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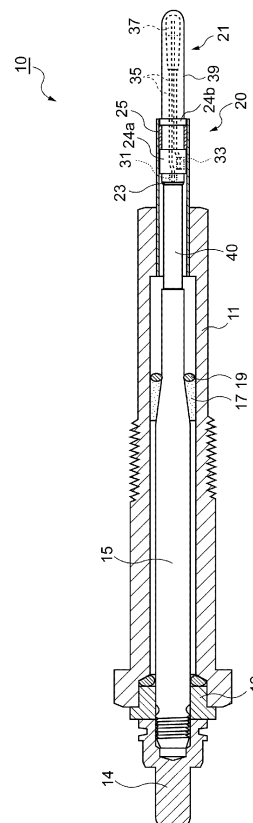
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(54) **CERAMIC HEATER GLOW PLUG AND METHOD FOR MANUFACTURING SAME**

(57) To provide a ceramic heater type glow plug that can efficiently supply as little brazing material as possible to a bonded section by preventing the brazing material from entering portions other than a bonded section as much as possible when a ceramic heater and a metal outer cylinder are bonded together by brazing, and a manufacturing method thereof.

A method for manufacturing a ceramic heater type glow plug including a ceramic heater and a metal outer cylinder having one end holding the ceramic heater and another end fixed by being inserted into an internal hole of a housing includes the step of forming a first metallization section so as to cover an electrode exposed on an outer peripheral portion in circumferential direction of the ceramic heater and forming a second metallization section for improving surface wettability in a position corresponding to a front end of the metal outer cylinder closer to a front end side than the first metallization section.

[Figure 1]



Description

Technical Field

[0001] The present invention relates to a ceramic heater type glow plug used for start aid of a diesel engine and a manufacturing method thereof. More particularly, the present invention relates to a ceramic heater type glow plug with a structure in which a ceramic heater is fixed to a metal outer cylinder by brazing and a manufacturing method thereof.

Background Art

[0002] A ceramic heater type glow plug used for start aid of a diesel engine generally has a structure in which the rear end side is bonded with the inside of the metal outer cylinder by brazing in a state in which a heating section on the front end side of a ceramic heater projects outward. In such a ceramic heater type glow plug, the rear end side of the metal outer cylinder fixed by being inserted into the front end of the cylindrical housing, which is a fitting for installation in the cylinder head of an engine.

[0003] Generally, in a brazing step, brazing material is disposed in the vicinity of the bonded section between the ceramic heater and the metal outer cylinder and the brazing material is heated to the melting temperature or higher so that the brazing material flows into the gap of the bonded section for bonding due to surface tension. At this time, the wettability of the brazing material relative to the material of the bonded section is important and, when the contact angle is large, the brazing material does not easily flow into the gap of the bonded section. Therefore, the technique for applying alloy plating 118d to the surface of a metal outer cylinder 118 has been disclosed (see PTL 1).

Citation List

Patent Literature

[0004] PTL 1: JP-A-2005-315447

Summary of Invention

Technical Problem

[0005] When the treatment of the alloy plating 118d is applied to the surface of the metal outer cylinder 118 as in the method for manufacturing a glow plug disclosed in PTL 1, the contact angle of the brazing material becomes substantially zero, significantly increasing the flowability of the brazing material on the surface of the alloy plating 118d surface. When brazing is performed in such a glow plug, processing such as heating is performed with brazing material placed in the metal outer cylinder 118.

[0006] The alloy plating 118d applied to the surface of the metal outer cylinder 118 only needs to be present in

a position where the brazing material is placed and in the bonded section (brazed section) 119. However, when the plating is applied to such a limited area, masking needs to be applied to the surface of the metal outer cylinder 118 and this may increase the production cost. Accordingly, in PTL 1, after plating is applied to the entire surface of an inner peripheral surface 118c and an outer peripheral surface 118b on the front end side of the metal outer cylinder 118, the plating formed at the front end of the metal outer cylinder 118 is mechanically removed to form a plating removed section 118a, thereby preventing the brazing material from entering an outer peripheral surface 118b side of the metal outer cylinder 118. If the brazing material moves to a region such as the outer peripheral surface 118b side of the metal outer cylinder 118 in which the brazing material does not need to be disposed, many blowholes are formed in the gap of the bonded section 119, thereby reducing the bonding strength.

[0007] Since the alloy plating 118d with high surface wettability is formed on the entire surface on the front end side of the metal outer cylinder 118 in the glow plug in PTL 1, the brazing material is likely to move to an area not related to bonding. When the gap between the surface of the ceramic heater 130 and the inner peripheral surface 118c of the metal outer cylinder 118 corresponding to the surface of the ceramic heater 130 is evenly filled with the brazing material, the amount of brazing material, for example, three to ten times as much as the volume of the gap needs to be disposed in the metal outer cylinder 118 and the amount of relatively-expensive brazing material consumed increases, possibly increasing the production cost of the glow plug.

[0008] By considering such problems, the inventor of the invention has found that such problems can be solved by changing the arrangement of metallization sections provided on the outer peripheral surface of the ceramic heater and has achieved the invention. Accordingly, an object is to provide a ceramic heater type glow plug in which as little brazing material as possible may be supplied efficiently to a bonded section by preventing the brazing material from entering portions other than a bonded section as much as possible when a ceramic heater and a metal outer cylinder are bonded together by brazing, and a manufacturing method thereof.

Solution to Problem

[0009] According to the present invention, there is provided a method for manufacturing a ceramic heater type glow plug including a ceramic heater and a metal outer cylinder having one end holding the ceramic heater and another end fixed by being inserted into an internal hole of a housing, the method including the steps of forming a first metallization section so as to cover an electrode exposed on an outer peripheral portion in circumferential direction of the ceramic heater and forming a second metallization section for improving surface wettability in

a position corresponding to a front end of the metal outer cylinder closer to a front end side than the first metallization section, forming a metal layer removed section by providing a metal layer at least on an inner peripheral surface of the metal outer cylinder and removing the metal layer formed at the front end of the metal outer cylinder, inserting a rear end of the ceramic heater into one end side of the metal outer cylinder and disposing brazing material at an entrance of a gap between the ceramic heater and the metal outer cylinder, heating the ceramic heater and the metal outer cylinder so as to melt and pass the brazing material through the gap, and bonding the ceramic heater and the metal outer cylinder by cooling the brazing material, thereby solving the above problem.

[0010] That is, in the method for manufacturing a ceramic heater type glow plug according to the invention, the metal layer removed section is formed at the front end of the metal outer cylinder and the first metallization section used as a bonded portion covering the electrode and the second metallization section used to pass the brazing material through the gap between the ceramic heater and the metal outer cylinder are formed as metallization sections provided in the outer peripheral portion of the ceramic heater, so that the brazing material does not easily enter portions other than the gap and the brazing material can efficiently flow into the gap. In addition, the area in which the brazing material spreads can be reduced, enabling reduction in the amount of brazing material used. Accordingly, an increase in the production cost of the ceramic heater type glow plug can be suppressed. In addition, the bonded area between the ceramic heater and the metal outer cylinder is reduced, enabling reduction in the thermal stress generated in the bonded section between the ceramic heater and the metal outer cylinder.

[0011] In carrying out the method for manufacturing a ceramic heater type glow plug according to the invention, in the step of disposing and the step of melting the brazing material, the ceramic heater and the metal outer cylinder are preferably disposed with the front end sides facing upward and the brazing material is preferably placed at the front end of the metal outer cylinder and then melted. By disposing and melting the brazing material in this way, the metal layer removed section at the front end of the metal outer cylinder prevents the brazing material from entering the outer peripheral surface side of the metal outer cylinder and the second metallization section efficiently passes the brazing material through the bonded section between the ceramic heater and the metal outer cylinder.

[0012] In carrying out the method for manufacturing a ceramic heater type glow plug according to the invention, the surface area of the second metallization section is preferably smaller than the surface area of the first metallization section. By forming the first and second metallization sections in this way, the total amount of the brazing material used can be suppressed by reducing as much as possible the amount of brazing material used

for the second metallization section for bringing the brazing material to the gap between the ceramic heater and the metal outer cylinder.

[0013] In carrying out the method for manufacturing a ceramic heater type glow plug according to the invention, one or both of the first metallization section and the second metallization section are preferably formed by being divided into a plurality of portions. By forming the first metallization section and the second metallization section in this way, the bonded area between the ceramic heater and the metal outer cylinder is reduced, enabling reduction in the thermal stress generated in the bonded section.

[0014] In carrying out the method for manufacturing a ceramic heater type glow plug according to the invention, the length in the ceramic heater axial direction of each of the plurality of portions generated by dividing the second metallization section is preferably larger than the length in the circumferential direction. By forming the second metallization section in this way, the brazing material flowing through the front end side of metal outer cylinder can be efficiently brought to the first metallization section.

[0015] In carrying out the method for manufacturing a ceramic heater type glow plug according to the invention, the metal layer on the inner peripheral surface of the metal outer cylinder is preferably formed in a region from the front end of the metal outer cylinder to a position corresponding to an end on a rear end side of the first metallization section formed on the ceramic heater. The metal layer formed in this way prevents the brazing material from flowing into the region at the back of the metal outer cylinder not contributing to bonding, thereby reducing the amount of the brazing material used.

[0016] According to another aspect of the invention, there is provided a ceramic heater type glow plug including a ceramic heater and a metal outer cylinder having one end holding the ceramic heater and another end fixed by being inserted into an internal hole of a housing, in which the ceramic heater has one electrode in an outer peripheral portion in a circumferential direction and a first metallization section so as to cover the one electrode, the metal outer cylinder has a metal layer formed at least on an inner peripheral surface and a metal layer removed section formed at a front end, the ceramic heater and the metal outer cylinder are bonded together by brazing in regions in which the first metallization section and the metal layer have been formed, and a second metallization section for improving surface wettability is formed in a position corresponding to the front end of the metal outer cylinder closer to a front end side than the first metallization section of the ceramic heater.

[0017] That is, the ceramic heater type glow plug according to the invention includes the metal layer removed section at the front end of the metal outer cylinder and, as metallization sections provided in the outer peripheral portion of the ceramic heater, the first metallization section that is a bonded portion covering the electrode and the second metallization section that passes the brazing

material through the gap between the ceramic heater and the metal outer cylinder, so that the amount of the brazing material used can be reduced and an increase in the production cost can be suppressed. In addition, the bonded area between the ceramic heater and the metal outer cylinder is reduced, enabling reduction in the thermal stress generated in the bonded section between the ceramic heater and the metal outer cylinder.

Brief Description of Drawings

[0018]

[Fig. 1] Fig. 1 is a cross-sectional view showing a cross section including an axis of a glow plug according to a first embodiment of the present invention.

[Fig. 2] Fig. 2 is a cross-sectional view showing a cross section including an axis of a ceramic heater assembly of the glow plug according to the first embodiment.

[Fig. 3] Fig. 3 is a cross-sectional view showing a cross section including an axis of a modification of the ceramic heater assembly.

[Fig. 4] Fig. 4 shows a method for manufacturing the ceramic heater assembly.

[Fig. 5] Fig. 5 shows a method for manufacturing the ceramic heater assembly.

[Fig. 6] Fig. 6 shows a method for manufacturing the ceramic heater assembly.

[Fig. 7] Fig. 7 shows a method for manufacturing the ceramic heater assembly.

[Fig. 8] Fig. 8 is a cross-sectional view showing a cross section including an axis of a ceramic heater assembly of a glow plug according to a second embodiment.

[Fig. 9] Fig. 9 is a cross-sectional view showing a cross section including an axis of a ceramic heater assembly of a glow plug according to a third embodiment.

[Fig. 10] Fig. 10 shows the structure of the ceramic heater assembly of a conventional glow plug.

Description of Embodiments

[0019] A ceramic heater type glow plug and a manufacturing method thereof according to embodiments of the present invention will be specifically described with reference to the drawings.

[0020] Components given the same reference sign in the drawings indicate the same component unless otherwise specified and descriptions are omitted as necessary.

[First embodiment]

1. Entire structure of glow plug

[0021] Fig. 1 is a cross-sectional view showing a cross section including an axis of a diesel engine glow plug 10 according to a first embodiment of the invention.

[0022] The glow plug 10 shown in Fig. 1 is configured as a ceramic heater type glow plug including a ceramic heater assembly 20. The ceramic heater assembly 20 includes a ceramic heater 21, a metal outer cylinder (sheath) 25, a large diameter lead section 40, and so on as main components.

[0023] In Fig. 1, the ceramic heater 21, the large diameter lead section 40, an external connection terminal 15, and so on are shown in a side view not in a cross-sectional view.

[0024] The ceramic heater 21 has a U-shaped ceramic heating element 37 embedded in a ceramic insulation base 39 that configures the main unit. A positive electrode 31 and a negative electrode 33 are provided at both ends of the ceramic heating element 37, respectively, via metal leads 35. Of these electrodes, the negative electrode 33 is drawn out onto the outer peripheral surface of the ceramic insulation base 39 and, on the outer peripheral surface of the ceramic insulation base 39 including the negative electrode 33, the first metallization section (negative electrode side metallization section) 24a is formed. The first metallization section 24 is bonded with the internal surface of the metal outer cylinder 25 by brazing and the negative electrode 33 is electrically connected to the metal outer cylinder 25.

[0025] The positive electrode 31 is drawn out onto the outer surface of the ceramic insulation base 39 at the rear end opposite to the front end side in which the ceramic heating element 37 is embedded. The rear end surface of the ceramic insulation base 39 including the positive electrode 31 is bonded with the front end surface of the large diameter lead section 40 by brazing using brazing material 23 to electrically connect the positive electrode 31 with the large diameter lead section 40.

[0026] The ceramic heater assembly 20 configured in this way is press-inserted into a cylindrical housing 11, which is a fitting for installation in the cylinder head of an engine (not shown), and fixed by brazing or the like. In the example in Fig. 1, the metal outer cylinder 25 is fixed in the housing 11 by brazing or the like. However, the metal outer cylinder 25 may be fixed in a metal tube or the like by brazing or the like and the metal tube may be welded with a member included in the main body of the housing to integrally form the housing 11.

[0027] In the housing 11, the rear end surface of the large diameter lead section 40 is electrically connected with a front end surface of the external connection terminal 15 by being bonded through welding or the like. The external connection terminal 15 is held by an insulator 12 at the rear end of the housing 11, and the rear end is exposed to the outside of the housing 11 and connected

to a round pin 14.

[0028] The large diameter lead section 40 included in the glow plug 10 according to the embodiment is defined as a lead bar having a relatively large diameter and a sectional area, which is, for example, 20% or more of the cross sectional area of the ceramic insulation base 39. Since the temperature is high and a large current (for example, 4 to 30 amperes) flows through the large diameter lead section 40 during operation of the glow plug 10, if the diameter of the large diameter lead section 40 is too small for example, less than 1 mm, in addition, self heating occurs, therefore, oxidation may occur in a short time. On the other hand, when the cross sectional area of the large diameter lead section 40 is 20% or more of the cross sectional area of the ceramic insulation base 39, the area of the bonded section between the rear end surface of the ceramic heater 21 and the front end surface of the large diameter lead section 40 becomes large, thereby securing the bonding strength. That is, it is possible to obtain the bonding strength that bears vibrations caused during installation in the engine or the like of a vehicle or a stress applied during manufacturing of the glow plug 10.

[0029] In contrast, when the diameter of the large diameter lead section 40 is too large, the distance between the large diameter lead section 40 and the metal outer cylinder 25 becomes insufficient, possibly causing dielectric breakdown. Accordingly, the cross sectional area of the large diameter lead section 40 is, for example, preferably 70% or less of the cross sectional area of the ceramic insulation base 39. The cross sectional area of the large diameter lead section 40 is more preferably 50% or less, and still more preferably 40% or less of the cross sectional area of the ceramic insulation base 39.

[0030] In addition, the large diameter lead section 40 is preferably made of a material with a lower stiffness than a lead bar as the external connection terminal 15. As such a material, for example, copper (Cu), aluminum (Al), or alloy of these materials can be used. Alternatively, iron alloy or cast iron with low stiffness can also be used. In the case of the large diameter lead section 40 with a relatively small stiffness as described above, even when a bending stress is caused in a bonded section between the ceramic heater 21 and the large diameter lead section 40 due to vibrations generated when an engine is driven or stresses applied to bonded sections during assembly of the glow plug 10, the large diameter lead section 40 is bent to prevent the bending stress from concentrating on the bonded section. In order to make the large diameter lead section 40 to be easily bent to prevent such concentration of a bending stress, the length of the large diameter lead section 40 is preferably increased to twice or more of the diameter.

[0031] Since the resistance of the large diameter lead section 40 can be reduced in such a large diameter lead section 40, even when the temperature is high and a large current flows, self heating can be suppressed and deterioration due to oxidation can be prevented for a long

period of time. In addition, application of nickel (Ni) plating or the like to the large diameter lead section 40 further improves the heat resistance. In addition, an increasing in the thermal conductivity of the large diameter lead section 40 efficiently transfers the heat transferred from a ceramic heater 21 to the external connection terminal 15, thereby improving the heat resistance of the large diameter lead section 40.

[0032] In the glow plug 10 according to the embodiment, the external connection terminal 15 is fixed in the housing 11 by filling the gap between the external connection terminal 15 and the housing 11 with a filler 17 including resin, low-melting glass, or the like. Accordingly, when a connector (not shown) is inserted or screwed onto the round pin 14, a stress added to the external connection terminal 15 is not applied to the bonded section between the external connection terminal 15 and the large diameter lead section 40, thereby preventing the bonded section from being broken. Although vibrations applied by the engine in a state in which the glow plug 10 is mounted in the engine may cause stresses in portions in the glow plug 10, since the external connection terminal 15 is fixed by the filler 17, application of a stress to the bonded section between the external connection terminal 15 and the large diameter lead section 40 and to the bonded section between the large diameter lead section 40 and the ceramic heater 21 can be reduced. In addition, heat transferred from the ceramic heater 21 via the large diameter lead section 40 can be radiated to the housing 11 via the filler 17.

[0033] In the glow plug 10 having such a structure, the ceramic heater 21 can be shortened and the step of filling the metal outer cylinder 25 with powder and the step of reducing the diameter of the metal outer cylinder 25 can be omitted, thereby simplifying the manufacturing process. Since the glow plug 10 according to the embodiment fixes the metal outer cylinder 25 to the inside of the housing 11 using brazing instead of press-insertion, this step can also be simplified. In addition, structural members such as the external connection terminal 15, the large diameter lead section 40, and the metal outer cylinder 25 are simplified without having complicated shapes or structures, so the production cost can be reduced.

2. Ceramic heater assembly

[0034] Fig. 2 is a cross-sectional view showing a cross section including an axis of the ceramic heater assembly 20 included in the glow plug 10 according to the embodiment. The ceramic heater 21 and the large diameter lead section 40 are shown in a side view not in a cross-sectional view.

[0035] In the ceramic heater assembly 20 included in the glow plug 10 according to the embodiment, a metal layer 26 is provided on the inner peripheral surface and the outer peripheral surface of the metal outer cylinder 25. On the other hand, a metal layer removed section 26a not having the metal layer 26 is formed at the front

end of the metal outer cylinder 25. This metal layer 26 is formed by applying, for example, Ni-B (nickel-boron) alloy plating. When the brazing material is brazing silver, since the contact angle of brazing silver relative to Ni-B alloy plating is substantially zero, the metal layer 26 becomes optimum. However, even when a material other than Ni-B alloy plating is used, if the wettability of the material with the brazing material such as brazing silver is high, the material can be advantageously used.

[0036] A second metallization section 24b as well as the first metallization section (metallization section on the negative electrode side) 24a is provided on the outer peripheral surface in the radial direction of the ceramic heater 21. These metallization sections are formed by, for example, silver-copper (Ag-Cu) brazing material including titanium (Ti). The first metallization section 24a and the second metallization section 24b are provided to bond the outer peripheral surface of the ceramic heater 21 with the inner peripheral surface of the metal outer cylinder 25 using a brazing material 27.

[0037] Of these components, the negative electrode 33 and the metal outer cylinder 25 are electrically connected together via the first metallization section 24a. On the other hand, the second metallization section 24b is used to bond the ceramic heater 21 with the metal outer cylinder 25 and has a main function of causing the brazing material 27 to efficiently flow into the gap, which becomes a bonded portion, when bonding the ceramic heater 21 with the metal outer cylinder 25 by improving the wettability of the surface of the ceramic heater 21. Since the above metal layer removed section 26a is provided at the front end of the metal outer cylinder 25 at this time, the brazing material 27 does not easily enter the outer peripheral surface side of the metal outer cylinder 25.

[0038] In this case, when the first metallization section 24a and the second metallization section 24b are formed as one integrated metallization section without being separated, the amount of expensive material used to form the metallization section increases. A difference in the thermal expansion coefficient between the material of the metallization section and the ceramic heater 21 and the metal outer cylinder 25 generates an excess thermal stress on the surface of the ceramic insulation base 39 and breakage of the surface of the ceramic insulation base 39 may occur due to repetition of a high temperature state and a room temperature state. Accordingly, the first metallization section 24a is formed separately from the second metallization section 24b.

[0039] In addition, the surface area of the second metallization section 24b is smaller than the surface area of the first metallization section 24a. Accordingly, since the brazing material 27 does not need to be present sufficiently in the second metallization section 24b, which does not contribute to an electric connection between the negative electrode 33 and the metal outer cylinder 25, the amount of the brazing material 27 used can be reduced, thereby contributing to reduction in the production cost.

[0040] Fig. 3 shows the ceramic heater assembly 20 used in a modification of the glow plug according to the embodiment. In this ceramic heater assembly 20, a metal layer removed section 26b is provided not only in the metal layer removed section 26a at the front end of the metal outer cylinder 25, but also on the inner peripheral surface of the metal outer cylinder 25. This metal layer removed section 26b is provided in a position closer the rear end than a region corresponding to the first metallization section 24a to prevent the brazing material 27 from flowing into a region not used for bonding with the first metallization section 24a. This metal layer removed section 26a also reduces the amount of the brazing material 27 used.

3. Method for manufacturing glow plug

[0041] Next, a method for manufacturing the glow plug 10 according to the embodiment will be described with reference to Figs. 4 to 7. In the following method for manufacturing the glow plug 10, the structure of the ceramic heater assembly 10 shown in Fig. 3 is assumed.

[0042] First, as shown in Figs 4(a) to (b), the first metallization section 24a and the second metallization section 24b are formed on the outer peripheral surface in the radial direction of the ceramic heater 21 using silver-copper (Ag-Cu) brazing material including, for example, titanium (Ti). The first metallization section 24a is formed in a position corresponding to the position where the negative electrode 33 is provided. The second metallization section 24b is formed in a position corresponding to the position of the front end of the metal outer cylinder during assembly to the metal outer cylinder.

[0043] Next, although not shown in the drawing, the large diameter lead section 40 is bonded with the rear end surface of the ceramic heater 21 on which the positive electrode 31 is exposed, using the brazing material 27.

[0044] Next, as shown in Figs. 5(a) to (b), the metal layer 26 is formed on the entire inner peripheral surface and the entire outer peripheral surface of the metal outer cylinder 25 using the nickel-boron (Ni-B) plating, and then the metal layer removed sections 26a and 26b are formed as shown in Fig. 5(c) by mechanically removing a part of the metal layer 26. The metal layer removed section 26a is formed by removing the metal layer at the front end of the metal outer cylinder 25 and the metal layer removed section 26b is formed by removing the metal layer located in a region closer to the rear end side than the first metallization section 24a provided on the outer peripheral surface of the ceramic heater 21 during assembly of the ceramic heater 21.

[0045] Next, as shown in Fig. 6(a), the ceramic heater 21 is inserted into the metal outer cylinder 25 and, in a state in which the ceramic heater 21 and the metal outer cylinder 25 are held with their front end sides facing upward as shown in Fig. 6(b), brazing material 27a such as silver brazing material is disposed at the entrance of the

gap between the outer peripheral surface of the ceramic heater 21 and the inner peripheral surface of the metal outer cylinder 25. In the embodiment, since the large diameter lead section 40 is used as an electrode draw-out lead that draws out the positive electrode 33 of the ceramic heater 21, the brazing material cannot be disposed in the metal outer cylinder 25. Accordingly, the brazing material is disposed at the entrance of the gap.

[0046] Next, as shown in Fig. 7(a), the brazing material 27a is heated and melted so as to flow into the gap between the outer peripheral surface of the ceramic heater 21 and the inner peripheral surface of the metal outer cylinder 25. Since the metal layer removed section 26a is provided at the front end of the metal outer cylinder 25, the brazing material 27a does not easily flow onto the outer peripheral surface side of the metal outer cylinder 25. In addition, since the second metallization section 24b for improving the surface wettability is formed on the outer peripheral surface of the ceramic heater 21 corresponding to the front end of the metal outer cylinder 25, the brazing material 27a efficiently flows into the gap. Since the brazing material 27a flows in a state in which the ceramic heater 21 and the metal outer cylinder 25 are held with their front end sides facing upward, the brazing material 27a easily reaches the region of the first metallization section 24a, thereby facilitating reduction in the amount of the brazing material 27a used.

[0047] In the case of the ceramic heater assembly 20 shown in Fig. 3, the metal layer removed section 26b is also provided in a portion closer to the rear end side than the region in which the first metallization section 24a has been provided, in the metal layer 26 formed on the inner peripheral surface of the metal outer cylinder 25. Accordingly, the brazing material 27a is prevented from flowing into the region not contributing to bonding.

[0048] Next, by cooling the brazing material 27a in a state in which the brazing material 27a has reached the region in which the first metallization section 24a is provided, the ceramic heater 21 is bonded with the metal outer cylinder 25 as shown in Fig. 7(b) and the ceramic heater assembly 20 is obtained. After that, although not shown in the drawing, the ceramic heater type glow plug 10 shown in Fig. 1 can be manufactured through a step for, for example, bonding the ceramic heater assembly 20 with the inside of the housing 11 and making an electric connection of the external connection terminal 15.

4. Effects of glow plug and manufacturing method thereof according to the embodiment

[0049] As described above, in the ceramic heater type glow plug 10 and the manufacturing method thereof according to the embodiment, by forming the metal layer removed section 26a at the front end of the metal outer cylinder 25 and forming, as metallization sections provided in the outer peripheral portion of the ceramic heater 21, the first metallization section 24a used as a bonded portion covering the negative electrode 33 and the sec-

ond metallization section 24b used to pass the brazing material 27 through the gap between the ceramic heater 21 and the metal outer cylinder 25, the brazing material 27 does not easily enter portions other than the gap and the brazing material 27 can efficiently flow into the gap. Accordingly, the amount of the brazing material 27 used can be reduced.

[0050] Since the first metallization section 24a is formed separately from the second metallization section 24b in the glow plug 10 and the manufacturing method thereof according to the embodiment, the area of the bonded section contributing to the electric connection of the negative electrode 33 and the metal outer cylinder 25 can be reduced as compared with the case in which one metallization section is formed in a wide range, and the amount of the brazing material 27 used can be easily reduced. The amount of material of the metallization sections 24a and 24b can also be reduced. Accordingly, an increase in the production cost of the ceramic heater type glow plug 10 can be suppressed. In addition, the bonded area by the metallization sections is reduced, thereby preventing breakage caused by repetition of a high temperature and a room temperature when an excess thermal stress is generated on the surface of the ceramic insulation base 39 due to a difference in the thermal expansion coefficient between the metallization sections and the ceramic insulation base 39 and the metal outer cylinder 25.

[0051] In the method for manufacturing a ceramic heater type glow plug according to the invention, in the steps of disposing and melting the brazing material 27a, the ceramic heater 21 and the metal outer cylinder 25 are disposed with their front end sides facing upward and the brazing material 27a is placed at the front end of the metal outer cylinder 25 and then melted. By disposing and melting the brazing material 27a in this way, the metal layer removed section 26a at the front end of the metal outer cylinder 25 prevents the brazing material from entering the outer peripheral surface side of the metal outer cylinder 25 and the second metallization section 24b efficiently passes the brazing material 27a through the bonded section between the ceramic heater 21 and the metal outer cylinder 25.

[0052] In the method for manufacturing a ceramic heater type glow plug according to the embodiment, the surface area of the second metallization section 24b is smaller than the surface area of the first metallization section 24a. By forming the first metallization section 24a and the second metallization section 24b in this way, the amount of brazing material used for the second metallization section 24b for bringing the brazing material 27a to the gap between the ceramic heater 21 and the metal outer cylinder 25 is reduced as much as possible, thereby contributing to reduction in the production cost.

[0053] In the method for manufacturing a ceramic heater type glow plug according to the embodiment, the metal layer 26 on the inner peripheral surface of the metal outer cylinder 25 is provided in a region from the front end of

the metal outer cylinder 25 to a position corresponding to the end of the rear end side of the first metallization section 24a formed on the ceramic heater 21. Forming of the metal layer 26 in this way prevents the brazing material 27 from flowing into the region at the back of the metal outer cylinder 25 not contributing to bonding.

[Second embodiment]

[0054] A glow plug and a manufacturing method thereof according to a second embodiment of the invention is different from the glow plug according to the first embodiment in that at least one of the first metallization section 24a and the second metallization section 24b is formed by being divided into a plurality of portions.

[0055] Figs. 8(a) and (b) are cross-sectional views showing cross sections including axes of ceramic heater assemblies 20A and 20B of the glow plug according to the embodiment.

[0056] In the ceramic heater assembly 20A shown in Fig. 8(a), the second metallization section 24b is divided into a plurality of portions 24ba and 24bb. In the ceramic heater assembly 20B shown in Fig. 8(b), the first metallization section 24a is divided into a plurality of portions 24aa and 24ab. Although not shown in the drawing, both the first metallization section 24a and the second metallization section 24b may be divided into a plurality of portions.

[0057] Accordingly, the glow plug and the manufacturing method thereof according to the embodiment have the effect of further reducing the bonded area between the ceramic heater 21 and the metal outer cylinder 25 so as to reduce the thermal stress generated in their bonded sections, in addition to the effect described in the first embodiment. As a result, breakage of the surface of the ceramic heater 21 can be further reduced.

[Third embodiment]

[0058] A glow plug and a manufacturing method thereof according to a third embodiment of the invention is different from the glow plugs according to the first embodiment and the second embodiment in that, when the second metallization section 24b is divided into a plurality of portions, the length in the ceramic heater 21 axial direction of each of the divided portions is longer than the length in the circumferential direction.

[0059] Fig. 9 is a cross-sectional view showing a cross section including an axis of a ceramic heater assembly 20C of the glow plug according to the embodiment.

[0060] In the ceramic heater assembly 20C, the length in the ceramic heater 21 axial direction (X-direction) of each of the divided portions 24ba, 24bb, and 24bc of the second metallization section 24b is larger than the length in the circumferential direction (Y-direction). Accordingly, when the brazing material 27 is melted and flows into the gap between the ceramic heater 21 and the metal outer cylinder 25, the brazing material 27 can be efficiently

moved to the bonded portion of the first metallization section 24a.

[0061] Accordingly, the glow plug and the manufacturing method thereof according to the third embodiment have the effect of causing the brazing material 27 to efficiently flow onto the first metallization section 24a so as to improve the reliability of an electric connection between the negative electrode 33 of the ceramic heater 21 and the metal outer cylinder 25, in addition to the effects described in the first and second embodiments.

[0062] The above glow plug according to the embodiments of the invention indicates an aspect of the invention and does not limit the invention and the embodiments may be arbitrarily changed within the scope of the invention. For example, in the glow plug according to the first to third embodiments, the ceramic heater assembly 20 using the large diameter lead section 40 as an electrode draw-out member drawing out the positive electrode 31 of the ceramic heater 21 to the outside of the metal outer cylinder 25 is adopted, but the invention is not limited to such a structure.

Claims

1. A method for manufacturing a ceramic heater type glow plug including a ceramic heater and a metal outer cylinder having one end holding the ceramic heater and another end fixed by being inserted into an internal hole of a housing, the method comprising the steps of:

forming a first metallization section so as to cover an electrode exposed on an outer peripheral portion in circumferential direction of the ceramic heater and forming a second metallization section for improving surface wettability in a position corresponding to a front end of the metal outer cylinder closer to a front end side than the first metallization section;

forming a metal layer removed section by providing a metal layer at least on an inner peripheral surface of the metal outer cylinder and removing the metal layer formed in the front end of the metal outer cylinder;

inserting a rear end of the ceramic heater into one end side of the metal outer cylinder and disposing brazing material at an entrance of a gap between the ceramic heater and the metal outer cylinder;

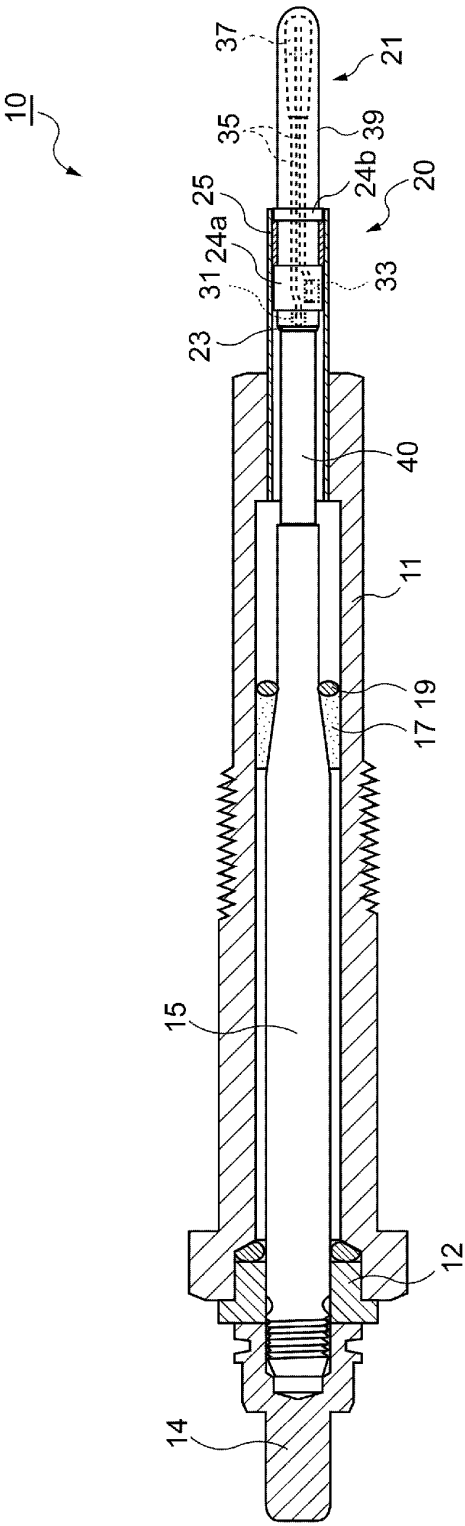
heating the ceramic heater and the metal outer cylinder to melt and pass the brazing material through the gap; and

bonding the ceramic heater and the metal outer cylinder together in regions in which the first metallization section and the metal layer have been formed by cooling the brazing material.

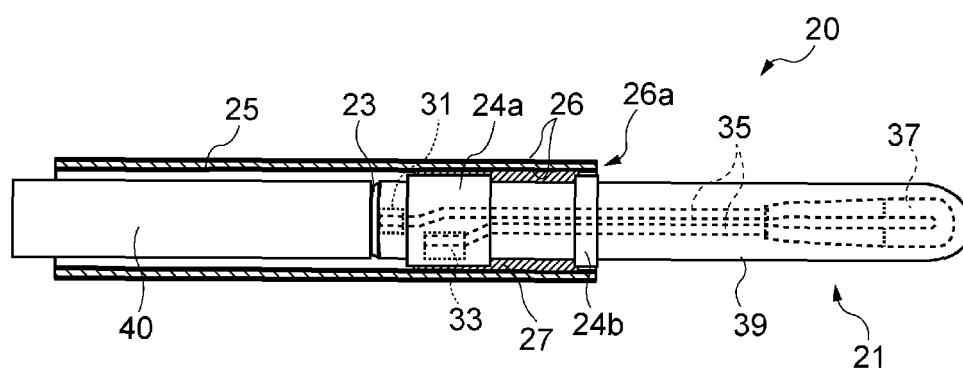
2. The method for manufacturing a ceramic heater type glow plug according to claim 1, wherein, in the step of disposing the brazing material and the step of melting the brazing material, the ceramic heater and the metal outer cylinder are disposed with the front end sides facing upward and the brazing material is placed at the front end of the metal outer cylinder and then melted. 5
3. The method for manufacturing a ceramic heater type glow plug according to claim 1 or 2, wherein a surface area of the second metallization section is smaller than a surface area of the first metallization section. 10 15
4. The method for manufacturing a ceramic heater type glow plug according to any one of claims 1 to 3, wherein one or both of the first metallization section and the second metallization section are formed by being divided into a plurality of portions. 20
5. The method for manufacturing a ceramic heater type glow plug according to claim 4, wherein a length in a ceramic heater axial direction of each of the plurality of portions generated by dividing the second metallization section is larger than a length in the circumferential direction. 25
6. The method for manufacturing a ceramic heater type glow plug according to any one of claims 1 to 5, wherein the metal layer on the inner peripheral surface of the metal outer cylinder is formed in a region from the front end of the metal outer cylinder to a position corresponding to an end on a rear end side of the first metallization section formed on the ceramic heater. 30 35
7. A ceramic heater type glow plug comprising:
 - a ceramic heater; and 40
 - a metal outer cylinder having one end holding the ceramic heater and another end fixed by being inserted into an internal hole of a housing, wherein the ceramic heater has one electrode in an outer peripheral portion in a circumferential direction and a first metallization section so as to cover the one electrode, 45
 - the metal outer cylinder has a metal layer formed at least on an inner peripheral surface and a metal layer removed section formed at a front end, 50
 - the ceramic heater and the metal outer cylinder are bonded together by brazing in regions in which the first metallization section and the metal layer have been formed, and 55
 - a second metallization section for improving surface wettability is formed in a position corresponding to the front end of the metal outer cyl-

inder closer to a front end side than the first metallization section of the ceramic heater.

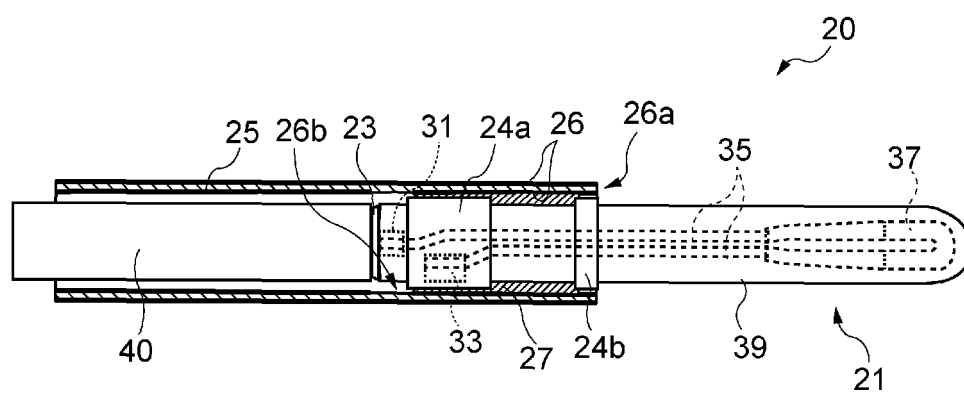
[Figure 1]



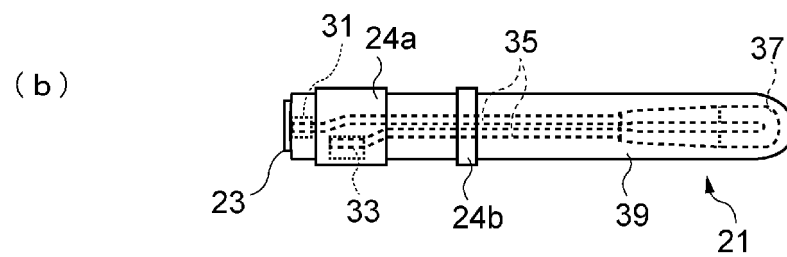
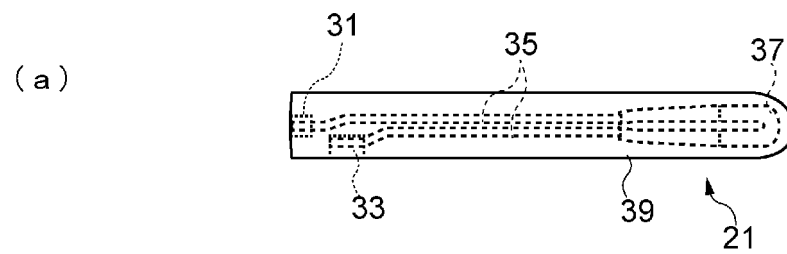
[Figure 2]



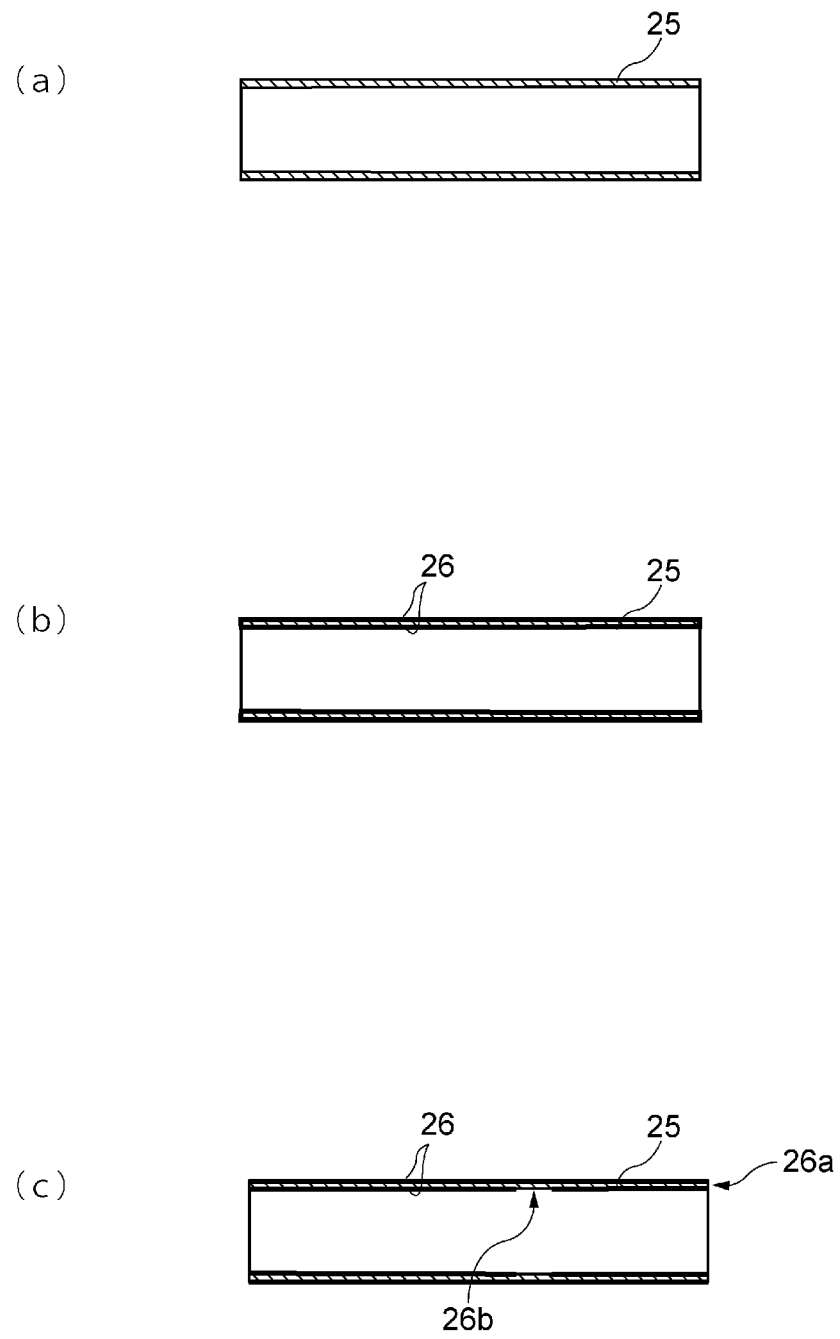
[Figure 3]



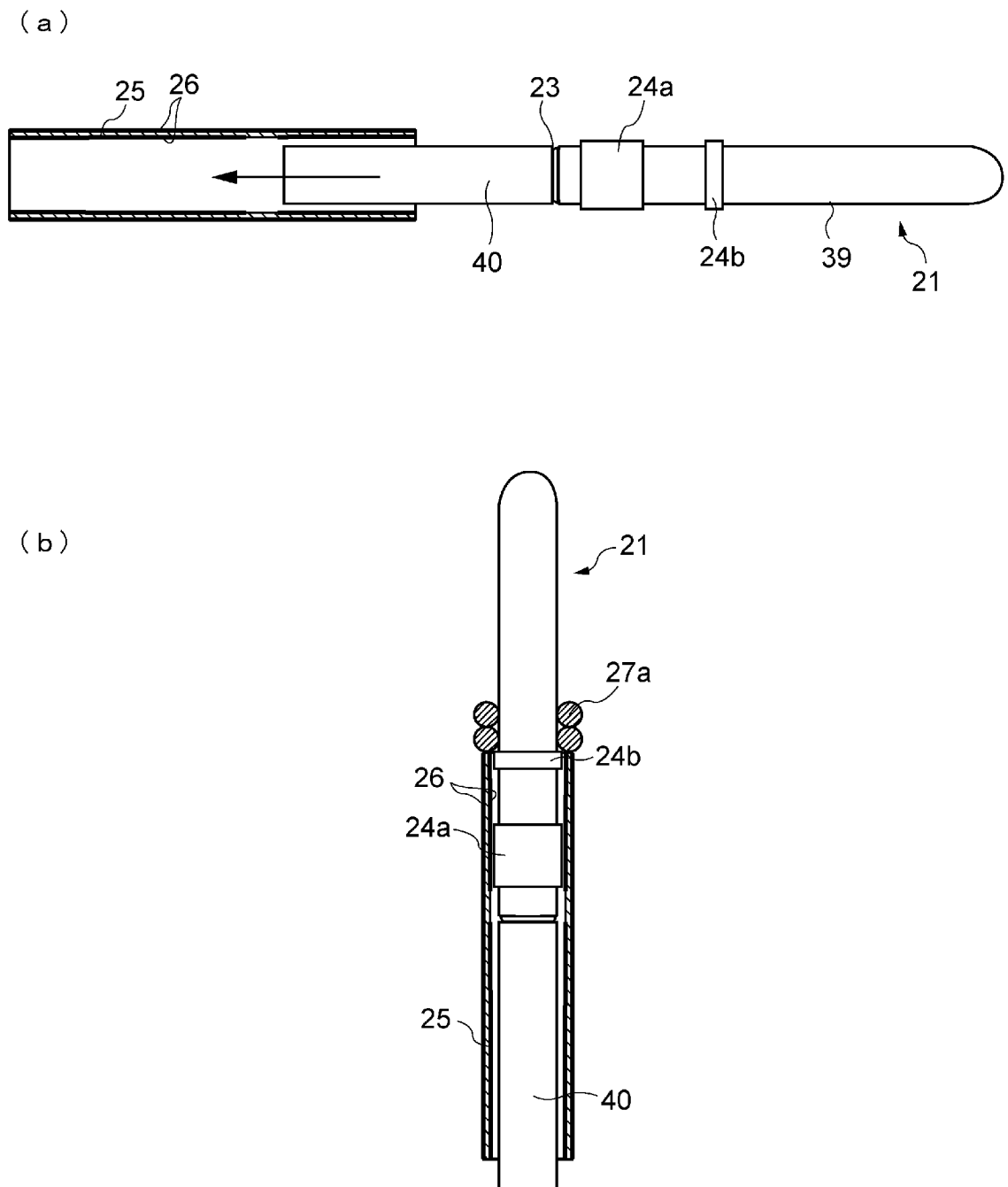
[Figure 4]



[Figure 5]

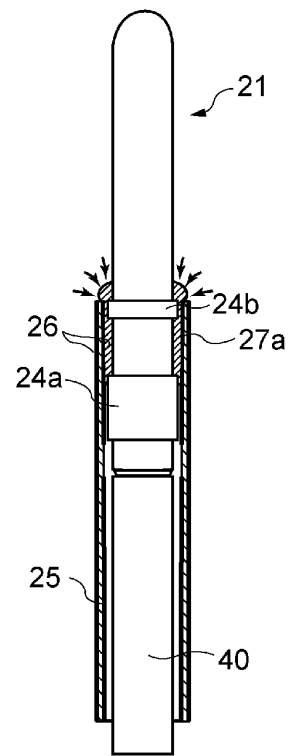


[Figure 6]

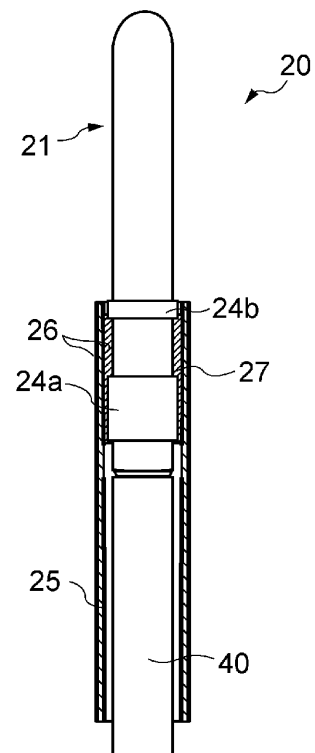


[Figure 7]

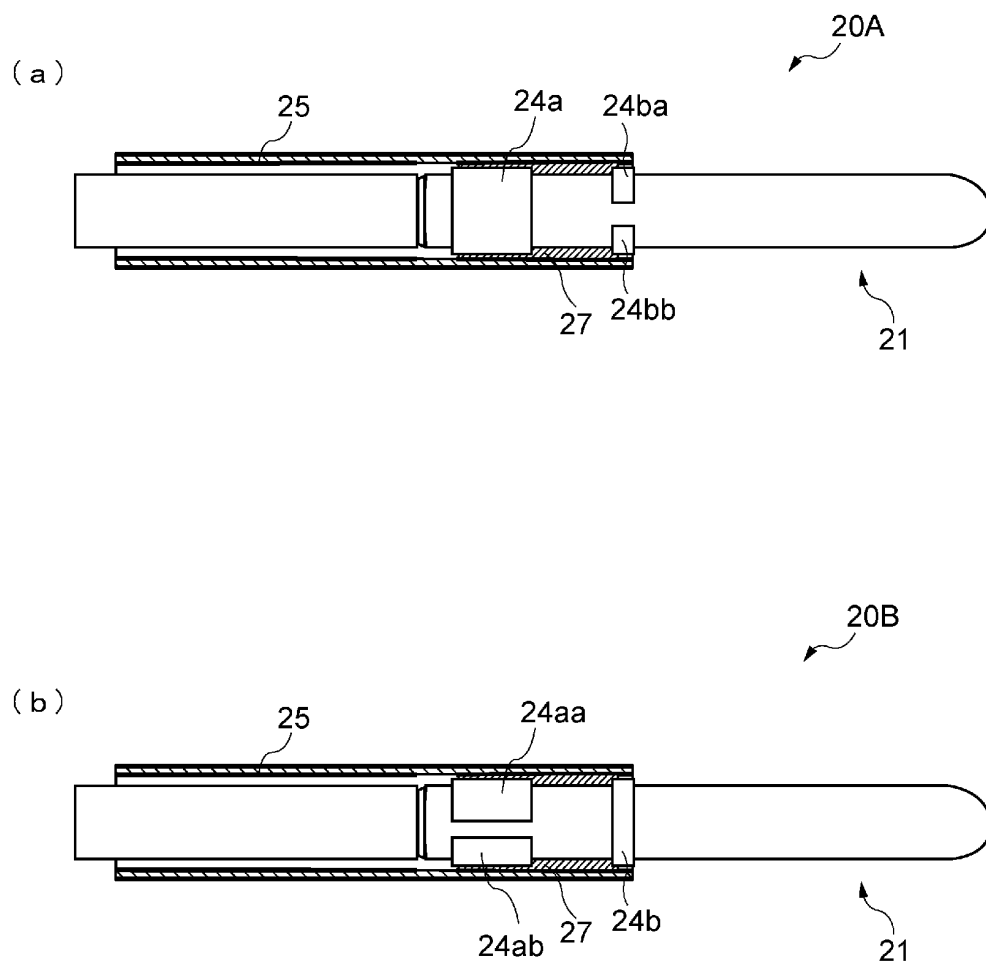
(a)



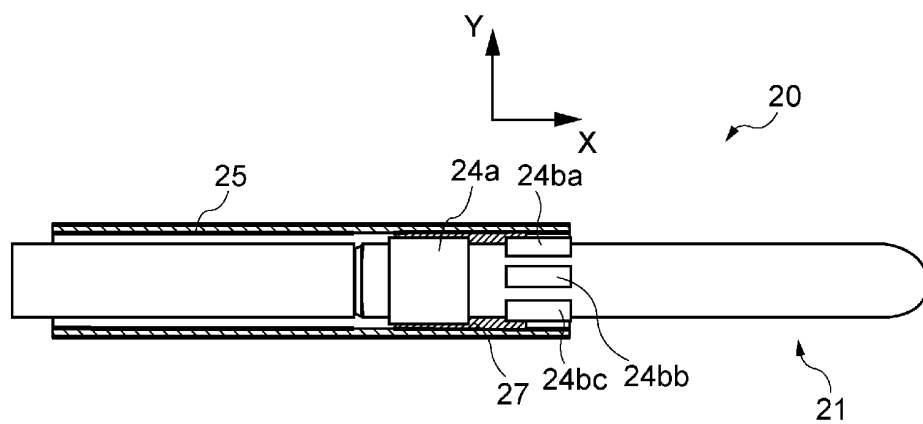
(b)



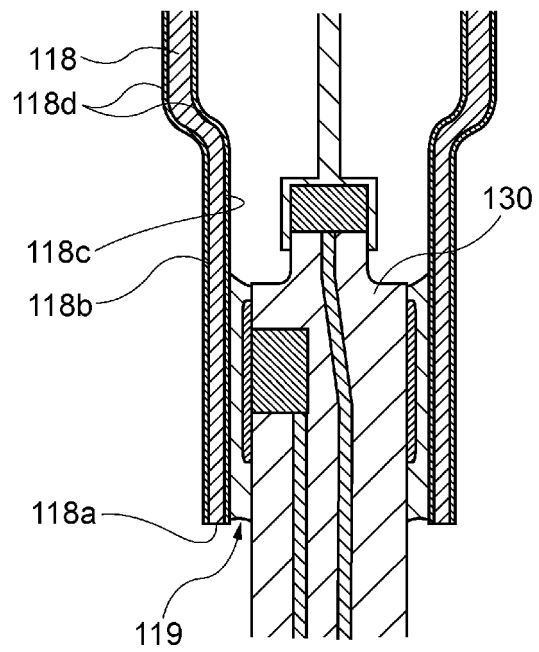
[Figure 8]



[Figure 9]



[Figure 10]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2013/074635

A. CLASSIFICATION OF SUBJECT MATTER

F23Q7/00 (2006.01) i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F23Q7/00

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2013

Kokai Jitsuyo Shinan Koho 1971-2013 Toroku Jitsuyo Shinan Koho 1994-2013

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	WO 2007/013497 A1 (Kyocera Corp.), 01 February 2007 (01.02.2007), paragraphs [0016] to [0045]; fig. 2, 3 & JP 4751392 B2 & US 2010/0006557 A1 & US 2013/0157075 A1 & EP 1916480 A1 & CN 101228396 A & KR 10-2008-0031314 A & KR 10-1016977 B1	1, 2, 7 3-6
Y	JP 2012-33340 A (Kyocera Corp.), 16 February 2012 (16.02.2012), paragraphs [0024] to [0033]; fig. 1, 2 (Family: none)	1, 2, 7
A	JP 2005-315447 A (Kyocera Corp.), 10 November 2005 (10.11.2005), entire text; all drawings (Family: none)	1-7

☒ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search
08 October, 2013 (08.10.13)Date of mailing of the international search report
22 October, 2013 (22.10.13)Name and mailing address of the ISA/
Japanese Patent Office

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2013/074635

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2002-270349 A (NGK Spark Plug Co., Ltd.), 20 September 2002 (20.09.2002), entire text; all drawings & US 2002/0153365 A1 & EP 1239222 A2 & DE 60225200 T2	1-7
A	JP 7-233944 A (NGK Spark Plug Co., Ltd., Isuzu Motors Ltd.), 05 September 1995 (05.09.1995), entire text; all drawings (Family: none)	1-7

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2005315447 A [0004]