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(71) Applicant: **YAZAKI CORPORATION**
4-28, Mita 1-chome
Minato-ku Tokyo 108(JP)

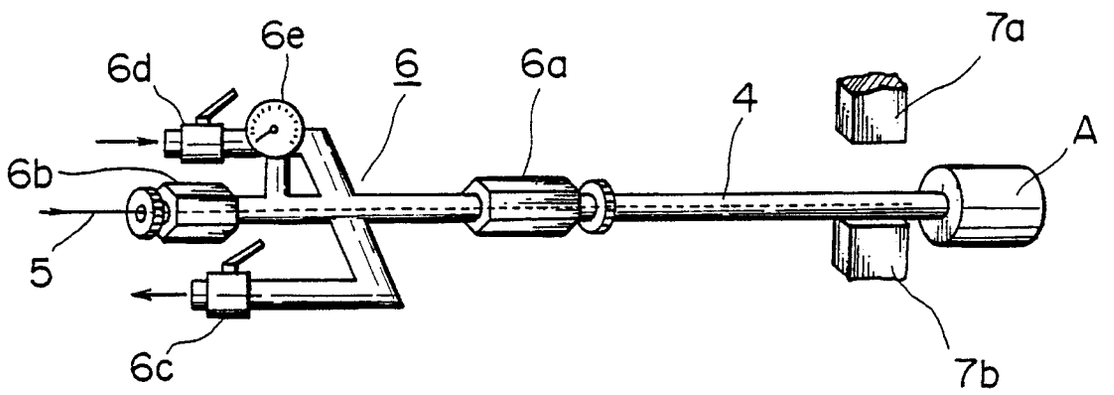
(72) Inventor: **Yagi, Kiyoshi, c/o Yazaki Parts Co. Ltd.**
252 Kawashimada
Gotenba-shi, Shizuoka 412(JP)
Inventor: **Wakabayashi, Seiichi, c/o Yazaki Parts Co. Ltd.**
252 Kawashimada
Gotenba-shi, Shizuoka 412(JP)

(74) Representative: **Patentanwälte Grünecker, Kinkeldey, Stockmair & Partnerner**
Maximilianstrasse 58
D-8000 München 22(DE)

(54) Method of manufacturing gas sealed discharge tube.

(57) A method of manufacturing a gas sealed discharge tube (A) including an electrical insulating cylindrical body and a pair of electrodes attached to opposite ends of the electrical insulating cylindrical body. The method comprises the steps of inserting a heat melting sealing material (5) into a gas introducing pipe (6b) mounted to at least one of the electrodes so as to communicate an inside space of the cylindrical body to an outside thereof, the heat melting sealing material being a solid having an outer diameter smaller than an inner diameter of the gas introducing pipe (6d); introducing a gas through the gas introducing pipe into the cylindrical body; heating the gas introducing pipe together with the heat melting sealing material under pressure at a sealing position where the gas introducing pipe is intended to be sealed to thereby press the gas introducing pipe and simultaneously melt the heat melting sealing material; and cutting the gas introducing pipe at the sealing position together with the heat melting sealing material after solidified.

FIG. 1



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METHOD OF MANUFACTURING GAS SEALED DISCHARGE TUBE

BACKGROUND OF THE INVENTION

The present invention relates to a method of manufacturing a voltage controlling discharge tube, and more particularly to a method of manufacturing a gas sealed discharge tube for a series gap in an ignition device for an automotive engine, for example.

An ignition device for an automotive engine or the like is designed to apply a high voltage to a spark plug and thereby generate a spark. To prevent the generation of misfire and precisely control an ignition timing, there has been proposed a so-called series gap ignition device having a discharge gap formed in series with the spark plug. It is known to use a discharge tube for the formation of such a series gap which discharge tube is provided with a pair of discharge electrodes mounted on opposite ends of a cylindrical body and filled with an inert gas.

In precisely controlling an ignition timing of the spark plug with use of such a discharge tube for a series gap, a discharge starting voltage in the discharge tube is required to be high to some extent as compared with that of the ignition plug. It is also known to increase a pressure of the inert gas to be filled, so as to increase the discharge starting voltage with the discharge tube maintained compact.

In assembling such a discharge tube, there has been conventionally adopted a melt-bonding method using a glass frit or metal solder to hermetically connect a cylindrical body formed of an electrical insulating material capable of enduring a high voltage such as glass or ceramics to electrode terminals formed of metal. It has been considered to be preferable that such a bonding process should be carried out in a vacuum electric furnace, so as to ensure a quality of the discharge tube. In assembling a gas sealed discharge tube, it is necessary to change an atmosphere in the electric furnace from a vacuum condition to a gas atmosphere. However, to fill a high pressure gas in the discharge tube, the electric furnace is required to endure a high pressure. As a result, an apparatus for assembling the discharge tube becomes large and complicated, and the number of assembling steps is also increased to cause a disadvantage from an economical viewpoint.

SUMMARY OF THE INVENTION

In view of the foregoing, it is an object of the present invention to provide a method of economically manufacturing a high-pressure gas sealed discharge tube having a uniform performance suitable for the series gap.

The above object can be achieved by the following construction of the present invention. That is, according to the present invention, there is provided a method of manufacturing a gas sealed discharge tube including an electrical insulating cylindrical body and a pair of electrodes attached to opposite ends of said electrical insulating cylindrical body, said method comprising the steps of inserting a heat melting sealing material into a gas introducing pipe mounted to at least one of said electrodes so as to communicate an inside space of said cylindrical body to an outside thereof, said heat melting sealing material being a solid having an outer diameter smaller than an inner diameter of said gas introducing pipe; introducing a gas through said gas introducing pipe into said cylindrical body; heating said gas introducing pipe together with said heat melting sealing material under pressure at a sealing position where said gas introducing pipe is intended to be sealed to thereby press said gas introducing pipe and simultaneously melt said heat melting sealing material; and cutting said gas introducing pipe at said sealing position together with said heat melting sealing material after solidified.

The gas introducing pipe to be mounted to the discharge tube in the present invention is required to be pressed by heating under pressure. Furthermore, it is necessary to hermetically mount the gas introducing pipe to at least one of the electrodes by any bonding means such as welding or brazing. Moreover, the gas introducing pipe is preferably formed of an electrical conductive material such as metal, preferably, a copper material.

The heat melting sealing material to be inserted into the gas introducing pipe has a melting point lower than that of the gas introducing pipe, and preferably has an affinity to the material of the gas introducing pipe and a good wettability. For example, the sealing material is selected from silver solder, solder or high-molecular adhesive. However, the sealing material is not limited to these materials. Furthermore, the heat melting sealing material is required to be a solid having an outer diameter smaller than an inner diameter of the gas introducing pipe. For example, the sealing material is in the form of rod, wire or granule. Particularly, a wire form of the sealing material is preferable since an insert position of the sealing material in the gas introducing pipe can be easily controlled and adjusted.

According to the method of manufacturing a gas sealed discharge tube of the present invention,

a composition and pressure of a gas to be sealed can be greatly easily adjusted, and a manufacturing equipment and its operation are simple. Therefore, mass production of a gas sealed discharge tube having a high quality can be economically carried out.

Other objects and features of the invention will be more fully understood from the following detailed description and appended claims when taken with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic illustration of a device embodying the method of manufacturing a gas sealed discharge tube according to the present invention;

Fig. 2 is a sectional view of a discharge tube assembly to be suitably used for embodying the manufacturing method of the present invention; and

Fig. 3 is a sectional view of a gas sealed discharge tube manufactured by the manufacturing method of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

There will now be described a preferred embodiment of the method of manufacturing a gas sealed discharge tube according to the present invention with reference to the drawings.

Referring to Fig. 2 which is a sectional view of a discharge tube assembly A before applying the method of the present invention, reference numeral 1 designates an electrical insulating cylindrical body formed of glass or ceramics, and reference numerals 2 and 3 designate discharge electrodes bonded to opposite ends of the cylindrical body 1. The electrode 2 is formed with a through-hole 2′. A gas introducing pipe 4 is engaged with the through-hole 2′, and is brazed to the electrode 2. Such an assembly A can be formed under vacuum or in the atmosphere of air or inert gas, for example.

The assembly A is mounted to a device as shown in Fig. 1, so as to form a gas sealed discharge tube B as shown in Fig. 3. This device is constructed of a jig 6 and a press including a pair of heating electrodes 7a and 7b. The jig 6 is constructed of a piping system including a joint portion 6a adapted to be hermetically connected to a free end of the gas introducing pipe 4, a wire inserting portion 6b adapted to hermetically insert a silver solder wire 5, a connecting portion 6c connected to a vacuum device (not shown) for evacuating the inside of the assembly A, a gas introducing portion 6d for supplying an inert gas into the assembly A, and a manometer 6e.

In manufacturing the gas sealed discharge tube B by using the above device, the free end of the gas introducing pipe 4 of the assembly A is first connected to the joint portion 6a, and then the silver solder wire 5 is inserted through the wire inserting portion 6b into the gas introducing pipe 4 as far as a sealing position where the gas introducing pipe 4 is intended to be sealed. Then, the wire inserting portion 6b and the gas introducing portion 6d are closed, and the inside of the assembly A is evacuated through the connecting portion 6c by the vacuum device. Then, the connecting portion 6c is closed, and an inert gas is introduced from the gas introducing portion 6d until a predetermined pressure is reached. Then, the gas introducing pipe 4 is pressed by the heating electrodes 7a and 7b, and simultaneously the silver solder wire 5 is molten by the heating electrodes 7a and 7b. Then, the heating electrodes 7a and 7b are moved away from each other to solidify the silver solder of the wire 5, thus completing the sealing operation of the assembly A. Then, the assembly A containing the sealed gas is removed from the joint portion 6a, and the gas introducing pipe 4 is cut at a sealing portion 4′ as shown in Fig. 3. Thus, the gas sealed discharge tube B sealed by a solidified silver solder 5′ as shown in Fig. 3 is obtained.

While the invention has been described with reference to a specific embodiment, the description is illustrative and is not to be construed as limiting the scope of the invention. Various modifications and changes may occur to those skilled in the art without departing from the spirit and scope of the invention as defined by the appended claims.

Claims

1. A method of manufacturing a gas sealed discharge tube including an electrical insulating cylindrical body and a pair of electrodes attached to opposite ends of said electrical insulating cylindrical body, said method comprising the steps of inserting a heat melting sealing material into a gas introducing pipe mounted to at least one of said electrodes so as to communicate an inside space of said cylindrical body to an outside thereof, said heat melting sealing material being a solid having an outer diameter smaller than an inner diameter of said gas introducing pipe; introducing a gas through said gas introducing pipe into said cylindrical body; heating said gas introducing pipe together with said heat melting sealing material under pressure at a sealing position where said gas introducing pipe is intended to be sealed to thereby press said gas introducing pipe and simultaneously melt said heat melting sealing material;

and cutting said gas introducing pipe at said sealing position together with said heat melting sealing material after solidified.

2. The method as defined in claim 1, wherein said gas introducing pipe is hermetically mounted to at least one of said electrodes.

3. The method as defined in claim 2, wherein said gas introducing pipe is welded to at least one of said electrodes.

4. The method as defined in claim 2, wherein said gas introducing pipe is brazed to at least one of said electrodes.

5. The method as defined in claim 1, wherein said gas introducing pipe is formed of an electrical conductive material.

6. The method as defined in claim 5, wherein said electrical conductive material comprises metal.

7. The method as defined in claim 6, wherein said metal comprises a copper material.

8. The method as defined in claim 1, wherein said heat melting sealing material has a melting point lower than that of said gas introducing pipe.

9. The method as defined in claim 8, wherein said heat melting sealing material has an affinity to a material forming said gas introducing pipe and has a good wettability.

10. The method as defined in claim 9, wherein said heat melting sealing material is selected from the group consisting of silver solder, solder and high-molecular adhesive.

11. The method as defined in claim 1, wherein said heat melting sealing material is in the form of wire.

12. The method as defined in claim 1 further comprising the step of evacuating an inside space of said cylindrical body before said gas introducing step.

13. The method as defined in claim 1, wherein said heating step is carried out by a press device including a pair of heating electrodes.

FIG. 1

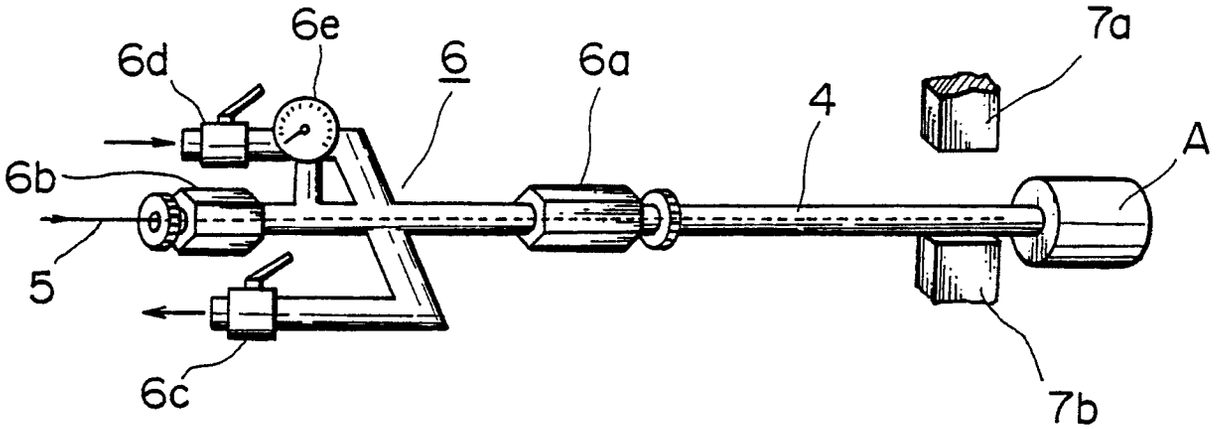


FIG. 2

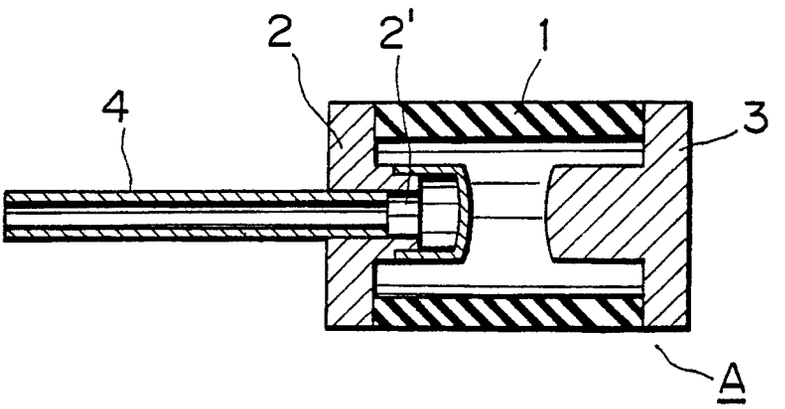
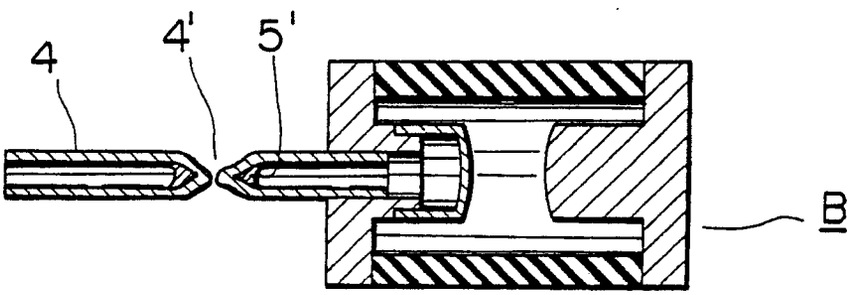


FIG. 3



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EUROPEAN SEARCH REPORT

Application Number

EP 90113182.1

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	SOVIET INVENTIONS ILLUSTRATED, El section, week 8446, January 2, 1985 DERWENT PUBLICATION LTD., London, V 05 * SU-1 081-702 (SIMAKIN) * --	1	H 01 J 9/00 H 01 T 21/00
A	DD - A - 30 936 (BARTHO) * Fig. 1; claims * --	1	
A	PATENT ABSTRACTS OF JAPAN, unexamined applications, E field, vol. 4, no. 28, March 8, 1980 THE PATENT OFFICE JAPANESE GOVERNMENT page 32 E 1 * Kokai-no. 55-1 013 (MEGURO DENKI SEIZOU) * --	1	
A	DE - A1 - 2 507 322 (TELEFONAKTIEBOLAGET) ----		TECHNICAL FIELDS SEARCHED (Int. Cl.5) H 01 J 7/00 H 01 J 9/00 H 01 J 17/00 H 01 T 21/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	17-10-1990	BRUNNER

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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