



(11)

EP 3 852 199 A1

(12)

EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
21.07.2021 Bulletin 2021/29

(51) Int Cl.:
H01R 9/16 (2006.01)

(21) Application number: **19861121.2**

(86) International application number:
PCT/JP2019/035503

(22) Date of filing: **10.09.2019**

(87) International publication number:
WO 2020/054703 (19.03.2020 Gazette 2020/12)

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

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(30) Priority: **11.09.2018 JP 2018169868**

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(54) **HERMETIC TERMINAL**

(57) A hermetic terminal includes a plate-shaped ceramic substrate provided with a through hole for inserting a columnar conductive member in a thickness direction, a first tube body surrounding the ceramic substrate, and a second tube body coaxially connected with the first tube body. The first tube body includes a ferrite-type alloy, an Fe-Ni alloy, an Fe-Ni-Cr-Ti-Al alloy, an Fe-Cr-Al alloy or an Fe-Co-Cr alloy, and the second tube body includes an austenitic stainless steel with a nickel content of 10.4 mass% or more.

FIG. 2(a)

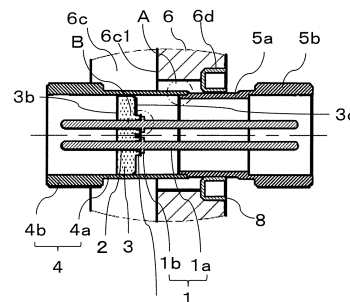


FIG. 2(b)

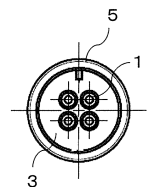


FIG. 2(c)

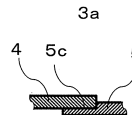


FIG. 2(d)

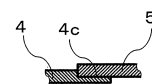
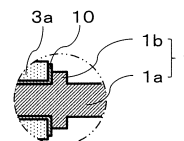


FIG. 2(e)



Description**BRIEF DESCRIPTION OF THE DRAWINGS****TECHNICAL FIELD****[0007]**

[0001] The present disclosure relates to a hermetic terminal.

BACKGROUND

[0002] Conventionally, in hermetic terminals used in a vacuum equipment, a nuclear equipment, or the like, a contact pin 21, a heat-resistant insulator 22, and a pipe flange (tube body) 23 are hermetically connected to each other as a hermetic terminal 30 shown in Fig. 5 to obtain a high leakage resistance, and the connecting is performed by brazing or the like, and it is required to have a necessary mechanical strength, and withstand impact and high temperature sufficiently. Therefore, alumina is used as the heat-resistant insulator 22, its surface is metallized, it is hermetically connected to the contact pin 21 and the pipe flange 23 by brazing, and to reduce difference of thermal expansion coefficients of the contact pin 21 and the pipe flange 23 with respect to the alumina, the contact pin 22 and the pipe flange 23 are normally formed by an iron-nickel alloy or an iron-nickel cobalt alloy.

[0003] Further, recently, as shown in Non-Patent Document 1, a multi-pole terminal is used as a hermetic terminal for extracting signal of a liquid hydrogen tank of a rocket.

PRIOR ART DOCUMENTS**Patent Document**

[0004] Patent Document 1: Japanese Patent Publication No. 2519642

Non-Patent Document

[0005] Non-Patent Document 1: Hajime Ishimaru, Hermetic Seal for Low Temperature, TEION KOGAKU 17(1), pp. 61-62 (1982)

SUMMARY

[0006] A hermetic terminal of the present disclosure includes a plate-shaped ceramic substrate in a plate shape provided with a through hole for inserting a columnar conductive member in a thickness direction, a first tube body surrounding the ceramic substrate, and a second tube body coaxially connected with the first tube body, and the first tube body includes a ferrico-type alloy, an Fe-Ni alloy, an Fe-Ni-Cr-Ti-Al alloy, an Fe-Cr-Al alloy or an Fe-Co-Cr alloy, and the second tube body includes an austenitic stainless steel with a nickel content of 10.4 mass% or more.

FIG. 1(a) is a perspective view at a side of a first tube body, and FIG. 1(b) is a perspective view at a side of a second tube body, illustrating one embodiment of a hermetic terminal of the present disclosure.

FIG. 2(a) is a drawing illustrating one embodiment of a sectional view along an axis direction of the first tube body and the second tube body, FIG. 2(b) is a side view of FIG. 2(a), FIG. 2(c) is a sectional view illustrating one embodiment enlarging the part A shown in FIG. 2(a), FIG. 2(d) is a sectional view illustrating another embodiment enlarging the part A shown in FIG. 2(a), and FIG. 2(e) is a sectional view illustrating one embodiment enlarging the part B shown in FIG. 2(a), illustrating the hermetic terminal of FIG. 1.

FIG. 3 is a sectional view illustrating another embodiment enlarging the part A of the hermetic terminal shown in FIG. 2.

FIG. 4(a) is a drawing illustrating another embodiment of a sectional view along the axis direction of the first tube body and the second tube body, FIG. 4(b) is a side view of FIG. 4(a), FIG. 4(c) is a sectional view illustrating one embodiment enlarging the part A shown in FIG. 4(a), FIG. 4(d) is a sectional view illustrating another embodiment enlarging the part A shown in FIG. 4(a), and FIG. 4(e) is a sectional view illustrating one embodiment enlarging the part B shown in FIG. 4(a), illustrating the hermetic terminal of FIG. 1.

FIG. 5 is a perspective view illustrating one embodiment of a conventional hermetic terminal.

EMBODIMENT

[0008] Embodiments of the present invention are described in detail below with reference to the drawings. In all the drawings of the present description, the same parts are designated by the same reference numerals unless confusion occurs, and the description thereof will be omitted as appropriate.

[0009] FIG. 1(a) is a perspective view at a side of a first tube body, and FIG. 1(b) is a perspective view at a side of a second tube body, illustrating one embodiment of a hermetic terminal of the present disclosure.

[0010] FIG. 2(a) is a drawing illustrating one embodiment of a sectional view along an axis direction of the first tube body and the second tube body, FIG. 2(b) is a side view of FIG. 2(a), FIG. 2(c) is a sectional view illustrating one embodiment enlarging the part A shown in FIG. 2(a), FIG. 2(d) is a sectional view illustrating another embodiment enlarging the part A shown in FIG. 2(a), and FIG. 2(e) is a sectional view illustrating one embodiment enlarging the part B shown in FIG. 2(a), illustrating the hermetic terminal of FIG. 1.

[0011] A hermetic terminal 20 illustrated in FIGs. 1 and 2 includes a plate shape ceramic substrate 3 provided with a through hole 2 for inserting a columnar conductive member 1 in a thickness direction, a first tube body 4 surrounding the ceramic substrate 3, and a second tube body 5 coaxially connected with the first tube body 4.

[0012] The conductive member 1 includes a columnar base part 1a inserted into the through hole 2, and a collar part 1b opposing to the ceramic substrate 3 on the mid-way in an axis direction of the columnar base part 1a. The conductive member 1 includes a fernico-type alloy, an Fe-Ni alloy, an Fe-Ni-Cr-Ti-Al alloy, an Fe-Co-Cr alloy or an Fe-Cr-Al alloy, the ceramic substrate 3 includes ceramics including aluminum oxide as a main component, and the conductive member 1 is supported by the ceramic substrate 3 provided with a metallized layer 10 formed on the surface by a brazing material including silver such as BAg-8, BAg-8A, BAg-8B or the like as a main component.

[0013] The term "main component in the ceramics" denotes a component of 85 mass% or more in 100 mass% of the components constituting the ceramics, the term "main component in the brazing material" denotes a component of 60 mass% or more in 100 mass% of the components constituting the brazing material.

[0014] The ceramics may include at least one of silicon, calcium and magnesium as an oxide in addition to aluminum oxide which is a main component.

[0015] The components constituting the ceramics may be identified by using an X-ray diffractometer (XRD), and then the content of components may be determined by using an X-ray fluorescent analyzer (XRF) or an ICP emission spectrometer (ICP), and converted it into the content of the identified components.

[0016] The content of the components constituting the brazing material may be determined by using an X-ray fluorescent analyzer (XRF) or an ICP emission spectrometer (ICP).

[0017] The first tube body 4 includes a shaft part 4a and a head part 4b having an outer diameter larger than the outer diameter of the shaft part 4a. Similarly, the second tube body 5 includes a shaft part 5a and a head part 5b having an outer diameter larger than the outer diameter of the shaft part 5a.

[0018] The hermetic terminal 20 includes a flange 6 provided with a plurality of through holes 6a for inserting the second tube body 5, and a plurality of through holes 6b for inserting fastening members such as bolts or the like on the outer peripheral side to fix a storage container for low temperature liquid or the like (not shown). The flange 6, for example, includes an austenitic stainless steel.

[0019] As shown in FIG. 2(a), the flange 6 surrounds the shaft part 4a of the first tube body 4 and the shaft part 5a of the second tube body 5, and separates an environment different on the left and right sides with the flange 6 as a boundary.

[0020] In FIG. 2(a), the side of the head part 4b of the

head part 4b and the shaft part 4a of the first tube body 4 located on the left side of the ceramic substrate 3 is used in an environment exposed to the atmosphere, the second tube body 5 located on the right side of the ceramic substrate 3 is used in an environment exposed to liquid hydrogen. The shaft part 4a of the first tube body 4 located on the right side of the ceramic substrate 3 is configured not to be directly exposed to the liquid hydrogen by the second tube body 5.

[0021] The first tube body 4 includes a fernico alloy, an Fe-Ni alloy, an Fe-Ni-Cr-Ti-Al alloy, an Fe-Cr-Al alloy or an Fe-Co-Cr alloy, and the second tube body 5 includes an austenitic stainless steel with a nickel content of 10.4 mass% or more.

[0022] If the first tube body 4 includes the above-described alloys, even if heating and cooling are repeated, linear expansion coefficients of these alloys have a small difference from a linear expansion coefficient of aluminum oxide, so residual stress is less likely to accumulate in the ceramic substrate 3, and thus cracks are less likely to occur in the ceramic substrate 3. Additionally, if the second tube body 5 includes the austenitic stainless steel with the nickel content of 10.4 mass% or more, it is less likely to be embrittled by hydrogen and can therefore be used for a long period of time.

[0023] The second tube body 5 includes, for example, SUS310S, SUS316L, SUS316LN, SUS316J1L or SUS317L.

[0024] In FIGs. 1 and 2, the first tube body 4 and the second tube body 5 are both circular cylindrical bodies, and the ceramic substrate 3 is a disk, but the first tube body 4 and the second tube body 5 may be both square cylindrical bodies, and the ceramic substrate 3 may be a square plate.

[0025] As shown in FIG. 2(c), an end of the second tube body 5 on the side of the first tube body 4 includes a step surface 5c.

[0026] As shown in FIG. 2(d), an end of the first tube body 4 on the side of the second tube body 5 includes a step surface 4c.

[0027] As shown in FIGs. 2(c) and 2(d), at least one of the end of the second tube body 5 on the side of the first tube body 4 and the end of the first tube body 4 on the side of the second tube body 5 may include the step surfaces 4c and 5c. In FIG. 2(c), the step surface 5c is included on the outer peripheral surface of the second tube body 5, but the step surface may be included on the inner peripheral surface of the second tube body 5. Additionally, in FIG. 2(d), the step surface 4c is included on the outer peripheral surface of the first tube body 4, but the step surface may be included on the inner peripheral surface of the first tube body 4.

[0028] With such a configuration, hydrogen volatilized by applying a high pressure is difficult to pass through a gap between the first tube body 4 and the second tube body 5, so that the volatilized hydrogen becomes difficult to leak to the outside through an internal space of the first tube body 4.

[0029] FIG. 3 is a sectional view illustrating another embodiment enlarging the part A of the hermetic terminal shown in FIG. 2.

[0030] As shown in FIG. 3, the second tube body 5 may include a coating layer 5d composed of nickel, copper or a copper-nickel alloy as a main component at least on a connecting part with the first tube body 4.

[0031] With such a configuration, the first tube body 4 and the second tube body 5 can be connected firmly by a connecting layer 7 including a brazing material, and thus reliability is improved.

[0032] The second tube body 5 may include the coating layer 5d composed of nickel, copper or a copper-nickel alloy as a main component on at least one of the surfaces exposed to the liquid hydrogen such as the inner peripheral surface, the outer peripheral surface, and the end surface in addition to the connecting part.

[0033] With such a configuration, embrittlement due to hydrogen of the austenitic stainless steel constituting the second tube body 5 can be delayed, so that it can be used for a longer period of time.

[0034] The second tube body 5 shown in FIG. 3 includes the coating layer 5d on the inner peripheral surface, the outer peripheral surface, and the end surface.

[0035] The first tube body 4 may include a coating layer 4d composed of nickel, copper or a copper-nickel alloy as a main component at least on a connecting part with the second tube body 5.

[0036] With such a configuration, the first tube body 4 and the second tube body 5 can be connected firmly by a brazing material, and thus reliability is improved.

[0037] As shown in FIG. 3, the inner peripheral surface of the first tube body 4 may be located outward rather than the outer peripheral surface of the second tube body 5.

[0038] With such a configuration, the first tube body 4 has a linear expansion coefficient smaller than the second tube body 5, so the gap is less likely to expand even if heating and cooling are repeated, and thus the volatilized hydrogen is less likely to leak to the outside through the internal space of the first tube body 4.

[0039] As shown in FIG. 3(a), if the second tube body 5 includes the step surface 5c on the end of the second tube body 5 on the side of the first tube body 4, the outer peripheral surface corresponds to the step surface 5c.

[0040] As shown in FIGs. 1 and 2, the flange 6 connected to the outer peripheral surface of the second tube body 5 and surrounding the second tube body 5 may be further included.

[0041] With such a configuration, different environments can be separated on the outer peripheral side of the second tube body 5 with the flange 6 as a boundary.

[0042] Then, as shown in FIG. 2, the flange 6 includes a second recessed part 6d at the side of the second tube body 5, a collar part 8 having a U-shaped cross section along an axial direction of the second tube body 5 is attached to the second recessed part 6d, and the second tube body 5 and the flange 6 are connected via the collar

part 8.

[0043] The collar part 8 may include a coating layer (not shown) including nickel, copper or a copper-nickel alloy as a main component at least on the connecting part with the second tube body 5, and the coating layer (not shown) may be included on entire surface of the collar part 8.

[0044] The term "main component in the coating layer" in the present disclosure denotes a component of 88 mass% or more in 100 mass% of the components constituting the coating layer, and may include phosphorus or the like in addition to the main component. If the coating layer including the copper-nickel alloy as a main component, the total content of copper and nickel is the content of the main component.

[0045] The content of the components in the coating layer may be determined by using an X-ray fluorescent analyzer (XRF) or an ICP emission spectrometer (ICP).

[0046] The collar part 8 and the second tube body 5 are connected by the brazing material including silver such as BAg-8, BAg-8A, BAg-8B or the like as a main component, and the flange 6 and the collar part 8 are welded by a TIG (Tungsten Inert Gas) welding method, and this welding is performed after each member is connected with the brazing material.

[0047] The flange 6 includes a first recessed part 6c at the side of the first tube body 4, and it is preferable that the connecting part between the ceramic substrate 3 and the first tube body 4 is located away from the second tube body 5 than a bottom surface 6c1 of the first recessed part 6c (that is, in FIG. 2(a), it is preferable that the connecting part between the ceramic substrate 3 and the first tube body 4 is located on the left side of the drawing with respect to a virtual plane where the bottom surface 6c1 of the first recessed part 6c is located, and the second tube body 5 is located on the right side of the drawing with respect to the virtual plane).

[0048] If the connecting part between the ceramic substrate 3 and the first tube body 4 is at this position, the heat generated by welding is less likely to be transferred to the ceramic substrate 3, so that residual stress is less likely to be generated in the ceramic substrate 3, and cracks are less likely to occur in the ceramic substrate 3.

[0049] Here, the first recessed part 6c is a counterbore for facilitating the attachment of the first tube body 4.

[0050] Further, the collar part 8 may include the austenitic stainless steel with the nickel content of 10.4 mass% or more. If the collar part 8 has such a configuration, it is less likely to be embrittled by hydrogen and can therefore be used for a long period of time.

[0051] The collar part 8 includes, for example, SUS310S, SUS316L, SUS316LN, SUS316J1L or SUS317L.

[0052] The nickel content in the second tube body 5 and the collar part 8 can be measured by using an ICP (Inductively Coupled Plasma) emission spectrometer or an X-ray fluorescent analyzer (XRF).

[0053] FIG. 4(a) is a drawing illustrating another em-

bodiment of a sectional view along the axis direction of the first tube body and the second tube body, FIG. 4(b) is a side view of FIG. 4(a), FIG. 4(c) is a sectional view illustrating one embodiment enlarging the part A shown in FIG. 4(a), FIG. 4(d) is a sectional view illustrating another embodiment enlarging the part A shown in FIG. 4(a), and FIG. 4(e) is a sectional view illustrating one embodiment enlarging the part B shown in FIG. 4(a), illustrating the hermetic terminal of FIG. 1.

[0054] As shown in FIG. 4, a plurality of conductive members 1 are individually inserted into a plurality of through holes 2, and the ceramic substrate 3 includes step parts 9 (9a, 9b) recessed from at least one of the main surfaces 3b, 3c around the through holes 2.

[0055] With such a configuration, a creepage distance between columnar base parts 1a of the conductive members 1 adjacent to each other becomes long, so that generation of creepage discharge between the columnar base parts 1a can be suppressed.

[0056] The ceramic substrate 3 includes the step parts 9 recessed from both of the main surfaces 3b, 3c around the through holes 2, and one of the step parts 9a further includes a metallized layer 10 on the step surface, and the step part 9a on the side provided with the metallized layer 10 may be deeper than the step part 9b on the side not provided with the metallized layer 10. Here, the metallized layer 10 is for fixing the conductive member 1 to the ceramic substrate 3 by brazing, and the thickness thereof is, for example, 5 μm or more and 55 μm or less.

[0057] If the step part 9a on the side provided with the metallized layer 10 is deeper than the step part 9b on the side provided with the metallized layer 10, the creepage distance between the columnar base parts 1a of the conductive members 1 adjacent to each other can be lengthened, so that even if the metallized layer 10 is made thicker, generation of creepage discharge between the conductive members 1 can be suppressed. Here, the depth of the step part 9a is a distance from the main surface to the step surface, and it does not include the thickness of the metallized layer 10.

[0058] The depth of the step part 9a on the side provided with the metallized layer 10 may be 45% or less of the thickness of the ceramic substrate 3. If the depth of the step part 9a is in this range, mechanical strength of the ceramic substrate 3 around the through holes 2 can be ensured. Here, the thickness of the ceramic substrate 3 is a distance between both main surfaces 3b, 3c of the ceramic substrate 3.

[0059] Further, as shown in FIG. 2, the plurality of conductive members 1 are individually inserted into the plurality of through holes 2, and the ceramic substrate 3 includes a protrusion part 3a extending from at least one of the main surfaces (the main surface 3c in the example shown in FIG. 2) around the through holes 2. With such a configuration, the metallized layer 10 opposing to the conductive member 1 can be lengthened, so that reliability of the connecting of the conductive member 1 to the ceramic substrate 3 can be increased.

[0060] The ceramic substrate 3 includes a plurality of open pores on the step surface where the metallized layer 10 is included or the tip end surface of the protrusion part 3a, and the value obtained by subtracting an average value of the equivalent circle diameters of the open pores from the distance between the centers of gravity of the open pores may be 20 μm or more and 50 μm or less.

[0061] If the value obtained by subtracting the average value of the equivalent circle diameters of the open pores from the distance between the centers of gravity of the open pores is 20 μm or more, it becomes difficult for the open pores to communicate with each other even if used in an environment where heating and cooling are repeated, so that the mechanical strength can be maintained, and cracks are less likely to occur in the metallized layer 10. Further, if the value obtained by subtracting the average value of the equivalent circle diameters of the open pores from the distance between the centers of gravity of the open pores is 50 μm or less, the density of the open pores is increased, so that an anchor effect of the metallized layer 10 to the ceramic substrate 3 is improved, and adhesion strength of the metallized layer 10 is increased.

[0062] If the value obtained by subtracting the average value of the equivalent circle diameters of the open pores from the distance between the centers of gravity of the open pores is 20 μm or more and 50 μm or less, the mechanical strength of the ceramic substrate 3 can be maintained, cracks can be suppressed in the metallized layer 10, and the adhesion strength of the metallized layer 10 can be improved.

[0063] In case of obtaining the distance between the centers of gravity of the open pores, the step surface of the ceramic substrate 3 or the tip end surface of the protrusion part 3a is polished with diamond abrasive grains to obtain a mirror surface. Here, an arithmetic mean roughness Ra of the mirror surface is set to 0.2 μm or less by using a measurement method in accordance with JIS B 0601: 2013. A part where the size and distribution of the open pores are observed on average is selected from the mirror surface, and an optical microscope is used with a magnification of 200 times to measure an area of, for example, $1.5 \times 10^5 \mu\text{m}^2$ as a measurement area.

[0064] By using the measurement area as a measurement object, a method called a distance between centers of gravity of an image analysis software "A-ZOKUN (ver 2.52)" (registered trademark, produced by Asahi Kasei Engineering Corporation, and hereinafter, indicated by the image analysis software) is applied, and the distance between the centers of gravity of the open pores adjacent to each other can be obtained. The distance between the centers of gravity of the open pores in the present disclosure is a linear distance connecting the centers of gravity of the open pores.

[0065] To measure the equivalent circle diameter of the open pores, a method called a particle analysis of the image analysis software is applied to the above meas-

urement area as an object

[0066] As setting conditions for the distance between the center of gravity method and the particle analysis, for example, brightness is set to be dark, binarization method is set to be manual, a small figure removal area is set to be $1\text{ }\mu\text{m}^2$, and a noise removal filter is set to be present, and then a threshold value should be set in such a way that a marker appearing on the screen matches the shape of the open pore. The threshold value is, for example, 155.

[0067] One of embodiments of a method for manufacturing the hermetic terminal of the present disclosure is described below.

[0068] A first tube body, a second tube body, and a ceramic substrate in which a conductive member is inserted into a through hole are prepared.

[0069] The ceramic substrate can be obtained by the following manufacturing method.

[0070] First, aluminum oxide powder, which is the main component, magnesium hydroxide, silicon oxide, calcium carbonate, and zirconium oxide powders, a dispersant to disperse the aluminum oxide powder as needed, and an organic binder are wet-mixed by a ball mill, a bead mill, or a vibration mill to obtain a slurry.

[0071] Here, the mean particle size (D_{50}) of the aluminum oxide powder is $3\text{ }\mu\text{m}$ or less, preferably $1\text{ }\mu\text{m}$ or less, and in a total of 100 mass% of the above-described powders, the content of the magnesium hydroxide powder is 0.87 mass% to 1.07 mass%, the content of the silicon oxide powder is 6.1 mass% to 7.5 mass%, the content of the calcium carbonate powder is 2.5 mass% to 3.1 mass%, and the content of the zirconium oxide is 1.0 mass% to 1.3 mass%.

[0072] The time for wet mixing is, for example, 40 to 50 hours. Examples of the organic binder include paraffin wax, wax emulsion (wax and emulsifier), PVA (polyvinyl alcohol), PEG (polyethylene glycol), and PEO (polyethylene oxide).

[0073] Next, the slurry obtained by the above-described method is spray-granulated to obtain granules, and then the granules are molded by a powder press molding method or a cold isostatic pressing method to obtain a molded body in a disk shape. Then, a ceramic substrate can be obtained by forming a through hole and step parts or a protrusion part by a cutting process, and sintering the molded body in which the through holes and the like are formed at a temperature of 1550°C or more and 1750°C or less.

[0074] To obtain a ceramic substrate provided with a plurality of open pores on the step surface where the metallized layer is included or on the tip end surface of the protrusion part, and where the value obtained by subtracting an average value of the equivalent circle diameters of the open pores from a distance between centers of gravity of the open pores is $20\text{ }\mu\text{m}$ or more and $50\text{ }\mu\text{m}$ or less, a molded body is manufactured by the cold isostatic pressing method with a molding pressure of 98 MPa or more and 147 MPa or less, and sintered at a

temperature of 1580°C or more and 1750°C or less.

[0075] A coating layer composed of nickel, copper, or a copper-nickel alloy as a main component may be formed in advance on at least one of the connecting part of the conductive member with the ceramic substrate, the connecting part of the first tube body with the second tube body, the connecting part of the first tube body with the ceramic substrate, the connecting part of the second tube body with the first tube body, and the connecting part of the ceramic substrate with the first tube body by a plating method.

[0076] The above-described coating layer may be formed on the entire surface of each of the conductive member, the first tube body, and the second tube body.

[0077] If at least one of the end of the second tube body on the side of the first tube body and the end of the first tube body on the side of the second tube body includes a step surface, the above-described coating layer may be formed on the step surface.

[0078] In at least one of the connecting part of the ceramic substrate with the conductive member and the connecting part of the ceramic substrate with the first tube body the metallized layer may be formed in advance by a Mo-Mn method, and then a coating layer composed of nickel, copper or the copper-nickel alloy as a main component by the plating method.

[0079] The above-described coating layer may be formed on the entire outer peripheral surface of the ceramic substrate.

[0080] Then, by applying a brazing material including silver such as BAg-8, BAg-8A, BAg-8B as a main component to each of the opposing connecting parts and performing a heat treatment at an appropriate temperature, the connecting parts are connected, and the hermetic terminal of the present disclosure can be obtained.

[0081] Here, the appropriate temperature is the brazing temperature described in JIS Z 3281: 1998.

[0082] Further, to obtain a hermetic terminal provided with a flange, a first tube body, a ceramic substrate in which a conductive member is inserted into a through hole, and a second tube body to which a collar part is attached are prepared.

[0083] Then, after connecting each of the opposing connecting parts with the above-mentioned brazing material, the flange is attached to the outer peripheral side of the collar part, and the hermetic terminal of the present disclosure can be obtained by welding and fixing by the TIG (Tungsten Inert Gas) welding method.

[0084] The hermetic terminals of the present disclosure obtained by the above-mentioned manufacturing method have high embrittlement to hydrogen, and can therefore be used for a long period of time.

[0085] The present invention is not limited to the foregoing embodiment, and various changes and improvements can be made in accordance with the technical idea of the present invention.

[0086] For example, in the above-described embodiment, an example that the second tube body 5 is con-

nected to the flange 6 via the collar part 8 is shown, but the second tube body 5 may be directly connected to the flange 6. Further, in the above-described embodiment, an example that the collar part 8 has a U-shaped cross section is shown, but the collar part 8 may have another shape such as an L-shaped cross section or the like. If the collar part 8 has a U-shape, an L-shape, or the like, the bent part may be curved. Additionally, in the above-described embodiment, an example that the collar part 8 is connected to the second recessed part 6d of the flange 6 is shown, but the flange 6 may not include the second recessed part 6d, and the collar part 8 may be connected to the inner peripheral surface of the flange 6 or the main surface at the side of the second tube body 5. Description of the Reference Numeral

[0087]

1	conductive member
2	through hole
3	ceramic substrate
3a	protrusion part
3b, 3c	main surface
4	first tube body
5	second tube body
6	flange
7	connecting layer
8	collar part
9	step part
10	metallized layer
20	hermetic terminal

Claims

1. A hermetic terminal comprising a plate-shaped ceramic substrate provided with a through hole for inserting a columnar conductive member in a thickness direction, a first tube body surrounding the ceramic substrate, and a second tube body coaxially connected with the first tube body, wherein the first tube body comprises a ferrico-type alloy, an Fe-Ni alloy, an Fe-Ni-Cr-Ti-Al alloy, an Fe-Cr-Al alloy or an Fe-Co-Cr alloy, and the second tube body comprises an austenitic stainless steel with a nickel content of 10.4 mass% or more.
2. The hermetic terminal according to claim 1, wherein at least one of the end of the second tube body on the side of the first tube body and the end of the first tube body on the side of the second tube body has a step surface.
3. The hermetic terminal according to claim 1 or 2, wherein the second tube body is provided with a coating layer composed of nickel, copper or a copper-nickel alloy as a main component at least on a connecting part with the first tube body.

4. The hermetic terminal according to any one of claims 1 to 3, wherein an inner peripheral surface of the first tube body is located outward rather than an outer peripheral surface of the second tube body.
5. The hermetic terminal according to any one of claims 1 to 4, further comprising a flange connected to the outer peripheral surface of the second tube body and surrounding the second tube body.
6. The hermetic terminal according to claim 5, wherein the flange is provided with a second recessed part on the side of the second tube body, a collar part having a U-shaped cross section along an axial direction of the second tube body is attached to the second recessed part, and the second tube body and the flange are connected to each other via the collar part, and wherein the flange is provided with a first recessed part at the side of the first tube body, and a connecting part between the ceramic substrate and the first tube body is located away from the second tube body than a bottom surface of the first recessed part.
7. The hermetic terminal according to claim 6, wherein the collar part comprises an austenitic stainless steel with a nickel content of 10.4 mass% or more.
8. The hermetic terminal according to any one of claims 1 to 7, wherein a plurality of the conductive members are individually inserted into a plurality of the through holes, and the ceramic substrate is provided with step parts recessed from at least one of the main surfaces around the through holes.
9. The hermetic terminal according to claim 8, wherein the ceramic substrate comprises the step parts recessed from both of the main surfaces around the through holes, one of the step parts is further provided with a metallized layer on the step surface, and the step part on the side provided with the metallized layer is deeper than the step part on the side not provided with the metallized layer.
10. The hermetic terminal according to claim 9, wherein a depth of the step part on the side provided with the metallized layer is 45% or less of a thickness of the ceramic substrate.
11. The hermetic terminal according to any one of claims 1 to 7, wherein the plurality of conductive members are individually inserted into the plurality of through holes, and the ceramic substrate is provided with a protrusion part extending from at least one of the main surfaces around the through holes.
12. The hermetic terminal according to any one of claims 9 to 11, wherein the ceramic substrate is provided

with a plurality of open pores on the step surface provided with the metallized layer or a tip end surface of the protrusion part, and a value obtained by subtracting an average value of equivalent circle diameters of the open pores from a distance between centers of gravity of the open pores is 20 μm or more and 50 μm or less.

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FIG. 1(a)

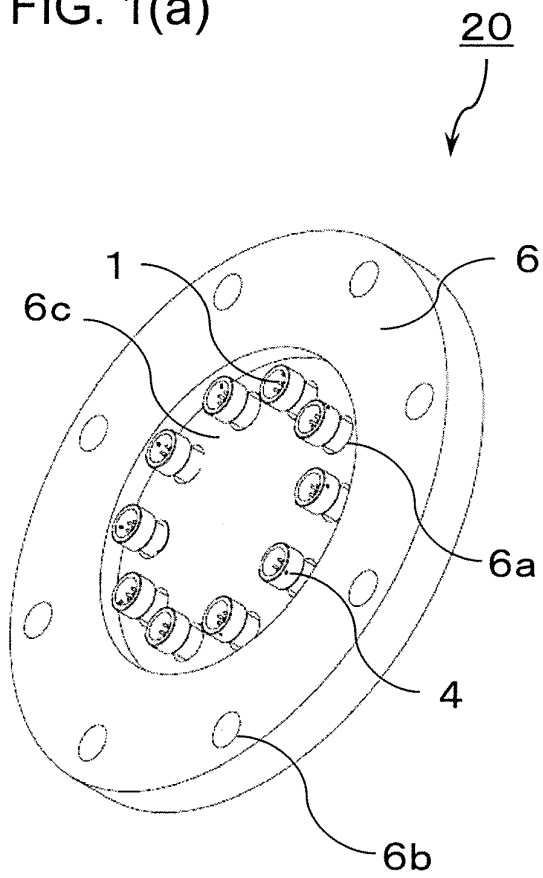


FIG. 1(b)

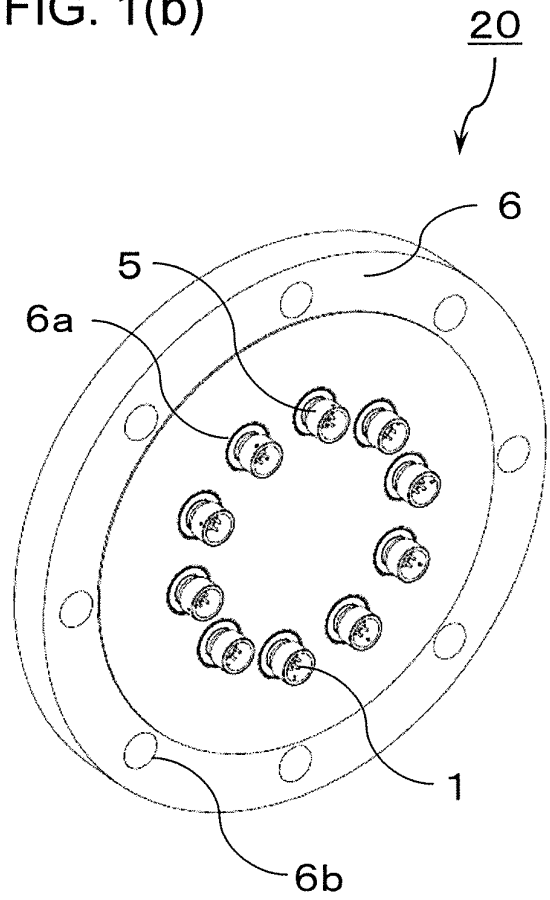


FIG. 2(a)

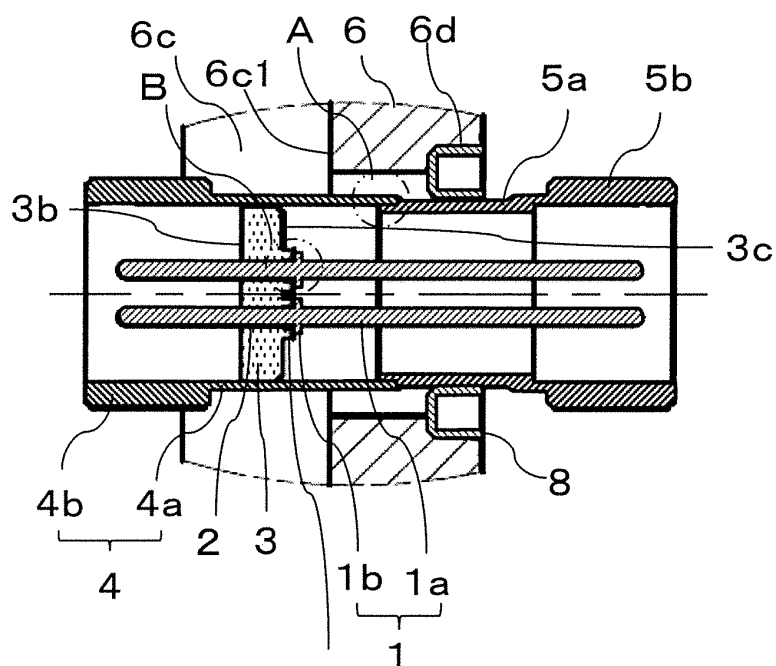


FIG. 2(b)

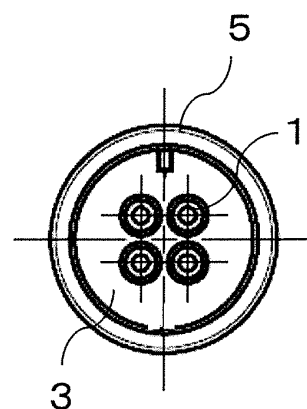


FIG. 2(c)

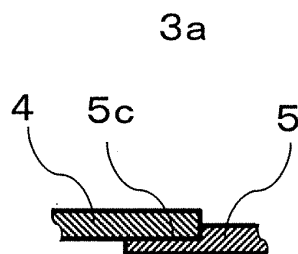


FIG. 2(d)

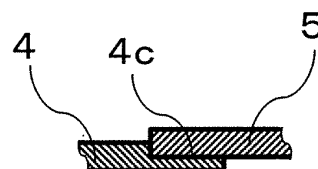


FIG. 2(e)

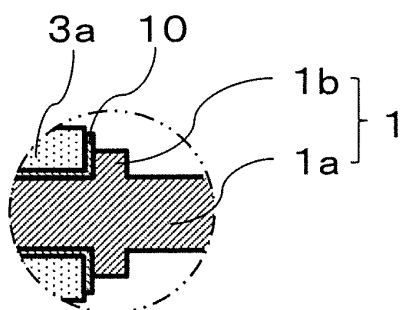


FIG. 3(a)

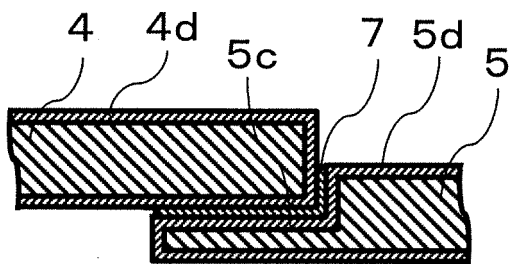


FIG. 3(b)

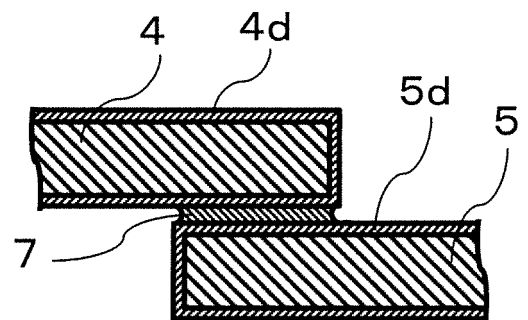


FIG. 4(a)

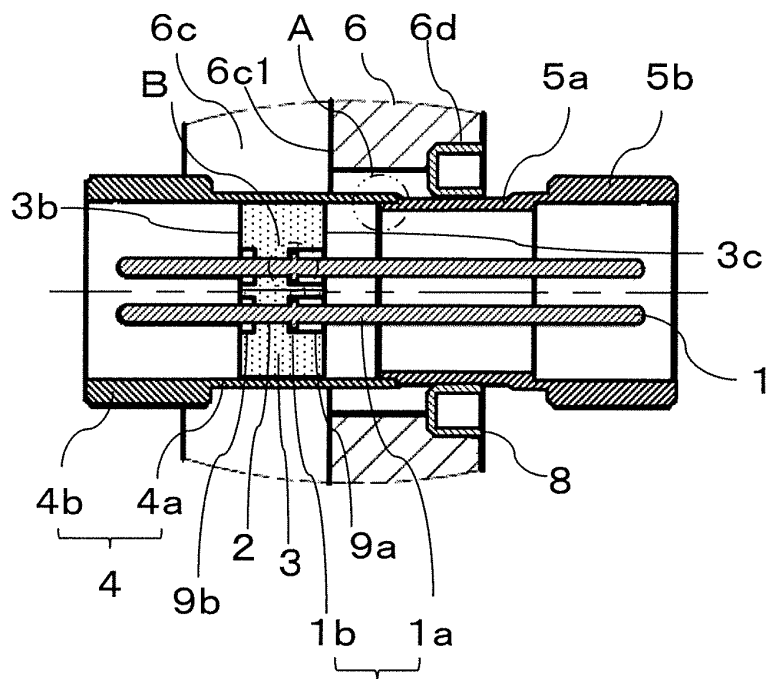


FIG. 4(b)

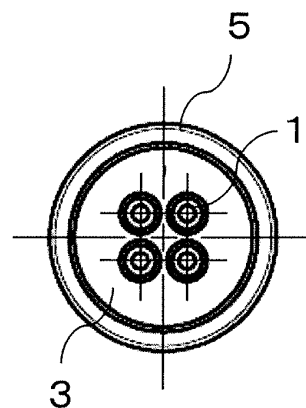


FIG. 4(c)

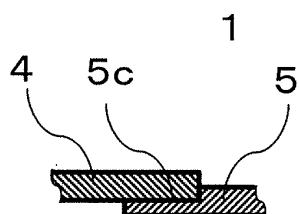


FIG. 4(d)

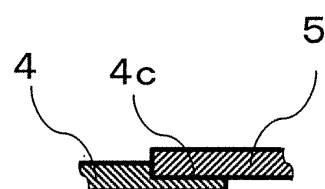


FIG. 4(e)

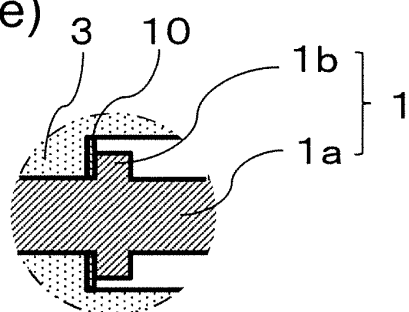
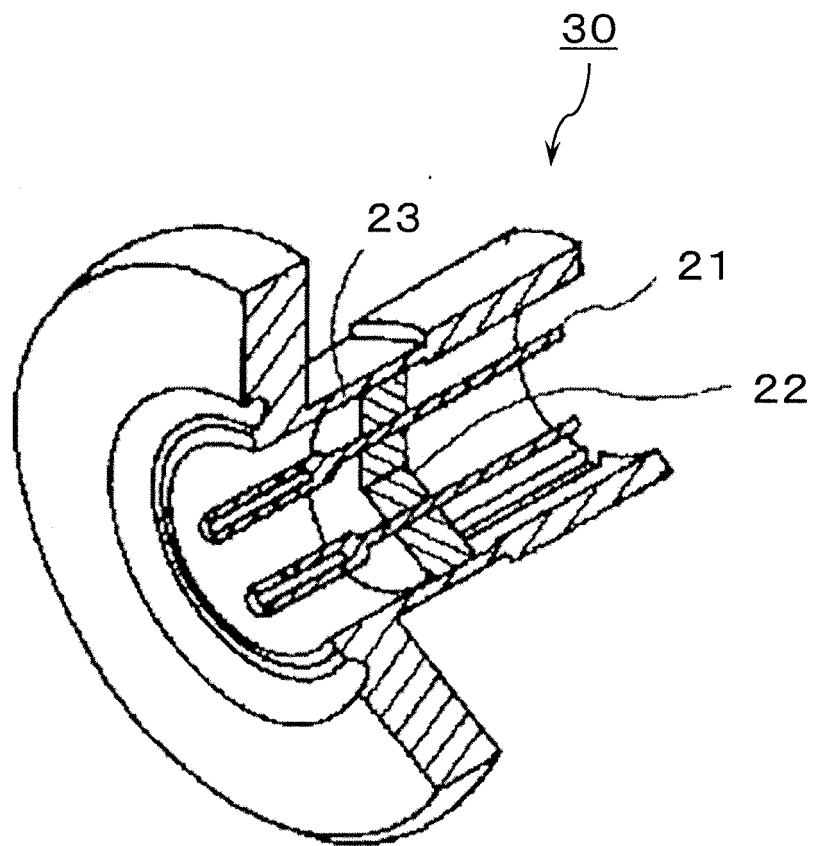


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2019/035503

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. H01R9/16 (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)

Int.Cl. H01R9/16

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

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2019

Registered utility model specifications of Japan 1996-2019

Published registered utility model applications of Japan 1994-2019

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	JP 2005-235577 A (KYOCERA CORPORATION) 02 September 2005, paragraphs [0017]-[0036], fig. 1, 2 (Family: none)	1-5, 8, 11-12 6-7, 9-10
Y A	JP 2519642 B2 (HITACHI HARAMACHI SEMICONDUCTOR LTD.) 31 July 1996, paragraphs [0002]-[0016], fig. 1-6 (Family: none)	1-5, 8, 11-12 6-7, 9-10
Y A	JP 2006-324229 A (KYOCERA CORPORATION) 30 November 2006, paragraphs [0029]-[0071], fig. 1-3 (Family: none)	1-5, 8, 11-12 6-7, 9-10



Further documents are listed in the continuation of Box C.



See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search

08.10.2019

Date of mailing of the international search report

21.10.2019

Name and mailing address of the ISA/

Japan Patent Office

3-4-3, Kasumigaseki, Chiyoda-ku,

Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2019/035503

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	WO 2011/096592 A1 (MIURA, Harumatsu) 11 August 2011, paragraphs [0035], [0036], [0038]-[0087], fig. 1, 2 & JP 2016-65314 A & US 2013/0004883 A1, paragraphs [0051], [0052], [0060]-[0130], fig. 1, 2 & US 2016/0289812 A1	1-5, 8, 11-12 6-7, 9-10
Y A	JP 2007-201335 A (KYOCERA CORPORATION) 09 August 2007, paragraphs [0030]-[0077], fig. 1-3 (Family: none)	8, 11-12 9-10
Y	JP 07-282621 A (ROHM CO., LTD.) 27 October 1995, paragraphs [0022], [0023], fig. 3-7 (Family: none)	12
A	JP 2005-235576 A (KYOCERA CORPORATION) 02 September 2005 (Family: none)	1-12
A	JP 02-012682 Y2 (KYOCERA CORPORATION) 10 April 1990 (Family: none)	1-4
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 032806/1991 (Laid-open No. 119964/1992) (KYOCERA CORPORATION) 27 October 1992 (Family: none)	1-4
A	JP 2006-179340 A (KYOCERA CORPORATION) 06 July 2006 (Family: none)	1, 8-12

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2519642 B [0004]

Non-patent literature cited in the description

- **HAJIME ISHIMARU**. Hermetic Seal for Low Temperature. *TEION KOGAKU*, 1982, vol. 17 (1), 61-62 [0005]