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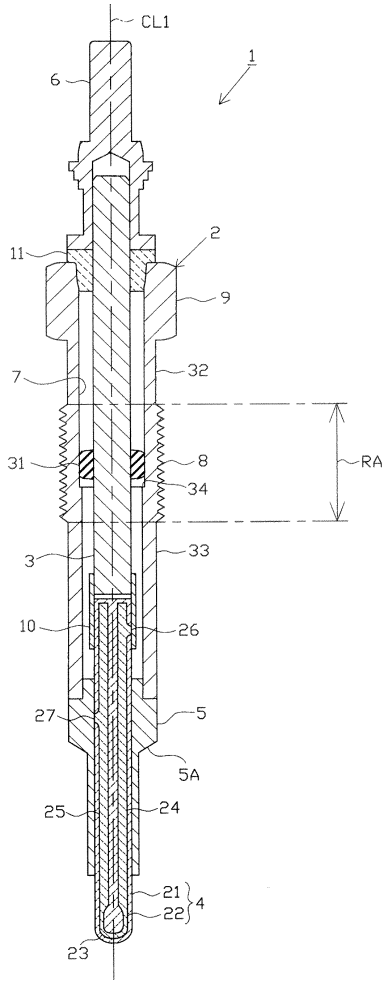
(54) Glow plug

(57) [Objective] To more reliably prevent a deterioration of a seal member due to heat.

[Means for Solution] A glow plug 1 includes a cylindrical housing 2, having an axial hole 7 extending in a direction of an axis CL1, which includes an external thread portion 8 for coming into threaded engagement with an internal thread portion FS provided on a mounting hole HO of an internal combustion engine EN; a ceramic heater 4 inserted in the axial hole 7 in a condition in which at least a leading end portion of the ceramic heater 4 protrudes from the leading end of the housing 2; and a center pole 3, having a bar shape extending in the direction of the axis CL1 and inserted into the axial hole 7, which forms an energizing path to the ceramic heater 4. An annular seal member 31 formed from an insulating material is disposed between the inner periphery of the housing 2 and the outer periphery of the center pole 3 within a range of formation of the external thread portion 8 along the axis CL1.

FIG. 2



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Description

[Technical Field]

[0001] The present invention relates to a glow plug used to, for example, preheat a diesel engine.

[Background Art]

[0002] A glow plug used to, for example, aid in starting a diesel engine includes a housing having an axial hole extending in an axial direction, a heater member which, being inserted in the axial hole, generates heat by being energized, and a rod-shaped center pole forming an energizing path to the heater member. A ceramic heater having a heater element formed from a conductive ceramic or a sheathed heater having a heater coil formed from a conductive metal is employed as the heater member. Also, in general, the heater member is press fitted into and fixed to the housing or the inner periphery of a cylindrical member joined to the housing. In addition, the housing includes in a rear end portion thereof a tool engagement portion for engaging a tool when mounting the glow plug in an internal combustion engine.

[0003] Furthermore, an annular seal member formed from a predetermined insulating material (for example, fluororubber or silicone rubber) is provided between the inner periphery of the housing and the outer periphery of the center pole on the inner side of the tool engagement portion (for example, refer to Patent Document 1). By providing the seal member, it is possible to suppress the infiltration of a liquid (for example, oil) into the axial hole. As a result of this, it is possible to achieve the maintenance of insulating properties between the axial hole and housing, and it is possible to prevent a liquid from being attached to a region of the heater member press fitted into and fixed to the housing or the like, and a short circuit from occurring due to the attached liquid being carbonized by heat generation of the heater member.

[Related Art Documents]

[Patent Documents]

[0004] [Patent Document 1] JP-A-2005-315474

[Summary of the Invention]

[Problems to be solved by the Invention]

[0005] Meanwhile, the glow plug is normally disposed on the intake side of an internal combustion engine in order to achieve a decrease in environmental temperature, but it may happen that it is not possible to secure a sufficient disposition space on the intake side, and in this kind of case, the glow plug is disposed on the exhaust side of the internal combustion engine. However, when the glow plug is disposed on the exhaust side of the internal combustion engine, the tool engagement portion and the vicinity thereof, of the housing, can become a high temperature of the order to 250°C due to the effect of radiation heat or heat transfer from an exhaust manifold, a turbocharger, or the like. Because of this, there is fear that deterioration due to heat (a decrease in elasticity due to an occurrence of a compression set) occurs in the seal member disposed on the inner side of the tool engagement portion.

[0006] Therefore, it is conceivable that the seal member is formed from a special material superior in heat resistance (for example, Kalrez (registered trademark) byDuPont) in order to prevent a deterioration of the seal member due to heat. However, even though this kind of material superior in heat resistance is applied to the seal member, the compression set increases when the seal member is used in an environment wherein a seal member, such as of a glow plug, is exposed to a high temperature atmosphere for a long time, and there is fear that it is not possible to secure airtightness.

[0007] The invention, having been contrived bearing in mind the heretofore described circumstances, has an object of providing a glow plug such that it is possible to more reliably prevent a deterioration of a seal member due to heat.

[Means for Solving the Problems]

[0008] Hereafter, an itemized description will be given of each configuration suitable for achieving the object. Working effects specific to the corresponding configurations are quoted as necessary.

[0009] Configuration 1. In this configuration, a glow plug is characterized by including a cylindrical housing, having an axial hole extending in a direction of an axis, which includes an external thread portion for coming into threaded engagement with an internal thread portion provided on a mounting hole of an internal combustion engine, and a tool engagement portion, positioned closer to a rear end side than the external thread portion, with which a tool is engaged when mounting the glow plug in the internal combustion engine; a heater member inserted in the axial hole in a condition in which at least a leading end portion of the heater member protrudes from the leading end of the housing; and a center pole, having a bar shape extending in the direction of the axis and inserted into the axial hole, which forms an energizing path to the heater member, wherein an annular seal member formed from an insulating material is disposed between the inner periphery of the housing and the outer periphery of the center pole within a range of formation of the external thread portion along the axis.

[0010] According to the configuration 1, the seal member is configured so as to be disposed between the housing and center pole within the range of formation of the external thread portion along the axis. Consequently, the seal member is provided in a position spaced apart from the tool engagement portion which can become a high

temperature, and it is possible to keep the temperature of the seal member sufficiently low.

[0011] Also, as the internal combustion engine is generally cooled by cooling water or the like, the external thread portion in contact with the internal combustion engine (internal thread portion) and the vicinity thereof, of the housing, become a sufficiently low temperature (for example, 100°C or less) even in an environment such that the tool engagement portion becomes an extremely high temperature. Because of this, it is possible to keep even lower the temperature of the seal member positioned on the inner side of the external thread portion.

[0012] As above, according to the configuration 1, by the heretofore described working effects acting synergistically, it is possible to more reliably prevent a deterioration of the seal member due to heat.

[0013] Configuration 2. In this configuration, the glow plug according to the configuration 1 is **characterized in that** in a condition in which the external thread portion is threadedly engaged with the internal thread portion, the seal member is positioned within a range of formation of the internal thread portion along the axis.

[0014] According to the configuration 2, a configuration is adopted such that the seal member is positioned on the inner side of the internal thread portion in a condition in which the external thread portion is threadedly engaged with the internal thread portion provided on the internal combustion engine (that is, in a condition in which the glow plug is mounted in the internal combustion engine). Consequently, it becomes more difficult for the heat of the tool engagement portion to transfer to the seal member, and a region of the housing, whose outer periphery is in contact with the internal thread portion (internal combustion engine) and which thus becomes a lower temperature, comes into contact with the seal member. Because of this, it is possible to keep the temperature of the seal member still lower, and it is possible to more effectively prevent a deterioration of the seal member due to heat.

[0015] Configuration 3. In this configuration, the glow plug according to the configuration 1 or 2 is **characterized in that** a shoulder portion, positioned closer to a leading end side in the direction of the axis than the seal member, which protrudes inward in a radial direction is provided on the inner periphery of the housing within the range of formation of the external thread portion along the axis.

[0016] According to the configuration 3, it is possible to restrict a movement of the seal member toward the leading end side beyond the shoulder portion. Consequently, it is possible to more reliably fulfill the original function of the seal member securing airtightness.

[0017] Configuration 4. In this configuration, the glow plug according to the configuration 3 is **characterized in that** the housing includes a large diameter portion with the inner periphery of which the seal member comes into contact; and a small diameter portion, positioned closer to the leading end side in the direction of the axis than the large diameter portion, whose inner diameter is smaller than the inner diameter of the large diameter portion, wherein the shoulder portion is configured of a region linking the leading end of the large diameter portion and the rear end of the small diameter portion, and the shoulder portion is provided closer to the rear end side in the direction of the axis by a distance three or more times the thread pitch of the external thread portion away from the leading end of the complete thread portion of the external thread portion.

[0018] The "complete thread portion" refers to a thread portion whose crest and bottom both have a complete angle shape.

[0019] In a condition in which the glow plug is mounted in the internal combustion engine, an axial force is applied to a region of the housing positioned closer to the leading end side than the external thread portion, and to a region of the external thread portion positioned in the vicinity of the previously described region. Because of this, it is desirable that the region of the housing to which the axial force can be applied has a superior mechanical strength in order to prevent a deformation due to the axial force.

[0020] In light of this point, according to the configuration 4, the shoulder portion is provided closer to the rear end side in the direction of the axis by a distance three or more times the thread pitch of the external thread portion away from the leading end of the complete thread portion of the external thread portion. That is, the large diameter portion, larger in inner diameter than the small diameter portion, which can be comparatively thin-walled is provided in a position away from the region to which the axial force can be applied, and the small diameter portion, smaller in inner diameter than the large diameter portion, which can be comparatively thick-walled is provided in a position to which the axial force can be applied. Consequently, it is possible to sufficiently secure the mechanical strength of the region of the housing to which the axial force can be applied. As a result of this, it is possible to more reliably prevent a deformation of the housing.

[0021] Configuration 5. In this configuration, the glow plug according to any one of the configurations 1 to 4 is **characterized in that** a protruding portion, positioned closer to the leading end side in the direction of the axis than the seal member, which protrudes outward in the radial direction is provided on the outer periphery of the center pole within the range of formation of the external thread portion along the axis.

[0022] According to the configuration 5, it is possible to restrict a movement of the seal member toward the leading end side beyond the protruding portion. Consequently, it is possible to more reliably fulfill the function of securing airtightness with the seal member.

[0023] Configuration 6. In this configuration, the glow plug according to any one of the configurations 1 to 5 is **characterized in that** the seal member is formed from an insulating elastic material, and on a section of the seal member including a central axis of the seal member be-

fore the seal member is disposed between the inner periphery of the housing and the outer periphery of the center pole, an outline on the section of the seal member has a first outline, positioned on the outer peripheral side, which has a curved shape expanding outward in the radial direction; and a second outline, positioned on the inner peripheral side, which has a curved shape expanding inward in the radial direction in a condition in which the radius curvature of the second outline is larger than the radius curvature of the first outline, or a linear shape along the central axis of the seal member.

[0024] According to the configuration 6, a region of the seal member configuring the second outline, by supporting the whole of the seal member, functions as a center core which prevents the seal member from being distorted or curled, when pushing the seal member between the housing and center pole. Consequently, it is possible to more reliably prevent a distortion or wrinkle from occurring on an inner peripheral surface of the seal member coming into contact with the center pole, and it is possible to more reliably bring the inner peripheral surface of the seal member into contact with the center pole. As a result of this, it is possible to further enhance the sealing properties between the seal member and center pole.

[0025] Also, the seal member is compressed in the radial direction when pushing the seal member between the housing and center pole, but according to the configuration 6, the first outline is formed in a curved shape expanding outward in the radial direction, meaning that it is possible to smoothly carry out a change in shape of the seal member by compression.

[0026] Furthermore, by forming the first outline in a curved shape, the seal member changes in shape so that a portion large in thickness in the radial direction moves to a portion small in thickness when the seal member changes in shape. Consequently, it is difficult for a deformed region locally high in internal stress to occur in the seal member disposed between the housing and center pole. As a result of this, it is possible to more reliably prevent damage to (breakage of) the seal member resulting from internal stress when the glow plug receives a vibration or the like from the exterior.

[Brief Description of the Drawings]

[0027]

[Fig. 1] Fig. 1 is a front view showing a configuration of a glow plug.

[Fig. 2] Fig. 2 is a sectional view showing a configuration of the glow plug.

[Fig. 3] Fig. 3 is a sectional view of a seal member before the seal member is disposed between a housing and a center pole.

[Fig. 4] Fig. 4 is a sectional view showing another example of the seal member before the seal member is disposed between the housing and center pole.

[Fig. 5] Fig. 5 is an enlarged sectional view of the housing and the like, showing configurations of a shoulder portion and the like.

[Fig. 6] Fig. 6 is an enlarged sectional view showing the glow plug in a condition mounted in an internal combustion engine.

[Fig. 7] Fig. 7 is a sectional view showing a protruding portion provided on the center pole, and the like, in another embodiment.

[Modes for Carrying Out the Invention]

[0028] Hereafter, a description will be given, referring to the drawings, of one embodiment. Fig. 1 is a front view of a glow plug 1, and Fig. 2 is a sectional view of the glow plug 1. In Figs. 1, 2, and the like, a description will be given with the lower side in the drawings as a leading end side of the glow plug 1 and the upper side as a rear end side.

[0029] As shown in Figs. 1 and 2, the glow plug 1 includes a housing 2, a center pole 3, a ceramic heater 4 as a heater member, a metal pipe 5, a terminal pin 6, and the like.

[0030] The housing 2 has an axial hole 7, formed in a cylindrical shape from a predetermined metal material (for example, an iron-based material such as S45C), which extends in a direction of an axis CL1. Furthermore, an external thread portion 8 for mounting the glow plug 1 in an internal thread portion provided in a mounting hole of an internal combustion engine is formed on the outer periphery of a central portion of the housing 2 in the direction of the axis CL1. Besides, a tool engagement portion 9 of hexagon cross-section is formed on the outer periphery of a rear end portion of the housing 2, and an arrangement is such that a mounting tool is engaged with the tool engagement portion 9 when the external thread portion 8 is brought into threaded engagement with the internal thread portion. In the embodiment, a configuration is adopted such that a wall thickness of the housing 2 in the bottom portion of the external thread portion 8 is equal to or less than a predetermined value (for example, 1.7mm).

[0031] Also, the metallic center pole 3 of a round bar shape is housed in the axial hole 7 of the housing 2. The center pole 3 has a solid core form and, in the embodiment, is configured so as to have a constant outer diameter along the axis CL1. Also, a leading end portion of the center pole 3 is joined (for example, welded) to a rear end portion of a cylindrical connection member 10 formed from a conductive metal material (for example, an iron-based material such as SUS), and a rear end portion of the ceramic heater 4 is press fitted in a leading end portion of the connection member 10. By so doing, the center pole 3 and the ceramic heater 4 are mechanically and electrically connected via the connection member 10.

[0032] Furthermore, the metallic terminal pin 6 is fixed by crimping on a rear end portion of the center pole 3, and an insulating bush 11 formed from an insulating material is provided between a leading end portion of the

terminal pin 6 and a rear end portion of the housing 2 in order to prevent direct conduction (short circuit) between the two.

[0033] Besides, the metal pipe 5 is formed in a cylindrical shape from a predetermined metal material, and joined to the leading end portion of the housing 2. Also, the metal pipe 5 holds an intermediate portion of the ceramic heater 4 in the direction of the axis CL1, and a leading end portion of the ceramic heater 4 is in a condition exposed from the leading end of the metal pipe 5. Furthermore, the metal pipe 5 includes on the outer periphery thereof a tapered press contact portion 5A whose outer diameter decreases gradually toward the leading end side in the direction of the axis CL1. An arrangement is such that when the glow plug 1 is mounted in an internal combustion engine, airtightness in a combustion chamber is secured by the press contact portion 5A being pressed against a tapered sheet provided in the internal combustion engine. The metal pipe 5 is joined to the housing 2 by performing a laser welding along the outer edge of a surface of contact between the metal pipe 5 and housing 2 in a condition in which a rear end portion of the metal pipe 5 is inserted in the axial hole 7.

[0034] The ceramic heater 4 includes a round bar-shaped substrate 21 extending in the direction of the axis CL1 and an elongated U-shaped heater element 22 buried inside the substrate 21. The substrate 21 is configured from an insulating ceramic (for example, silicon nitride or alumina), and the heater element 22 is configured from a silicon nitride-based conductive ceramic containing a conductive material (for example, carbide or silicide of molybdenum or tungsten).

[0035] Also, the heater element 22 includes a heater portion 23 disposed in a leading end portion of the ceramic heater 4 and a pair of bar-shaped lead portions 24 and 25 extending from the end portion of the heater portion 23 toward the rear end side. The heater portion 23 is a region which functions as a so-called heat resistor and has a U-shape so as to follow the curved surface of a leading end portion of the ceramic heater 4 formed in a curved surface shape.

[0036] Also, the lead portions 24 and 25 are extended substantially parallel to each other toward the rear end side of the ceramic heater 4. Further, an electrode lead-out portion 26 is provided in a position nearer the rear end of one lead portion 24 so as to protrude in an outer peripheral direction, and the electrode lead-out portion 26 is exposed from the outer peripheral surface of the ceramic heater 4. In the same way, an electrode lead-out portion 27 is also provided in a position nearer the rear end of the other lead portion 25 so as to protrude in the outer peripheral direction, and the electrode lead-out portion 27 is exposed from the outer peripheral surface of the ceramic heater 4. The electrode lead-out portion 26 of the one lead portion 24 is positioned closer to the rear end side in the direction of the axis CL1 than the electrode lead-out portion 27 of the other lead portion 25.

[0037] In addition, the exposed portion of the electrode lead-out portion 26 is in contact with the inner peripheral surface of the connection member 10, thus achieving an electrical continuity between the center pole 3 connected to the connection member 10 and the lead portion 24. Also, the exposed portion of the electrode lead-out portion 27 is in contact with the inner peripheral surface of the metal pipe 5, thus achieving an electrical continuity between the housing 2 joined to the metal pipe 5 and the lead portion 25. That is, in the embodiment, an arrangement is such that the center pole 3 and housing 2 function as an anode and cathode for energizing the heater portion 23 of the ceramic heater 4.

[0038] Furthermore, in order to secure the airtightness in the axial hole 7, an annular seal member 31 formed from an insulating elastic member (for example, fluororubber or silicone rubber) is provided between the housing 2 and center pole 3. In the embodiment, the seal member 31 is provided between the inner periphery of the housing 2 and the outer periphery of the center pole 3 within a range of formation RA of the external thread portion 8 along the axis CL1. The seal member 31 is provided in the axial hole 7 by being pushed between the housing 2 and center pole 3 after the housing 2, center pole 3, and the like have been mounted.

[0039] Also, in the embodiment, as shown in Fig. 3, on a section of the seal member 31 including a central axis CL2 of the seal member 31 passing through the inner periphery of the seal member 31 before the seal member 31 is disposed between the inner periphery of the housing 2 and the outer periphery of the center pole 3, a first outline OL1, of an outline OL on the section of the seal member 31, positioned on an outer peripheral side (that is, coming into contact with the inner periphery of the housing 2) has a curved shape expanding outward in a radial direction. Meanwhile, a second outline OL2, of the outline OL on the section, positioned on an inner peripheral side (that is, coming into contact with the outer periphery of the center pole 3) has a linear shape along the central axis CL2.

[0040] A configuration may be adopted such that the second outline OL2 has a curved shape expanding inward in the radial direction in a condition in which a curvature radius R2 of the second outline OL2 is larger than a curvature radius R1 of the first outline OL1, on the section, as shown in Fig. 4.

[0041] In addition, as shown in Fig. 5, the housing 2 includes a large diameter portion 32, with the inner periphery of which the seal member 31 comes into contact, and a small diameter portion 33, positioned closer to the leading end side in the direction of the axis CL1 than the large diameter portion 32, the inner diameter of which is smaller than the inner diameter of the large diameter portion 32. In the embodiment, the outer diameter of the large diameter portion 32 and the outer diameter of the small diameter portion 33 are made substantially equal, and the wall thickness of the small diameter portion 33 is larger than the wall thickness of the large diameter portion 32.

[0042] Also, a shoulder portion 34, positioned closer to the leading end side in the direction of the axis CL1 than the seal member 31, which protrudes inward in the radial direction is formed at the junction of the leading end of the large diameter portion 32 and the rear end of the small diameter portion 33. The shoulder portion 34 is provided within the range of formation RA of the external thread portion 8 along the axis CL1 and, in the embodiment, is provided closer to the rear end side in the direction of the axis CL1 by a distance three or more times the thread pitch of the external thread portion 8 away from the leading end of the complete thread portion of the external thread portion 8. That is, a configuration is adopted such that in a condition in which the glow plug 1 is mounted in an internal combustion engine, the comparatively thin-walled large diameter portion 32 is positioned closer to the rear end side than a position to which is applied an axial force in the direction of the axis CL1, and the comparatively thick-walled small diameter portion 33 superior in strength is positioned in the position to which the axial force is applied.

[0043] Furthermore, in the embodiment, as shown in Fig. 6, in a condition in which the external thread portion 8 is threadedly engaged with an internal thread portion FS of a mounting hole HO provided in an engine head EH of an internal combustion engine EN, a position in which to dispose the seal member 31 is set so that the seal member 31 is positioned within a range of formation of the internal thread portion FS along the axis CL1. Also, the engine head EH, being cooled by cooling water or the like, is configured in such a way that the external thread portion 8 in contact with the engine head EH and the vicinity thereof, of the housing 2, become a sufficiently low temperature (for example, 100°C or less) even when the internal combustion engine EN is in operation.

[0044] In the embodiment, the glow plug 1 is disposed on the exhaust side of the internal combustion engine EN. Because of this, the tool engagement portion 9 protruding from the engine head EH and the vicinity thereof, of the housing 2, can become a high temperature of the order of 250°C due to the effect of radiation heat or heat transfer from an exhaust manifold, a turbocharger, or the like.

[0045] As heretofore described, according to the embodiment, the seal member 31 is disposed between the housing 2 and center pole 3 within the range of formation of the external thread portion 8 along the axis CL1. Consequently, the seal member 31 is provided in a position spaced apart from the tool engagement portion 9 which can become a high temperature, and it is possible to keep the temperature of the seal member 31 sufficiently low.

[0046] Also, as the internal combustion engine EN is cooled by cooling water or the like, the external thread portion 8 in contact with the internal combustion engine EN (internal thread portion FS) and the vicinity thereof, of the housing 2, become a sufficiently low temperature (for example, 100°C or less) even in an environment such that the tool engagement portion 9 becomes an extremely high temperature. Because of this, it is possible to keep even lower the temperature of the seal member 31 positioned on the inner side of the external thread portion 8.

[0047] As above, according to the embodiment, by the heretofore described working effects acting synergistically, it is possible to more reliably prevent a deterioration of the seal member 31 due to heat.

[0048] Furthermore, a configuration is adopted such that the seal member 31 is positioned on the inner side of the internal thread portion 8 in a condition in which the external thread portion 8 is threadedly engaged with the internal thread portion FS (that is, in a condition in which the glow plug 1 is mounted in the internal combustion engine EN). Consequently, it becomes more difficult for the heat of the tool engagement portion 9 to transfer to the seal member 31, and a region of the housing 2, whose outer periphery is in contact with the internal thread portion FS (internal combustion engine EN) and which thus becomes a lower temperature, comes into contact with the seal member 31. Because of this, it is possible to keep the temperature of the seal member 31 still lower, and it is possible to more effectively prevent a deterioration of the seal member 31 due to heat.

[0049] In addition, it is possible to restrict a movement of the seal member 31 toward the leading end side beyond the shoulder portion 34 by virtue of the shoulder portion 34 provided on the inner periphery of the housing 2. Consequently, it is possible to more reliably fulfill the original function of the seal member 31 securing airtightness.

[0050] Besides, in the embodiment, the comparatively thin-walled large diameter portion 32 larger in inner diameter than the small diameter portion 33 is provided in a position away from a region to which the axial force can be applied, and the comparatively thick-walled small diameter portion 33 smaller in inner diameter than the large diameter portion 32 is provided in the position to which the axial force can be applied. Consequently, it is possible to sufficiently secure the mechanical strength of the region of the housing 2 to which the axial force can be applied. As a result of this, it is possible to more reliably prevent a deformation of the housing 2.

[0051] Also, in the embodiment, a configuration is adopted such that the second outline OL2 of the seal member 31 has a linear shape or a gently curved shape. Consequently, a region of the seal member 31 configuring the second outline OL2, by supporting the whole of the seal member 31, functions as a center core which prevents the seal member 31 from being distorted or curled, when pushing the seal member 31 between the housing 2 and center pole 3. Consequently, it is possible to more reliably prevent a distortion or wrinkle from occurring on an inner peripheral surface of the seal member 31 coming into contact with the center pole 3, and it is possible to more reliably bring the inner peripheral surface of the seal member 31 into contact with the center pole 3. As a result of this, it is possible to further enhance the sealing properties between the seal member 31 and

center pole 3.

[0052] Furthermore, the first outline OL1 is formed in a curved shape expanding outward in the radial direction. Because of this, it is possible to smoothly carry out a change in shape of the seal member 31 by compression. Also, the seal member 31 changes in shape so that a portion large in thickness in the radial direction moves to a portion small in thickness when the seal member 31 changes in shape. Consequently, it is difficult for a deformed region locally high in internal stress to occur in the seal member 31 disposed between the housing 2 and center pole 3. As a result of this, it is possible to more reliably prevent damage to (breakage of) the seal member 31 resulting from internal stress when the glow plug 1 receives a vibration or the like from the exterior.

[0053] Also, in the embodiment, as the wall thickness of the housing 2 in the bottom portion of the external thread portion 8 is made equal to or less than the predetermined value, it is possible to increase an amount of heat transferring from the external thread portion 8 to the internal combustion engine EN as compared with an amount of heat transferring to the external thread portion 8, and the external thread portion 8 and the vicinity thereof become a sufficiently low temperature. Consequently, it is possible to still more reliably keep the temperature of the seal member 31 low, and it is possible to effectively prevent a deterioration of the seal member 31 due to heat. Also, as it is possible to achieve a reduction in weight of the glow plug 1 by making the wall thickness of the housing 2 equal to or less than the predetermined value, it is possible to achieve an improvement in fuel efficiency and a reduction in material cost.

[0054] The invention, not being limited to the contents of the description of the heretofore described embodiment, may be implemented in, for example, the following ways. As a matter of course, other applications and modification examples not illustrated hereafter are naturally possible.

[0055]

(a) In the heretofore described embodiment, the seal member 31 is disposed closer to the rear end side in the direction of the axis CL1 by a distance three or more times the thread pitch of the external thread portion 8 away from the leading end of the external thread portion 8 but, a position in which to dispose the seal member 31 not being limited to this, it is sufficient that the seal member 31 is disposed within the range of formation RA of the external thread portion, 8 along the axis CL1.

[0056]

(b) The sectional shape of the seal member 31 before the seal member 31 is disposed between the inner periphery of the housing 2 and the outer periphery of the center pole 3 is not particularly limited. Consequently, for example, a configuration may be adopted such that the sectional shape of the seal member 31 is circular or rectangular.

[0057]

(c) In the heretofore described embodiment, the shoulder portion 34 is formed on the inner periphery of the housing 2 in order to restrict a movement of the seal member 31 toward the leading end side. As opposed to this, a protruding portion 35, positioned closer to the leading end side in the direction of the axis CL1 than the seal member 31, which protrudes outward in the radial direction may be provided on the outer periphery of the center pole 3 within the range of formation of the external thread portion 8 along the axis CL1, as shown in Fig. 7. In this case too, it is possible to restrict a movement of the seal member 31 toward the leading end side, in the same way as when the shoulder portion 34 is provided. Also, in this case, the protruding portion 35 may be provided, closer to the leading end side in the direction of the axis CL1 than the rear end side position, at a distance three times the thread pitch of the external thread portion 8 away from the leading end of the external thread portion 8. Both the shoulder portion 34 and protruding portion 35 may be provided, thereby further enhancing the effect of movement restriction of the seal member 31.

[0058]

(d) In the heretofore described embodiment, the technical idea of the invention is applied to the glow plug 1 (a so-called ceramic glow plug) having the ceramic heater 4 acting as a heater member. However, a glow plug to which the technical idea of the invention can be applied is not limited to this. Consequently, the technical idea of the invention may be applied to, for example, a glow plug (a so-called metal glow plug) including as a heater member a sheathed heater configured having a heater coil formed from a conductive metal.

[0059]

(e) In the heretofore described embodiment, the glow plug 1 is disposed on the exhaust side of the internal combustion engine EN, but the glow plug 1 may be disposed on the intake side of the internal combustion engine EN. That is, a position in the internal combustion engine EN in which to dispose the glow plug 1 is not particularly limited.

[0060]

(f) In the heretofore described embodiment, the center pole 3 is configured so as to have an outer diameter constant along the axis CL1, but a taper wherein

the outer diameter of the center pole 3 is gradually reduced toward the leading end side may be provided on the leading end side of the center pole 3. In this case, it is possible to achieve, for example, a relaxation of stress transferring from the center pole 3 to the ceramic heater 4. It is preferable that the taper is provided closer to the leading end side than the shoulder portion 34 and protruding portion 35.

[0061]

(g) In the heretofore described embodiment, the center pole 3 and the ceramic heater 4 are electrically connected via the connection member 10, but the center pole 3 and the ceramic heater 4 may be electrically connected by a predetermined lead wire or the like.

[0062]

(h) The shape of the ceramic heater 4, not being particularly limited, may be, for example, elliptical in section, rectangular in section, or polygonal in section. Also, a so-called plate-like heater wherein a heater element is sandwiched between a plurality of substrates formed plate-like may be used as a ceramic heater.

[Description of Reference Numerals and Signs]

[0063] 1 ··· Glow plug, 2 ··· Housing, 3 ··· Center pole, 4 ··· Ceramic heater (heater member), 7 ··· Axial hole, 8 ··· External thread portion, 9 ··· Tool engagement portion, 31 ··· Seal member, 32 ··· Large diameter portion, 33 ··· Small diameter portion, 34 ··· Shoulder portion, 35 ··· Protruding portion, CL1 ··· Axis, CL2 ··· Central axis (of seal member), EN ··· Internal combustion engine, FS ··· Internal thread portion, HO ··· Mounting hole, OL ··· Outline, OL1 ··· First outline, OL2 ··· Second outline.

Claims

1. A glow plug (1), **characterized by** comprising:

   a cylindrical housing (2), having an axial hole (7) extending in a direction of an axis (CL1), which includes an external thread portion (8) for coming into threaded engagement with an internal thread portion (FS) provided on a mounting hole (HO) of an internal combustion engine (EN), and a tool engagement portion (9), positioned closer to a rear end side than the external thread portion (8), with which a tool is engaged when mounting the glow plug (1) in the internal combustion engine (EN);
   a heater member (4) inserted in the axial hole (7) in a condition in which at least a leading end portion of the heater member (4) protrudes from the leading end of the housing (2); and
   a center pole (3), having a bar shape extending in the direction of the axis (CL1) and inserted into the axial hole (7), which forms an energizing path to the heater member (4), wherein
   an annular seal member (31) formed from an insulating material is disposed between the inner periphery of the housing (2) and the outer periphery of the center pole (3) within a range of formation of the external thread portion (8) along the axis (CL1).

2. The glow plug (1) according to claim 1, **characterized in that**
   in a condition in which the external thread portion (8) is threadedly engaged with the internal thread portion (FS), the seal member (31) is positioned within a range of formation of the internal thread portion (FS) along the axis (CL1).

3. The glow plug (1) according to claim 1 or 2, **characterized in that**
   a shoulder portion (34), positioned closer to a leading end side in the direction of the axis (CL1) than the seal member (31), which protrudes inward in a radial direction is provided on the inner periphery of the housing (2) within the range of formation of the external thread portion (8) along the axis (CL1).

4. The glow plug (1) according to claim 3, **characterized in that**
   the housing (2) includes:

   a large diameter portion (32) with the inner periphery of which the seal member (31) comes into contact; and
   a small diameter portion (33), positioned closer to the leading end side in the direction of the axis (CL1) than the large diameter portion (32), whose inner diameter is smaller than the inner diameter of the large diameter portion (32), wherein
   the shoulder portion (34) is configured of a region linking the leading end of the large diameter portion (32) and the rear end of the small diameter portion (33), and
   the shoulder portion (34) is provided closer to the rear end side in the direction of the axis (CL1) by a distance three or more times the thread pitch of the external thread portion (8) away from the leading end of the complete thread portion of the external thread portion (8).

5. The glow plug (1) according to any one of claims 1 to 4, **characterized in that**
   a protruding portion (35), positioned closer to the leading end side in the direction of the axis (CL1)

than the seal member (31), which protrudes outward in the radial direction is provided on the outer periphery of the center pole (3) within the range of formation of the external thread portion (8) along the axis (CL1).

6. The glow plug (1) according to any one of claims 1 to 5, **characterized in that**
the seal member (31) is formed from an insulating elastic material, and
on a section of the seal member (31) including a central axis (CL2) of the seal member (31) before the seal member (31) is disposed between the inner periphery of the housing (2) and the outer periphery of the center pole (3),
an outline (OL) on the section of the seal member (31) has:

a first outline (OL1), positioned on the outer peripheral side, which has a curved shape expanding outward in the radial direction; and
a second outline (OL2), positioned on the inner peripheral side, which has a curved shape expanding inward in the radial direction in a condition in which the radius curvature of the second outline (OL2) is larger than the radius curvature of the first outline (OL1), or a linear shape along the central axis (CL2) of the seal member (31).

FIG. 1

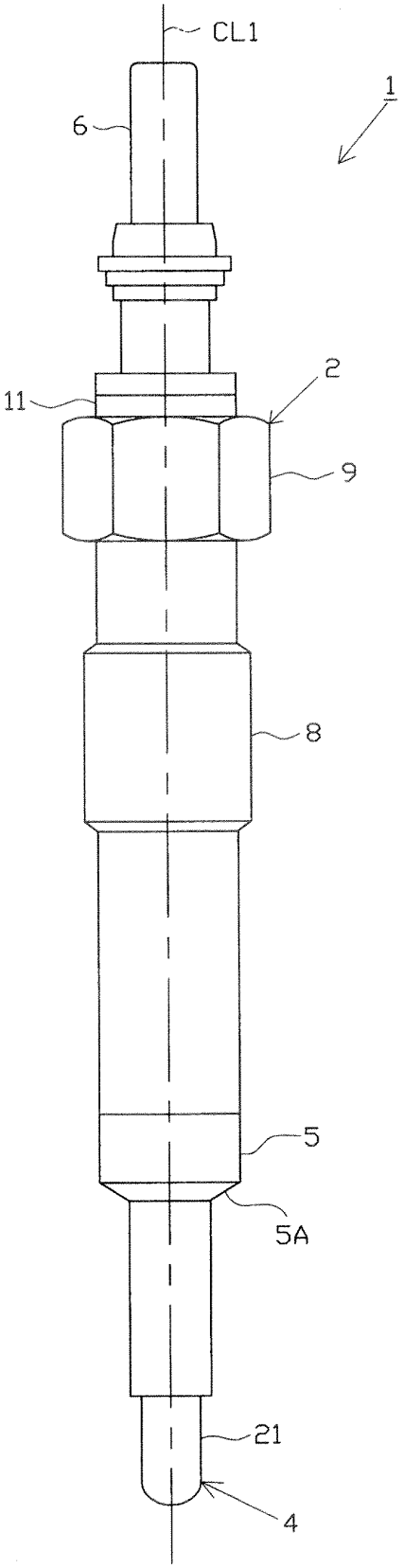


FIG. 2

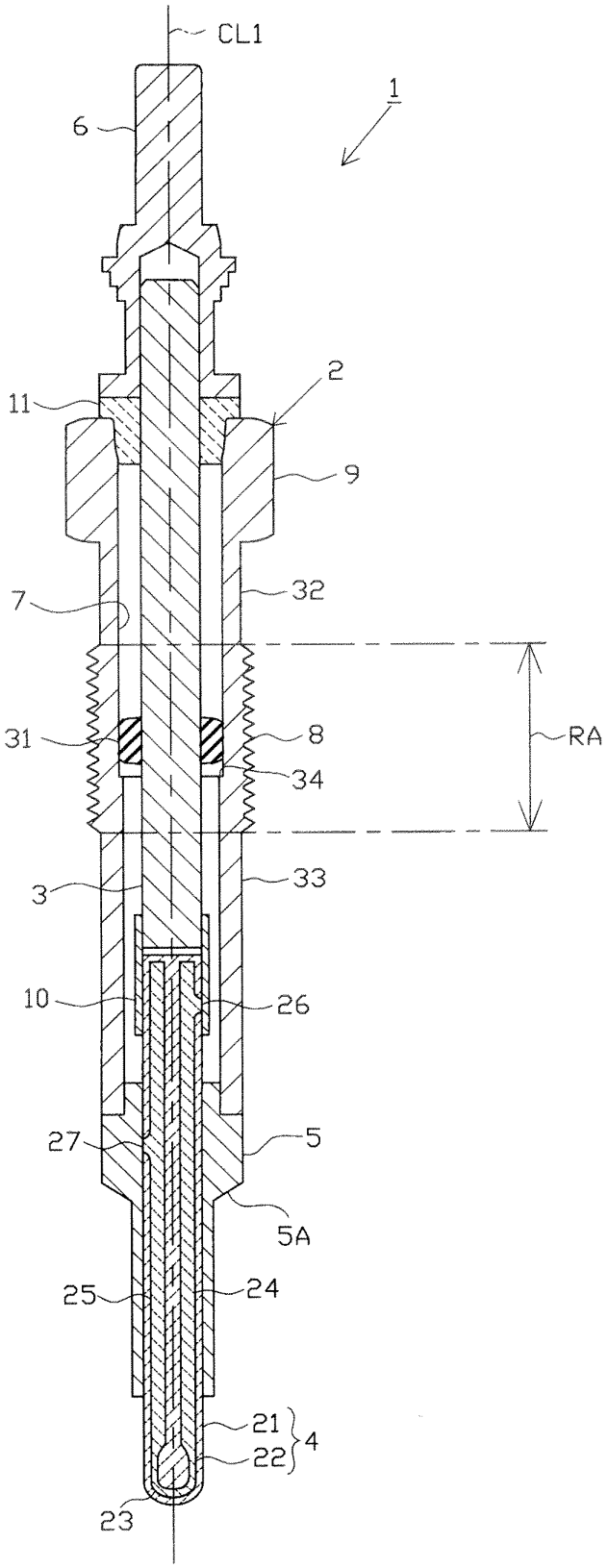


FIG. 3

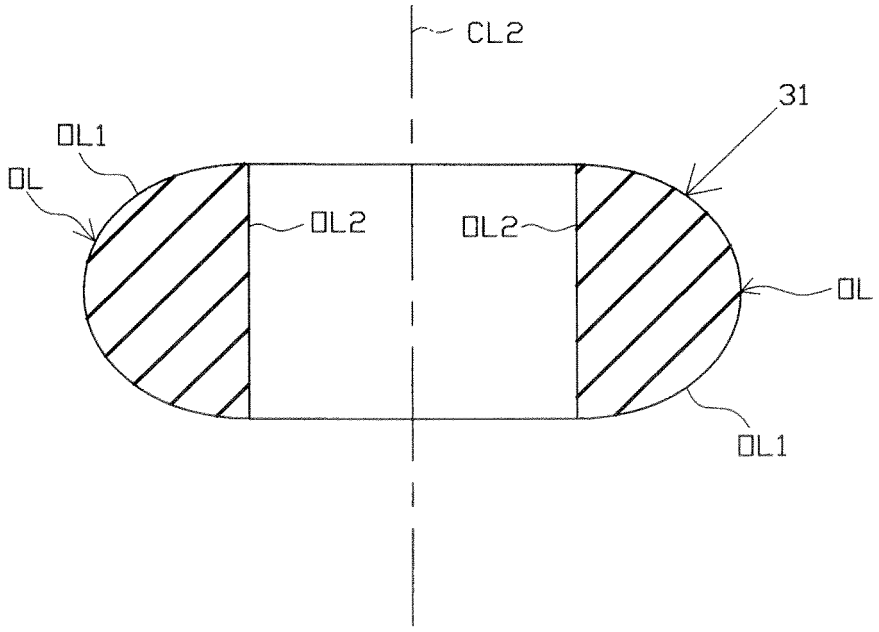


FIG. 4

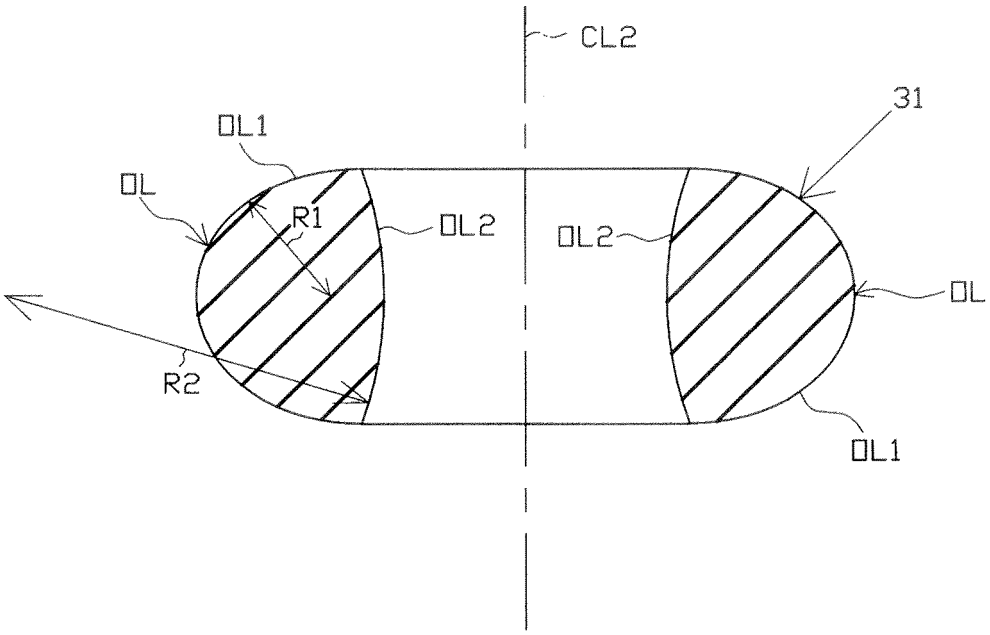


FIG. 5

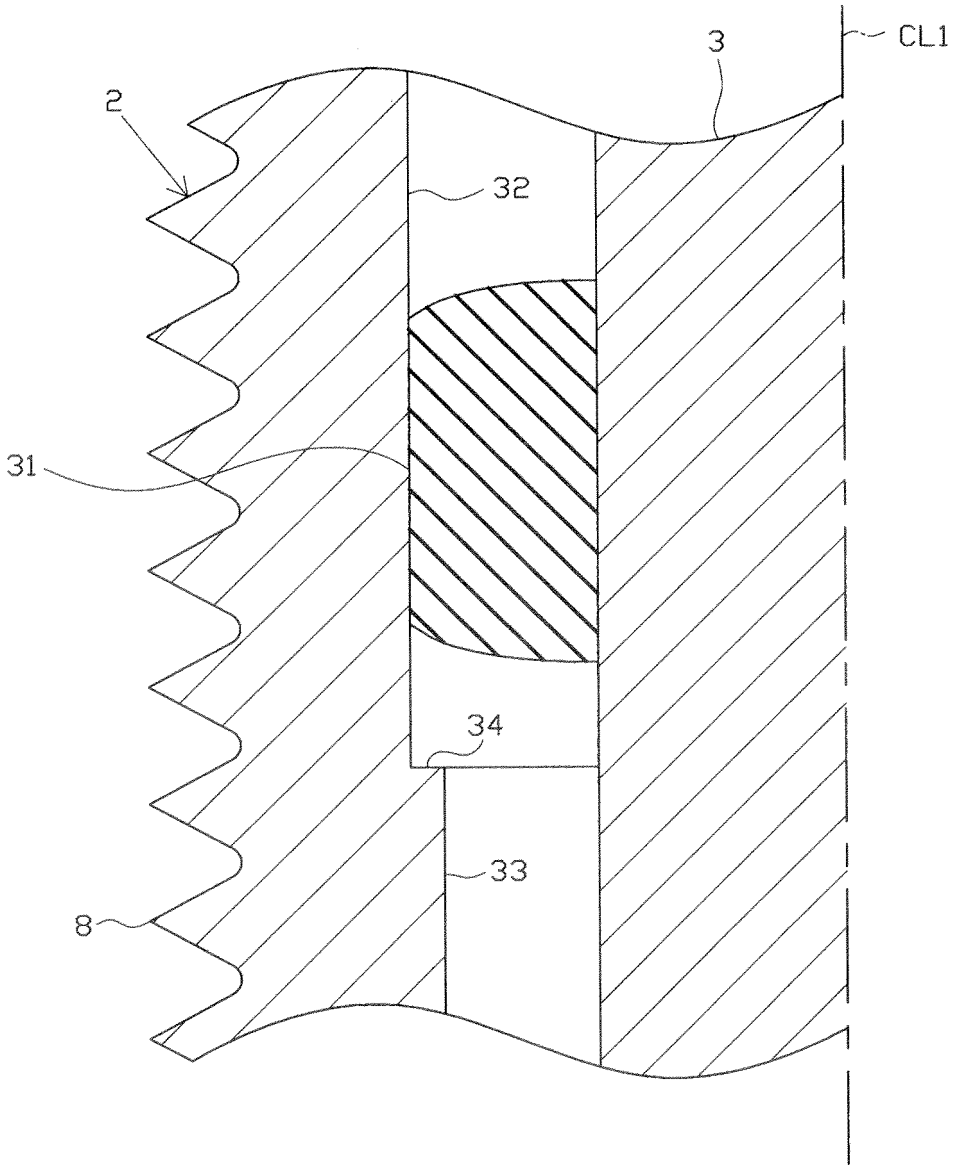


FIG. 6

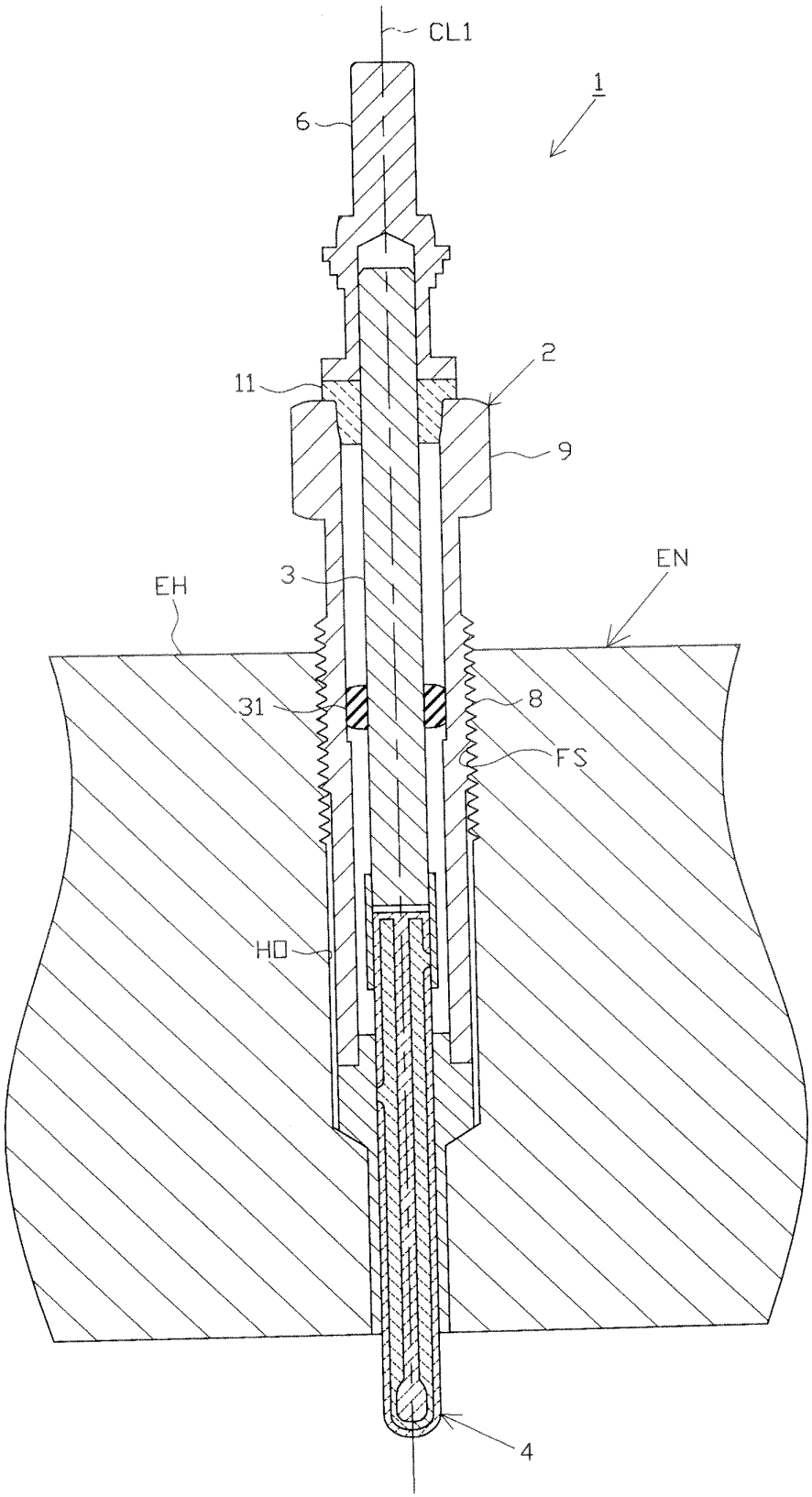
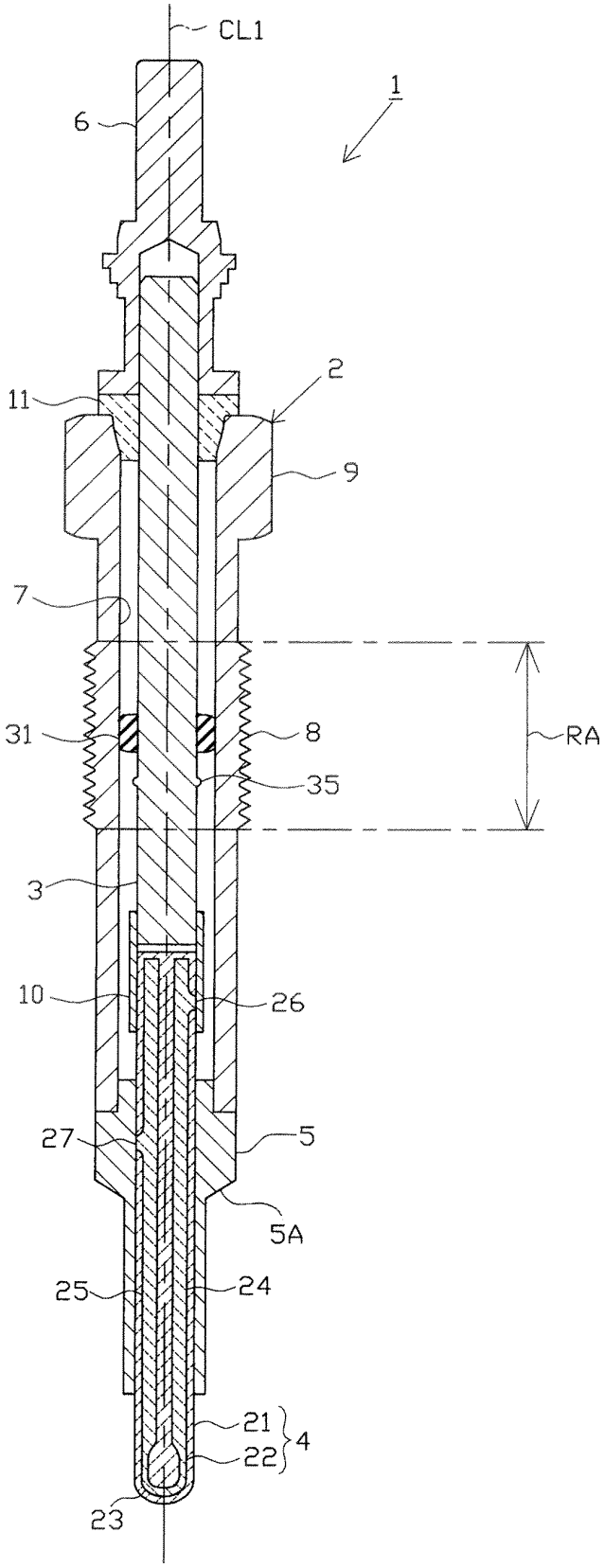


FIG. 7



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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