

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
23 August 2007 (23.08.2007)

PCT

(10) International Publication Number
WO 2007/093344 A1

(51) International Patent Classification:
H01R 13/717 (2006.01) **H01R 13/66** (2006.01)

(21) International Application Number:
PCT/EP2007/001182

(22) International Filing Date:
12 February 2007 (12.02.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10 2006 006 726.6
13 February 2006 (13.02.2006) DE

(71) Applicant (for all designated States except US): **IFM ELECTRONIC GMBH** [DE/DE]; Teichstrasse 4, 45127 Essen (DE).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **MEHNERT, Wolfgang** [DE/DE]; Zwanwigerstrasse 16, 88131 Lindau (DE).
ANZERT, Gilbert [DE/DE]; Boskoopstrasse 28, 88048 Friedrichshafen (DE).

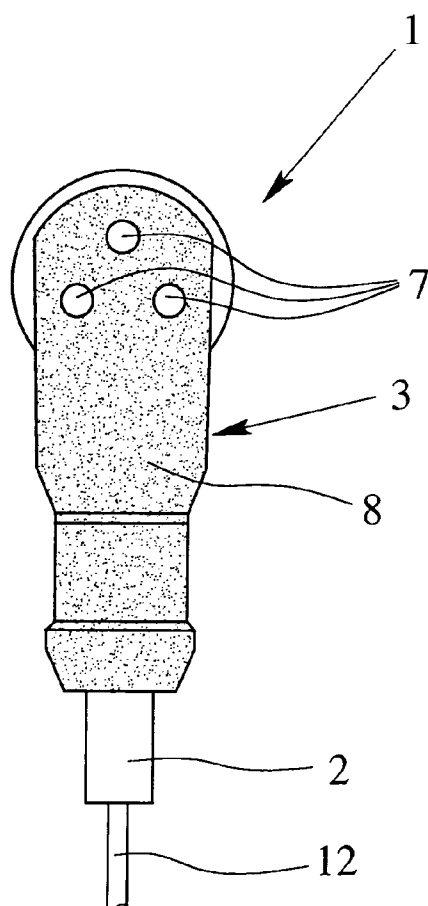
(74) Agent: **GESTHUYSEN, VON ROHR & EGGERT**;
Huysenallee 100, 45128 Essen (DE).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: ELECTRICAL PLUG CONNECTOR



(57) Abstract: An electrical plug connector is illustrated and described, for connection of an electrical cable (2) to an apparatus, in particular to a sensor or an actuator, having a housing (3), having a contact mount (5) which holds a variety of contacts (4), and having an electronics circuit (6) which is arranged in the housing (3) with the electronics circuit (6) having at least one light-emitting element, in particular an LED (7) and being electrically connected to the contacts (4). In the plug connector (1), the status of the LED (7) - LED (7) illuminated or LED (7) not illuminated - can be identified particularly well, even in the presence of strong external incident light, in that the housing (3) is composed of a thermoplastic material, at least in the area of the LEDs (7), with the thermoplastic material having an additive (8) which influences the transparency and colour, and which reduces the transparency of the thermoplastic material.

WO 2007/093344 A1

**Published:**

- *with international search report*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Electrical plug connector

The invention relates to an electrical plug connector for connection of an electrical cable to an apparatus, in particular to a sensor or an actuator, or for detachable connection of two electrical cables to one another, having a housing, having a contact mount which holds a variety of contacts, and having an electronics circuit which is arranged in the housing with the electronics circuit having at least one light-emitting element, in particular an LED and be electrically connected to the contacts.

Essentially, electrical plug connections are composed of two parts, the electrical plug connector and the mating plug connector. It can either be used to connect an electrical cable to an electrical or electronic appliance, or to connect two cables to one another. In the first case, the mating plug connector is connected to the electrical housing, and in the second case it is connected to the cable. Both the plug connector and the mating plug connector each have a contact mount with corresponding contacts, which are either contact pins or the corresponding sockets. Dependent on whether the contact pins or sockets are arranged in the respective contact mount, the associated connecting part is referred to as a plug or a socket.

In the case of plug connections such as these, it is known for the plug connector and the mating plug connector to be mechanically connected to one another by, for example, arranging a union nut on the plug connector, which is screwed to the thread that is formed on the outer sleeve of the mating plug connector. In this case, the union nut then has an internal thread which corresponds with the thread on the mating plug connector. However, as an alternative to this, it is also possible for a union screw to be arranged on the plug connector and to have an external thread, so that the plug connector with the union screw can be screwed into an outer sleeve, which has a corresponding internal thread, on the mating plug connector.

Electrical plug connections or plug connectors such as these are used in automation as a component of electronic equipment, sensors, actuators and controllers. In this case, in particular, M12 and M8 types are in widespread use, with three, four, five or eight contacts, in which case the electrical plug connectors and mating plug connectors are known both in a straight form and in a form angled through 90°. In the case of the latter, the housing of the electrical plug connector is angled through 90°, so that there is an angle of

90° between the longitudinal direction of the connecting cable being held and the longitudinal direction of the contacts. Corresponding plug connections are known, for example, from the 2005 Catalogue “Positionssensorik” [Position sensor system], pages 430 – 444 from ifm electronic gmbh.

Electrical plug connectors such as these can either be connected as required or can be ready-wired, in which case the contact mount and the cable are extrusion-coated by the housing, which is then also referred to as a grip.

10 Finally, electrical plug connectors may also be in the form of adapters, with the plug connector then having two contact mounts, which can each be connected to a corresponding mating contact mount. In this case, as a rule, a cable which has already been connected to a corresponding mating contact mount is connected at least to one contact mount, while the other contact

15 mount is then generally connected to the mating contact mount of a device or apparatus.

Electrical plug connectors of the type described initially and which are used in particular for connection of an electrical connection to an appliance, in particular a sensor, also have, in addition to the contact mount, an electronics circuit having at least one light-emitting element, generally an LED. The LEDs, of which there are up to three in practice, are in this case used to visually signal the serviceability and in particular the switching state of the connected sensor.

25 For this purpose, either an appropriate window is formed in the housing, which is generally closed by a separate, transparent cover, or the housing is entirely composed of a transparent material. In this way, the light beams which are emitted from the LEDs can pass either through the transparent

30 cover or through the transparent material of the housing, so that the status of the LED can be seen.

The first variant has the disadvantage that, first of all, the production is relatively complex and costly since the various parts – housing and cover –

35 must be produced and connected to one another, for example by adhesive bonding or ultrasound welding. Furthermore, the two-part configuration means that sealing problems can also occur, so that, for applications in which the sealing of the housing is significant, the complexity and thus also

the costs for production of a corresponding electrical plug connector rise further.

For this reason, a transparent plastic is being increasingly used to produce
5 the housing in practice for electrical plug connectors which have at least one
LED. For applications in which the electrical plug connector is subject to
strong external incident light, there is a problem, however, in that it is often
no longer reliably possible to tell whether or not an LED is illuminated.
Because of the transparent material that is used, it is also possible in
10 particular in this case for reflections to occur of the light striking the plug
connector from the outside onto components arranged in the housing, which
it is then virtually impossible to distinguish from the light from an LED.

The present invention is therefore based on the object of providing an
15 electrical plug connector as described in the introduction, which avoids the
disadvantages mentioned above and furthermore can be produced as easily
as possible, and thus at low cost.

In the case of the electrical plug connector described in the introduction, this
20 object is achieved and the housing is composed of a thermoplastic material,
at least in the area of the light-emitting element, with the thermoplastic
material having an additive which influences the transparency and colour,
and which reduces the transparency of the thermoplastic material. Contrary
to the procedure which has been practised until now in the prior art, of using
25 a highly transparent material at least in the area of the light-emitting
element, the invention now proposes that the transparency of the material be
deliberately reduced. In this case this is done in a simple manner by adding
an additive to the thermoplastic material for production of the housing, thus
reducing the colour and hence the transparency of the housing.

30 In this case, a colour concentrate with organic and/or inorganic dyes is
preferably used as the additive, and is added to the thermoplastic material in
the form of powder or granulate. In this case, the dyes preferably have a
grey or black colour, so that the complete housing also overall has a grey to
35 black colour. The proportion by weight of the additive is in this case less
than 5%, preferably between 1% and 3%, and in particular about 2%, thus
making it possible to reduce the transparency by about 60% to 80%,
preferably by about 70%.

As before, the colouring of the housing according to the invention makes it possible to tell whether an LED is illuminated from the outside through the housing, furthermore resulting in a considerable increase in contrast, so that the status of an LED can be seen well even when the plug connector is
5 subject to strong external incident light. In this case, the thermoplastic materials which are already known from practical use, in particular polyurethane, thermoplastic elastomer or polyvinyl chloride, can still be used as the basic material for the housing, so that the production process for the electrical plug connector can remain virtually unchanged.

10 According to one preferred embodiment of the invention, the housing of the electrical plug connector is composed entirely of the thermoplastic material which is provided with the additive. The housing can thus still be produced in a single injection-moulding process. No sealing problems can occur at
15 junctions between different housing parts. Furthermore, the use of a housing that is coloured overall has the advantage that the electronics circuit which is arranged within the housing and/or is extrusion-coated by the thermoplastic material can no longer be seen as clearly from the outside as would be the case with a "completely" transparent housing. In consequence, a user's
20 attention is no longer distracted, so that he can concentrate on telling whether the LED is or is not illuminated. Preferably the colouring of the housing is such that the housing is completely nontransparent and only the specific wavelength of the LED – if illuminated – can be seen from outside the housing.

25 In principle, the colour of the housing of the electrical plug connector is independent on what configuration the electrical plug connector would otherwise have. In particular, the electrical plug connector may already be ready-wired and connected to an electrical cable, in which case one end of
30 the cable is then sealed on the side of the housing facing away from the contact mount. Since the housing is generally produced using an injection-moulding process that end of the cable which is electrically connected to the electronics circuit is thus also directly extrusion-coated during the production of the electrical plug connector.

35 Alternatively, however, the electrical plug connector can also be designed such that it can be wired up as required, so that the electrical plug connector has appropriate connecting elements for connection of the individual

conductors of a separate electrical cable. Finally, the electrical plug connector may also have two contact mounts, wherein the contacts of the second contact mount are likewise electrically connected to the electronics circuit, so that a cable which is connected to a corresponding mating contact mount can then be connected to the second contact mount.

According to a final particular embodiment of the invention, which will also be explained briefly here, the electrical plug connector has at least two LEDs which are arranged under a transparent cover which is arranged within the housing, in which case two symbols which are associated with the two LEDs are formed in the housing above the cover. The two symbols have preferably the shape of two arrows which point in opposite directions and through which the light from the LEDs can pass.

An embodiment of the electrical plug connector such as this is particularly advantageous when the electrical plug connector is intended to be connected to so-called "intelligent" sensors, which have an integrated microcontroller. In an electrical plug connector such as this, the electronics circuit of the plug connector likewise has a microcontroller, so that the sensor is not only supplied with electrical power via the plug connector, but data can also be transmitted to and from the sensor via the electrical plug connector. The symbols which are formed in the housing, in particular by being embossed, can then indicate the direction of the actual data transfer, by the illumination of the LED associated with the corresponding symbol. Reference should be made to the subsequently published DE 10 2005 049 483 A1 for the specific configuration of an "intelligent" electrical plug connector such as this.

The transparent cover, which is arranged above the LEDs, may in this case be used in particular for focusing and guidance of the light emitted from the LEDs, to the symbols formed in the housing. The cover is in this case preferably in the form of a shutter such that only the light coming from the associated LED in each case passes through the two symbols. This ensures that, despite the physical proximity of the two LEDs within the housing, light passes only through the symbol associated with one LED when that LED is illuminated.

The LEDs are preferably mounted using SMD technology on a printed circuit board associated with the electronics circuit or on a flexible

conductor film, so that a plurality of LEDs can be used even in a small housing, as is the case with M8 plugs.

5 In detail, there are now a large number of possible ways to refine and develop the electrical plug connector according to the invention. For this purpose, reference is made on the one hand to the dependent claims, and on the other hand to the following description of the preferred exemplary embodiment of the invention described with reference to the attached drawing. In the drawing:

10

Figure 1 shows an electrical plug connector according to the prior art,

Figure 2 shows an electrical plug connector according to the invention, from the rear, with illuminated and non-illuminated LEDs,

15

Figure 3 shows one embodiment of the electrical plug connector as shown in Figure 2, from the side and from the front, and

Figure 4 shows a second exemplary embodiment of an electrical plug connector according to the invention, from the side and from the rear.

20

The figures show various exemplary embodiments of an electrical plug connector 1, with Figure 1 showing an electrical plug connector 1 according to the prior art and Figures 2 to 4 showing two variants of an electrical plug connector 1 according to the invention. The electrical plug connectors 1 illustrated in Figures 1 to 3 are used for connection of an electrical cable 2 to an electronic apparatus, in particular a sensor, for example a proximity switch, a temperature sensor or a flow sensor.

30

The electrical plug connector 1 – both according to the prior art and according to the invention – has a housing 3, a contact mount 5 which holds a plurality of contacts 4 and an electronics circuit 6 arranged in the housing 3. In this case, the electronics circuit 6 generally has a printed circuit board on which, in addition to a number of electrical and electronic components, a plurality of LEDs 7, generally up to three LEDs 7, are arranged. The LEDs 7 are in this case used as a status indication for the connected sensor. The electrical plug connector 1 is also referred to as a cable plug or a cable.

35

socket, dependent on the nature of the contacts arranged in the contact mount 5 – plugs or sockets.

5 In order that it is possible to tell from outside the housing 3 in the case of the known electrical plug connector 1 illustrated in Figure 1 whether the LEDs 7 arranged in the housing 3 are or are not illuminated, the housing 3 is composed of a completely transparent plastic. As indicated in Figure 1, the electronics circuit 6 with the electrical and electronic components arranged on it, in particular the LEDs 7, can thus be seen through the housing 3, as
10 well. If the known electrical plug connector 1 is now subjected to strong external incident light, then it is very often no longer possible to reliably tell, especially when looked at it quickly, whether one or more of the LEDs 7 is or is not illuminated.

15 In contrast, in the case of the electrical plug connector 1 according to the invention and illustrated in Figures 2 to 4, the housing 3 is no longer composed of “completely” transparent material, but of a thermoplastic material to which an additive 8 which influences the transparency and colour has been added. Thus, overall, the housing 3 has a grey or black
20 colour depending on the proportion by weight of the additive 8. An illuminated LED 7 can thus, as before, be seen from outside the housing 3, while an LED 7 which is not illuminated and the electronics circuit 6 cannot be seen, or can be seen only poorly. This is illustrated in Figure 2 by the fact that, in Figure 2a (LEDs off), the LEDs 7 which are arranged in the interior
25 of the housing 3 are illustrated just by dashed lines while, in Figure 2b (LEDs on), the LEDs 7 are illustrated by solid lines.

Polyurethane (PUR) or polyether polyurethane is preferably used as the thermoplastic material for the housing 3, since these plastics have a very
30 good resistance to oils, and are considerably better than thermoplastic elastomer (TPE). In this case, the proportion by weight of the additive 8 is chosen, preferably in the range from 1% to 3%, such that the transparency of the thermoplastic material of the housing 3 is decreased by 20 to 40%, preferably by about 30%. In this case, the resultant increase in contrast
35 improves the capability to see an illuminated LED 7, particularly in the presence of incident light, considerably.

The electrical plug connectors 1 according to the invention and illustrated in Figures 2 to 4 have a union nut 9 for mechanical connection to a corresponding mating plug connector, which is arranged such that it can rotate and can be moved axially to a limited extent on the contact mount 5.

5 The union nut 9, which has an internal thread, can thus be screwed onto a sleeve, which has a corresponding external thread, on a mating plug connector. In order to make it easier to screw the union nut 9 on, it has a knurl 10 on its outer circumference. The electrical plug connector 1 also has vibration protection, which prevents the union nut 9 from inadvertently
10 becoming loose from the sleeve of the mating connector. The vibration protection is in this case provided by an appropriate embodiment of the contact mount 5 and of the union nut 9. In order to allow a union nut 9 which has been tightened firmly to be released relatively easily again, the union nut 9 also has a flat 11 for a spanner.

15 While, in the case of the electrical plug connector 1 illustrated in Figures 2 and 3, the conductors 12 in the electrical cable 2 have already been firmly connected to the electronic circuit 6 and the electrical cable 2 has been surrounded by the housing 3 on the side facing away from the contact mount
20 5, the electrical plug connector 1 shown in Figure 4 has a second contact mount 13, which is provided for connection of a cable 2 with a corresponding plug. An electrical plug connector 1 such as this can also be referred to as an adaptor. In addition to this difference with respect to the connection of the electrical cable 2, the electrical plug connector illustrated
25 in Figure 4 also has further differences from the plug connectors 1 illustrated in Figures 2 and 3.

Specifically, the electrical plug connector 1 illustrated in Figure 4 is an
30 "intelligent" plug connector 1, which is intended for connection to an "intelligent" sensor which has a microcontroller. The sensor can then not only be supplied with electrical power via the electrical plug connector 1, which likewise has a microcontroller, but data can also be transmitted from the sensor and to the sensor. Reference is made to the subsequently published DE 10 2005 049 483 A1 with regard to the further configuration
35 of the "intelligent" plug connector 1 illustrated in Figure 4, in particular with regard to the configuration and function of the microcontroller associated with the electronics circuit 6.

As can be seen from Figure 4a, in the case of the electrical plug connector 1 illustrated there, a transparent cover 14 is arranged between the electronics circuit 6, which has two LEDs 7, and the upper face of the housing 3, through which light emitted from the LEDs 7 is passed to the upper face 15 of the housing 3. Two arrows 16, 17 which point in opposite directions are formed, in particular embossed, on the upper face 15 of the housing 3 associated with the LEDs 7, through which light from a respectively associated LED 7 can shine. In fact, the two LEDs 7 illustrated in Figure 4a are arranged one behind the other in the plane of the drawing – and not alongside one another, as illustrated. The cover 14 is in this case used not only for guidance of the light emitted from the LEDs 7 but furthermore, also as a shutter, which is designed such that the light shines only through one of the arrows 16, 17 in each case from the associated LED 7. The operator can thus tell immediately, depending on which arrow 16, 17 is or is not illuminated, the direction, for example, in which data is being transferred through the “intelligent” electrical plug connector 1.

In addition to the embodiments of the electrical plug connector 1 illustrated in the figures, which each relate to an embodiment angled through 90° , in which the longitudinal direction of a connected electrical cable 2 and the longitudinal direction of the contacts 4 of the contact mount 5 therefore form an angle of about 90° , the electrical plug connector 1 may, of course, also be in the form of a “straight” plug connector. Furthermore, the electrical plug connector 1 shown in Figure 4 also has an inclined area in which the symbols, which are in the form of arrows 16, 17, are embossed in the housing 3 or in the upper face 15 of the housing 3.

Patent Claims:

1. Electrical plug connector for connection of an electrical cable (2) to an apparatus, in particular to a sensor or an actuator, or for detachable
5 connection of two electrical cables (2) to one another, having a housing (3), having a contact mount (5) which holds a variety of contacts (4), and having an electronics circuit (6) which is arranged in the housing (3) with the electronics circuit (6) having at least one light-emitting element, in particular an LED (7) and being electrically connected to the contacts (4),
10 **characterized**
in that the housing (3) is composed of a thermoplastic material, at least in the area of the light-emitting element, with the thermoplastic material having an additive (8) which influences the transparency and colour, and which reduces the transparency of the thermoplastic material.
- 15 2. Electrical plug connector according to claim 1, characterized in that the additive (8) is a colour concentrate with organic and/or inorganic colorant, which have a dark colour in particular grey and/or black.
- 20 3. Electrical plug connector according to claim 1 or 2, characterized in that the proportion by weight of the additive (8) is less than 5%, preferably between 1% and 3%.
4. Electrical plug connector according to one of claims 1 to 3,
25 characterized in that polyurethane (PUR), polyether-polyurethane, thermoplastic elastomer (TPE) or polyvinylchloride (PVC) is used as the thermoplastic material.
5. Electrical plug connector according to one of claims 1 to 4,
30 characterized in that the housing (3) is composed entirely of the thermoplastic material which is provided with the additive (8).
6. Electrical plug connector according to claim 1 to 5, characterized in that the transparency and colour of the housing (3) is such that the housing
35 (3) is completely intransparent and only the specific wavelength of the light-emitting element, in particular the LEDs (7) can be seen from outside the housing (3).

7. Electrical plug connector according to one of claims 1 to 6, characterized in that a union nut (9) is provided and is arranged on the contact mount (5) such that it can rotate and can be moved axially to a limited extent, in which case the union nut (9) has an internal thread or an external thread and can be screwed to a sleeve, which has a corresponding thread, on a mating plug connector.

8. Electrical plug connector according to one of claims 1 to 7, characterized in that the conductors (12) of an electrical cable (2) are connected to the electronic circuit (6) and the electrical cable (2) is surrounded by the housing (3) on the side facing away from the contact mount (5).

9. Electrical plug connector according to one of claims 1 to 7, characterized in that a second contact mount (13), which holds a plurality of contacts, is arranged on the side of the housing (3) facing away from the first contact mount (5) with the contacts of the second contact mount (13) being electrically connected to the electronics circuit (6).

10. Electrical plug connector according to one of claims 1 to 9, characterized in that a plurality of preferably differently coloured LEDs (7) are provided, and are used as a status indication.

11. Electrical plug connector according to claim 10, characterized in that the LEDs (7) are surface mounted devices (SMDs).

12. Electrical plug connector according to one of claims 1 to 11, having two LEDs (7), characterized in that the LEDs (7) are arranged under a transparent cover (14) which is arranged within the housing (3), and in that two symbols which are associated with the two LEDs (7) in particular two arrows (16, 17) which point in opposite directions and through which the light from the LEDs (7) can pass, are formed in the housing (3) above the cover (14).

13. Electrical plug connector according to claim 12, characterized in that the cover (14) is in the form of a aperture such that only the light coming from the associated LED (7) in each case passes through the two symbols.

14. Electrical plug connector according to one of claims 1 to 13, characterized in that the plug connector (1) has a cross section which is angled through about 90° , such that there is an angle of about 90° between the longitudinal direction of a connected electrical cable (2) and the longitudinal direction of the contacts (4).
- 5

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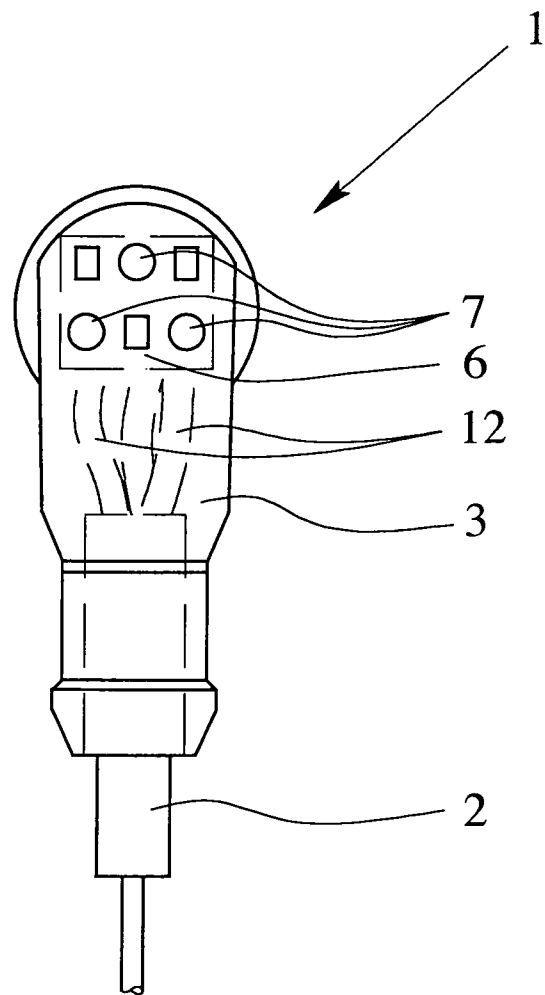


Fig. 1

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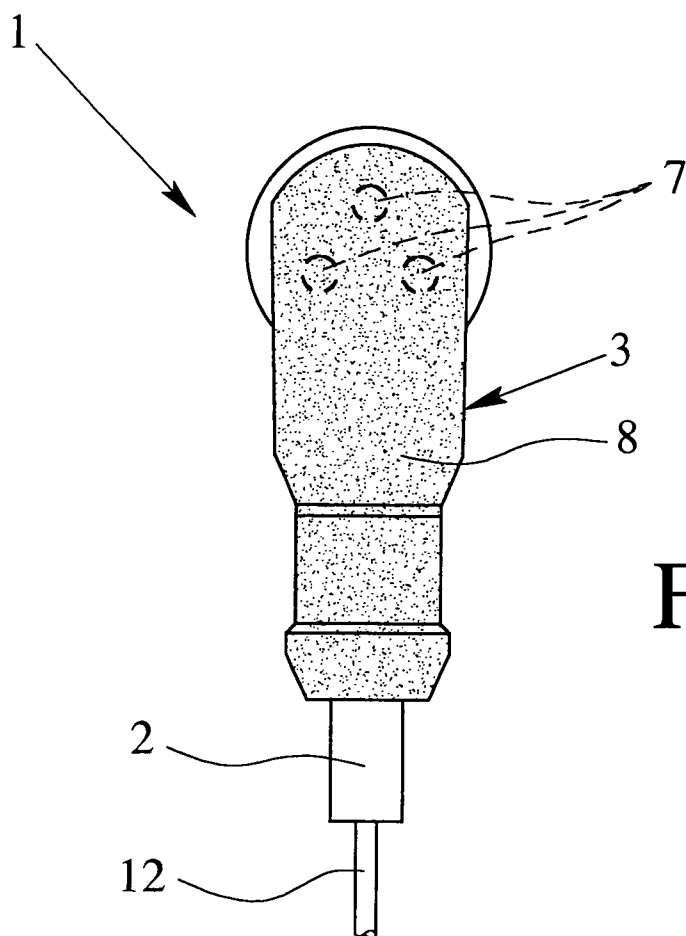
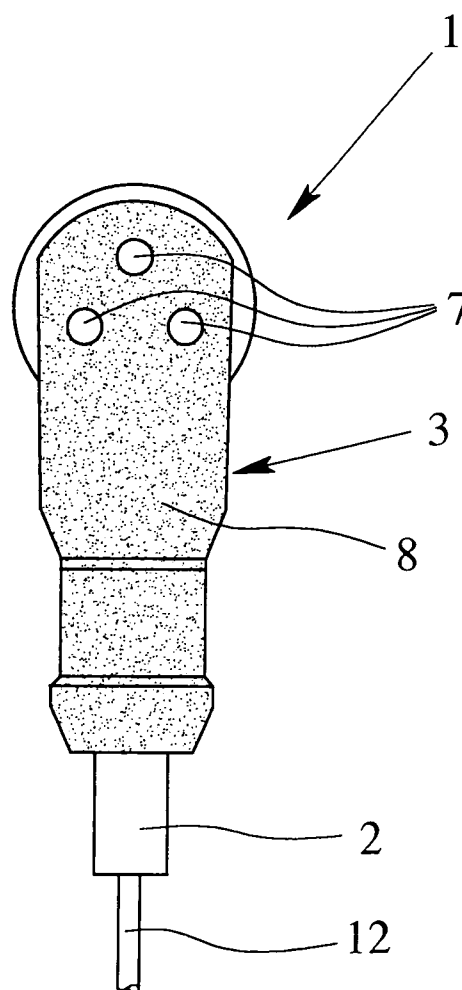


Fig. 2a

Fig. 2b



3/4

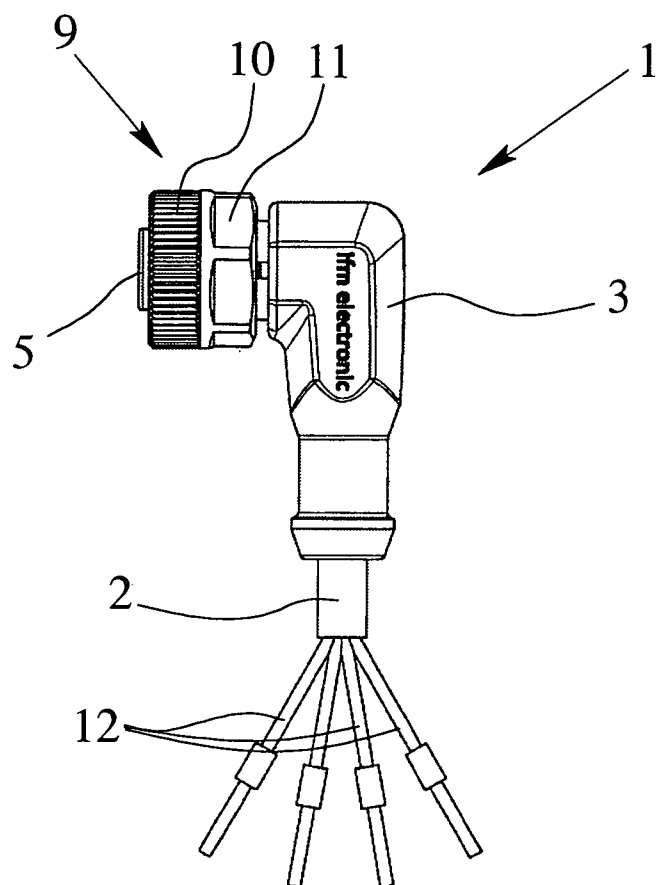


Fig. 3a

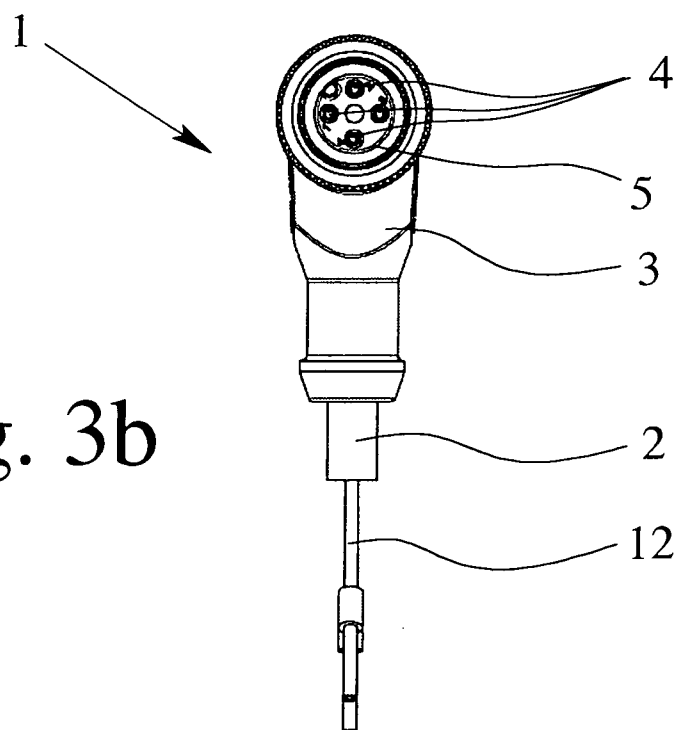


Fig. 3b

4/4

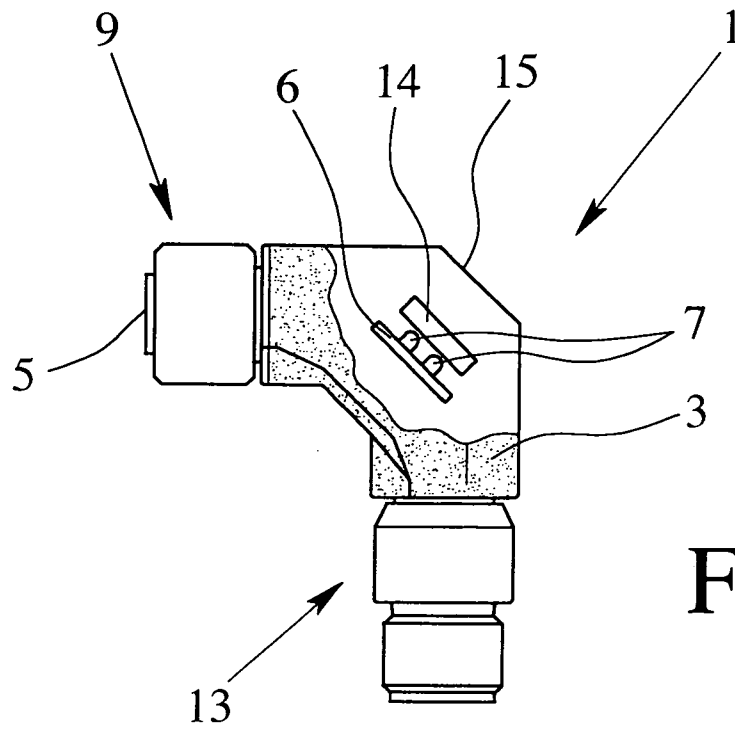


Fig. 4a

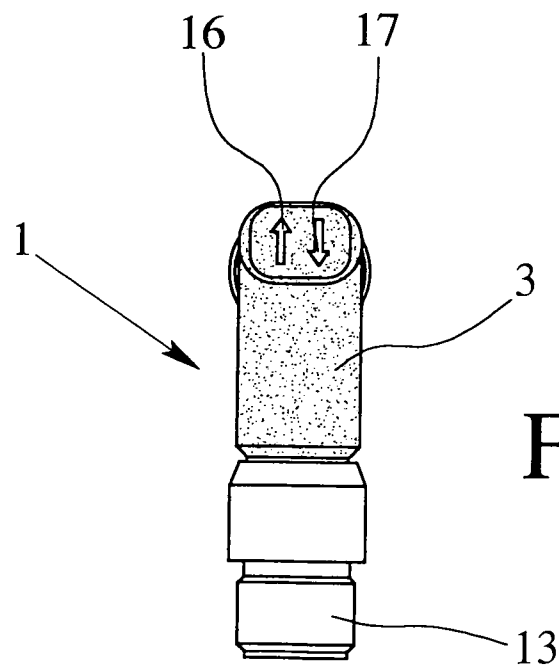


Fig. 4b

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2007/001182

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01R13/717 H01R13/66

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 244 409 A (GUSS III ROBERT J [US] ET AL) 14 September 1993 (1993-09-14) column 3, line 13 - line 42; figures 1,2,5	1-14
X	EP 1 624 538 A (TECHTRONIC IND CO LTD [CN]) 8 February 2006 (2006-02-08) paragraphs [0014], [0017]; figure 1	1-14
X	EP 0 700 130 A (COGIP SRL [IT]) 6 March 1996 (1996-03-06) column 4, line 35 - line 46; figures 3,4,11	1-14
A	US 6 259 170 B1 (LIMOGE HENRY J [US] ET AL) 10 July 2001 (2001-07-10) column 4, paragraph 14 - paragraph 33; figure 1	1
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the International search

11 June 2007

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19/06/2007

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Jiménez, Jesús

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2007/001182

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2007/001182

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