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GB 1385357 A **DE 019854200 A1**
US 5330369 A

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INT CL^{7} **H01R**
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(54) Abstract Title: **Connector for multicore cable with positionable pin**

(57) A connector assembly 1 comprising an enclosure 2, a plurality of piercing members 3a, 3b and 3c each having an end for piercing the insulation portion of an electrical cable. The position of the piercing member 3c is changeable so that it can contact with any of a plurality of cores of a multicore cable 20. The connector is fabricated from a variety of materials suitable for confined environments with fire risks. A cable with a plurality of cores each with their own insulating and an outer insulating sheath is also disclosed.

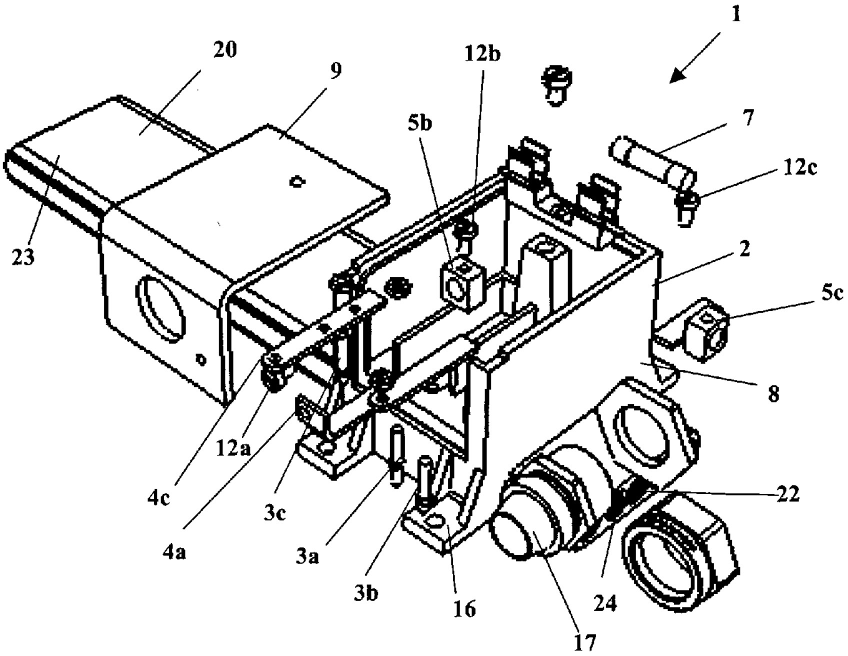

FIGURE 2

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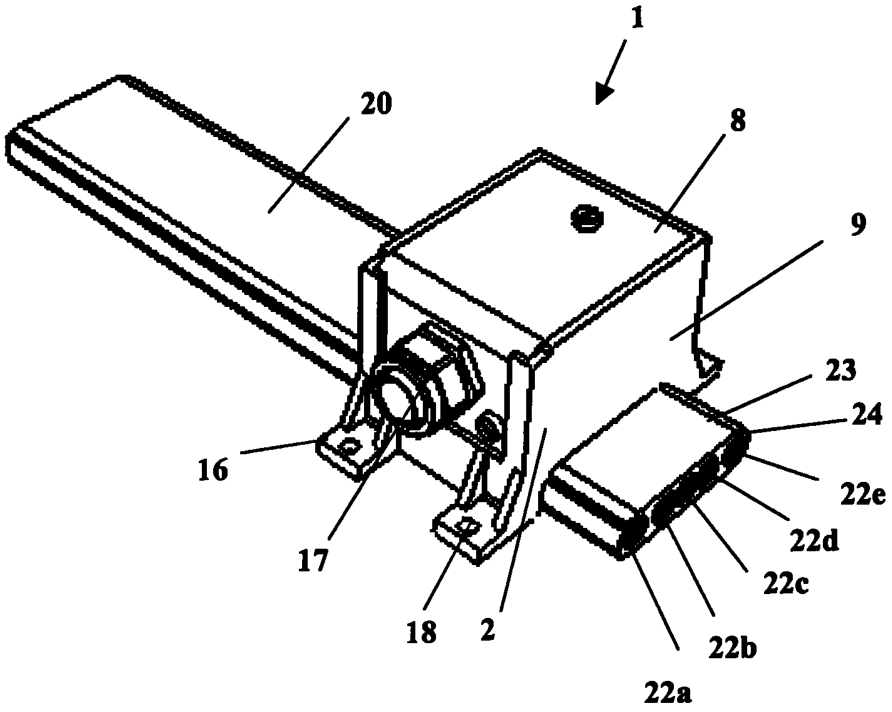

FIGURE 1

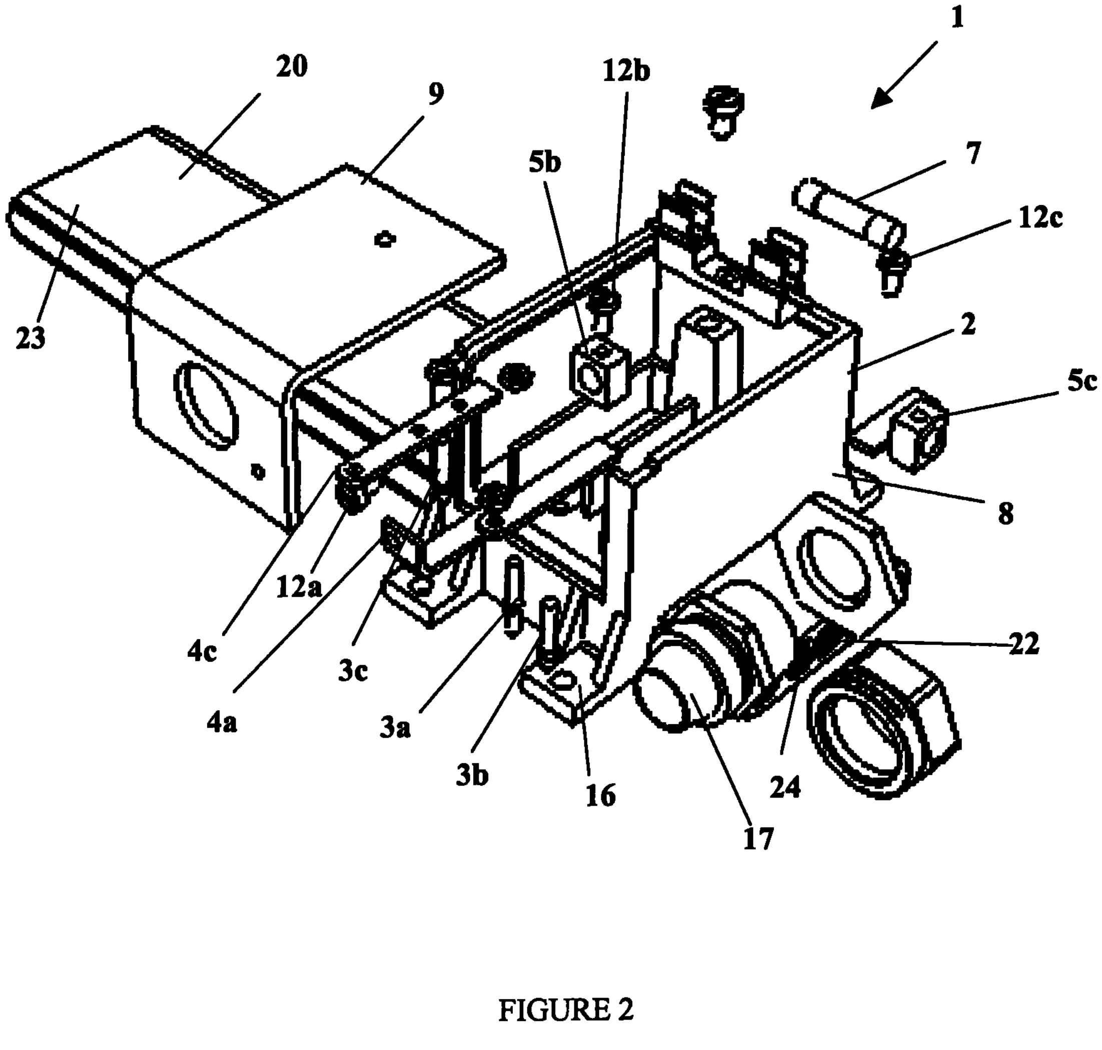

FIGURE 2

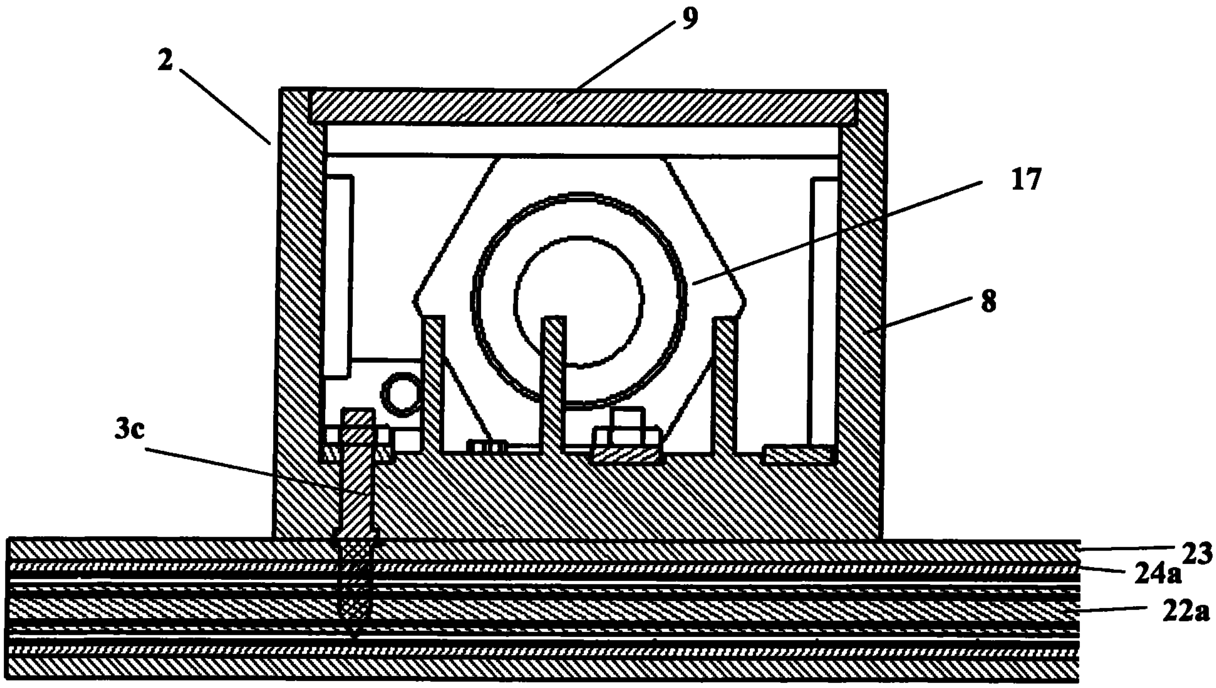

FIGURE 3

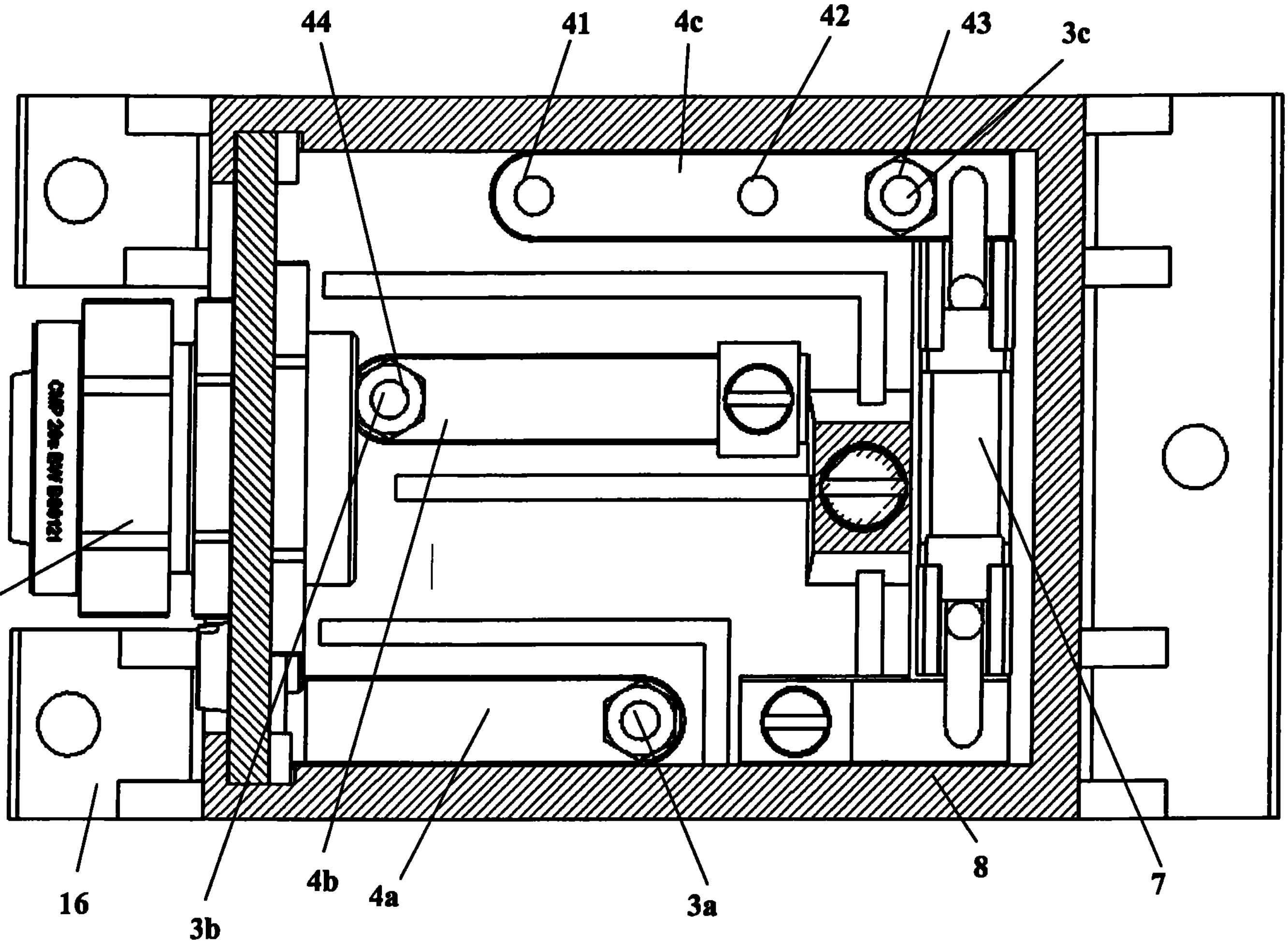

FIGURE 4

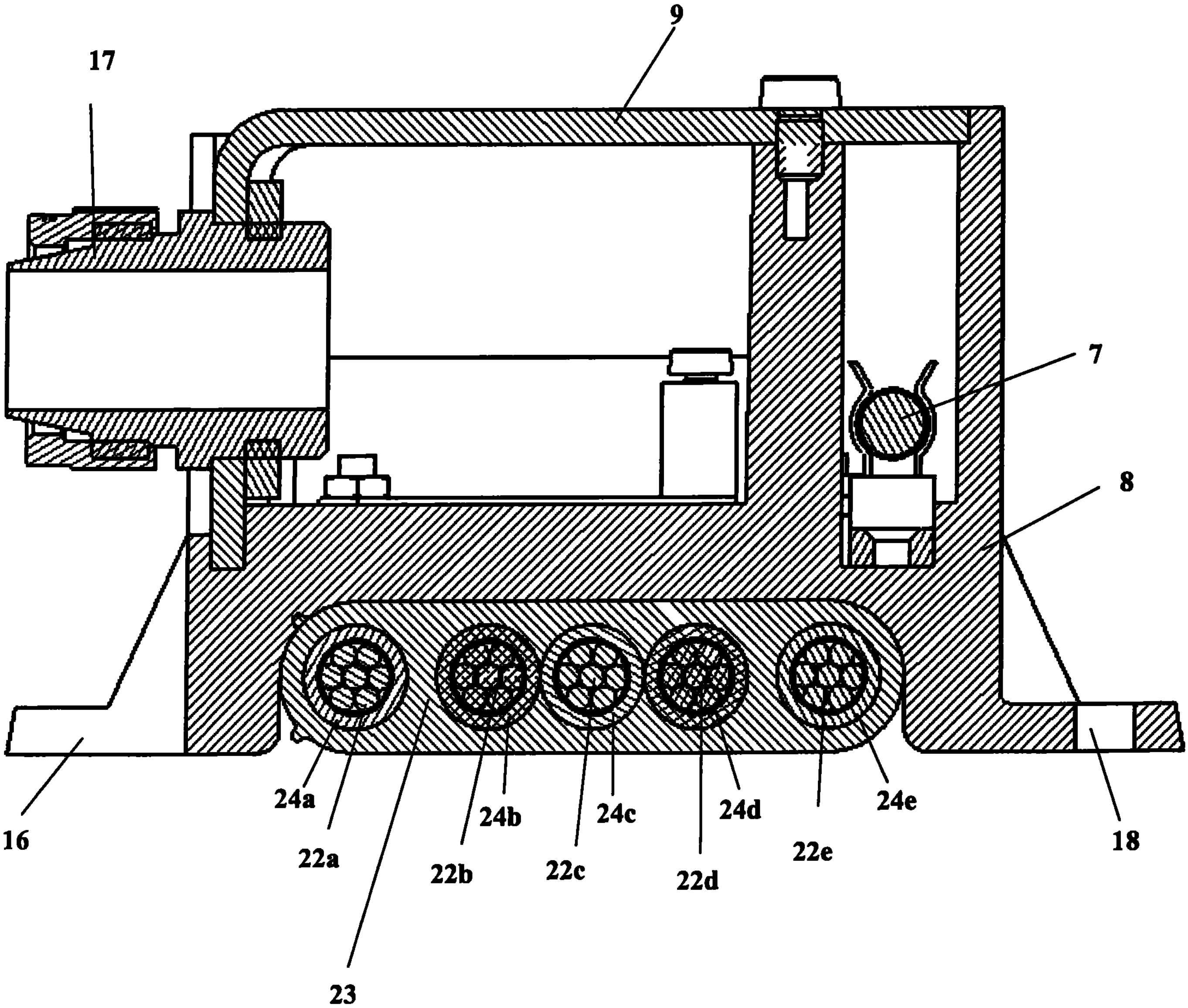

FIGURE 5

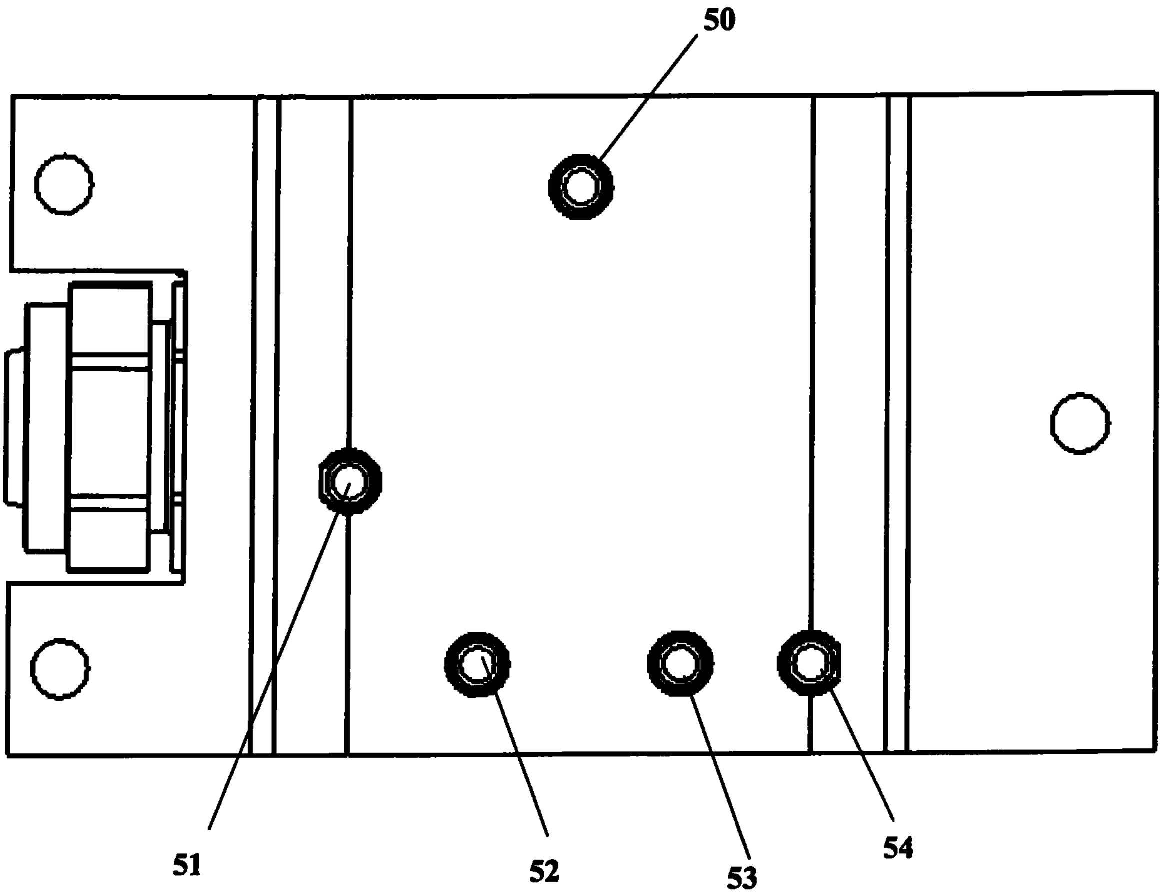

FIGURE 6

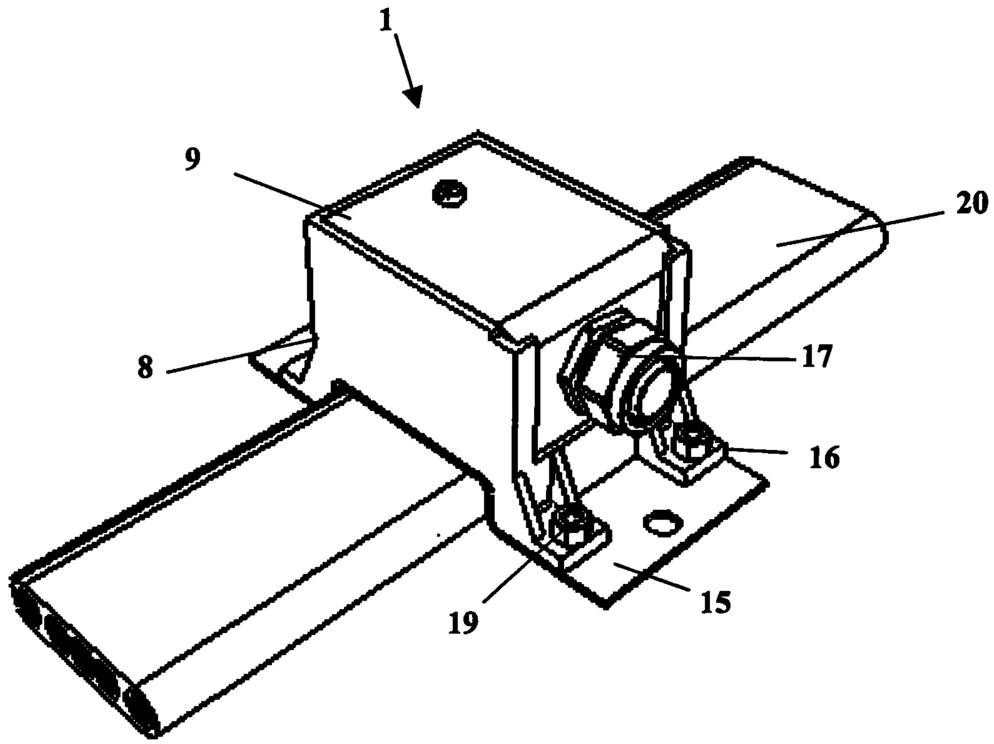

FIGURE 7

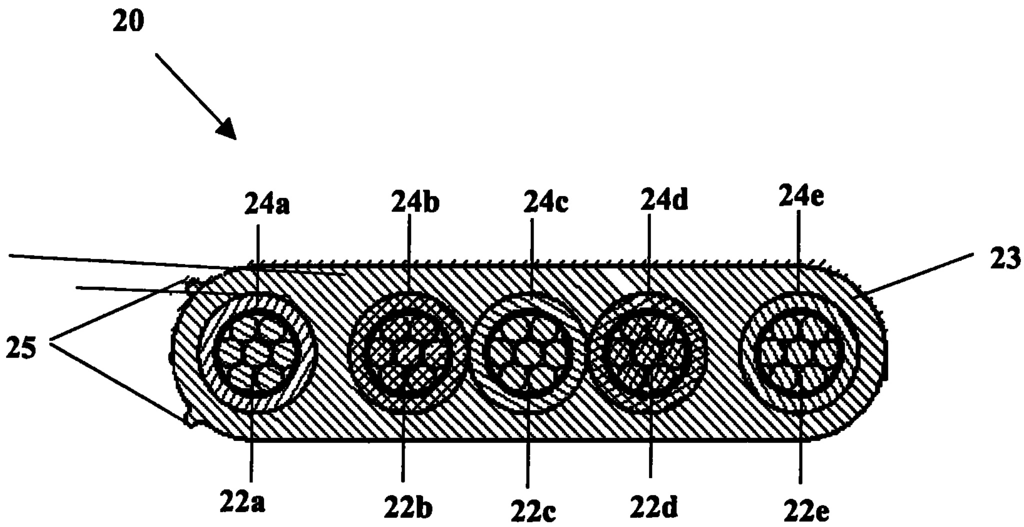

FIGURE 8

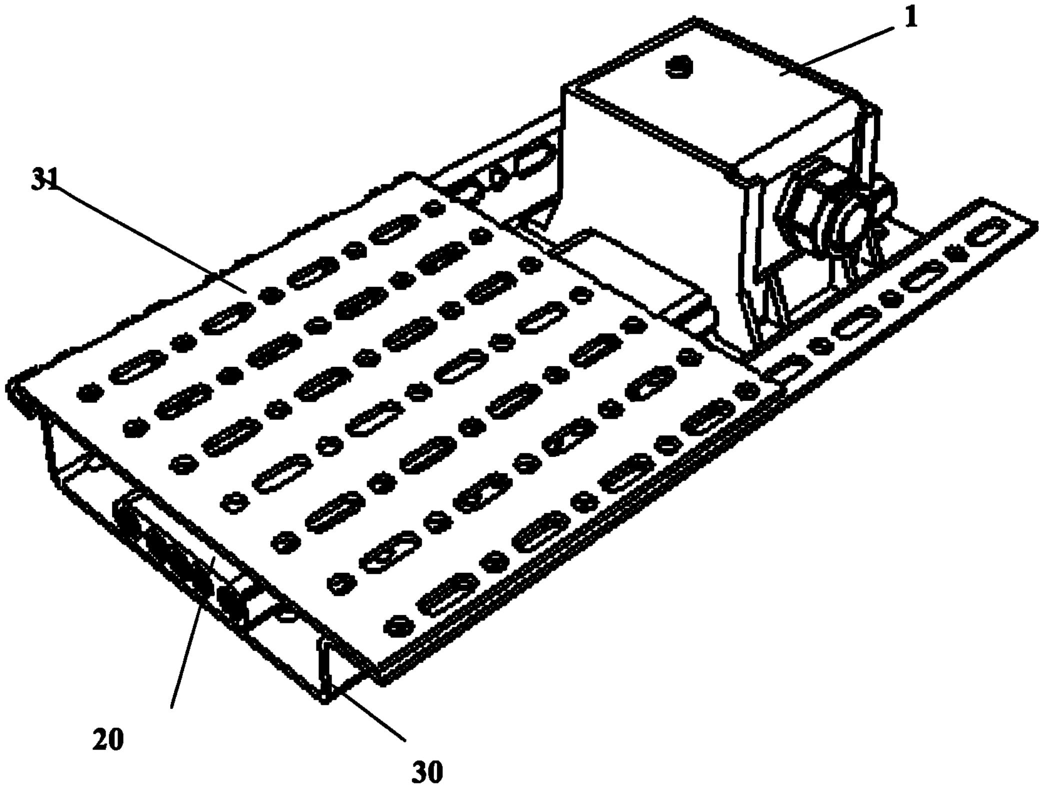

FIGURE 9

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A CONNECTOR AND CABLE ASSEMBLY FOR A POWER DISTRIBUTION SYSTEM

The present invention relates to a cable and connector assembly for a power distribution system. Particularly, but not exclusively, the invention relates to a connector and cable assembly for a power distribution system for connecting a multiplicity of distributed loads in a simple and flexible manner.

Installation of power distribution systems for distributed loads in relatively inaccessible locations such as tunnels is generally difficult due to the large number of connections that need to be made to luminaires or other devices. Furthermore, the fact that these connections must be made by skilled electricians further complicates installation.

It may sometimes be desirable to provide a power distribution system which can be dismounted and reused. Such a system needs to be simple to install and dismount in order to provide flexibility for reuse.

Historically, power distribution cables were delivered to a site and then a skilled electrician would make the connections between the power distribution cable and the distributed loads. This usually involves breaking the cable to form the connection. However, such a procedure is very time consuming and requires a skilled electrician to complete the task. It is therefore desirable to improve the ease of installation of such cable systems and the ease of connection of the distributed loads.

There are various known methods for facilitating the connection of electric lamps to cables. GB368023 describes an electric lamp connector which can be used with a multi-core flat cable, or a number of single core cables. Electrical contact is established by means of a pointed contact element piercing the insulating covering of the cables. Electric current can be drawn from any of the cables by altering the position of the contact element in the rear of the connecting socket. GB417393 describes an electric lamp holder which can be connected to wires supplying electric current without the need for striping the insulation from the wires. The holder is arranged so that screws are threaded through the upper ends of the two pole pieces of the holder. The screws each have an insulated knob projecting from the side of the holder so that the screw can be turned to pierce the current carrying wire. DE19940148 describes a power branching unit with electrically conducting contact pins which penetrate the insulation of a flat cable to take current from any point along the length of the flat cable.

Power distribution systems in tunnels may be exposed to different conditions such as moisture, dust and other contaminants, and so they are often designed to operate in such environments. GB1449163 describes a lamp holder having a weatherproof sealing arrangement between the contact assembly and the cable insulation.

Such systems suffer from the disadvantages that they are not designed to continue to operate in the event of a fire when they could be exposed to heat, flames, smoke, water and other elements which may affect their performance.

In order to withstand the elements accompanying a fire, power distribution systems must be fabricated from materials which can maintain a sufficient degree of electrical insulation between electrically conductive components when exposed to these elements and other hazardous substances. These materials therefore usually conform to performance standards such as IEC331, EN50200 or BS6387CWZ. It is also important to ensure that the cable distributing power to distributed loads remains operational even if some of the devices attached to it fail. For example, if some of the luminaires local to a tunnel fire fail, it is important that the power supply to the remaining functioning luminaires is maintained irrespective of the nature of the failure.

The system must often be designed to withstand the invasion of dust particles and moisture into the system. Preferably, they should be designed to have an IP rating of IP65.

In addition, such systems are preferably required to be fabricated from materials which do not emit hazardous or toxic combustion products, or excessive quantities of smoke when exposed to a fire. This helps to ensure the safety of any personnel within the area to be served by the system. These materials therefore usually conform to safety and fire performance standards such as IEC754-1 (EN50268) or BS7622 (EN50267).

At the same time such power distribution systems should be capable of being readily produced using cost effective manufacturing processes.

WO 0109990 describes a connector and cable assembly for lighting in a tunnel which may be used in an emergency or during repairs. The described system incorporates modular pre-fitted plug and socket type connector fittings. The pre-fitted socket outlets are provided at pre-set, periodic intervals along the length of a power cable so that connections can be made to, and power tapped from the cable.

Such a system suffers from the disadvantage that it necessitates off-site preparation of the backbone distribution cable to facilitate the plug and socket connection of the lights. Furthermore, the position of the socket outlets must be determined before manufacture and installation of the cable assembly in a tunnel. Such a feature limits the flexibility of the system. The pre-fitted socket outlets also make the transportation of the cable to site more problematic due to the cumbersome nature of the prefabricated backbone cable. Other disadvantages of the system include the large quantities of material required to manufacture the system as well as the bulkiness, complexity and cost of the system.

There is therefore a need to overcome these problems by providing a connector arrangement which eliminates the necessity for any off-site preparation of the complex backbone electrical distribution cable, which allows a large number of connections to be made without the requirement for skilled electricians and which can continue to operate in the event of a fire.

In addition, it would be desirable to provide a connector assembly that does not require determining the position of connectors in advance thereby allowing connections to be made at any point along the cable after installation.

It is further desirable to provide a connector assembly which can be dismounted and used again elsewhere.

According to a first aspect of the present invention there is provided a tunnel cable connector assembly for use with a multicore cable, the assembly comprising: an enclosure; a plurality of electrically conductive piercing members, each having an end adapted to pierce the insulation of an electrical cable; a plurality of electrically conductive elements, each adapted to receive one of said piercing members; at least one of the piercing members being provided in one of a plurality of positions corresponding to respective cores of a multicore cable to which the connector assembly is to be connected.

This arrangement simplifies the connection of a plurality of distributed loads to a power distribution system.

A further advantage of this arrangement is that any spark which may occur on connection of a piercing member to a core of a multicore cable will be contained within the cable, away from flammable gases which may be present in the tunnel environment.

Preferably, the connector assembly comprises an enclosure having an electrically non-conductive portion for supporting the conductive elements.

Advantageously, the connector assembly comprises an enclosure having a metallic portion. The use of metallic components has the advantage that they do not contribute to the spread of fire thus improving the overall fire performance of the connector assembly. Furthermore, the use of metallic components reduces the number of separate mouldings that are required to make the connector. The construction of the connector therefore becomes more cost effective since press metal tools have a lower cost than injection moulding tools. The metallic portion also provides a safety earthing path thereby simplifying the connection from the earth pin of the connector assembly to a metallic gland to which spur cables, in many cases armoured, may be connected. This helps to eliminate the need for additional earth components in the connector assembly.

The enclosure may comprise a detachable portion to facilitate access to the internal components.

The enclosure may be designed to co-operate with fixing systems moulded within the insulation around a power distribution cable so permitting the use of the minimum number of screws. Alternatively, a simple mechanical clamp or strap may be used to hold the connector assembly to a power distribution cable.

It is particularly preferred that the electrically non-conductive portion is fabricated from a material with conforms to safety and fire performance standards. It may be fabricated from a material exhibiting non-toxic, low-smoke or zero-halogen combustion properties. For example it may be a material conforming to an acid gas emission standard such as IEC 754-1 or EN50268, or smoke emission standards in the spirit of BS7622 or EN50267. Such a material may be a mineral filled glass reinforced polyester or a ceramic. This feature provides a connector assembly which does not emit hazardous combustion products or excessive amounts of smoke when exposed to a fire, thereby helping to protect personnel in the area of the fire.

It is further preferred that the electrically non-conductive portion is fabricated from a material which retains sufficient physical and electrical properties during a fire to prevent electrical breakdown, thereby maintaining insulation between the different connector poles. For example, it may be fabricated from a material which conforms to fire performance standards similar to IEC331, EN50200 or BS6387CWZ.

The connector assembly may comprise a plurality of electrically conductive terminals. It is preferred that the plurality of electrical conductive terminals comprises an earth terminal, a neutral terminal and at least one phase terminal.

In order to reduce the number of different voltages within the connector, the plurality of electrical conductive terminals may comprise only one phase terminal. In this arrangement the voltages present within a connector for connection of a single-phase load to a polyphase backbone cable are lower than would be the case if all the phases were present in the connector. This configuration therefore has the advantage that the voltages present in the connector are lower than when all three phases of a polyphase connection are present (i.e. 230V compared to 400 V). Such an arrangement reduces the size and complexity of the connector assembly.

Advantageously, one of the plurality of electrically conductive elements is provided with holes to receive one of said piercing members allowing it to pierce any core of a multi-core cable to which the connector assembly is to be connected.

Preferably, each of the plurality of piercing elements is arranged to make contact with a different core of a multi-core cable.

Alternatively, a plurality of piercing elements may be arranged to make contact with the same core of a multi-core cable. This would be useful in high current applications.

The connector assembly may comprise an interrupter within the enclosure. In the event of a catastrophic failure or overload (e.g. during shorting of the phase to neutral or earth in one of the distributed loads due to failure of the insulation during a fire) the interrupter disconnects that load. It may be reasonably anticipated in the event of a fire that a load such as a luminaire will fail to operate since such loads are not normally designed to be fireproof. This feature then allows other distributed loads connected to the same electric cable and phase to continue to operate. For example, in the event of a fire in a tunnel, the continued operation of other loads such as luminaires would then permit evacuation of the tunnel despite one load having failed. An advantage of the interrupter being contained within the connector assembly is that if the interrupter blows, the resultant spark will be contained within the connector assembly, away from flammable gases which may be presence within the tunnel environment.

The interrupter may be an over-current device, a fuse that operates when the temperature proximal to the connector exceeds a predetermined value, or some combination of the two.

It is further preferred that the interrupter is disposed as close as possible to the power distribution cable in order to provide the highest degree of protection. In this way only the final part of the connection between the interrupter and the phase cable is vulnerable to failure.

In a preferred embodiment of the invention, the piercing element in electrical contact with the earth terminal is positioned to make contact with the central core of the multi-core cable.

Beneficially, one of the piercing elements is arranged to make contact with one of the conductors of a multi-core cable before any of the other piercing elements make contact with any other cores of the cable.

It is further preferred that the piercing elements have different lengths. For example, having the earth connector as the longest piercing element ensures that a safety earth connection is provided before any other connection is made. If the load being connected has an earthed metallic enclosure then the safety of the load (and hence the person holding it) is guaranteed before power is applied to the connector.

The connector assembly may comprise a larger male projecting element to co-operate with a matching female recess on a multicore cable to prevent incorrect connection of the connector to the cable.

Advantageously, one or more of the piercing elements comprise an insulated sheath portion. The presence of an insulated sheath portion allows the connector to co-operate with shielded cables (e.g. cables with an earthed conductive sheath) without the electrically conductive piercing element being in electrical contact with the metallic shielding. The insulated sheath portion may be made from a high temperature fire resistant insulation material. Including an insulated sheath portion has the further advantage that it reduces the electrical insulation requirements that need to be placed on the sheathing material used on the multi-core cable to which the connector assembly is to be connected to. This is particularly useful during a fire if the outer insulating sheath has been burned and exposed to water because the insulation can break down and become at least partially conductive. Generally the sheathing material used in fire performance cables does not have any special dielectric requirements, with the principle focus being upon its fire retardant properties, and in its virgin state, its ability to resist mechanical abrasions and chemical attack. However, with this arrangement there will be no direct electrical contact between the sheath and the electrically conducting part of the piercing element.

The connector assembly may be arranged in multiple variants, each of which connects to one phase conductor only and includes marks or other means (e.g. colour) of identifying which core of a multi-core cable it will connect to. In this way, phase balancing in the tunnel can be confirmed by noting an appropriately alternating marking scheme. Preferably, the multiple variants can be fabricated from the same moulding in order to reduce the production and tooling costs.

Preferably, the electrically conductive piercing members make contact with the conductors of the multi-core cable at different axial positions along the length of the cable in order to increase the separation distances between the poles of the connector thereby reducing the necessity for insulation materials to maintain low volume conductivity during a fire. This feature therefore permits the use of organic based mouldable compounds as insulation rather than necessitating the use of inorganic, ceramic-based insulations.

The non-conductive portion of the enclosure may comprise a raised portion or an inverted O-ring which engages the cable providing a seal around the region where the piercing members pierce the cable. Individual seals may also be provided around each individual piercing member. This helps to provide a connection system with the highest IP rating. The small dimension of the raised portion or O-ring causes localised pressure on the cable sheath forming a seal without raising the total sealing force necessary to provide a reliable seal. It is clearly undesirable that the installation force required to form a seal exceeds that which would render mechanical complexity and so detract from the ease of installation. This feature accommodates for variations in the dimensions of the cable. By pressing the raised portion into the surface of the cable a good seal is formed even if there are variations in the surface of the cable.

The connector assembly may further comprise an integral spur cable for attaching to a luminaire in order to further simplify installation.

The connector assembly may be moulded into the luminaires directly.

The connector assembly may further comprise an insulated saddle bracket or cleat so that the connector can be dismounted easily. The cleat may include a sealing ring in order to maintain a high IP rating between the cleat and the cable. It may also have holes through which the piercing elements may pass and may include a catch retention system or a screw fixing system to connect the connector to the cleat. The cleat connector combination enables reconnection of the connector assembly with electrical safety and high IP integrity.

The spur cable may be armoured to increase its resistance to mechanical damage. Armouring the spur cable to increase its resistance to mechanical damage is desirable since, unlike the backbone electrical distribution cable which can be sited in a location where mechanical damage is unlikely, the routing of the spur may traverse areas where mechanical damage is reasonably foreseeable. Furthermore, armouring affords increased strain relief of the internal connections and provides an external continuous safety barrier.

The connector assembly may comprise metallic structural components which retain their structural integrity when exposed to high temperatures in the event of a fire. These metallic components can be used to strengthen polymer based components.

According to a second aspect of the invention there is provided a flat cable comprising: a plurality of conductive cores arranged such that the centres of the cores are arranged along a line perpendicular to the longitudinal axis of the cable; an insulating portion around each conductive core and an insulating portion surrounding the plurality of insulated conductive cores.

The principle advantage arising from this arrangement is that the order and position of each core is constant along the total length of the cable and so easily determinable at any point in the cable. This allows connection to the desired conductor to be achieved easily without having to remove the outer insulation.

Preferably, one or more of the insulation portions are fabricated from a material with conforms to safety and fire performance standards such as IEC331, EN50200 or BS6387CWZ. They may be fabricated from a material exhibiting low smoke, zero-halogen combustion properties. For example it may be fabricated from a material conforming to smoke emission standards EN50267 or BS7622, or acid emission standards EN50268 or IEC754-1. This feature provides a cable assembly which does not emit hazardous combustion properties or excessive amounts of smoke when exposed to a fire, thereby helping to ensure the safety of personnel in the tunnel area.

The insulation portions may be fabricated from a material which conforms to low fire propagation standard BS4066 to impede the propagation of a fire.

Preferably, the insulation portion surrounding the conductive cores and the outer insulating sheath are fabricated from a material that has mechanical properties that are sufficiently weak to permit penetrations while being sufficiently strong to withstand the reasonable foreseeable strains to which it will be subjected to during manufacture, storage, installation and operation. It is further preferred that the insulation portion retains a degree of electrical insulation conforming for example to BS6387CWZ during a fire.

Advantageously, the inner conducting cores are fabricated from a plurality of electrically conductive strands to allow adequate rigidity and an ability to accommodate the penetration of a piercing member.

The cable assembly may comprise five conductive cores. The plurality of conductive cores may comprise one earth conducting core, one neutral conducting core and three phase conducting cores.

Preferably the earth conductive core is located in the centre of the cable in order that the safety earth connection to a connector assembly is made even in the event of incorrect connection to the cable.

The insulating sheath surrounding the conductive cables may have non-uniform thickness across its width. This arrangement has the advantage that incorrect assembly of the cable to a connector assembly will not result in any electrical contact between the cores of the cable and the contact elements of the connector assembly.

Alternatively the insulating layers around the conductive cores may be of different thickness.

Advantageously, the cable assembly further comprises locating means to identify orientation of the cable and/or the location of one or more of the conductive cores. This feature provides a means to identify the position of the conductive core along the full length of the cable system without the need to use special equipment or remove a covering sheath.

The locating means may be one or more ribs located on one side of the cable. The locating means may be a stripe along one side of the cable. Preferably, the locating means does not impede assembly of an insulation displacement connector.

In order to aid correct assembly of the cable to the connector assembly the cable may comprise one or more protrusions to mate with one or more corresponding recesses in the connector assembly.

The cable assembly may further comprise an armouring sheath around the cores to increase the mechanical strength of the cable. The armouring sheath may be metallic.

The cable may be mounted inside a trough onto which closing sections may be fastened. The advantage of this feature is that it removes the need to armour the cable while providing a high level of mechanical protection.

The luminaires may be connected to the cable in a star form in order to minimise the quantity of copper used within the cable system. The luminaires may also be connected in a delta form (cross-phase connection).

Preferred embodiments of the invention will now be described, by way of example and with reference to the accompanying drawings in which: -

Figure 1 is a perspective view of an embodiment of a connector assembly in accordance with the first aspect of the invention;

Figure 2 is an exploded view of an embodiment of a connector assembly in accordance with the first aspect of the invention;

Figure 3 is a cross sectional side view of an embodiment of a connector assembly in accordance with the first aspect of the invention;

Figure 4 is a top view of an embodiment of a connector assembly in accordance with the first aspect of the invention;

Figure 5 is a cross sectional end view of an embodiment of a connector assembly in accordance with the first aspect of the invention;

Figure 6 is a bottom view of a connector assembly in accordance with the first aspect of the invention;

Figure 7 is a perspective view of a further embodiment of a connector assembly in accordance with first aspect of the invention;

Figure 8 is a cross sectional end view of a cable according to the second aspect of the invention; and

Figure 9 is a perspective view of an embodiment of a connector and cable assembly in accordance with the invention.

Figures 1 to 6 show an embodiment of a connector assembly in accordance with the first aspect of the invention.

The connector assembly 1 comprises an enclosure 2, a plurality of piercing members 3a, 3b and 3c and conductive elements 4a, 4b and 4c. The enclosure 2 comprises a base 8 and a closure 9.

As can be seen from the arrangement shown in Figures 1 to 3, the piercing members 3a, 3b and 3c each have an end adapted to pierce the outer insulation sheath 23 and insulation layers 24a, 24b, 24c, 24d or 24e of an electrical multicore cable 20, to make electrical contact with the underlying conductive cores 22a, 22b, 22c, 22d or 22e.

As shown in Figure 4, conductive element 4c is provided with holes 41, 42 and 43 through which piercing member 3c can be disposed, allowing it to pierce the insulating sheath 23 around a multi core cable 20 and insulation layers 24b, 24d or 24e at different points across the width of a multicore cable 20 and make contact with any of the conductive cores 22b, 22d or 22e.

In other embodiments of the invention, the conductive element 4c may be arranged in such a way that the piercing element 3c can make contact with a different selection of the conductive cores 22a-22e. For example, the conductive element 4c may be arranged in such a way that piercing element 3c may make contact with any of the conductive cores 22a, 22b, or 22d. In another example, the conductive element 4c can be arranged in such a way that piercing element 3c may make contact with any of the conductive cores 22a, 22b or 22c, or alternatively 22c, 22d or 22e.

In this embodiment, conductive element 4b is provided with a hole 44 through which piercing element 3b can be disposed allowing it to make contact with conductive core 22a of multicore cable 20.

Again, in alternative embodiments, the conductive element 4b may be arranged so that piercing element 3b may make contact with any of the conductive cores 22a-22e.

Conductive element 4a is provided with a hole 45 through which piercing element 3a can be disposed allowing it to make contact with conductive core 22c of multicore cable 20.

In alternative embodiments conductive element 4a can be positioned so that piercing element 3a may make contact with one of the other conductive cores 22a-22e.

The connector assembly in this embodiment also includes conductive terminals 5b and 5c. A neutral connection can be made to terminal 5b and a phase connection can be made to terminal 5c. Electrical connection to the terminals can be made using screws 12b and 12c.

The neutral terminal 5b is electrically connected to piercing member 3b via the conductive element 4b.

In this embodiment, a fuse 7 is provided between the phase terminal 5c and the phase piercing element 3c. The fuse in this embodiment is a fuse that operates when the temperature proximal to the connector exceeds a predetermined value. In alternative embodiments a simple over-current device or a combination of a simple over-current device and a temperature operational fuse can be used.

The base 8 in this embodiment is fabricated from an electrically non-conductive material conforming to fire performance standards in the spirit of standards IEC331, EN50200and BS6387CWZ which apply to cables. This ensures that the connector assembly will maintain its insulating characteristics in the event of a fire. The material from which the base is fabricated also conforms to acid emission safety standards IEC754-1 and EN50268, and smoke emission standards in the spirit of BS7622 which applies to cables.

In this embodiment, the closure 9 is made from metal. This gives structural strength to the enclosure and also provides a safety earthing path. Furthermore, it eliminates the need for additional earthing components and provides a standard mounting point to which the mechanical strain relief and earth connection for the spur to the luminaire, may be directly fixed. The closure 9 of the connector assembly in this embodiment is detachable from the base 8. In alternative embodiments of the connector assembly the closure 9 may not be detachable from the base 8. In other embodiments still, the enclosure is not made from metal.

Conductive element 4a is electrically connected to the closure 9 with screw 12a providing an electrically conductive connection between piercing element 3a and closure 9. In this arrangement closure 9 is earthed, providing an earth connection for a spur cable which can be attached with gland body 17.

When a pressing force is applied to the connector assembly 1 in this embodiment, piercing elements 3a, 3b and 3c penetrate the insulation portion 23 and insulation layers 24c, 24a and 24e of the multi core cable 20 and make electrical contact with the underlying conductive cores 22c, 22a and 22e, respectively.

Whilst the piercing elements 3a, 3b and 3c in Figure 4 are arranged to make contact with underlying conductive cores 22c, 22a and 22e respectively, it should be understood that other embodiments can use different arrangements of the piercing elements to make contact with a different selection of underlying conductive cores.

Figure 6 is a bottom view of the connector assembly showing positions 50, 51, 52, 53, 54 through which the piercing elements may pass to make contact with the underlying cable. In this embodiment piercing element 3a may pass through position 50, piercing element 3b may pass through position 51 and piercing element 3c may pass through position 52, 53 or 54. In this arrangement the positions of the point of contact between the piercing elements and the conductive cores are spaced along the length of the cable. This arrangement allows increased separation between the different poles of the connector since they are not positioned side by side

The enclosure 2 comprises projections 16 disposed on two sides of the enclosure 2. The connector assembly can then be mounted on a support such as a wall or ceiling through holes 18 in the projections 16 with fixing means 19.

In an alternative embodiment of the invention shown in Figure 7, the connector assembly 1 comprises a cleat 15. The connector is attached to the cleat by fixing means 19 through the projections 16.

Figure 8 shows a cable in accordance with a second aspect of the invention. The cable assembly comprises conducting cores 22a, 22b, 22c, 22d and 22e lying side by side.

Each of the conducting cores 22a, 22b, 22c, 22d and 22e is surrounded by a layer of an electrically insulating material 24a, 24b, 24c, 24d and 24e respectively. An outer electrically insulation sheath 23 surrounds the insulated cores. The cable assembly comprises ribs 25 on a side of the cable which act as identifying means. The presence of the ribs helps to identify the orientation of the cable and the arrangement of the cores within. Furthermore, at least one of the ribs can be seen irrespective of which particular face of the cable is viewed. The conductive core situated in the centre of the core is connected to earth. The layout of the conductive cores in this embodiment is Neutral, Phase, Earth, Phase, Phase.

In an alternative embodiment of the invention, the layout of the conductive cores is Phase, Phase, Earth, Neutral, Phase.

In an alternative embodiment still, the layout of the conductive cores is Phase, Phase, Earth, Neutral, Phase.

In a further embodiment of this aspect of the invention the cable assembly is provided with a stripe along one side of the cable.

In an alternative embodiment of this aspect of the invention the cable assembly can be armoured with a metallic or non-metallic sheath to increase the mechanical strength of the cable.

In a further embodiment of the invention shown in Figure 8, the cable assembly 20 is mounted inside a U-shaped trough 30 on which closing sections 31 are mounted. This arrangement provides a high level of mechanical protection without the need to amour the cable.

Many further modifications and variations will suggest themselves to those versed in the art upon making reference to the foregoing illustrative embodiments, which are given by way of example only and which are not intended to limit the scope of the invention, that being determined solely by the appended claims.

CLAIMS:

1. A tunnel cable connector assembly for use with a multicore cable, the assembly comprising:

an enclosure;

a plurality of electrically conductive piercing members, each having an end adapted to pierce the insulation of an electrical cable;

a plurality of electrically conductive elements, each adapted to receive one of said piercing members;

at least one of the piercing members being provided in one of a plurality of positions corresponding to respective cores of a multicore cable to which the connector assembly is to be connected.

2. A tunnel cable connector assembly according to Claim 1, further comprising an enclosure having an electrically non-conductive portion for supporting the conductive elements.

3. A tunnel cable connector assembly according to Claim 2 wherein the electrically non-conductive portion is fabricated from a material with low-smoke combustion properties.

4. A tunnel cable connector assembly according to Claim 2 or 3, wherein the electrically non-conductive portion is fabricated from a material with zero-halogen combustion properties.

5. A tunnel cable connector assembly according to any one of Claims 2 to 4, wherein the electrically non-conductive portion is fabricated from a material conforming to one or more of the following standards EN50267, BS7622, EN50268 and IEC754-1.

6. A tunnel cable connector assembly according to any one of Claims 2 to 5, wherein the electrically non-conductive portion is fabricated from a material conforming to one or more of the following standards IEC331, EN50200 and BS6387CWZ .

7. A tunnel cable connector assembly according to any one of Claims 1 to 6 further comprising a plurality of electrically conductive terminals.

8. A tunnel cable connector assembly according to any one of Claims 1 to 7, wherein the plurality of electrically conductive terminals includes one phase terminal.

9. A tunnel cable connector assembly according to any one of Claims 1 to 8, wherein each of the plurality of electrically conductive piercing members make contact with a different conductor of a multi-core cable to which the connector assembly is to be connected.

10. A tunnel cable connector assembly according to any one of Claims 1 to 9, further comprising a fuse in the enclosure.

11. A tunnel cable connector assembly according to any one of Claims 1 to 10, arranged such that when the connector assembly is engaging with a multi-core cable one of the piercing members makes contact with one of the conductors of a multi-core cable before any of the other piercing members make contact with other conductors of the cable.

12. A tunnel cable connector assembly according to any one of Claims 1 to 11, wherein the piecing members have different lengths.

13. A tunnel cable connector assembly according to any one of Claims 1 to 12, wherein the said one piercing member is longer than the other piercing members.

14. A tunnel cable connector assembly according to any one of Claims 1 to 13, wherein one or more of the piecing members comprises an insulating portion.

15. A tunnel cable connector assembly according to any one of Claims 1 to 14, wherein at least one of the plurality of electrically conductive elements is provided with a plurality of holes to receive one of said piercing members, allowing said one of said piercing members to pierce one of a plurality of the cores of a multi-core cable to which the connector assembly is to be connected.

16. A tunnel cable connector assembly according to any one of Claims 1 to 15, wherein the connector assembly comprises marks to identify which phase conductor of a multi-core cable it will connect to.

17. A tunnel cable connector assembly according to any one of Claims 1 to 16, wherein the piercing elements make contact with the conductors of the multi-core cable at different positions axially along the length of a multi-core cable.

18. A tunnel cable connector assembly according to any one of Claims 1 to 17, wherein the electrically non-conductive portion is fabricated from an organic based mouldable compound.

19. A tunnel cable connector assembly according to any one of Claims 1 to 18, wherein the electrically non-conductive portion includes an area having a raised portion around it.

20. A tunnel cable connector assembly according to any one of Claims 1 to 19, further comprising a spur cable connected to the electrically conductive elements.

21. A tunnel cable connector assembly according to any one of Claims 1 to 20, further comprising an insulated saddle bracket.

22. A luminaire assembly comprising a tunnel cable connector assembly according to any of Claims 1 to 21.

23. A flat cable comprising:

a plurality of conductive cores arranged such that the centres of the cores are arranged along a line perpendicular to the longitudinal axis of the cable;

an insulating portion around each conductive core and

an insulating portion surrounding the plurality of insulated conductive cores.

24. A flat cable according to claim 23 comprising five conductive cores.

25. A flat cable according to claim 23 or 24 further comprising locating means to identify the orientation of the cores of the cable.

26. A flat cable according to Claim 25, wherein the locating means comprises one or more ribs located to one side of the cable.

26. A flat cable according to any one of claims 23 to 25 wherein the insulation portions are fabricated from a material complying with one or more of the following standards BS6387CWZ, IEC331, EN50200, EN50268 and EN50267.

27. A cable assembly according to any one of claims 23 to 26, wherein the insulation portions are fabricated from a zero halogen material.

28. A flat cable according to any of Claims 23 to 27, wherein the earth conductive core is located in the centre of the cable.

29. A connector assembly substantially as hereinbefore described with reference to the attached figures.

30. A flat cable substantially as hereinbefore described with reference to the attached figures.

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Claims searched: 1-22, 29

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Date of search: 12 January 2005

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
A	-	US5330369 A TSURUZONO: see whole document
A	-	GB1385357 A WOERTZ: see whole document
A	-	DE19854200 A1 VACHE: see fig. 1

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Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

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The following online and other databases have been used in the preparation of this search report

Online: WPO, EPODOC, JAPIO