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(54) **ELECTRICAL CONNECTOR ASSEMBLY FOR A LIGHTING UNIT**

(57) An electrical connector assembly (1) arranged for electrically connecting together at least one supply side electrical power cable (302) and a device electrical power cable (202). The electrical connector assembly (1) includes: a first connector (3) arranged for electrical attachment to one of the first and device power cables (302,202), said first connector (3) including a set of first electrical connectors (7); and a second connector (5) arranged for electrical attachment to the other of the first and device power cable s (302,202), said second connector (5) including a set of second electrical connectors (55); the sets of first and second electrical connectors (7,55) are arranged for mating engagement to form an electrical connection between the first and device power cables (302,202) and for disengagement to break the electrical connection; wherein the set of first electrical connectors (7) is moulded into a plastics support member (13), thereby embedding at least part of each first electrical connector (7) within the plastic support member (13).

A lighting unit (200) and lighting system (100) that include electrical connector assembly, and a method for manufacturing the first connector (3), are also disclosed.

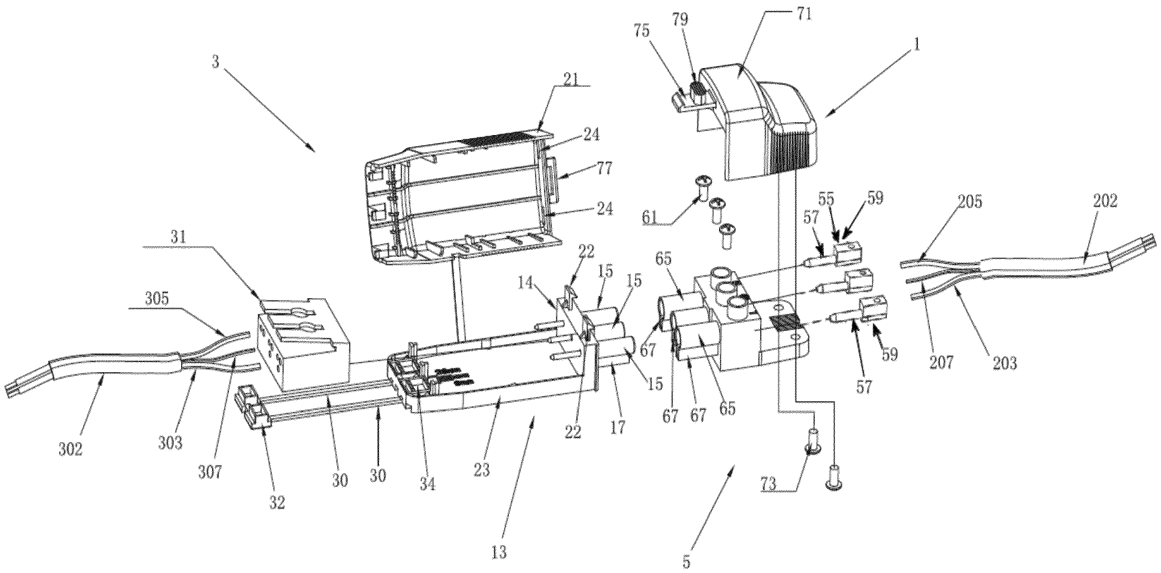

Fig. 1

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Description

[0001] The invention relates to an electrical connector assembly. The electrical connector assembly is arranged for connecting together electrical power cables. The invention also relates to a lighting unit and a lighting system that each include the electrical connector assembly, and a method for manufacturing a first connector, which is part of the electrical connector assembly.

[0002] Electrical connector assemblies for electrically connecting a lighting unit power cable to a mains lighting ring are known. This type of electrical connector assembly includes a first electrical connector that is connected to the supply side and a second connector that is applied to the lighting unit power cable. However a significant disadvantage of such known electrical connector assemblies is that they are difficult to manufacture and assembly, for example it is necessary to manually insert each electrical connector into a housing during an assembly process. Assembly is thus prone to error and is relatively slow and costly.

[0003] A further problem is that the structure of at least one connector part is not particularly optimised. For example, one known example includes a conventional screw operated terminal block for receiving wires that is connected to electrical connectors via a PCB. This requires additional components to manufacture and is relatively difficult for an electrician to install.

[0004] Accordingly the invention seeks to provide apparatus and a method for manufacturing a connector that mitigates at least one of the above-mentioned problems or at least provides an alternative solution to known solutions.

[0005] According to one aspect, there is provided an electrical connector assembly arranged for electrically connecting together at least one supply side electrical power cable and a device electrical power cable according to claim 1.

[0006] The invention provides assembly advantages for the electrical connector since moulding the set of first electrical connectors into the plastics support means that it is not necessary to individually mount each electrical connector into a support member, for example by hand. Hand mounting is a time consuming, costly and highly dexterous process that is prone to error, for example dropping the electrical connectors. The arrangement also enables a press terminal block to slide on to the electrical connectors, as described in more detail below. In preferred arrangements the first connector is attached to the supply side power cable and the second connector is attached to the device power cable.

[0007] The second connector is typically attached to the device power cable during a device assembly process and is sold in a configuration with the second connector attached thereto. The first connector is typically attached to at least one supply side power cable by an electrician, for example during a device installation process. Once the first connector is installed, subsequent removal and replacement of the device can be undertaken by a non-skilled person, such as a home owner, simply by separating the second connector of the current device from the installed first connector and then connecting the second connector of a new device to the installed first connector. The processing is similar to removing and inserting a plug into a socket.

[0008] It will be appreciated that the electrical connector assembly can be sold separately from a lighting unit, for example to enable it to be retrofitted to an existing device.

[0009] The electrical connector assembly enables the device, such as a lighting unit and preferably a solid state lighting unit, to be electrically connected to electrical power circuitry. For example, electrical power circuitry having an electrical supply and at least one supply side electrical power cable connected directly or indirectly to the electrical supply.

[0010] According to another aspect, there is provided an electrical connector assembly arranged for electrically connecting together at least one supply side electrical power cable and a device electrical power cable. The electrical connector assembly can include a first connector arranged for electrical attachment to one of the supply side and device power cables. The first connector can include a set of first electrical connectors. The electrical connector assembly can include a second connector arranged for electrical attachment to the other of the supply side and device power cables. The second connector can include a set of second electrical connectors. The sets of first and second electrical connectors can be arranged for mating engagement to form an electrical connection between the supply side and device power cables and for disengagement to break the electrical connection. The set of first of electrical connectors can be moulded into a plastics support member, thereby embedding at least part of each first electrical connector within the plastic support member.

[0011] The first connector can include a plurality of first electrical connectors, for example two or three first electrical connectors. The assembly can include at least one of live, switched live and neutral connectors. The assembly can include an earth connector. The second connector can include a plurality of second electrical connectors, for example two or three second electrical connectors. The assembly can include at least one of live, switched live and neutral connectors. The assembly can include an earth connector.

[0012] The support member can include a mounting wall. The mounting wall can comprise a cuboid block.

[0013] The support member can include a plurality of tubular shrouds. The plurality of tubular shrouds can protrude outwardly from a first side of the mounting wall. Each tubular shroud can protrude perpendicularly outwards from the first side of the mounting wall.

[0014] Each first electrical connector can include a first part. Each first part can protrude outwards from the support member, and preferably from a first side of the sup-

port member. Each first part of each first electrical connector can be housed within a respective one of the tubular shrouds. Typically the number of tubular shrouds matches the number of first electrical connectors. Each tubular shroud is preferably arranged co-axially with the first part of its respective first electrical connector.

[0015] The first part of each first electrical connector can be elongate. Each tubular shroud can be moulded circumferentially around the first part of its respective first electrical connector.

[0016] Each tubular shroud can be formed integrally with the mounting wall during the moulding process.

[0017] The tubular shrouds can be arranged parallel with one another. Each tubular shroud can have a longitudinal axis. The longitudinal axes can be arranged parallel to one another. Typically the shrouds are offset from one another in a first direction, such as lateral direction.

[0018] Each tubular shroud can extend beyond a distal end of the first part of its respective first connector. This protects the electrical connector and provides creepage and clearance compliance.

[0019] The first part of each first electrical connector can comprise a female connector. For example, the first part can comprise a plurality of circumferentially distributed prongs. The female connector can be arranged to receive a male connector. The female part of the connector can be used to electrically test the connection to the supply cables.

[0020] Each first electrical connector can comprise a second part. Each second part can protrude outwards from the support member into a terminal block. This arrangement allows for easy assembly of the electrical connector assembly. Each second part can protrude outwards from the mounting wall. Each second part can protrude outwards from a second side of the mounting wall directly into the terminal block, and preferably a first side of the terminal block. The second side of the mounting wall can be opposite to the first side of the mounting wall. The second part of each first electrical connector can extend in a direction that is opposite to the direction of its respective first part.

[0021] The second part of each first electrical connector can comprise a male connector, such as a pin. The first and second parts of each first electrical connector can be arranged co-axially. Preferably each first electrical connector is elongate. Preferably each first electrical connector is rectilinear. The first part of each first electrical connector can comprise a leading side and the second part of each first electrical connector can comprise a trailing side with respect to the direction of insertion of the first connector.

[0022] The terminal block can include a set of first apertures. Each first aperture can be arranged to receive a respective one of the second parts of the first electrical connectors. The terminal block can include a set of resilient electrical connectors. The second part of each first electrical connector can form an electrical connection with a first part of a respective resilient electrical connector, for example via a respective first aperture. The engagement of the terminal block with the second parts of each first electrical connector can provide sufficient retaining force to fix the position of the terminal block within the first connector. That is, no further fixing means, such as screws and/or adhesive, are required to fix the location of the terminal block within the first con nector.

[0023] During assembly, the terminal block can be pushed on to the first electrical connectors. This is a very quick and easy assembly method, and leads to low manufacturing cost.

[0024] The terminal block can include a set of second apertures each arranged to receive a respective wire from the power cable, and typically the supply side power cable. Each resilient electrical connector can include a second part that is arranged to electrically connect with a respective wire from the power cable. The first and second parts of each resilient electrical connector are electrically connected together thereby enabling electricity to flow between the power cable and the set of first electrical connectors.

[0025] The terminal block can be arranged to receive a plurality of supply side power cables, for example in a "loop in" "loop out" arrangement. In this arrangement, one of the supply side power cables carries electricity into the first connector and another one of the supply side power cables "loops out" electricity to the next light fitting and connector in the lighting circuit. In this arrangement, the terminal block can include at least one of: a plurality of live terminals, a plurality of earth terminals and a plurality of neutral terminals.

[0026] The terminal block can be a quick release terminal block. This terminal block is convenient for installers as it doesn't require a tool to operate it, such as a screw driver, and it speeds up installation.

[0027] The terminal block can include a set of manually operable actuators. Each actuator can be arranged to actuate the second part of a respective resilient electrical connector, thereby enabling the respective resilient electrical connector to be moved into and/or out of electrical connection with the respective wire. When the respective actuator is in a non-actuated condition, the second part of the respective resilient electrical connector is arranged to bias against its respective wire, thereby fixing it in place. Thus the second part of the respective resilient electrical connector is arranged to mechanically load its respective wire in the non-actuated condition.

[0028] Each manually operable actuator can include a lever. Each lever can be pivotally attached to a terminal block housing. For example, one end of each lever can be pivotally attached to the terminal block housing. The lever can include an actuator member. The actuator member can be located on one side of the lever, such as the underside of the lever. The actuator member can be arranged to act on the second part of its respective resilient electrical connector, or an intermediate component attached thereto, to move the second part of the respective resilient electrical connector between wire en-

gaging and wire non-engaging positions.

[0029] The support member can include a base. The base can be arranged perpendicularly to the mounting wall. The base can be formed integrally with the mounting wall and the tubular shrouds during the moulding process.

[0030] The terminal block can be mounted on the base.

[0031] The first connector can include a cover. The cover can form a housing with the support member. The housing can house the terminal block and an end portion of at least one power cable. Preferably the housing is arranged to house end portions of a plurality of supply side power cables. The cover can be arranged to snap-fit to the support member, for example to snap-fit to at least one of the base and the mounting wall. The support member base can provide a base for the housing. The support member mounting wall can provide a leading wall of the housing.

[0032] One of the first and second connectors can include a latch and the other of the first and second connectors can include a latch receiving formation. The latch and latch receiving formation can be arranged to releasably connect the first and second connectors together. The latching arrangement helps to prevent physical separation of the first and second connectors when they are electrically connected together.

[0033] The first connector can include a cord grip adaptor that is arranged to adapt the size of a cable receiving aperture from a first size to a second size. The first size can be larger than the second size. The cord grip adaptor can be an integral part of the support member, which is formed during the moulding process. The cord grip adaptor can include a plurality of flexible straps. The cord grip adaptor includes a plug located at distal ends of the flexible straps, which is adapted to adapt the size of the aperture.

[0034] The second connector can include a plurality of tubular shrouds. A first part of each second electrical connector can be housed within a respective one of the tubular shrouds. The first part of each second electrical connector is preferably a male connector, for example a pin. The first part of each second electrical connector is preferably rectilinear. Typically the number of tubular shrouds matches the number of second electrical connectors. Preferably each tubular shroud extends beyond a distal end of the first part of its respective second connector. This protects the electrical connector.

[0035] The tubular shrouds of one of the first and second connectors can be each sized and shaped to receive at least part of a respective one of the tubular shrouds of the other of the first and second connectors therein. Thus each tubular shroud of one of the first and second connectors acts as a socket to receive a respective one of the tubular shrouds of the other of the first and second connectors. The tubular shrouds that are arranged to receive at least a part of a respective one of the other tubular shrouds each have an internal diameter that is greater than or equal to the outside diameter of the respective tubular shrouds that are received. The internal surface of each receiving tubular shroud is spaced apart from its electrical connector housed therein to create a space to receive the respective tubular shroud of the other connector.

[0036] In preferred embodiments each tubular shroud of the second connector is sized and shaped to receive at least part of a respective one of the tubular shrouds of the first connector. For example, the inside diameter of each tubular shroud of the second connector can be greater than or equal to the outside diameter of its respective tubular shroud of the first connector. The internal surface of each tubular shroud of the second connector is spaced apart from the first part of its respective second electrical connector housed therein to create a space to receive the respective tubular shroud of the first connector.

[0037] One of the first and second connectors includes at least one key, and preferably a plurality of keys. The other of the first and second connectors includes at least one slot for receiving the key, and preferably a plurality of slots each arranged to receive a respective one of the keys. The keys and slots are arranged for mating engagement. The key-slot arrangement helps to prevent relative rotation between the first and second connectors. At least one of the tubular shrouds can include the key. At least one of the tubular shrouds can include the slot for receiving the key. Preferably each tubular shroud of the first connector includes a respective one of the keys. Preferably each tubular shroud of the second connector includes a respective one of the slots that is arranged to receive a respective one of the keys.

[0038] According to another aspect there is provided a lighting unit including an electrical power cable and an electrical connector assembly according to any configuration described herein.

[0039] The lighting unit can include at least one solid state lighting device. The lighting unit can include at least one LED light source. The lighting unit can include at least one PCB.

[0040] The lighting unit can be a downlight that is arranged to be fitted into an aperture formed in a partition such as a ceiling. The lighting unit is preferably an LED downlight.

[0041] The lighting unit can include a fire resistant housing. The fire resistant housing can include material that melts at a temperature greater than or equal to 900C, preferably greater than or equal to 950C and more preferably still greater than or equal to 1000C. For example, the housing can include at least one of steel, brass, copper and ceramic. The housing can be made from sheet material. In a particularly preferred arrangement the fire resistant housing is made from steel. The housing can be made by pressing sheet material, for example pressing sheet steel. The housing can include a plurality of materials. For example, the housing can comprise a plurality of parts attached together. The fire resistant housing can have a flange at an open side of the housing.

The flange prevents fire from passing through gaps between the lighting unit and a ceiling.

[0042] The downlight can include a heatsink. The heatsink can be mounted on a rear side of the fire resistant housing. The heatsink is entirely optional since many modern LEDs no longer require a heatsink to function adequately. A heatsink may be required for some high power applications.

[0043] The LED light source and PCB can be mounted within the fire resistant housing. For example, the LED light source and PCB can be mounted on a front face of end wall of the housing. Alternatively, the LED light source and PCB can be mounted on a rear side of the fire resistant housing. The fire resistant housing can include at least one hole formed through the housing to enable light emitted by the LED light source to pass through the housing.

[0044] According to another aspect there is provided a lighting system, including: electrical circuitry including an electrical supply and at least one supply side power cable connected directly or indirectly to the electrical supply; a lighting unit having a power cable; and an electrical connector assembly according to any configuration described herein. The electrical connector assembly electrically connects the at least one supply side power cable and the lighting unit power cable together. The lighting unit can be arranged according to any configuration described herein.

[0045] The electrical supply is typically a mains supply. Additionally, or alternatively, the electrical supply can include at least one electrical cell or a power generation means such as a solar panel.

[0046] In use, the first connector is electrically attached to the at least one supply side power cable. This is typically done by an electrician. The second connector is electrically attached to the device power cable. This may be done when manufacturing and assembling the lighting unit or can be done at some other time, such as during the installation process. The first and second connectors are electrically connected together by moving the set of first electrical connectors into mating engagement with the set of second electrical connectors. The lighting unit can be disconnected from the electrical supply circuit by uncoupling the first and second electrical connectors.

[0047] According to another aspect there is provided a method for manufacturing a first connector. The first connector is part of the electrical connector assembly according to any configuration described herein. The method includes: providing a set of first electrical connectors; placing the set of first electrical connectors into a mould for manufacturing a support member; inserting a flowable plastics material into the mould; and allowing the plastics material to solidify to form the support member, said support member having a mounting wall and a plurality of tubular shrouds protruding outwardly from a first side of the mounting wall, wherein the set of first electrical connectors is at least partly embedded within the mounting wall, a first part of each first electrical connector is housed within a respective one of the tubular shrouds, and a second part of each first electrical connector protrudes outwards from a second side of the mounting wall.

[0048] The second side of the mounting wall can be opposite to the first side of the mounting wall. The moulding step can make use of any suitable moulding method, for example an injection moulding method.

[0049] The flowable plastics material can be a thermoplastic, such as at least one of Polycarbonate (PC), Polypropylene (PP) and Polyamide (PA).

[0050] The method can include providing a terminal block having a set of first apertures and a set of resilient electrical connectors. The method can include attaching the terminal block to the set of first electrical connectors such that the second part of each first electrical connector extends into a respective first aperture and forms an electrical connection with a first part of a respective resilient electrical connector.

[0051] The terminal block can be a quick release terminal block.

[0052] The method can include sizing the outside diameter of each tubular shroud to fit into a respective tubular shroud on a second connector.

[0053] Embodiments of the invention will now be described by way of example only with reference to the drawings, wherein:

Figure 1 is an exploded isometric view of an electrical connector assembly according to an embodiment, which includes a supply side connector and a device connector;

Figure 2 is an isometric view of an electrical terminal block mounted in the supply side connector shown in Figure 1;

Figure 3 is a rearward end view of the electrical terminal block of Figure 2;

Figure 4 is a longitudinal cross-sectional view of the electrical terminal block of Figure 2;

Figure 5 is an isometric view of the electrical connector assembly of Figure 1 in an assembled state, wherein the supply side and device connectors are connected together;

Figure 6 is a longitudinal cross-sectional view of the electrical connector assembly of Figure 1, with the supply side and device connectors connected together (N.B. the electrical terminal block is shown in simplified form for clarity of the overall arrangement);

Figure 7 is an enlarged view of part of Figure 6;

Figure 8 is a diagrammatic view of a lighting system embodiment; and

Figure 9 is a diagrammatic view of a lighting unit, which is part of the lighting system of Figure 8.

[0054] Figures 1 to 6 show an electrical connector assembly 1 in accordance with an embodiment. The electrical connector assembly 1 is arranged to electrically connect supply side and device electrical power cables 302,202 together. For example, a device 200, such as a solid state lighting unit, having an electrical power cable 202 can be connected to electrical power circuitry. The electrical circuitry can include an electrical supply 300 and at least one supply side electrical power cable 302, which is electrically connected to the electrical supply 300 either directly or indirectly.

[0055] Each electrical power cable 202,302 includes a live wire 203,303 and a neutral wire 205,305. Each cable 202,302 may also include an earth wire 207,307.

[0056] The electrical connector assembly 1 includes a first, supply side, connector 3 and a second, device, connector 5. The supply side connector 3 is connectable to at least one supply side power cable 302 and the device connector 5 is connectable to the device power cable 202. The supply side and device connectors 3,5 can be coupled together, in a releasable manner, in order to electrically connect the device 200 to the power supply 300. The supply side and device connectors 3,5 can be uncoupled to electrically disconnect the device 200 from the power supply 300.

[0057] In some arrangements the supply side connector 3 can be connected to a plurality, for example two or three, first electrical cables 302 in order to loop electrical current to other devices, such as other lighting units 200.

[0058] The supply side connector 3 includes a plurality of first electrical connectors 7, which are arranged to engage with a plurality of complementary electrical connectors on the device connector 5. Each electrical connector 7 includes a first part 9. The first part 9 comprises a leading part of the electrical connector. The first part 9 preferably comprise a female electrical connector. Each electrical connector 7 includes a second part 11. The second part 11 is a rearward part of the electrical connector. Preferably the second part 11 comprises a male connector, such as a pin. The second part 11 is typically rectilinear or includes a rectilinear engagement part. The terms leading and rearward are with respect to the direction of connection of the supply side connector 3 with the device connector 5. The supply side connector 3 typically includes two or three electrical connectors 7. Typically, the supply side connector 3 includes, live, neutral and earth electrical connectors 7. In some arrangements the supply side connector 3 may include live and neutral electrical connectors 7 only.

[0059] The electrical connectors 7 are moulded into a plastics support member 13 during manufacture. That is, the support member 13 comprises a plastics moulded component, and when the component is formed by a moulding process, such as injection moulding, the electrical connectors 7 are located in the mould and the mould is then filled with flowable plastics material. The flowable plastics material moulds over the electrical connectors 7 according to the shape of the mould, and any spacers present, to produce the support member 13, when the plastic material solidifies, with the electrical connectors 7 embedded therein. Typically, the plastics material comprises a thermoplastic material such as at least one of Polycarbonate (PC), Polypropylene (PP) and Polyamide (PA). This method of manufacture provides an arrangement that is easier to assemble than a conventional arrangements, for example it is not necessary to fit individual electrical connectors into cavities formed in a support member during the assembly process. This leads to a decrease in assembly time and assembly cost, and with no additional components allows the use a push-fit terminal block 31.

[0060] The support member 13 includes a mounting wall 14. The mounting wall 14 has a leading side 16 and a rearward side 18. The terms leading and rearward are with respect to the direction of connection of the supply side connector 3 with the device connector 5. Each electrical connector 7 is mounted in the mounting wall 14. The electrical connectors 7 are arranged parallel to one another. Each electrical connector 7 extends through the mounting wall 14. The first part 9 of each electrical connector protrudes perpendicularly outwards from the front side 16 of the wall. The second part 11 of each electrical connector protrudes perpendicularly outwards from the rearward side 18 of the wall. The support member 13 includes a plurality of shrouds 15, one for each electrical connector 7. Each shroud 15 comprises a cylindrical tube that protrudes outwardly from the front side 16 of the wall. Each shroud 15 houses the first part 9 of its respective electric connector. Each shroud 15 protrudes axially beyond a distal end of the first part 9 of its respective electrical connector, thereby protecting the connector. Each shroud 15 includes a key 17 running axially along the length of the shroud 15. The keys 17 help to properly align the supply side and device connectors 3,5 and to prevent relative rotation of the supply side and device connectors 3,5 in use.

[0061] The supply side connector includes a cover 21 that is arranged to snap-fit to the support member 13 to form a housing 19. The support member 13 includes snap-fit latches 22 that are arranged to engage snap-fit formations 24 formed in the cover 21. It will be appreciated by the skilled person that the cover 21 can include at least one snap-fit latch 22 and the support member can include at least one snap-fit formation 24. The mounting wall 14 provides at least part of a leading end wall of the housing 19. The support member 13 can include a base 23. The base 23 extends perpendicularly from a lower end of the rearward side 18 of mounting wall 14. Thus the support member 13 has an L-shaped configuration when viewed side on (see Figure 1)

[0062] The housing 19 has an aperture 25 located towards a rearward end 27 for receiving the supply side cable(s) 302. The support member 13 includes a cord

grip adaptor 29 for fixing the cable(s) 302 to the housing 19. The cord grip adaptor 29 can be an integral part of the support member, which is formed during the moulding process. The cord grip adaptor includes a plurality of flexible straps 30. The cord grip adaptor 29 includes a plug 32 located at distal ends of the flexible straps 29. The cord grip adaptor 29 an optional part the installer can choose to use depending on the thickness of cable he is wiring to. The cord grip adaptor 29 is designed to accept two thicknesses of cable. For the thinner of the two cables the installer can use the plug 32 to make the aperture 25 slightly smaller and therefore grip the thinner cable.

[0063] A terminal block 31 is located in the housing 19. The terminal block 31 is electrically connected to electrical connectors 7 at a first side 33 and is electrically connectable to the supply side cable(s) 302 at a second side 35. The terminal block 31 includes a first set of three apertures 37 at the first side. Each aperture 37 receives the second part 11 of a respective electrical connector therein. Each aperture 37 is axially aligned with the second part 11 of its respective electrical connector, which enables the terminal block 31 to be pushed onto the electrical connectors 7 during the assembly process. This provides for a fast assembly process. For example, the terminal block 31 can slide into position along the base 23, and is seated on the base 23 in its resting position. The terminal block 31 includes resilient internal electrical connectors 39. Each resilient connector 39 includes a first part 41 that is arranged to resiliently engage the second part 11 of its respective first electrical connector. In some arrangements, no further fixing means, such as screws or adhesive are required to fix the terminal block 31 within the housing 19. The frictional and/or resilient engagement between the resilient connector 39 and the electrical connectors 7 is sufficient to firmly locate the terminal block 31. However in some arrangements additional fixings can be used. For example, there may be retaining clips in the base 23 that help lock terminal block 31 in position.

[0064] The terminal block 31 includes a second set of three apertures 44 formed in the second side 35. Each aperture 44 is arranged to receive a respective wire, live 303/ neutral 305 /earth 307, from the supply side cable 302. Each resilient connector 39 includes a second part 43 that is arranged to resiliently engage its respective wire 303,305,307 to firmly hold the wire into engagement with the terminal block 31. Each resilient connector 39 includes a third part 47 which electrically connects the first and second parts 41,43 of the resilient connector together and enables an electrical current to flow between the wire and the respective electrical connector 7, and hence the device 200 and the electrical supply 300.

[0065] The terminal block 31 has a mechanism for providing quick wire attachment and quick wire release. That is, it is not necessary to secure the wires 303,305,307 to their resilient connectors 39 using screws. The terminal block 31 includes 3 levers 49 that are pivotally attached to an upper side 51, preferably towards the first side 33. Each lever 49 is associated with a respective resilient connector 39. Each lever 49 includes an actuating member 53 that is arranged to move the second part 43 of its respective resilient connector. Typically the actuating member 53 is located on an underside of the lever 49. In its non-actuated state, the second part 43 of the resilient connector is biased into engagement with its respective wire 303,305,307. When the lever 49 is depressed by the user, the actuating member 53 biases the second part 43 of the resilient connector away from the wire 303,305,307, which enables the wire 303,305,307 to be easily inserted into the aperture 44 to a position wherein the second part 43 of the resilient connector will engage the wire when the user releases the lever 49. When the lever is released, the resiliency of the second part 43 causes the second part 43 to return to its non-actuated wire engaging position, and returns the lever 49 to its non-depressed state. The mechanism can also be used to remove the wire 303,305,307 from the terminal block 31. Depressing the lever 49 releases the biasing force applied to the wire 303,305,307 by the second part 43 of the resilient connector, thereby enabling the wire to be removed from the terminal block 31.

[0066] The terminal block 31 can include additional apertures 46 to receive additional cable wires. For example, one or more additional supply side power cables 302 can be connected to supply side connector 3, thereby looping in additional devices 200, such as additional lighting units.

[0067] The device connector 5 includes a plurality of second electrical connectors 55, which are arranged to engage with the first electrical connectors 7 on the supply side connector 3. Each second electrical connector 55 comprises a male connector part 57 that is arranged to electrically connect with a respective one of the female first parts 9 of the electrical connectors 7, and a terminal 59 for receiving a respective wire 203,205,207 from the device cable 202. Each terminal 59 has an associated screw 61 that is used to fix the respective wire 203,205,207 to the terminal 59. The terminals 59 are mounted in a second terminal block 63. The male connector parts 57 protrude out of the second terminal block 63 into tubular shrouds 65. The male connector parts 57 are elongate and are arranged co-axially with the tubular shrouds 65. Each electrical connector 55 is inserted into the second terminal block 63 individually during assembly, in a conventional fashion in some arrangements.

[0068] Each shroud 65 protrudes axially beyond a distal end of its respective male connector part 57. Each tubular shroud 65 has an internal diameter that is sufficiently large to receive a respective one of the shrouds 15 of the supply side connector 3. The internal surface 66 of each shroud 65 is spaced apart from the external surface of its respective male connector part 57 to enable the shroud 15 to be received within the shroud 65. Each tubular shroud 65 has a longitudinal slot 67 that is arranged to receive a respective one of the keys 17. When the supply side and device connectors 3 and 5 are con-

nected together the shrouds 15 on the supply side connector 3 slide axially into their respective shrouds 65 on the device connector 5, the keys 17 slide into their respective slots 67, and the male connector parts 57 of the device connector 5 slide into, and electrically connect with, the female connector parts 9 of the supply side connector 3.

[0069] The device connector 5 includes a base 69 and a cover 71. The cover 71 overlies the base and the second terminal block 63. The cover 71 is attached to the base 69 by screws 73.

[0070] The cover 71 includes a latch 75 that is arranged to engage a latch receiving formation 77 on the cover 21. The latch 75 is arranged to engage the latch receiving formation 77 when the supply side and device connectors 3,5 are connected together. The latch 75 and receiving formation 77 hold the connectors 3,5 together. The latch 75 includes an actuator button 79. A user can separate the supply side and device connectors 3,5 by pressing the button 79 to release the latch and pulling the connectors 3,5 apart. It will be appreciated that the latch 75 instead can be mounted on cover 21 and the latch receiving formation 77 can be mounted on cover 71.

[0071] Typically, the device connector 5 is attached to the device cable 202 during the device 200 assembly process. Thus it is envisaged that the device 200 will be sold with the device connector 5 pre-attached. Of course, the electrical connector assembly can be sold separately from the device, for example for retrofitting purposes.

[0072] The supply side connector 3 is attached to the supply side cable(s) 302 by an electrician during an installation process. The device 200 is the connected to the circuitry by connecting the device connector 5 to the supply side connector 3. When the device comprises a lighting unit, such as a downlight, the downlight is then mounted into an aperture formed in a ceiling and is secured in place. In the future, if it is necessary to replace the lighting unit for example due to a lighting unit failure, or simply for a change in style of the lighting unit, the user is able to disconnect the existing lighting unit from the power supply and connect a new lighting unit to the power supply without the need of an electrician. The user simply disconnects the supply side connector 3 from the existing device connector 5 and then connects the new device connector 5 to the already installed supply side connector 3. Thus fitting a new lighting unit 200 no longer requires a skilled electrician.

[0073] Figure 7 and 8 show a lighting system 100 in accordance with an embodiment. The lighting system includes: at least one lighting unit 200 having an electrical cable 202; an electrical connector assembly 1 similar to that described above; and further electrical circuitry including an electrical supply 300, such as a mains supply and at least one supply side cable 302 the is directly or indirectly connected to the electrical supply 300.

[0074] The lighting unit 200 can be a downlight, and is preferably a solid state downlight. For example, the downlight 200 can include at least one LED light source 204, such as an LED chip, and a PCB 206. The downlight includes a power supply cable 202 that is connected to the PCB 206. A device connector 5 attached is attached to cable 202.

[0075] The downlight 200 can include a fire resistant housing 208. The fire resistant housing includes material that melts at a temperature greater than or equal to 900C, preferably greater than or equal to 950C and more preferably still greater than or equal to 1000C. For example, the housing 208 can include at least one of steel, brass, copper and ceramic. The housing 208 can be made from sheet material. In a particularly preferred arrangement the fire resistant housing is made from steel. Preferably the housing 208 is made by pressing sheet material, for example pressing sheet steel. The fire resistant housing 208 can have a flange 210 at an open side. The flange 210 prevents fire from passing through gaps between the lighting unit 200 and a ceiling. The downlight 200 can include a heatsink 212. Preferably the heatsink 212 is mounted on a rear side of the fire resistant housing. The heatsink 212 is entirely optional since many modern LEDs no longer require a heatsink to function adequately. A heatsink 212 however may be required for some high power applications. The LED light source 204 and PCB 206 can be mounted within the fire resistant housing 208, for example on a front face of end wall 214 thereof (see Figure 8). Alternatively, the LED light source 204 and PCB 206 can be mounted on a rear side of the fire resistant housing 208, and the fire resistant housing can include at least one hole formed through the housing 208 to enable light emitted by the LED light source 204 to pass through the housing.

[0076] The lighting unit 200 can include at least one of: an optical device 216, such as at least one lens; a front cover 218; and a trim element 220.

[0077] The lighting system 100 may be used in a domestic dwelling, such as a house or an apartment or can be used in other facilities such as offices, shops, community buildings, etc. The lighting system 100 typically includes several lighting units 200, which are each individually connected to the further electrical circuitry by electrical connector assemblies 1 described above. The electrical circuitry typically includes at least one mains lighting circuit defined by electrical cables 302 which is connected to a mains distribution board. The or each mains lighting circuit may include other devices that are typically included in such circuits such as electrical switches, dimmers, and other controllers.

[0078] It will be appreciated by the skilled person that modifications can be made to the above embodiments that fall within the scope of the invention, for example the first part of each electrical connector on the supply side can comprise a male connector and the first part of each electrical connector on the lighting unit side can comprise a female connector.

[0079] The moulded support member can sit within a housing rather than being part of the housing.

[0080] In some arrangements the connector described

as the supply side connector 3 above can be attached to the device cable 202 instead of the supply side cable 302, and the connector described as the device connector 5 above can be attached to the supply side cable 302 instead of the device cable 202.

[0081] In some arrangements the electrical connectors 55 in the device connector 5 can be moulded into a plastics support member, in a similar fashion to the electrical connectors 7 in the supply side connector 3.

[0082] In some arrangements the second terminal block 63 in the device connector 5 can be replaced by a terminal block 31 similar to that used in the supply side connector 3, with the electrical connectors 55 being adapted for this purpose. For example, instead of the electrical connectors 55 including terminals 59, the length of connectors 55 can be increased to enable a part of the connectors to protrude into apertures 37.

[0083] Not all of the shrouds need include a key or keyway.

[0084] The electrical power supply circuitry can include batteries or a power generation device such as at least one photo voltaic unit.

Claims

1. An electrical connector assembly (1) arranged for electrically connecting together at least one supply side electrical power cable (302) and a device electrical power cable (202), wherein the electrical connector assembly (1) includes: a first connector (3) arranged for electrical attachment to one of the first and device power cables (302,202), said first connector (3) including a set of first electrical connectors (7); and a second connector (5) arranged for electrical attachment to the other of the first and device power cable s (302,202), said second connector (5) including a set of second electrical connectors (55); the sets of first and second electrical connectors (7,55) are arranged for mating engagement to form an electrical connection between the first and device power cables (302,202) and for disengagement to break the electrical connection; wherein the set of first electrical connectors (7) is moulded into a plastics support member (13), thereby embedding at least part of each first electrical connector (7) within the plastic support member (13), wherein each first electrical connector comprises first and second parts (9,11), and each second part (11) protrudes outwards from the support member (13) into a terminal block (31).

2. The assembly of claim 1, wherein the support member (13) includes a mounting wall (14) and a plurality of tubular shrouds (15) protrude outwardly from a first side (16) of the mounting wall, and the first part (9) of each first electrical connector is housed within a respective tubular shroud (15).

3. The assembly of claim 2, wherein each tubular shroud (15) protrudes perpendicularly outwards from the first side (16) of the mounting wall, and preferably the tubular shrouds (15) are parallel to one another.

4. The assembly of any one of the preceding claims, wherein terminal block (31) includes a set of first apertures (37) and a set of resilient electrical connectors (39), and the second part (11) of each first electrical connector extends into a respective first aperture (39) and forms an electrical connection with a first part (41) of a respective resilient electrical connector.

5. The assembly of claim 4, wherein the terminal block (31) includes a set of second apertures (44) each arranged to receive a respective wire (303, 305, 307) from the power cable (302), each resilient electrical connector (39) includes a second part (43) that is arranged to electrically connect with a respective wire (303, 305, 307) from the power cable (302).

6. The assembly of claim 5, wherein the terminal block (31) includes a set of manually operable actuators (49,53), each actuator (49,53) is arranged to actuate the second part (43) of a respective resilient electrical connector (39), thereby enabling the respective wire (303, 305, 307) to be moved into and/or out of electrical connection with the respective resilient electrical connector (39).

7. The assembly of claim 6, wherein each actuator (49,53) includes a lever (49) that is pivotally attached at one end to a terminal block housing.

8. The assembly of any one of the preceding claims, wherein support member includes a base (23) and a cover (21), and the terminal block (31) is mounted on the base (23).

9. The assembly of any one of the preceding claims, wherein engagement of the terminal block (31) with the second parts (11) of each first electrical connector provides sufficient retaining force to fix the position of the terminal block (31) within the first connector.

10. The assembly of any one of the preceding claims, wherein one of the first and second connectors (3,5) includes a latch (75) and the other of the first and second connectors includes a latch receiving formation (77), wherein the latch (75) and latch receiving formation (77) are arranged to releasably connect the first and second connectors (3,5) together.

11. The assembly of any one of the preceding claims, wherein the first connector includes a cord grip adap-

tor (29).

12. The assembly of any one of the preceding claims, wherein the second connector (5) includes a plurality of tubular shrouds (65) and a first part (57) of each second electrical connector is housed within a respective one of the tubular shrouds (65), and wherein the tubular shrouds (15,65) of one of the first and second connectors (3,5) are each sized and shaped to receive at least part of a respective one of the tubular shrouds (15,65) of the other of the first and second connectors (3,5) therein.

13. The assembly of claim 12, wherein each tubular shroud (15,65) of one of the first and second connectors (3,5) includes a key (17) and each tubular shroud (15,65) of the other of the first and second connectors (3,5) includes a slot (67) for receiving a respective one of the keys (17), and preferably each tubular shroud (15) of the first connector (3) includes a key (17) and each tubular shroud (65) of the second connector (5) includes a slot (67) for receiving a respective one of the keys (17).

14. A lighting unit (200) including an electrical power cable (202) and an electrical connector assembly according to any one of the preceding claims.

15. The lighting unit of claim 14, wherein the lighting unit (200) includes at least one solid state lighting device (204).

16. The lighting unit of claim 14 or 15, wherein the lighting unit (200) is a downlight that is arranged to be fitted into an aperture formed in a partition such as a ceiling, and preferably the lighting unit (200) includes a fire resistant housing (208).

17. A lighting system, including: electrical circuitry including an electrical supply and at least one supply side power cable (302) connected directly or indirectly to the electrical supply (300); a lighting unit (200) having an electrical power cable (202); and an electrical connector assembly according to any one of claims 1 to 13; wherein the electrical connector assembly is arranged to electrically connect the at least one supply side power cable (302) and the lighting unit power cable (202) together.

18. A method for manufacturing a first connector that is part of the electrical connector assembly according to any one of claims 1 to 13, including providing a set of first electrical connectors (7); placing the set of first electrical connectors (7) into a mould for manufacturing a support member (13); inserting flowable plastics material into the mould; allowing the flowable plastics material to solidify to form the support member (13), said support member (13) having a mounting wall and a plurality of tubular shrouds (15) protruding outwardly from a first side (16) of the mounting wall, wherein the set of first electrical connectors (7) is at least partly embedded within the mounting wall, a first part (9) of each first electrical connector is housed within a respective one of the tubular shrouds (15), and a second part (11) of each first electrical connector protrudes outwards from a second side of the mounting wall into a terminal block (31).

19. A method according to claim 18, including providing a terminal block (31) having a set of first apertures (37) and a set of resilient electrical connectors (39); attaching the terminal block (31) to the set of first electrical connectors (7) such that the second part (11) of each first electrical connector (7) extends into a respective first aperture (37) and forms an electrical connection with a first part (41) of a respective resilient electrical connector (39).

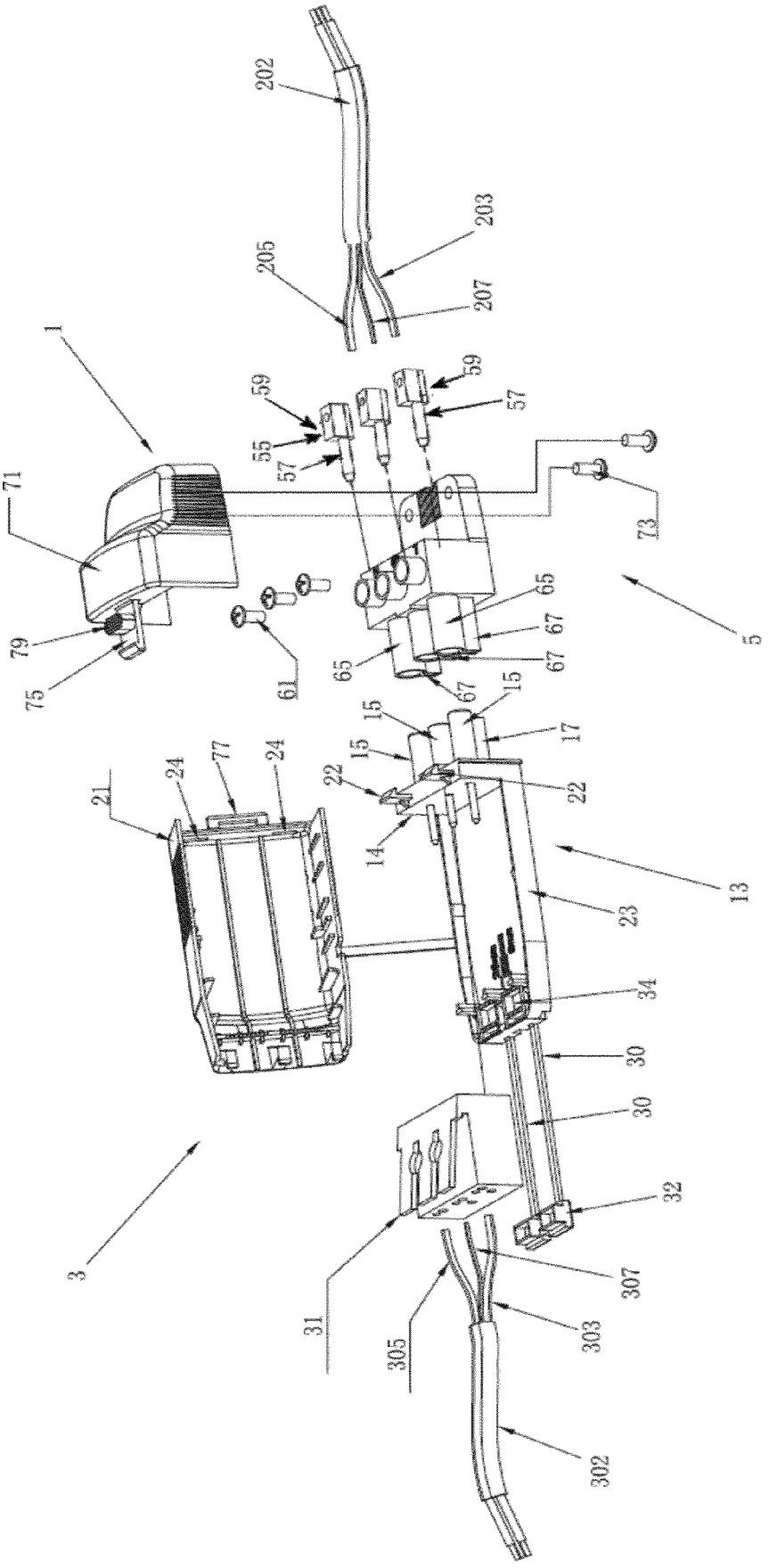
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Fig. 1

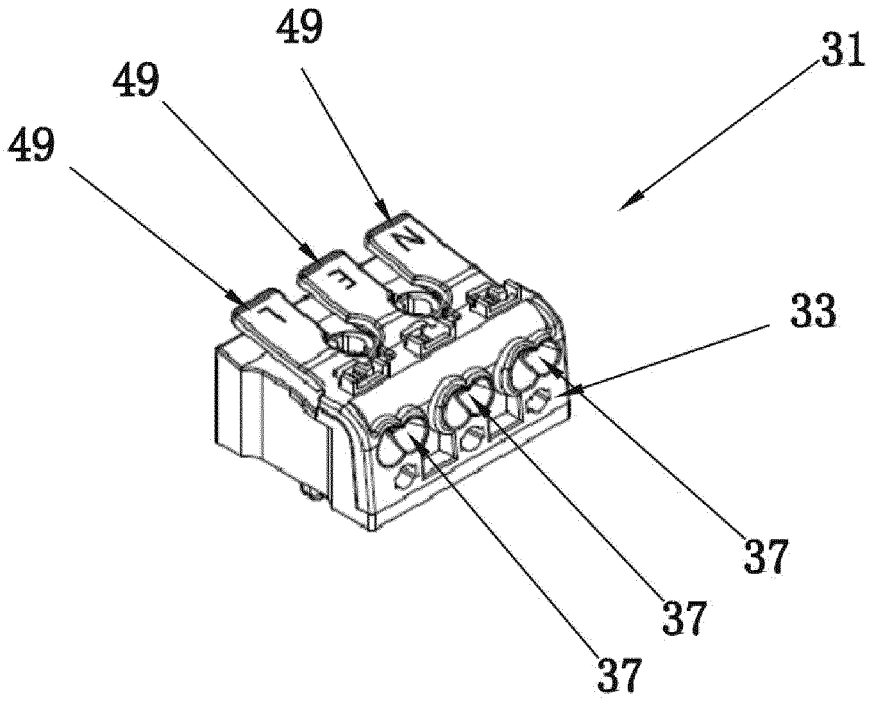

Fig. 2

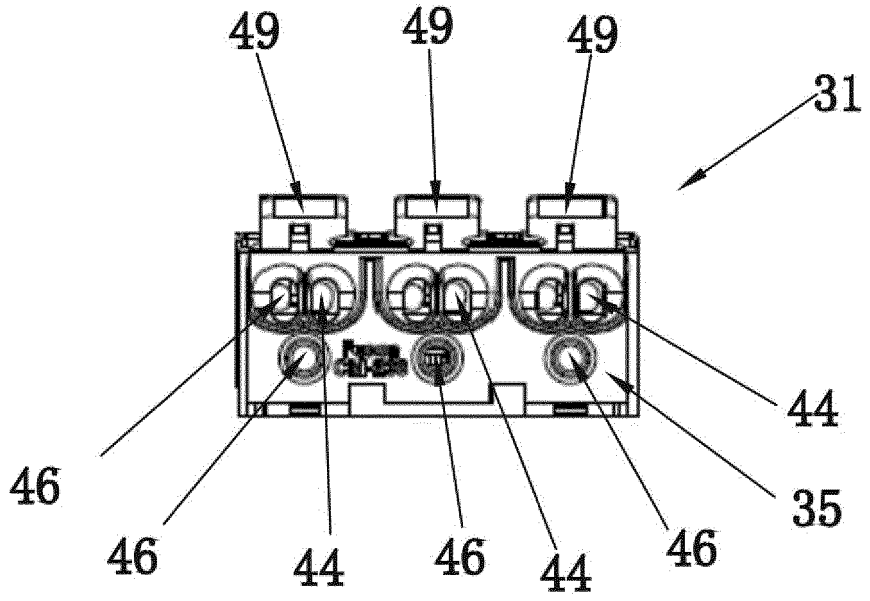

Fig. 3

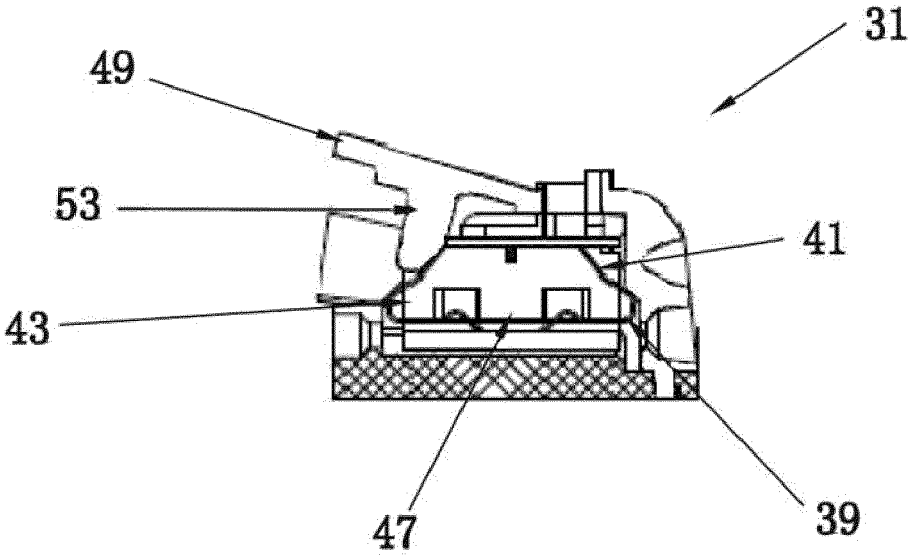

Fig. 4

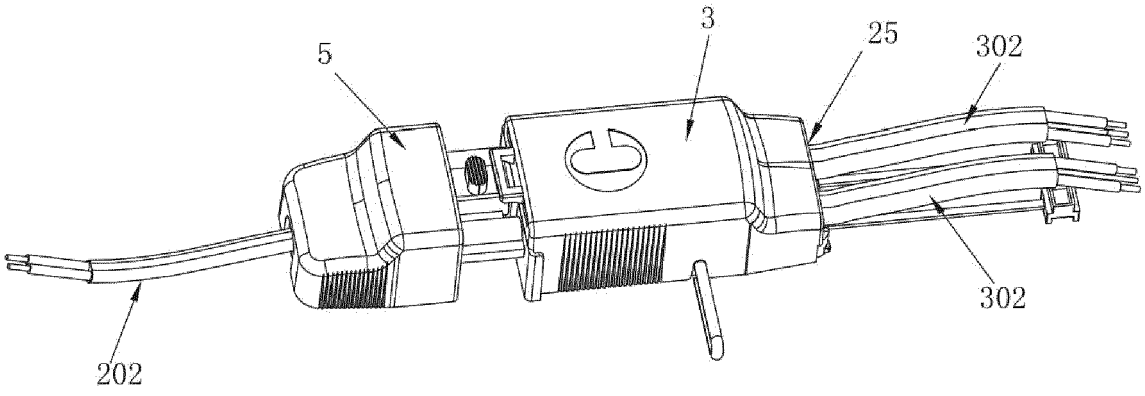

Fig. 5

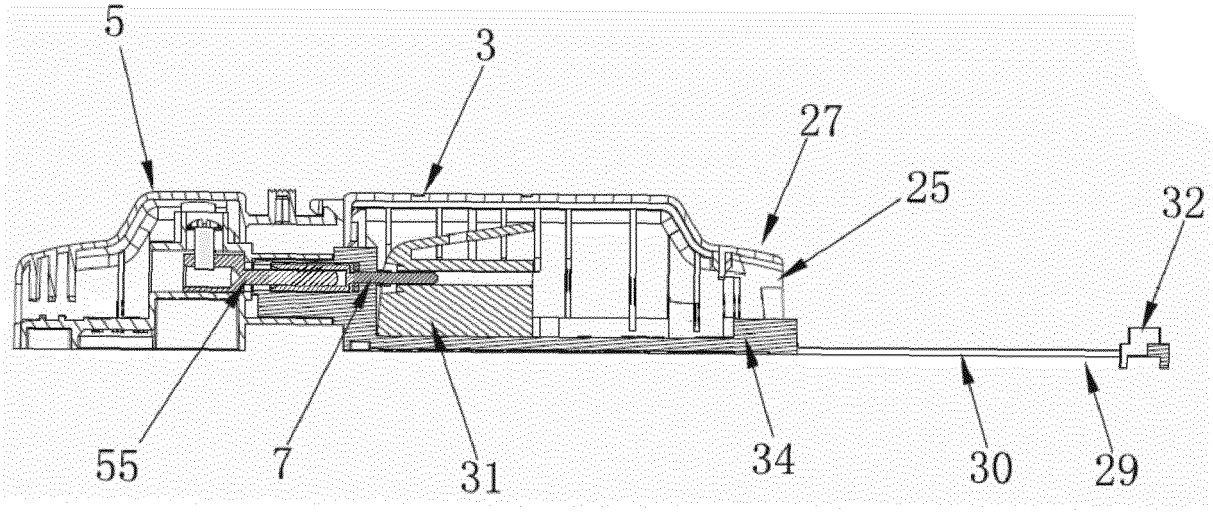
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Fig. 6

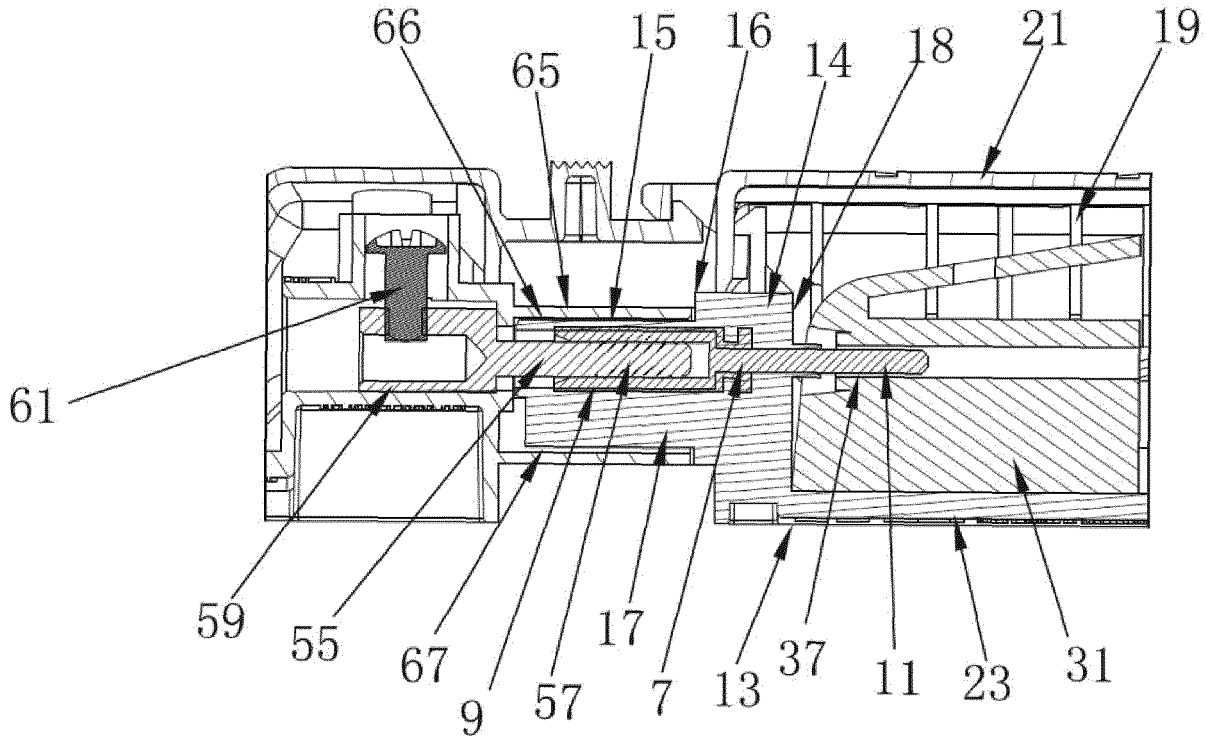
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Fig. 7

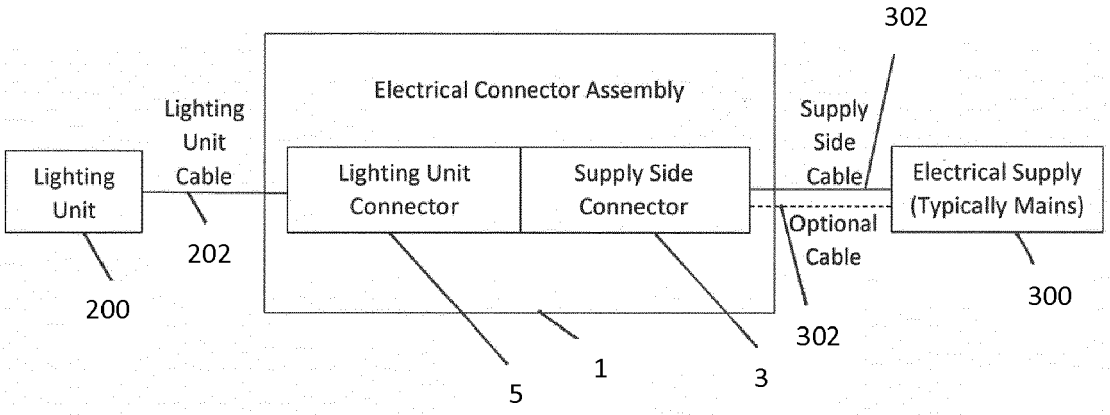
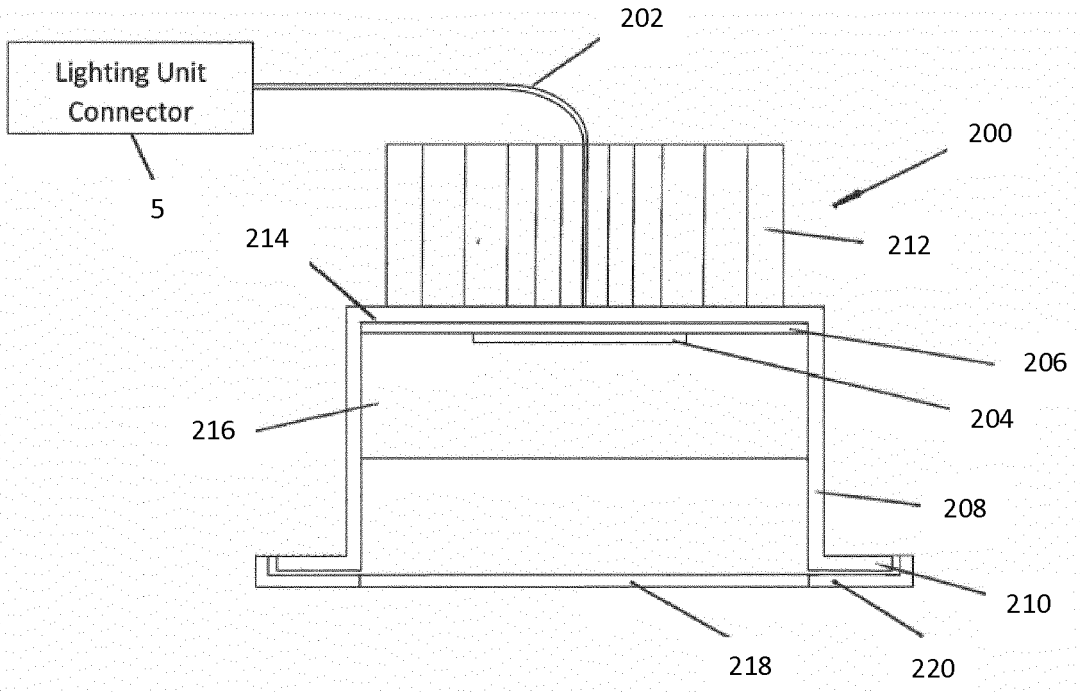

302
Electrical Connector Assembly
Lighting Unit Cable
Supply Side Cable
Lighting Unit
Lighting Unit Connector
Supply Side Connector
Electrical Supply (Typically Mains)
Optional Cable
202
200
300
302
5
1
3

Fig. 8


202
Lighting Unit Connector
200
5
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212
206
204
216
208
210
218
220

Fig. 9

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 19 20 3361

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2018/269602 A1 (OTTO DAVID [ZA]) 20 September 2018 (2018-09-20) * abstract; figures 1,4,5 * -----	1,4-7	INV. H01R9/24 H01R13/405
X	CN 108 468 989 A (HUANG SHIMING) 31 August 2018 (2018-08-31) * figures 3,4 * -----	1-6,8-19	ADD. H01R4/48 F21V23/06

TECHNICAL FIELDS SEARCHED (IPC)

H01R
F21V
F21S

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	27 March 2020	Corrales, Daniel

CATEGORY OF CITED DOCUMENTS

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27-03-2020

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82