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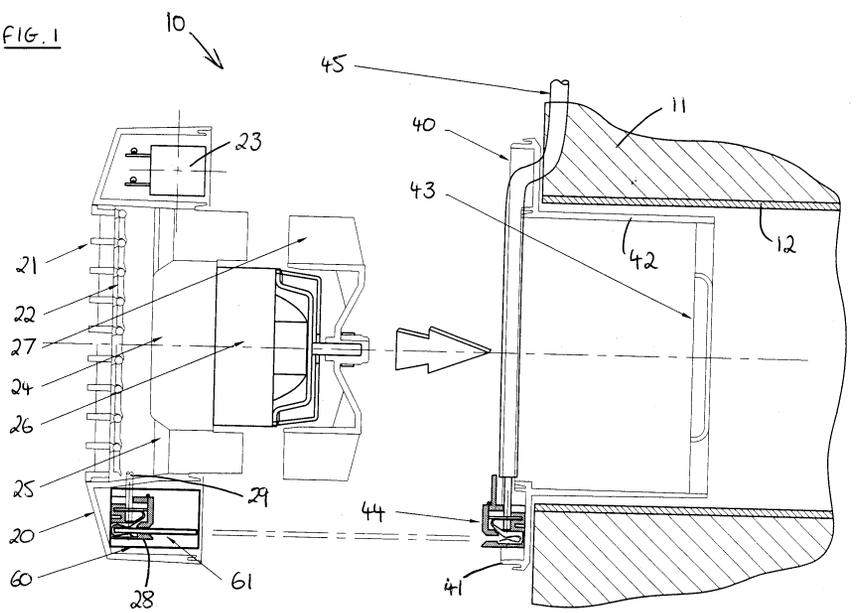
(54) Electric fan and electrical connector

(57) An electric fan (10) is disclosed, comprising a fan body (20), a back plate (40), a power supply connector (44) and a plug-in control module (60) for controlling the fan motor (26). The control module (60) is received in the fan body (20) and, in the assembled fan, is connected to the power supply connector (44) and to the fan motor (26). The fan body (20) and the control module (60) are together removable from the back plate (40) such that the control module (60) and the motor (26) become isolated from the power supply. The isolated control module (60) is then removable from the fan body (20). An electrical connector (28;44) for electrically connecting a conductor (29) to a contact on a printed circuit board (61) is also disclosed. The connector comprises an electrically-conductive clench (100) which, in use, displaces insulation around the conductor and makes electrical contact with the inner conductive core, and an electrically-conductive spring contact (110) which is resilient and which, in use, forms a resilient electrical connection between the clench and the contact of the printed circuit board.

FIG. 1



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Description

[0001] The present invention relates to an electric fan, and also to an electrical connector which may be employed in such a fan.

[0002] The type of fan to which the present invention is primarily directed is one which may be used to remove air from an interior space in a building. Such a fan is suitable for mounting on a generally planar surface such as a wall or ceiling, and may also be suitable for mounting in a window. The fan will usually be in communication with a duct which allows the withdrawn air to escape. This type of fan generally comprises a back plate having an aperture which leads to the duct, a body having an air-intake aperture which is mounted on the back plate in the assembled fan, and a fan driven by an electric motor mounted between the body and the back plate.

[0003] It is known to control electric fans simply by means of an on/off switch, which may be either in the fan itself or positioned remote from the fan. A later refinement is to include a over-run timer so that the fan remains on for a predetermined time after the switch has been operated to turn the fan off. This feature is useful in a bathroom, for example, and particularly where the fan is controlled by the same switch which also operates the lighting. The fan continues to operate for a set time after the room has been vacated and the light switched off.

[0004] In recent years, electric fans have become more sophisticated in the way they can be controlled. Additional control functions which may be provided include temperature change sensing and humidity sensing. If the main function of the fan is to prevent condensation forming on the interior surfaces of the room, it is desirable to maintain humidity below a certain level. This can be achieved by controlling the fan in response to measured humidity, or alternatively by controlling the fan in response to a measured temperature change in the room. As temperature rises, the more moisture can be retained in the air, and therefore the greater the chance of condensation forming on relatively cold surfaces such as windows and mirrors. The fan can therefore be configured to switch on when the temperature rises by more than a predetermined amount.

[0005] Another recent control function is that of passive infrared detection. This avoids the need for a standard on/off switch, as the presence of a person in the room will trigger the sensor and turn the fan on. Once the person leaves the room, the sensor will be de-activated and the fan will turn off.

[0006] It will be understood that for some applications, it is advantageous to control a fan with more than one of the above control functions in combination. For example, the passive infrared control would benefit from an additional over-run timer feature to allow the fan to work for a set time after the person has left the room, or in the case of the person remaining still for a period of time. The humidity-dependent control could be employed in combination with the passive infrared in order to control the fan either in response to humidity, or in response to the presence of a person in the room.

[0007] From the above, it can be seen that there are a large number of possible fan control permutations, each requiring a particular control circuit to be present in the assembled fan. For fan manufacturers, this means that if they are to offer the full range of control functions, they would need to produce a correspondingly large range of fan models. Due to manufacturing costs and economies of scale, this has meant in the past that a smaller range of fans has been available than that which could be produced.

[0008] However, a more recent development has been for manufacturers to employ a plug-in control module system, which houses all the necessary control circuitry. This allows the manufacturer to produce a single basic fan design, possibly simply with switched on/off capability, which can then be "upgraded" either in the factory or later by the customer, by the addition of a plug-in control module which has the desired additional control functions.

[0009] There are clear manufacturing advantages in having to produce only a single fan design. Furthermore, the use of a plug-in control module also has manufacturing advantages in terms of easier component handling. Large numbers of the basic fan design can be manufactured, and the appropriate control module can be inserted into the fan according to production requirements, or according to the particular control features required by a customer. Alternatively, the customer could purchase a basic switchable fan at the point of sale, and optionally purchase a control module to obtain the desired additional control features. The control module may be purchased at the same time as the fan, or possibly at a later stage when an upgrade is desired.

[0010] A known fan employing such a "modular" control system comprises a back plate on which a connector is mounted which is connected to the power supply. The fan motor is also mounted on the back plate, and the motor control wires are also terminated in a connector on the back plate. When the module is plugged into the connectors, the circuit is completed and the fan motor can be controlled by the functions provided in the control module. The body is mounted on the back plate, over the fan, fan motor and plugged-in control module.

[0011] However, this known system has a disadvantage in that there is the potential for electrically live components or conductors to be exposed when the body is removed from the back plate. This presents a shock hazard if cleaning or maintenance of the components and/or the motor is required, or if a new control module is required. Isolation of the fan by turning off the power supply would prevent this hazard, but this relies on the maintenance person remembering first to switch off the power supply. Furthermore, switching off the power supply may not be desirable in some situations if the operation of other electrical devices would be affected, such

as lighting for example.

[0012] Therefore, in accordance with a first aspect, the present invention provides an electric fan, comprising a front housing portion, a fan motor, a back housing portion, a connector mounted on the back housing portion which is connectable to a power supply, and a control module for controlling the fan motor, wherein the control module is received in the front housing portion and, in the assembled fan, is connected to the connector and to the fan motor, the front housing portion being openable or removable from the back housing portion such that the control module and the motor become isolated from the power supply, the isolated control module being removable from the front housing portion.

[0013] By virtue of the control module being received in the front housing portion of the fan and not mounted on the back housing portion, and being removable from the back housing portion when the front housing portion is opened or removed from the back housing portion, automatic electrical isolation of both the fan motor and the control module is achieved as soon as the front housing portion is pulled away from the back housing portion. The isolated control module may then be safely removed from the front housing portion for repair, maintenance or replacement as necessary. The isolated motor may also be serviced or replaced in a safe manner.

[0014] In a preferred embodiment, the front housing portion may be entirely removed from the back housing portion. Alternatively, the front housing portion may be opened from the back housing portion without complete separation of the parts, for example by hinging open.

[0015] Preferably, the control module is connected to the motor by means of a second connector, i.e. a motor control connector. In the assembled fan, the control module will then form a connection with both the first connector, i.e. the power supply connector, and with the motor control connector.

[0016] Preferably, the motor, and therefore the motor control connector if employed, is mounted on the front housing portion. This has the advantage that once the front housing portion is opened or removed from the back housing portion, all the principal electrical components of the fan, with the exception of the power supply connector, are separated from the power supply connector. This allows the fan components to be repaired, replaced or maintained safely.

[0017] It is envisaged that the control module may be adapted to carry out one or more of the following motor control functions: direct on/off switching, remote on/off switching, over-run timer (time-delayed switch-off), delayed switch-on, temperature-related control, humidity-related control, passive infrared control, odour-related control, air-quality control. The control module may also vary the speed of the motor, in response either to sensed conditions or to the operator's requirements.

[0018] The control module may be provided with means for allowing the operating states or settings of the module and/or fan to be altered. This may be in the form of one or more potentiometers or switches, for example, or may take on a more sophisticated form to allow remote alteration of the operating states or settings. A preferred remote control system employs infra-red signals to transmit information to the fan. Another remote control method involves the transmission of control signals through the power supply lines to the fan. If the fan is powered by an alternating current supply, these control signals would have a relatively higher frequency than that of the power supply, to allow their detection over the power supply oscillations. Remote control is be desirable in many industrial applications, such as where the fan is relatively inaccessible, but remote control may also be suited to domestic or small-scale applications as well.

[0019] Any suitable means for carrying out the desired control function may be present in the control module, including mechanical or electrical devices. The control module may, for example, contain a simple electrical switch for controlling the motor, which may be operated by a pull-cord connected thereto. Alternatively, more sophisticated control functions may be realised through the use of electrical circuits built up from electronic components.

[0020] The control module may consist simply of a printed circuit board (PCB) with components mounted thereon. Preferably in this case, however, the control module also comprises an insulating casing around the PCB to protect the components from damage and to reduce the risk of electric shock. Such a casing is advantageously adapted to receive the power supply connector, and preferably also the motor control connector, for example by having one or two openings for receiving the connector(s).

[0021] The control module is designed to be retained in the front housing portion when the front housing portion is opened or removed from the back housing portion. This may be achieved simply by sufficient frictional engagement between the module and the front housing portion, which is greater than any frictional engagement between the module and the back housing portion. This could be achieved by providing a tight fit between the module and the fan front housing portion.

[0022] Alternatively, some form of retaining means may be employed which positively fixes the module in the front housing portion. The retaining means may comprise screws, clips, locating pins, snap retainers, or the like.

[0023] In the preferred embodiment, in which the control module comprises a PCB mounted inside an insulating casing, the PCB may protrude slightly from the casing at the edges thereof, these protruding portions engaging in runners on the inside of the front housing portion when the control module is located inside the front housing portion. The runners can then provide sufficient frictional engagement to retain the control module in the front housing portion when it is removed from the back housing portion.

[0024] In one preferred embodiment, the power supply connector is provided with insulation displacement means for connection to the power supply cable. This allows a simple connection of the connector to the power supply, avoiding the need to strip insulation from around the conductive core. In an alternative embodiment, the power supply connector may have a screw terminal for connection to the power supply cable.

[0025] The motor control connector is preferably equipped with insulation displacement means for connection to the motor control wires. This is advantageous when the connection is made during manufacture of the fan as it can facilitate automation, avoiding the need to tighten screws onto stripped conductors. Moreover, the connection of two or more wires can be made simultaneously, for example by movement of a jig which operates two or more insulation displacement means at the same time.

[0026] Preferably, the control module engages the power supply connector in a push-fit manner. This allows the fan to be correctly assembled simply by fitting the front housing portion to the back housing portion in the normal manner. Any suitable engagement is envisaged, such as a plug and socket arrangement. When the control module includes a PCB, a suitable arrangement has been found to be the provision of electrical contacts on the surface of the PCB which contact with resilient contacts mounted in the power supply connector when the PCB is inserted into the connector. This type of connector is described in detail below.

[0027] The above features may also be present in the motor control connector, if fitted. When such a motor control connector is fitted, and this connector is mounted on the front housing portion, direct interconnection between the power supply connector, the PCB and the motor control connector has been found to be a particularly effective and relatively simple arrangement. Both connections are of the push-fit type, and do not require the use of screws or other tools to effect. The arrangement is mechanically simple, thus saving on production costs, and also provides a safe and reliable connection.

[0028] The front housing portion may also include one or more shutters which close the intake aperture of the front housing portion, to prevent back-draughts when the fan motor is switched off. These shutters may be of the one-way type, which allows the passage of air in the extraction direction, but not in the reverse direction. Alternatively, the shutters may be operated by an actuator. The actuator may be electrically-controlled, in which case the control is preferably effected by means of the control module. The actuator may be controlled by the same signal as the fan motor.

[0029] As mentioned above, alongside their invention of an electric fan in accordance with the first aspect of the invention, the applicants have also invented an electrical connector. Although this connector will be described with reference to its application in an electric fan, it will be appreciated that such a connector will have many different applications in the electrical field which are not concerned with electric fans, and therefore such a limitation should not be inferred.

[0030] Some form of connector will usually be necessary in an electric fan in order to connect the power supply to the electric motor. A standard connector which has been used extensively in electric fans as well as in many other electrical applications comprises a conductive hollow cylinder with two axially-spaced screws mounted through one wall thereof, the cylinder and screws being mounted in an insulating casing. The wires which are to be connected to each other are stripped of their insulation, placed in either end of the cylinder and the screws tightened to effect electrical connection. The connectors are usually supplied in strips or blocks comprising a number of such connectors with their insulating casings joined together. For this reason, such connectors are often referred to as "chocolate block" connectors. As many connectors as are required to effect the connection can be cut from the strip, for example to connect live, neutral and possibly earth to the motor.

[0031] In an electric fan, it is necessary to connect the power supply to the electric motor. The power supply will normally be a mains supply provided by means of a cable terminating at the fan, and including live, and neutral insulated conductors. An earth conductor may also be provided. The motor will therefore also have at least two insulated conductors connected to it for the live and neutral supplies. One or both of the live and neutral supplies to the motor will be switched.

[0032] In a known electric fan, the power supply conductors are connected to the motor conductors by means of the above-described chocolate block connector, via a switch. Because screw terminals are employed in the connector, it is usual for the motor and the switch to be mounted on the back housing portion of the fan rather than on the front housing portion, otherwise separation of the two parts is difficult.

[0033] Another known electric fan employs a modified version of the above "chocolate block" type. In this fan, the motor is mounted on the front housing portion of the fan. The power supply wires are screwed into chocolate block-type terminals as before, but the other side of the connector has plate contacts to allow a corresponding contact mounted on the front housing portion to connect the motor to the power supply when the unit is assembled. This therefore has the advantage that the unit can be easily dismantled, and once dismantled, the motor is automatically isolated from the power supply.

[0034] However, both the above types of connectors have the disadvantage that the cables need to be stripped of their insulation prior to insertion into the connector, and both require the presence of screws to hold the stripped conductors in place.

[0035] In the particular application of electric fans employing a control module as discussed above, the applicants' preferred arrangement is to mount the control components on a printed circuit board. One or more

electrical connectors are therefore needed to supply the power to the PCB and to take the motor supply from the PCB.

[0036] The applicants have therefore identified a need for a connector for electrically connecting an insulated conductor to a contact on a printed circuit board which has a simplified connection procedure for the conductors compared with the prior art connectors.

[0037] In accordance with a second aspect, therefore, the present invention provides an electrical connector for electrically connecting a conductor to a contact on a printed circuit board, the conductor having an inner conductive core and an outer non-conductive sheath, the connector comprising:

first electrically-conductive means which, in use, displaces the insulation around the conductor and makes electrical contact with the inner conductive core; and

second electrically-conductive means which is resilient and which, in use, forms a resilient electrical connection between the first electrically-conductive means and the contact of the printed circuit board.

[0038] In order to connect the connector to the insulated conductor, only a simple operation is required. The conductor is inserted into the connector, and the first electrically-conductive means, preferably a clench, is positioned so that it displaces the insulation around the conductor and makes electrical contact with the inner conductive core. The first electrically-conductive means may be moved by the use of a tool, such as pliers or a screwdriver, in a relatively simple operation. No stripping of the insulation around the conductor is required, and no screws are required to secure the cable.

[0039] The first electrically-conductive means preferably includes means for cutting into the insulation of the conductor. This cutting means may comprise a notch or V-shaped slit which, in use, receives the conductor. The notch or slit will be appropriately dimensioned for the type of conductor to which it is to be connected such that a sufficient electrical connection is made between the conductive core and the first electrically-conductive means, but without cutting the conductor completely.

[0040] The first electrically-conductive means may also include means for facilitating movement from its in-use position. This may comprise a slot or aperture which enables a tool such as a screwdriver to be used to prise the first electrically-conductive means from the in-use position, and possibly out of the connector. With this feature, the connector is advantageously re-useable. Wiring mistakes can therefore be corrected, or the electrical equipment to which the connector is attached may be re-used.

[0041] The first electrically-conductive means may be made from any suitable conductive material. Preferably, the first electrically-conductive means is made from nickel plated brass. The first electrically-conductive means may also be of any suitable shape, but is preferably substantially planar.

[0042] The second electrically-conductive means is preferably provided with a portion adapted to make electrical contact with the first electrically-conductive means. If the first electrically-conductive means is planar, this portion is preferably planar also. Alternatively, the second electrically-conductive means may be integral with the first electrically-conductive means.

[0043] The second electrically-conductive means also includes a portion for contact with the printed circuit board. Preferably, the resilience of the second electrically-conductive means is configured to act such that the electrical connection with the first electrically-conductive means and the circuit board is improved. Preferably, the resilience acts in a direction generally perpendicular to the plane of contact between the components.

[0044] The second electrically-conductive means may be either substantially C-shaped or substantially S-shaped. If the second electrically-conductive means is substantially S-shaped, it also preferably grips the printed circuit board. This may be achieved by means of the provision of a narrow neck portion past which the PCB is inserted.

[0045] Preferably, the second electrically-conductive means is provided with an aperture through which the conductor is inserted in use. The purpose of the aperture is to restrain movement of conductor during movement of the first electrically-conductive means to its in-use position.

[0046] The second electrically-conductive means may be made from any suitable conductive material. Preferably, the second electrically-conductive means is made from stainless spring steel.

[0047] The connector preferably further comprises an insulating housing, inside which the first and second electrically-conductive means are located. The housing is preferably formed from nylon. The housing is preferably provided with a first aperture adapted to receive the conductor in use and a second aperture adapted to receive the PCB in use. The first aperture may be substantially circular and the second aperture substantially elongate.

[0048] In order to allow access to the first and second electrically-conductive means, the housing is preferably provided with a lid which in use covers at least the first electrically-conductive means. Preferably, the lid is formed integrally with the rest of the housing and is therefore made from the same material. The lid is preferably joined to the rest of the housing by means of a hinge, e.g. an integral hinge.

[0049] The housing may be provided with a shield means adjacent the first aperture whose function is to protect the conductor. The shield means may have any suitable form to carry out the desired function. Preferably, however, the shield means comprises a substantially planar member which extends from the housing par-

allel to the direction of insertion of the conductor. The shield means is preferably formed integrally with the housing.

[0050] The housing may also be provided with one or more protrusions adjacent the second aperture. These protrusions provide a spacing from the periphery of the connector to the nearest electrically-live component inside, such as the first or second electrically-conductive means. Such a spacing can maintain the distance between the periphery and the component at a safe level such that the risk of electric shock is minimised. Preferably, in connectors connected to a 230 volt a.c. supply, this distance should not be less than 8 millimetres.

[0051] The connector may further include a cable clamp for securing the conductor adjacent the connector. This will maintain the end of the conductor in a fixed position relative to the connector, and therefore prevent any breakages of the conductive core due to flexing. The cable clamp may be formed integrally with the housing, and may be attached to the housing by means of a flexible link.

[0052] An embodiment 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 cross-sectional side elevation of a fan in accordance with the invention, in which the components are separated slightly for ease of identification of the various features;

Fig. 2 shows an elevation of the fan as viewed from the front;

Fig. 3 shows an elevation of the front housing portion, motor and fan impeller as viewed from behind, together with the plug-in module removed from the front housing portion;

Fig. 4 shows an elevation of the back housing portion as viewed from the front;

Fig. 5A shows the power supply connector in isometric view;

Figs. 5B to 5G show the power supply connector as viewed from all six sides of the body;

Fig. 6A shows the power supply connector as viewed from the side, with the clench and spring contact removed therefrom;

Fig. 6B shows the clench as viewed from above;

Figs 6C and 6D respectively show the spring contact as viewed from above and below;

Fig. 6E shows the power supply connector as viewed from the side with the clench and spring contact located inside, prior to cable connection;

Fig. 7 shows in enlarged cross-sectional elevation the front housing portion, back housing portion, control module, PCB and connectors in the assembled fan;

Fig. 8 shows the control module PCB in plan view and the configuration of the connectors in the assembled fan; and

Fig. 9 shows a cross-sectional view of an alternative embodiment of the power supply connector.

[0053] With reference to Fig. 1, a fan 10 in accordance with the invention is shown with the front housing portion separated slightly from the back housing portion. The back housing portion is shown mounted in a wall 11 which is provided with a cylindrical air duct 12.

[0054] With reference to Figs. 1 to 3, the fan 10 comprises a front housing portion in the form of a fan body 20, preferably made from a plastics material, which includes an air intake grille 21 and shutter blades 22. The shutter blades 22 are designed to prevent a back-draft through the fan and are controlled by actuator 23, which opens the blades when the motor is operating and closes them when the motor is switched off. This can most simply be achieved by connecting the actuator to the same controlled supply as that for the motor. The fan body also includes a motor hub 24 which is supported by spokes 25. Mounted on the motor hub 24 is an electric motor 26 which rotates fan impeller 27.

[0055] Mounted on the fan body 20 is a motor control connector 28 which is connected to the live L and neutral N conductors of the motor/actuator supply cable 29. Connector 28 is preferably made from a plastics material, such as nylon for example, and will be described in more detail below.

[0056] With reference to Figs. 1 and 4, fan 10 also includes a back housing portion in the form of a back plate 40 which is mounted on the wall 11 and which is also preferably made from a plastics material. The back plate comprises a generally planar front portion 41 and a generally cylindrical rear portion 42, which fits into the circular cross-section of air duct 12. The rear portion is provided with an anti-crush spider 43.

[0057] Mounted on the back plate 40 is a power supply connector 44 which is connected to the live L, neutral N and optional "switch line" SL conductors of the power supply cable 45. This cable is not part of the fan, but is routed to the fan as part of the installation. The "switch line" SL would be employed if the fan is to be controlled by a remote switch. The power supply may be an alternating current supply as shown, such as 230 volts a.c. or 12 volts a.c. (SELV). A 12 volts a.c. (SELV) supply is suitable for use in wet environments. Alternatively, the power supply may be a direct current supply, such as 12 volts d.c. Connector 44 is preferably made from a plastics material, such as nylon for example, and will be described in more detail below.

[0058] Mounted on the fan body 20 is a plug-in control module 60. This is shown in cross-section in Figs. 1 and 3, from which it can be seen that the module has a generally rectangular cross-section in all planes. The module 60 contains a control circuit comprising a printed circuit board or PCB 61 and various electronic components shown schematically as 62 (Fig.3). The control circuit may be configured to provide any of the control functions previously mentioned, or any other desirable control functions.

[0059] The module 60 is designed to be retained in the fan body 20 when the body is separated from the back plate 40. In the shown embodiment (Fig. 3), PCB 61 protrudes through slots at each end of the module 60. These protruding portions 63 of the PCB engage in racks 64 which are moulded on the interior surface of the body 20. However, any suitable means of locating and retaining the module 60 in the body 20 may be employed, such as screws, clips, locating pins, snap retainers, or the like. The locating and/or retaining means may act on the PCB as in the embodiment, or may act on the module casing. The requirement for the mounting of the module 60 in the body 20 is that the control module is retained within the body when the body is removed from the back plate. This may be achieved simply by sufficient frictional engagement between the module and the body, which is greater than the frictional engagement between the module and the back plate, or alternatively by positively fixing the module in the body.

[0060] When the module is mounted in the body, as shown in Fig. 1, contacts on the PCB 61 are automatically connected via motor control connector 28 to the live L and neutral N conductors of the motor/actuator supply cable 29. When the fan body and back plate are brought together (as shown by the dashed line in Fig. 1) and fixed to one another, control module 60 is located in the void space provided between the two components. The power supply connector 44 is positioned such that contacts provided on that side of the PCB are automatically connected to the live L, neutral N and optional "switch line" SL conductors of the power supply cable 45. The motor is then automatically connected to the power supply via the control module. The particular connection arrangement between the PCB and the two connectors will be described in more detail below.

[0061] It can be seen that there is provided automatic electrical isolation of both the fan motor and the control module as soon as the body is pulled away from the back plate. The isolated control module may then be safely removed from the body for maintenance or replacement as desired. The isolated motor may also be serviced or replaced in a safe manner.

[0062] With reference now to Figs. 5 and 6, connectors 28 and 44 will be described in detail. In the preferred embodiment, motor control connector 28 is a two-pole connector whereas power supply connector 44 is a three-pole connector. However, the relevant features are common to both connectors, and therefore only the three-pole connector will be described.

[0063] Connector 44 comprises a generally rectangular body 80. Fig. 5A shows the connector in isometric view, and Figs. 5B to 5E show in third angle projection the connector 44 as viewed in elevation from the four sides of the body. Fig. 5F shows the top view and Fig. 5G shows the underneath view.

[0064] The connector body 80 has three apertures 81 (two only are shown in Fig. 5F) for receiving the three power supply wires L, N and SL, and an elongate aperture 82 for receiving the PCB of the control module. The body is provided with three internal slots 83 (Fig. 5B), each for receiving a clench and a spring contact as will be described later. Connected to body 80 via a plurality of live hinges 84 is a lid 85 which, once the connectors are connected to the cables, is designed to fold down and cover the clenches and spring contacts, leaving the elongate aperture 82 open to receive the PCB. Lid 85 is provided with two projections 86 which frictionally engage in corresponding resilient recesses 87 on the body, holding the lid closed. The closed connector is shown in cross-section in Fig. 7.

[0065] Connector 44 is provided with an elongate shield 88 which extends from the body 80, adjacent the apertures 81. The shield 88 is designed to protect the individual conductors of the power supply cable, which are inserted into connector 44 by the installer, from any contact by fingers, tools, etc. to provide a safe connection and prevent electric shock. The effect of shield 88 can be seen clearly in Fig. 4.

[0066] In order to further improve safety and reduce the risk of electric shock, connector 44 has protrusions 89 at the edges of elongate aperture 82 which are designed to prevent fingers from being less than 8 millimetres from any live components.

[0067] Connector 44 also includes a cable clamp 90 which is attached to the body of the connector via a strip 91 of connector material. This is advantageous, as it prevents the cable clamp from becoming lost. In use, after the power supply wires have been connected to the connector, the cable clamp 90 is bent into position and screwed through holes 92 onto a corresponding boss (not shown) on the back plate, over the power supply cable, thus holding the cable in position.

[0068] Although not described, motor control connector 28 is similar to power supply connector 44 in many respects. Some of the above-described features are, however, not necessary for connector 28. For example, because the connector becomes disconnected from the supply the moment the fan body is separated from the back plate, there is no need to provide protrusions 89 around the elongate aperture. Furthermore, for the same reason, it is not necessary to have a shield such as 88. The cable clamp 90 may also be omitted if desired.

[0069] The insertion and function of the clench and spring contact will now be described below in more detail with reference to Fig. 6. Figure 6A shows a side view of connector 44, with a clench 100 and a spring contact 110 removed therefrom. Clench 100 is shown in plan view in Fig. 6B, and is made from any electrically-conductive material. Nickel-plated brass is a suitable material. Clench 100 is generally rectangular, and is provided with a slit 101 and a generally V-shaped portion 102 at the outer end of the slit, whose purpose is to cut into the insulation around the conductor and to make electrical contact with the inner conductive core. Clench 100 is also provided with an aperture 103 which is designed to

receive the blade of a small screwdriver, to allow the clench to be raised from its in-use position, out of the connector body. This feature allows the connector to be re-useable.

[0070] The top view of spring contact 110 is shown in Fig. 6C and the underneath view is shown in Fig. 6D. Spring contact 110 is made from any suitable electrically-conductive material which is also resilient. An example of such a material is stainless spring steel. Contact 110 is generally S-shaped, and has a portion 111 (Fig. 6A) which in use receives the PCB of the control module and makes electrical contact with a track or pad thereon. Portion 111 is shaped with a narrow neck portion 112 so as to provide some resilience to the connection with the PCB, and to ensure that a good electrical connection is made. Contact 110 has a flat portion 113 which is designed to mate against clench 100 in use and to provide electrical connection between the two components. This flat portion 113 is provided with an aperture 114 which is designed to receive the conductor of the power supply cable therethrough, before the clench 100 is pushed into its in-use position, cutting through the insulation and contacting the inner conductive core. The aperture 114 therefore restrains the conductor from any movement in the same direction as that of the clench whilst connection is being effected, and holds the conductor in position.

[0071] Figure 6E shows the clench 100 and spring contact 110 inserted in the connector body, ready to receive a conductor from the power supply cable. This is how the power supply connector will be presented to the customer. The customer will install the fan and during the course of the installation will connect the power supply cable to the connector 44 as described below. The connection of the motor control wires to motor control connector 28 will normally be carried out in the factory, but the connection operation will be the same in both cases.

[0072] Referring to Fig. 6E, spring contact 110 is fully inserted into the slot 83, but clench 100 partly protrudes from the slot. This positioning of the clench and spring contact allows insertion of the conductor of the power supply cable along the line of the arrow shown, into the connector body, past the tip of the clench 100, and through the aperture 114 in the spring contact 110 until the end of the conductor abuts an internal surface of the connector body.

[0073] A suitable tool, such as pliers or a screwdriver, is then employed to push clench 100 fully into its the slot 83. This action causes the V-shaped portion 102 and slit 101 of the clench to cut into the insulation around the conductor and to make electrical contact with the inner conductive core. Lid 85 is then closed shut over the clench 100, the tip of the conductor and flat portion 113 of spring contact 110, leaving neck portion 112 positioned in the elongate aperture 82, ready to receive the PCB.

[0074] The final arrangement, showing the relative positions of power supply connector 44, motor control connector 28 and PCB 61, can be seen in cross-section in Figs. 7 and 8.

[0075] Fig. 7 shows in cross-section fan body 20, back plate 40, power supply connector 44, power supply conductor 120 comprising insulating sheath 121 and conductive core 122, motor control connector 28, motor control conductor 123 comprising insulating sheath 124 and conductive core 125, clenches 100, spring contacts 110, and PCB 61.

[0076] Fig. 8 shows a schematic view of power supply connector 44, power supply conductors 120, motor control connector 28, motor control conductors 123 and PCB 61. PCB tracks 126 can be seen on the PCB 61, and are positioned to make electrical contact with the neck portions of the spring contacts of both connectors.

[0077] It can therefore be seen that removal of the body from the back plate breaks the electrical connection between power supply connector 44 and the PCB, leaving the control module and the motor disconnected and safe for maintenance purposes. The module can then be removed from the body, thus breaking the electrical connection between the motor control connector 28 and the PCB.

[0078] Fig. 9 shows an alternative form of the power supply connector 44, in a cross-sectional view similar to those seen in Figs. 1 and 7. The principal difference between this second connector embodiment and the first embodiment is that a displacement type connection to the conductors of the power supply cable 45 is not used, but rather a screw and terminal block arrangement is used. The power supply connector 45 therefore has a metal terminal block 201 formed with a conductor hole 202 for receiving a conductor 120, and formed with a threaded screw hole 203 for receiving a screw 200.

[0079] In the case of the power supply connector 44 of Fig. 9, the installer of the fan will strip the insulation from the ends of the conductor of the power supply cable 45, will insert the conductors through the conductor hole 202 in the terminal block 201, and will tighten the screw 200 so that it enters the conductor hole to force the conductor into good electrical contact with the terminal block. The terminal block is in electrical contact with the flat portion 113 of the spring contact 110, thereby providing a conductive path between the end of the conductor of the power supply cable 45 and the spring contact 110. This procedure is repeated for each conductor. With this arrangement, if the installer makes a mistake, for example by connecting a conductor to the wrong terminal block, it is a simple matter to loosen the screw and release the conductor.

Claims

1. An electric fan, comprising a front housing portion, a fan motor, a back housing portion, a connector mounted on the back housing portion which is con-

nectable to a power supply, and a control module for controlling the fan motor, wherein the control module is received in the front housing portion and, in the assembled fan, is connected to the connector and to the fan motor, the front housing portion being openable or removable from the back housing portion such that the control module and the motor become isolated from the power supply, the isolated control module being removable from the front housing portion.

2. An electric fan as claimed in claim 1, wherein the motor is mounted on the front housing portion.

3. An electric fan as claimed in claim 1 or 2, wherein the control module is connected to the motor by means of a second connector.

4. An electric fan as claimed in claim 3, wherein the motor is provided with one or more insulated conductors and the second connector is provided with insulation displacement means for connection to the or each motor conductor.

5. An electric fan as claimed in any preceding claim, wherein power is supplied to the fan via one or more insulated conductors and the first-mentioned connector is provided with insulation displacement means for connection to the or each power supply conductor.

6. An electric fan as claimed in any preceding claim, wherein the control module comprises a printed circuit board.

7. An electric fan as claimed in claim 6, wherein the control module further comprises an insulating casing around the printed circuit board.

8. An electric fan as claimed in claim 7, wherein the insulating casing has an opening for receiving the first-mentioned connector.

9. An electric fan as claimed in claim 7 or 8, wherein the printed circuit board protrudes from the casing at the edges thereof, these protruding portions frictionally engaging in runners on the front housing portion when the control module is located inside the front housing portion.

10. An electric fan as claimed in any of claims 6 to 9, wherein electrical contacts are provided on the printed circuit board which contact with resilient contacts mounted in the first connector when the printed circuit board is inserted into the connector.

11. An electrical connector for electrically connecting a conductor to a contact on a printed circuit board, the conductor having an inner conductive core and an outer non-conductive sheath, the connector comprising:

first electrically-conductive means which, in use, displaces the insulation around the conductor and makes electrical contact with the inner conductive core; and
second electrically-conductive means which is resilient and which, in use, forms a resilient electrical connection between the first electrically-conductive means and the contact of the printed circuit board.

12. An electrical connector as claimed in claim 11, wherein the first electrically-conductive means includes means for facilitating movement from its in-use position.

13. An electrical connector as claimed in claims 11 or 12, wherein the second electrically-conductive means is discrete from the first electrically-conductive means.

14. An electrical connector as claimed in any of claims 11 to 13, wherein the second electrically-conductive means grips the printed circuit board.

15. An electrical connector as claimed in any of claims 11 to 14, wherein the second electrically-conductive means is provided with an aperture through which the conductor is inserted in use.

16. An electrical connector as claimed in any of claims 11 to 15, wherein the connector further comprises an insulating housing inside which the first and second electrically-conductive means are located.

17. An electrical connector as claimed in any of claims 11 to 16, wherein the housing is provided with a first aperture adapted to receive the conductor in use and a second aperture adapted to receive the printed circuit board in use.

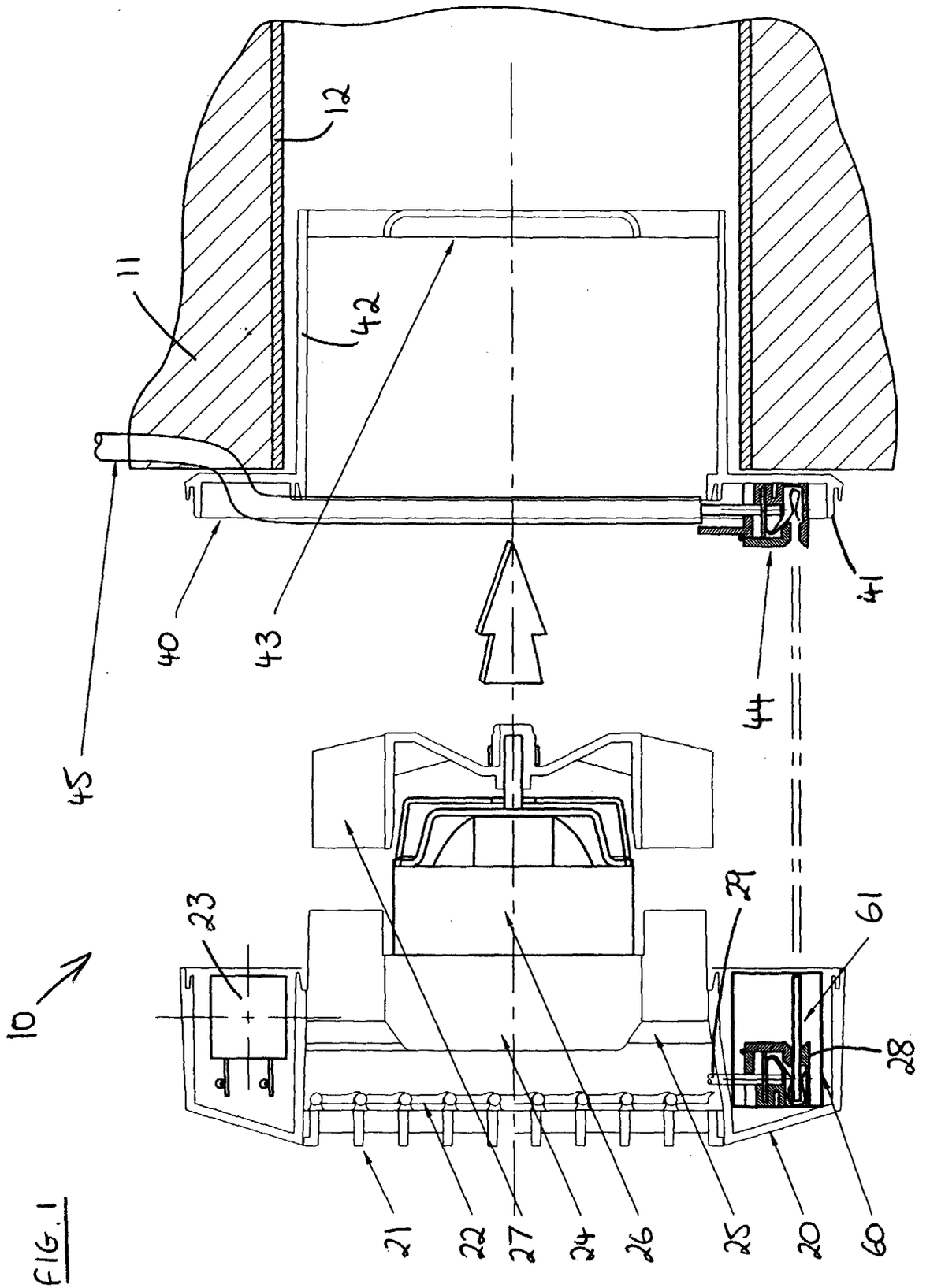

FIG. 1

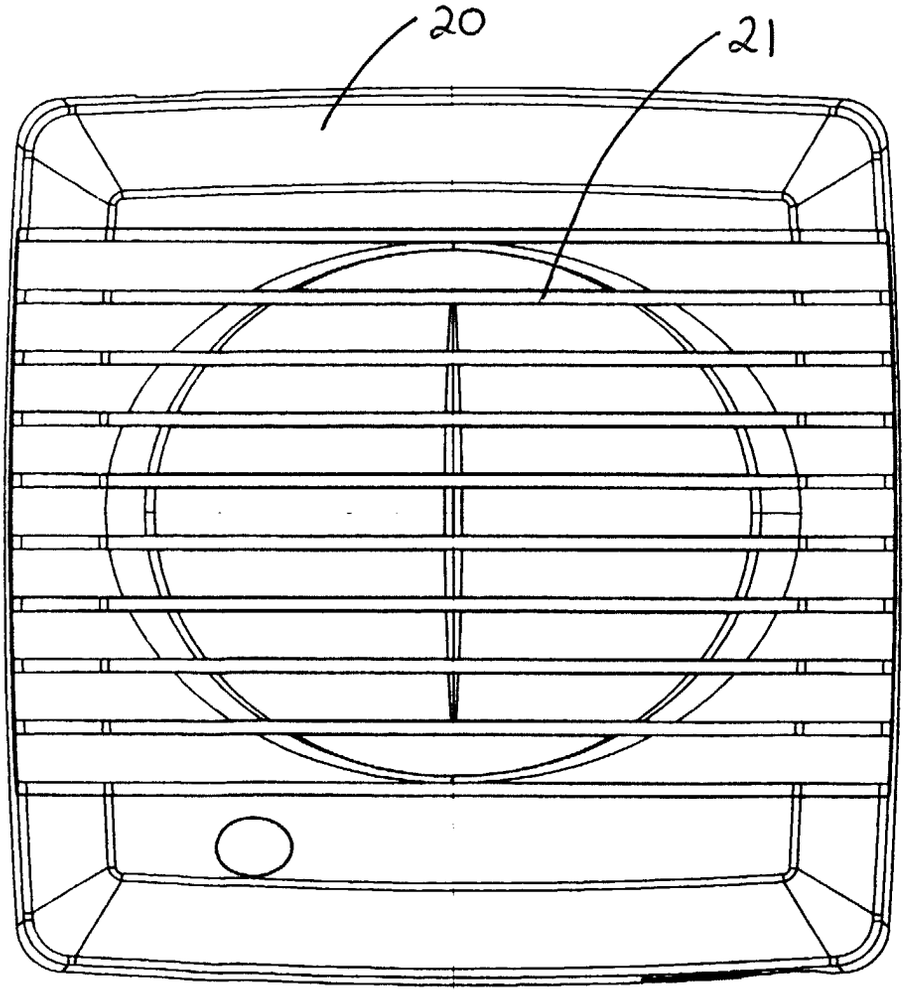

FIG. 2

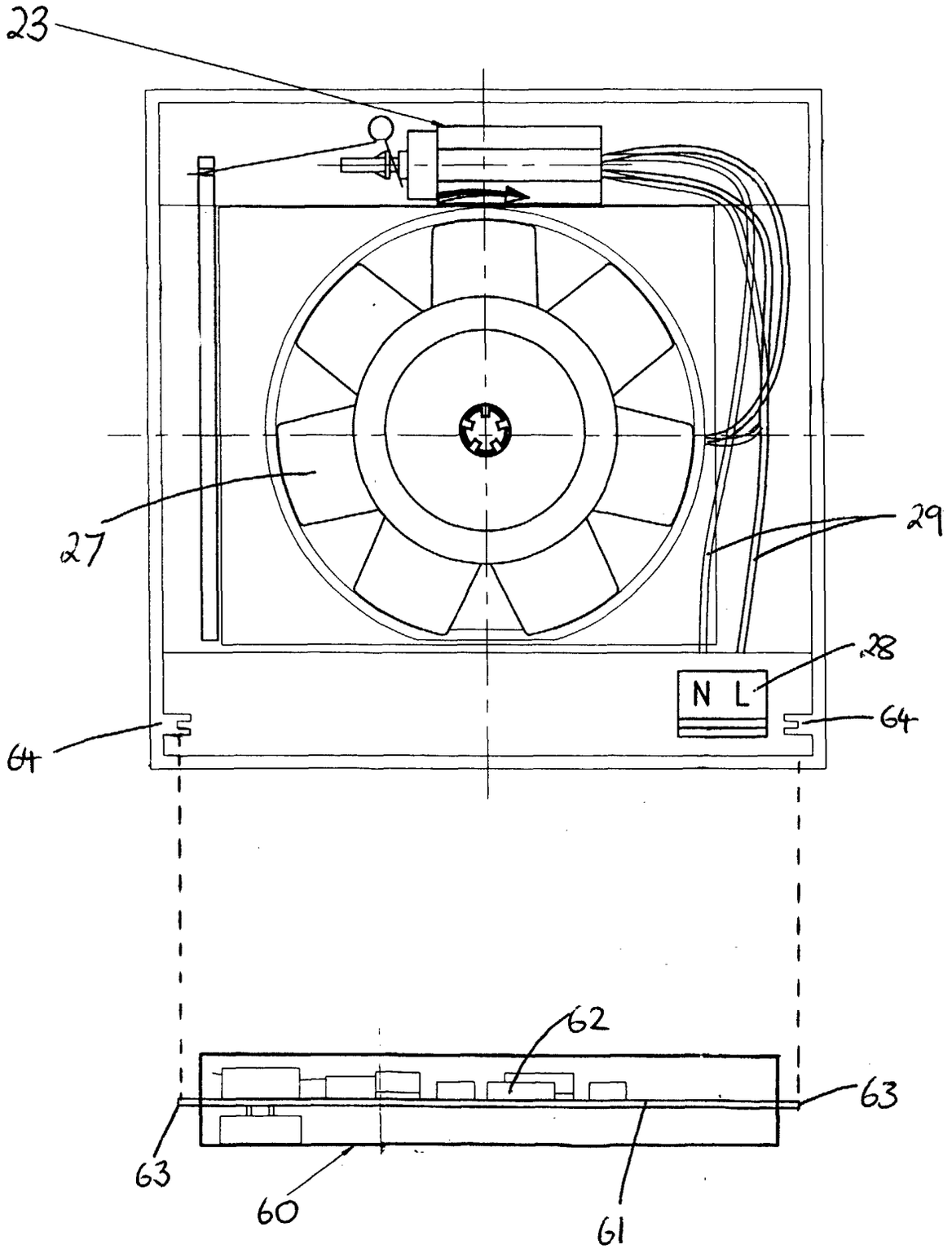

FIG.3

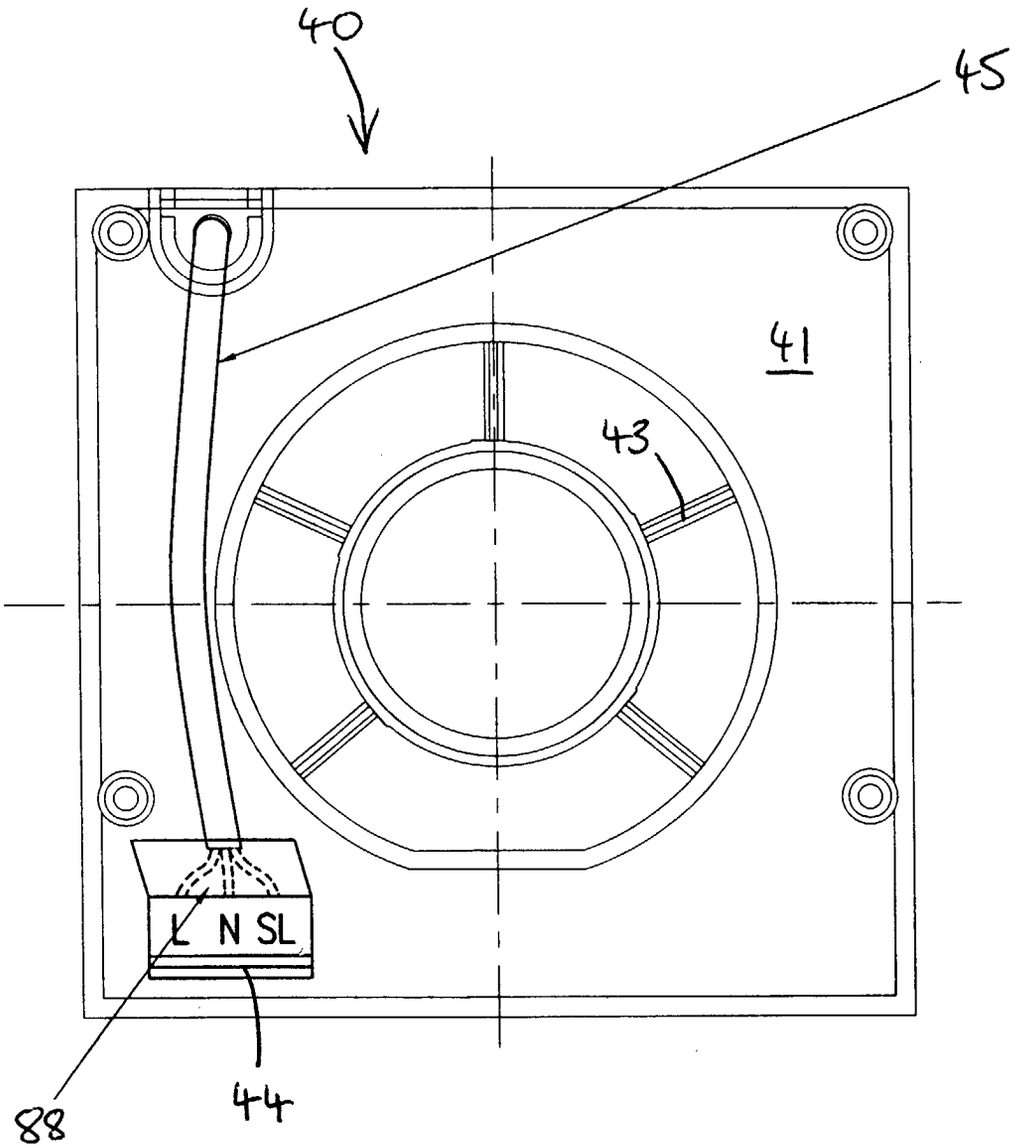

FIG. 4

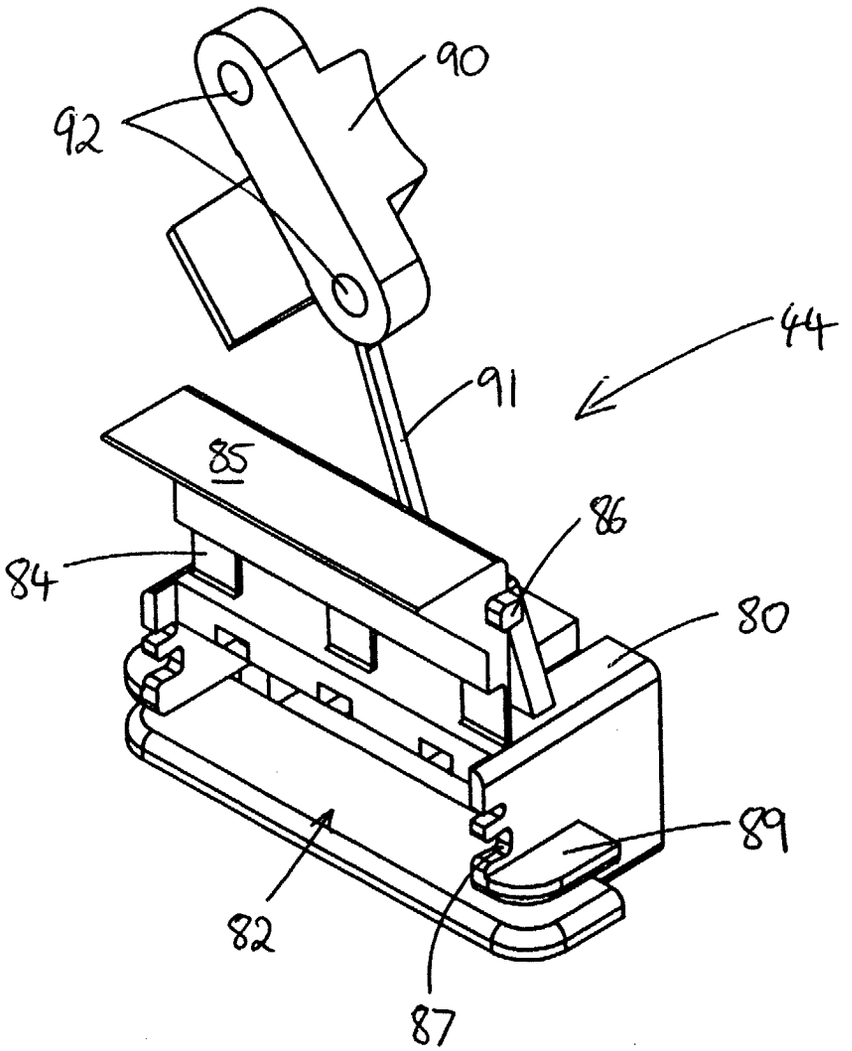

FIG. 5A

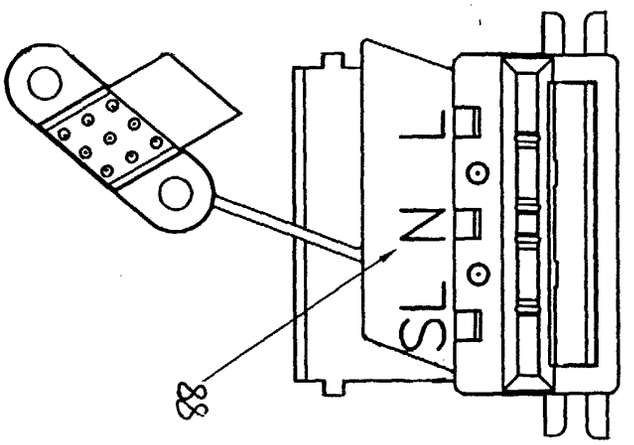

FIG. 5E

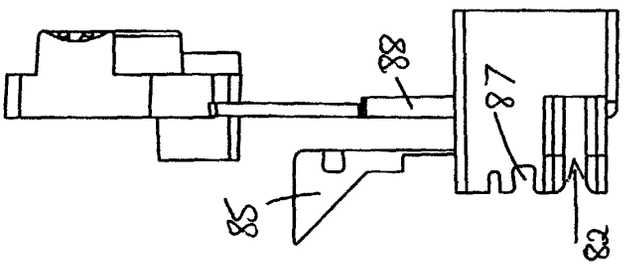

FIG. 5D

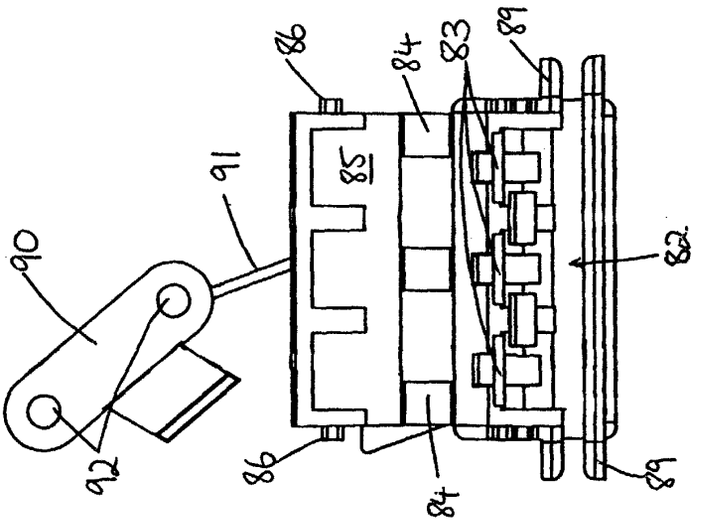

FIG. 5B

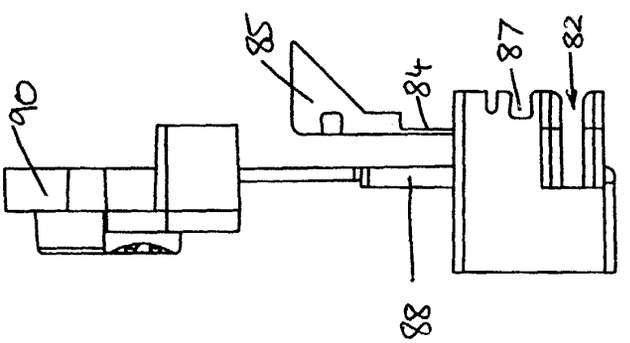

FIG. 5C

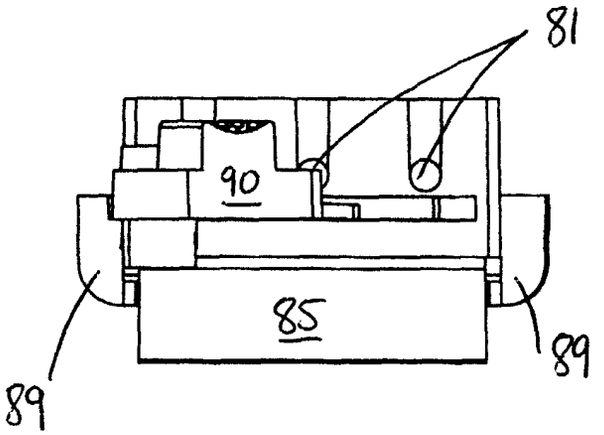

FIG. 5F

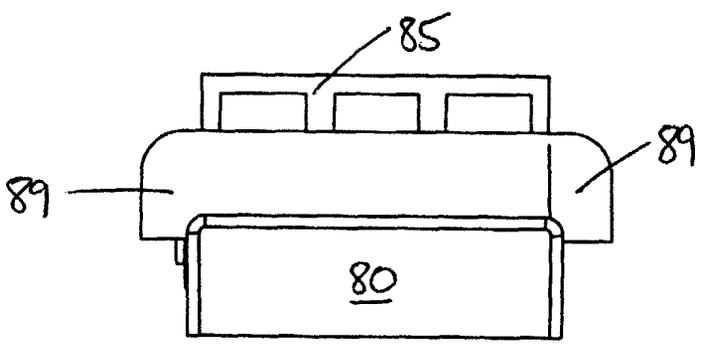

FIG. 5G

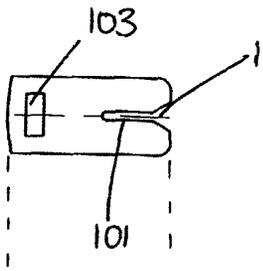

FIG. 6B

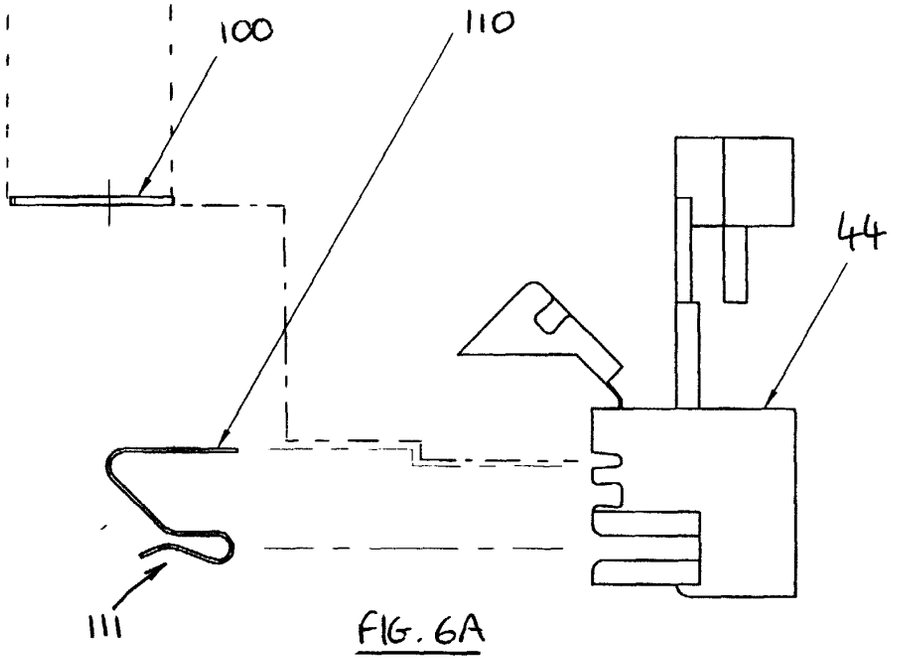

FIG. 6A

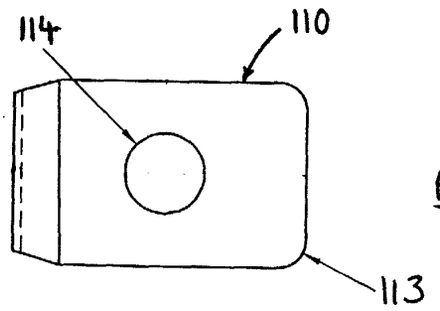

FIG. 6C

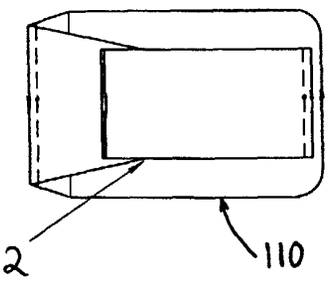

FIG. 6D

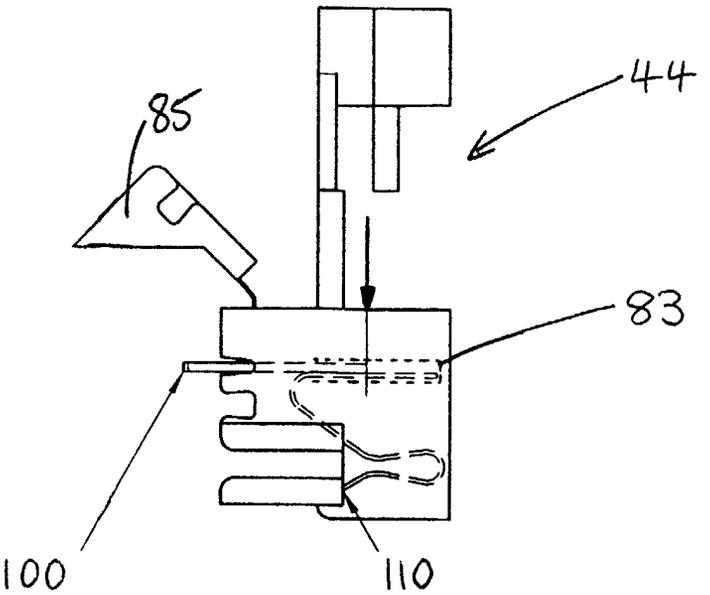

FIG. 6E

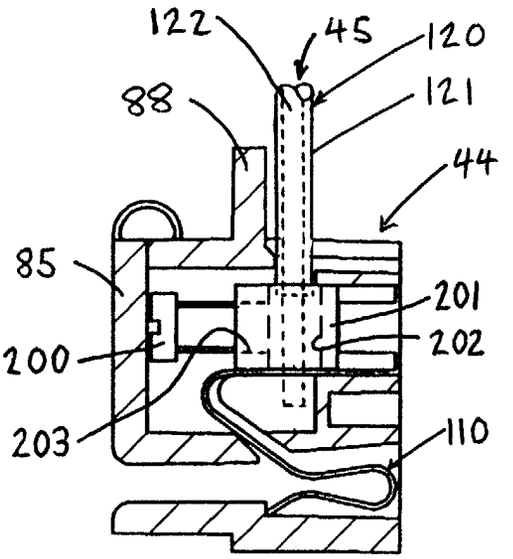

FIG. 9

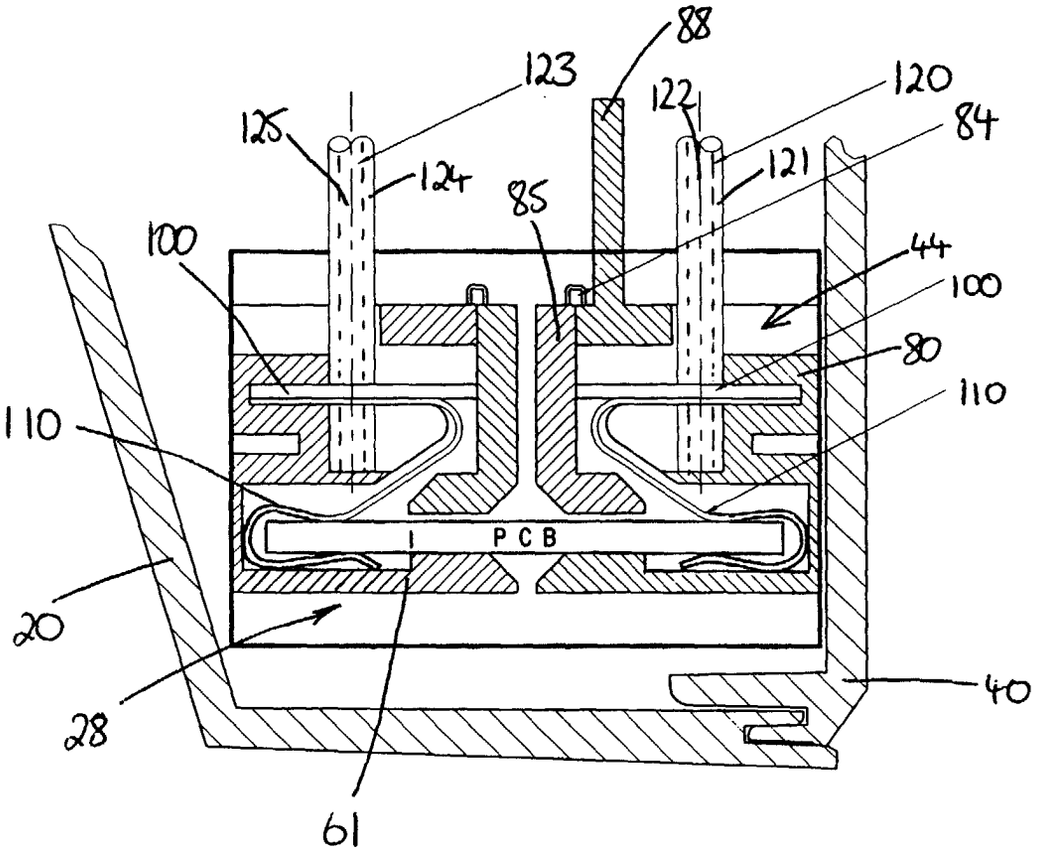
88
123
122
120
125
84
124
121
85
100
44
100
80
110
110
PCB
20
40
28
61

FIG. 7

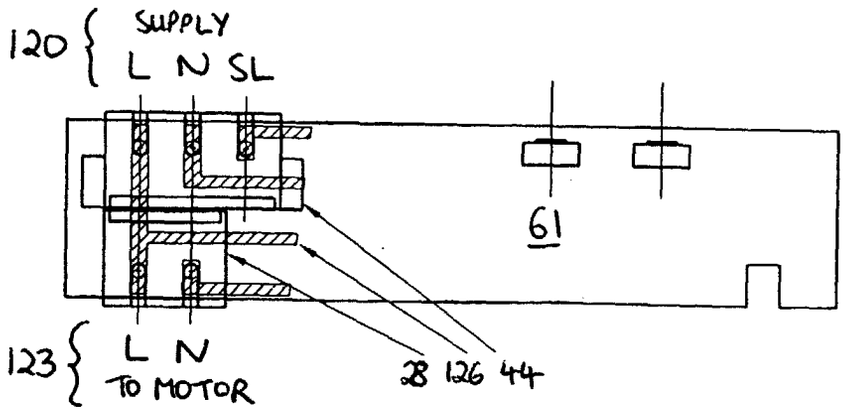
120
SUPPLY
L N SL
61
123
L N
TO MOTOR
28 126 44

FIG. 8