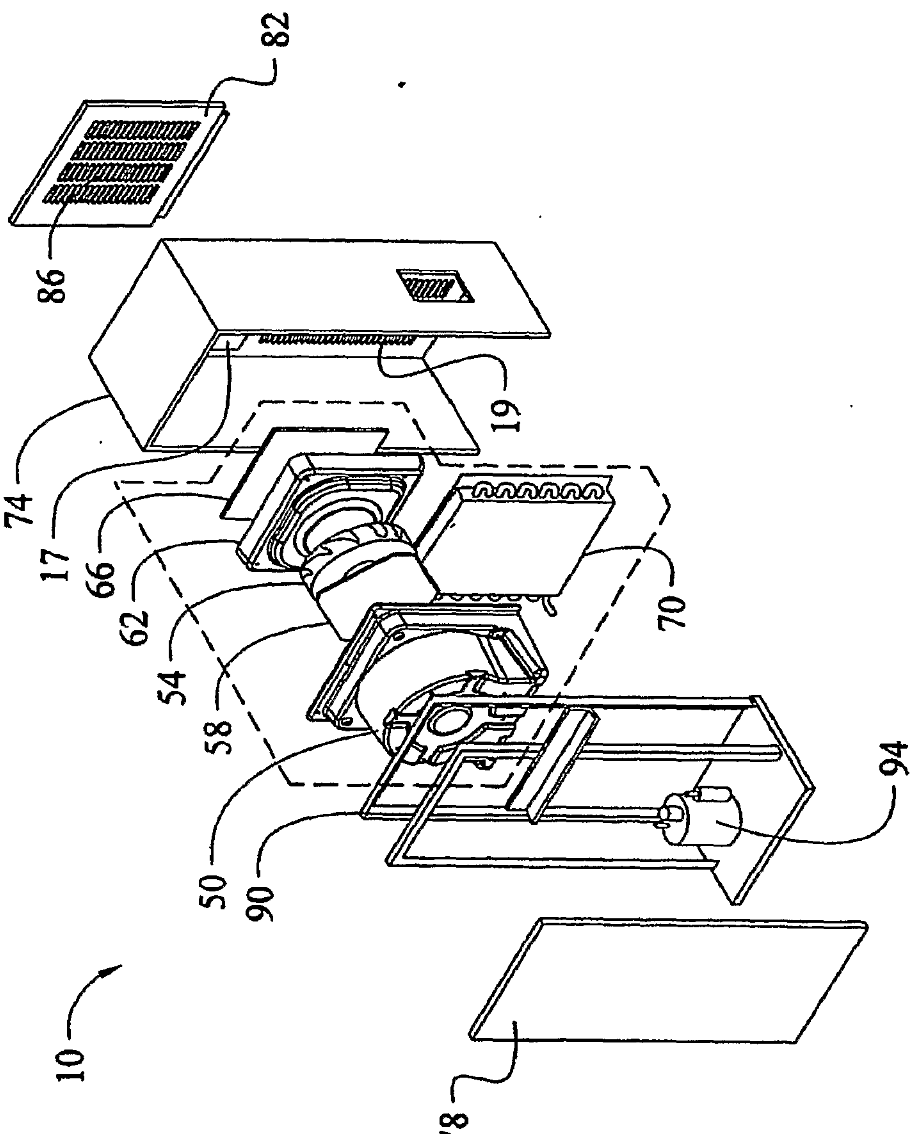

Fig. 2

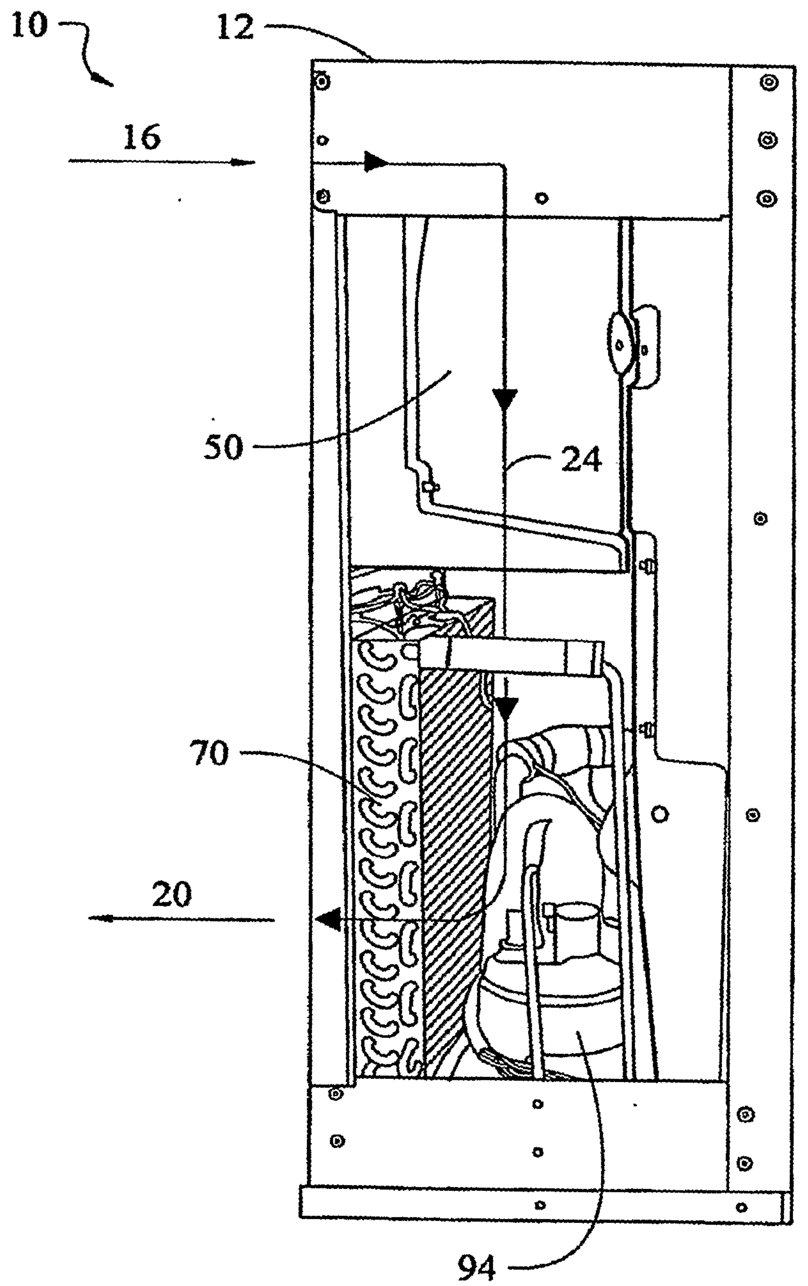

Fig. 3

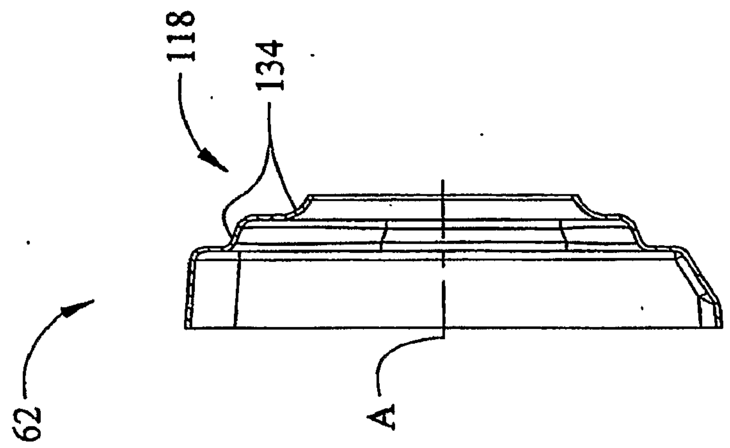

Fig. 5

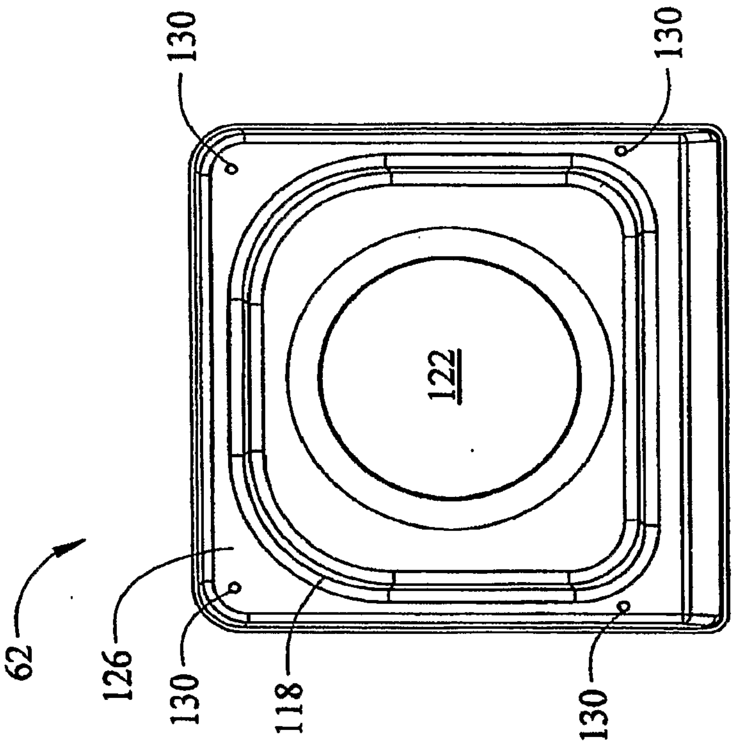

Fig. 4

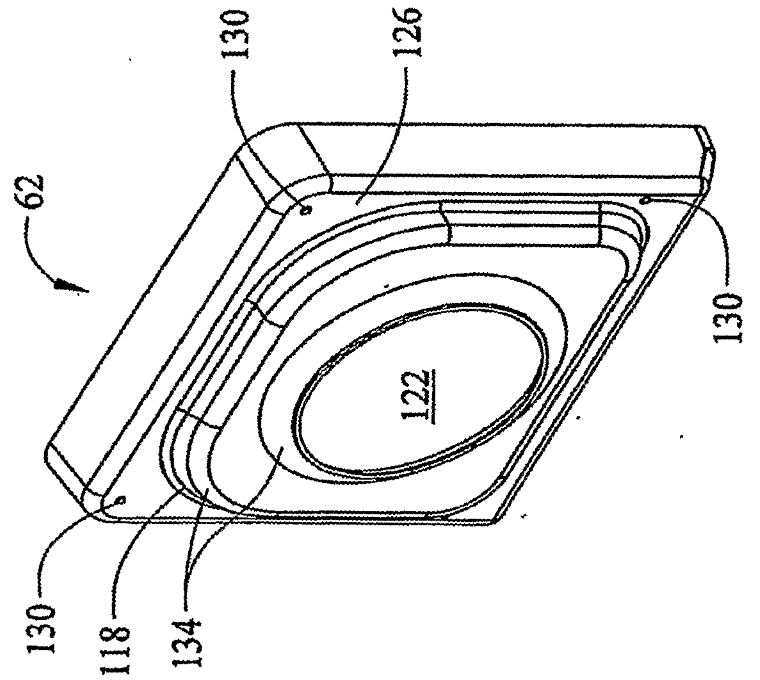

Fig. 6

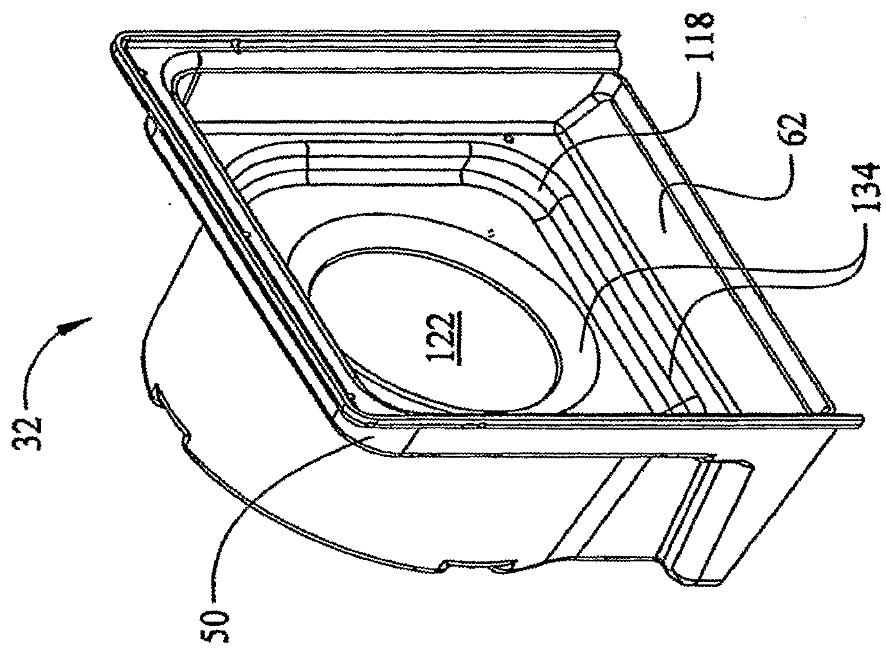

Fig. 7

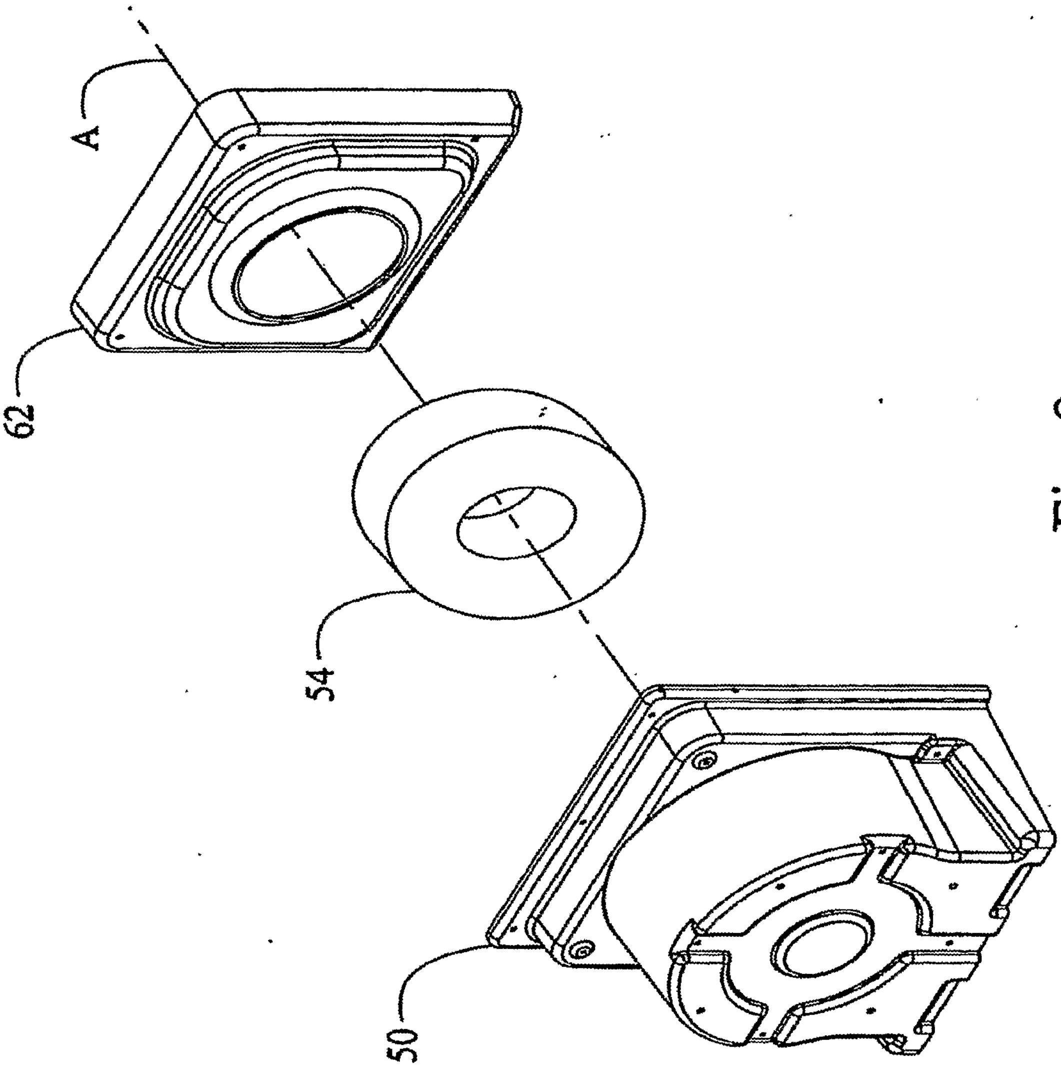

Fig. 8

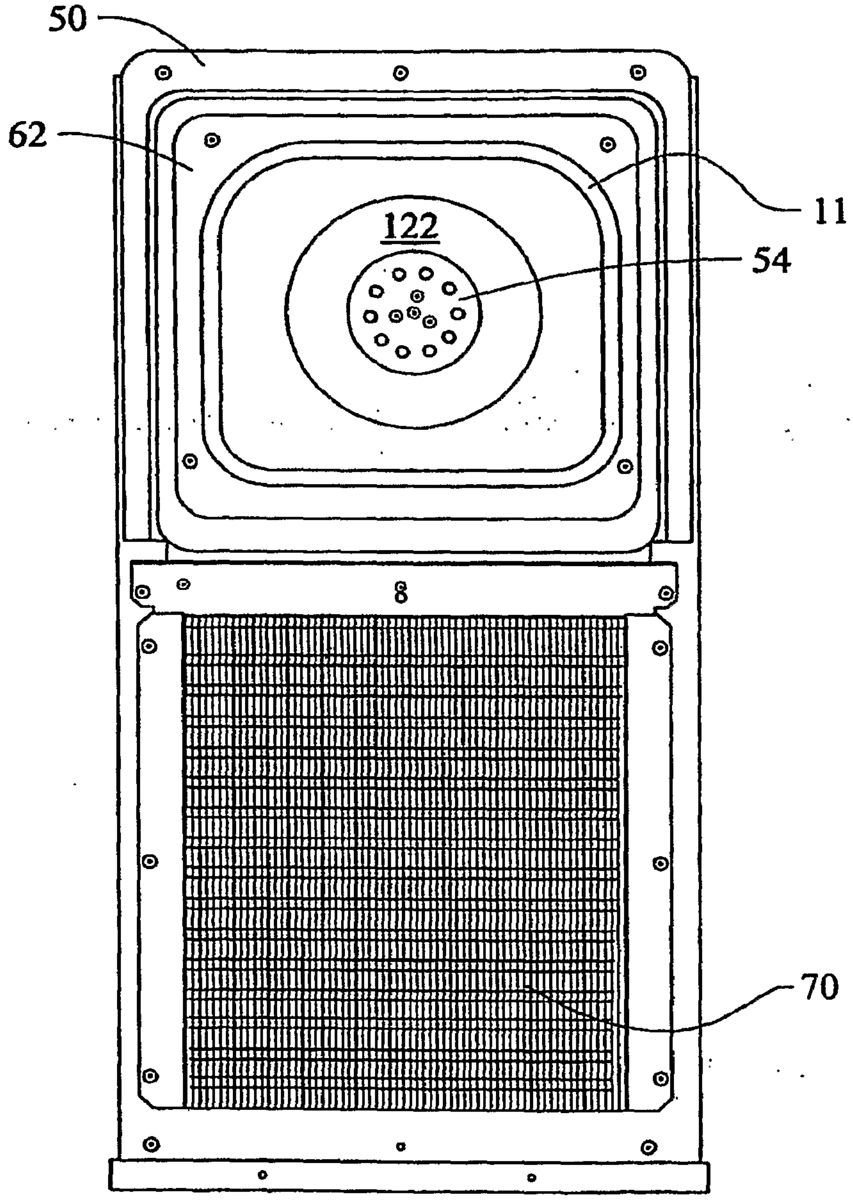

Fig. 9

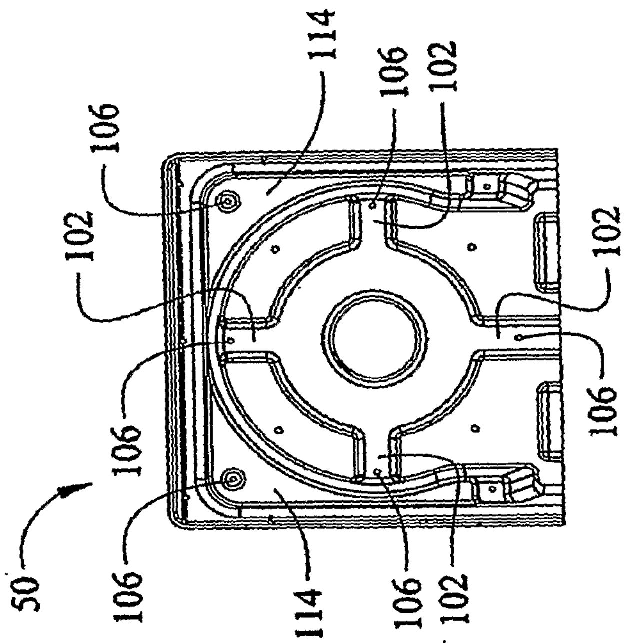
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Fig. 10

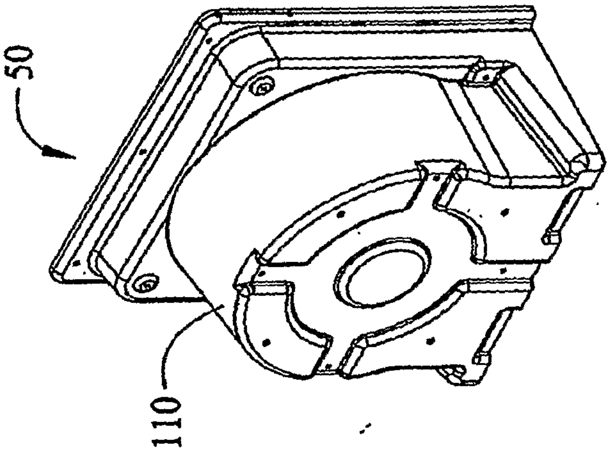
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Fig. 11