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(54) **Magnetically coupled fan blade and motor for a food cabinet**

(57) A food cabinet (70) includes a container (50) holding a refrigerated food product, and the cabinet (70) further includes a cooling device to refrigerate the food product. A fan (10) for the cooling device includes an impeller (10) mounted to a stationary shaft (20) and a motor (30) with a rotor (40). The impeller (10) is exposed

to fluids, but the motor (30) and rotor (40) are opposite a sealed surface (2) and not exposed to the fluids. The impeller (10) is coupled to the rotor (40) by means of complementary sets of magnets (18) mounted on each, such that rotation of the rotor (40) similarly rotates the impeller (10).

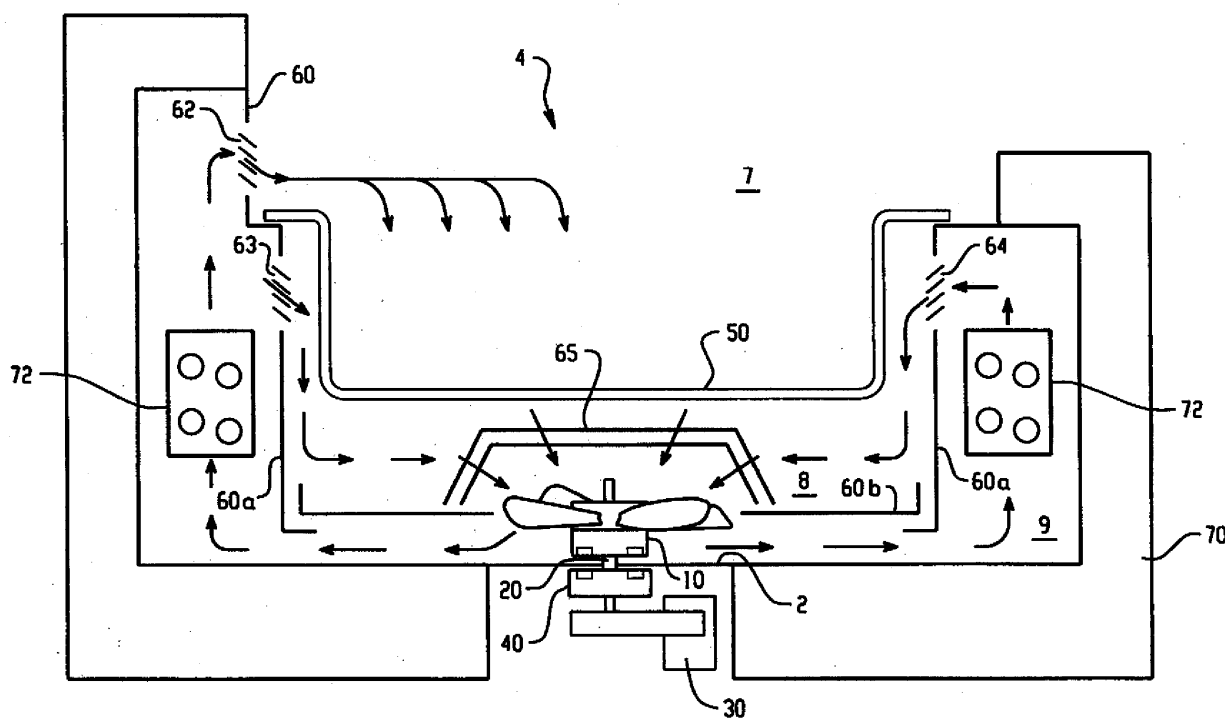


Fig. 2

Description

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Application No. 60/984,222, filed October 31, 2007, and herein incorporated by reference.

TECHNICAL FIELD

[0002] The application relates to a food refrigeration system, more specifically to a system for cooling food containers associated with commercial food cabinets.

BACKGROUND

[0003] Commercial food cabinets are often equipped with removable food pans allowing for ready access to food that needs to be kept cool. In order to keep the food pans cool, fans are placed below the pans to circulate air and otherwise reduce the temperature of the pan environment. Liquids from the food pans can spill down into the fan area. If the liquids contact the motor, this can impact motor performance and negatively interfere with the operation of the cooling system. Similarly, washing of the upper area of the cabinet can be made more difficult if special care must be taken to avoid contacting the fan motor with wash liquid.

[0004] Traditionally, both area shielding and shaft seals have been used to limit the contamination. However, neither of these methods can form a complete seal against contact with liquids because of the necessary operation of the fan rotor and impeller.

[0005] It would be desirable to provide a refrigeration system wherein the fan motor is completely isolated from the food environment by a fully waterproof barrier.

SUMMARY

[0006] A fan is part of a cooling system to cool the removable pans of a food cabinet such as a presentation cabinet or preparation table. The fan impeller is mounted on a stationary shaft in the same environment as the food pans, while the electric motor that powers the fan is mounted outside of the operative environment, separated from the fan impeller and the food pans by a sealed, water-tight barrier. The motor is coupled with the impeller by means of magnets mounted on one or both of the fan and the rotor of the motor. Because there is no direct mechanical connection between the motor and the impeller, the need for some type of moving seal through an opening of the internal housing wall is eliminated. The risk of a liquid contacting the motor from a food spill or during washing is greatly reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Figs. 1A and 1B show two examples of food

cabinets with removable pans.

[0008] Fig. 2 shows a pan cooling system for a food cabinet.

[0009] Figs. 3A and 3B show two views of an impeller for a cooling system fan assembly.

[0010] Figs. 4A and 4B show two views of a drive motor for a cooling system fan assembly.

[0011] Fig. 5 shows a cooling system fan assembly.

[0012] Fig. 6 shows an exploded view of a cooling system fan assembly.

[0013] Fig. 7 shows the assembly of Fig. 6 mounted to a sealed surface.

[0014] Fig. 8 shows a cross-section view of a self-sealing screw mounting a shaft to a sealed surface.

DETAILED DESCRIPTION

[0015] Fig. 1A shows a food preparation table 70a including condiment pans 50a. The table 70a provides ready access to a user, which may be an employee or a customer at a food establishment. The food preparation table 70a allows for quick access to small quantities of condiment 52a for preparing individual servings of food. In typical use, the cabinet 70a may be present in a room temperature environment for several hours. The condiment pan 50a stores a condiment 52a, which needs to be kept at a temperature substantially below room temperature in order to stay fresh.

[0016] Fig. 1B shows a food presentation station 70b including removable pans 50b. The station 70b displays fresh seafood 52b which must also be kept at a low temperature in order to stay fresh. Because the presentation station 70b displays fresh seafood 52b to customers, it must be washed frequently to avoid the possibility of developing an unpleasant odor.

[0017] Fig. 2 shows an embodiment of a cooling system appropriate to a food cabinet 70, of which both the food preparation table 70a and the food presentation station 70b are embodiments. A food pan 50 sits within a cooling frame 60, which itself sits within the insulated cabinet 70. As shown, the food pan 50 is easily removable, and several identically shaped food pans may be provided for easy replacement. This configuration divides the cooling environment 4 into an open environment 7 above the food pan 50, an inner ventilation chamber 8 between the food pan 50 and the cooling frame 60, and an outer ventilation chamber 9 between the cooling frame 60 and the cabinet 70.

[0018] The cooling frame 60 includes a set of vertical air grills 62, 63, and 64. The cooling frame 60 also includes a horizontal air grill 65. As shown in Fig. 2, the cooling frame 60 comprises separate sections 60a and 60b, the upper section 60a primarily vertical in construction and including the vertical air grills 62, 63, and 64 while the bottom section 60b is primarily horizontal and includes the horizontal air grill 65. The bottom section 60b may be independently removable from the cabinet 70 (such as for accessing the fan impeller 10) while leav-

ing the upper section 60a in place. In other embodiments, the cooling frame 60 may be a single unified component including both vertical and horizontal grill sections.

[0019] A fan impeller 10 draws air from the inner ventilation chamber 8 into the outer ventilation chamber 9 and impels the air toward the evaporator coil 72 which is located in a vertical section of the outer ventilation chamber 9. Air passes the evaporator coil 72 and exits the outer ventilation chamber 9 through one of the vertical air grills 62, 63, and 64. One of these air grills 62 leads to the open environment 7 above the food pan 50; the other two air grills 63 and 64 lead to the inner ventilation chamber 8 directly below the food pan 50. Passing over the evaporator coil 72 cools the air which subsequently passes through the vertical grills, so that when this air comes in contact with the food pan 50 it acts to reduce the temperature of the food pan 50.

[0020] Liquids may enter the outer ventilation chamber 9, either from food spills or during a washing procedure. The impeller 10 and stationary shaft 20 are not vulnerable to damage from casual contact with liquids, and the impeller 10 may be easily removed during washing of the upper area of the cabinet. However, contact with liquids may damage the electric drive motor 30 that drives the impeller 10 if the liquids are able to reach those components. Fortunately, the surface 2 separating the rotor 40 from the impeller 10 also works to isolate the motor 30 from the cooling environment 4 without blocking the magnetic coupling between the rotor 40 and impeller 10. Thus, food falling proximate to the impeller 10 during operation does not contact the motor 30, and wash liquid directed to washing the cabinet 70 also does not contact the motor 30.

[0021] Fig. 3 shows the fan impeller 10. Four fan blades 12 are evenly positioned about the central body 14. In the center of the body 14 is a hole 16 to receive the stationary fan shaft 20 (shown in Fig. 5). Positioned within the radius of the body 14 are four magnets 18. The magnets 18 are positioned a similar distance from the center of the body 14 and are spaced evenly.

[0022] The number of magnets 18 may vary. In one embodiment, an even number of magnets 18 are used. If an even number of magnets 18 are mounted on the central body 14, the magnets 18 may be aligned in an alternating fashion such that the poles of adjacent magnets are opposite each other, thus reducing a potential source of error in manufacturing. If the four magnets 18 are accidentally placed backwards into the impeller 10, there is no practical effect, as the same number and relative position of the magnets 18 is preserved. It has also been found that the magnetic coupling between the impeller 10 and the rotor 30 is stronger in the case of alternating opposite poles than if all the poles of the magnets 18 are facing the same direction.

[0023] Fig. 4 shows an electric drive motor 30, which includes a rotor 40. The rotor contains magnets 48, which are spaced evenly in a circular configuration identical to that of the impeller magnets 18. The rotor magnets 48

should be configured in both spacing and polarity to couple with the impeller magnets 18. As shown in Figs. 3 and 4, if the impeller magnets 18 are alternating in polarity, the rotor magnets 48 should do likewise.

[0024] As shown in Fig. 5, when the fan is assembled, the fan impeller 10 is mounted on the stationary fan shaft 20. The fan impeller 10 is configured to rotate freely when mounted on the shaft 20. The stationary fan shaft 20 is secured to the sealed surface 2, which separates the cooling environment 4 from the motor environment 6. The surface 2 may be made up of multiple contiguous surfaces or may be a single unbroken surface, but the surface 2 is sealed such that likely contaminants (e.g., fluids) which exist within the cooling environment 4 cannot pass the surface 2 into the motor environment 6. The sealed surface 2 could be made of any material that will not interfere with the magnetic coupling of the fan assembly - for example, a nonmagnetic metal, or a nonmetal such as plastic or glass. In one embodiment, the sealed surface is made of stainless steel.

[0025] The stationary fan shaft 20 may be attached to the sealed surface by mechanical means. In one embodiment, the fan shaft 20 may protrude through the sealed surface 2. Because the fan shaft 20 is stationary and does not have to mechanically impart rotation from the motor 30, an effective seal can still be produced at the surface 2 even if the shaft 20 extends completely through the surface 2 as shown in Fig. 5. In the configuration shown in Fig. 5, the fan assembly including the impeller 10, shaft 20, and motor 30 with rotor 40, are all physically connected to the surface 2 through the use of an attachment plate 22. In other configurations, the shaft 20 may be bolted to the surface independently of the motor 40, may be glued or otherwise directly attached to the surface 2, or may be built integrally with the surface 2. The shaft 20 may be secured to the surface 2 by any method that allows the surface 2 to maintain its seal.

[0026] The drive motor 30 is positioned on the other side of the sealed surface 2 in the motor environment 6, where it is not subject to contact with contaminants from the cooling environment 4. The drive motor 30 is positioned as shown such that the rotor 40 is aligned with the central body 14 of the impeller 10. The magnets 18 of the impeller 10 are aligned with the magnets 48 of the rotor 40 such that the rotor 40 and central body 14 are magnetically coupled. When the motor 30 is activated to rotate the rotor 40, the magnetically coupled impeller 10 also rotates, including the fan blades 12. Rotation of the fan impeller 10 acts to circulate air within the cooling environment 4.

[0027] Another embodiment of a cooling assembly is shown in an exploded view as Fig. 6. Here, the impeller 10' is securely attached to a hub 14' which includes four magnets 18'. The hub 14' is mounted on a stationary shaft 20'. The stationary shaft 20' includes a wide base that abuts the sealed surface 2 (shown in Fig. 7) to provide additional stability for the fan assembly.

[0028] The shaft 20' is secured to the sealed surface

2 by means of a screw member 24. In one embodiment, the screw member 24 is a self-sealing screw, such as a screw with a silicon o-ring under the screw head available from McMaster-Carr. The screw member 24 fastens the shaft 20' tightly to the sealed surface 2. The screw 24 and shaft 20' are stationary relative to the sealed surface 2, which allows the sealed surface 2 to maintain an effective seal around the shaft 20'.

[0029] In the embodiment of Fig. 6, the motor 30' with the rotor 40' is attached to the sealed surface independently of the impeller 10' and hub 14' on the shaft 20'. The motor 30' is connected to a motor mount plate 80. A set of four hex standoffs 82 attach the plate 80 to the sealed surface. Both the motor 30' and standoffs 82 are fastened to the motor mount plate 80 using nuts 84. The standoffs 82 are attached to the sealed surface by means of screws 26, which may be self-sealing screws substantially identical to the screw member 24 described above. The motor 30' drives the rotor 40', which is positioned close to the sealed surface and is magnetically coupled by interaction of the rotor magnets 48' and the hub magnets 18'.

[0030] The top surface of the rotor 40' includes a central recess of sufficient depth such that the rotor 40', which rotates rapidly during operation of the cooling system, does not come into physical contact with the head of the screw member 24, which remains stationary during cooling.

[0031] Fig. 7 shows an elevation view of the cooling system as shown in Fig. 6, assembled and mounted upon the sealed surface 2. The shaft 20', the central hub 14', and the impeller 10' are above the surface 2 within the cooling environment 4. The motor 30', rotor 40', and motor mount plate 80 with standoffs 82 are below the surface 2 within the motor environment 6. These two part groups do not form a mechanical connection; most notably the head of the screw member 24 does not contact the rotor 40' but rather is located within the recess in the rotor 40'. During operation, the motor mount plate 80 attached to the motor 40' does not rotate, and the shaft 20' also does not rotate. The rotor 30', central hub 14', and impeller 10' rotate together due to the magnetic coupling.

[0032] Fig. 8 is a cross-section view of the stationary shaft 20' and self-sealing screw member 24, which includes an o-ring 25. When the screw is attached to the sealed surface 2 as shown, the o-ring 25 presses upward tightly to maintain a seal and prevent fluids in the cooling environment 4 from entering the motor environment 6.

[0033] The embodiments described above are shown by way of illustration and are not limiting on the scope of the invention. Variations, such as in the configuration of the coupled magnets, the fan blades, the motor, or the air circulation within the cooling cabinet, are possible.

Claims

1. A food product refrigeration system, comprising:

a container for holding a refrigerated food product;
a cooling frame substantially around and below the container, the cooling frame including openings designed for allowing the passage of air therethrough;
a ventilation chamber defined by the cooling frame and an insulated wall substantially around and below the cooling frame, the ventilation chamber containing a fan impeller and an evaporator coil; and
a motor controlling a rotor, the rotor magnetically coupled to the impeller such that rotation of the rotor by the motor results in operation of the impeller, the motor and rotor separated from the ventilation chamber by a sealed surface; wherein the impeller operates to draw air into the ventilation chamber, past the evaporator coil, and out of the ventilation chamber into contact with the container.

2. The refrigeration system of claim 1, wherein the ventilation chamber is an outer ventilation chamber;
an inner ventilation chamber is formed between the container and the cooling frame;
the cooling frame includes an outlet that opens into the inner ventilation chamber and an outlet that opens into the air above the container; and wherein the fan impeller operates to draw air from the inner ventilation chamber into the outer ventilation chamber, past the evaporator coil, and through the outlets of the outer ventilation chamber into both the inner ventilation chamber and the air above the container.
3. The refrigeration system of claim 1, wherein the rotor contains a set of magnets spaced therein, and wherein the impeller contains a set of magnets spaced such that the magnets of the impeller and the magnets of the rotor form individual pairs for magnetic coupling of the rotor and impeller.
4. The refrigeration system of claim 3, wherein each individual pair of coupled magnets is positioned such that the magnets are proximate the sealed surface and on opposite sides of the sealed surface, such that the magnets communicate magnetically across the sealed surface.
5. The refrigeration system of claim 3, wherein the set of impeller magnets are spaced evenly and at a common distance from the center of the impeller, and wherein each magnet is oriented such that its polarity is opposite from the polarity of both of the two magnets adjacent to it.
6. The refrigeration system of claim 1, wherein the container is a condiment pan.

7. The refrigeration system of claim 1, wherein the sealed surface is made of a nonmagnetic material.
8. The refrigeration system of claim 7, wherein the non-magnetic material is stainless steel. 5
9. The refrigeration system of claim 1 wherein the impeller is mounted on a stationary shaft that extends upward through the sealed surface, the stationary shaft having an associated stationary seal member. 10
10. A food cooling system, comprising:
- a food holding area;
 - a fan impeller mounted for rotation below the food holding area; 15
 - a motor including a rotor magnetically coupled to drive the fan impeller without mechanical contact between the rotor and the fan impeller; and
 - a sealed surface separating the motor from the impeller. 20
11. The food cooling system of claim 10, wherein the rotor contains a set of magnets spaced therein, and wherein the impeller contains a set of magnets spaced such that the magnets of the impeller and the magnets of the rotor form individual pairs for magnetic coupling of the rotor and impeller. 25
12. The refrigeration system of claim 1, wherein the set of impeller magnets are spaced evenly and at a common distance from the center of the impeller, and wherein each magnet is oriented such that its polarity is opposite from the polarity of both of the two magnets adjacent to it. 30 35
13. The food cooling system of claim 10, wherein the sealed surface is made of a nonmagnetic material.
14. The food cooling system of claim 13, wherein the nonmagnetic material is stainless steel. 40
15. The food cooling system of claim 10 wherein the impeller is mounted on a stationary shaft that extends upward through the sealed surface, the stationary shaft having an associated stationary seal member. 45
16. A food preparation cabinet including the food cooling system of claim 10, wherein: 50
- the food holding area includes a condiment pan holding a condiment;
 - the fan impeller located below the condiment pan and exposed to potential contact with condiment that falls from the condiment pan; 55
 - the sealed surface preventing the motor from being contacted by condiment.
17. A food presentation station including the food cooling system of claim 10, wherein:
- the food holding area includes a display area with a removable food tray displaying food product;
 - the fan impeller located below the food tray and within the display area;
 - the sealed surface preventing the motor from being contacted by wash liquid during cleaning of the display area.

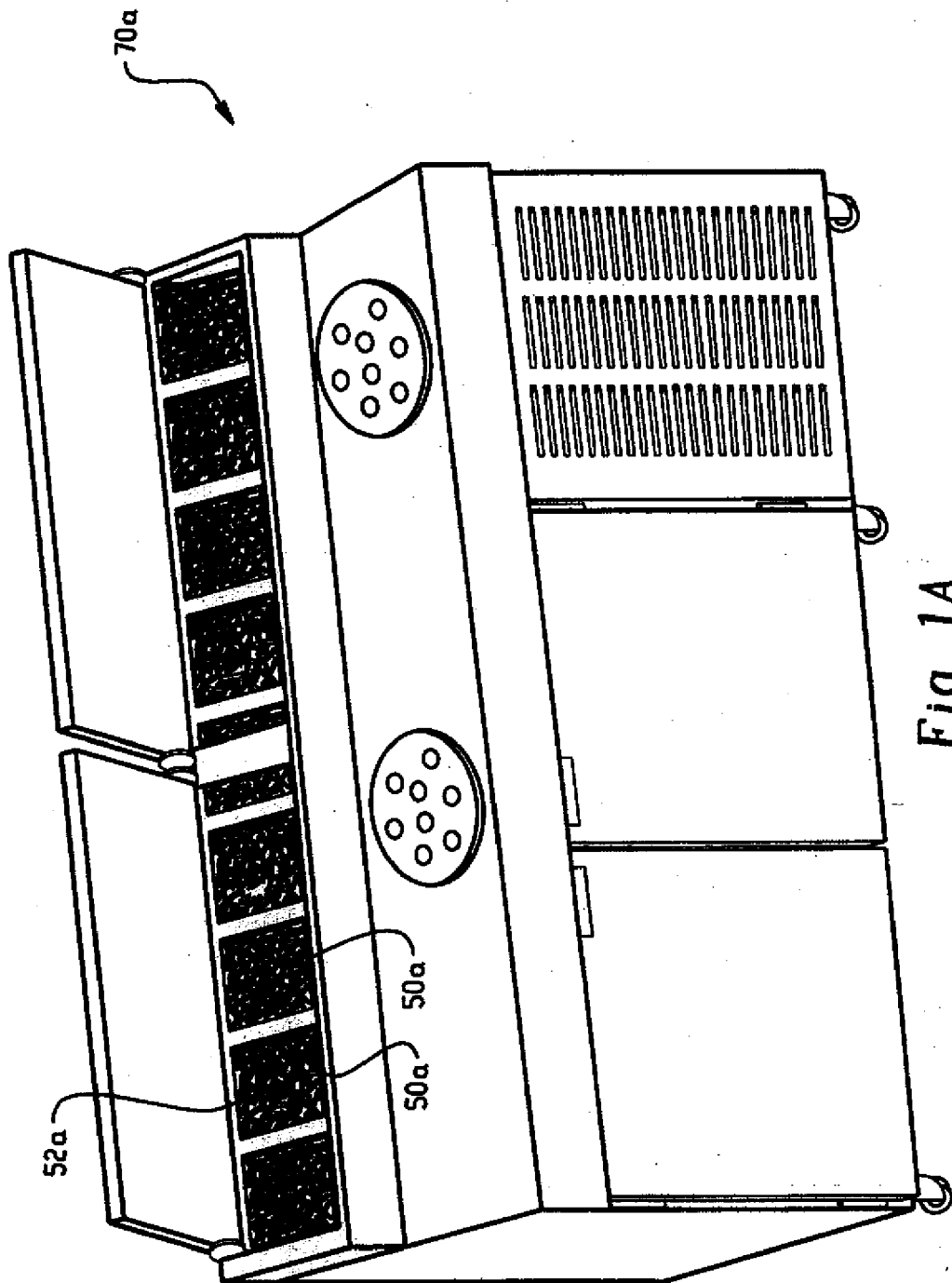


Fig. 1A

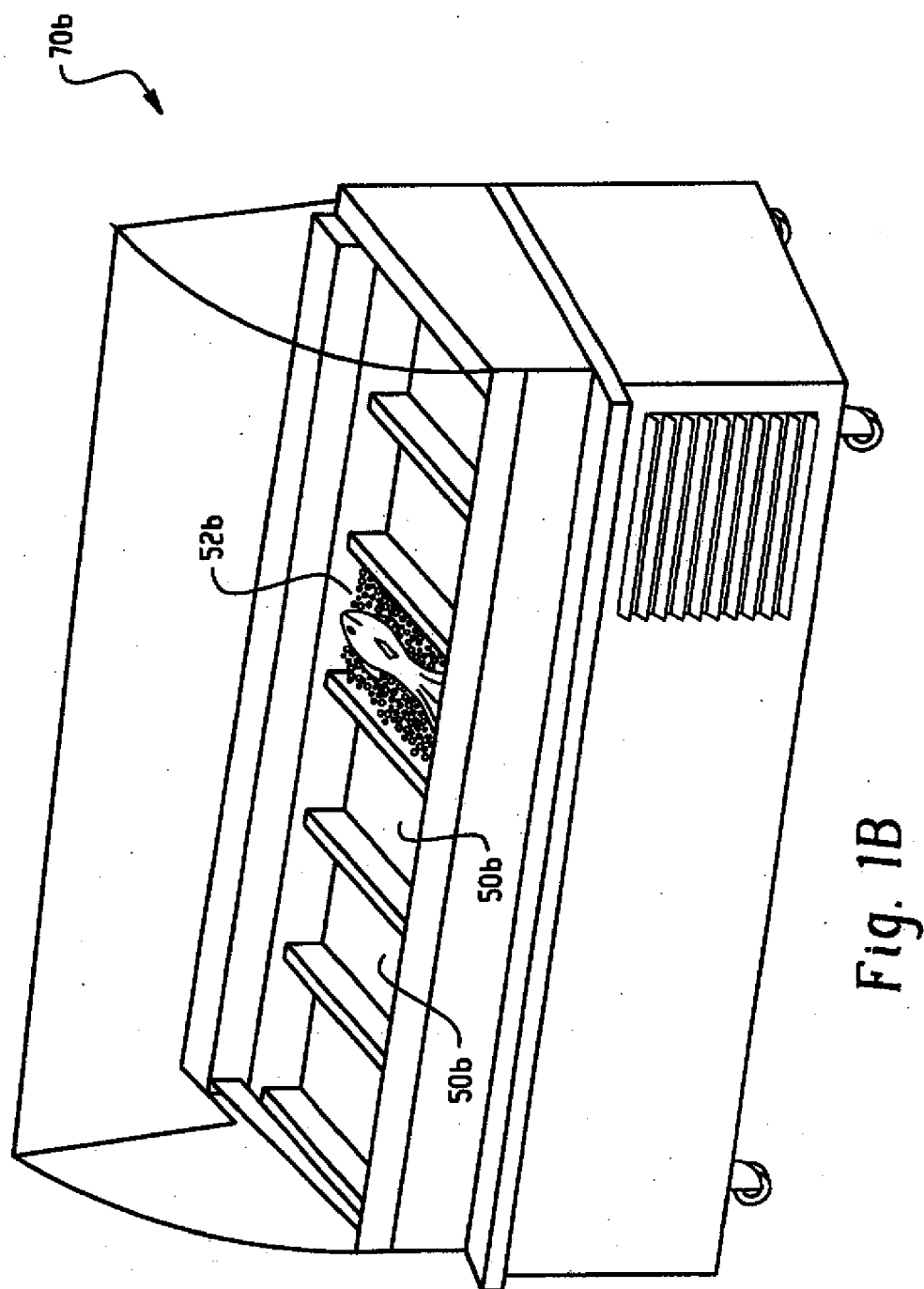


Fig. 1B

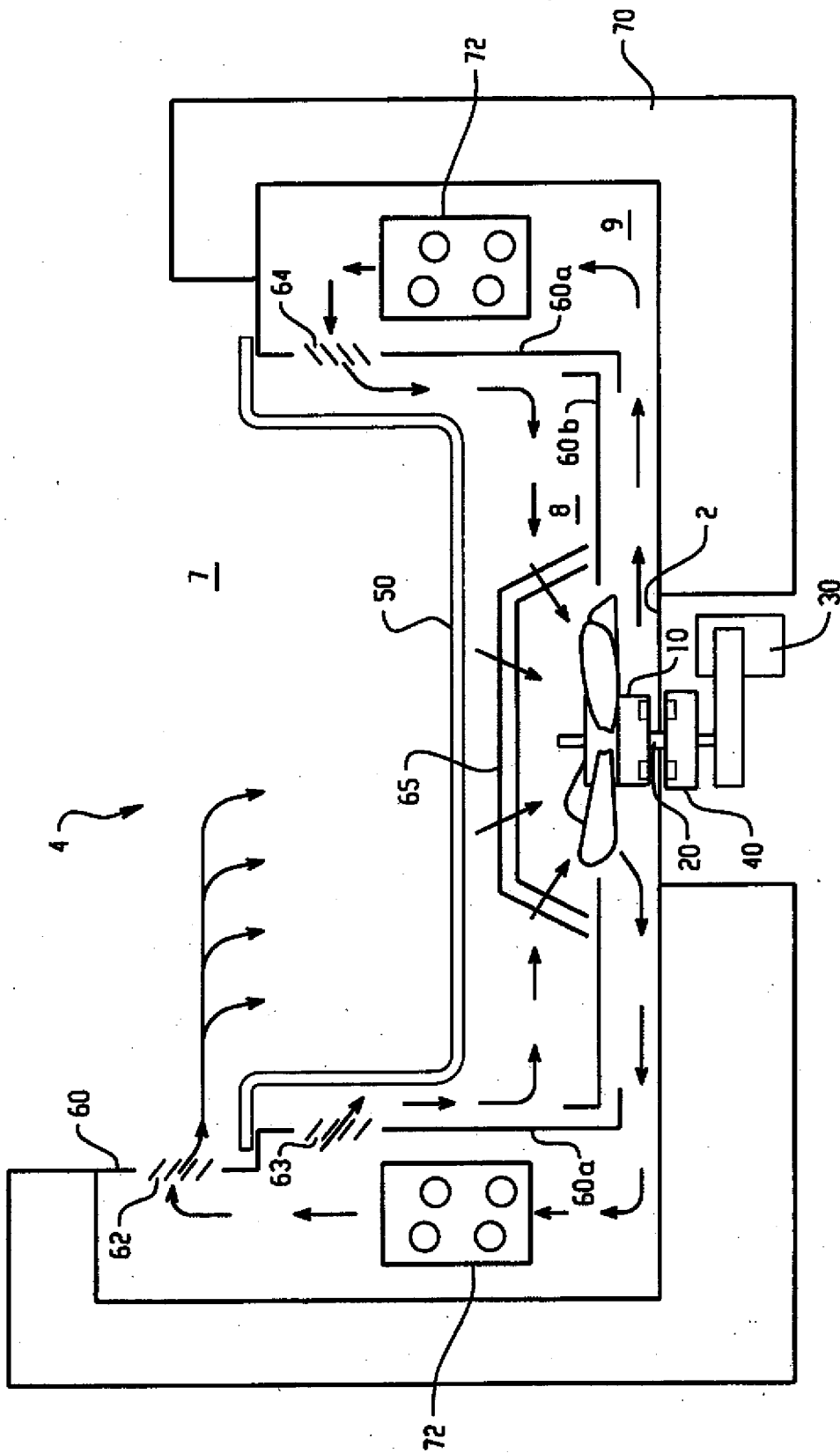


Fig. 2

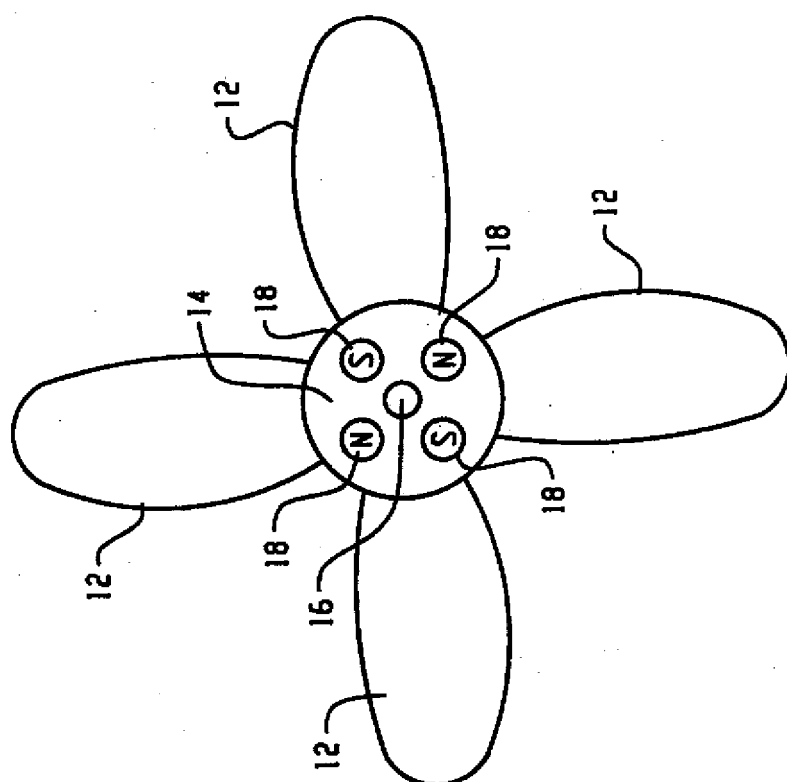


Fig. 3A

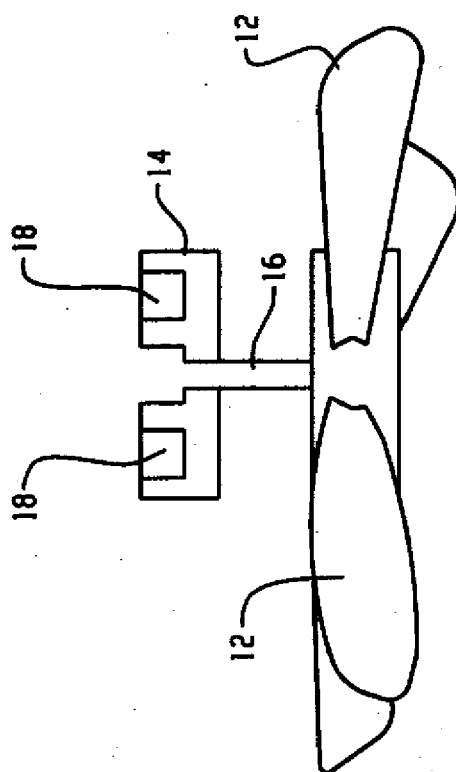


Fig. 3B

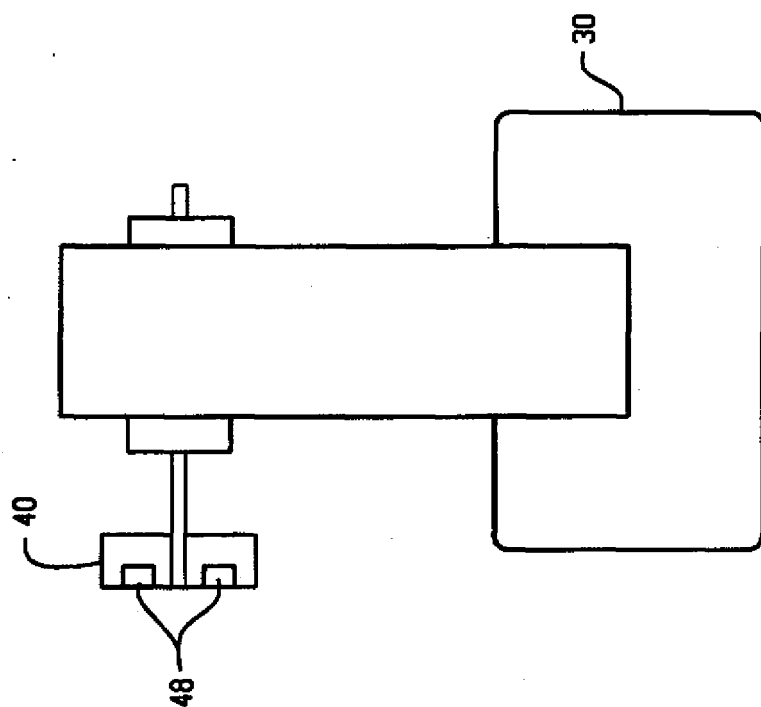


Fig. 4B

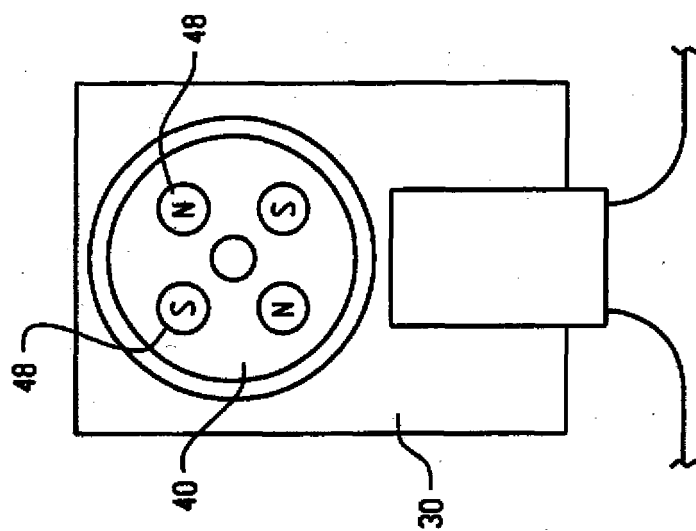


Fig. 4A

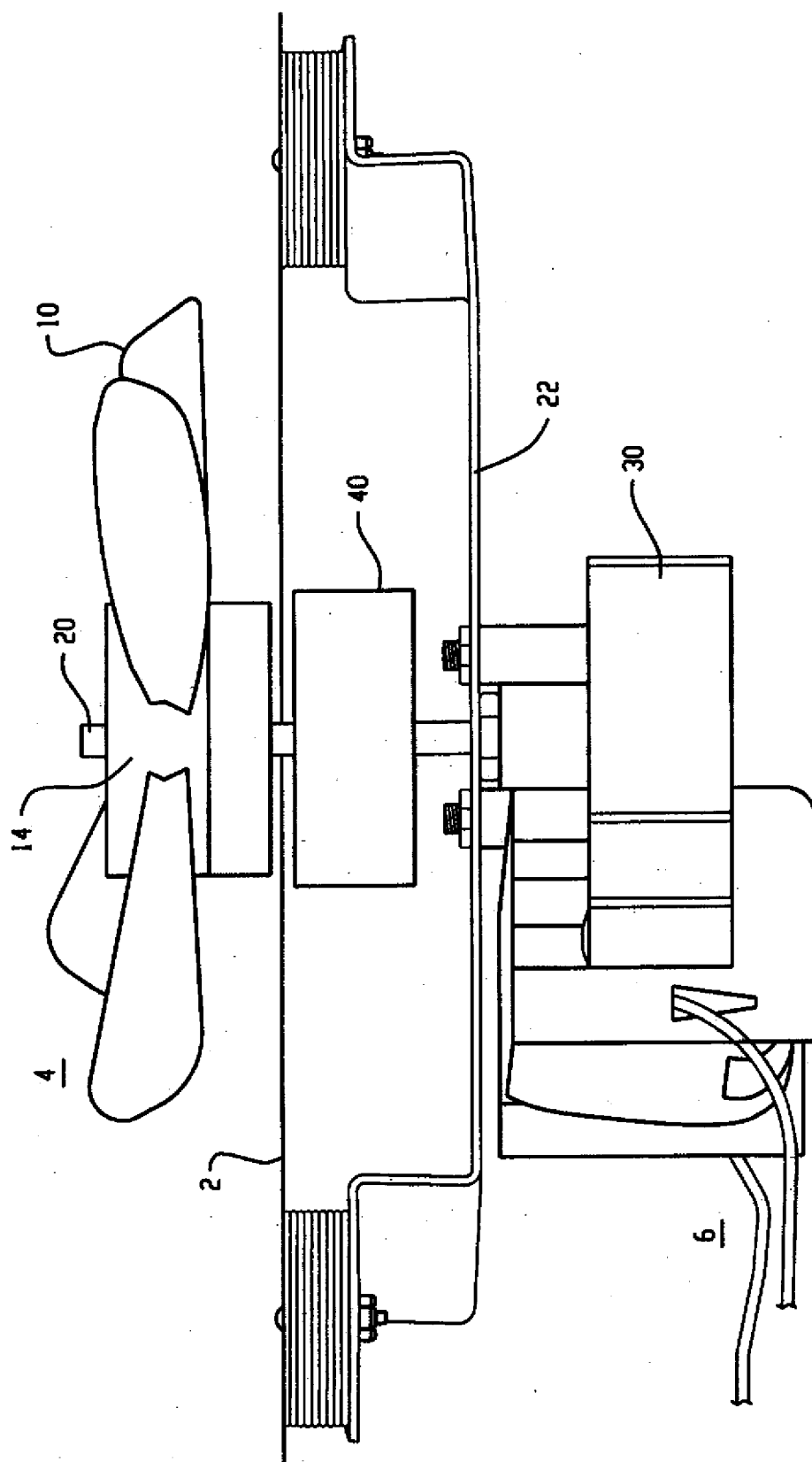


Fig. 5

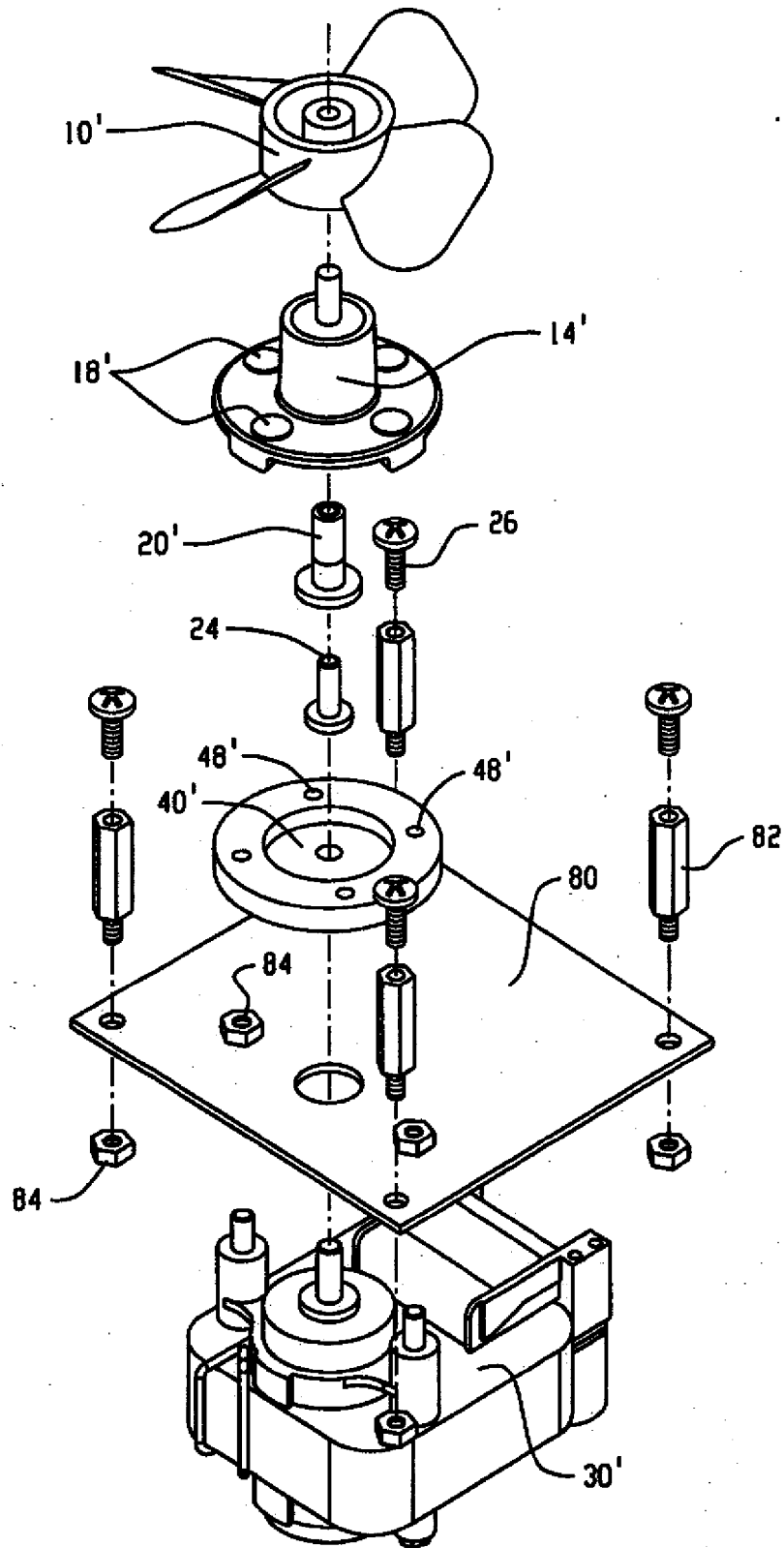


Fig. 6

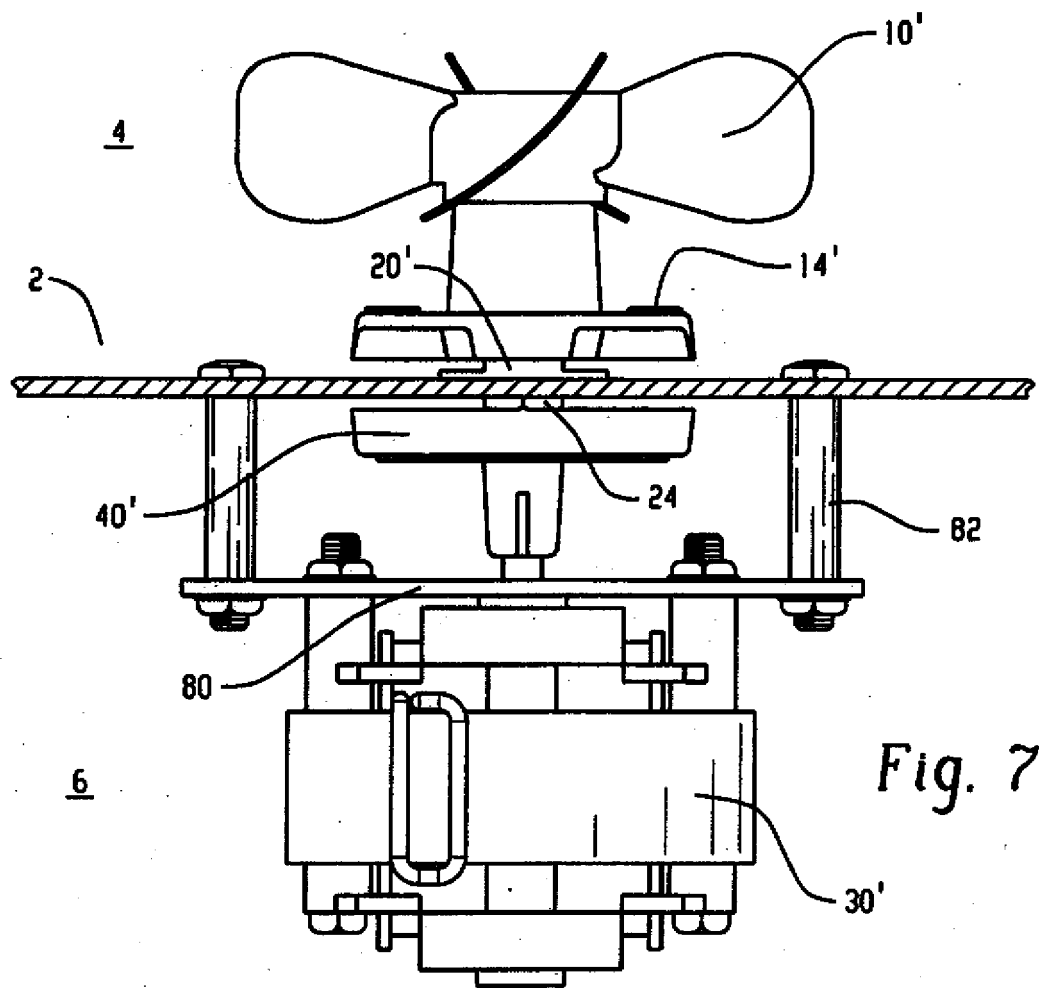
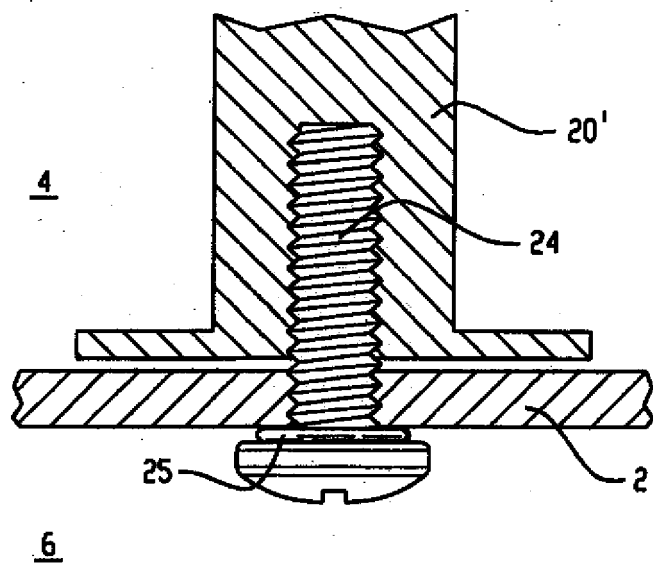


Fig. 8





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Application Number
EP 08 16 7488

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Place of search Munich		Date of completion of the search 9 February 2009	Examiner Lucic, Anita
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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