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(54) Vibration damped electric fan

(57) A fan (1) for mounting in a duct (12), comprising: an outer support (3) which in use fits in the duct; an inner support (4) separated from the outer support by at least one radial member such that an airflow passage is formed between the inner and outer supports; and a motor (5) mounted in vibration damping manner to the inner support, wherein the motor is mounted on at least one central axial shaft (9) and the at least one shaft is mounted in vibration damping manner to the inner support.

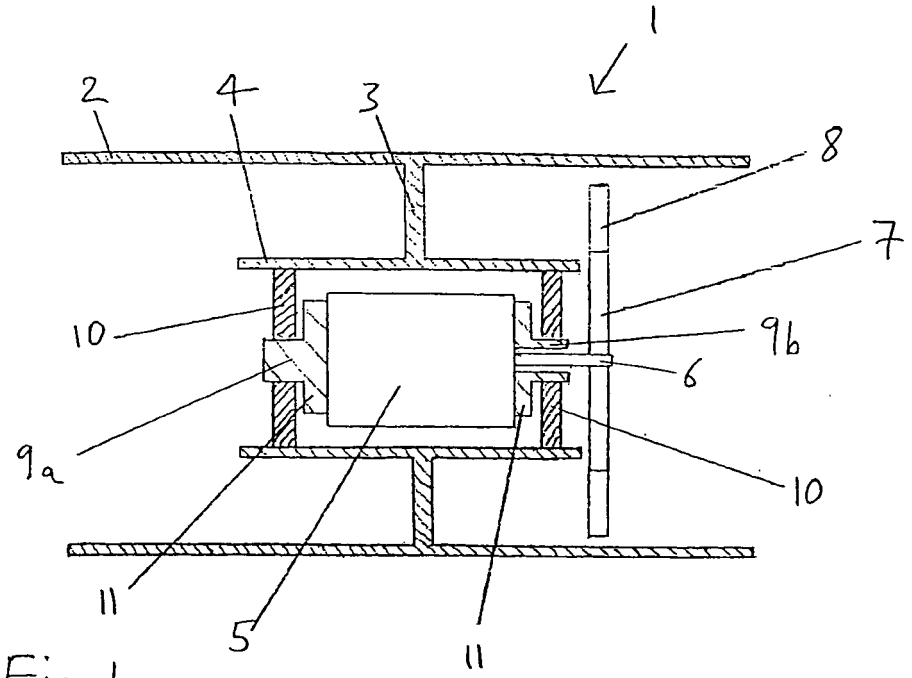

Fig. 1

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Description

[0001] This invention relates to vibration damping of electric fan motors, particularly of in-duct axial extractor fans such as those found around the home in kitchens and bathrooms.

[0002] It is well known that electric motors generate vibrations which in turn lead to noise which is often inconvenient to the user. It is desired to minimise this noise.

[0003] A variety of techniques have been used to reduce the vibrations in motors and thereby to reduce the noise generated by the motors. For example WO 01/54252 describes a fan motor which is held in a housing pot. The housing pot has a fastening flange which is connected via an annular damping element to a fastening area. EP 1075075 describes a mounting system for a fan motor where the motor is connected to the support by a number of elastic web-like connecting pieces which are elastically movable relative to each other three-dimensionally. EP 1152154 reduces vibrations by increasing the rigidity of the motor holder.

[0004] None of the above systems address the problems of in-duct axial fans. Extractor fan units can be wall mounted or ceiling mounted and are often used around the home, for example in the kitchen or the bathroom. The unit is mounted inside a duct which carries the air away from the room which is being ventilated. In such units, the fan and motor must be fitted inside the duct, or inside a housing which connects to the duct. The motor is usually mounted centrally within the duct or housing.

[0005] Conventional methods of vibration damping involve providing a vibration damping material between the element which causes the vibration and a solid external component. The diameter of the duct for domestic extractor fans is small and space is limited within the duct. Also a significant air passage has to be provided around the fan motor so that air can be sucked into the fan unit and driven past the motor and out through the duct.

[0006] Therefore large vibration damping elements around the motor are not appropriate as they would block the airflow passage and prevent the unit from operating properly. Such extractor fans have previously been fitted with rubber or foam rings to hold the unit within the duct, but these rings provide very little in the way of damping vibrations.

[0007] Extractor fan motors can either be of the inner rotor type with an impeller attached to the axle of the rotor or they can be of the outer rotor type where the outer rotor is formed as the impeller.

[0008] It is known to provide an inner rotor motor which is mounted in a vibration damping manner to an inner housing of an extractor fan assembly. The Soler & Palau SILENT-100 is such a fan. The inner housing of the SILENT-100 is formed in two halves with the vibration damping members formed integrally therewith. Each half of the inner housing comprises a cylindrical housing part made from plastic, a rubber disc integrally moulded with the cylindrical housing part and forming an end to the cylinder and a plastic mounting disc integrally formed inside the rubber disc. The mounting disc has two protrusions which stick out of the rubber disc and are friction fitted into holes in the motor housing and a central hole through which the axle of the motor projects. The two plastic cylindrical housing parts connect together thus suspending the motor within a cylindrical housing via a rubber disc at each end. The casing halves are formed by a complex injection moulding process.

[0009] The arrangement of the SILENT-100 is suitable only for inner rotor type motors as the motor is mounted at both ends with the axle of the inner rotor sticking out from one end. An impeller is fitted onto the axle and the whole assembly is mounted within an outer housing to complete the fan.

[0010] In the present invention, it has been realised that vibration damping can be improved by providing the motor with at least one central axially extending shaft, and providing vibration damping means between the axially extending shaft or shafts and the inner housing.

[0011] Therefore according to a first aspect, the invention provides a fan for mounting in a duct, comprising: an outer support which in use fits in the duct; an inner support separated from the outer support by at least one radial member such that an airflow passage is formed between the inner and outer supports; and a motor mounted on at least one central axial shaft, the at least one shaft being mounted in vibration damping manner to the inner support.

[0012] In this way, more vibration absorbing material can be provided between the point of attachment to the motor (the shaft) and the point of attachment to the rest of the fan (the inner support). With more material, more vibrations can be absorbed and the overall noise produced by the fan can be reduced. It is also much easier and more cost effective to produce and assemble a fan in this manner. The outer support (which may be in the form of an outer housing) and inner support (which may be in the form of an inner housing) can be moulded as a single piece and vibration absorbing means can be formed as a separate piece or pieces, thereby negating the need for costly complex moulding processes.

[0013] Preferably the diameter of the shaft or shafts is less than half the diameter of the inner support. The diameter of the shaft or shafts is preferably less than 10 mm and is most preferably about 6 mm.

[0014] By having a small shaft diameter, and particularly one which is small in comparison with the inner support, more vibration absorbing material is available for absorbing the vibrations generated by the motor.

[0015] The motor may be mounted in cantilever fashion on a single central axial shaft. Alternatively, the motor may be supported on two central axial shafts extending from opposite axial ends of the motor.

[0016] It is possible to mount either an inner rotor motor or an outer rotor motor. For an inner rotor motor, a central, axial shaft and a corresponding vibration absorbing member are preferably provided on each side of the mo-

tor and the output drive axle of the motor extends through one of the shafts. The assembly may be mounted in the inner support, e.g. inner housing and an impeller fitted to the motor axle.

[0017] For an outer rotor motor, it would be possible to provide a central axial shaft and corresponding vibration damping members on each side of the motor, but because the impeller is formed integrally with the rotor, a separate inner support would be required with its own radial members for each vibration damping member in order to maintain an airflow passage through the fan. Also commercially available outer rotor motors only have a mount point on one side, so a special motor would need to be constructed for this arrangement. With the arrangement of this invention, it is possible to provide an outer rotor motor with a single central axial shaft on the end opposite the rotor/impeller. The motor may then be supported in cantilever fashion on the single central axial shaft.

[0018] Any of these alternative structures (inner or outer rotor motor, single or double central axial shafts) can be chosen depending on the structural arrangement of the rest of the unit and on the choice of fan motor.

[0019] Preferably the motor is mounted to the inner support by means of at least one vibration absorbing member, for example a vibration aborbing disc. More preferably the motor is mounted to the inner support by means of two vibration absorbing members. If one central axial shaft extends from the motor, both vibration absorbing members will be on the same side and preferably axially spaced from one another so as to support the motor in cantilever fashion. If there are two axial shafts extending from the motor in opposite directions, a respective vibration absorbing member will be provided on each shaft, thereby supporting the motor between them.

[0020] During operation of the fan, water vapour may enter the fan and condense on its surfaces. It is desirable to avoid such water condensate contacting the motor or entering its immediate environment. Preferably therefore a first means for guiding water axially away from the motor is provided between the motor and the impeller. A second means for guiding water axially away from the motor may be provided rearwardly of the motor.

[0021] The first and second guide means may for example have a radially outer surface which slopes radially inwardly and a radially inner surface which slopes radially outwardly in an axially outward direction so that when the fan is arranged horizontally, water is carried axially away from the motor. In other words the guide means is in the form of an axially projecting rim which tapers away from the motor.

[0022] The first guiding means may be provided on an annular cap which fits into the inner housing at the end nearest the impeller. The hole through the centre of the cap still permits air flow past the motor from behind.

[0023] The second guiding means may be formed on a radially inward extension of the inner housing. When the fan is mounted vertically, the guiding means prevents water from pooling on the rear vibration absorbing member and thereby prevents ingress of water towards the motor.Preferably the vibration absorbing members are formed from elastomeric material. Preferably rubber or foam is used.

[0024] Electrical wiring which supplies power to the motor or supplies control signals to the motor needs to pass from an external power supply to the motor itself. It is most convenient for the purposes of assembly if this wiring can pass through the vibration absorbing member or members. Therefore in the preferred embodiments, at least one of the vibration absorbing members comprises a hole through which electrical wiring may be passed. For example the vibration absorbing member may be in the form of a disc with a hole extending parallel to the motor axis.

[0025] The motor needs an air flow past it in use in order to cool it. In the case of a motor supported between two vibration absorbing members, the vibration absorbing members preferably have a hole or more preferably a plurality of holes through which air can flow. In a particularly preferred embodiment, the hole or holes are suitable for electrical wiring to be passed through.

[0026] In order to suck air through the holes, the impeller may be provided with internal fins which act as a centrifugal fan, driving air out into the main backwards air flow between the inner and outer supports, thereby causing air to be drawn forward past the motor through the holes in the vibration absorbing members.

[0027] Preferably the at least one central axial shaft extends from at least one plate attached to the motor. This allows any suitable and commercially available motor to be adapted for use with the vibration damping system of the invention. Preferably the plate is provided with a hole or more preferably a plurality of holes through which air can be drawn or electrical wiring may be passed. These holes may be aligned with the corresponding holes in the vibration absorbing members.

[0028] In the preferred embodiments, the inner and outer supports are substantially cylindrical housings. Preferably the at least one radial member extends obliquely radially between the inner and outer supports.

[0029] In a preferred embodiment, the fan further comprises a spacing member formed on the outer surface of the outer support for radially offsetting the fan in use within the duct. Offsetting the fan within the duct maximises the space on one side of the duct and can provide enough space that cables can be channelled along the outside of the outer housing, between the housing and the duct. This has the advantage that the cables do not get in the way of the impeller of the fan and do not use up valuable air space within the fan. The spacing member prevents the cable from snagging or scraping on the inside of the duct

[0030] Preferably the fan further comprises a square or rectangular grill mounted to a mounting plate so as to be rotatably adjuastable relative thereto. Preferably, the mounting plate is circular or part-circular and the grill is

provided with a circular or part-circular mounting structure for rotatably mounting the grill to the mounting plate. Square grills are often desired because they look better with the tiles often found in kitchens and bathrooms. However, it is easy to mount the fan slightly squint and the grill would then be out of alignment with the tiles. The above arrangement permits easy rotation of the grill with respect to the fan after the fan has been fixed in place. Once the grill has been properly aligned, it may be desired to prevent it from coming out of alignment again. Therefore, preferably the fan further comprises a releasable fixing means for preventing relative rotation of the grill with respect to the mounting plate.

[0031] Although the grill can be made more attractive by making it square and aligning it properly with the tiles, it still looks like a fan and detracts from the appearance of the room. Therefore in a preferred embodiment, the fan further comprises a decorative panel for mounting on the grill. The decorative panel can be designed to complement the decor of the room.

[0032] The grill may be provided with at least one pocket and the decorative panel may be provided with at least one hook for hooking into the at least one pocket. This provides a quick and easy way to mount the decorative panel to the grill. The pocket is unobtrusive and so the fan can be used without the decorative panel if desired.

[0033] Preferably the decorative panel is further provided with at least one stay for supporting the panel against the grill or a wall when the grill is mounted vertically. In the preferred embodiments, the at least one hook spaces the panel axially from the grill to allow air to flow laterally into the axial space between the panel and the grill.

[0034] With a sufficient axial spacing, an adequate air flow can be maintained even if the decorative panel itself has no apertures for air flow. The hooks and stays can be arranged to keep the panel parallel with the grill and at any desired spacing depending on the amount of air which must be ventilated through the fan According to a second aspect, the invention provides a fan for mounting in a duct, comprising: an outer support which in use fits in the duct; an inner support separated from the outer support by at least one radial member such that an airflow passage is formed between the inner and outer supports; and a motor which is supported by the inner support in cantilever fashion and via at least two vibration absorbing members which are spaced from each other in the axial direction of the motor.

[0035] The various preferred features described above in relation to the first aspect of the invention are also applicable to the second aspect of the invention.

[0036] Certain preferred embodiments of the invention will now be described by way of example only and with reference to the accompanying drawings in which:

Fig. 1 shows a first embodiment of the invention with an inner rotor motor mounted on two central axially extending shafts;

Fig. 2 shows a second embodiment of the invention with an outer rotor motor mounted on a single central axially extending shaft;

Fig. 3 shows a fan according to the second embodiment of the invention mounted in a duct in a wall;

Figs. 4 and 5 show cross-sections of a perspective view and a side view of a third embodiment which is similar to the first embodiment;

Figs. 6 and 7 show cross-sections of a perspective view and a side view of a fourth embodiment which is similar to the second embodiment;

Fig. 8 shows a rotatable mount structure for a grill; and

Fig. 9 shows a decorative panel for mounting on a grill.

[0037] Figs. 1 and 2 show alternative embodiments of the invention. The main structure of the unit is the same for both fans and comprises an outer housing 2 which in use is fitted inside a duct, and an inner housing 4 which is separated from the outer housing 2 by radial fin members 3. The radial fins 3 are provided to separate the inner housing 4 from the outer housing 2 and to align the inner and outer housings coaxially. Typically the fins 3 are distributed evenly around the inner housing 4. There may for example be three fins 3 spaced at 120° intervals or four fins spaced at 90° intervals. An air passage is formed between the inner housing 4 and the outer housing 2 through which air is forced when the fan is operated. The fins 3 also act as air straighteners.

[0038] A first embodiment of the invention is shown in Fig. 1. In this embodiment, the motor 5 is an inner rotor motor and has an axle 6 protruding from one side. An impeller 7 is mounted on the axle 6. The blades 8 of the impeller 7 force air through the air passage which is formed between the inner housing 4 and the outer housing 2 when the fan is operated.

[0039] Attached to either side of the motor 5 are plates 11. The plates 11 are attached to mount points which are provided on the motor. On each of the front/rear plates 11, 11 a central axially extending shaft 9a, 9b is formed. The rear shaft 9a may be solid, but the front shaft 9b is formed with a central axial bore through which the axle of the motor 5 extends. The shafts 9a, 9b are about 6 mm in diameter.

[0040] A vibration absorbing disc 10 is centrally mounted on each central axial shaft 9a, 9b. The vibration absorbing discs 10 have a diameter corresponding to the inner diameter of the inner housing 4. The whole motor assembly (vibration absorbing discs 10, plates 11 with central axial shafts 9a, 9b, motor 5 and impeller 7) is fitted inside the inner housing 4 so that the motor 5 is supported by the vibration absorbing discs 10 in the inner housing 4.

[0041] When the fan is operated, the motor generates vibrations which are largely absorbed by the vibration absorbing discs 10 and therefore less vibration is transmitted to the main fan unit (inner housing 4, radial fans 3 and outer housing 2). The noise of the fan is thus greatly

reduced.

[0042] A second embodiment of the invention is shown in Fig. 2. In this embodiment, the motor 5 is an outer rotor motor. The outer rotor of the motor 5 forms the body of the impeller 7 and has blades 8 formed on it. The motor 5 is axially spaced from the inner housing 4 so that the blades 8 of the impeller 7 extend out to the outer housing 2 and therefore when the fan is operated, the blades 8 force air through the air passage which is formed between the inner housing 4 and the outer housing 2.

[0043] In order to mount the outer rotor motor 5 in the inner housing 4, a central axially extending shaft 9 (again about 6 mm in diameter) is attached to the body of the motor 5. Two vibration absorbing discs 10 are centrally mounted on the shaft 9 and are axially spaced from each other. The vibration absorbing discs 10 have a diameter corresponding to the inner diameter of the inner housing 4. The whole motor assembly (motor 5, shaft 9 and vibration absorbing discs 10) is then fitted inside the inner housing 4 so that the motor 5 is supported in the inner housing 4 in cantilever fashion by the vibration absorbing discs 10. Spacing the vibration absorbing discs 10 as much as possible within the inner housing 4 gives better support to the motor 5 and better vibration absorbing capability.

[0044] When the motor 5 is operated so that the impeller blades 8 drive air through the air passageway, the motor 5 generates vibrations which are largely absorbed by the vibration absorbing discs 10 and are therefore not transmitted to the main fan unit (inner housing 4, radial fins 3 and outer housing 2). The noise of the fan is thus greatly reduced.

[0045] Fig. 3 shows the second embodiment of the invention in greater detail and with the unit mounted in a duct in a wall.

[0046] The structure of the unit is the same as previously described with the inner housing 4, separated from the outer housing 2 by radial fins 3. The radial fins 3 may also act as air straighteners. The motor 5 is an outer rotor motor with an impeller 7 forming the outer rotor and blades 8 formed on the impeller/outer rotor. The motor 5 is mounted on central axial rod 9 and the rod 9 is mounted in vibration damping discs 10 which are in turn mounted in the inner housing 4. The motor 5 is thus mounted in vibration damping manner in the inner housing 4.

[0047] The unit is mounted within a duct 12 in a wall. The outer housing 2 is sized so as to fit inside the duct 12. However, in order to accommodate a slight size difference and to allow for easy insertion, the duct 12 is formed slightly larger than the outer housing 2 and foam rings 13 are provided around the outside of the outer housing 2 to secure the unit in place.

[0048] If the unit is to be wall mounted as shown in Fig. 3, a removable plate 22 is fitted to the front of the outer housing 2. The plate 22 provides attachment points for securing the fan unit to the wall. In Fig. 3 the fan is secured to the wall by screws, but any suitable attaching means may be used.

[0049] A grill 14 is also provided on the front of the unit to protect the fan and provide an aesthetic front.

[0050] The unit is provided with logic controls 15 and a variable timing capacitor 16. The logic control 15 can be used to control aspects of the fan operation such as whether the fan is switched on and off by a switch or by a humidity sensor or a combination of these and whether the unit should remain operational for a certain time after the switch is switched off or the humidity sensor drops below a certain level. The variable timing capacitor 16 is used to determine how long the unit remains on.

[0051] The logic control 15 and the variable timing capacitor 16 are connected to control boards 17 via control cable 18.

[0052] The unit is powered from an external power supply such as a connection to the mains ring in a building. This external power supply is connected to a wiring connector 20 and power is transferred from the wiring connector 20 to the control boards 17 and/or the fan motor 5 via a mains cable 19.

[0053] The logic control 15, the variable timing capacitor 16 and the wiring connector 20 may be positioned wherever is most convenient. In Fig. 3 the wiring connector 20 and the logic controls are located at the front of the unit on the removable plate 22, but behind the grill 14, and the variable timing capacitor 16 is located on the front of the grill 14 as this control needs to be more readily accessible to the user.

[0054] When the wiring connector and the controls 15, 16 are located at the front of the unit as shown, the control cable 18 and the mains cable 19 are fed to the control boards 17 at the back of the unit through a cable duct 21 so as to guard them from the impeller blades 8 and the heat generated by the motor 5.

[0055] Figs. 4 and 5 show a third embodiment of the invention. This third embodiment of the invention is of a similar arrangement to the first embodiment.

[0056] The motor 5 is an inner rotor motor and has an axle 6 protruding from one side. An impeller 7 is mounted on the axle 6. The blades 8 of the impeller 7 force air through the air passage which is formed between the inner housing 4 and the outer housing 2 when the fan is operated.

[0057] Attached to each side of the motor 5 are plates 11. The plates 11 are attached to mount points which are provided on the motor. On each of the front/rear plates 11, 11 a central axially extending shaft 9a, 9b is formed. The rear shaft 9a may be solid, but the front shaft 9b is formed with a central axial bore through which the axle 6 of the motor 5 extends. The shafts 9a, 9b are about 6 mm in diameter.

[0058] A vibration absorbing disc 10 is centrally mounted on each central axial shaft 9a, 9b. The vibration absorbing discs 10 have a diameter corresponding to the inner diameter of the inner housing 4. The whole motor assembly (vibration absorbing discs 10, plates 11 with central axial shafts 9a, 9b, motor 5 and impeller 7) is fitted inside the inner housing 4 so that the motor 5 is supported

by the vibration absorbing discs 10 in the inner housing 4. The vibration absorbing discs have holes 35 formed at intervals around the disc 10. These holes 35 allow air to be sucked through the inner housing, past the motor 5. This air circulation is created by the interior fins 34 on the inside of the impeller 7. These fins 34 act as a centrifugal fan, pushing air from the centre out towards the edge and into the main backwards airflow generated by the impeller blades 8. A forward air stream is thus created through the inner housing 4 through the holes 35 in the discs 10 so as to cool the motor 5.

[0059] In addition, an annular cap 60 fits into the end of the inner housing 4 nearest the impeller and is provided with a circular axially extending rim 30b which projects away from the motor 5. During operation of the fan in a humid environment such as a bathroom, a lot of water vapour enters the fan and condenses on the surfaces of the housing. It is necessary to stop this water from entering into the motor in order to meet certain water resistance regulations. The rim 30 helps to channel any water which drips down from the end of the inner housing 4 away from the motor 5 when the fan is arranged horizontally.

[0060] At the rear end of the fan, a rim 30a is provided on a radially inward extension of the inner housing 4. With this arrangement, the rim 30a still serves to shed water axially away from the motor when the fan is horizontally mounted (as shown in the drawings). If the fan is vertically mounted, for example in a ceiling, water is prevented from gathering on the vibration absorbing member 10 and is allowed to drain through a hole or holes 62 into the air flow passage between the inner housing 4and the outer housing 2. Water is prevented from seeping past the radially outer surface of the disc 10 into the motor area. this problem can be alleviated by extending the inner housing 4 radially inwards and forming a rim 30a on that end portion of the inner housing 4. This rim 30b prevents water from collecting on the vibration absorbing member 10 at the rear of the fan when the fan is arranged vertically (e.g. in a ceiling).

[0061] The shafts 9a, 9b are each formed with a locating lip 31a, 31 b which serves to position the vibration absorbing disc 10 correctly on the shaft 9a, 9b. The discs 10 can easily be pushed over the lips 31a, 31b during assembly, but are then retained in position by the lips 31 a, 31b when the fan assembly is inserted into the inner housing 4. The plates 11 extend radially outwardly from the shaft 9a, 9b. The diameter of the plates 11 is slightly smaller than the inner diameter of the inner housing 4. The clearance is typically 1 mm on each side. In the event that the rubber vibration absorbing discs 10 fail, the plates 11 will support the motor 5 and impeller 7 within the housing so that the fast spinning impeller 7 does not contact the outer housing 2 and damage itself or other components of the fan assembly. The plates 11 have holes formed in them which are aligned with the holes 35 in the vibration absorbing discs 10 so as to maintain the passageway for air to flow through the inner housing 4.

[0062] Each plate 11 has an axially projecting flange 11a which makes light contact with the radially outer parts of the respective discs 10. The flanges serve to support the discs 10 during assembly of the fan. During assembly, the motor 5, plates 11 and discs 10 together form a cartridge 61 which is inserted into the inner housing 4 from the front end of the fan, with the impeller being inserted later. The rear plate 11 prevents the rear disc 10 from being bent too far towards the front during the insertion. The front plate 11 prevents the front disc 10 from being bent rearwardly when pushed during insertion.

[0063] Cap 60 is secured to the front of inner housing 4 to hold the cartridge 61 in place.

[0064] When the fan is operated, the motor generates vibrations which are largely absorbed by the vibration absorbing discs 10 and therefore less vibration is transmitted to the main fan unit (inner housing 4, radial fins 3 and outer housing 2). The noise of the fan is thus greatly reduced.

[0065] Figs. 6 and 7 show a fourth embodiment of the invention. This fourth embodiment of the invention is of a similar arrangement to the second embodiment.

[0066] The motor 5 is an outer rotor motor. The outer rotor of the motor 5 forms the body of the impeller 7 and has blades 8 formed on it. The motor 5 is axially spaced from the inner housing 4 so that the blades 8 of the impeller 7 extend out to the outer housing 2 and therefore when the fan is operated, the blades 8 force air through the air passage which is formed between the inner housing 4 and the outer housing 2.

[0067] In order to mount the outer rotor motor 5 in the inner housing 4, the outer rotor is mounted inside a hollow central axially extending shaft 9 (again about 6 mm in diameter). The rotor is mounted inside the shaft 9 on two sets of bearings 40.

[0068] Two vibration absorbing discs 10 are centrally mounted on the shaft 9 and are axially spaced from each other. As in the third embodiment, the discs 10 are located in the shaft 9 by means of small locating lips 31 formed on the shaft 9. Locating lips 31 are provided for each side of each vibration absorbing disc 10. The vibration absorbing discs 10 have a diameter corresponding to the inner diameter of the inner housing 4. The whole motor assembly (motor 5, shaft 9 and vibration absorbing discs 10) is then fitted inside the inner housing 4 so that the motor 5 is supported in the inner housing 4 in cantilever fashion by the vibration absorbing discs 10. Spacing the vibration absorbing discs 10 as much as possible within the inner housing 4 gives better support to the motor 5 and better vibration absorbing capability.

[0069] In order to keep the vibration absorbing discs 10 properly aligned during insertion of the fan assembly, a cylindrical spacing member 41 is provided around the shaft 9 and between the discs 10 so that it is in contact with the outer portion of the discs 10 and with the inner housing 4. The spacing member 41 has a width equal to the desired spacing of the two vibration absorbing discs so that it is lightly in contact with them when the assembly

is inserted into the inner housing. The spacing member 41 can be formed from a cylinder which is smaller in diameter than the inner diameter of the inner housing 4, but with axial ribs which extend out to the inner housing 4 so as to minimise friction between the spacing member 41 and the inner housing 4 during insertion. It is important that there is a good fit between the spacing member 41 and the inner housing 4 so that it doesn't rattle in use. An alternative arrangement is to form an axial gap in the spacing member 41 so that in cross-section it is an incomplete circle. During insertion, the gap can be squeezed shut and the spacing member 41 can be easily inserted. When the spacing member is released, it springs outwards to engage firmly with the inner housing 4.

[0070] To further hold the front vibration absorbing discs 10 in place, an end cap 42 is provided at the front end of the fan near the impeller 7. The end cap 42 has a protruding circular locating portion 44 which fits into the inner housing 4 in contact with the inner surface thereof and abuts against the vibration absorbing disc 10 so as to keep it in position. The end cap is prevented from further insertion into the inner housing 4 by shoulder 45 which abuts on the inner housing 4.

[0071] At the rear of the inner housing, a shoulder 46 is formed as part of the inner housing 4. This keeps the rear vibration absorbing disc 10 spaced away from the end wall 47 of the inner housing 4 so that it is not obstructed and can absorb the vibrations of the motor 5 better.

[0072] The shaft 9 extends out of a hole in the end wall 47 of the inner housing 4 and a circlip 48 is attached to the shaft 9. The circlip 48 has a diameter greater than that of the hole in the end wall 47 and prevents the whole motor assembly from being accidentally pulled out of the housing.

[0073] An electronics housing 43 is provided on the rear end of the inner housing 4 and contains the electronics for controlling the motor 5. In this embodiment, the motor 5 is an electrically commutated (EC) motor and therefore can be accurately varied in speed according to various logic controls. In order to protect the electronics from water which may be present in the fan, the housing 43 is potted with resin after the circuits have been inserted.

[0074] In order to keep the whole assembly tightly fitted together, a bolt 50 is passed through the electronics housing 43, the end wall 47 of the inner housing 4, the vibration absorbing discs 10 and the front cap 42. A captive nut 49 is mounted in the front cap 42 to receive the bolt 50. As the bolt 50 is screwed into the captive nut 49, the cap 42 and the electronics housing 43 are held tightly onto the ends of the inner housing. Two bolts 50 are shown in Figs. 6 and 7 although it will be appreciated that only one is necessary. The bolts could also equally well be inserted the other way around with the captive nut mounted in the electronics housing 43. A tube is formed in the electronics housing 43 for accommodating the bolt so that there is a passage through the resin which fills the rest of the housing 43.

[0075] As the bolt 50 is inserted through the assembly, it passes through one of the holes 35 formed in the vibration absorbing discs. Therefore alignment of these holes is important when they are mounted in the inner housing 4. In order to facilitate this alignment, the front cap 42, the vibration absorbing discs 10 and the electronics housing 43 are each formed with a slot which mates with a rib 51 running the length of the inner surface of the inner housing 4. This ensures that all the holes line up correctly to receive the bolt 50.

[0076] When the motor 5 is operated so that the impeller blades 8 drive air through the air passageway, the motor 5 generates vibrations which are largely absorbed by the vibration absorbing discs 10 and are therefore not transmitted to the main fan unit (inner housing 4, radial fins 3 and outer housing 2). The noise of the fan is thus greatly reduced.

[0077] In both of the third and fourth embodiments, the outer housing 2 is offset relative to the duct 12 (not shown). By offsetting the housing 2, the space between the housing 2 and the duct 12 is maximised on one side of the housing 2. This offset can create enough space to run the power cables and control wires from the front of the fan to the back along the outside of the housing 2. Because the fan is designed to be quiet, the impeller 7 must be located at the front of the fan to act as further sound proofing and therefore the power connection must be fed to the back of the fan, Feeding the cables along the outside of the housing is beneficial as they do not then interfere with the impeller or with the airflow within the housing. They can also be channelled easily into the electronics housing 43 or the circuit board 32 through a protective conduit 33 which extends from the PCB housing or the electronics housing 43 out to a hole 53 formed in the outer housing 2.

[0078] The cables/wires are passed from the front of the fan to the back along a channel 52 formed in the space created by offsetting the fan housing 2 within the duct 12. The hole 53 is formed at the end of the channel 52. The channel 52 may be formed by axially extending ribs on the outer surface of the outer housing. The unit is securely held in the offset position by means of a number of circumferential ribs which have an outer diameter which fits snugly in the duct. These ribs are raised from the outer surface of the outer housing more on one side than on the other so as to offset the fan unit within the duct.

[0079] Figure 8 shows a square grill 101 for mounting onto a circular mounting plate 102. The circular mounting plate may be removably attached to an in-duct type fan unit 103.

[0080] The grill 101 has a circular mounting structure 104 which is sized so as to fit over the circular mounting plate 102. The circular mounting structure is fitted with a hook 105 at the top which is designed to fit over the rim 106 of the circular mounting plate 102. The rim 106 ex-

tends around the whole periphery of the circular mounting plate 102, so the orientation of the fan does not affect the ability of the hook 105 to hook at the top. The circular mounting structure 104 of the grill 101 is also provided with clips 107 towards the bottom of the grill. These clips are also designed to hook over the rim 106 of the circular mounting plate 102. The clips 107 are flexible so that they are deformed out of the way as the mounting structure 104 is squeezed over the mounting plate 102. The clips spring back in behind the rim 106 and hold the grill 101 onto the mounting plate 102. However, once mounted, the grill 101 can still be rotated relative to the mounting plate 102. Therefore the grill can still be re-aligned after the fan has been fixed into a wall or ceiling without having to re-align the fan unit itself.

[0081] Once the orientation of the grill 101 has been perfected, the grill may be fixed relative to the circular mounting plate 102 so as to prevent it from becoming easily mis-aligned again. These is done be means of two screws (not shown) which are inserted into openings 111 in the underside of the grill 101. These openings are small and unobtrusive so they do not detract from the appearance of the grill. A captive nut (not shown) is mounted in the opening 111 of the grill 101 and the screw is screwed through it. When the screw is tightened, the end of the screw will press against the hooks 107 preventing them from disengaging and also it will press the hooks 107 tightly against the rim 106 of the circular mounting plate 102. The friction thus generated between the hooks 107 and the rim 106 prevents further rotation of the grill 101 with respect to the mounting plate 102.

[0082] The circular mounting plate 102 is provided with first fixing holes 108 near the centre of the ring. These may be used to attach the fan to the plastic ducting which is fitted in a hole in the wall or ceiling. The mounting plate 102 is also provided with second fixing holes 109 near the outside edge of the ring. These may be used to fix the fan to the wall or ceiling. Once attached in this manner, the fan cannot easily be re-aligned.

[0083] The grill 101 is also provided with pockets 110 located towards the rear side of the fan. These pockets are unobtrusive when seen from the front, so they do not detract from the appearance of the grill on its own. However, to further improve the look of the fan unit, a decorative panel may be mounted to the pockets 110.

[0084] Figure 9 shows a decorative panel 120 according to a second embodiment of the invention.

[0085] The decorative panel 120 comprises a facia 121, a support frame 122 and a removable centre panel 123. The facia 121 provides a decorative front end to the fan, concealing the fan unit from view. The facia 121 is attached to the support frame 122 by adhesive.

[0086] The support frame 122 is designed to attach to the front end of a fan, e.g. the grill. In Fig. 3, the panel 120 is shown being mounted to a specific mounting structure provided on the fan unit. The support frame has two hooks 124 provided at the top. These hooks fit into pockets 125 on the grill or mounting structure 126. The hooks 124 have a length which spaces the panel 120 from the grill or mounting structure 126 so that a gap is provided around the panel 120 allowing air to flow into the fan.

[0087] A stay 127 is provided on the bottom of the support frame 122. The stay 127 also serves to space the panel 120 from the wall or from the grill or mounting structure 126 to create a space for air to flow into the fan. The stay 127 and the hooks 124 provide the same amount of spacing between the panel 120 and the mounting structure 126 at the top and the bottom.

[0088] A locating portion 128 is provided on the mounting structure 126. This locating portion 128 engages with the stay 127 when the panel 120 is mounted, thereby ensuring a good alignment of the panel 120 with the mounting structure 126. Once fitted, the panel 120 may be fixed in place by means of a screw passed through the bottom of the stay 127 and into the locating portion 128. The panel can easily be removed by removing the screw.

[0089] The removable centre panel 123 provides additional variation in the design of the panel 120. The centre panel 123 is not permanently attached to the support frame 122 and so it can quickly and easily be replaced with an alternative centre panel 123.

[0090] The support frame 122 is provided with an elongate pocket 130 at the top of a central portion thereof. On the opposite side of the central portion of the support frame 122, a retaining clip 131 is provided. In use, one edge of the centre panel 123 is fitted into the elongate pocket 130, and then the opposite edge of the centre panel 123 is clipped in by the retaining clip 131. The centre panel 123 can easily be removed simply by releasing the clip 131 and pushing the centre panel 123 out.

[0091] The facia 121 is slightly curved, being closer to the mounting structure 126 at the sides than it is at the top and bottom. Wall mounted fans are usually seen from the side as they tend to be positioned around head height. By curving the decorative panel 120 inwards, the grill or mounting structure 126 is concealed from a greater range of viewing angles. However, the panel 120 must still allow sufficient air to flow into the fan so that the room is adequately ventilated. The top and bottom of the fan are separated from the mounting structure 126 by a greater amount to compensate for the sides being closer.

[0092] The decorative panel 120 shown in Figure 9 may be hooked onto the pockets 110 on the grill shown in Figure 8, thus improving the aesthetic appearance of the fan unit 103.

Claims

1. A fan for mounting in a duct, comprising:

an outer support which in use fits in the duct;
an inner support separated from the outer support by at least one radial member such that an airflow passage is formed between the inner and

outer supports; and
a motor mounted on at least one central axial shaft, the at least one shaft being mounted in vibration damping manner to the inner support.

2. A fan as claimed in claim 1, wherein the diameter of the shaft or shafts is less than half the diameter of the inner support.

3. A fan as claimed in claim 1 or 2, wherein the diameter of the shaft or shafts is less than 10 mm.

4. A fan as claimed in claim 3, wherein the diameter of the shaft or shafts is about 6 mm.

5. A fan as claimed in any preceding claim, wherein the motor is mounted in cantilever fashion on a single central axial shaft.

6. A fan as claimed in any of claims 1 to 4, wherein the motor is supported on two central axial shafts extending from opposite axial ends of the motor.

7. A fan as claimed in any preceding claim, wherein the motor is mounted to the inner support by means of at least one vibration absorbing member.

8. A fan as claimed in claim 7, wherein the motor is mounted to the inner support by means of two vibration absorbing members.

9. A fan as claimed in claim 7 or 8, wherein the or each vibration absorbing member is formed from elastomeric material.

10. A fan as claimed in claim 7, 8 or 9, wherein at least one of the vibration absorbing members comprises a hole through which electrical wiring may be passed.

11. A fan as claimed in any preceding claim, wherein a first means for guiding water axially away from the motor is provided between the motor and the impeller.

12. A fan as claimed in any preceding claim, wherein a second means for guiding water axially away from the motor is provided rearwardly of the motor.

13. A fan as claimed in any preceding claim, wherein the at least one axial shaft extends from at least one plate attached to the motor housing.

14. A fan as claimed in any preceding claim, wherein the outer support is a substantially cylindrical housing.

15. A fan as claimed in any preceding claim, wherein the inner support is a substantially cylindrical housing.

16. A fan for mounting in a duct, comprising:

an outer support which in use fits in the duct;
an inner support separated from the outer support by at least one radial member such that an airflow passage is formed between the inner and outer supports;
and a motor which is supported by the inner support in cantilever fashion and via at least two vibration absorbing members which are spaced from each other in the axial direction of the motor.

17. A fan as claimed in any preceding claim, wherein the fan further comprises a spacing member formed on the outer surface of the outer support for radially offsetting the fan in use within the duct.

18. A fan as claimed in any preceding claim, further comprising a circular mounting plate provided on the front of the outer support and a square grill with a circular mounting structure for rotatably mounting the grill to the mounting plate.

19. A fan as claimed in claim 18, further comprising a releasable fixing means for preventing relative rotation of the grill with respect to the mounting plate.

20. A fan as claimed in claim 19, further comprising a decorative panel for mounting on the grill.

21. A fan as claimed in claim 20, wherein the grill is provided with at least one pocket and the decorative panel is provided with at least one hook for hooking into the at least one pocket.

22. A fan as claimed in claim 21, wherein the decorative panel is further provided with at least one stay for supporting the panel against the grill or a wall when the grill is mounted vertically.

23. A fan as claimed in claim 21 or 22, wherein the at least one hook spaces the panel axially from the grill to allow air to flow laterally into the axial space between the panel and the grill.

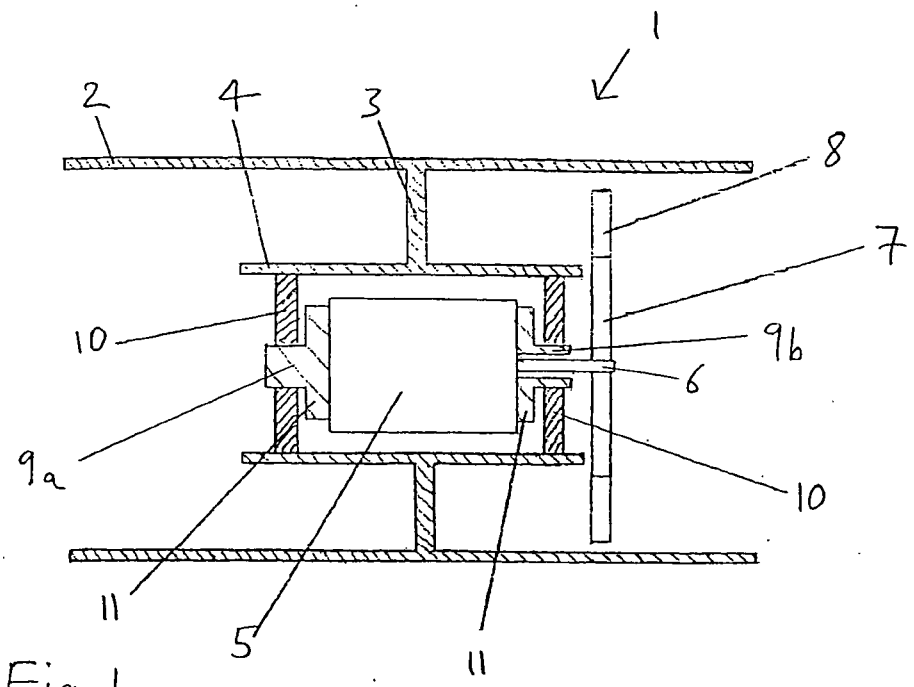

Fig. 1

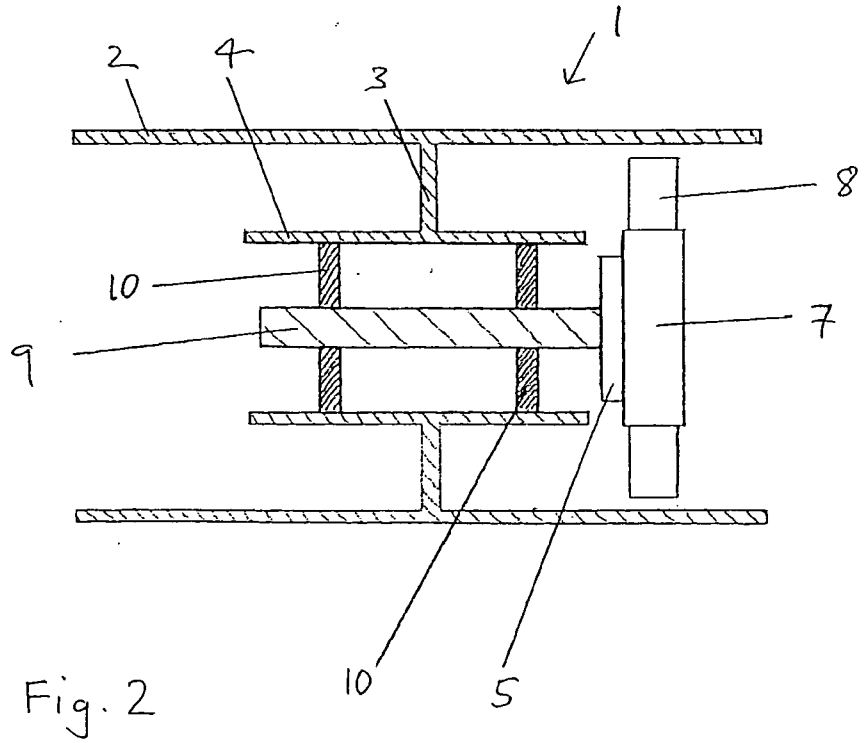

Fig. 2

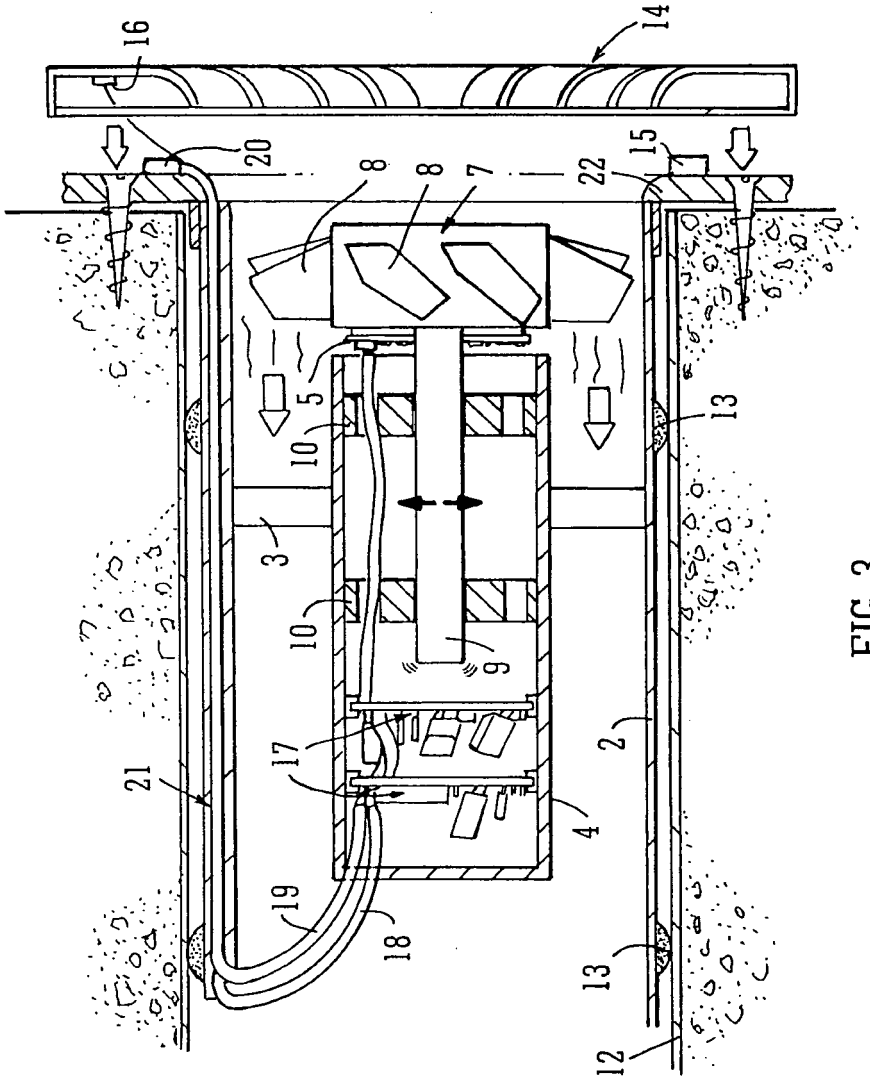

FIG. 3

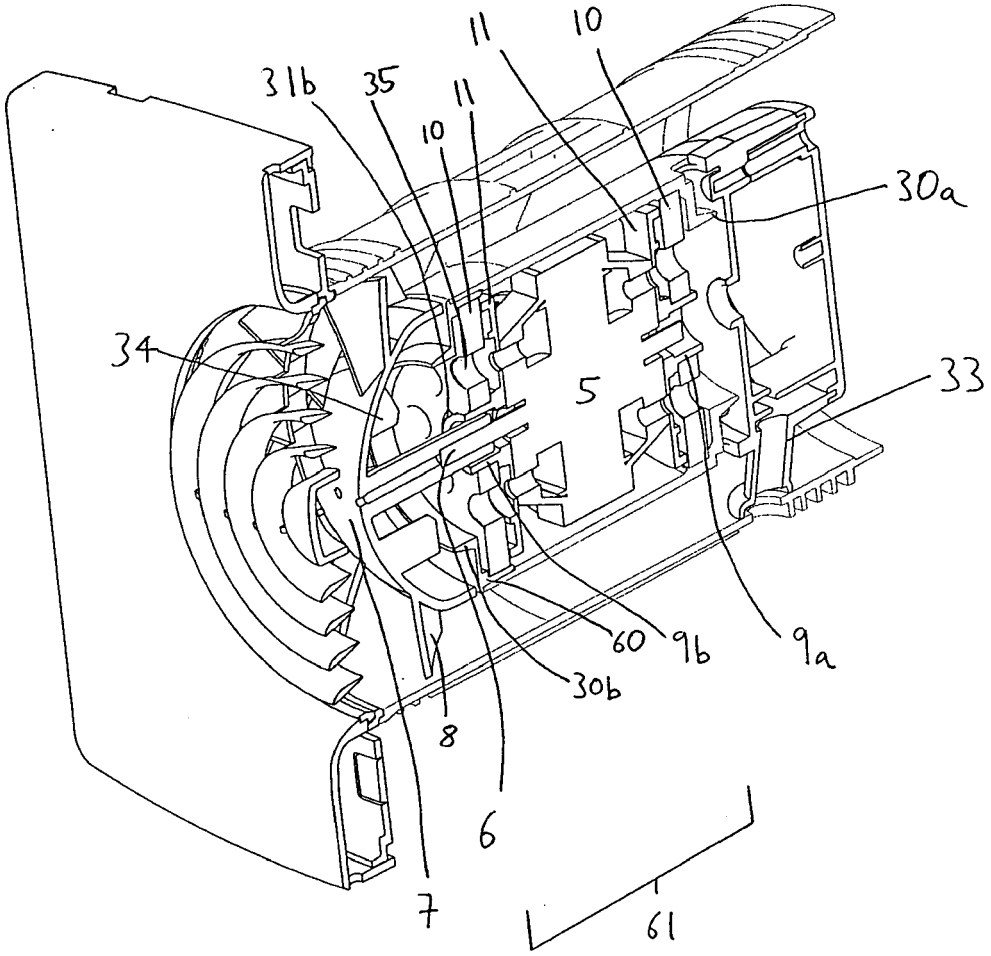

Fig. 4

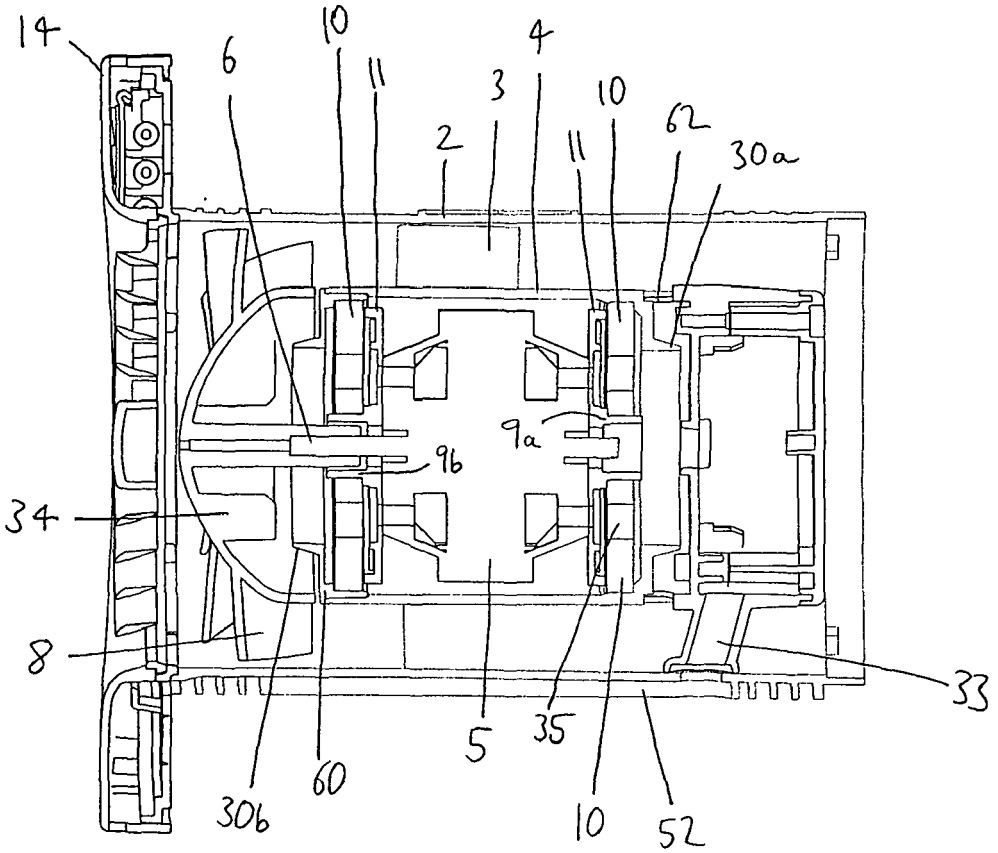

Fig 5

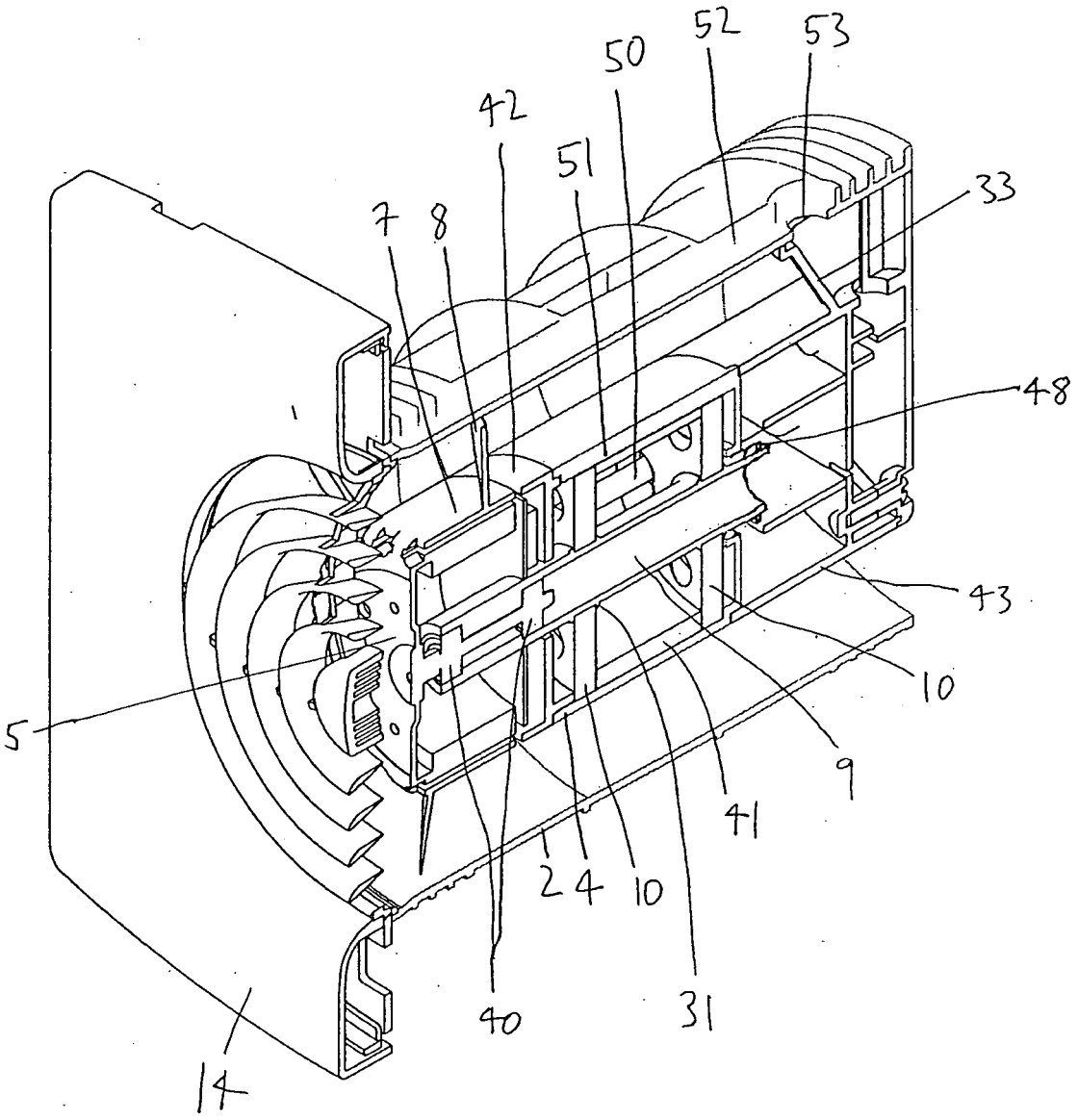

Fig. 6

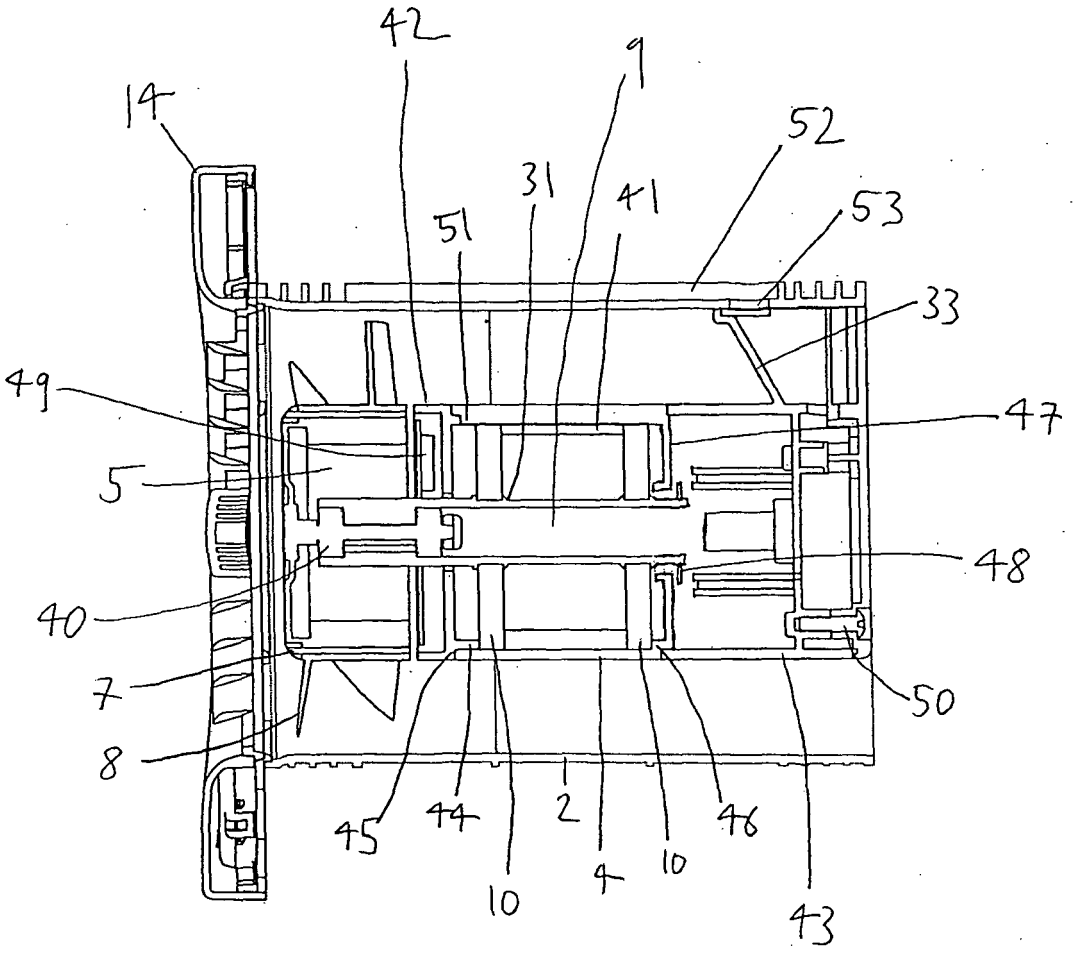

Fig. 7

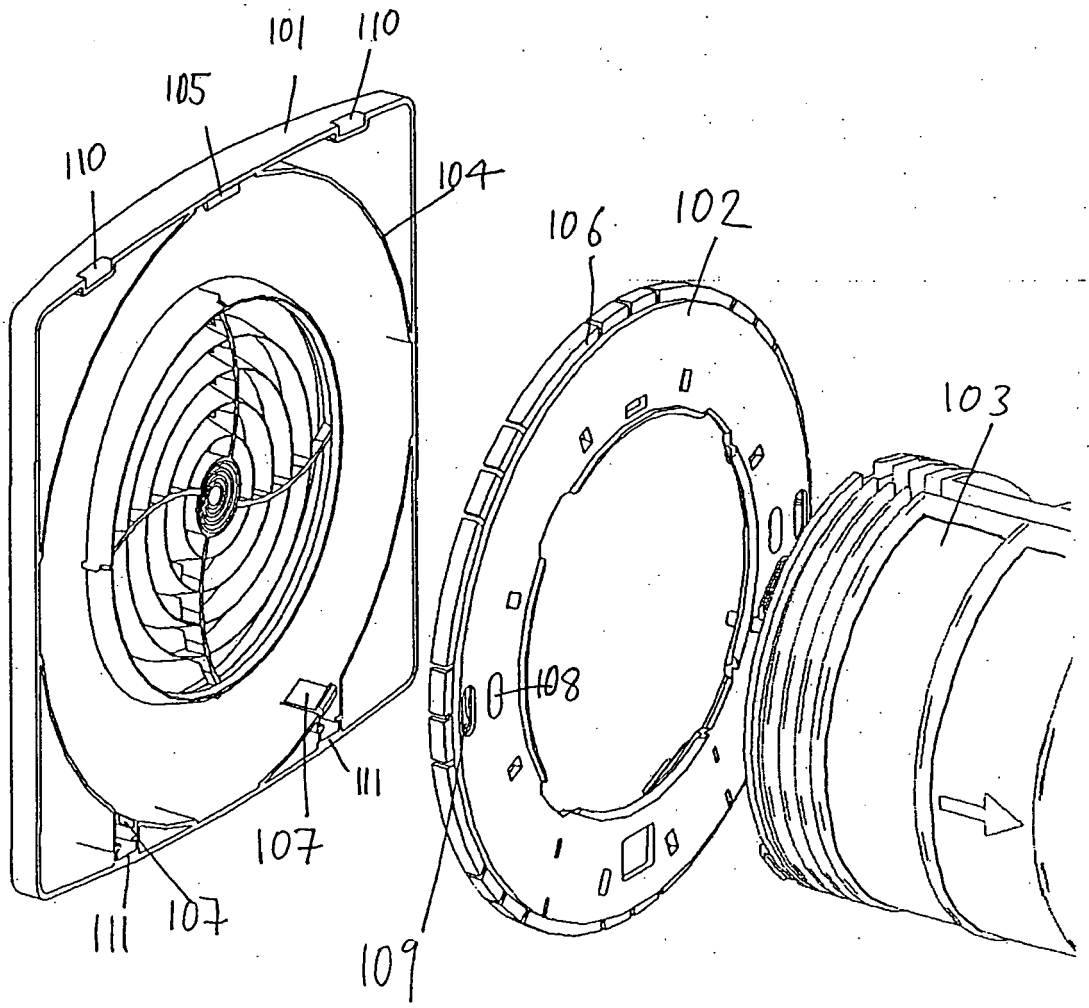

Fig. 8

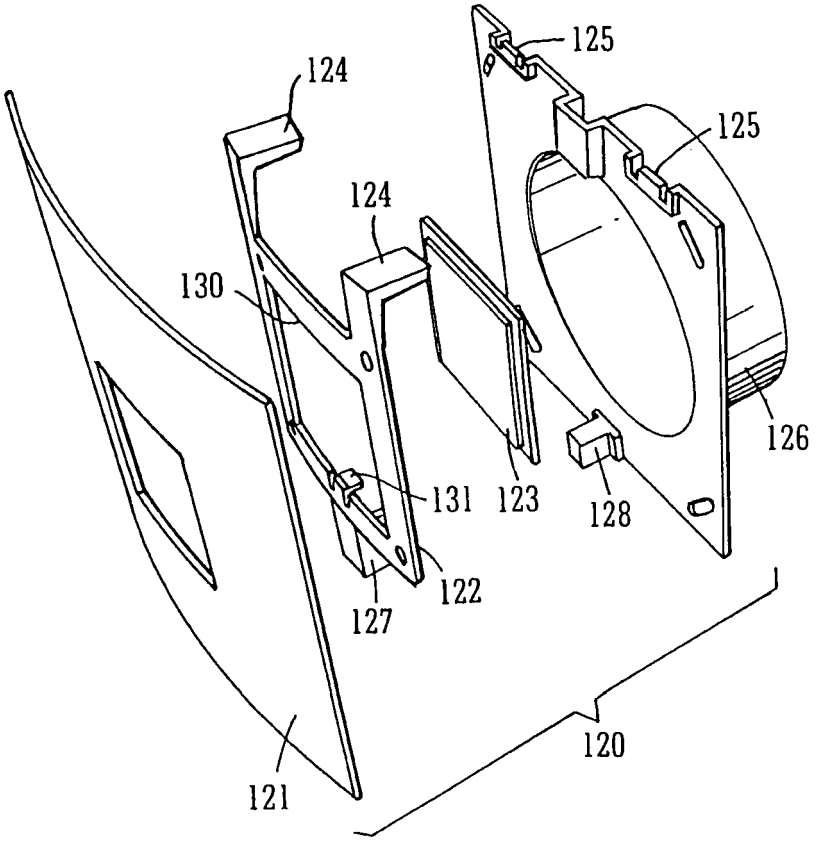

FIG. 9

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 0154252 A **[0003]**
- EP 1075075 A **[0003]**
- EP 1152154 A **[0003]**