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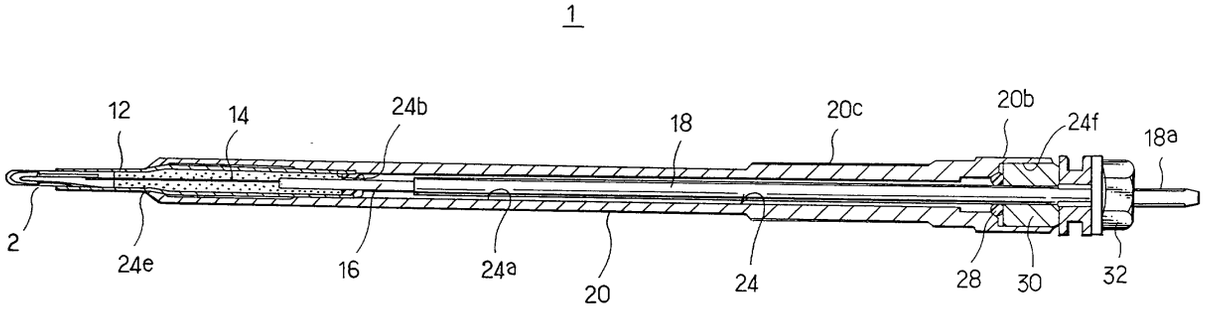
(54) Glow plug for diesel engine and method of manufacturing same

(57) A sufficient area is secured for a seat area 26 which is to be disposed in abutment against a cylinder head when the external diameter of a housing 20 (a fixture for mounting a glow plug on a cylinder head) is reduced while maintaining the internal diameter unchanged. A press fit region 24b is defined in an internal bore 24 of a housing 20 toward the distal end 20a, and a rear portion of a sheath 12 to which a ceramics heater 2 is secured is disposed as a press fit in the press fit region 24b to be secured therein. The sheath 12 has a portion 12b of an increased diameter which is inserted into the housing 20 and a portion 12a of a reduced diameter in which the ceramics heater 2 is contained and which projects externally. The internal bore 24 of the housing 20 has an opening 24e which is of a smaller diameter than the press fit region 24b, increasing the radial breadth of the seat area 26 formed on the front end face of the housing 20.

FIG. 1



EP 1 308 672 A2

Description

DETAILED DESCRIPTION OF THE INVENTION

Field of the Invention

[0001] The invention relates to a glow plug which is used as a starting aid for a diesel engine, and a method of manufacturing same.

Description of the Prior Art

[0002] To accommodate for regulatory requirements on exhaust gases, a combustion scheme of a diesel engine is shifting from a type using sub-combustion chambers to a so-called direct injection type and also toward a multiplication of valves. A glow plug which is used in a diesel engine of direct injection type is disposed in facing relationship with a main combustion chamber through the wall of an interposed cylinder head, and thus requires an increased overall length and a reduced diameter as compared with one which has been used to preheat sub-combustion chambers.

[0003] The thickness of the cylinder head must be increased in order to secure the strength thereof, and in addition, there must be secured spacings between valve openings, injection nozzles mounting opening and a glow plug mounting opening in order to prevent an interference therebetween. This results in a need for an opening of a small diameter and a greater length which is formed therein to receive the glow plug, which thus must be formed into an elongate configuration in a corresponding manner.

[0004] As a consequence, there is a tendency to reduce the size of threads which are formed around the outer surface of a cylindrical housing, which is a fixture to mount the glow plug into the cylinder head, from M12 or M10 which has been used in the prior art to M8, for example. When the external diameter of the housing is reduced, there arises a problem in the construction of an external connection terminal for a positive electrode. Specifically, referring to the construction of a conventional glow plug for a diesel engine, the positive pole of a heater is taken out thereof through an electrode fitting, which is in turn connected to the external connection terminal. An integral assembly which comprises the heater, the electrode fitting and the external connection terminal is inserted through an end of the housing which is to be secured to the heater with a threaded end of the external connection terminal disposed foremost; the heater is secured into the distal end of the housing as by a press fit; the threaded end of the external connection terminal is allowed to project through the other end of the housing and is supported by the housing through an insulating bushing interposed therebetween.

[0005] In the conventional practice, an M4 thread is used for the external connection terminal, and the M4 threaded portion must be passed through the distal end to the other end of an internal bore of the housing. Consequently, it is necessary that the inner diameter of the housing be greater than 4mm which is a maximum diameter of the M4 thread, and usually the inner diameter is chosen to be on the order of 4.4mm to provide a certain margin. However, when the outer diameter of the housing is reduced while maintaining a required size for the inner diameter, it follows that the wall thickness of the housing is reduced. As a consequence, the wall thickness of the distal end, which represents a seat area to be disposed in abutment against the seat portion of the cylinder head, will, be greatly reduced. In particular, because a clearance is required for the opening in the cylinder head through which the glow plug is passed, the actual thickness of the seat area will be further reduced.

[0006] When a maximum value of a torque specified for M8 bolt is applied to the seat area which is restricted as mentioned above, a deep depression will be created in the seat surface of the cylinder head, considering a usual cylinder head which normally comprises aluminum alloy, and if tightened repeatedly, there arises a likelihood of causing a poor hermetic seal. If the housing is tightened with an over-torque, there occurs the likelihood that the entire cylinder head may be damaged.

OBJECT AND SUMMARY OF THE INVENTION

[0007] In order to overcome the difficulty mentioned above, it is an object of the present invention to provide a glow plug for a diesel engine which allows a sufficient seat area to be secured on the distal end of the housing or on the front end of a sheath if the outer diameter of the housing, which is a fixture for mounting the glow plug into the cylinder head, is reduced while securing a required inner diameter.

[0008] Such an object is accomplished by a glow plug for a diesel engine defined in Claim 1 in which one end of a sheath which carries a heater is disposed as a press fit in the internal bore of the cylindrical housing and is secured therein. In particular, in a region where the sheath is disposed as a press fit, the housing has an inner diameter which is greater than the inner diameter of an opening in the housing through which the sheath projects.

[0009] In a conventional glow plug for a diesel engine, a difference between the inner diameter and the outer diameter of the housing normally represents the width of the seat area located at the distal end of the housing. However, according to the invention defined in Claim 1, the inner diameter of the housing is maintained in a region where the sheath is inserted, but the diameter of the opening in the housing is reduced as compared with the inner diameter where the sheath is disposed as a press fit. Accordingly, the width of the seat area at the distal end of the housing can be increased. In other words, if the outer diameter of the housing is reduced while the inner diameter is chosen to permit the thread-

ed portion of the external connection terminal to pass therethrough, there can be obtained a seat area having a sufficient area of contact, thus reducing the likelihood that the cylinder head may be damaged.

[0010] As defined in Claim 2, the housing comprises a body in which the sheath is disposed as a press fit and secured therein, and a seat adapter mounted on the distal end of the body and presenting a seat area for contact with the cylinder head.

[0011] According to the present invention, the seat adapter is engaged with the sheath to urge it so that the sheath can be disposed as a press fit in the housing, thus greatly facilitating disposing it as a press fit therein. This also allows a ceramics heater which has been difficult to be disposed as a press fit to be disposed in a safe manner. In addition, the material for the seat adapter can be chosen to be different from the material for the body of the housing, thus allowing the hermetic seal of the seat to be improved.

[0012] As defined in Claim 3, the distal end of the sheath is formed with a portion of a reduced diameter while a rear end thereof is formed with a portion of an increased diameter which is secured to the internal surface of the housing. The portion of the reduced diameter projects through the opening in the housing.

[0013] As defined in Claim 4, one end of the sheath which carries the heater is disposed as a press fit in and secured to the internal bore of the cylindrical housing. In particular, a portion of the sheath which is located nearer the distal end of the housing than the remainder which is disposed within the housing is formed with an increased diameter, and the sheath is also formed with a portion of a reduced diameter at a location forward of the increased diameter so that the front end of the increased diameter serves as a seat area for contact with the cylinder head.

[0014] According to the invention defined in Claim 4, the seat area which is disposed for contact with the cylinder head is formed on the front surface of the sheath, and hence it is a simple matter to increase the area of the seat area which is defined by the difference between the outer diameter of the portion of the increased diameter and the outer diameter of the portion of the reduced diameter which is located toward the distal end and carrying the heater.

[0015] As defined in Claim 5, the present invention also relates to a method of manufacturing a glow plug for a diesel engine in which one end of a sheath carrying a heater is disposed as a press fit and secured in an internal bore of a cylindrical housing. A sheath having a reduced diameter toward the distal end and an increased diameter toward a rear end is inserted through the distal end of the cylindrical housing. After the rear end of the sheath is disposed as a press fit in and secured against the internal surface of the housing, the distal end of the housing is subject to a plastic deformation so as to extend along a juncture between the reduced diameter and the increased diameter of the sheath, thus increasing the area of the seat area formed at the distal end of the housing.

[0016] According to the method of the present invention, the sheath configuration is such that it has a reduced diameter toward the distal end and an increased diameter toward the rear end. The distal end of the housing is subject to a plastic deformation so as to conform to the configuration of the sheath, whereby the inner diameter in the region of the opening can be made coincident with the portion of the reduced diameter of the sheath while maintaining the outer diameter of the seat area located at the distal end of the housing unchanged from the remainder of the housing, thus allowing a seat area having a sufficient area to be formed while facilitating the machining of the housing, contributing to a reduction in the total cost.

[0017] In the method of manufacturing a glow plug for a diesel engine as defined in Claim 6, the housing comprises a body in which the sheath is secured, and a seat adapter which is located toward the distal end thereof. The diameter toward the front opening is chosen to be less than the inner diameter of the rear end of the seat adapter, and the outer profile of the sheath comprises a portion of a reduced diameter which substantially coincides with the diameter of the opening in the sheet adapter and a portion of an increased diameter which is located rearward thereof, thus allowing the rear end of the sheath to be disposed as a press fit in the housing through the seat adapter.

[0018] According to the method of the present invention, the inner profile of the seat adapter is chosen to conform to the outer profile of the sheath, whereby when the sheath is to be disposed as a press fit into the housing, the sheath can be urged into the housing through the seat adapter, thus facilitating the operation of disposing it as a press fit. A ceramics heater which has been difficult to be disposed as a press fit can be safely disposed as a press fit in this manner. In addition, the material for the seat adapter can be chosen to be different from the material for the body of the housing, allowing the hermetic seal of the seat to be improved.

[0019] According to the method of manufacturing a glow plug for a diesel engine as defined in Claim 7, a portion of the sheath which is located forwardly of the portion thereof which is inserted into the housing is formed with a portion of an increased diameter, the front end of which is formed with a seat area for contact with a seat of the cylinder head, and this seat area may be urged to dispose the rear end of the sheath as a press fit into the housing.

[0020] According to the method of the present invention, when the sheath is to be disposed as a press fit into the housing, the seat area formed on the front end of the sheath can be directly urged, thus facilitating the operation of disposing it as a press fit. In addition, a ceramics heater which has been difficult to be disposed as a press fit in the prior art can be safely disposed as a press fit without any likelihood of causing a damage

thereto.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021]

Fig. 1 is a longitudinal section of a ceramics heater glow plug according to one embodiment of the present invention;
Fig. 2 is an enlarged view of an essential part of the glow plug shown in Fig. 1;
Figs. 3 is a longitudinal section of part of the ceramics heater housing;
Figs. 4 (a) and (b) are illustrations of a method of manufacturing the ceramics heater glow plug according to the first embodiment;
Fig. 5 is a longitudinal section of an essential part of a ceramics heater glow plug according to a second embodiment of the present invention;
Fig. 6 is a longitudinal section of an essential part of a metal heater glow plug according to a third embodiment of the present invention;
Fig. 7 is a longitudinal section of an essential part of a ceramics heater glow plug according to a fourth embodiment of the present invention;
Figs. 8 (a), (b) and (c) are longitudinal sections illustrating successive steps of a method of manufacturing the ceramics heater glow plug according to the fourth embodiment; and
Fig. 9 is a longitudinal section of an essential part of a ceramics heater glow plug according to a fifth embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0022] Several embodiments of the present invention will now be described with reference to the drawings. A glow plug, generally designated by numeral 1, of the embodiment shown in Figs. 1 and 2 represents a ceramics heater glow plug including a ceramics heater 2 as a heating element.

[0023] The ceramics heater 2 includes a heating element 6 which is embedded in a ceramics insulator 4 which constitutes the body of the heater. One end 6a of the heating element 6 is connected to a negative pole lead wire 8 while the other end 6b is connected to a positive pole lead wire 10. The negative pole lead wire 8 is taken out to the outer periphery of the ceramics insulator 4 to be brazed to the internal surface of a sheath (metallic outer casing) 12, which will be described later, to be electrically connected therewith. On the other hand, the positive pole lead wire 10 extends to the opposite end from the location where the heating element 6 is embedded (or the left end as viewed in Figs. 1 and 2), and is brazed to the distal end of an electrode fitting lead wire 14 within a mounting opening formed in this end face, and thus is electrically connected therewith.

[0024] The rear end of the electrode fitting lead wire 14 (or the right end as viewed in Figs. 1 and 2) is secured to the distal end of an electrode fitting 16 which is formed of a rigid body, the rear end of which is in turn secured to the distal end of an external connection terminal 18.

[0025] The ceramics heater 2 constructed in the manner mentioned above is joined to the sheath 12 by brazing, and thus is secured through the interposed sheath 12 to a cylindrical housing 20 which represents a fixture to the cylinder head. In this embodiment, the sheath 12 includes a portion of a reduced diameter 12a toward its front end, and a portion of an increased diameter 12b which is located rearward thereof. A rear portion of the ceramics heater 2 is inserted into the portion of a reduced diameter 12a and is joined thereto as by brazing.

[0026] The electrode fitting 16 which is electrically connected to the positive pole lead wire 10 of the ceramics heater 2 through the electrode fitting lead wire 14 is secured to the sheath 12 by a swaging operation. This swaging operation will be described briefly. Initially, the positive pole lead wire 10 of the ceramics heater 2 and the electrode fitting lead wire 14 which is secured to the electrode fitting 16 are inserted into a mounting opening formed in the ceramics insulator 4 and are joined together by brazing, and the ceramics heater 2 is secured to the end of the sheath 12 which is close to the end of the portion of a reduced diameter 12a by brazing. It should be noted that at this time, a heater portion 2a located at the distal end of the ceramics heater 2 in which the heating element 6 is embedded should remain exposed outside the sheath 12.

[0027] After the ceramics heater 2 is secured inside the portion 12a of the sheath 12 having a stepped configuration, a refractory insulating powder such as magnesia (MgO) 22 is filled into a space in which the junction between the electrode fitting lead wire 14 and the electrode fitting 16 is contained through an opening 12c which is formed in the end of the portion 12b of an increased diameter of the sheath 12. Subsequently, a seal member 25 which is formed of rubber such as silicone rubber or fluorine-contained rubber is inserted into the opening 12c of the sheath 12. By closing the opening 12c of the sheath 12 with the seal member 25, a spillage of the refractory insulating powder 22 can be prevented during a subsequent swaging operation and the electrode fitting 16 can be prevented from contacting the sheath 12.

[0028] The portion of an increased diameter 12b of the sheath 12 in which the junction between the electrode fitting lead wire 14 and the electrode fitting 16 is contained is subject to a swaging operation to reduce the outer diameter of the sheath 12 while increasing a density of the refractory insulating powder 22 to secure the electrode fitting 16 within the sheath 12.

[0029] The housing 20 in which the sheath 12 is secured is substantially cylindrical in configuration and is internally formed with a stepped axial bore 24. The internal bore 24 of the housing 20 includes a central por-

tion 24a of a reduced diameter, and a press fit region 24b which is located nearer the distal end 20a (or the left end as viewed in Fig. 2) of the housing and which has a slightly greater inner diameter than the portion 24a of a reduced diameter. The rear end of the sheath 12 is disposed as a press fit in the press fit region 24b to be secured therein. The internal bore 24 of the housing 20 also includes a portion 24c of an inner diameter which is slightly greater than the inner diameter of the press fit region 24b at a location further nearer the distal end 20a.

[0030] The distal end 20a of the housing 20 includes an internal surface 24d which is tapered substantially in conformity to the tapering of the juncture 12d between the portion of a reduced diameter 12a and the portion of an increased diameter 12b of the sheath 12. Around its outer periphery, the distal end 20a has a front end face 26 which is sharply beveled and which serves as a seat area which is to be disposed in abutment against the seat of the cylinder head of an engine not shown. A threaded portion 20c, which allows the glow plug 1 to be threadably engaged with the cylinder head is formed around the outer periphery of the end 20b of the housing 20 which is opposite from the distal end 20a in which the ceramics heater 2 is secured through the interposed sheath 12 (or the right end as viewed in Fig. 1).

[0031] Referring to Fig. 3, the configuration of the distal end 20a of the housing 20 to which the ceramics heater 2 is secured will be described in detail. As mentioned previously, the central portion of the internal bore 24 in the housing 20 is the portion 24a of a reduced diameter, and the press fit region 24b of a diameter which is slightly greater than the inner diameter of the portion 24a is formed forwardly of the portion 24a (or to the left thereof as viewed in Fig. 3), and another portion 24c of a slightly greater diameter is formed forwardly of the press fit region 24b. As mentioned previously, the internal surface 24d of the distal end 20a is tapered, and hence the axial bore 24 has a minimum inner diameter at the location of an opening 24e which is disposed at the forward end thereof. The housing 20 used for the glow plug 1 for a diesel engine according to the present invention is characterized in that the inner diameter D1 of the press fit region 24b is greater than the diameter D2 of the opening 24e or D1 > D2.

[0032] The assembly of the glow plug 1 for a diesel engine according to the present embodiment will now be described with reference to Fig. 4. As shown in Fig. 4(a), the configuration of the housing 20 before the assembly is such that the distal end 20X has the same inner diameter and outer diameter as the portion 24c which is contiguous to the press fit region 24b of the axial bore 24 and which has a slightly greater diameter than the press fit region 24b, and an assembly which integrally includes the sheath 12, the electrode fitting 16 and the external connection terminal 18 is inserted into the distal end 20X with the threaded portion 18a (see Fig. 1) of the external connection terminal 18 disposed foremost. The assembly is inserted into the housing 20 from the left side as viewed in Fig. 4 (a), and the rear end of the sheath 12 is disposed as a press fit into the press fit region 24b of the axial bore 24 in the housing 20 and is then secured therein. Subsequently, the distal end 20X of the housing 20 is subject to a plastic deformation so that the internal surface 24d of the distal end (this end after the plastic deformation is designated by numeral 20a) extends along the tapered juncture 12d between the portion of an increased diameter 12b and the portion of a reduced diameter 12a of the sheath 12 while forming a beveled surface which provides a seat area 26 which is to be brought into contact with the cylinder head around the outer periphery thereof (see Fig. 4(b)).

[0033] When the rear end of the sheath 12 is disposed as a press fit in the housing 20 and secured therein in the manner mentioned above, the threaded portion 18a which is located toward the rear end of the external connection terminal 18 will project externally through the rear end 20b of the housing 20 (see Fig. (1)). A seal member 28 and an insulating bushing 30 are fitted over the external connection terminal 18 from the end located toward the threaded portion 18a and are inserted into a portion 24f of an increased diameter which is located at the rear end of the internal bore 24 of the housing 20. Subsequently, a nut formed of aluminum is fitted and tightened to secure the external connection terminal 18 to the housing 20 through the insulating bushing 30 interposed therebetween.

[0034] It will be seen that the distal end 20X having the same diameter as the remainder of the housing 20 is subject to a plastic deformation to form the seat area 26 which is to be disposed in abutment against the cylinder head. In this manner, the outer surface of the distal end 20a retains the same diameter as the remainder of the housing 20 which is not subject to the plastic deformation while the opening 24e has an inner diameter which is substantially equal to the diameter of the portion 12a of a reduced diameter of the sleeve 12. In this manner, if the outer diameter of the housing 20 is reduced (to M8, for example) and the inner diameter is maintained so as to allow the threaded portion 18a of the external connection terminal 18 (which may be M4, for example) to pass therethrough, there can be obtained a seat area 26 having a sufficient area, reducing any likelihood that the cylinder head may be damaged. The internal bore 24 of the housing 20 has a similar size as a conventional large diameter housing (M10, for example), allowing the strength of the electrode fitting 16 to be maintained and allowing a torque which is applied when tightening the threaded portion 18a of the external connection terminal 18 to be chosen in a usual manner as in the conventional practice. In addition, the machining of the housing 20 is facilitated, allowing a total cost to be reduced.

[0035] Fig. 5 is a longitudinal section of a glow plug 101 for a diesel engine according to a second embodiment. A ceramics heater 2, a sheath 12, an electrode

fitting lead wire 14, an electrode fitting 16 and an external connection terminal 18 which are secured within a housing 120 are each constructed in the similar manner as shown in the first embodiment, and therefore will not be described again by using a similar reference character as used before for a corresponding part.

[0036] In this embodiment, the housing 120 comprises a housing body 120A in which the described parts are secured, and a seat adapter 120B which is mounted on the distal end of the body 120A. The housing body 120A has an internal axial bore 124, which includes a central portion 124a of a reduced diameter, a press fit region 124b of a slightly greater diameter than the portion 124a and disposed forwardly of the portion 141a and offset toward the distal end 120Aa of the housing body 120A, and a portion 124c of a slightly greater diameter than the press fit region 124b which is disposed forwardly of the press fit region 124b and offset toward the distal end 120Aa.

[0037] The seat adapter 120B having a seat area 126 which is to be disposed in abutment against the cylinder head is similarly constructed as a portion of the housing 20 of the first embodiment which is disposed toward the distal end 20a. The distal end 120Ba of the seat adapter has an internal surface 124Bd which is tapered substantially in conformity to the juncture 12d between the portion 12b of an increased diameter and the portion 12a of a reduced diameter of the sheath 12. A seat area 126 is formed around the outer periphery of the distal end 120Ba and has an external diameter which is the same as the remainder of the seat adapter and an internal diameter which substantially coincides with the external diameter of the portion 12a of a reduced diameter of the sheath 12. The seat adapter 120B has an opening 120Be at its distal end which is of an inner diameter which is less than the inner diameter of the press fit region 124b of the housing body 120A. Accordingly, the inner diameter of the housing body 120A can be reduced while using a conventional large diameter ceramics heater 2 in the similar manner as in the prior art. In addition, there can be secured a seat area 126 having a sufficient breadth.

[0038] In the first embodiment, the distal end 20X of the housing remains to be of a uniform diameter up to the opening before the assembly takes place, and the sheath 12 having the ceramics heater 2 secured therein is inserted into the housing 20 through the distal end 20X and disposed as a press fit in the press fit region 24b to be secured therein. Subsequently, the distal end 20X is subject to a plastic deformation, whereby the inner diameter D2 of the opening 24e is reduced below the inner diameter D1 of the press fit region 24b. However, in the second embodiment, the seat adapter 120B is previously configured as shown in Fig. 5. Thus, the inner surface 120Bd of the distal end 120Ba is engaged with the juncture 12d between the portion 12b of an increased diameter and the portion 12a of a reduced diameter of the sheath 12 to allow the sheath 12 to be disposed as a press fit in the press fit region 124b of the housing 120, thus greatly facilitating disposing it as a press fit. This allows a ceramics heater 2 which has been difficult to be disposed as a press fit to be safely disposed as a press fit. When the housing 120 is split into the body 120A and the seat adapter 120B, the material for the seat adapter 120B can be chosen to be different such as aluminum alloy or brass from the material for the housing body 120A, thus allowing the hermetic seal of the seat to be improved.

[0039] Fig. 6 is a longitudinal section of a glow plug 201 for a diesel engine according to a third embodiment. The glow plug 201 is distinct from the glow plug 101 of the second embodiment only in the construction of a heater 202. In the previous embodiments, a ceramics heater 2 has been used, but in the third embodiment, a metal heater 202 is used. The metal heater 202 includes a sheath 212 including a portion 212b of an increased diameter which is disposed as a press fit within the housing body 120A, and a portion 212a of a reduced diameter which projects externally of the seat adapter 120B. Again, the assembly can take place by similar steps as used in the second embodiment, achieving a similar advantage. In addition, it will be seen that the metal heater 202 is inexpensive as compared to the ceramics heater 2, thus providing a glow plug 201 for a diesel engine which is of a lower cost.

[0040] Fig. 7 is a longitudinal section of a glow plug 301 for a diesel engine according to a fourth embodiment. In this embodiment, a housing 320 is integral up to a seat area 326 which is to be disposed in abutment against the cylinder head in the similar manner as in the first embodiment (shown in Fig. 1). However, in the fourth embodiment, the housing 320 includes a distal end 320a which is previously formed with an internal tapered surface 324d and an outer surface which provides a seat area 326 having a sufficient seat area. Accordingly, the ceramics heater 2 cannot be inserted through an opening 324e formed in the distal end 320a, and thus is inserted through the rear end (not shown, but through the end to which the external connection terminal 18 is secured) to be secured therein.

[0041] A procedure which is used to secure a sheath 12 which carries the ceramics heater 2 within the housing 320 will now be described with reference to Figs. 8 (a), (b) and (c). In this embodiment, the internal bore 324 of the housing 320 is not provided with a press fit region of a reduced diameter as shown in other embodiments at a location where the sheath 12 is to be secured, but has an inner diameter which allows the portion 12b of an increased diameter of the sheath 12 to pass therethrough. The ceramics heater 2 is inserted into the internal axial bore 324 through the rear end (located to the right, as viewed in Fig. 8) of the housing 320 (see Fig. 8(a)). The ceramics heater 2 and the portion 12a of a reduced diameter of the sheath 12 to which the ceramics heater 2 is secured are caused to project externally through the opening 324e in the housing 320

(see Fig. 8(b)). Under this condition, the juncture 12d located between the portion 12a of a reduced diameter and the portion 12b of an increased diameter of the sheath 12 abuts against the tapered surface 324d formed on the internal surface of the distal end 320a of the housing 320 to be positioned.

[0042] Subsequently, a portion 320d around the outer periphery of the housing 320 into which the rear end of the sheath 12 is received is subjected to a plastic deformation (see an arrow P shown in Fig. 8 (c)), thereby securing the ceramics heater 2 and the sheath 12 within the housing 320. Again, the housing 320 has an inner diameter at a location where the external surface of the sheath 12 is secured as a result of the plastic deformation which is greater than the inner diameter of the opening 324e, achieving a similar effect and advantage as in the previous embodiments.

[0043] Fig. 9 is a longitudinal section of a glow plug 401 for a diesel engine according to a fifth embodiment. In the previous embodiments, a seat area 26, 126 or 326 which is to be disposed in abutment against the cylinder head of an engine is formed on the front end face of the housing 20 or 320 or on the front end face of the seat adapter 120B which is disposed forwardly of the housing body 120A. However, in the fifth embodiment, a seat area 426 is formed on the external surface of a sheath 412 to which the ceramics heater 2 is secured.

[0044] The sheath 412 to which the ceramics heater 2 is secured includes a portion 412a of a reduced diameter in a region toward the front end where the ceramics heater 2 is secured, and a portion 412b of a greater diameter than the portion 412a which is to be disposed as a press fit in the housing 420 to be secured, in the similar manner as in the previous embodiments. The diameter of the portion 412b is slightly greater than the diameter of a press fit region 424b defined in the internal axial bore 424 of the housing 420, with a portion 412e of an increased diameter being formed between the portion 412a of a reduced diameter and the portion 412b of an increased diameter. The portion 412e of an increased diameter has an external diameter which is substantially equal to the external diameter of the housing 420, and the rear end face 412f of the portion 412e of an increased diameter, or a region between the portion 412e of an increased diameter and the rear portion 412b which is disposed as a press fit into the housing 420, represents a substantially upright step. A seat area 426 which is to be disposed in abutment against the cylinder head is formed on the front end face of the portion 412e of an increased diameter which faces the portion 412a of a reduced diameter.

[0045] Also in this embodiment, the portion 412e of an increased diameter which has substantially the same external diameter as the housing 420 is formed on a portion of the sheath 412 which is located outside the housing 420, and the seat area 426 is defined between the portion 412e of an increased diameter and the portion 412a of a reduced diameter which is located forwardly thereof, thus allowing a sufficient area to be secured on the seat area 426. Since the sheath 412 can be disposed as a press fit in the housing 420 by utilizing the seat area 426, it is a simple matter to dispose it as a press fit, and even a ceramic heater 2 which has been difficult to disposed as a press fit can be safely disposed as a press fit.

Claims

1. A glow plug for a diesel engine in which one end of a sheath carrying a heater is disposed as a press fit in an internal bore of a cylindrical housing to be secured therein;

the housing having an internal diameter in a region where the sheath is disposed as a press fit which is greater than the internal diameter of a opening in the housing through which the sheath projects.

2. A glow plug for a diesel engine according to Claim 1 in which the housing comprises a body in which the sheath is disposed as a press fit and secured therein, and a seat adapter mounted on the front end of the body and having a seat area which is to be disposed in abutment against the cylinder head.

3. A glow plug for a diesel engine according to Claim 1 or 2 in which the sheath is formed with a portion of a reduced diameter at its distal end and is formed with a portion of an increased diameter toward the rear end which is secured to the internal surface of the housing, the portion of a reduced diameter projecting through an opening in the housing.

4. A glow plug for a diesel engine in which one end of a sheath carrying a heater is disposed as a press fit in an internal bore of a cylindrical housing to be secured therein;

the sheath being formed with a portion of an increased diameter at a location forwardly of a portion thereof which is inserted into the housing and is also formed with a portion of a reduced diameter forwardly of the portion of an increased diameter, the front surface of the portion of an increased diameter serving as a seat area which is to be disposed in abutment against a cylinder head.

5. A method of manufacturing a glow plug for a diesel engine in which one end of a sheath carrying a heater is disposed as a press fit in an internal bore of a cylindrical housing to be secured therein;

comprising the steps of

inserting a sheath having a reduced diameter toward its front end and an increased diameter toward a rear end through a forward end of the cylindrical housing;

disposing the rear end of the sheath as a press fit in the housing and securing it to the internal surface of the housing;

and subjecting the front portion of the housing to a plastic deformation so as to extend along a juncture between the portion of a reduced diameter and the portion of an increased diameter of the sheath, thus increasing the area of a seat area located at the front end of the housing.

6. A method of manufacturing a glow plug for a diesel engine in which one end of a sheath carrying a heater is disposed as a press fit in an internal bore of a cylindrical housing to be secured therein;

comprising the steps of

forming the housing with a body in which the sheath is secured and a seat adapter which is disposed forwardly of the body;

forming an opening in the front end of the seat adapter with a diameter which is less than the internal diameter of the housing toward rear portion of the seat adapter;

providing the sheath an outer profile comprising a portion of a reduced diameter which substantially coincides with the diameter of the opening in the sheet adapter and a portion of an increased diameter which is located rearward of the portion of a reduced diameter;

and disposing the rear end of the sheath as a press fit in the housing through the seat adapter.

7. A method of manufacturing a glow plug for a diesel engine in which one end of a sheath carrying a heater is disposed as a press fit in an internal bore of a cylindrical housing to be secured therein;

comprising the steps of

forming a portion of an increased diameter on the sheath at a location forwardly of a portion thereof which is inserted into the housing;

forming a seat area which is to be disposed in abutment against the seat of a cylinder head on the front surface of the portion of an increased diameter;

and urging the seat area to dispose the rear end of the sheath as a press fit into the housing.

FIG. 1

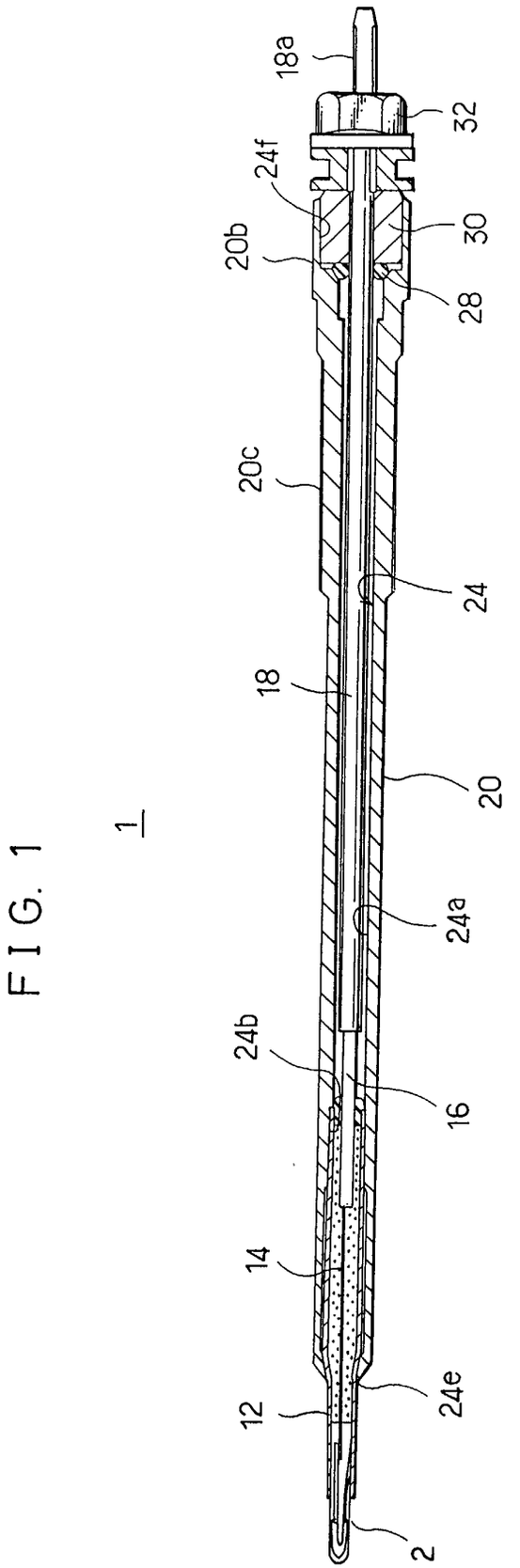


FIG. 2

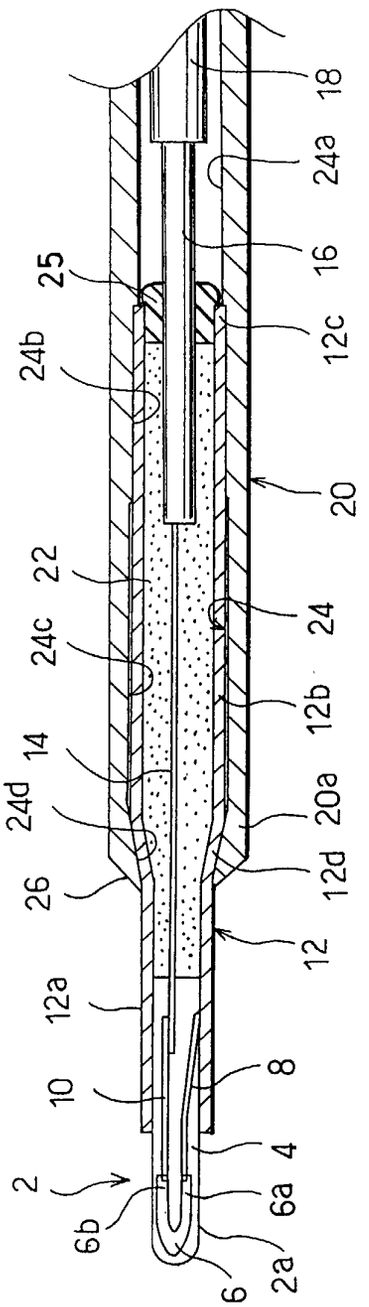

18
24a
16
25
12c
24b
20
22
24
24c
12b
14
20a
24d
12d
26
12
12a
8
10
4
2
6a
6b
2a
6

FIG. 3

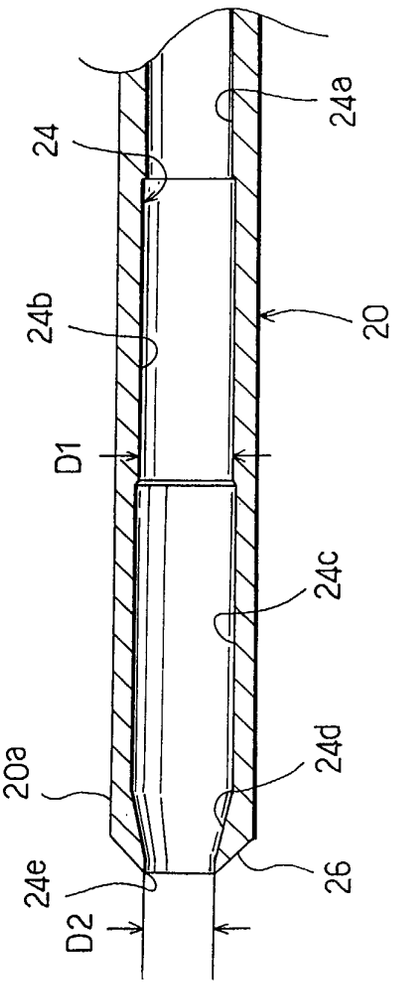

24a
24
24b
20
D1
24c
20a
24d
24e
26
D2

FIG. 4(a)

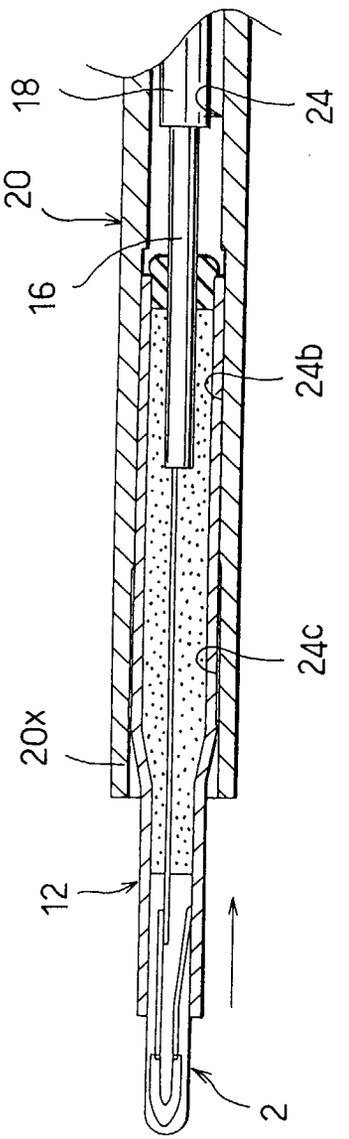


FIG. 4(b)

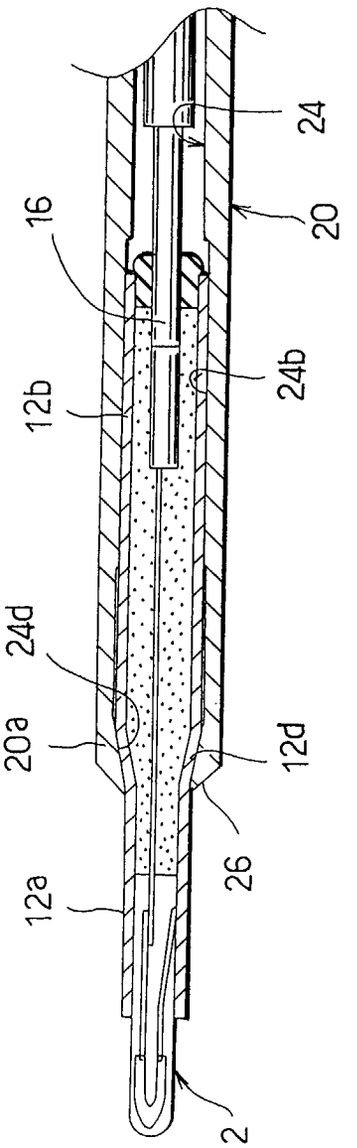
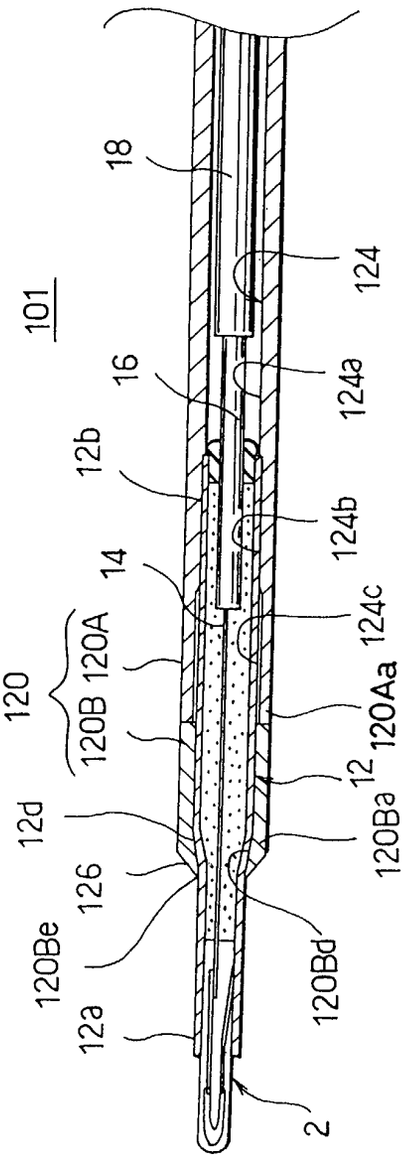


FIG. 5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124
16
124a
12b
124b
14
124c
120
120A
120B
120Aa
12
12d
120Ba
126
120Be
120Bd
12a
2

FIG. 6

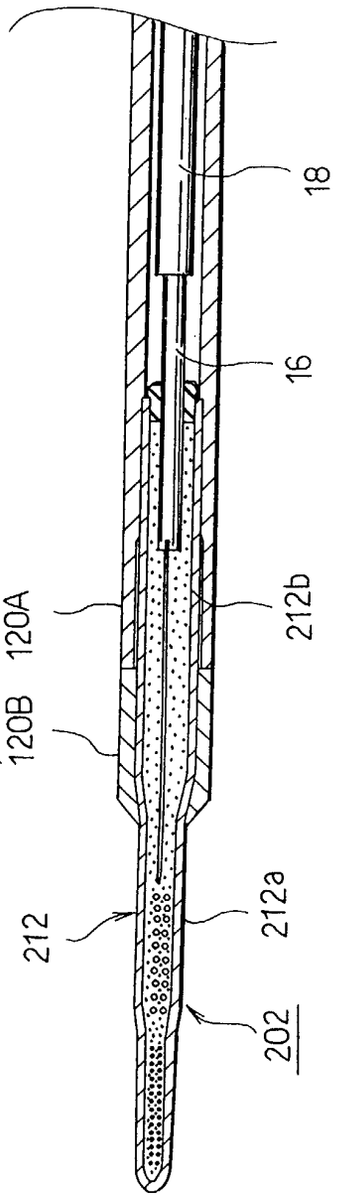
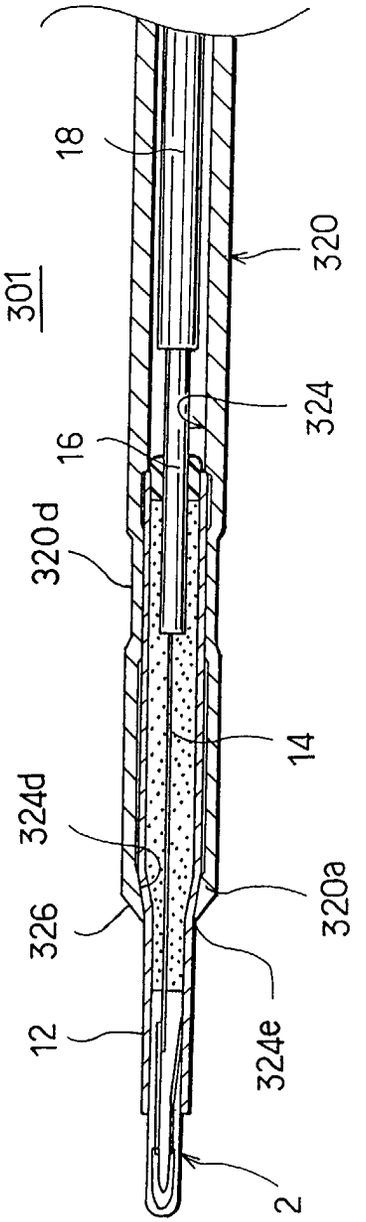

201
18
16
120
120A
212b
120B
212
212a
202

FIG. 7



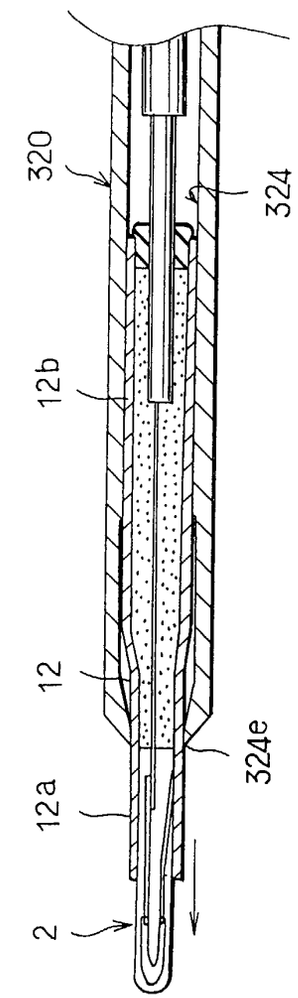


FIG. 8(a)

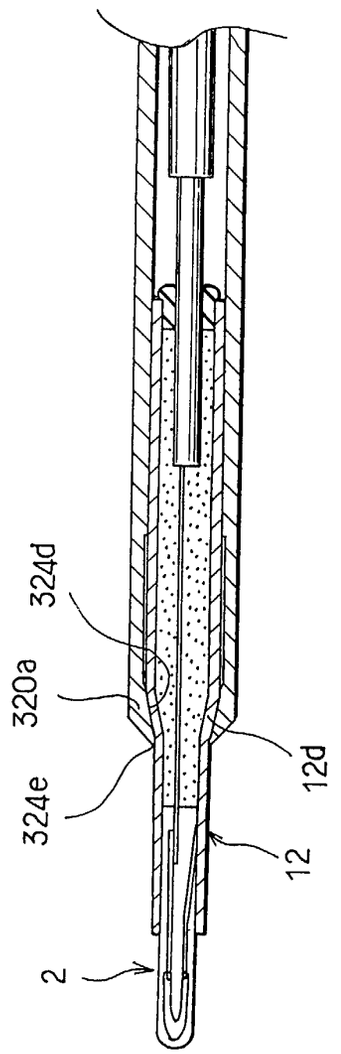


FIG. 8(b)

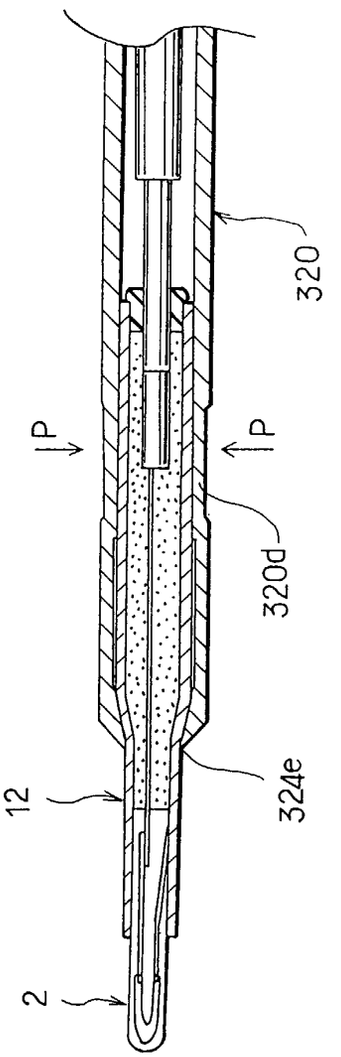


FIG. 8(c)

FIG. 9