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(54) Plug and socket arrangement for modular network

(57) An electrical plug and socket arrangement has a plug with first, male or female, interlocking members adapted to mate with second, female or male, interlocking members provided in a socket. The interlocking members are brought into a first mated configuration with the plug and socket engagement faces substantially mutually parallel then interlocked by movement along a second direction substantially parallel to the plug and socket engagement faces. The male interlocking members have a pillar of electrically insulating material holding a first electrical contact, and the female interlocking members have a cavity of electrically insulating material holding a second electrical contact so that the electrical contacts come together when the plug and socket are interlocked. The male interlocking members may be adapted to shield the first electrical contact from accidental contact with a human body part when the plug and socket are unengaged.

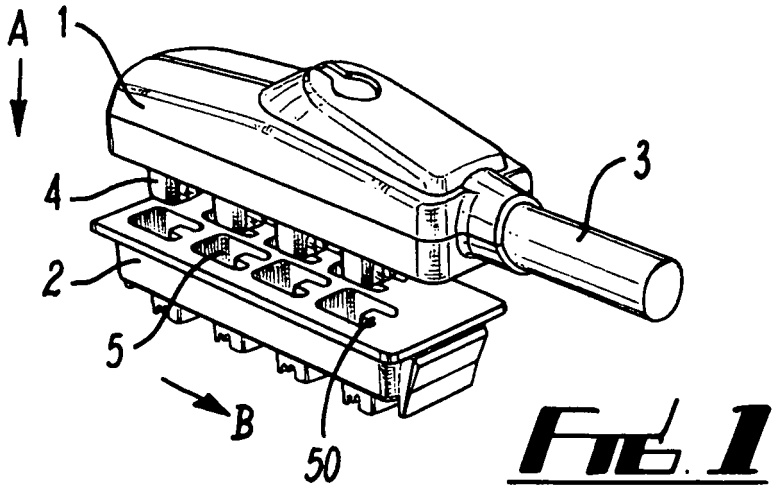

FIG. 1

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Description

[0001] The invention relates to plug and socket arrangements suitable for use with modular networks for distributing electrical power in a structure, such as a building, to power outlet sockets, luminaires, control switches and the like. In particular, the invention relates to plug and socket arrangements which may be used for customising a network to a particular structure, such as a building having various interior spaces such as rooms or corridors, by plugging together prefabricated modules using connection cables in order to achieve a power distribution network. Plugs and sockets are also provides, as are modular networks using the plug and socket arrangements for distributing electrical power to power outlets whilst also enabling control and switching of outlet sockets and/or luminaires.

[0002] Typical buildings are provided with networks of electrical power outlet sockets and lighting systems which are interconnected, via a wiring network and control switches, to a mains power supply. This is the case for both residential buildings and larger non-residential buildings. There may be a central distribution board providing single phase inlet electrical power to the networks, with the central distribution board powered by an external three phase (three pole and neutral) mains supply.

[0003] Various methods have been used in the past for the connection of electrical power and lighting systems. In one method, cables are connected from a central distribution board, which distributes the single phase mains supply, directly to outlet sockets, switches and luminaires. Containment of cables is typically within conduit or trunking extending through the structure. The wiring of switches, cables luminaires is typically achieved using hard-wired screw connectors. Cables are cut to length and hard-wired to the luminaires or switches.

[0004] In another method luminaires are linked into a hard wired system using plug and socket connection interfaces. The sockets form part of the fixed wiring with the plug connected to the luminaire fitting by a cable to allow simple connection and disconnection of luminaires into the power supply network. The plug may be prewired into order to reduce installation time.

[0005] Another method, typically referred to as a spider distribution method, involves the use of marshalling boxes. The marshalling boxes are used to distribute and control power to a number of luminaire fittings. Control may be integrated by the use of an occupancy sensor, for instance, to provide localised automatic switching of all luminaires attached to a particular marshalling box. Marshalling boxes have typically a single incoming hardwired connection and the electrical and are a cost effect method for installations of large numbers of luminaires. Rather than the luminaires being hard-wired to the marshalling box and control system, the luminaires may be connected to the marshalling box via a plug and socket connection at each luminaire.

[0006] Digital lighting control systems are also known in the prior art. Such systems distribute both power and data signals to digital controllers arranged to control the power supply to luminaires. Such systems offer benefits of increases levels of control and potential for energy saving. For instance, digital occupancy sensors may be used to detect when rooms are empty and switch off the lights in order to save energy. Ambient lighting detectors may also be used to switch off lights when there is sufficient ambient lighting that electrical lighting is unnecessary. Over-ride mechanisms can be provided. Digital communication protocols such as DALI or DSI are used to control the individual systems. DALI is Digital Addressable Lighting Interface as set out in IEC62386. DSI is Digital Signal Interface and was the precursor for the DALI system

[0007] Typically, control systems and power distribution systems are dealt with as separate or independent systems by installers.

[0008] In large structures, such as non-residential buildings, conventional hardwiring installation methods usually involve the installation of protective channels in walls or floors through which cables pass. Cables or bundles of cables are inserted through these channels and interconnected with the mains power supply through distribution boards, junction boxes, switches, luminaires and the like. Cable ends eventually connect to an end component such as a socket outlet, a control switch or a luminaire. Although some of the connections may be achieved using plug/socket arrangements, conventional systems invariably require extensive hardwiring by an electrician. Part of the reason for hard-wiring of connections in the prior art is that accidental or unintentional disconnection of plug and socket arrangements in modular networks could lead to live male electrical connections causing fires or making part of a structure live, leading to risk of electrical shock.

[0009] Hence, there is a need for a plug and socket arrangement for distributing electrical power from a mains source to power outlets, control switches and luminaires which overcomes the disadvantages associated with the existing arrangements for providing networks and which allows for the incorporation of a power, lighting, switching and environmental control system into a building without the need for extensive hardwiring operations by an electrician. There is also a need for plug and socket arrangements that are compatible with an integrated digital control network such that energy saving measures may be incorporated into the network by means of environmental sensor systems.

[0010] There is also a need for a plug and socket arrangement that is resistant to unintentional disengagement of its plugs and sockets, and which gives reduced risk of fire or electrocution if disconnected whilst live.

Summary of the Invention

[0011] It is one object of the invention to provide plug and socket arrangements for use in networks for of dis-

tributing electrical power throughout a building through a variety of circuits with minimal hardwiring requirements. It is also an object of the invention to provide plug and socket arrangements which are unlikely to disengage unintentionally and which are unlikely to cause fire or electrocution if left disconnected whilst live.

[0012] A first aspect of the invention provides an electrical plug and socket arrangement comprising a plug and a socket having an unengaged configuration wherein the plug and socket are physically separated and electrically unconnected, and an engaged configuration wherein the plug and socket are electrically connected and mechanically interlocked. The plug has a plug engagement face comprising plurality of first, male or female, interlocking members adapted to mate with a plurality of second, female or male, interlocking members provided in a socket engagement face of the socket. The first and second interlocking members are adapted to be brought into a first mated configuration with the plug and socket engagement faces substantially mutually parallel and brought together by a first relative movement of plug and socket along a first direction substantially normal to the engagement faces. The first and second interlocking members, when in the first mated configuration, are arranged to permit relative movement of the plug and socket into the engaged configuration along a second direction substantially parallel to the plug and socket engagement faces. The first and second interlocking members are arranged to interlock in a second mated configuration when the plug and socket are in the engaged configuration, whereby separation of the engagement faces along the first direction is prevented. The male interlocking members comprise a pillar having pillar walls of electrically insulating material comprising a first electrical contact, and the female interlocking members comprises a cavity having cavity walls of electrically insulating material comprising a second electrical contact, whereby the first and second electrical contacts are electrically isolated in the first mated configuration and electrically connected in the second mated configuration.

[0013] A second aspect of the invention provides a plug arranged for use in a plug and socket assembly according to the first aspect of the invention.

[0014] A third aspect of the invention provides a socket arranged for use in a plug and socket assembly according to the first aspect of the invention.

[0015] A fourth aspect of the invention provides a modular electrical distribution network comprising a plurality of modules interconnected through plug and socket arrangements according to the first aspect of the invention.

[0016] A fifth aspect of the invention provides connection cable comprising a first plug according to the second aspect of the invention, comprising male interlocking members, a second plug according to the second aspect of the invention, comprising female interlocking members and insulated electrical wires operably connecting electrical contacts of the first and second plugs, wherein each plug comprises at least three electrical contacts adapted to carry a current of 13 amperes or more.

Detailed Description of the Invention

[0017] The following detailed features of the invention, as set out for the first aspect of the invention, are also applicable to the other aspects of the invention where appropriate.

[0018] The plug and socket arrangement of the first aspect of the invention suitably has male interlocking members are adapted to shield the first electrical contact from accidental contact with a human body part when the plug and socket are in the unengaged configuration. Similarly, the female interlocking members are suitably adapted to shield the first electrical contact from accidental contact with a human body part when the plug and socket are in the unengaged configuration.

[0019] For instance, the male interlocking members may comprise a first insulating arm extending in the first direction from the engagement face of the plug or socket to a distal end of the first arm with a second insulating arm extending from the distal end of the first arm in the second direction, wherein the first electrical contact is located between the second arm and the engagement face of the plug or socket. With this arrangement, the female members suitably comprise a first shaft extending in the first direction from the plug or socket engagement face to a basal end, the first shaft being adapted to allow the first and second arms of the corresponding male interlocking member to enter the female interlocking member in the first direction to give the first mated configuration. A second shaft, extending from the basal end of the first shaft in the second direction, is adapted to allow the second arm to slide into the second shaft in the second direction to provide the second mated configuration. The second electrical contact is located between the second shaft and the engagement face of the plug or socket, whereby the first and second electrical contacts are brought into electrically conductive contact by the second movement.

[0020] Typically, the plug and socket may me formed from an insulating polymeric material such as nylons, polyesters, polyester containing copolymers, polyolefins, ethylene vinyl alcohol copolymers, acrylonitrile copolymers, acrylic polymers, vinyl polymers, polycarbonate, polystyrene, polyurethanes and combinations thereof. Such polymers are electrical insulators and the insulating parts of the male and female interlocking parts may be made from such polymers. Typically, the insulating parts of the male and female interlocking parts will be unitarily formed with a body of a plug or socket, such as by thermoplastic moulding. The female interlocking member will usually also be of insulating material, other than the second electrical contact it holds.

[0021] Preferably, the plug and socket arrangement comprises a latching arrangement having a latched configuration when the plug and socket are in the engaged configuration, whereby disengagement of the plug and

socket to the disengaged configuration requires release of the latching arrangement to a released configuration.

[0022] Suitably, the latching arrangement, when in a latched configuration, is adapted to prevent relative movement of plug and socket movement along the second direction from the engaged configuration.

[0023] The latching arrangement may comprise a male interlocking member comprising a latching means such as a tooth, catch, rib, detent or the like, with its corresponding female interlocking member comprising a notch, such as a groove or indentation, arranged to engage with the latching means in the second mated configuration.

[0024] Suitably, the plug and socket arrangement may comprise a resilient means arranged to urge the plug and socket engagement faces apart along the first direction, when in the engaged configuration, whereby a gap is formed between the plug and socket engagement faces such that the latching arrangement is held in the latched configuration. Unlatching is achieved by pushing the engagement faces together, against the urging of the resilient means, whereby the gap is closed and the latching arrangement brought into an unlatched configuration, such that the plug and socket may be disengaged by mutual relative movement in the reverse of the second direction followed by separation in the reverse of the first direction. The resilient means, may, for instance, be a resilient means such as a flap resiliently hinged to one of the plug or socket engagement faces such that the hinged flap may be pressed flat as the engagement faces are forced together. The resilient means may, for instance, then be unitarily formed with an engagement surface.

[0025] In another suitable latching arrangement, the latching arrangement may be disengageable by means of an actuation arm extending through the plug body. With this arrangement, the actuation arm may be urged by a resilient means to hold the latching arrangement in a latched configuration whilst the plug and socket are in the second mated configuration. And end of the actuation arm, protruding from the body of the plug, may be pressed in order to disengage the latching arrangement whereby the plug and socket bay be disengaged from the second mated configuration.

[0026] Suitably, the plug is arranged to accept an electrical cable substantially oriented along the second direction, whereby a tensile force along the cable urges the plug towards the engaged configuration.

[0027] The socket engagement surface may be provided with an indicator means which is covered by the plug (such that it is concealed from view) when the plug and socket are positioned with the male and female interlocking members in the first mated position. When the plug and socket are moved into the engaged configuration, with the male and female interlocking members in the second mated position, the movement of the plug relative to the socket suitably uncovers the indicator means, such that it becomes visible. Hence the indicator means can be used to demonstrate, to the person connecting the plug and socket arrangement, that the plug and socket are correctly and fully engaged in the second mated position of the engaged configuration.

[0028] Preferably, the plug and socket arrangement comprises seven or more female interlocking members whereby seven or more conductive pathways are interconnectable through the plug and socket arrangement of the first aspect of the invention.

[0029] Typically, a modular network for use with the plug and socket arrangements of the invention will comprise a permanent live conductor (live or phase live), a neutral conductor (neutral or phase neutral), a circuit protective conductor(earth), a switched live conductor (switched-live), an emergency switched-live conductor (emergency switched-live), a first control conductor(D+) and a second control conductor(D-).

[0030] Typically, the modular network will be arranged to provide at least one of a power outlet socket circuit, a switched lighting circuit, an emergency lighting circuit and an environmental lighting control circuit for a structure or part thereof. It may be configured to provide all or some of these circuits.

[0031] The plug and socket arrangements of the invention should preferably be suitable for providing interconnection of seven or more conductive pathways in order to form circuits. However, not all connectors will necessarily by interengaged to provide conductive pathways at every plug and socket interconnection. For instance, the arrangement may have seven female interlocking members, whereas there may be only three, five or seven male interlocking members arranged to interconnect with the corresponding female interlocking members when the plugs and sockets are interengaged. Hence, if a modular network, or part of a modular network, connected through the plug and socket arrangement of the invention only requires earth, live and neutral conductive pathways, the incoming connector may be a three-pin plug with the male members arranged to provide these three circuits. If the D+ and D- control circuits are not needed for a luminaire, then, for instance it may be connected into the network at a socket using a plug with five male members, wherein the connectors are arranged to provide live, neutral, earth, switched live and emergency switched live circuits.

[0032] Hence, the selection of a 3-, 5-, or 7-connector component (with male interlocking members) may be used to configure the circuit connections for the modular network of the invention.

[0033] In one plug and socket arrangement of the first aspect of the invention, the first electrical contact in the male interlocking member may be a male contact and the second electrical contact in the female interlocking member may be a female contact.

[0034] In another arrangement, the first electrical contact in the male interlocking member may be a female contact and the second electrical contact in the female interlocking member may be a male contact.

[0035] Typically, male electrical contacts will be in the form of metal blades or ribs forming part of a male or a female interlocking member and female electrical contacts will be in the form of sheaths or clips arranged to accept and grip the male electrical contacts whereby an electrically conductive contact may be formed.

[0036] The terms "plug" and "socket" applied to components of the plug and socket arrangement in this specification are meant to describe whether the component is a fixed component, typically rigidly fixed to a structure (i.e. a socket), or a moveable component (i.e. a plug) which is typically attached to a cable. Usually, when engaging a plug and socket, the socket will remain stationary and the plug will be moved relative to the socket. The terms are not intended to describe whether a component has male or female interlocking members.

[0037] Hence, the plug of the plug and socket arrangement of the invention may comprise male interlocking members with the socket comprising female interlocking members. Alternatively, the plug may comprise female interlocking members with the socket comprising male interlocking members.

[0038] The invention provides plug and socket arrangements suitable for interconnection of the components of a modular power distribution, lighting, switching and control network for a structure such as a building. It should be noted that although the modular network may be used to provide power outlets for a structure, these electrical power outlets would be conventional power outlet sockets, such as three-pin sockets according to the local national standards, and not sockets of the invention. For instance in the UK, the power outlet sockets will typically conform to British standard BS 1363. The plug and socket arrangements of the invention are specific arrangements for use within a modular network and are not intended for manipulation by an end-user once the modular network has been installed. Typically, the interconnections of a modular network will be concealed from an end-user within conduits or behind walls or ceilings of the structure so that they are only accessible by electricians rather than accessible to the end-user.

[0039] The fourth aspect of the invention provides a modular electrical distribution network comprising a plurality of modules interconnected through plug and socket arrangements according to the first aspect of the invention. For the sake of conciseness, in this specification, a plug according to the second aspect of the invention having male interlocking members is referred to as a male plug, and its corresponding socket a female socket. Similarly, a plug according to the second aspect of the invention having female interlocking members is referred to as a female plug, and its corresponding socket a male socket,

[0040] The modular network of the fourth aspect of the invention, for providing power, lighting and control circuits for a location in a structure, will typically comprises at least seven conductive pathways operably distributed to a plurality of power outlet sockets and/or luminaires and/or switching means and/or power control means.

[0041] Preferably, the modular network will comprise seven conductive pathways. These conductive pathways may include a permanent live conductor (live or phase live), a neutral conductor (neutral or phase neutral), a circuit protective conductor (earth), a switched live conductor (switched-live), an emergency switched-live conductor (emergency switched-live), a first control conductor (D+) and a second control conductor(D-).

[0042] The modular electrical distribution network preferably comprises two types of plug and socket arrangements, each according to the invention, which are mutually incompatible. In other words, the plug of one type cannot engage operably with a socket of the other type, and vice versa.

[0043] Preferably, the plug and socket arrangements comprise one type wherein the plugs comprise male interlocking members (male plugs) and another type wherein the plugs comprise female interlocking members (female plugs). This gives the advantage that two types of plug and socket arrangement may be used within a single modular network without risk of inappropriate connections being made unintentionally. Preferably, plugs with male interlocking members (male plugs) are used to connect end-components or termination modules such as switches, luminaires and controllers into the network, whereas plugs with female interlocking members (female plugs) are used for supplying power input into the network, as well as connecting other circuits. With such a configuration, in the event that any plug and socket arrangement is disconnected whilst the network is live, the plug with male connectors will not be live as explained above.

[0044] The network will suitably comprise a local distribution module operably connected to a single phase power supply as input and comprising a plurality of female sockets for output of the conductive pathways, optionally, one or more marshalling modules comprising a male socket for input of the conductive pathways and at least one female socket operably connected thereto for output of the conductive pathways, one or more termination modules selected from power outlet sockets, luminaires, switching means, power control means and combinations thereof, each comprising either a male plug or a male socket, and one or more connection cables comprising a male plug operably connected to a female plug by a length of insulated cable, wherein the termination modules are operably connected to the female sockets of the local distribution module either directly or indirectly via the connection cables and/or optional marshalling modules.

[0045] Typically, the modular network will be arranged to provide at least one of a power outlet socket circuit, a switched lighting circuit, an emergency lighting circuit and an environmental lighting control circuit for a structure or part thereof. It may be configured to provide all or some of these circuits.

[0046] Although the modular network preferably has

at least seven conductive pathways, and may typically only have seven conductive pathways, it should be noted that in any particular network configuration, not all of the pathways would necessarily be operably connected to form circuits. For instance, when the modules of the network are used solely to provide power outlet sockets, it may be that only the live, neutral and earth pathways need to be operably connected within the modular network. However, a benefit of the invention over the prior art is its versatility for use in provision of multiple circuits by means of interconnection of modular components with reduction in, or elimination of, the need for hard-wiring.

[0047] When the modules of the network are used to provide power outlet sockets and manually switched luminaires, it may be that only the live (i.e. phase live), neutral (i.e. phase neutral), earth and switched live pathways are operably connected within the modular network, or within a relevant part of the modular network, with switch modules connected into the network and switching between live and switched-live conductive pathways to control the luminaires.

[0048] When the modules of the network are used to provide electrical power outlet sockets and manually switched luminaires as well as emergency luminaires (which are arranged to illuminate when an alarm condition is activated, for instance illuminating emergency exit routes), then it may be that only the live, neutral, earth emergency switched live and switched live pathways are operably connected within the modular network, or within a part of the modular network, with an emergency control switch connected into the network and switching between live and emergency switched-live conductive pathways to control the emergency luminaires.

[0049] A termination module of the modular network interconnected using the plug and socket arrangements of the invention may be an electrical power outlet socket, comprising either a male plug or a male socket of the invention, connected to the female sockets (of the einvention) of the local distribution module either directly or indirectly via the connection cables and/or optional marshalling modules. Hence, the local distribution module may be used to provide a plurality of electrical power outlet sockets for part of a structure, such as part of a building, all powered through the local area module. Typically, only live, neutral and earth circuits will be connected for these power outlet socket modules.

[0050] A termination module of the network may be a luminaire comprising either a male plug or a male socket, connected to the female sockets of the local distribution module either directly or indirectly via the connection cables and/or optional marshalling modules. A luminaire will be arranged to have, as its main power supply, either the switched-live or emergency switched-live circuits. Luminaires for use in the modular network of the invention may also be provided with a digital controller, such as an electronic ballast, as part of the luminaire, such that signals to the luminaire's digital controller, sent using the D+ and D- conductive pathways, may be used to control the light output of the luminaire when it is switched on.

[0051] A termination module of the modular network of the invention may be a switching means, comprising either a male plug or a male socket, connected to the female sockets of the local distribution module either directly or indirectly via the connection cables and/or optional marshalling modules.

[0052] The switching means is suitably a conventional one-way on/off electrical power switch, and will typically be connected to make or break a connection between the live and switched-live conductive pathways connected through the switch. Such switches may be operably interconnected to one or more luminaires by operable connection of the switch module and the luminaires (directly or through a daisy-chain of further marshalling modules) to male sockets of the local distribution module of the network, such that when the switch makes or breaks the connection between live and switched-live circuits through the local distribution module, the luminaires connected through the local distribution module are switched on and off respectively. To achieve this, the luminaire power supply is arranged to be through the switched-live circuit from the local distribution module.

[0053] A similar arrangement may be used for an emergency lighting circuit, where the switch is an emergency switch and is arranged to make or break a connection between the live and emergency switched-live conductive pathways connected through the emergency switch. Any luminaires operably connected to a local distribution module (directly or through marshalling modules), where the local distribution module is also operably connected to the emergency switch, and with the power for the luminaires arranged to be supplied through the emergency switched-live circuit, will be switched on and off by the emergency switch. The emergency switch may be a manual switch, such as a circuit check switch, typically operated by a key to check correct functioning of an emergency lighting circuit, or may be a servo-controlled switch, for instance, operated by an alarm system of a structure. In one configuration, the emergency switched-live conductive pathway for the module may be connected to a central control system for the structure (such as an alarm system or building management system) so that in an emergency, the emergency switched live circuit would be made live from the central control system. However, the local circuit of the modular network can be tested using the emergency switch connected to the local distribution module.

[0054] A termination module of the network may be a power control means module comprising either a male plug or a male socket of the invention, connected to the female sockets (of the invention) of the local distribution module either directly or indirectly via the connection cables and/or optional marshalling modules. The power control means may thus be interconnected to the digital controllers of the luminaires of the network such that digital signals sent using the D+ and D+ circuits might be used to control the light output from the luminaires when

they are switched on. For instance, a power control module may comprise an occupancy sensor, such as a movement detector, whereby the power control module may reduce or turn off the luminaires output when no movement is detected, thus saving energy when a space to be illuminated is left unoccupied.

[0055] For instance a power control module may comprise an ambient light sensor, whereby the power control module may reduce or turn off the luminaires output when ambient light in a space is adequate, thus saving energy when a space to be illuminated is already illuminated by ambient light.

[0056] The modular network using the plug and socket arrangements of the invention may comprise marshalling modules. These comprise a male socket for input of the conductive pathways and at least one female socket operably connected thereto for output of the conductive pathways. Marshalling modules may be used to provide differing circuit arrangements from a local distribution module of the network of the invention.

[0057] In order to facilitate the configuration of the modular network for its particular purpose, the operable connection in marshalling module or in a connection cable may have some of the at least seven conductive pathways being unconnected.

[0058] Furthermore, an operable engagement between a male plug and a female socket of the invention may have some of the at least seven conductive pathways remaining unconnected.

[0059] Similarly, an operable engagement between a female plug and a male socket of the invention may have some of the at least seven conductive pathways being unconnected.

[0060] The male plugs may be colour-coded in order to indicate their function, such as what their safe current rating is and what modules they are suitable to connect. Similarly, the female plugs may be colour coded in order to indicate their function. The colour coding may similarly indicate the connectivity of the plugs (i.e. which connectors are connectable through that plug). Marshalling modules of the network may also be colour coded in a similar manner.

[0061] For instance the modular network interconnected using the plug and socket arrangements of the invention may be arranged to provide several self-contained lighting control circuits as part of the modular network. In this case, the switched-live of the central marshalling module for each self-contained lighting circuit is not connected to the switched lives of the other self-contained lighting circuits through the local distribution module. This disconnection may be by use of connection cables from the local distribution module to the respective marshalling modules where the switched live is not connected in those cables. The cables may be suitably marked to show this to facilitate correct interconnection of the modular network (such as by colour-coding).

[0062] The local distribution module is operably connected to a single phase power supply as input, providing live (phase live), neutral (phase neutral) and earth connections to the live, neutral and earth conductive pathways of the modular network of the invention. However, the other conductive pathways are not necessarily connected outside the modular network, and so can be used for self-contained control of lighting and emergency circuits within the modular network. The local distribution module may be provided with circuit breakers on some or all of the circuits of the conductive pathways. The circuit breakers may be arranged to switch to open circuit when an excessive current is passed through them.

[0063] Alternatively, the modular network may be operably connected to a central lighting control system for the structure. For instance, the local distribution module may have one or more of the emergency switched live, D+ and D- conductive pathways operably connected to a central lighting control system. Usually, the switched live pathway will not be operably connected in this way, so that local switching of luminaires may be effected by means of the switched live conductive pathway as set out hereinbefore.

[0064] The modular network interconnected with the plug and socket arrangements of the invention may be used to distribute power and control to an entire building or may be used for a part of a building. In this latter situation, it may be appropriate to provide the input mains power to the modular network from a mains cable already present in the building. This may be achieved by replacing an existing junction box, such as a ceiling rose junction box by a power outlet module, provided with a female socket of the invention. Such a power outlet module may be used to replace an existing junction box from a previous hardwired system in order to tap into the mains power supply from the previous system. This may suitably achieved by merely replacing the lid of an existing junction box with a lid comprising a type-one socket.

Examples

[0065] A specific embodiment of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 shows a schematic perspective view of a first embodiment of a plug and socket arrangement according to the invention

Figure 2 shows a sectional view through the first embodiment, showing interior detail,

Figure 3 shows details of the electrical contacts of the first embodiment.

Figure 4 shows a schematic perspective view of male plug of a second embodiment of a plug and socket arrangement according to the invention,

Figure 5 shows a schematic perspective view of the

corresponding female socket of the plug and socket arrangement of the second embodiment,

Figure 6 shows a schematic perspective view of female plug of a third embodiment of a plug and socket arrangement according to the invention,

Figure 7 shows a schematic perspective view of the corresponding male socket of the plug and socket arrangement of the third embodiment,

Figures 8A to 8D show a detailed cross-sectional view showing the interengagement of the interlocking members and electrical contacts of the third embodiment as shown in Figures 6 and 7.

[0066] Turning to Figures 1, 2 and 3, these show a first embodiment of a plug and socket arrangement according to the invention. The plug 1 has first interlocking members 4 which are male members, adapted to mate with second interlocking female members 5 of a socket 2. A cable 3 contains wires 10 which are connected to female electrical contacts 6 having a female clip 7, which is adapted to grip a blade 9 of a male electrical contact 8 which is held in a side wall of the second interlocking female members 5.

[0067] The first 4 and second 5 interlocking members are adapted to be brought into a first mated configuration with the plug and socket engagement faces substantially mutually parallel and brought together by a first relative movement of plug and socket along a first direction A substantially normal to the engagement faces. The first 4 and second 5 interlocking members, when in the first mated configuration, are arranged to permit relative movement of the plug and socket into the engaged configuration along a second direction B substantially parallel to the plug and socket engagement faces. The first 4 and second 5 interlocking members are arranged to interlock in a second mated configuration when the plug and socket are in the engaged configuration whereby separation of the engagement faces along the first direction is prevented. This is achieved by the projection 50 in the wall of the second female interlocking members 5 engaging into an opening (not shown) in a wall of the corresponding first interlocking male members 4. The blade of the male electrical contact 9 is held within the projection 50 such that it is brought into electrical engagement with the female electrical contact 7 held in the opening (not shown) when the movement in direction of arrow B takes place. The interlocking of projection 50 and opening prevents separation of the plug and socket in the reverse direction to arrow A.

[0068] The first male interlocking members 4 comprise a pillar having pillar walls of electrically insulating material, polymer in this embodiment and the second female interlocking members 5 comprise a cavity having cavity walls of electrically insulating material, again polymer in this case.

[0069] Figures 4 and 5 show respectively a plug and socket of a second embodiment of a plug and socket arrangement according to the invention. In this embodiment, the plug is a male plug, i.e. the first interlocking members 12 are male members having first 51 and second 52 arms with a male electrical contact 13 in the form of a blade located between the second arm 52 and the engagement face 53 of the plug.

[0070] For the socket 14, the second engagement members 15 are female members in the form of first shafts in the engagement face 54 of the socket 14, with second shafts (not shown) arranged to mate with the second arms 52 of the male interlocking members 12. Female electrical contacts 16 in the form of clips are concealed in a wall of the second engagement members 15.

[0071] As for the first embodiment, the plug 11 and socket 14 are engaged by mating the respective members by mutual movement normal to the engagement faces 53, 54 whilst aligned, followed by a movement parallel to the faces 53, 54 to lock the plug and socket together. In this case, the second arms 52 engage into second shafts (not shown) at the basal ends of the female members 15, such that direct disengagement by a pulling force normal to the engagement faces 53, 54 is prevented. In the fully engaged configuration, the male contacts 13 are gripped by the female contacts 16 to provide electrical connection.

[0072] The socket 14 is provided with a marker 18 such that the word "LOCKED" becomes visible when the plug and socket are fully engaged. The surrounding housing of the socket is not shown. Bus bars 17 are indicated, allowing electrical connection of the female electrical contacts 16 of the sockets.

[0073] Figures 6 and 7 show respectively a plug and socket of a third embodiment of a plug and socket arrangement according to the invention. In this embodiment, the plug 21 is a female plug, i.e. the first interlocking members 22 are female members having first 22 and second (not shown) shafts with a female electrical contact 23 in the form of a clip located in a wall of the first shafts 22.

[0074] For the socket 27, the second engagement members 28 are male members in the form of first arms 57 extending from the engagement face 30 of the socket 27, arranged to mate with the first shafts of female interlocking members 22 with second arms 58 arranged to mate with the second shafts of the female interlocking members 22. Male electrical contacts 29 in the form of blades are located in a wall of the second male engagement members 28, extending from the engagement face 30 of the socket to the second arms 58. The engagement face 30 of socket 27 is recessed and the engagement face 55 of plug 21 stands proud of its surface. Resilient means in the form of springs 42 are located on the engagement face.

[0075] The plug 21 and socket 27 are engaged by mating the respective members by mutual movement normal to the engagement faces 30, 55 whilst aligned parallel to

each other, followed by a movement parallel to the faces 30, 55 to lock the plug and socket together. In this case, the second arms 58 engage into second shafts (not shown) at the basal ends of the female members 22, such that direct disengagement by a pulling force normal to the engagement faces 30, 55 is prevented. In the fully engaged configuration, the male contacts 29 are gripped by the female contacts 23 to provide electrical connection.

[0076] The socket 27 is provided with a marker 32 such that the word "LOCKED" becomes visible when the plug and socket are fully engaged. The surrounding housing of the socket is not shown. Bus bars 31 are indicated, allowing electrical connection of the male electrical contacts 29 of the sockets.

[0077] Figures 8A to 8D show a detailed cross-sectional view showing the interengagement of the interlocking members and electrical contacts of the third embodiment as shown in Figures 6 and 7.

[0078] Figure 8A shows the plug 21 and socket 27 in the first mated configuration with the second interlocking member 28 of the socket located in first shaft of the first female interlocking member 22 of the plug. The location of the second shaft of the female interlocking member is denoted by 60.

[0079] In Figure 8D, partial movement in the direction of the arrow shown leads to second arm 58 sliding into second shaft 60 as male electrical contact blade 29 is engaged with female electrical contact clip 23.

[0080] Figures 8C and 8D show the plug 21 and socket 27 in fully engaged configuration. Male contact blade 29 has been removed from Figures 8C and 8D for the sake of clarity. A tooth 40 on second arm 58 is shown engaged with a rib 41 at the edge of shaft 60 in the wall of the female interlocking member 22 to form a latching arrangement. The tooth and rib are held in the latched configuration be the springs 42 (shown in Figure 7) urging the engagement faces 30, 55 apart whereby a gap 43 is formed. The latching arrangement prevents unintentional movement puling the second arm 58 out of second shaft 60. Before such movement can be made, the gap 43 must be closed by pressing the engagement faces 30, 55 together, against the urging force provided by springs 42, to disengage the latching arrangement formed between tooth 40 and rib 41.

[0081] It will be appreciated that numerous modifications to the above described embodiments may be made without departing from the scope of the invention as defined in the appended claims. For example, the plug and socket arrangement may have fewer than seven connectors, for instance three or five, or the plug and socket arrangement may have fewer male connectors than female connectors. For instance a male plug with three, five or seven first male interlocking members may be mated with a female socket with seven second female interlocking members.

[0082] The described and illustrated embodiments are to be considered as illustrative and not restrictive in character, it being understood that only the preferred embodiments have been shown and described and that all changes and modifications that come within the scope of the inventions as defined in the claims are desired to be protected. It should be understood that while the use of words such as "preferable", "preferably", "preferred" or "more preferred" in the description suggest that a feature so described may be desirable, it may nevertheless not be necessary and embodiments lacking such a feature may be contemplated as within the scope of the invention as defined in the appended claims. In relation to the claims, it is intended that when words such as "a," "an," "at least one," or "at least one portion" are used to preface a feature there is no intention to limit the claim to only one such feature unless specifically stated to the contrary in the claim. When the language "at least a portion" and/or "a portion" is used the item can include a portion and/or the entire item unless specifically stated to the contrary.

Claims

1. An electrical plug and socket arrangement comprising a plug and a socket having an unengaged configuration wherein the plug and socket are physically separated and electrically unconnected, and an engaged configuration wherein the plug and socket are electrically connected and mechanically interlocked,
wherein the plug has a plug engagement face comprising plurality of first, male or female, interlocking members adapted to mate with a plurality of second, female or male, interlocking members provided in a socket engagement face of the socket,
wherein the first and second interlocking members are adapted to be brought into a first mated configuration with the plug and socket engagement faces substantially mutually parallel and brought together by a first relative movement of plug and socket along a first direction substantially normal to the engagement faces,
wherein the first and second interlocking members, when in the first mated configuration, are arranged to permit relative movement of the plug and socket into the engaged configuration along a second direction substantially parallel to the plug and socket engagement faces,
and wherein the first and second interlocking members are arranged to interlock in a second mated configuration when the plug and socket are in the engaged configuration whereby separation of the engagement faces along the first direction is prevented,
characterized in that the male interlocking members comprise a pillar having pillar walls of electrically insulating material comprising a first electrical contact, and the female interlocking members comprises a cavity having cavity walls of electrically in-

sulating material comprising a second electrical contact, whereby the first and second electrical contacts are electrically isolated in the first mated configuration and electrically connected in the second mated configuration.

2. A plug and socket arrangement according to claim 1 wherein the male interlocking members are adapted to shield the first electrical contact from accidental contact with a human body part when the plug and socket are in the unengaged configuration.

3. A plug and socket arrangement according to claim 1 or claim 2 wherein the female interlocking members are adapted to shield the first electrical contact from accidental contact with a human body part when the plug and socket are in the unengaged configuration.

4. A plug and socket arrangement according to any preceding claim wherein the male interlocking members comprise a first insulating arm extending in the first direction from the engagement face of the plug or socket to a distal end of the first arm with a second insulating arm extending from the distal end of the first arm in the second direction, wherein the first electrical contact is located between the second arm and the engagement face of the plug or socket.

5. A plug and socket arrangement according to claim 4 wherein the female members comprise a first shaft extending in the first direction from the plug or socket face to a basal end, the first shaft being adapted to allow the first and second arms of the corresponding male interlocking member to enter the female interlocking member in the first direction to give the first mated configuration, and a second shaft, extending from the basal end of the first shaft in the second direction, adapted to allow the second arm to slide into the second shaft in the second direction to provide the second mated configuration, and wherein the second electrical contact is located between the second shaft and the engagement face of the plug or socket, whereby the first and second electrical contacts are brought into electrically conductive contact by the second movement.

6. A plug and socket arrangement according to any preceding claim comprising a latching arrangement having a latched configuration when the plug and socket are in the engaged configuration, whereby disengagement of the plug and socket to the disengaged configuration requires release of the latching arrangement to a released configuration.

7. A plug and socket arrangement according to claim 6 wherein the latching arrangement, when in a latched configuration, is adapted to prevent relative movement of plug and socket movement along the second direction from the engaged configuration.

8. A plug and socket arrangement according to claim 6 or claim 7 wherein the latching arrangement comprises a male interlocking member comprising a latching means and its corresponding female interlocking member comprising a notch arranged to engage with the latching means in the second mated configuration.

9. A plug and socket arrangement according to claims 6 to 8 comprising a resilient means arranged to urge the plug and socket engagement faces apart along the first direction, when in the engaged configuration, whereby a gap is formed between the plug and socket engagement faces and the latching arrangement is held in the latched configuration.

10. A plug and socket arrangement according to any preceding claim wherein the plug is arranged to accept an electrical cable substantially oriented along the second direction, whereby a tensile force along the cable urges the plug towards the engaged configuration.

11. A plug and socket arrangement according to any preceding claim comprising seven or more female interlocking members whereby seven or more circuits are interconnectable through the plug and socket arrangement.

12. A plug and socket arrangement according to any preceding claim wherein the first electrical contact in the male interlocking member is a male contact and the second electrical contact in the female interlocking member is a female contact.

13. A plug and socket arrangement according any preceding claim wherein the first electrical contact in the male interlocking member is a female contact and the second electrical contact in the female interlocking member is a male contact.

14. A plug and socket arrangement according to any preceding claim wherein the plug comprises male interlocking members and the socket comprises female interlocking members.

15. A plug and socket arrangement according to any preceding claim wherein the plug comprises female interlocking members and the socket comprises male interlocking members.

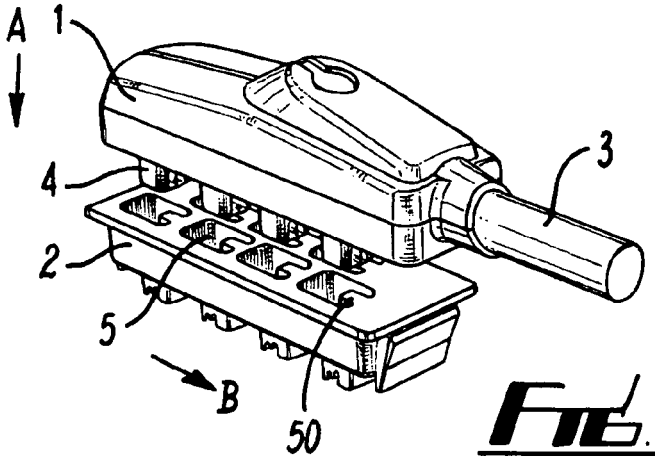

FIG. 1

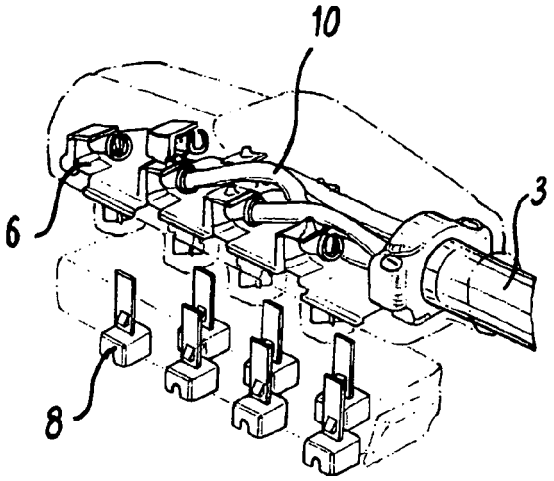

FIG. 2

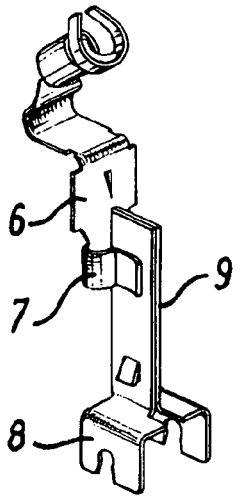

FIG. 3

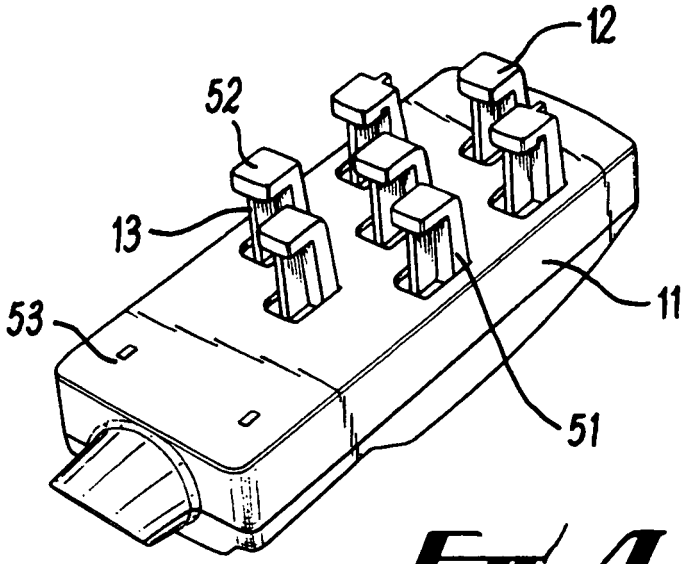

FIG. 4

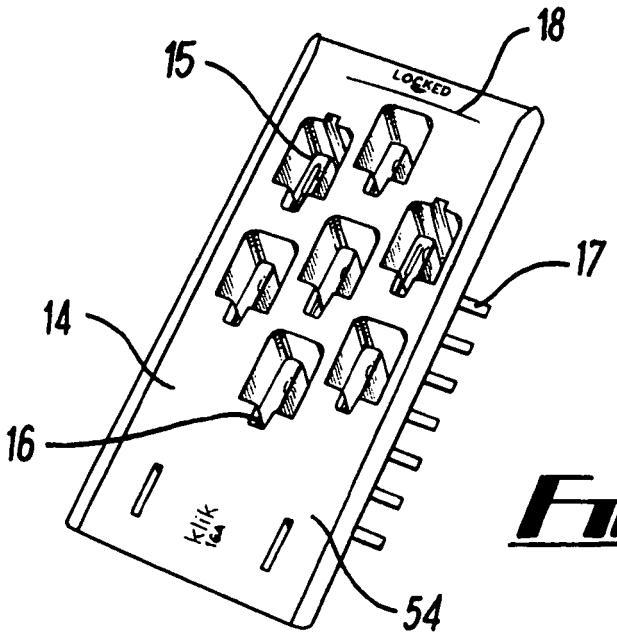

FIG. 5

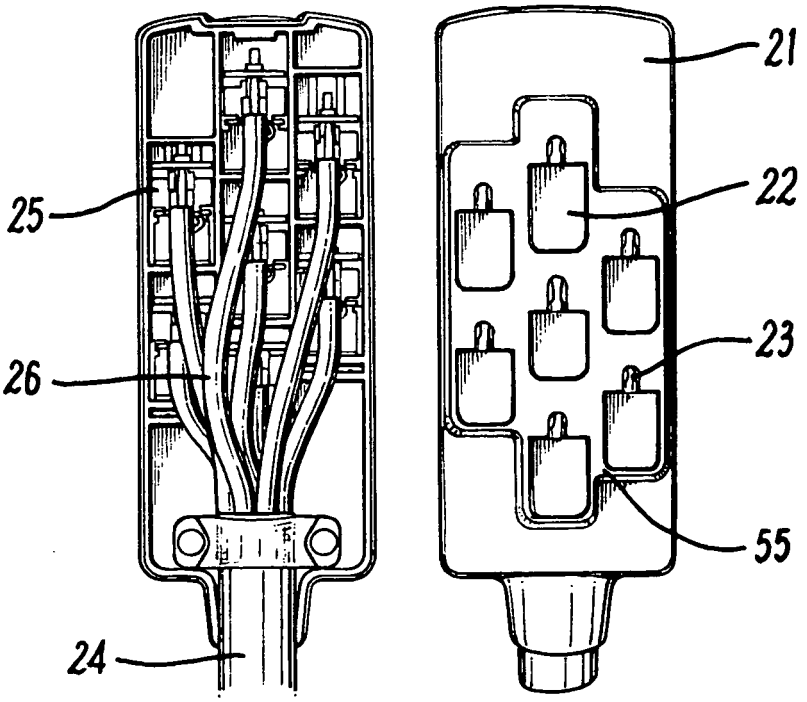

FIG. 6

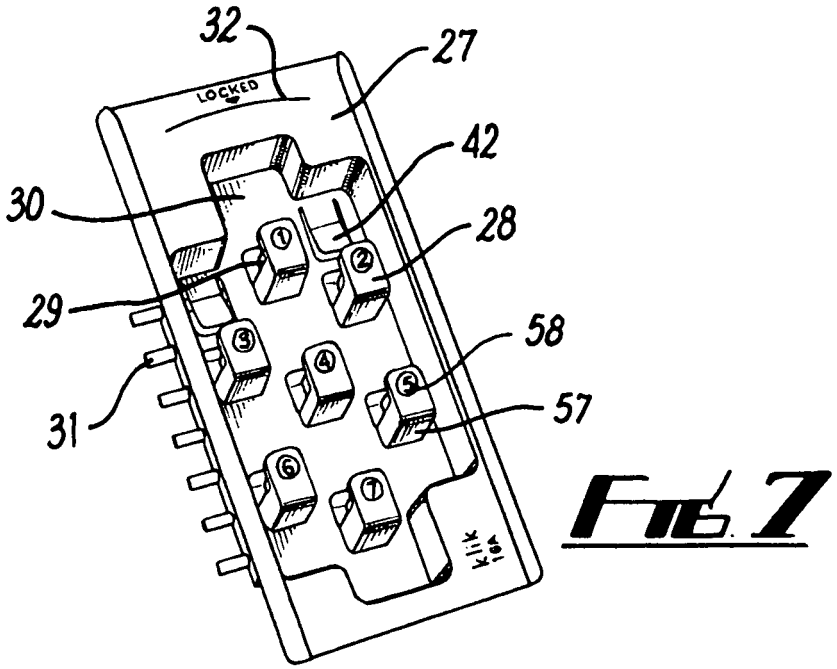

FIG. 7

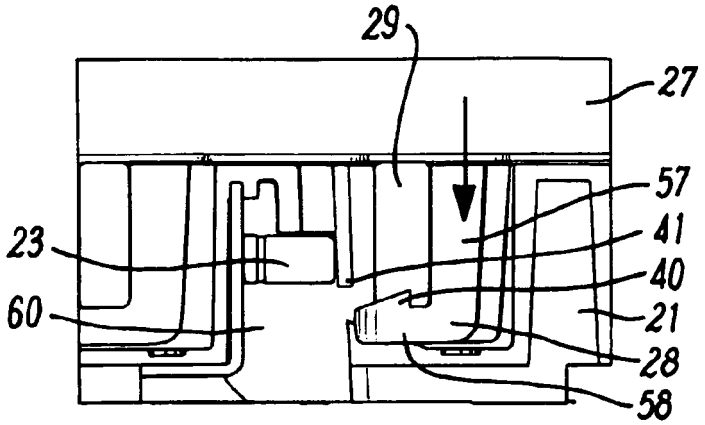

FIG. 8A

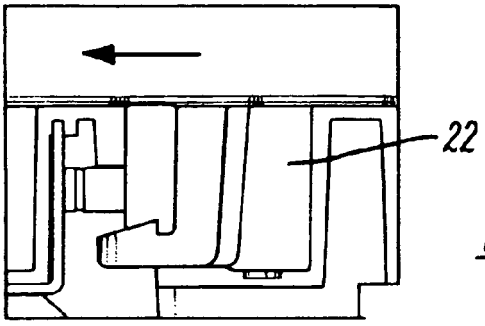

FIG. 8B

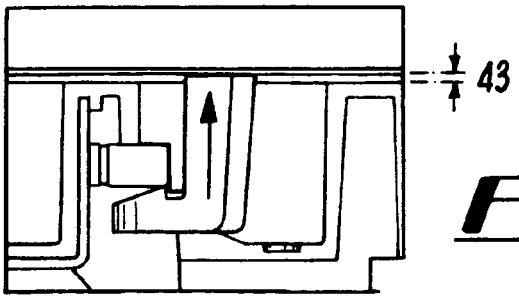

FIG. 8C

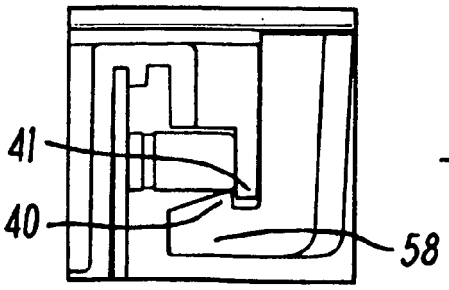

FIG. 8D