(12) UK Patent Application (19) GB (11) 2549495 (13) A

(43) Date of A Publication 25.10.2017

(21) Application No: 1606792.8

(22) Date of Filing: 19.04.2016

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(51) INT CL:
H01R 13/62 (2006.01) ***H01R 9/05*** (2006.01)
H01R 9/053 (2006.01) *H02G 3/20* (2006.01)

(56) Documents Cited:
US 6135799 A **US 5702264 A**

(58) Field of Search:
INT CL **F21S, F21V, F21W, H01R, H02G**
Other: **Online: WPI, EPODOC**

(54) Title of the Invention: **Electrical plug and socket**
Abstract Title: **Electrical plug and socket**

(57) An electrical plug suitable for low voltage lighting applications has a housing 110 and a connector assembly 120 which is movable within the housing to control the status of a locking means or lockable projection such as ball bearing 112. The locking means has a locked status in which the locking means projects radially from the housing and a released status in which the locking means is able to retract into the housing due to recess 127. The plug may accept a coaxial cable with grub screw 125 crushing ferrule 124 onto the outer conductor, restriction 128 preventing the outer conductor from entering further, and grub screw 129 piercing the insulation to contact the inner conductor. An electrical socket (200, Fig 6) for use with the plug comprises engagement means such as retaining ring or annulus (202, Fig 6) to engage with the locking means of the plug. The invention provides a quick-release plug which is suitable for lighting applications including SELV (Safety Extra Low Voltage) light fittings. The locking means doubles as the securement in the socket and also an electrical connection.

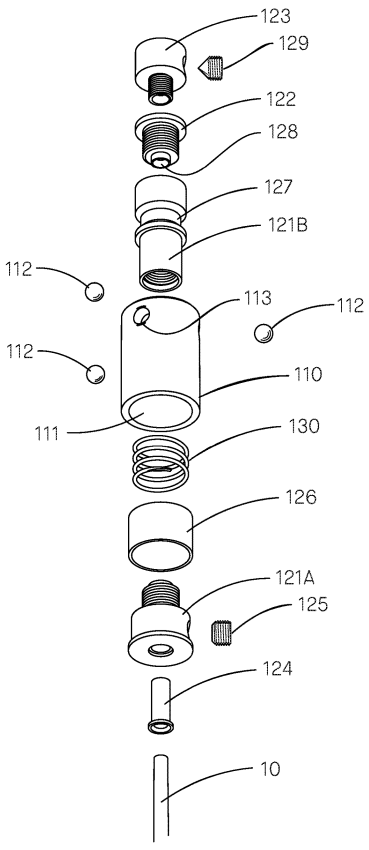

Fig.2

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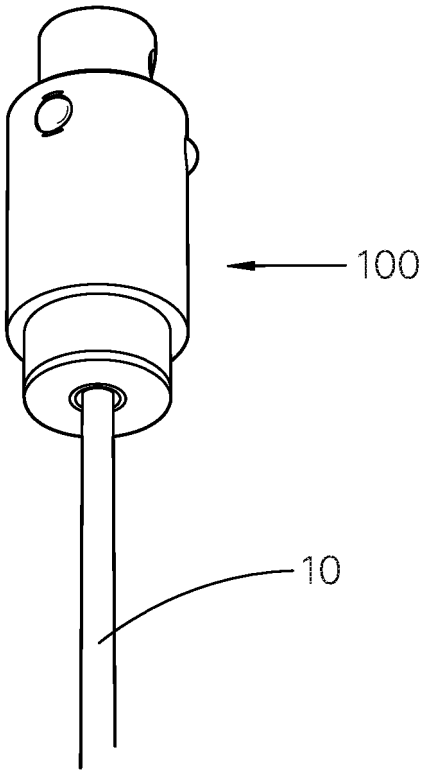
At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.



05 09 16

Fig.1

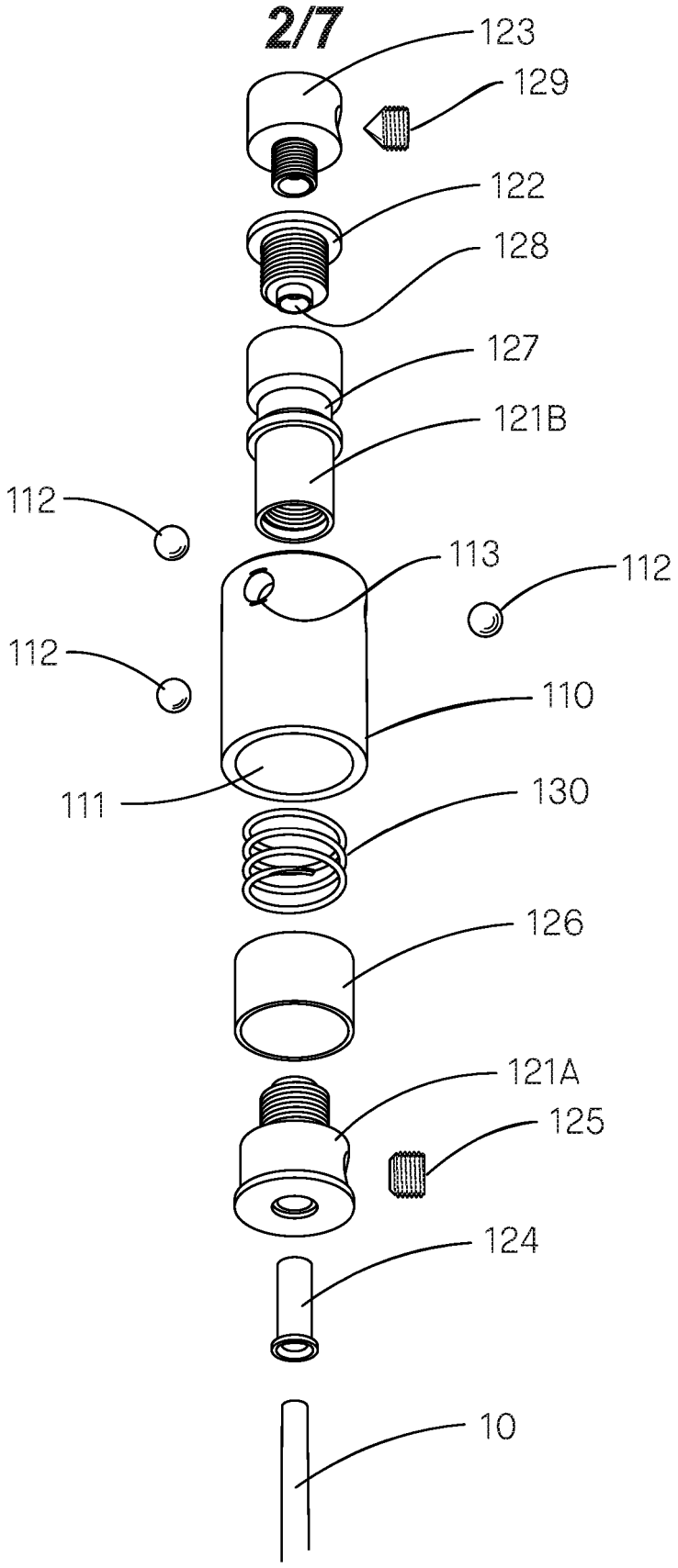

123
129
122
128
127
121B
112
113
112
112
110
111
130
126
121A
125
124
10

Fig.2

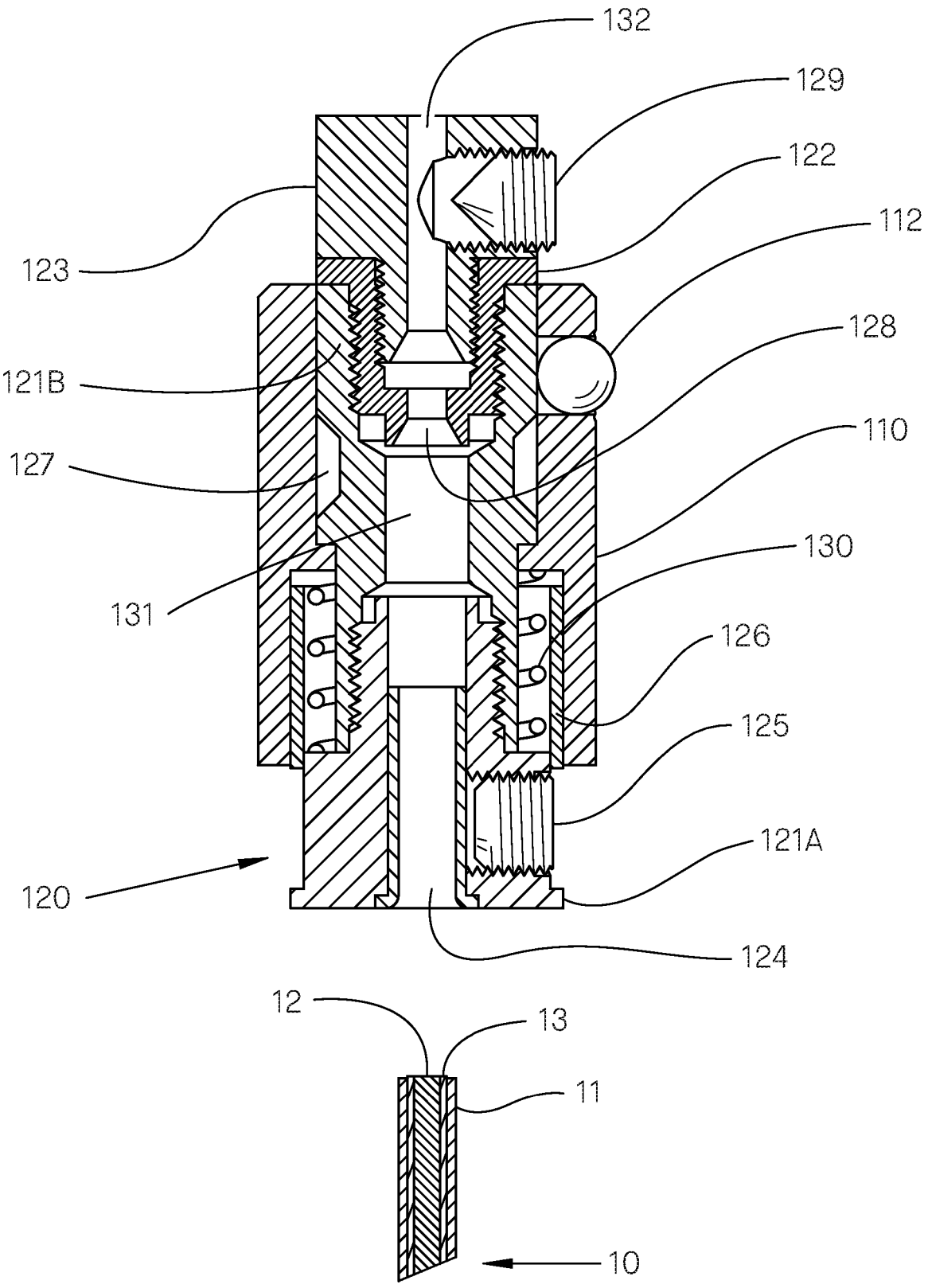

132
129
122
112
123
128
121B
110
127
130
131
126
125
121A
120
124
12
13
11
10

Fig.3

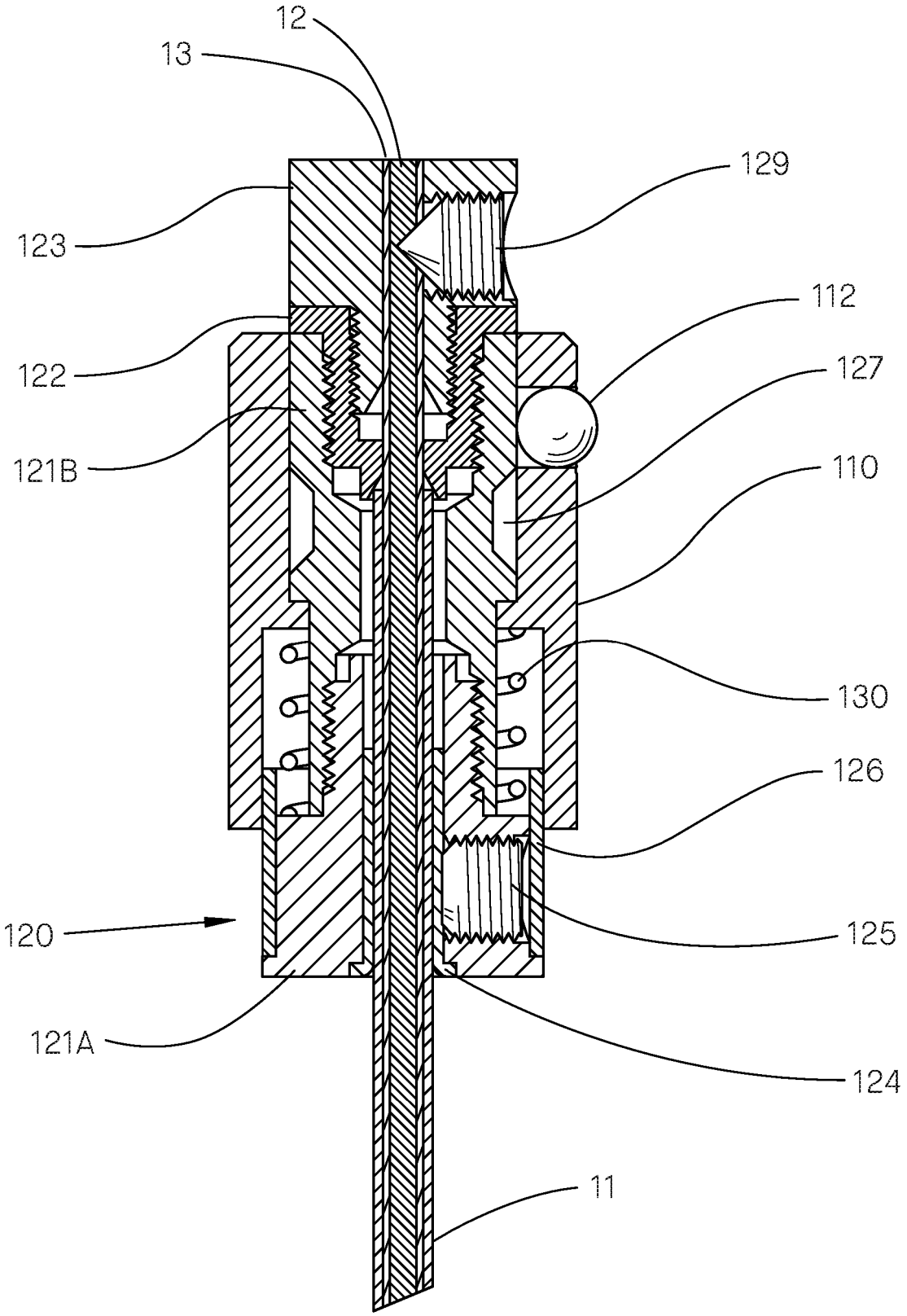


Fig.4

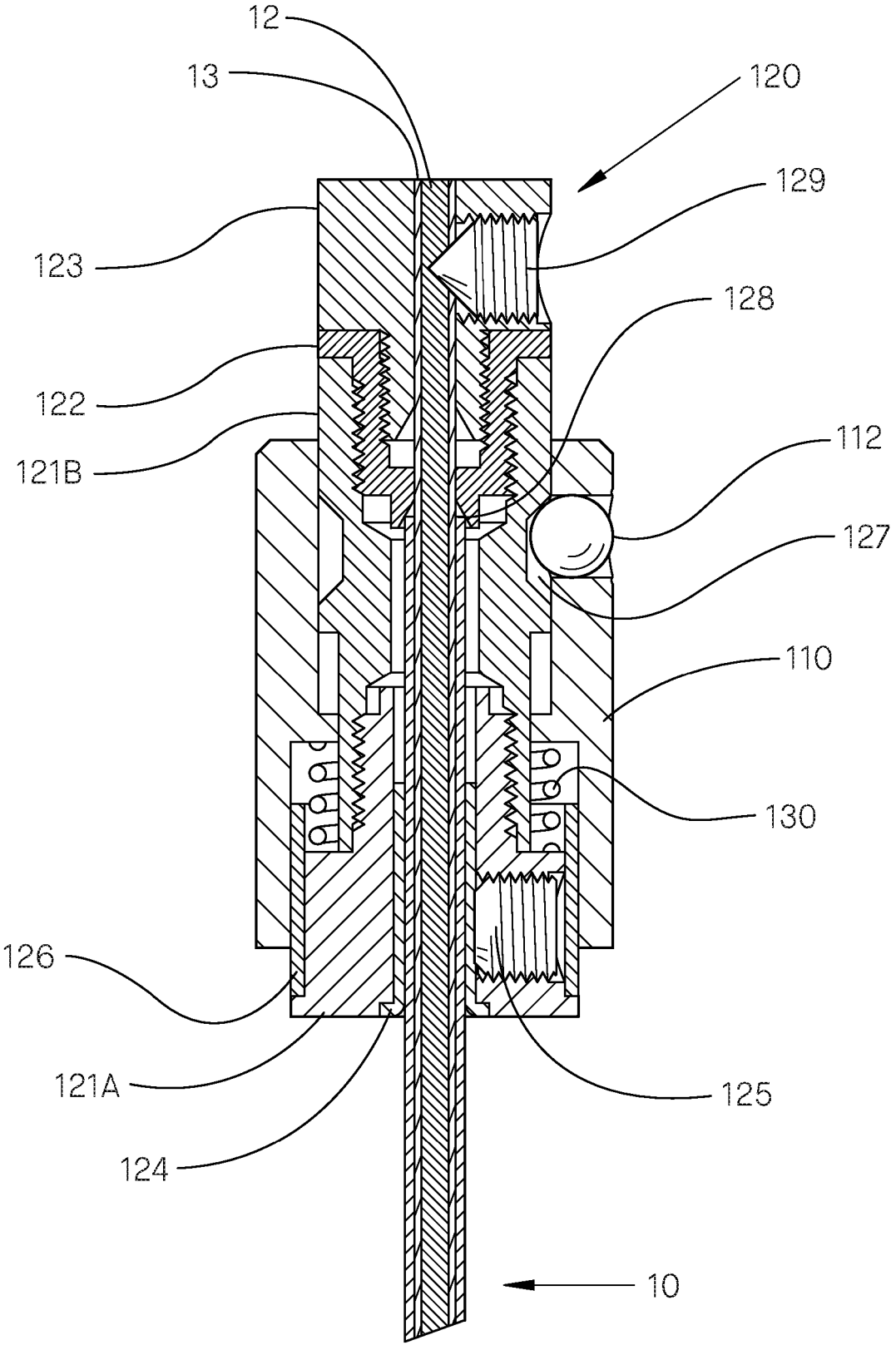

12
13
120
129
123
128
122
112
121B
127
110
130
126
121A
125
124
10

Fig.5

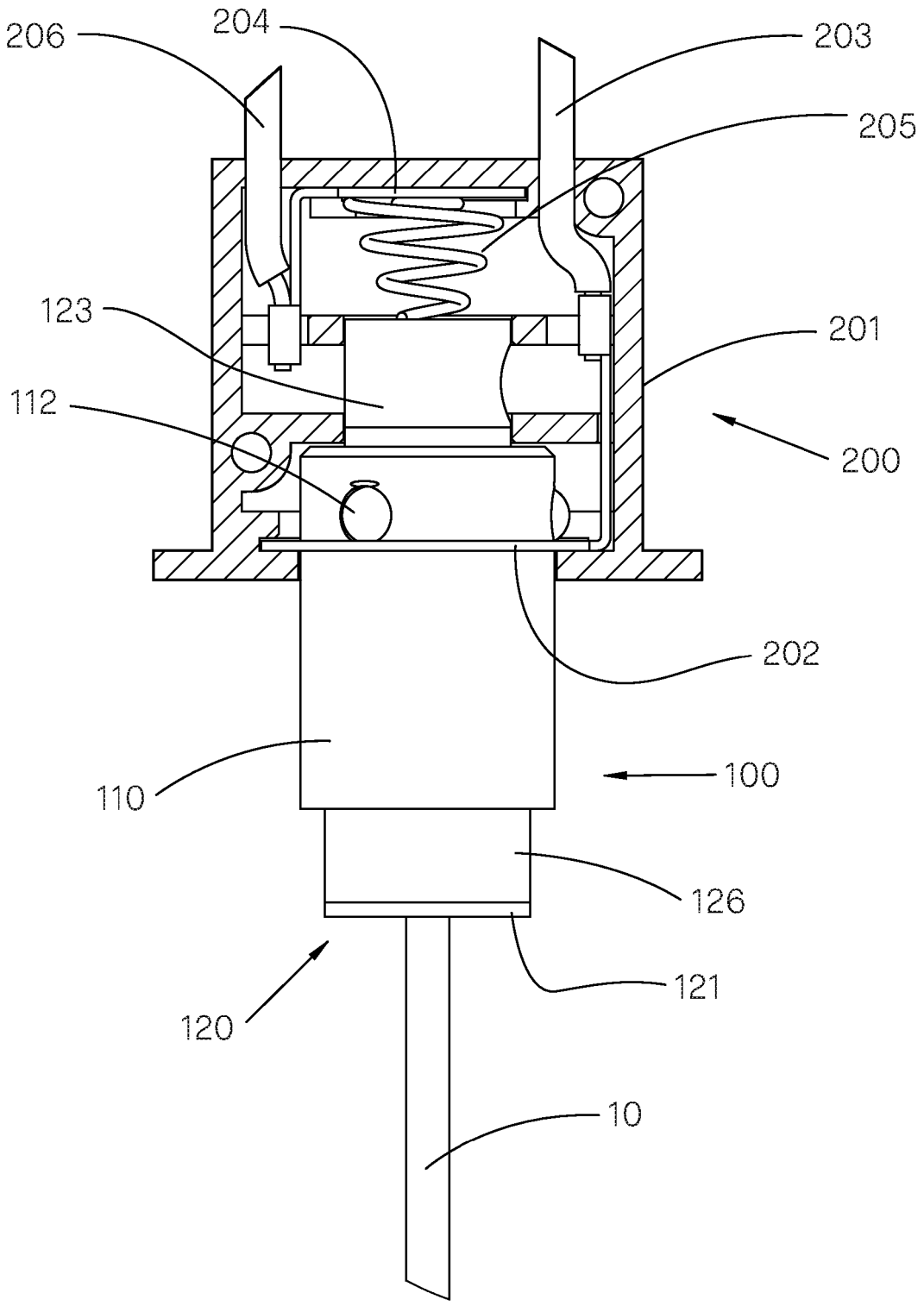


Fig.6

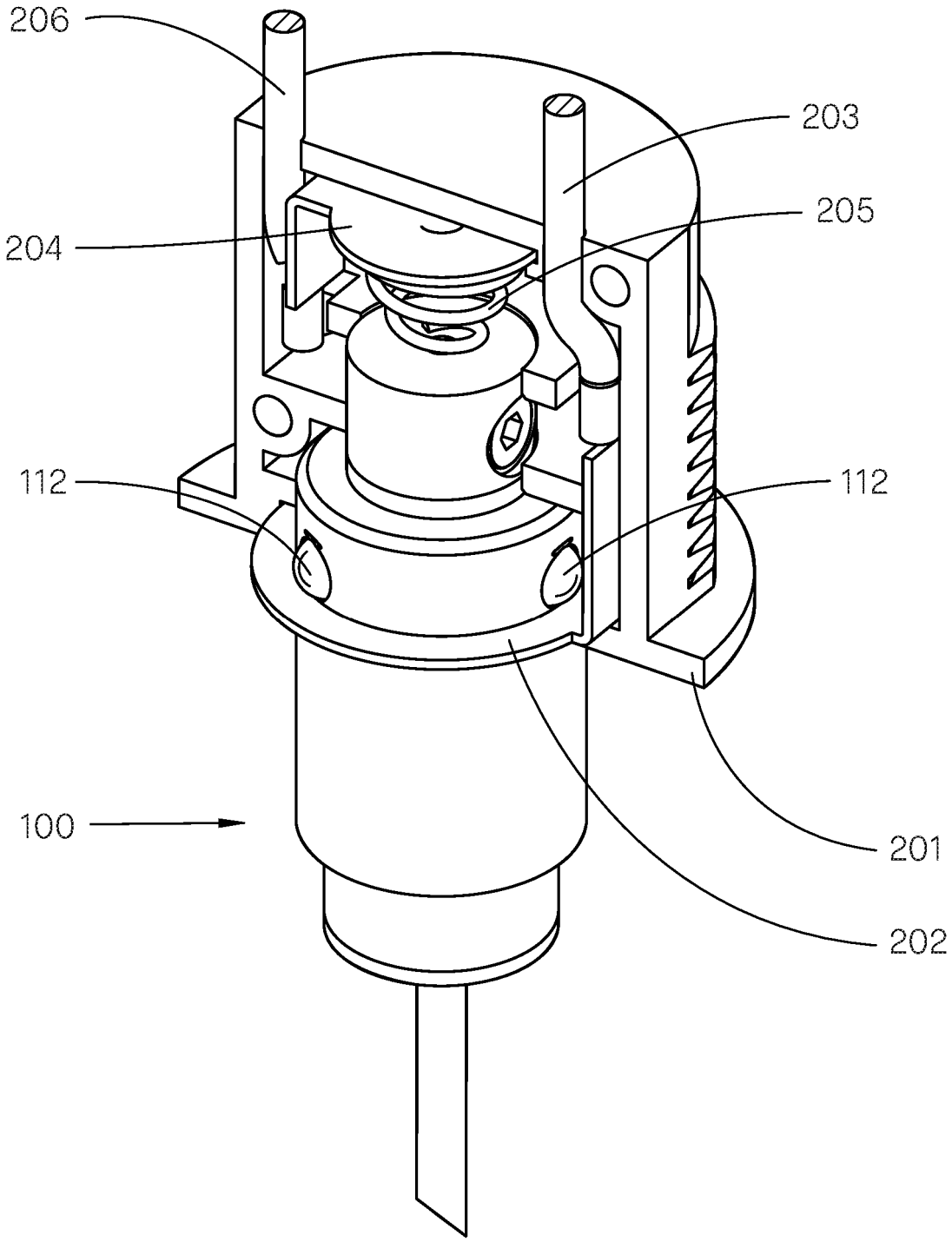


Fig.7

Electrical Plug and Socket

Technical Field

The present invention relates to an electrical plug and to an electrical plug and socket combination which is particularly suited for quick-release lighting applications but which will also be useful in many other applications.

Background Art

WO 03/044906 and US 2004/141328 both disclose plug/socket arrangements suitable for light fittings, but they are for mechanical fixing and do not provide any electrical connection.

The present invention aims to provide an electrical plug and an electrical plug and socket combination which is simple to connect to a conductor, and which is easy to connect and disconnect while providing a reliable electrical and mechanical engagement.

Summary of the Invention

In accordance with a first aspect, the invention provides an electrical plug for connection to an electrical cable having a conductor, comprising a housing having a passage therethrough defining a longitudinal axis, a connector assembly for electrical connection to the conductor, the connector assembly being located in the passage of the housing; and locking means having a locked status in which the locking means projects radially from the housing and a released status in which the locking means is able to retract into the housing, wherein the connector assembly is movable relative to the housing along the longitudinal axis of the passage between a first position and a second position to control the status of the locking means such that, in the first position, the locking means is in the locked status, and in the second position, the locking means is in the released status.

The housing and/or locking means is preferably electrically connected to the connector assembly.

Preferably, the connector assembly is biased towards the first position and this may be achieved by means of a coil spring acting between the housing and the connector assembly.

The locking means, locking mechanism or lock may take any suitable form for locking the plug in a suitably-configured socket as discussed below. The locking means may comprise one or more lockable projections. In a preferred embodiment, the locking means comprises one or more balls (e.g. ball bearings) which are locked in a position projecting radially from the housing in the locked status and are able to retract radially inwards in the released status. Preferably, a plurality of balls are spaced around the circumference of the plug. The or each ball is preferably located in a through-hole in the housing, the through-hole communicating to the connector assembly in the housing passage, wherein the connector assembly profile is configured such that in the first position, the connector assembly maintains the ball in the locked status, projecting radially from the housing in its outermost position in the through-hole, and in the second position, the connector assembly provides a recess for the ball to move into in the released status, in a direction radially towards the axis to its innermost position in the through-hole. The recess may be a concave recess, but the recess is conveniently formed by a reduced-diameter section of the connector assembly. This arrangement is particularly useful in the preferred embodiment in which a plurality of balls are spaced around the circumference of the plug.

In most situations, electrical cables will have at least two conductors, for positive and negative/earth, live and neutral, etc. In a preferred embodiment therefore, in which the electrical cable has at least two conductors, the connector assembly comprises a first connector part for electrical connection to the first conductor, a second connector part for electrical connection to the second conductor, and an insulator between the first connector part and the connector second part. The housing is preferably electrically connected to the first connector part and is electrically insulated from the second connector part. The locking means is also preferably electrically connected to the first connector part.

Preferably, the first connector part, insulator and second connector part are arranged adjacent to one another and sequentially along the longitudinal axis of the passage. While the housing and the connector assembly may be any suitable shape, a preferred shape is substantially cylindrical. The passage of the housing may also be substantially cylindrical. The housing may form a cylindrical sleeve around the connector assembly.

When the connector assembly is in the first position, the first connector part and the second connector part may project from each end of the housing. When moving to the second position,

the connector assembly preferably moves along the longitudinal axis relative to the housing, such that the second connector part projects further from the housing and the first connector part projects correspondingly less.

In the embodiment described above in which the locking means comprises one or more balls, the connector assembly profile which determines the locked or released status of the ball is the profile of the first connector part.

The present invention is particularly suited for use with a coaxial cable, having an inner insulated conductor and an outer uninsulated conductor substantially surrounding the inner insulated conductor. The first connector part is for electrical connection to the outer conductor and the second connector part is for electrical connection to the inner conductor. Preferably, the connector assembly comprises a channel to receive the coaxial cable, the channel extending through the first connector part and the insulator and extending into the second connector part, and wherein the channel includes a restriction such that, when the coaxial cable is inserted into the channel through the first connector part and the insulator and into the second connector part, the outer conductor is prevented from entering the second connector part by the restriction and only the inner insulated conductor is able to enter the second connector part.

While the restriction could be one or more projections extending into the channel to provide a restraint for the outer conductor, the restriction preferably comprises a reduction in the diameter of the channel. Preferably, the restriction is provided in the insulator section of the channel.

In a preferred embodiment, the first connector part includes a first grub screw for gripping the coaxial cable and providing an electrical connection to the outer conductor and the second connector part includes a second grub screw for providing an electrical connection to the inner conductor. In order to facilitate access, the first and second grub screws are preferably accessible by a fastening tool when the connector assembly is in the first position. A movable sleeve may be provided to shield the first grub screw. A conductive ferrule may be provided between the first grub screw and the coaxial cable. The second grub screw may have a conical inner head to pierce the insulation of the inner insulated conductor and electrically connect to the inner conductor.

In accordance with a second aspect, the invention provides an electrical plug as described above in combination with an electrical socket, the socket comprising a conductor for electrical

connection to the connector assembly and engagement means to engage with the locking means of the plug so that, when the plug is inserted in the socket, the plug is locked in the socket when the locking means is in the locked status and the plug can be withdrawn from the socket when the locking means is in the released status.

In a preferred arrangement of the plug and socket combination, the locking means is electrically connected to the connector assembly and the engagement means is the conductor of the socket.

The engagement means or retaining means may take any suitable form for engaging with the plug locking means to retain the plug in the socket in the locked status. The engagement means may comprise a surface or projection which cooperates with the locking means. The engagement means may comprise a retaining ring, which will work well when the locking means is in the form of a plurality of lockable projections or balls. Preferably, the locking means comprises an annulus, into which the plug housing is inserted when the plug and socket are assembled, the inner diameter of the annulus being smaller than radial extent of the locking means when projecting radially from the housing in the locked status.

Preferably, the socket further comprises a spring acting against the plug when the plug is inserted in the socket, the spring urging the locking means into engagement with the engagement means when the locking means is in the locked status and urging the plug out of the socket when the locking means is in the released status.

In the preferred embodiment described above in which the connector assembly comprises a first connector part, a second connector part and an insulator between the first connector part and the connector second part, the socket preferably comprises a first conductor for electrical connection to the first connector part of the plug and a second conductor for electrical connection to the second connector part of the plug.

Preferably, the locking means of the plug is electrically connected to the first connector part and the engagement means is the first conductor of the socket. The engagement means/first conductor may comprise an annulus, into which the plug housing is inserted when the plug and socket are assembled, the inner diameter of the annulus being smaller than the radial extent of the locking means when projecting radially from the housing in the locked status.

In the embodiment above in which the socket further comprises a spring, preferably the spring is the second conductor of the socket, acting against the second connector part of the plug when the plug is inserted in the socket.

The present invention also extends to an electrical plug as described above in combination with any of the following: an electrical cable having at least one conductor; an electrical cable having at least two conductors; a coaxial cable comprising an inner insulated conductor and an outer uninsulated conductor substantially surrounding the inner insulated conductor.

The present invention also provides a light fitting including an electrical cable connected to an electrical plug as described above, and also to a light fitting kit comprising a light fitting and the electrical plug and socket combination described above.

In at least the preferred embodiments described above, the present invention provides a quick-release plug which is suitable for lighting applications including SELV (Safety Extra Low Voltage) light fittings. The locking means doubles as the securement in the socket and also the electrical connection (for one polarity in the case of a multi-pole connector).

The connector assembly is pushed in relative to the housing, which allows the ball bearings to move into a recess, allowing the plug to be fitted into the socket. Once the connector assembly is released, the balls are pushed outwards and the plug is held securely in the socket. The electrical connection is immediate. The connection for one polarity is made by the ball bearings sitting on the metal ring (annulus) contact at the base of the socket. The balls are pressed against the connector assembly of the plug (first connector part), which in turn is connected to the cable conductor. The connection for the other polarity is made by the head of the connector assembly (second connector part) pressing against a sprung metal contact at the top of the socket. To release, the connector assembly is pushed in and the body of the plug is pulled out to remove the plug. No tools are needed to insert or release the plug.

When used with a coaxial cable, the invention does not require any insulation to be cut back or trimmed on the inner coaxial conductor. The coaxial cable is simply cut to the desired length and inserted directly into the connector assembly. The insulator has an opening just large enough for the insulated inner conductor to pass through. The outer braided conductor is therefore held back. A setscrew (grub screw) with a sharp cone head pierces the insulation to make electrical

contact with the central conductor. The outer braided conductor is secured with a standard setscrew, which crushes a ferrule around the cable. The wiring method is quick and only requires the tightening of two screws.

Another benefit, aside from being quick and easy, is that because the inner conductor has its insulation in place, no strands of bare wire can be bent backwards, possibly jamming the insertion hole, or making contact with the other conductor and making a short circuit.

When the plug is not in place, the socket is simply a neat round hole with no male threads or flanges on view.

Brief Description of the Drawings

An embodiment of the invention will now be described by way of example only and with reference to the accompanying drawings, in which:

Fig. 1 shows a perspective view of an electrical plug in accordance with the invention;

Fig. 2 shows an exploded view of the electrical plug of Fig. 1;

Fig. 3 shows a cross-sectional view of the electrical plug of Fig. 1 before insertion of the coaxial cable, with the connector assembly in the first (locked) position;

Fig. 4 shows a cross-sectional view of the electrical plug of Fig. 1 ready for use with the coaxial cable inserted, with the connector assembly also in the first (locked) position;

Fig. 5 shows a cross-sectional view of the electrical plug of Fig. 1 with the connector assembly in the second (unlocked) position;

Fig. 6 shows an electrical plug and socket combination in accordance with the invention, with the socket shown in cross-section; and

Fig. 7 shows a perspective view of the electrical plug and socket combination of Fig. 6.

Description of a Preferred Embodiment

Fig. 1 shows electrical plug 100 connected to coaxial cable 10.

With reference to Fig. 2, electrical plug 100 has a cylindrical housing 110 with a cylindrical passage 111. Ball bearings 112 are located in through-holes 113 in the housing. The connector assembly 120 comprises first connector part 121 which is formed from components 121A and 121B,

insulator 122 and second connector part 123. Components 121A and 121B screw together to form the complete first connector part 121. First connector part 121 has a crushable ferrule 124, a grub screw 125 and a slidable cover 126 to provide a clean aesthetic and hide the grub screw 125. First connector part 121 is also provided with a recess 127 for the ball bearings 112 in the unlocked position, as will be described later. Insulator 122 is provided with a restriction 128 which is sized to keep the outer conductor of the coaxial cable within the first connector part 121. Second connector part 123 has a grub screw 129. Finally, spring 130 acts between the housing 110 and the first connector part to urge the connector assembly towards the locked position as described in more detail below.

Turning to Fig. 3, a cross-sectional view of the electrical plug 100 is shown, before insertion of the coaxial cable and with the connector assembly in the first (locked) position. Slidable cover 126 is also in the open position, allowing access to grub screw 125. Coaxial cable 10 comprises an outer uninsulated conductor 11 and an inner conductor 12. The inner conductor is insulated by means of insulation 13. The method of connection to the coaxial cable is straightforward. Cable 10 is inserted into the ferrule 124 and into the channel 131 provided in the first connector part 121. When the cable meets restriction 128 at the insulator 122, the outer conductor 11 is automatically held back as the inner conductor 12 and insulator 13 continue to be inserted past the restriction 128 and into the channel 132 provided in the second connector part 123. Once the inner conductor 12 is fully inserted in channel 132 (a visual check through the hole at the end of channel 132 can be made), grub screw 129 can be tightened so that its conical head pierces the insulation 13 and makes electrical connection with inner conductor 12. Grub screw 125 can also be tightened, which crushes ferrule 124 onto the outer conductor 11 to make electrical contact. Grub screws 125 and 129 therefore both secure the cable and make the electrical connections. As a result, the inner conductor 12 is electrically connected to second conductor part 123 and the outer conductor 11 is electrically connected to first conductor part 121 and also to housing 110 and ball bearings 112. Insulator 122 separates the polarities.

The assembled plug and coaxial cable are shown in Fig. 4. Slidable cover 126 is shown in the closed position, covering grub screw 125. In this figure, the connector assembly 120 is shown in its first position, i.e. its at-rest locked position, with the ball bearings 112 projecting radially from the housing 110.

In Fig. 5, the connector assembly 120 is shown in its second position, i.e. with the ball bearings 112 in the released position. To achieve this, connector assembly 120 is pushed inward relative to housing 110 against the force of spring 130, until recess 127 lines up with through-holes 113. This allows ball bearings 112 to move radially inward and no longer project from the housing 110.

Figs. 6 and 7 show electrical plug 100 inserted in electrical socket 200. The socket comprises a body 201 made of insulating material. An annular first conductor 202 is positioned adjacent to the opening of the socket. This conductor, in conjunction with the ball bearings 112, provides the mechanical securement for the plug in the socket as well as the electrical connection for one polarity of the supply. The inner diameter of the annular first conductor 202 is smaller than the radial extent of the ball bearings 112 when projecting radially from the housing in the locked position.

First conductor is connected to supply lead 203. Via the annular first conductor 202, ball bearings 112 and housing 110, the supply from lead 203 is electrically connected to first conductor part 121 of the plug and on to coaxial cable outer conductor 11. A second conductor 204 and spring 205 connect supply lead 206 to second conductor part 123 of the plug, and on to coaxial cable inner conductor 12.

In order to insert plug 100 into socket 200, the connector assembly 120 is moved to its second position, i.e. with the ball bearings 112 in the released position, by pushing the connector assembly 120 inward relative to housing 110 against the force of spring 130. The plug can then be inserted into the socket. The second conductor part 123 will contact spring 205, making an electrical connection but also requiring an increased force to push the plug in further so that the ball bearings 112 pass annular first conductor 202. At that point, the connector assembly 120 can be released to allow it to return to its first position, with the ball bearings 112 in the locked position projecting radially from the housing 110. The force of the spring 205 maintains ball bearings 112 in contact with the annular first conductor 202, thereby providing a dual mechanical and electrical engagement.

To remove the plug 100 from the socket, sufficient force is applied to the connector assembly 120 to overcome the force provided by spring 205 and to move the connector assembly 120 relative to the housing, to its second position with the ball bearings 112 released. Spring 205 helps to urge the plug out of the socket and once the ball bearings have passed annular first conductor

202, the plug can be fully removed from the socket and the connector assembly 120 allowed to return to its first position.

Claims

1. An electrical plug for connection to an electrical cable having a conductor, comprising:

a housing having a passage therethrough defining a longitudinal axis

a connector assembly for electrical connection to the conductor, the connector assembly being located in the passage of the housing; and

locking means having a locked status in which the locking means projects radially from the housing and a released status in which the locking means is able to retract into the housing,

wherein the connector assembly is movable relative to the housing along the longitudinal axis of the passage between a first position and a second position to control the status of the locking means such that, in the first position, the locking means is in the locked status, and in the second position, the locking means is in the released status.

2. The electrical plug of claim 1, wherein the connector assembly is biased towards the first position.

3. The electrical plug of claim 1 or 2, wherein the locking means comprises one or more balls which are locked in a position projecting radially from the housing in the locked status and are able to retract radially in the released status.

4. The electrical plug of claim 3, wherein the or each ball is located in a through-hole in the housing, the through-hole communicating to the connector assembly in the housing passage, wherein the connector assembly profile is configured such that in the first position, the connector assembly maintains the ball in the locked status, projecting radially from the housing in its outermost position in the through-hole, and in the second position, the connector assembly provides a recess for the ball to move into in the released status, in a direction radially towards the axis to its innermost position in the through-hole.

5. The electrical plug of claim 4, wherein the recess is a reduced-diameter section of the connector assembly.

6. The electrical plug of any preceding claim, wherein the electrical cable has two conductors and the connector assembly comprises:

a first connector part for electrical connection to the first conductor,

a second connector part for electrical connection to the second conductor, and

an insulator between the first connector part and the connector second part.

7. The electrical plug of claim 4 or 5 and claim 6, wherein the connector assembly profile is the profile of the first connector part.

8. The electrical plug of claim 6 or 7, wherein the electrical cable is a coaxial cable having an inner insulated conductor and an outer conductor substantially surrounding the inner insulated conductor, the first connector part being for electrical connection to the outer conductor and the second connector part being for electrical connection to the inner conductor, wherein the connector assembly comprises a channel to receive the coaxial cable, the channel extending through the first connector part and the insulator and extending into the second connector part, and wherein the channel includes a restriction such that, when the coaxial cable is inserted into the channel through the first connector part and the insulator and into the second connector part, the outer conductor is prevented from entering the second connector part by the restriction and only the inner insulated conductor is able to enter the second connector part.

9. The electrical plug of claim 8, wherein the restriction comprises a reduction in the diameter of the channel.

10. The electrical plug of claim 8 or 9, wherein the restriction is provided in the insulator section of the channel.

11. The electrical plug of any of claims 8 to 10, wherein the first connector part includes a first grub screw for gripping the coaxial cable and providing an electrical connection to the outer conductor and wherein the second connector part includes a second grub screw for providing an electrical connection to the inner conductor.

12. The electrical plug of claim 11, wherein the first and second grub screws are accessible by a fastening tool when the connector assembly is in the first position.

13. The electrical plug of claim 11 or 12, further comprising a movable sleeve to shield the first grub screw.

14. The electrical plug of claim 11, 12 or 13, further including a conductive ferrule between the first grub screw and the coaxial cable.

15. The electrical plug of any of claims 11 to 14, wherein the second grub screw has a conical inner head to pierce the insulation of the inner insulated conductor and electrically connect to the inner conductor.

16. The electrical plug of any preceding claim in combination with an electrical socket, the socket comprising a conductor for electrical connection to the connector assembly and engagement means to engage with the locking means of the plug so that, when the plug is inserted in the socket, the plug is locked in the socket when the locking means is in the locked status and the plug can be withdrawn from the socket when the locking means is in the released status.

17. The plug and socket combination of claim 16, wherein the locking means is electrically connected to the connector assembly and the engagement means is the conductor of the socket.

18. The plug and socket combination of claim 16 or 17, wherein the engagement means comprises an annulus, into which the plug housing is inserted when the plug and socket are assembled, the inner diameter of the annulus being smaller than radial extent of the locking means when projecting radially from the housing in the locked status.

19. The plug and socket combination of claim 16, 17 or 18, wherein the socket further comprises a spring acting against the plug when the plug is inserted in the socket, the spring urging the locking means into engagement with the engagement means when the locking means is in the locked status and urging the plug out of the socket when the locking means is in the released status.

20. The plug and socket combination of claim 16, wherein the plug is in accordance with any of claims 6 to 15 and wherein the socket comprises a first conductor for electrical connection to the first connector part of the plug and a second conductor for electrical connection to the second connector part of the plug.

21. The plug and socket combination of claim 20, wherein the locking means is electrically connected to the first connector part and the engagement means is the first conductor of the socket.

22. The plug and socket combination of claim 20 or 21, wherein the engagement means comprises an annulus, into which the plug housing is inserted when the plug and socket are assembled, the inner diameter of the annulus being smaller than the radial extent of the locking means when projecting radially from the housing in the locked status.

23. The plug and socket combination of claim 20, 21 or 22, wherein the socket further comprises a spring acting against the plug when the plug is inserted in the socket, the spring urging the locking means into engagement with the engagement means when the locking means is in the locked status and urging the plug out of the socket when the locking means is in the released status.

24. The plug and socket combination of claim 23, wherein the spring is the second conductor of the socket, acting against the second connector part of the plug when the plug is inserted in the socket.

25. A light fitting including an electrical cable connected to the electrical plug of any of claims 1 to 15.

26. A light fitting kit comprising a light fitting and the electrical plug and socket combination of any of claims 16 to 24.

27. An electrical plug substantially as described herein with reference to the accompanying drawings.

28. An electrical plug and socket combination substantially as described herein with reference to the accompanying drawings.

Intellectual Property Office

Application No:	GB1606792.8	**Examiner:**	Paul Nicholls
Claims searched:	1 - 28	**Date of search:**	16 September 2016

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	-	US 5702264 A (ENDO) - Longitudinal movement of cover 25 causes ball 51 to be pushed in to hold counterpart 55, or allows it to retract outwards into recess 53, compare figures 1 and 3
A	-	US 6135799 A (LINCOLN) - Insertion of insulator 60 pushes ball 50 out so it retains nut 20

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

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

Worldwide search of patent documents classified in the following areas of the IPC

F21S; F21V; F21W; H01R; H02G

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

WPI, EPODOC

International Classification:

Subclass	Subgroup	Valid From
H01R	0013/62	01/01/2006
H01R	0009/05	01/01/2006
H01R	0009/053	01/01/2006
H02G	0003/20	01/01/2006