

This invention relates to electric plugs of the kind comprising at least two pins which protrude from the plug body and it is especially, but not exclusively, concerned with electric plugs of this kind
5 for use in domestic and similar wiring systems.

The use in domestic, industrial and other premises of visual display units, mini-computers and other equipment requiring both electrical and optical
10 connections to an electrical supply source and a light emitting device is increasing year by year and the provision of simple and inexpensive electric and optical connectors for effecting such connections is highly desirable.

15 According to the present invention we provide an improved electric plug comprising at least two pins which protrude from the plug body, wherein at least one of the pins of the plug has at least one throughbore extending along its length and wherein a
20 separate optical fibre or an optical bundle as hereinafter defined is housed in said throughbore, is fixed with respect to the pin over at least a part of the length of the fibre or bundle adjacent the free end of the pin, and is connected to, or adapted to be
25 connected to, or is integral with, an optical fibre or an optical bundle of a flexible electric cable extending into the plug body.

By the expression "optical bundle" is meant a group of optical fibres or a group of fibres including at least one optical fibre and at least one non-optical reinforcing fibre or other reinforcing elongate member.

5 In use, the improved electric plug can be inserted into an appropriate socket outlet having a socket contact or socket contacts for engagement by said optical fibre-containing pin or pins, said socket contact or each of said socket contacts having associated with the
10 contact at least one optical fibre or optical bundle which will be in substantial alignment with the or an optical fibre or optical bundle of the pin, when said pin is engaged in the socket contact, thereby to provide both an effective electrical connection and an optical fibre or
15 bundle joint of satisfactory light transfer efficiency.

An improved electric socket outlet for use in conjunction with the improved electric plug of the present invention is described and claimed in the Specification of our co-pending Patent Application No. 82 27596 filed
20 on the same day as the present application.

The extreme end face of the or each optical fibre or optical bundle in the or each pin may be substantially flush with the end face of the pin in which it is housed but, preferably, to reduce risk of damage to
25 the end face of the or each optical fibre or optical

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bundle, the extreme end face of the or each optical fibre or optical bundle is spaced from the free end of the pin. Losses due to damage, contamination and misalignment of optical fibres or bundles can be reduced by incorporating in the pin, at the optical interface with an associated socket contact, an optical element which reduces the risk of damage to the end of the or each optical fibre or bundle and/or enlarges the light beam or changes its angle of divergence. Suitable optical elements include quartz windows and lenses.

Preferably, alignment of the optical fibres or optical bundles to be connected is assisted by providing at least one longitudinally extending rib or groove along the outer surface of the pin and, where the pin is of substantially rectangular transverse cross-section preferably along each of two oppositely disposed side faces of the pin, which will engage in a complementary shaped groove or rib in an associated socket contact of an electric socket outlet so that transverse displacement of the pin when it is introduced into the socket contact is substantially prevented.

Where, as is preferred, the improved electric plug has an earth pin, preferably the earth pin is the pin or one of the pins of the plug which has at least one throughbore in which is housed an optical fibre or optical bundle.

The improved electric plug of the present invention may be a rewirable plug or, having regard to

the fragility of optical fibres and optical bundles, the plug may be non-rewirable and in this latter case it is preferably the plug component of a non-rewirable electric plug assembly of the kind in which the plug pins protrude through holes in one of, or between, two preformed shells of electrically insulating material, which shells are welded or otherwise permanently secured together to form an insulating plug body housing the permanent electrical connections between the plug pins and the electric conductors of a length of flexible insulated multi-conductor electric cable incorporating at least one optical fibre or optical bundle.

Preferably, the optical fibre or optical bundle housed in the or a throughbore of the or each pin is integral with the or an optical fibre or optical bundle of a flexible insulated multi-conductor cable and, in this case, to reduce the risk of damage to the optical fibre or optical bundle, where the plug body comprises two preformed shells permanently secured together at least a part of the optical fibre or optical bundle extending between the cutback end of the cable at the cable entry of the plug and the point at which it enters the throughbore of the pin is secured to one shell of the plug body, or, where the plug is non-rewirable and comprises a preformed base insert which has holes through which the plug pins protrude and which is wholly or partially encapsulated in a moulded plug body, at least a part of the optical fibre

or optical bundle extending between the cut back end of the cable at the cable entry of the plug and the point at which it enters the throughbore of the pin is secured to the preformed base insert.

- 5 Where the optical fibre or optical bundle housed in the or a throughbore of the or each pin is separately formed with respect to the or an optical fibre or optical bundle of the flexible cable, the or each optical fibre joint within the plug body is preferably a fusion joint.
- 10 Alternatively, the or each optical fibre joint within the plug body may be a joint made by the method described and claimed in our co-pending Patent Application No.8102450. In some circumstances, the or each optical fibre joint may be positioned within the or a throughbore of the pin and
- 15 in this case the optical fibre joint would be a mechanical joint.

The invention is further illustrated by a description, by way of example, of a preferred 13A three pin electric plug with reference to the accompanying

20 drawings, in which:-

Figure 1 is a plan view of the base of the plug in which two optical fibres of a multi-conductor cable C extend into two throughbores in the earth pin;

Figure 2 is a diagrammatic fragmental side view

25 of the plug showing the earth pin effecting electrical connection with a socket contact of an electrical socket outlet;

Figure 3, 4 and 5, respectively, are longitudinal sectional views and an end view of the earth pin; and

Figure 6 is cross-sectional view of the earth pin and socket contact taken on the line VI-VI in Figure 2.

The 13A three pin electric plug shown in the drawings is a rewirable plug comprising a preformed base 1 and a preformed cover (not shown) which is detachably secured to the base by a screw which passes through a hole 2 in the base and engages in an internally screw threaded hole in the cover. Protruding from the base 1 are two line pins 3, of which one only can be seen, and an earth pin 4. Clamping screws 5 detachably connected to the line pins 3 enable the line conductors of a three core electric wiring cable C to be electrically connected to the line pins. A clamping screw 6 detachably secured to and transversely spaced from the axis of the earth pin 4 enables the earth conductor of the cable C to be electrically connected to the earth pin.

Where desired, the plug may have provision for a cartridge fuse to be detachably electrically connected between that line pin 3 to which the live conductor of the cable C is to be electrically connected and its associated conductor clamping screw 5.

The earth pin 4 has two throughbores 7 and 8 and two optical fibres F protruding from the cut back end of the cable C extend into the two throughbores, parts of the optical fibres between the cut back end of the cable and the earth pin being secured to the base 1 by a fibre clamp 9. The earth pin 4 is of substantially rectangular transverse cross-section and has a rib 10 extending along each of its two major side faces.

By way of illustration, Figures 3 to 5 show two ways of fixing optical fibres F to the earth pin 4. The optical fibre F extending into the throughbore 7 of the earth pin 4 is loosely housed in the throughbore over a major part of the length of the earth pin but, over a part of the length of the fibre adjacent the free end of the pin, this part of the fibre is a tight fit in a part of the throughbore of reduced cross-section, the fibre being locked into position by a epoxy resin 12 and the extreme end of the fibre, which has been polished, being flush with the free end face of the pin. The optical fibre F extending into the throughbore 8 of the earth pin 4 is also loosely housed in the throughbore over a major part of the length of the earth pin but, over a part of the length of the fibre adjacent the free end of the pin, this part is a tight fit in a blind bore in a lens 14 which is secured in the end of the throughbore. An optical matching fluid (not shown) is employed to improve the optical connection between the optical fibre F and the lens 14.

As will be seen on referring to Figure 6, the socket contact of an electrical socket outlet with which the earth pin 4 is to make electrical and optical connection comprises a circumferentially discontinuous sleeve 20 which is made of a metal of high electrical conductivity and which has a substantially U-shaped transverse cross-section, the sleeve having in the internal surface of each of its opposed major side walls a longitudinally extending groove 21. Slidably mounted in the sleeve 20 is a spring-loaded tubular pin 22 of substantially rectangular transverse cross-section which has on each of its major side faces, a longitudinally extending rib 23 which engages in one of the grooves 21 of the sleeve and which is urged by the spring 24 towards one open end of the sleeve. The tubular pin 22 has, extending throughout the length of its bore, a pair of transversely spaced optical fibres F which protrude from the end of the pin remote from said open end of the sleeve 20 and which are encapsulated in epoxy resin within the bore of the tubular pin so that the optical fibres are substantially parallel to the axis of the sleeve with their ends flush with the end of the tubular pin. When the earth pin 4 of the plug is introduced into the sleeve 20 of the socket contact with its ribs 10 engaging in the grooves 21, the end face of the earth pin will abut the end face of the spring-loaded tubular pin 22 so that the optical fibres F housed in the earth pin are in alignment with the optical fibres F of the tubular pin to form optical fibre joints of satisfactory light transfer efficiency.

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CLAIMS:

1. An electric plug comprising at least two pins which protrude from the plug body, wherein at least one of the pins of the plug has at least one throughbore extending
5 along its length and wherein a separate optical fibre or an optical bundle as hereinbefore defined is housed in said throughbore, is fixed with respect to the pin over at least a part of the length of the fibre or bundle adjacent the free end of the pin, and is connected to, or
10 adapted to be connected to, or is integral with, an optical fibre or an optical bundle of a flexible electric cable extending into the plug body.
2. An electric plug comprising two line pins and an earth pin which protrude from the plug body, wherein at
15 least the earth pin of the plug has at least one throughbore extending along its length and wherein a separate optical fibre or an optical bundle as hereinbefore defined is housed in said throughbore, is fixed with respect to the earth pin over at least a part
20 of the length of the fibre or bundle adjacent the free end of the pin, and is connected to, or adapted to be connected to, or is integral with, an optical fibre or an optical bundle of a flexible electric cable extending into the plug body.
- 25 3. An electric plug as claimed in Claim 1 or 2, wherein the extreme end face of the or each optical fibre or optical bundle is flush with the free end face of the pin in which it is housed.



4. An electric plug as claimed in Claim 3, wherein said part of the length of the optical fibre or bundle adjacent the free end of the pin is a tight fit in a part of the throughbore of reduced cross-section.

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5. An electric plug as claimed in Claim 1 or 2, wherein the extreme end face of the or each optical fibre or optical bundle is optically connected to an optical element secured in the throughbore at the free end of the
10 pin.

6. An electric plug as claimed in Claim 5, wherein the optical element is a quartz window or lens.

7. An electric plug as claimed in any one of the preceding Claims, wherein the or each pin having at least
15 one throughbore housing an optical fibre or optical bundle has at least one longitudinally extending rib or groove along the outer surface of the pin.

8. An electric plug as claimed in Claim 7, wherein said pin is of substantially rectangular transverse
20 cross-section and has along each of two oppositely disposed side faces of the pin a longitudinally extending rib or groove.



9. An electric plug as claimed in any one of the preceding Claims, wherein the plug is the plug component of a non-rewirable electric plug assembly.

10. An electric plug as claimed in Claim 9, wherein the plug pins protrude through holes in one of, or between, two preformed shells of electrically insulating material, which shells are welded or otherwise permanently secured together to form an insulating plug body housing the permanent electrical connections between the plug pins and the electric conductors of a length of flexible insulated multi-conductor electric cable incorporating at least one optical fibre or optical bundle.

11. An electric plug as claimed in Claim 10, wherein at least a part of the optical fibre or optical bundle extending between the cut back end of the cable at the cable entry of the plug and the point at which it enters the or a throughbore of the or each pin is secured to one shell of the plug body.

12. An electric plug as claimed in any one of the preceding Claims in which the optical fibre or optical bundle housed in the or a throughbore of the or each pin is separately formed with respect to the or an optical fibre or optical bundle of the flexible electric cable, wherein the or each optical fibre joint within the plug body is a fusion joint.



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13. An electric plug as claimed in any one of Claims 1 to 11 in which the optical fibre or optical bundle housed in the or a throughbore of the or each pin is separately formed with respect to the or an optical fibre or optical bundle of the flexible electric cable, wherein the or each optical fibre joint is positioned within the or a throughbore of the pin.

14. An electric plug substantially as hereinbefore
5 described with reference to and as shown in the
accompanying drawings.
