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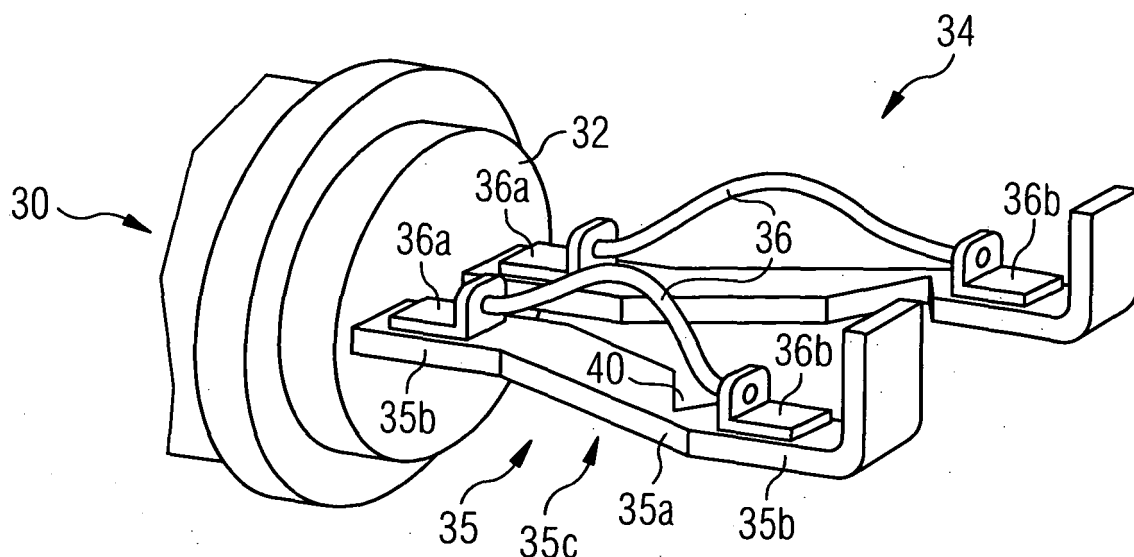
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56122 Pisa (IT)**(54) **Electrical connector and method for coupling an electrical connector to an actuator unit**

(57) Electrical connector (30) for an injector (20) comprising a connector body (32), a pin (38) being mechanically coupled to the connector body (32) and being electrically coupable to a power supply, and an electric conductor (34) being electrically coupled to the pin (38) and being electrically coupable to an actuator unit (28) of the injector (20), the electric conductor (34) comprising a first conducting element (35) and a second conducting

element (36), the first conducting element (35) having a first rigidity, the second conducting element (36) being elastically deformable and having a second rigidity being smaller than the first rigidity of the first conducting element (35), and the first conducting element (35) being coupled electrically to the second conducting element (36) in a manner that the second conducting element (36) electrically bridges a section (35c) of the first conducting element (35).

FIG 2**EP 1 961 951 A1**

Description

[0001] The invention relates to an electrical connector for an injector and a method for coupling an electrical connector to an actuator unit of an injector.

[0002] In order to meet the requirements of strict emission legalisation and in order to save fuel consumption, injectors, in particular fuel injectors for internal combustion engines are arranged in internal combustion engines in order to dose the fluid into an intake manifold of the internal combustion engine or directly into the combustion chamber of a cylinder of the internal combustion engine.

[0003] Injectors for an internal combustion engine comprise actuator units. In order to inject fuel, the actuator unit is energized so that a fluid flow through the fluid outlet portion of the injection valve is enabled.

[0004] In order to enhance the combustion process in view of the creation of unwanted emissions, the respective injector may be suited to dose fluids under very high pressures. The pressures may be in case of a gasoline engine, for example the range of up to 200 bar or in the case of diesel engines in the range of up to 2,000 bar. The injection of fluids under such high pressures has to be carried out very precisely.

[0005] During the injection process very fast changes of the pressure may occur. The fast changes of the pressure may cause pressure waves in the fluid which leads to pressure waves in different parts of the injector, in particular in the actuator unit.

[0006] The object of the invention is to create an electrical connector that is simply to be manufactured and which facilitates a reliable and precise function of the injection valve.

[0007] These objects are achieved by the features of the independent claims. Advantageous embodiments of the invention are given in the sub-claims.

[0008] According to a first aspect the invention is distinguished by an electrical connector for an injector comprising a connector body, a pin being mechanically coupled to the connector body and being electrically coupleable to a power supply, and an electric conductor being electrically coupled to the pin and being electrically coupleable to an actuator unit of the injector, the electric conductor comprising a first conducting element and a second conducting element, the first conducting element having a first rigidity and the second conducting element being elastically deformable and having a second rigidity being smaller than the first rigidity of the first conducting element, and the first conducting element being coupled electrically to the second conducting element in a manner that the second conducting element electrically bridges a section of the first conducting element.

[0009] This has the advantage that due to the elastic deformability of the second conducting element and due to the second rigidity being smaller than the first rigidity a high mechanical flexibility of the coupling of the electrical connector to the actuator unit is obtainable. Fur-

thermore, an electric current through the electrical connector is possible even in the case that the first conducting element is interrupted as the second conducting element bridges the first conducting element electrically.

[0010] In an advantageous embodiment the electrically bridged section of the first conducting element comprises an attenuation zone. This has the advantage that a destruction of the electrically bridged section of the first conducting element due to high mechanical forces exerted on the actuator unit or a forced destruction of the electrically bridged section of the first conducting element is possible nevertheless a secure electric coupling between the actuator unit and the electrical connector is remaining. Consequently, a damage of the injector can be avoided even in the case of high mechanical forces exerted on the actuator unit.

[0011] In a further advantageous embodiment the first conducting element is formed as a tape, and the attenuation zone of the first conducting element has a recess being formed in a manner that a width of the attenuation zone of the first conducting element is smaller than a width of further sections of the first conducting element. This has the advantage that a simple construction of the recess by stamping the first conducting element is possible.

[0012] In a further advantageous embodiment the first conducting element is formed as a tape, and the attenuation zone of the first conducting element has a recess in a manner that a thickness of the attenuation zone of the first conducting element is smaller than a thickness of further sections of the first conducting element. This has the advantage that a simple construction of the recess by rolling the first conducting element is obtainable.

[0013] In a further advantageous embodiment the recess is V-shaped. This makes it possible to simply stamp or roll the recess into the first conducting element.

[0014] In a further advantageous embodiment the recess has a semicircular shape. This makes it possible to simply stamp or roll the recess into the first conducting element and to simply remove the electrical coupling in the first conducting element if necessary.

[0015] In a further advantageous embodiment the second conducting element is a wire element. This makes a high elasticity of the second conducting element possible.

[0016] In a further advantageous embodiment the second conducting element comprises a plurality of wire elements. This has the advantage that a very high elasticity of the second conducting element is possible.

[0017] In a further advantageous embodiment the rigid first conducting element of the electric conductor is electrically coupleable to the actuator unit of the injector. This has the advantage that the position of the electrical connector relative to the actuator unit of the injector can be fixed with a high precision.

[0018] According to a second aspect the invention is distinguished by a method for coupling an electrical connector according to one of the preceding claims to an

actuator unit of an injector comprising the following steps: providing the electrical connector and the actuator unit of the injector, aligning the electrical connector relative to the actuator unit of the injector to obtain a defined position of the electrical connector relative to the actuator unit of the injector, coupling the first conducting element of the electric conductor of the electrical connector to the pin of the actuator unit to provide an electric coupling between the electrical connector and the actuator unit of the injector, and removing the attenuation zone of the first conducting element.

[0019] Exemplary embodiments of the invention are explained in the following with the help of schematic drawings. These are as follows:

Figure 1 an injector with an electrical connector in a longitudinal section view,

Figure 2 the electrical connector in a perspective view, and

Figure 3 the electrical connector in a further perspective view.

[0020] Elements of the same design and function that appear in different illustrations are identified by the same reference characters.

[0021] Figure 1 shows a part of an injector 20 with an actuator unit 28 and an electrical connector 30.

[0022] The actuator unit 28 comprises a housing 22 in which a piezo element 24 is arranged. The actuator unit 28 may, however, also comprise another type of actuator, which is known to the person skilled in the art for that purpose. Such an actuator may be, for example, a solenoid. The actuator unit 28 further comprises pins 26 for the supply of electrical energy to the actuator unit 28. The piezo element 24 of the actuator unit 28 may change its axial length if it is supplied with electrical energy. By changing its length the actuator unit 28 may effect a force on a valve needle of the injector 20. Due to the exerted force the valve needle is able to move in axial direction to prevent or enable a fluid flow through the injector 20.

[0023] The electrical connector 30 has a connector body 32 in which an electric conductor 34 and a pin 38 are arranged. The electric conductor 34 is electrically coupled with the pin 38 of the electrical connector 30 and with one of the pins 26 of the actuator unit 28. A power supply can be coupled to the pin 38 to supply the actuator unit 28 with electrical energy.

[0024] The electric conductor 34 comprises a first conducting element 35 and a second conducting element 36. The first conducting element 35 has a first rigidity. The second conducting element 36 is elastically deformable and has a second rigidity which is smaller than the first rigidity of the first conducting element 35. The first conducting element 35 and the second conducting element 36 are electrically coupled with each other in a manner that depending on the state of the first conducting

element 35 either a parallel current flow through the first conducting element 35 and the second conducting element 36 is enabled or a current flow through the elastically deformable second conducting element 36 is possible.

[0025] The first conducting element 35 has a section 35c with an attenuation zone 35a and two further sections 35b. The attenuation zone 35a is an area structurally weakened relative to the two further sections 35b. The section 35c with the attenuation zone 35a of the first conducting element 35 is arranged between the two further sections 35b of the first conducting element 35. The attenuation zone 35a of the first conducting element 35 has a recess 40. Due to the recess 40 the cross-section of the attenuation zone 35a of the first conducting element 35 is smaller than the cross-section of the two further sections 35b of the first conducting element 35.

[0026] In the shown embodiment of the electrical connector 30 the first conducting element 35 is formed as a tape. The section 35c and in particular the attenuation zone 35a of the first conducting element 35 have a thickness T1. The further sections 35b of the first conducting element 35 have a thickness T2. The thickness T1 of the attenuation zone 35a of the first conducting element 35 is smaller than the thickness T2 of the further sections 35b of the first conducting element 35. Consequently, the cross-section of the attenuation zone 35a of the first conducting element 35 is smaller than the cross-section of the further sections 35b of the first conducting element 35. The recess 40 of the first conducting element 35 is preferably produced by a rolling process during the production of the first conducting element 35.

[0027] The embodiment of the electrical connector 30 of figure 3 shows the first conducting element 35 with the section 35c comprising the attenuation zone 35a and the further sections 35b. A width W1 of the attenuation zone 35a of the section 35c of the first conducting element 35 is smaller than a width W2 of the further sections 35b of the first conducting element 35. Thus, the cross-section of the attenuation zone 35a of the first conducting element 35 is smaller than the cross-section of the further sections 35b of the first conducting element 35.

[0028] The second conducting element 36 has a first end 36a and a second end 36b. The first end 36a of the second conducting element 36 is electrically coupled to one of the two further sections 35b of the first conducting element 35. The second end 36b of the second conducting element 36 is electrically coupled to the other of the two further sections 35b of the first conducting element 35. This electrical coupling enables to electrically bridge the section 35c and in particular the attenuation zone 35a of the first conducting element 35. In the case that the attenuation zone 35a of the first conducting element 35 is intact a parallel current flow through the first conducting element 35 and the second conducting element 36 to the pin 26 of the actuator unit 28 is possible.

[0029] The recess 40 may also be V-shaped as shown in figure 2. This allows a simple stamping or rolling of the

recess 40 into the first conducting element 35.

[0030] The first conducting element 35 of the electrical connector 30 may also have a recess 40 with a semicircular shape. By this the first conducting element 35 is formed in a way that the electrical connections between the further sections 35b of the first conducting element 35 can be removed very simply.

[0031] Preferably, the second conducting element 36 is a wire. Wire elements enable a good elastic deformability of the second conducting element 36. Consequently, a high elasticity between the connector body 32 and the actuator unit 28 is available. Preferably, the second conducting element 36 comprises a plurality of wire elements which enable a very good elastic deformability of the second conducting element 36.

[0032] Preferably, the coupling between the first conducting element 35 and the second conducting element 36 is carried out by a welding process as this is a very robust mechanical coupling process. The coupling between the first conducting element 35 and the second conducting element 36 may also be achieved by brazing or a mechanical process such as pressing or clamping.

[0033] In the following a method for coupling the electrical connector 30 to the actuator unit 28 of the injector 20 will be described in detail:

[0034] The electrical connector 30 and the actuator unit 28 of the injector 20 are provided. The electrical connector 30 is aligned relative to the actuator unit 28 of the injector 20. As the first rigidity of the first conducting element 35 is high it is possible to obtain a well-defined position of the electrical connector 30 relative to the actuator unit 28 of the injector. Furthermore, the first conducting element 35 of the electric conductor 34 of the electrical connector 30 is coupled to the pin 26 of the actuator unit 28. This coupling is preferably carried out by welding. The coupling provides an electrical coupling between the electrical connector 30 and the actuator unit 24 of the injector. Finally, the attenuation zone 35a of the first conducting element 35 is removed. This makes it possible to obtain an elastic coupling between the two further sections 35b of the first conducting element 35.

[0035] In the following the function of the electrical connector 30 of the injector 20 will be described:

[0036] If the actuator unit 28 of the injector 20 is supplied with electric energy through the electrical connector 30 the valve needle is enabled to move as described above and to exert a reaction force on the actuator unit 28. Due to this a movement of the actuator unit 28 relative to the electrical connector 30 can occur in a manner that forces are exerted on the first conducting element 35 and the second conducting element 36.

[0037] If the attenuation zone 35a of the first conducting element 35 is intact a parallel current flow through the first conducting element 35 and the second conducting element 36 is enabled and the actuator unit 28 is supplied with electrical energy in a secure manner.

[0038] If the forces due to the movement of the actuator unit 28 relative to the electrical connector 30 are high

enough to destroy the attenuation zone 35a of the first conducting element 35 which has the high first rigidity or the attenuation zone 35a of the first conducting element 35 is removed by the method for coupling the electrical connector 30 to the actuator unit 28 of the injector 20 as described above the second conducting element 36 bridges the attenuation zone 35a of the first conducting element 35 and a current flow through the second conducting element 36 is enabled. Consequently, the actuator unit 28 is supplied with electrical energy in a secure manner as the second rigidity of the second conducting element 36 is smaller than the first rigidity of the first conducting element 35 and the second conducting element 36 is elastically deformable thus enabling to transmit a low mechanical stress to the pins 26 of the actuator unit 28.

Claims

1. Electrical connector (30) for an injector (20) comprising
 - a connector body (32),
 - a pin (38) being mechanically coupled to the connector body (32) and being electrically coupleable to a power supply, and
 - an electric conductor (34) being electrically coupled to the pin (38) and being electrically coupleable to an actuator unit (28) of the injector (20),
 the electric conductor (34) comprising a first conducting element (35) and a second conducting element (36), the first conducting element (35) having a first rigidity, the second conducting element (36) being elastically deformable and having a second rigidity being smaller than the first rigidity of the first conducting element (35), and the first conducting element (35) being coupled electrically to the second conducting element (36) in a manner that the second conducting element (36) electrically bridges a section (35c) of the first conducting element (35) .
2. Electrical connector (30) according to claim 1, with the electrically bridged section (35c) of the first conducting element (35) comprising an attenuation zone (35a).
3. Electrical connector (30) according to claim 1 or 2, with the first conducting element (35) being formed as a tape, and the attenuation zone (35a) of the first conducting element (35) having a recess (40) being formed in a manner that a width (W1) of the attenuation zone (35a) of the first conducting element (35) is smaller than a width (W2) of further sections (35b) of the first conducting element (35) .

4. Electrical connector (30) according to claim 1 or 2,
with the first conducting element (35) being formed
as a tape, and the attenuation zone (35a) of the first
conducting element (35) having a recess (40) in a
manner that a thickness (T1) of the attenuation zone
(35a) of the first conducting element (35) is smaller
than a thickness (T2) of further sections (35b) of the
first conducting element (35) . 5
5. Electrical connector (30) according to claim 3 or 4, 10
with the recess (40) being V-shaped.
6. Electrical connector (30) according to claim 3 or 4,
with the recess (40) having a semicircular shape. 15
7. Electrical connector (30) according to one of the pre-
ceding claims, the second conducting element (36)
being a wire element.
8. Electrical connector (30) according to one of the 20
claims 1 to 6, the second conducting element (36)
comprising a plurality of wire elements.
9. Electrical connector (30) according to one of the pre-
ceding claims, with the first conducting element (35) 25
of the electric conductor (34) being electrically coup-
able to the actuator unit (28) of the injector (20).
10. Method for coupling an electrical connector (30) ac-
cording to one of the preceding claims to an actuator 30
unit (28) of an injector (20) comprising the following
steps:
 - providing the electrical connector (30) and the
actuator unit (28) of the injector (20), 35
 - aligning the electrical connector (30) relative
to the actuator unit (28) of the injector (20) to
obtain a defined position of the electrical con-
nector (30) relative to the actuator unit (28) of
the injector (20), 40
 - coupling the first conducting element (35) of
the electric conductor (34) of the electrical con-
nector (30) to the pin (26) of the actuator unit
(28) to provide an electric coupling between the
electrical connector (30) and the actuator unit 45
(24) of the injector (20), and
 - removing the attenuation zone (35a) of the first
conducting element (35).

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FIG 1

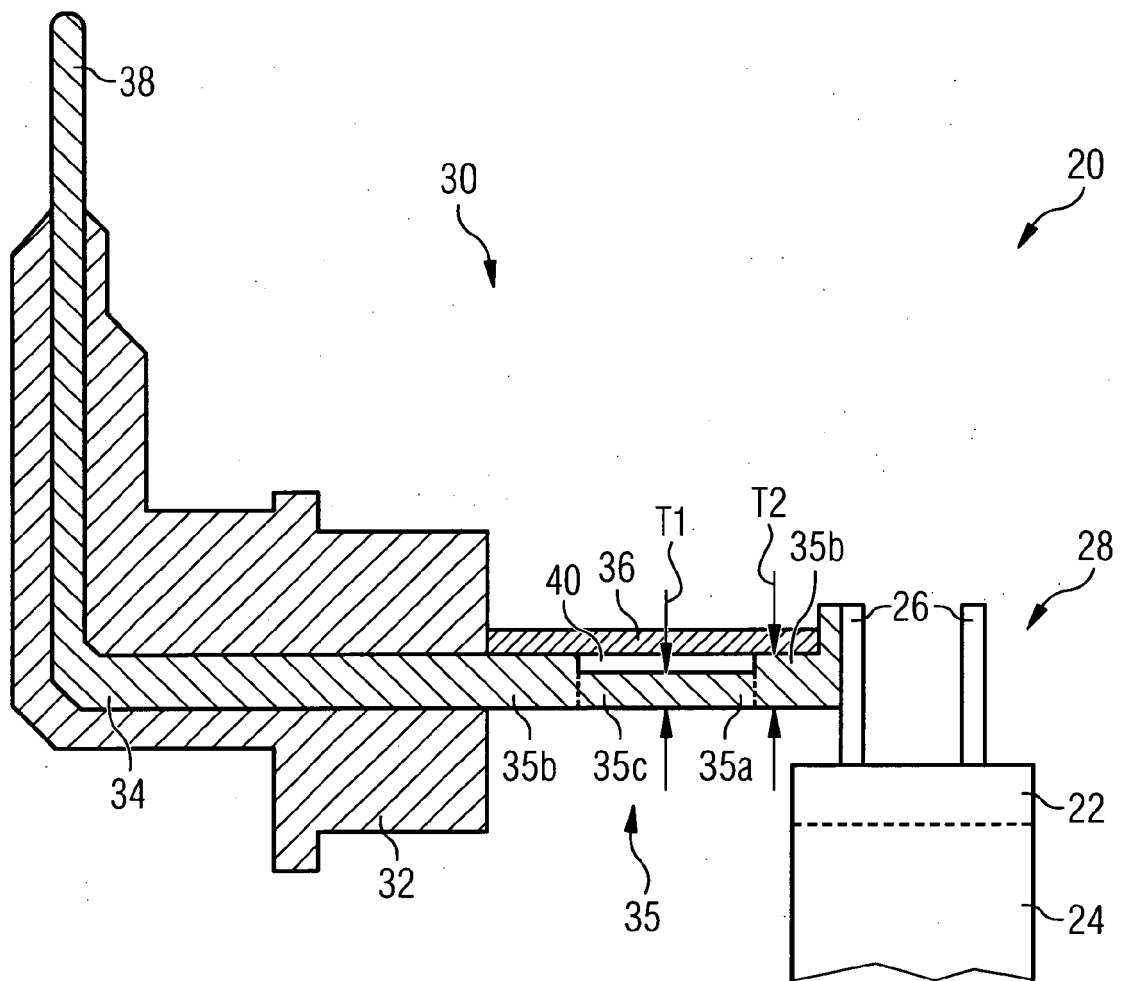


FIG 2

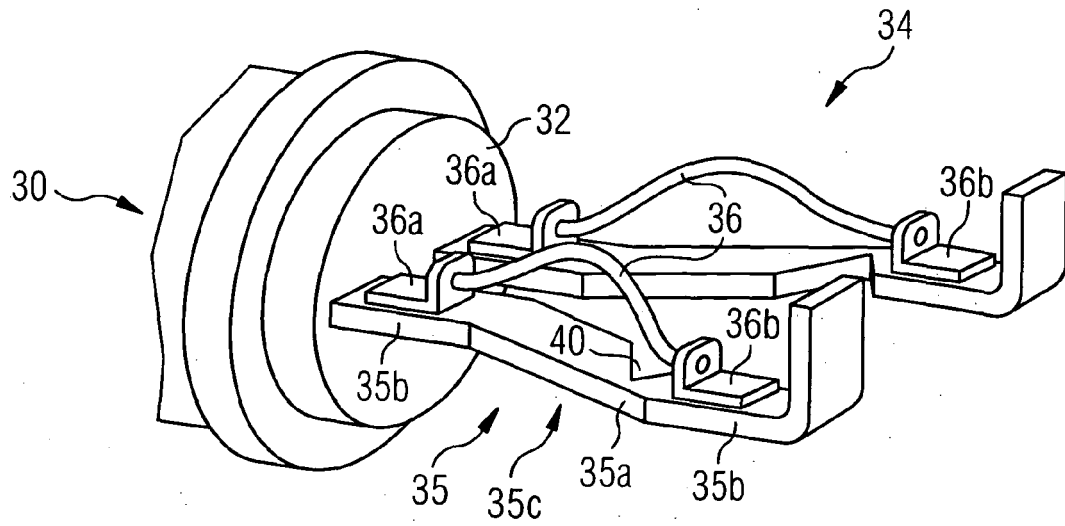
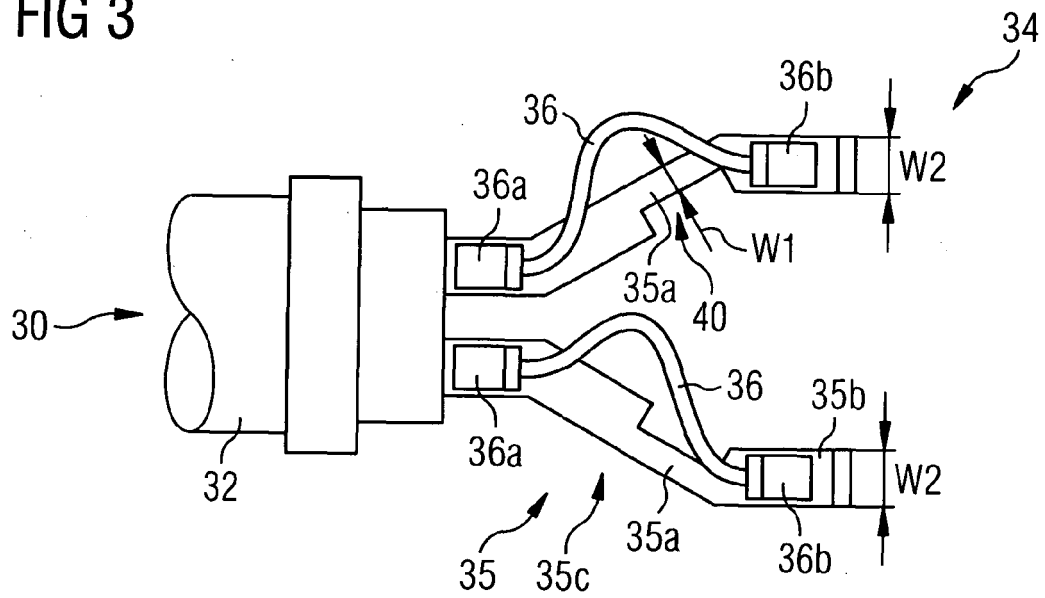


FIG 3





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Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 00 3683

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 12 June 2007	Examiner SERRANO FUNCIA, J
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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