(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 912 379 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
28.12.2016 Bulletin 2016/52

(21) Application number: **13785402.2**

(22) Date of filing: **28.10.2013**

(51) Int Cl.:
F23Q 7/00 *(2006.01)*

(86) International application number:
PCT/EP2013/072467

(87) International publication number:
WO 2014/064285 (01.05.2014 Gazette 2014/18)

(54) **GLOW PLUG COMPRISING AN ELECTRICALLY INSULATING SLEEVE AND METHOD OF MANUFACTURING THE SAID PLUG**

ZÜNDKERZE MIT EINER ELEKTRISCH ISOLIERENDEN HÜLLE UND VERFAHREN ZUR HERSTELLUNG DIESER ZÜNDKERZE

BOUGIE DE PRÉCHAUFFAGE COMPRENANT UN MANCHON ÉLECTRIQUEMENT ISOLANT ET PROCÉDÉ DE FABRICATION DE LADITE BOUGIE

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **26.10.2012 EP 12190099**

(43) Date of publication of application:
02.09.2015 Bulletin 2015/36

(73) Proprietor: **SIEVA d.o.o., PE Spodnja Idrija**
5290 Sempeter Pri Gorici (SI)

(72) Inventors:
- **RAMOND, Alain**
  F-31330 Merville (FR)
- **RATOSA, Gverino**
  6280 Ankaran (SI)
- **GOLOB, Jure**
  5242 Grahovo Ob Baci (SI)

(74) Representative: **Cabinet BARRE LAFORGUE & associés**
35, rue Lancefoc
31000 Toulouse (FR)

(56) References cited:
EP-A1- 0 834 652
DE-A1- 10 346 294
JP-A- 2006 336 918
US-A- 2 641 239
US-A- 4 425 692

EP 2 912 379 B1

Description

[0001] The invention relates to a glow plug, especially a glow plug for a diesel engine, and to a method of manufacturing a glow plug of this kind.

[0002] Such a glow plug is mounted in the head of an engine cylinder - especially a diesel-type engine - for the purpose of pre-heating the gas before switching the engine on in order to facilitate combustion of the gas when the engine is still cold, and therefore to facilitate the starting thereof.

[0003] In document EP 1 707 883, a plug is proposed in which two internal conducting rods are welded end-to-end instead of a single conducting rod extending from the plug head right up to the heating rod. According to this document, the ceramic heating rod is short and is mounted in a metal mounting tube which prolongs it right into the plug body in order to reduce the manufacturing costs, while the most distal conducting rod (towards the heating rod) is also held in position by the metal mounting tube.

[0004] However, the method of manufacturing such a plug is complicated and the plug thus obtained is not very durable: the welded joint between two conducting rods is not robust over time, and is therefore not very reliable. In actual fact, the conditions a plug of this kind has to withstand are particularly stringent: substantial variations in temperature, major vibrations, etc. The method of this kind is also expensive because it requires time and/or sophisticated tools in order to bring about the centring of one conducting rod in relation to the other, but also in relation to the plug body throughout the manufacturing process.

[0005] Moreover, the plug body, and therefore in this case the metal tube for mounting the heating rod, often serve as an electrical connection to the vehicle earth and therefore cannot be in contact with either of the internal conducting rods of the plug.

[0006] US 4 425 692 discloses a glow plug in which a terminal cap is mounted on the rear of a heating rod, said terminal cap being secured to the heating rod by a silver brazing. The glow plug also contains a conductor extending in a holder from the terminal cap to a connecting terminal. The glow plug also contains a bushing made of an insulator and of a metal sleeve that holds the connecting terminal at the centre of the holder. The bushing only extends around the connecting terminal. The insulator does not surround the proximal end of the conductor.

[0007] DE10346294 discloses a glow plug with a housing, a heating rod connected to a central metallic rod via a conductive cap. Said conductive cap has a small diameter portion, and said central metallic rod has a small diameter portion that are engaged into each other and fixed to each other by 8 crimping points. A glass holder is placed between the central metallic rod and the housing in order to fix the central metallic rod in the housing. An insulator sits astride on the conductive cap and the central metallic rod and has the function of centering the central metallic rod in the glow plug's housing when the glass holder is made. The insulator can slide in the housing and around the central metallic rod and around the conductive cap.

[0008] EP 0834652 discloses a glow plug including an insulator, a heating element embedded in the insulator and energized through a pair of lead wires to generate heat; and an ion current detecting electrode embedded in the insulator with a portion exposed into a flame in the combustion chamber so that an ionization state in the flame can be detected. The heating element is mounted in the plug's housing with an annular support made of metal so as to connect the heating element to the housing.

[0009] The object of the invention is therefore to overcome these drawbacks by proposing a new glow plug and a corresponding method of manufacture.

[0010] The object of the invention is, in particular, to propose a glow plug in which the conducting rods are joined to one another by a new method.

[0011] The object of the invention is also to propose a glow plug in which electrical insulation between the conducting rod(s) and the plug body is achieved in a simple manner.

[0012] The object of the invention is to propose a glow plug, the cost of manufacturing which is low.

[0013] The object of the invention is also to propose a glow plug which can be produced on a large scale and at low cost.

[0014] The object of the invention is also such method, the stages of which are simple and can be carried out by robots.

[0015] Throughout the text, the term "distal" and its derivatives designate directions, elements or parts which are situated axially towards the heating rod of the glow plug, which rod is intended to extend into the combustion chamber. Likewise, the term "proximal" and its derivatives designate directions, elements or parts which are situated axially in the opposite direction, that is to say towards the head of the glow plug.

[0016] A glow plug has an elongated shape, so that it has a longitudinal main axis along which the concepts of "proximal" and "distal" are defined. Throughout the text, the terms "axial", "axially", "longitudinal", "longitudinally", etc. are used with reference to this longitudinal main axis of the plug.

[0017] The invention therefore relates to a glow plug comprising:

- a hollow plug body extending along a longitudinal axis and having a proximal end and a distal end along the longitudinal axis;
- a heating rod:
  - having at least one distal portion extending axially and projecting from the distal end of the plug body; and
  - having a proximal end equipped with at least

one connector for supplying the heating rod with electricity;

- at least one electrical connector, called the external connector, which:
  - projects axially from the proximal end of the plug body; and
  - is adapted to be capable of having a cable for supplying the glow plug with electricity connected to it;
- a first, rigid, electrically conductive rod, called the distal rod, which is connected electrically, by a distal end, to at least one connector for supplying the heating rod with electricity;
- a second, rigid, electrically conductive rod, called the proximal rod, which:
  - extends at least partially within the plug body;
  - is connected electrically, by a proximal end, to at least one external connector; and
  - is connected electrically, by a distal end, to a proximal end of the distal rod;

characterised in that the glow plug also comprises an electrically insulating tubular sleeve which is mounted:

- around the distal end of the proximal rod and the proximal end of the distal rod so as to clamp at least one bare portion of the distal end of the proximal rod against at least one bare portion of the proximal end of the distal rod, so that the sleeve keeps the proximal rod and the distal rod in electrical contact; and
- inside the plug body, so as to space the proximal rod and the distal rod apart radially from the plug body.

[0018] The plug comprises a cylindrical plug body having a threaded external portion for mounting it on a cylinder head. The plug body forms an internal cylindrical seating for receiving a proximal portion of the heating rod, the said seating having an aperture for the heating rod to pass through, so that the latter extends axially in a manner projecting (on the distal side) beyond the pass-through aperture while having a distal portion which effects heating as far as the distal end of the heating rod.

[0019] The distal portion of the heating rod therefore projects from the distal end of the plug body so as to be capable of being in direct contact with a gas in a combustion chamber of an engine so as to be capable of heating the said gas when the plug is mounted in the cylinder head of the said engine.

[0020] The heating rod is either in the form of a bar of ceramic material which is fitted (for example by brazing or hooping) into a peripheral metal tube for the purpose of mounting it in the plug body, or directly into the plug body; or else in the form of a metal tube which is closed at its distal end.

[0021] In such plug, an electric current has to be conducted from a plug head situated at the proximal end of the plug to the heating rod situated at the distal end of the plug.

[0022] The plug head is mounted at the proximal end of the plug body so as to close the latter. The plug head advantageously has at least one external connector and an insulating material between the external connector and the plug body. The said external connector is adapted to be capable of having a cable for supplying the plug with electricity connected to it.

[0023] That is why an electricity-conducting element has to be mounted in the plug, within the internal seating of the plug body, which electrically connects an external connector belonging to the plug head to a connector for supplying electricity to the heating rod. Such conducting element is sometimes called an "electrode", by comparison with sparking plugs. In the invention, this conducting element comprises two rigid electricity-conducting rods.

[0024] Thus, the proximal end of the proximal rod is advantageously connected electrically to an external connector projecting from a plug head. It is, in particular, connected electrically within a seating that receives the plug head, the said receiving seating being connected electrically to the external connector (it is, for example, a metal piece).

[0025] For its part, the distal end is advantageously connected electrically to a connector for supplying the heating rod with electricity, which is present close to the proximal end of the said heating rod.

[0026] The two rods, the proximal rod and the distal rod, are connected electrically to one another.

[0027] A plug according to the invention has, for the first time, a multifunctional sleeve which insulates the electrically conductive rods from the plug body.

[0028] The plug body is, in fact, advantageously connected electrically to the heating rod in order to bring about an electrical connection between the heating rod and the engine cylinder head (the vehicle's earth).

[0029] Now the diameter of the plug body generally diminishes towards its distal end, so it is important to have a fine distal rod. Since the distal rod has to be fine, it is advantageously made of a material which is a very good conductor of electricity.

[0030] However, metals which are good conductors of electricity, such as copper, are particularly expensive. In a plug in accordance with the invention, the distal rod is therefore relatively short and is connected to a proximal rod which brings about conduction in the widest portion of the plug body, between the distal rod and an external connector. For its part, the proximal rod can be of larger diameter, and is therefore made of a less conductive but less expensive material, while at the same time conducting the current for the plug equally well.

[0031] The sleeve brings about electrical insulation between the intermediate joint and the plug body, and therefore between each of the conducting rods, the distal rod and the proximal rod, and the plug body. The said sleeve

brings about this electrical insulation by being made of an electrically insulating material, on the one hand, and by bringing about centring of each of the conducting rods, the distal rod and the proximal rod, in relation to the plug body, on the other.

[0032] In actual fact, the distal and proximal rods are advantageously mounted in the plug body.

[0033] Now, the sleeve is adapted to keep each of the conducting rods, the distal rod and the proximal rod, at a positive non-zero distance from the plug body, which distance is sufficient to bring about electrical insulation between the conducting rods (the [proximal rod and the distal rod) and the plug body. The sleeve is especially adapted to bring about centring of the proximal and distal conducting rods in relation to the plug body, and more particularly the centring thereof in relation to the (generally cylindrical) internal surface of the plug body. The sleeve thus makes it possible to avoid any electrical contact between either of the conducting rods, the distal rod or the proximal rod, and the plug body.

[0034] The sleeve is more particularly adapted to be capable of keeping the distal rod and the proximal rod at a positive non-zero radial distance from the internal diameter of the plug body (and from any other electrically conductive element connected to the plug body).

[0035] In actual fact, the proximal rod and the distal rod are advantageously bare, that is to say are devoid of an electrically insulating coating, and especially are devoid of an electrically insulating sheath. They are then not insulated by a layer of gas, especially air.

[0036] That is why, the distal end of the proximal rod and the proximal end of the distal rod being bare, the sleeve also makes it possible to bring about electrical contact between the distal rod and the proximal rod by bringing about mechanical contact between them.

[0037] If, on the other hand, the proximal and distal rods have an electrically insulating coating or sheath, opposing portions of surface of each of the two rods are bare so that bringing them into mechanical contact makes it possible to bring about electrical contact between them.

[0038] In actual fact, the sleeve also has the technical function of bringing about mechanical contact between a first bare metal surface of the proximal rod and a second bare metal surface of the distal rod, which surface is opposite the said first surface. For this purpose, the sleeve is, for example, mounted tight around the distal end of the proximal rod and the proximal end of the distal rod.

[0039] Moreover, the said sleeve makes it possible to bring about the centring of the distal rod and the proximal rod in relation to one another, for example so as to be able to keep them in the longitudinal prolongation of one another. More particularly, the sleeve is advantageously adapted to be capable of keeping the distal rod and the proximal rod substantially along the longitudinal axis of the plug.

[0040] The sleeve is a simple, inexpensive piece because it is made of an inexpensive material (for example polymer), because it is produced in a simple manner, for example by extrusion or moulding, and because it is easily mounted around the intermediate joint and within the mounting tube and/or within the plug body.

[0041] The said sleeve can be fitted-on by many methods around the proximal and distal rods and within the plug body.

[0042] The invention thus makes it possible to obtain a glow plug, the assembly and manufacture of which are simple, inexpensive and easily carried out by robots.

[0043] Moreover, the distal end of the proximal rod forms, advantageously and according to the invention, a joint, called the intermediate joint, with the proximal end of the distal rod.

[0044] Thus, in a plug according to the invention, it is not necessary to weld the distal rod to the proximal rod: the electrical contact between the conducting rods is simply carried out by fitting them together. This results in better reliability and durability of the plug, and in a simplified and less expensive method of assembly (no heat treatment to be used).

[0045] To that end, the distal end of the proximal rod and the proximal end of the distal rod advantageously have complementary shapes, for example shapes of the male-female type, and the distal end of the proximal rod is joined together with the proximal end of the distal rod in order to form the intermediate joint.

[0046] The sleeve makes it possible to bring about mechanical, and therefore electrical, contact between the distal and proximal rods within the intermediate joint. For this purpose, the sleeve is advantageously mounted tight around the intermediate joint.

[0047] The sleeve is advantageously mounted in such a way as to avoid tearing either of the conducting rods out of the intermediate joint.

[0048] The intermediate joint is, advantageously and according to the invention, such that the distal rod and proximal rod are in the longitudinal prolongation of one another.

[0049] For that purpose, advantageously and according to the invention, the sleeve has, axially at the intermediate joint, at least one radial deformation which makes it possible to bring about mechanical and electrical contact between the proximal rod and the distal rod.

[0050] The mechanical and electrical contact between the proximal rod and the distal rod is brought about by a radial mechanical deformation of the sleeve, which deformation is situated at the intermediate joint along the longitudinal axis.

[0051] The sleeve according to the invention is advantageously deformed plastically and elastically, so that it gives rise to clamping of the intermediate joint. In particular, it advantageously exerts a residual elastic stress on the intermediate joint.

[0052] At least one of the two conducting rods, the proximal or the distal rod, is also, advantageously and according to the invention, deformed in such a way as to bring about electrical contact with the second of the two

conducting rods. More particularly, at least one end, the distal end of the proximal rod or the proximal end of the distal rod, has an at least partially elastic deformation.

[0053] This deformation of the sleeve and of the intermediate joint makes it possible to bring about clamping of a bare span of the distal end of the proximal rod against a bare span of the proximal end of the distal rod, and therefore electrical contact between them.

[0054] This deformation also has the advantage of bringing about great mechanical resistance of the intermediate joint, especially against axial tearing-out of one or other of the conducting rods and against rotation of the conducting rods in relation to one another along the longitudinal axis.

[0055] The sleeve is therefore chosen from a material which is sufficiently resistant to deformation (rigid) to be able to transmit at least part of a radial deformation which is applied to it to at least one of the two conducting rods at the intermediate joint.

[0056] A plug according to the invention is, moreover, advantageously characterised in that it also comprises a tube, called the mounting tube:

- in which the heating rod is mounted;
- which is mounted in the plug body; and
- which is disposed at a non-zero annular distance around the distal rod, so as to leave a space, called the annular space, between the distal rod and the mounting tube.

[0057] Such a mounting tube is generally used in order to obtain a heating rod with a substantial length of projection into the combustion chamber at lower cost - the length of projection being the length measured from the distal end of the plug body to the distal end of the heating rod. The fact is, ceramic heating rods are particularly expensive and the more so, the longer they are. Recently, short ceramic heating rods have been mounted in metal intermediate tubes which are themselves mounted in a distal portion of the plug body in order to obtain a substantial length of projection with a short ceramic heating rod.

[0058] Since the mounting tube is mounted in the plug body, the internal diameter of the mounting tube is smaller than the internal diameter of the plug body. That is why the distal rod has to be fine and therefore made of a material which is a good conductor of electricity.

[0059] In actual fact, the mounting tube is advantageously fitted into the plug body in such a way that it is connected electrically to the latter in order to bring about an electrical link between the heating rod and said plug body. That is why the distal and proximal conducting rods have to be electrically insulated from the mounting tube and from the plug body.

[0060] The sleeve is, advantageously and according to the invention, disposed radially between at least one portion of the intermediate joint and the mounting tube, so that the sleeve also brings about the electrical insulation of the proximal rod and distal rod from the mounting tube.

[0061] The sleeve brings about electrical insulation between the intermediate joint and the mounting tube. The said sleeve especially brings about the centring of the distal rod in relation to said mounting tube.

[0062] In actual fact, the sleeve is adapted to be capable of avoiding any electrical contact between either of the conducting tubes, the distal or proximal tube, and the mounting tube. For this purpose, the sleeve is more particularly adapted to be capable of keeping the distal rod at a positive non-zero radial distance from the internal diameter of the mounting tube (and from any other electrically conductive element connected to the mounting tube).

[0063] The sleeve is advantageously mounted tight in the mounting tube.

[0064] The mounting tube advantageously extends at least longitudinally as far as the distal end of the proximal rod.

[0065] Furthermore, advantageously and according to the invention, the glow plug also comprises a tube, called the mounting tube:

- in which the heating rod is mounted;
- which is mounted in the plug body; and
- which is disposed at a non-zero annular distance around the distal rod, so as to leave a space, called the annular space, between the distal rod and the mounting tube.

[0066] In a plug according to the invention, electrical insulation between the distal rod and the metal mounting tube is advantageously brought about by air or any other gaseous composition which is deemed to provide sufficient electrical insulation. The manufacture of a glow plug according to the invention therefore does not necessitate filling the annular space between the distal rod and the internal diameter of the mounting tube with a solid material, and filling it with air has the advantage of permitting manufacture of the said glow plug in a normal atmosphere. In particular, the invention makes it possible to avoid the stage involving the filling of this annular space with an electrically insulating powder and the stage involving the compressing of this electrically insulating powder.

[0067] The inventors did, in fact, establish that air was sufficiently electrically insulating between the distal rod and the mounting tube if the radial width of the annular space were chosen correctly according to the voltage applied to the heating rod.

[0068] Also, the said annular space is, advantageously and according to the invention, entirely occupied by air.

[0069] Thus, whatever the annular space is filled with (solid powder, gas, a vacuum, etc.), the sleeve brings about the closure of the annular space at a proximal end of the latter.

[0070] A plug according to the invention is, advanta-

geously, more particularly characterised in that the said sleeve is mounted between the said mounting tube and the proximal and distal rods, in such a way that the sleeve brings about:

- electrical insulation of the proximal rod and distal rod from the mounting tube; and
- sealing of the annular space with regard to the rest of the plug.

[0071] In particular, crimping with a number of detents - especially crimping with four detents - is advantageously carried out at the periphery of the mounting tube.

[0072] Thus no thermal assembling (welding, brazing, etc.) is necessary for joining the proximal and distal rods together: assembly and crimping alone bring about the electrical connection, and the fastening-together, of the two rods.

[0073] Furthermore, advantageously and according to the invention, the mounting tube has, axially at the intermediate joint, at least one radial deformation, so that:

- the mounting tube, the sleeve, the proximal rod and the distal rod are integral, at least in longitudinal translation; and
- the proximal rod and the distal rod are in mechanical and electrical contact at the intermediate joint.

[0074] The external shoulder makes it possible to secure the longitudinal position of the sleeve within the plug body and in relation to the mounting tube.

[0075] The external shoulder is advantageously produced by a collar, called the outer collar.

[0076] The outer collar may serve for centring the proximal and distal conducting rods in relation to the internal diameter of the plug body, especially if the external diameter of the outer collar is substantially equal to the internal diameter of the plug body.

[0077] In the absence of a mounting tube, the outer shoulder advantageously rests against a shoulder projecting from the internal diameter of the plug body.

[0078] The collar, called the inner collar, projecting from the internal diameter of the sleeve has an internal diameter which is substantially equal to the external diameter of the distal rod, so that it makes it possible to achieve sealing of the annular space at the proximal end of the latter.

[0079] The inner collar thus also serves for centring the distal rod in relation to the internal diameter of the mounting tube.

[0080] In addition, the inner collar of the sleeve forms a shoulder against which the distal end of the proximal rod (which is of larger diameter than the distal rod) can come into contact. The inner collar then serves, in particular, to secure the longitudinal position of the sleeve in relation to the intermediate joint.

[0081] Alternatively, or as a combination, a shoulder on the proximal rod may abut against the outer collar of the sleeve, thus also securing the longitudinal position of the sleeve in relation to the intermediate joint.

[0082] Moreover, the sleeve has, advantageously and according to the invention:

- a shoulder projecting from its external diameter and resting axially against a proximal end of the mounting tube;
- a collar projecting from its internal diameter and having an internal diameter which is substantially equal to the external diameter of the distal rod.

[0083] In particular, the sleeve is, advantageously and according to the invention, made of electrically insulating polymer material. Thus the material for the sleeve may be chosen, for example, from among the following: polyether-type thermoplastic polymers, liquid crystal polymers, or thermosetting polymers. For example, PEEK (polyether ether ketone), PPA (alveolar polypropylene) etc., may be chosen.

[0084] Since the sleeve is in one piece, it is advantageously easily mounted around the intermediate joint and within the plug body.

The invention also extends to a method in which the sleeve is in one piece and made of electrically insulating synthetic material.

[0085] The distal rod may be connected electrically to an electrical connector belonging to the heating rod by various methods: for example by welding, mechanical assembly, etc. In particular, an electrical linking part is, advantageously and according to the invention, interposed between the distal end of the distal rod and the electrical connector of the heating rod.

[0086] Likewise, the proximal rod is introduced into a plug head mounted at the proximal end of the plug body. Emerging from the plug head is an external connector which is connected electrically to the proximal rod as a result of the introduction of the latter into a seating which receives the plug head.

[0087] Advantageously, moreover, a method of manufacturing a glow plug comprising:

- a hollow plug body extending along a longitudinal axis and having a proximal end and a distal end along said longitudinal axis;
- a heating rod having a proximal end equipped with at least one connector for supplying said heating rod with electricity;
- at least one electrical connector, called the external connector, which is adapted to be capable of having a cable for supplying the glow plug with electricity connected to it;
- a first, rigid, electrically conductive rod, called the distal rod; and
- a second, rigid, electrically conductive rod, called the proximal rod;

comprises the steps of:

- mounting the heating rod within the plug body in such a way as to have at least one distal portion projecting axially from the distal end of the plug body;
- mounting each external connector in a manner projecting axially from the proximal end of the plug body;
- electrically connecting the said distal rod by a distal end to at least one connector for supplying the heating rod with electricity;
- mounting the said proximal rod at least partially within the plug body, electrically connecting it by a proximal end to at least one external connector, and electrically connecting it by a distal end to a proximal end of the distal rod;

characterised in that it comprises a step of mounting an electrically insulating tubular sleeve:

- around the distal end of the proximal rod and the proximal end of the distal rod so as to clamp at least one bare portion of the distal end of the proximal rod against at least one bare portion of the proximal end of the distal rod, so that the sleeve keeps the proximal rod and the distal rod in electrical contact; and
- inside the plug body, so as to space the proximal rod and the distal rod apart radially from the plug body.

The intermediate joint brings about an electrical connection by surface contact between the proximal rod and the distal rod.

[0088] A method according to the invention further comprises a step of fitting the distal end of the proximal rod together with the proximal end of the distal rod so as to form a joint, called the intermediate joint.

[0089] In particular, the mounting tube is advantageously chosen so as to have an internal diameter which is smaller than the external diameter of the distal rod.

[0090] Various modes of embodiment of a method in accordance with the invention may be envisaged, especially methods comprising various stages, in particular for the joining-on of the sleeve in relation to the intermediate joint. Thus, the distal and proximal conducting rods may be fitted together first of all in order to form the intermediate joint, and the sleeve then mounted around said intermediate joint. Likewise, the sleeve may, alternatively, be first of all mounted on the distal rod or on the proximal rod, the second of the two conducting rods then being fitted into the sleeve and fitted onto the first of the two conducting rods.

[0091] However, a method according to the invention advantageously comprises a step of mounting a tube, called the mounting:

- on the heating rod;
- within the plug body; and
- at a non-zero annular distance around the distal rod so as to leave a space, called the annular space, between the distal rod and the mounting tube.

[0092] In such method, the sleeve is advantageously introduced directly between the distal rod and the mounting tube, that is to say without a prior stage involving filling (or evacuating) the annular space between the distal rod and the mounting tube with an electrically insulating solid material, especially without filling it with an electrically insulating powder, and without a stage involving compacting the said electrically insulating solid material. In such method, the stages involving filling the annular space with an electrically insulating powder (generally magnesium oxide) and then compacting the said powder and finally sealing the annular space at its proximal end are avoided. The method according to the invention is therefore simplified, a fact which permits a substantial saving in the cost of manufacture of each glow plug, because the method is shorter, requires fewer machines and does not require any electrically insulating pulverulent material.

[0093] The sleeve is advantageously inserted in the mounting tube through the proximal end of the latter until a shoulder on the outside of the sleeve abuts on the proximal end of the mounting tube.

[0094] In a method according to the invention, the mounting of the sleeve is then advantageously made by introducing it directly between the distal rod and the mounting tube, through a proximal end of the annular space.

[0095] In addition to its functions that have already been described, the multifunctional sleeve therefore also makes it possible, in a method of manufacturing a glow plug according to the invention, to guide the distal end of the proximal rod when fitting it together with the distal rod in order to form the intermediate joint.

[0096] The introduction of the proximal rod is advantageously terminated when a shoulder produced on the external diameter of the proximal rod and/or the distal end of said proximal rod abuts against a shoulder produced within the internal diameter of the sleeve and/or against the proximal end of the sleeve.

[0097] A method according to the invention is also advantageously characterised in that the distal end of the proximal rod is introduced into the sleeve, so as to be joined together with the proximal end of the distal rod in order to form the intermediate joint at that point.

[0098] A method of manufacture according to the invention further comprises a step of deforming radially the mounting tube, axially at the intermediate joint, so as to:

- render at least the mounting tube, the sleeve, the distal rod and the proximal rod integral with each other, in longitudinal translation at least;
    - bring about mechanical and electrical contact between the proximal rod and the distal rod at the intermediate joint.

[0099] Thus, in a method of manufacture according to the invention, the distal rod, the proximal rod, the sleeve

and the mounting tube are simply fitted together with one another and then crimped in order to be mechanically integral in translation, especially by way of translation along the longitudinal axis.

[0100] In particular, crimping with detents - especially crimping with four detents - is, advantageously and according to the invention, carried out at the periphery of the mounting tube, opposite the intermediate joint.

[0101] Crimping is carried out by a simple, rapid and inexpensive operation, unlike other methods of assembly such as welding for example. These four elements which have been joined together in this way do not have any zone which is affected by heat.

[0102] Following such stages, the mounting tube is advantageously mounted within a plug body and the proximal end of the proximal rod is advantageously connected electrically to an external connector belonging to a plug head which is itself mounted at a proximal end of the plug body.

[0103] The invention also relates to a glow plug and to a method of manufacturing a glow plug which are characterised, in combination, by all or some of the features mentioned above or below.

[0104] Other objectives, features and advantages of the invention will become apparent on reading the following description, which is given on a non-limitative basis and which refers to the appended drawings, in which:

- figure 1 is a diagrammatic representation of a particular mode of embodiment of a glow plug in longitudinal section (apart from the heating rod which is in side view), in the course of a first intermediate stage of manufacture by a method in accordance with the invention;
- figure 2 is a diagrammatic representation, in accordance with figure 1, of a glow plug in longitudinal section after a second stage of manufacture by a method in accordance with the invention;
- figure 3 is a diagrammatic representation, in accordance with figures 1 and 2, of a glow plug in transverse section along the plane III referred to figure 2, after a third stage of manufacture by a method in accordance with the invention;
- figure 4 is a diagrammatic representation, in accordance with figures 2 and 3, of a portion of a glow plug in perspective view; and
- figure 5 is a diagrammatic representation, in accordance with figures 1, 2 and 3, of a glow plug in accordance with the invention, of which half is represented in longitudinal section and the other half by a side view.

[0105] An intermediate stage in the manufacture of a glow plug 1 according to the invention is represented in figure 1.

[0106] Prior to this stage, a conducting rod, called the distal rod 2, is assembled and connected electrically by its distal end to an electrical connector situated in the proximal portion of the heating rod 3. The distal rod 2 therefore extends in the prolongation of the heating rod 3 along a longitudinal axis 13 of the glow plug 1.

[0107] For this purpose, a cylindrical metal piece, called the trumpet 10, with an internal diameter which is substantially equal to the external diameter of the distal rod, is mounted at the distal end of the distal rod. The said trumpet 10 has a flared distal portion which is adapted to be capable of being mounted and connected electrically onto a proximal end of the heating rod 3 which is substantially conical in shape.

[0108] After or before the connection of the distal rod to the heating rod, a metal mounting tube 4 has been joined onto a ceramic heating rod 3, for example by brazing.

[0109] The mounting tube 4 makes it possible to obtain a considerable length of projection into the combustion chamber in spite of a short heating rod 3.

[0110] The distal rod 2 is chosen so as to have an external diameter which is strictly smaller than the internal diameter of the mounting tube, so that there is an annular space 19 between the distal rod 2 and the mounting tube 4.

[0111] Thus, for example, in the case of a mounting tube 4 having an internal diameter of about 3.6 mm, a distal rod 2 having an external diameter of about 1 mm is chosen, so that the minimum radial distance between the distal rod 2 and the mounting tube 4 - that is to say the breadth of the annular space 19 - is about 1.3 mm.

[0112] In actual fact, neither the proximal rod 6 nor the distal rod 2 is covered with an electrically insulating sheath because this is not necessary with voltages of the order of 12 V and makes it possible to obtain a more economical plug and more economical manufacture.

[0113] The distal rod 2 is made of a material which is a very good conductor of electricity, for example copper. However, these materials are generally expensive, so that, in a glow plug according to the invention, an attempt is made to reduce to the greatest possible extent the quantity of material needed to produce a conducting rod: an attempt is therefore made to reduce the diameter and length of the distal rod 2. Now a small diameter and therefore good electrical conduction are only necessary within the mounting tube 4, so that the length of the distal rod 2 is chosen so the proximal end 11 of the distal rod 2 is located close, longitudinally, to the proximal end 9 of the mounting tube 4.

[0114] In the stage represented in figure 1, a one-piece sleeve 5 made of electrically insulating material is introduced directly into the proximal portion of the annular space 19, without the latter being filled beforehand. This stage is carried out under a normal atmosphere, so that the annular space is filled with air at atmospheric pressure.

[0115] The sleeve 5 advantageously has a cylindrical shape with an external diameter which is substantially equal to the internal diameter of the mounting tube 4. The sleeve 5 also has a collar, called the internal collar

17, projecting from its internal diameter. The internal diameter of the internal collar 17 is substantially equal to the external diameter of the distal rod 2.

[0116] The sleeve 5 thus ensures that the proximal end 11 of the distal rod 2 is kept at a strictly positive radial distance from the (internal diameter of the) mounting tube 4 in order to avoid any electrical contact between these two elements. The sleeve thus especially brings about spacing between the distal rod 2 and the mounting tube 4, and brings about, more particularly, centring of the distal rod 2 in relation to the mounting tube 4.

[0117] Moreover, the sleeve 5 closes the annular space 19 at its proximal end. The sleeve may advantageously be forcibly introduced between the distal rod and the mounting tube so as to form a leakproof barrier at the proximal end of the annular space 19, especially because the internal diameter of the internal collar 17 is substantially equal to, or smaller than, the external diameter of the distal rod 2.

[0118] The annular space 19 is advantageously left full of air originating from the atmosphere in its place of manufacture, and thus does not require any operation involving either evacuation or filling with a gas or a material other than air.

[0119] The sleeve 5 is introduced into the annular space until a collar, called the outer collar 16, projecting from the external diameter of the sleeve abuts against the proximal end 9 of the mounting tube 4.

[0120] The sleeve 5 is fitted-on without any stresses.

[0121] Said sleeve 5 is made, for example, of a polymer belonging to the family of thermoplastic polymers of the polyether type, liquid crystal polymers or thermosetting polymers and, in particular, may be chosen to be made of PEEK (polyether ether ketone). The sleeve 5 advantageously has a thickness of about 200 micrometers, which is sufficient to bring about electrical insulation between the proximal 6 and distal 2 conducting rods, and the mounting tube 4 (or the plug body). The sleeve 5 is advantageously made in one piece, for example by moulding.

[0122] In a subsequent stage of a method of manufacture according to the invention, the distal end 12 of a second conducting rod, called the proximal rod 6, is introduced into the sleeve 5. The result of this stage of manufacture is represented in figure 2.

[0123] The distal end 12 of this proximal rod 6 has a seating which is adapted to receive the proximal end 11 of the distal rod 2. The distal end 12 of the proximal rod 6 and the proximal end 11 of the distal rod 2 are therefore adapted to form a joint, especially a joint of the male-female type. In particular, the distal end 12 of the proximal rod 6 has an internal diameter which is substantially equal to the external diameter of the proximal end 11 of the distal rod 2.

[0124] The proximal rod 6 and distal rod 2 are thus fitted one into the other by their distal end 12 and proximal end 11 respectively, and thus form a joint, called the intermediate joint. The intermediate joint of the distal rod and proximal rod thus brings about electrical contact between them.

[0125] The sleeve is therefore located at the periphery of the intermediate joint, between the latter and the mounting tube 4, which is itself intended to be mounted and connected electrically within a plug body 7.

[0126] The distal end 12 of the proximal rod 6 also advantageously has an external diameter which is substantially equal to the internal diameter of the sleeve 5.

[0127] Said sleeve 5 serves as a guide for mounting the proximal rod 6 in relation to the distal rod 2, a fact which is particularly advantageous for the purpose of automating the assembly of a plug according to the invention. The sleeve 5 thus brings about satisfactory positioning of the proximal rod in relation to the distal rod, and therefore makes it possible to ensure that they are really in electrical contact.

[0128] The manufacturing cost of a glow plug according to the invention is thus greatly diminished because its assembly is very simple, requires few delicate operations such as welding, compacting, etc., and because the method of manufacture can be largely automated, thanks to simple assembling operations carried out along the longitudinal axis 13.

[0129] In addition, the proximal rod 6 has a shoulder which is adapted to be capable of abutting on the proximal end (and/or on the outer collar 16) of the sleeve 5.

[0130] The proximal rod and distal rod are aligned in the prolongation of one with the other along the longitudinal axis 13.

[0131] The proximal rod 6 is advantageously of larger diameter, because the internal diameter of the plug body 7 within which it is intended to be mounted is much larger than the internal diameter of the mounting tube 4. Consequently, the proximal rod 6 can be made of a material which is a less good conductor and therefore less expensive than that of the distal rod 2.

[0132] Thus, the proximal rod 6 is made, for example, of stainless steel.

[0133] Since the sleeve 5 is made of an electrically insulating material, it brings about electrical insulation of the intermediate joint (and therefore of the distal rod 2 and proximal rod 6) from the mounting tube 4.

[0134] Figures 3 and 4 are representations, in transverse section (as indicated in figure 2) and in perspective view respectively, of a plug element as represented in figure 2 after a new stage in a method of manufacture according to the invention.

[0135] In this new stage, the mounting tube 4 has undergone crimping with four detents which creates four detents 8 which radially deform the mounting tube and are distributed over its periphery.

[0136] The detents 8 do not extend over the entire length of the mounting tube but only over a longitudinal portion opposite the intermediate joint, as represented in figure 4.

[0137] The radial deformation created by the crimping of the mounting tube 4 with four detents results in radial

deformation of four zones of the sleeve 5. The sleeve 5 transmits this radial deformation, at least partially, to the distal end 12 of the proximal rod 6, which itself transmits the said radial deformation, at least partially, to the proximal end 11 of the distal rod 2.

[0138] The four elements constituted by the mounting tube 4, the sleeve 5, the proximal rod 6 and the distal rod 2, all of which have the shape of a cylinder of revolution when they are assembled, thus undergo a radial deformation in four zones distributed axially over their periphery at the intermediate joint.

[0139] This crimping operation with four detents 8 makes it possible to render the four segments integral, at least in translation along the longitudinal axis 13. In particular, the crimping operation with four detents makes it possible to fasten the distal end of the proximal rod and the proximal end of the distal rod together so as to avoid their being torn longitudinally, in relation to one another, out of the intermediate joint, but also to improve the electrical contact between them at the zones of radial deformation (opposite the detents 8).

[0140] The sleeve 5 is thus chosen from a material which is sufficiently rigid to be capable of transmitting at least some of the radial deformations created by the crimping operation with four detents 8.

[0141] The plug element which is represented in figure 2 and is crimped in accordance with figures 3 and 4 is then introduced into its plug body 7.

[0142] In particular, the mounting tube 4 having an external diameter which is substantially equal to the internal diameter of the plug body 7 is fitted into the plug body. The mounting tube 4 is joined, for example by welding, to the plug body, so that they are in electrical contact. An electrical connection between the heating rod 3 and the vehicle earth is produced via the mounting tube 4 and the plug body 7 as a result of the screwing of the latter into the metal cylinder head of an engine, the mounting tube 4 having been previously connected to an electrical connector belonging to the heating rod 3.

[0143] The mounting tube 4 is mounted within the plug body in such a way as to project from the distal end 18 of the latter. More particularly, the mounting tube 4 is mounted within the plug body in such a way that at least one distal portion of the heating rod 3 projects from the distal end 18 of the plug body and is able to come into contact with a gas from a combustion chamber when the glow plug 1 is mounted in the head of an engine.

[0144] Thanks to the mounting tube 4, the length of projection measured between the distal end 18 of the plug body and the distal end of the heating rod 3 is, advantageously, greater than the length of the heating rod 3.

[0145] The sleeve 5 brings about electrical insulation between the intermediate joint (and therefore the distal rod 2 and proximal rod 6), on the one hand, and the plug body 7 on the other. It also brings about this electrical insulation as a result of the centring of the proximal rod 6 in relation to the internal diameter of the plug body.

[0146] In actual fact, the external diameter of the proximal rod 6 is chosen so as to be at a distance, radially, from the internal diameter of the plug body 7. There is therefore a layer of air between the proximal rod 6 and the plug body.

[0147] The plug body 7 has means for fixing the plug in the cylinder head of an engine, for example a thread 14, and a clamping nut.

[0148] The plug 1 also comprises a plug head 15 which is mounted at the proximal end of the plug body 7. The plug head 15 is that portion of the plug 1 which is situated outside a cylinder head when the plug is fitted into the latter.

[0149] The plug head 15 brings about the sealing of the plug by closing the hollow body 7 of the plug at its proximal end, and also brings about an electrical connection between the proximal rod 6 and an external connector 20 belonging to the plug head 15, which connector is adapted to be capable of having a cable for supplying the plug with electricity connected to it. For this purpose, the proximal rod 6 is fitted into a seating in the plug head 15.

[0150] The invention may form the subject of numerous other variants of embodiment which are not represented.

[0151] Thus, the multifunctional sleeve 5 may have other shapes. The sleeve 5 may also be made of other electrically insulating materials. In addition, it may be fitted-on at other stages in the manufacture of a plug according to the invention, for example after the proximal and distal conducting rods have been fitted together.

[0152] Other shapes of the distal end 12 of the proximal rod 6 and of the proximal end 11 of the distal rod 2 may also be envisaged for the purpose of forming the intermediate joint.

[0153] Likewise, other methods of radial deformation, at least of the proximal and distal conducting rods at the intermediate joint, may be envisaged, in particular other modes of crimping.

[0154] Moreover, there is nothing to prevent the sleeve from bringing about mechanical, and therefore electrical, contact between the proximal rod and the distal rod, not by radial deformation but by bringing about end-to-end clamping between the two rods. Thus, a set of shoulders on the proximal and distal rods and of internal collars on the sleeve may, for example, bring about retention of the two conducting rods in end-to-end abutment.

[0155] In a plug according to the invention, there is nothing to prevent the length of the distal rod 2 from being significantly reduced, and the sleeve 5 and distal end 12 of the proximal rod 6 from being significantly lengthened, in order to reduce the cost of manufacture resulting from the purchase of the material for the distal rod 2, the sleeve 5 continuing to bring about electrical insulation between the proximal rod 6 and the mounting tube 4.

Claims

1. Glow plug (1) comprising:

- a hollow plug body (7) extending along a longitudinal axis (13) and having a proximal end and a distal end (18) along the longitudinal axis;
- a heating rod (3):

  • having at least one distal portion extending axially and projecting from the distal end (18) of the plug body; and
  • having a proximal end equipped with at least one connector for supplying the heating rod (13) with electricity;

- at least one electrical connector, called the external connector (20), which:

  • projects axially from the proximal end of the plug body (7); and
  • is adapted to be capable of having a cable for supplying the glow plug (1) with electricity connected to it;

- a first, rigid, electrically conductive rod, called the distal rod (2), which is connected electrically, by a distal end, to at least one connector for supplying the heating rod (3) with electricity;
- a second, rigid, electrically conductive rod, called the proximal rod (6), which:

  • extends at least partially within the plug body (7);
  • is connected electrically, by a proximal end, to at least one external connector (20); and
  • is connected electrically, by a distal end (12), to a proximal end (11) of the distal rod (2);

- an electrically insulating tubular sleeve (5) which is mounted:

  • around the distal end (12) of the proximal rod (6) and the proximal end (11) of the distal rod (2); and
  • inside the plug body, so as to space the proximal rod (6) apart radially from the plug body (7);

characterised in that the electrically insulating tubular sleeve (5) is mounted:

- around the distal end (12) of the proximal rod (6) and the proximal end (11) of the distal rod (2) so as to clamp at least one bare portion of the distal end (12) of the proximal rod (6) against at least one bare portion of the proximal end (11) of the distal rod (2), so that the sleeve (5) keeps the proximal rod (6) and the distal rod (2) in electrical contact; and
- so as to space the distal rod (2) apart radially from the plug body (7).

2. Plug according to claim 1, **characterised in that** the distal end (12) of the proximal rod (6) forms a joint, called the intermediate joint, with the proximal end (11) of the distal rod (2).

3. Plug according to claim 2, **characterised in that** the sleeve (5) has, axially at the intermediate joint, at least one radial deformation bringing about mechanical and electrical contact between the proximal rod (6) and the distal rod (2).

4. Plug according to any of claims 1 to 3, **characterised in that** it also comprises a tube, called the mounting tube (4):

- in which the heating rod (3) is mounted;
- which is mounted in the plug body (7); and
- which is disposed at a non-zero annular distance around the distal rod (2), so as to leave a space, called the annular space (19), between the distal rod and the mounting tube (4).

5. Plug according to claim 4, **characterised in that** the said annular space (19) is entirely occupied by air.

6. Plug according to either of claims 4 or 5, **characterised in that** the said sleeve (5) is mounted between the said mounting tube (4) and the proximal and distal rods (6, 2), so that the sleeve brings about:

- electrical insulation of the proximal rod (6) and distal rod (2) from the mounting tube (4); and
- sealing of the annular space (19) with regard to the rest of the plug.

7. Plug according to any of claims 4 to 6, **characterised in that** the mounting tube (4) has, axially at the intermediate joint, at least one radial deformation (8), so that:

- the mounting tube (4), the sleeve (5), the proximal rod (6) and the distal rod (2) are integral with each other, at least in longitudinal translation; and
- the proximal rod (6) and the distal rod (2) are in mechanical and electrical contact at the intermediate joint.

8. Plug according to any of claims 4 to 7, **characterised in that** the sleeve (5) has:

- a shoulder (16) projecting from its external diameter and resting axially against a proximal end (9) of the mounting tube (4);
- a collar (17) projecting from its internal diam-

eter and having an internal diameter which is substantially equal to the external diameter of the distal rod (2).

9. Plug according to any of claims 1 to 8, **characterised in that** the sleeve (5) is in one piece and made of electrically insulating synthetic material.

10. Method of manufacturing a glow plug comprising:

- a hollow plug body (7) extending along a longitudinal axis (13) and having a proximal end and a distal end (18) along the longitudinal axis (13);
- a heating rod (3) having a proximal end equipped with at least one connector for supplying the heating rod (3) with electricity;
- at least one electrical connector, called the external connector (20), which is adapted to be capable of having a cable for supplying the glow plug (1) with electricity connected to it;
- a first, rigid, electrically conductive rod, called the distal rod (2); and
- a second, rigid, electrically conductive rod, called the proximal rod (6);

which method comprising the steps of:

- mounting the heating rod (3) in the plug body (7) in such a way as to have at least one distal portion projecting axially from the distal end (18) of the plug body (7);
- mounting each external connector (20) projecting axially from the proximal end of the plug body (7);
- electrically connecting the said distal rod (2), by a distal end, to at least one connector for supplying the heating rod (3) with electricity;
- mounting the said proximal rod (6) at least partially within the plug body (7), electrically connecting it by a proximal end to at least one external connector (20), and electrically connecting it, by a distal end (12), to a proximal end (11) of the distal rod (2);
- mounting an electrically insulating tubular sleeve (5):

  • around the distal end (12) of the proximal rod (6) and the proximal end (11) of the distal rod (2); and
  • inside the plug body, so as to space the proximal rod (6) apart radially from the plug body (7);

characterised in that the electrically insulating tubular sleeve (5) is mounted:

- around the distal end (12) of the proximal rod (6) and the proximal end (11) of the distal rod (2) so as to clamp at least one bare portion of the distal end (12) of the proximal rod (6) against at least one bare portion of the proximal end (11) of the distal rod (2), so that the sleeve (5) keeps the proximal rod (6) and the distal rod (2) in electrical contact; and
- so as to space the distal rod (2) apart radially from the plug body (7).

11. Method according to claim 10, further comprising a step of fitting the distal end (12) of the proximal rod (6) together with the proximal end (11) of the distal rod (2) so as to form a joint, called the intermediate joint.

12. Method according to either of claims 10 or 11, further comprising a step of mounting a tube, called the mounting tube (4):

- on the heating rod (3);
- within the plug body (7); and
- at a non-zero annular distance around the distal rod (2) so as to leave a space, called the annular space (19), between the distal rod (2) and the mounting tube (4).

13. Method according to claim 12, **characterised in that** the mounting of the sleeve (5) is made by introducing it directly between the distal rod (2) and the mounting tube (4), through a proximal end of the annular space (19).

14. Method according to claim 11 and either of claims 12 or 13, **characterised in that** the distal end (12) of the proximal rod (6) is introduced into the sleeve (5), so as to be joined together with the proximal end (11) of the distal rod (2) in order to form the intermediate joint at that point.

15. Method according to claim 11 and any of claims 12 to 14, further comprising a step of deforming radially the mounting tube (4), axially at the intermediate joint, so as to:

- render at least the mounting tube (4), the sleeve (5), the distal rod (2) and the proximal rod (6) integral with each other, in longitudinal translation at least;
- bring about mechanical and electrical contact between the proximal rod (6) and the distal rod (2) at the intermediate joint.

Patentansprüche

1. Glühkerze (1) umfassend:

- einen hohlen Kerzenkörper (7), der sich entlang einer Längsachse (13) erstreckt und ein proximales Ende und ein distales Ende (18) entlang der Längsachse aufweist;
- einen Heizstab (3):

  • mit mindestens einem distalen Abschnitt, der sich axial erstreckt und vom distalen Ende (18) des Kerzenkörpers hervorsteht; und
  • mit einem proximalen Ende, das mit mindestens einer Verbindungsvorrichtung ausgestattet ist, um den Heizstab (13) mit Strom zu versorgen;

- mindestens eine elektrische Verbindungsvorrichtung, genannt externe Verbindungsvorrichtung (20), die:

  • axial vom proximalen Ende des Kerzenkörpers (7) hervorsteht; und
  • ausgelegt ist, um dazu in der Lage zu sein, ein Kabel aufzuweisen, um die Glühkerze (1) mit Strom zu versorgen, der damit verbunden ist;

- einen ersten steifen, elektrisch leitenden Stab, genannt distaler Stab (2), der durch ein distales Ende elektrisch mit mindestens einer Verbindungsvorrichtung verbunden ist, um den Heizstab (3) mit Strom zu versorgen;
- einen zweiten, steifen, elektrisch leitenden Stab, genannt proximaler Stab (6), der:

  • sich mindestens teilweise innerhalb des Kerzenkörpers (7) erstreckt;
  • durch ein proximales Ende mit mindestens einer externen Verbindungsvorrichtung (20) verbunden ist; und
  • durch ein distales Ende (12) mit einem proximalen Ende (11) des distalen Stabs (2) elektrisch verbunden ist;

- eine elektrisch isolierende rohrförmige Muffe (5), die wie folgt montiert ist:

  • um das distale Ende (12) des proximalen Stabs (6) und das proximale Ende (11) des distalen Stabs (2); und
  • innerhalb des Kerzenkörpers, um den proximalen Stab (6) radial vom Kerzenkörper (7) zu beabstanden;

dadurch gekennzeichnet, dass die Glühkerze auch eine elektrisch isolierende rohrförmige Muffe (5) umfasst, die wie folgt montiert ist:

- um das distale Ende (12) des proximalen Stabs (6) und das proximale Ende (11) des distalen Stabs (2), um mindestens einen blanken Abschnitt des distalen Endes (12) des proximalen Stabs (6) gegen mindestens einen blanken Abschnitt des proximalen Endes (11) des distalen Stabs (2) zu klemmen, so dass die Muffe (5) den proximalen Stab (6) und den distalen Stab (2) in elektrischem Kontakt hält; und
- um den distalen Stab (2) radial vom Kerzenkörper (7) zu beabstanden.

2. Kerze nach Anspruch 1, **dadurch gekennzeichnet, dass** das distale Ende (12) des proximalen Stabs (6) eine Verbindung, genannt Zwischenverbindung, mit dem proximalen Ende (11) des distalen Stabs (2) bildet.

3. Kerze nach Anspruch 2, **dadurch gekennzeichnet, dass** die Muffe (5) axial an der Zwischenverbindung mindestens eine radiale Verformung aufweist, die einen mechanischen und elektrischen Kontakt zwischen dem proximalen Stab (6) und dem distalen Stab (2) verursacht.

4. Kerze nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** sie auch ein Rohr, genannt Montagerohr (4), umfasst:

- in dem der Heizstab (3) montiert ist;
- das im Kerzenkörper (7) montiert ist; und
- das in einem ringförmigen Abstand verschieden von null um den distalen Stab (2) angeordnet ist, um einen Raum, genannt ringförmiger Raum (19), zwischen dem distalen Stab und dem Montagerohr (4) zu lassen.

5. Kerze nach Anspruch 4, **dadurch gekennzeichnet, dass** der ringförmige Raum (19) vollständig von Luft ausgefüllt ist.

6. Kerze nach einem der Ansprüche 4 oder 5, **dadurch gekennzeichnet, dass** die Muffe (5) zwischen dem Montagerohr (4) und den proximalen und distalen Stäben (6, 2) montiert ist, so dass die Muffe Folgendes bewirkt:

- eine elektrische Isolierung des proximalen Stabs (6) und des distalen Stabs (2) vom Montagerohr (4); und
- eine Dichtung des ringförmigen Raums (19) mit Bezug auf den Rest der Kerze.

7. Kerze nach einem der Ansprüche 4 bis 6, **dadurch gekennzeichnet, dass** das Montagerohr (4) axial an der Zwischenverbindung mindestens eine radiale Verformung (8) aufweist, so dass:

- das Montagerohr (4), die Muffe (5), der proximale Stab (6) und der distale Stab (2) fest mit-

einander verbunden sind, mindestens in längs gerichteter Translation; und
- der proximale Stab (6) und der distale Stab (2) in mechanischem und elektrischem Kontakt an der Zwischenverbindung stehen.

8. Kerze nach einem der Ansprüche 4 bis 7, **dadurch gekennzeichnet, dass** die Muffe (5) Folgendes aufweist:

- einen Absatz (16), der von ihrem äußeren Durchmesser hervorsteht und axial gegen ein proximales Ende (9) des Montagerohrs (4) aufliegt;
- eine Manschette (17), die von ihrem inneren Durchmesser hervorsteht und einen inneren Durchmesser aufweist, der im Wesentlichen gleich dem äußeren Durchmesser des distalen Stabs (2) ist.

9. Kerze nach einem der Ansprüche 1 bis 8, **dadurch gekennzeichnet, dass** die Muffe (5) in einem Stück vorliegt und aus einem elektrisch isolierenden synthetischen Material hergestellt ist.

10. Verfahren zur Herstellung einer Glühkerze, umfassend:

- einen hohlen Kerzenkörper (7), der sich entlang einer Längsachse (13) erstreckt und ein proximales Ende und ein distales Ende (18) entlang der Längsachse (13) aufweist;
- einen Heizstab (3) mit einem proximalen Ende, das mit mindestens einer Verbindungsvorrichtung ausgestattet ist, um den Heizstab (3) mit Strom zu versorgen;
- mindestens eine elektrische Verbindungsvorrichtung, genannt externe Verbindungsvorrichtung (20), die ausgelegt ist, um dazu in der Lage zu sein, ein Kabel aufzuweisen, um die Glühkerze (1) mit Strom zu versorgen, der damit verbunden ist;
- einen ersten steifen, elektrisch leitenden Stab, genannt distaler Stab (2); und
- einen zweiten steifen, elektrisch leitenden Stab, genannt proximaler Stab (6);

wobei das Verfahren die folgenden Schritte umfasst:

- Montieren des Heizstabs (3) im Kerzenkörper (7) auf eine Weise, um mindestens einen distalen Abschnitt aufzuweisen, der axial vom distalen Ende (18) des Kerzenkörpers (7) hervorsteht;
- Montieren jeder externen Verbindungsvorrichtung (20), die axial vom proximalen Ende des Kerzenkörpers (7) hervorsteht;
- elektrisches Verbinden des distalen Stabs (2) durch ein distales Ende mit mindestens einer Verbindungsvorrichtung, um den Heizstab (3) mit Strom zu versorgen;
- Montieren des proximalen Stabs (6) mindestens teilweise innerhalb des Kerzenkörpers (7), elektrisches Verbinden, durch ein proximales Ende, mit mindestens einer externen Verbindungsvorrichtung (20), und elektrisches Verbinden durch ein distales Ende (12) mit einem proximalen Ende (11) des distalen Stabs (2);
- eine elektrisch isolierende rohrförmige Muffe (5), die wie folgt montiert ist:

  • um das distale Ende (12) des proximalen Stabs (6) und das proximale Ende (11) des distalen Stabs (2); und
  • innerhalb des Kerzenkörpers, um den proximalen Stab (6) radial vom Kerzenkörper (7) zu beabstanden;

Montierens einer elektrisch isolierenden rohrförmigen Muffe (5) umfasst:

- um das distale Ende (12) des proximalen Stabs (6) und das proximale Ende (11) des distalen Stabs (2) um mindestens einen blanken Abschnitt des distalen Endes (12) des proximalen Stabs (6) gegen mindestens einen blanken Abschnitt des proximalen Endes (11) des distalen Stabs (2) zu klemmen, so dass die Muffe (5) den proximalen Stab (6) und den distalen Stab (2) in elektrischem Kontakt hält; und
- um den distalen Stab (2) radial vom Kerzenkörper (7) zu beabstanden.

11. Verfahren nach Anspruch 10, weiter umfassend einen Schritt des Befestigens des distalen Endes (12) des proximalen Stabs (6) zusammen mit dem proximalen Ende (11) des distalen Stabs (2), um eine Verbindung, genannt Zwischenverbindung, zu bilden.

12. Verfahren nach einem der Ansprüche 10 oder 11, weiter umfassend einen Schritt des Montierens eines Rohrs, genannt Montagerohr (4):

- auf dem Heizstab (3);
- innerhalb des Kerzenkörpers (7); und
- in einem ringförmigen Abstand nicht verschieden von null um den distalen Stab (2), um einen Raum, genannt ringförmiger Raum (19), zwischen dem distalen Stab (2) und dem Montagerohr (4) zu lassen.

13. Verfahren nach Anspruch 12, **dadurch gekennzeichnet, dass** die Montage der Muffe (5) erfolgt, indem sie direkt zwischen dem distalen Stab (2) und dem Montagerohr (4) durch ein proximales Ende des

ringförmigen Raums (19) eingeführt wird.

14. Verfahren nach Anspruch 11 oder einem der Ansprüche 12 oder 13, **dadurch gekennzeichnet, dass** das distale Ende (12) des proximalen Stabs (6) in die Muffe (5) eingeführt wird, um zusammen mit dem proximalen Ende (11) des distalen Stabs (2) verbunden zu werden, um die Zwischenverbindung an diesem Punkt zu bilden.

15. Verfahren nach Anspruch 11 und einem der Ansprüche 12 bis 14, weiter umfassend einen Schritt des radialen Verformens des Montagerohrs (4) axial an der Zwischenverbindung, um:

- mindestens das Montagerohr (4), die Muffe (5), den distalen Stab (2) und den proximalen Stab (6) mindestens in längs gerichteter Translation fest miteinander zu verbinden;
- einen mechanischen und elektrischen Kontakt zwischen dem proximalen Stab (6) und dem distalen Stab (2) an der Zwischenverbindung zu verursachen.

Revendications

1. Bougie (1) de préchauffage comprenant :

- un corps (7) de bougie creux s'étendant selon un axe longitudinal (13) et présentant une extrémité proximale et une extrémité distale (18) selon l'axe longitudinal ;
- un doigt chauffant (3) :
  - présentant au moins une portion distale s'étendant axialement en saillie de l'extrémité distale (18) du corps de bougie ; et
  - présentant une extrémité proximale dotée d'au moins un connecteur d'alimentation électrique du doigt chauffant (13) ;
- au moins un connecteur électrique, dit connecteur externe (20), lequel :
  - est axialement en saillie de l'extrémité proximale du corps (7) de bougie ; et
  - est adapté pour pouvoir y connecter un câble d'alimentation électrique de la bougie (1) de préchauffage ;
- une première tige rigide électriquement conductrice, dite tige distale (2), reliée électriquement par une extrémité distale à au moins un connecteur d'alimentation électrique du doigt chauffant (3) ;
- une deuxième tige rigide électriquement conductrice, dite tige proximale (6) :
  - s'étendant au moins partiellement dans le corps (7) de bougie ;
  - reliée électriquement par une extrémité proximale à au moins un connecteur externe (20) ; et
  - reliée électriquement par une extrémité distale (12), à une extrémité proximale (11) de la tige distale (2) ;
- un manchon (5) tubulaire électriquement isolant monté :
  - autour de l'extrémité distale (12) de la tige proximale (6) et l'extrémité proximale (11) de la tige distale (2) ; et
  - à l'intérieur du corps de bougie, de façon à espacer radialement la tige proximale (6) par rapport au corps (7) de bougie ;

caractérisée en ce que le manchon (5) tubulaire électriquement isolant est monté :

- autour de l'extrémité distale (12) de la tige proximale (6) et de l'extrémité proximale (11) de la tige distale (2) de façon à serrer au moins une portion nue de l'extrémité distale (12) de la tige proximale (6) contre au moins une portion nue de l'extrémité proximale (11) de la tige distale (2), de sorte que le manchon (5) maintient la tige proximale (6) et la tige distale (2) en contact électrique ; et
- de façon à espacer radialement la tige distale (2) par rapport au corps (7) de bougie.

2. Bougie selon la revendication 1, **caractérisée en ce que** l'extrémité distale (12) de la tige proximale (6) forme un emboîtement, dit emboîtement intermédiaire, avec l'extrémité proximale (11) de la tige distale (2).

3. Bougie selon la revendication 2, **caractérisée en ce que** le manchon (5) présente, axialement au niveau de l'emboîtement intermédiaire, au moins une déformation radiale permettant d'assurer un contact mécanique et électrique entre la tige proximale (6) et la tige distale (2).

4. Bougie selon l'une des revendications 1 à 3, **caractérisée en ce qu'**elle comprend en outre un tube, dit tube de montage (4) :

- dans lequel le doigt chauffant (3) est monté ;
- lequel est monté dans le corps (7) de bougie ; et
- lequel est disposé à une distance annulaire non-nulle autour de la tige distale (2), de façon à laisser un espace, dit espace annulaire (19), entre la tige distale et le tube de montage (4).

5. Bougie selon la revendication 4, **caractérisée en ce que** ledit espace annulaire (19) est entièrement occupé par de l'air.

6. Bougie selon l'une des revendications 4 ou 5, **caractérisée en ce que** ledit manchon (5) est monté entre ledit tube de montage (4) et les tiges (6, 2) proximale et distale, de sorte que le manchon assure :

- une isolation électrique de la tige proximale (6) et de la tige distale (2) par rapport au tube de montage (4) ; et
- une étanchéité de l'espace annulaire (19) vis-à-vis du reste de la bougie.

7. Bougie selon l'une des revendications 4 à 6, **caractérisée en ce que** le tube de montage (4) présente, axialement au niveau de l'emboîtement intermédiaire, au moins une déformation (8) radiale, de sorte que :

- le tube de montage (4), le manchon (5), la tige proximale (6) et la tige distale (2) sont solidaires en translation longitudinale au moins ; et
- la tige proximale (6) et la tige distale (2) sont en contact mécanique et électrique au niveau de l'emboîtement intermédiaire.

8. Bougie selon l'une des revendications 4 à 7, **caractérisée en ce que** le manchon (5) présente :

- un épaulement (16) en saillie de son diamètre extérieur axialement en appui contre une extrémité proximale (9) du tube de montage (4) ;
- un collet (17) en saillie de son diamètre intérieur de diamètre intérieur sensiblement égal au diamètre extérieur de la tige distale (2).

9. Bougie selon l'une des revendications 1 à 8, **caractérisée en ce que** le manchon (5) est monobloc en matériau synthétique électriquement isolant.

10. Procédé de fabrication d'une bougie de préchauffage comprenant :

- un corps (7) de bougie creux s'étendant selon un axe longitudinal (13) et présentant une extrémité proximale et une extrémité distale (18) selon l'axe longitudinal (13) ;
- un doigt chauffant (3) présentant une extrémité proximale dotée d'au moins un connecteur d'alimentation électrique du doigt chauffant (3) ;
- au moins un connecteur électrique, dit connecteur externe (20), adapté pour pouvoir y connecter un câble d'alimentation électrique de la bougie (1) de préchauffage ;
- une première tige rigide électriquement conductrice, dite tige distale (2) ; et
- une deuxième tige rigide électriquement conductrice, dite tige proximale (6) ;

dans lequel :

- le doigt chauffant (3) est monté dans le corps (7) de bougie de façon à présenter au moins une portion distale axialement en saillie de l'extrémité distale (18) du corps (7) de bougie ;
- chaque connecteur externe (20) est monté axialement en saillie de l'extrémité proximale du corps (7) de bougie ;
- ladite tige distale (2) est reliée électriquement par une extrémité distale à au moins un connecteur d'alimentation électrique du doigt chauffant (3) ;
- ladite tige proximale (6) est montée au moins partiellement dans le corps (7) de bougie, est reliée électriquement par une extrémité proximale à au moins un connecteur externe (20), et est reliée électriquement par une extrémité distale (12) à une extrémité proximale (11) de la tige distale(2) ;
- un manchon (5) tubulaire électriquement isolant est monté :
  - autour de l'extrémité distale (12) de la tige proximale (6) et l'extrémité proximale (11) de la tige distale (2) ; et
  - à l'intérieur du corps de bougie, de façon à espacer radialement la tige proximale (6) par rapport au corps (7) de bougie ;

caractérisé en ce le manchon (5) tubulaire électriquement isolant est monté :

- autour de l'extrémité distale (12) de la tige proximale (6) et de l'extrémité proximale (11) de la tige distale (2) de façon à serrer au moins une portion nue de l'extrémité distale (12) de la tige proximale (6) contre au moins une portion nue de l'extrémité proximale (11) de la tige distale (2), de sorte que le manchon (5) maintient la tige proximale (6) et la tige distale (2) en contact électrique ; et
- de façon à espacer radialement la tige distale (2) par rapport au corps (7) de bougie.

11. Procédé selon la revendication 10, **caractérisé en ce que** l'extrémité distale (12) de la tige proximale (6) est emboîtée avec l'extrémité proximale (11) de la tige distale (2) de façon à former un emboîtement, dit emboîtement intermédiaire.

12. Procédé selon l'une des revendications 10 ou 11, **caractérisé en ce qu'**un tube, dit tube de montage (4), est monté :

- sur le doigt chauffant (3) ;
- dans le corps (7) de bougie;
- à une distance annulaire non-nulle autour de la tige distale (2), de façon à laisser un espace, dit espace annulaire (19), entre la tige distale (2) et le tube de montage (4).

13. Procédé selon la revendication 12, **caractérisé en ce que** le manchon (5) est introduit directement entre la tige distale (2) et le tube de montage (4), par une extrémité proximale de l'espace annulaire (19).

14. Procédé selon la revendication 11 et l'une des revendications 12 ou 13, **caractérisé en ce que** l'extrémité distale (12) de la tige proximale (6) est introduite dans le manchon (5), de façon à s'assembler avec l'extrémité proximale (11) de la tige distale (2) pour y former l'emboîtement intermédiaire.

15. Procédé selon la revendication 11 et l'une des revendications 12 à 14, **caractérisé en ce que**, axialement au niveau de l'emboîtement intermédiaire, le tube de montage (4) est déformé radialement de façon à :

- solidariser en translation longitudinale au moins le tube de montage (4), le manchon (5), la tige distale (2) et la tige proximale (6) ;
- assurer un contact mécanique et électrique entre la tige proximale (6) et la tige distale (2) au niveau de l'emboîtement intermédiaire.

Fig 1

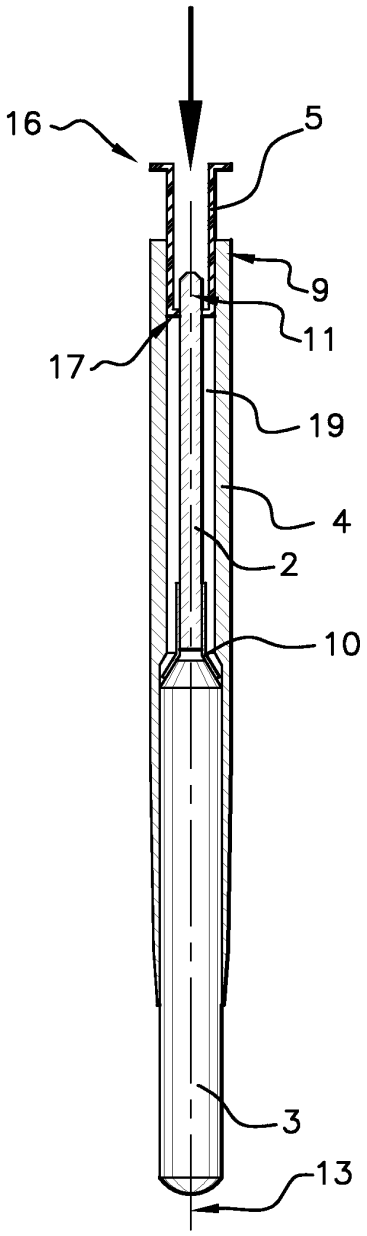


Fig 2

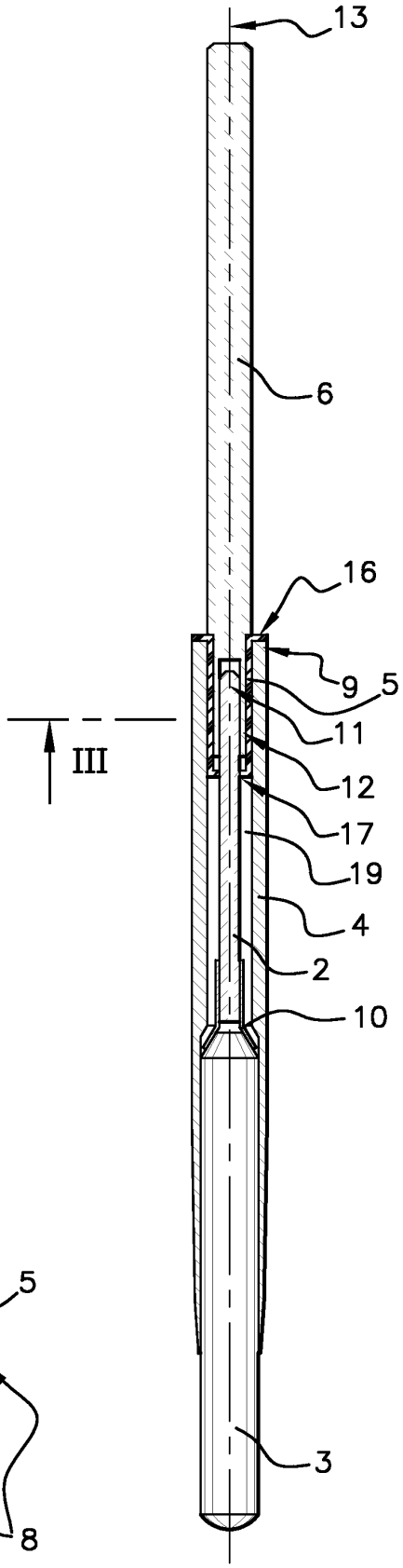


Fig 3

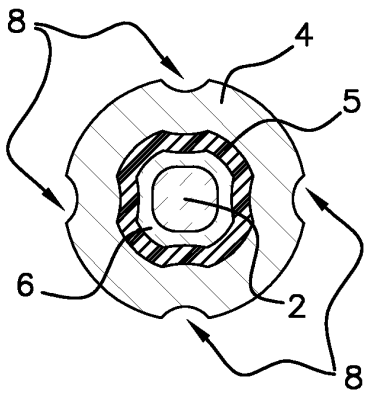


Fig 4

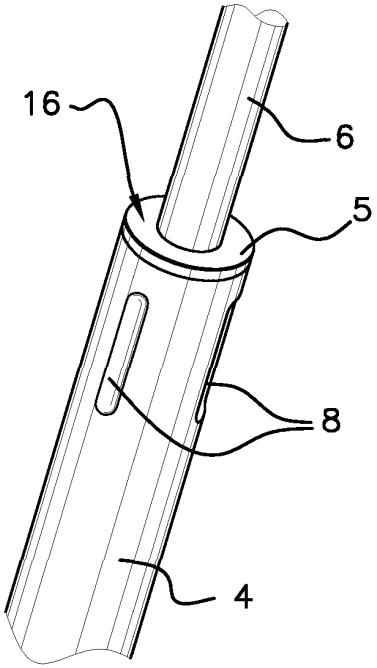
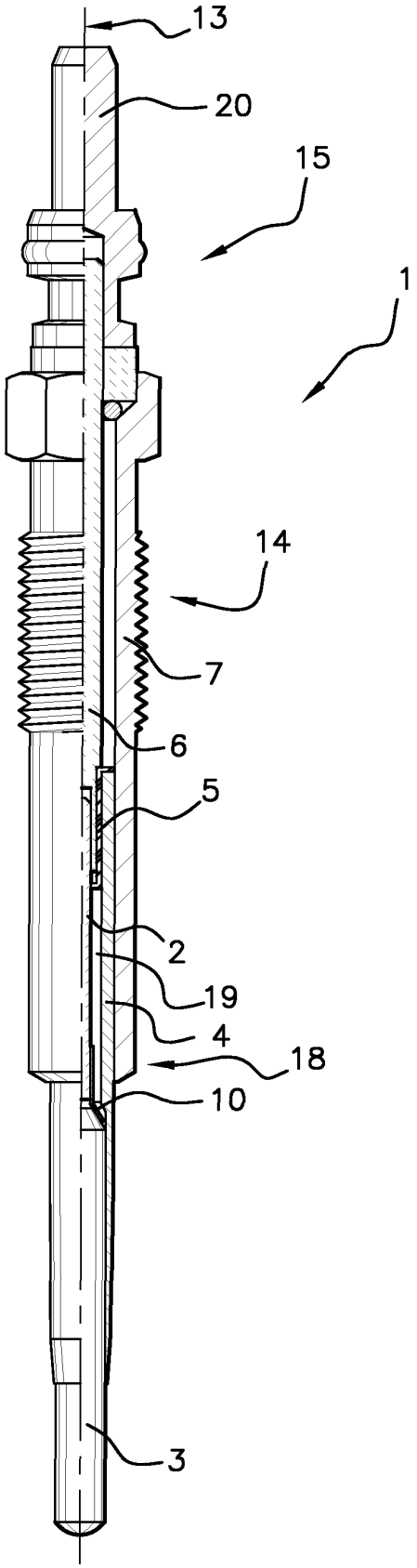


Fig 5



REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 1707883 A **[0003]**
- US 4425692 A **[0006]**
- DE 10346294 **[0007]**
- EP 0834652 A **[0008]**