(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 381 004 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **90101235.1**

(51) Int. Cl.[5]: **H01J 17/02, F02P 15/00**

(22) Date of filing: **22.01.90**

(30) Priority: **30.01.89 JP 17773/89**

(43) Date of publication of application:
08.08.90 Bulletin 90/32

(84) Designated Contracting States:
DE FR GB

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

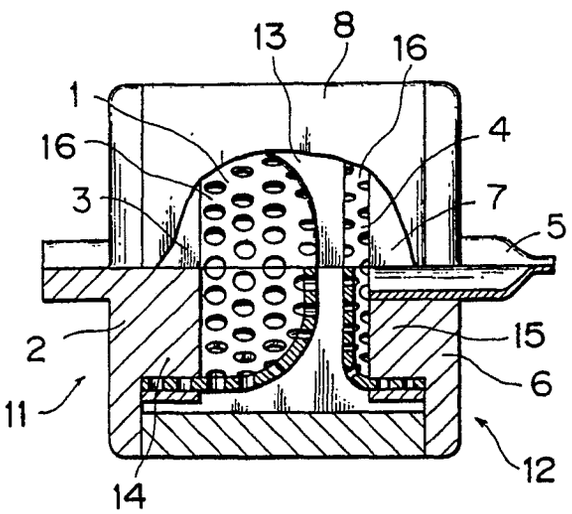
(72) Inventor: **Yagi, Kiyoshi, c/o Yazaki Parts Co., Ltd.**
252, Kawashimada
Gotenba-shi, Shizuoka 412(JP)
Inventor: **Wakabayashi, Seiichi c/o Yazaki Parts Co. Ltd.**
252, Kawashimada
Gotenba-shi, Shizuoka 412(JP)

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

(54) Discharge tube.

(57) A discharge tube which has a stabilized discharge voltage characteristic irrespective of a change of the frequency of discharge. The discharge tube comprises a hollow tubular casing (8), and cathode (11) and anode (12) electrodes secured to the axial opposite ends of the tubular casing to define an enclosed hollow spacing in which inert gas is filled such that a discharge can be started by application of a pulse voltage between the electrodes. Each of the electrodes includes an electrode base secured to the tubular casing and an electrode member (1, 4) securely mounted on the electrode base (2) in the hollow spacing. The electrode member at least of the cathode electrode is composed of a layered metal body including a ground layer and a thin surface layer formed on one or each of the opposite faces of the ground layer and having a considerably smaller thickness of 5 to 20 μm than the ground layer.

FIG. 1



EP 0 381 004 A1

DISCHARGE TUBE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a discharge tube for voltage control, and more particularly to a discharge tube which is used for a series gap of an ignition system of an automobile engine or the like.

2. Description of the Prior Art

An ignition system of an automobile engine or the like is adapted to supply a high voltage to an ignition plug to produce a spark. In order to accurately control the ignition timing, an ignition system with a so-called series gap is employed wherein a discharge gap is provided in series to an ignition plug. In order to form such a series gap, a discharge tube is employed wherein inert gas is enclosed in a tube and a pair of electrodes are provided at the opposite ends of the tube. An exemplary one of such discharge tubes is shown in FIG. 4. Referring to FIG. 4, the discharge tube shown includes a glass tube 21 and a pair of metal wire electrodes 22 each covered with a zirconium nitride layer not shown and mounted in an enclosed relationship at the opposite end portions of the glass tube 21. Pressurized mixture gas of nitrogen and hydrogen is filled in the glass tube 21.

Further, the discharge starting voltage of such a discharge tube must necessarily be high to some degree. Accordingly, the discharge tube has a problem that, if the distance between the electrodes is increased to this end, then the discharge maintaining voltage of the discharge tube is also increased and consequently the loss of energy to be supplied to an ignition plug is increased. Also there is another problem that the exhaustion of the electrodes is increased and the life of the discharge tube is reduced accordingly.

The inventors have made an investigation for improvement of making opposing faces of a pair of electrodes less acute or non-acute to raise the discharge voltage and lower the discharge maintaining voltage. Then, it has been found out that improvement in accuracy of the discharge voltage can be attained by the provision of a large number of convex and/or concave portions on a surface at least of the cathode. However, no solution has been found out yet to the problem that the discharge voltage drops as the frequency of discharge rises as described above.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a discharge tube which has a stabilized discharge voltage characteristic irrespective of a change of the frequency of discharge.

In order to attain the object, according to the present invention, there is provided a discharge tube which comprises a hollow tubular casing, and a pair of opposing cathode and anode electrodes secured to the axial opposite ends of the tubular casing to define in the tubular casing an enclosed hollow spacing in which inert gas is filled such that a discharge can be started by application of a pulse voltage between the cathode and anode electrodes, each of the electrodes including an electrode base secured to the tubular casing and an electrode member securely mounted on the electrode base in the hollow spacing, the electrode member of the cathode electrode being composed of a layered metal body including a ground layer and a thin surface layer formed on a surface of the ground layer opposing to the anode electrode and having a considerably smaller thickness than the ground layer.

The electrode member may be of the two-layer structure only including the ground layer and the thin surface layer or of a three- or more-layer structure including an additional layer or layers. The thin surface layer can be formed on the ground layer by plating or the like, and desirably the thickness of the surface layer is within the range from 5 to 20 μm.

Preferably, the electrode member of the cathode electrode has another similar thin surface layer formed on the other surface of the ground layer thereof.

Also, the electrode member of the anode electrode may be composed of a layered metal body including a ground layer and a thin surface layer formed on one or each of the opposite surfaces of the ground layer. The shape of the cathode electrode and/or the anode electrode can be determined suitably such that it may have an optimum characteristic in accordance with an application of the discharge tube.

With the discharge tube of the present invention, even if the frequency of discharge rises, the discharge voltage does not drop very much. Since the change of the discharge voltage with respect to the frequency of ignition is improved in this manner, the discharge tube is advantageous in that it exhibits an excellent effect in maintenance of a stabilized running condition even if a considerable

change takes place in the number of revolution of an engine of an automobile or the like in which the discharge tube is incorporated.

The above and other objects, features and advantages of the present invention will become apparent from the following description and the appended claims, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front elevational view, partly in section, showing a discharge tube to which the present invention is applied:

FIG. 2 is a circuit diagram showing an ignition system with a series gap with which a discharge tube is to be tested:

FIG. 3 is a graph showing results of a discharge voltage test of discharge tubes conducted with the ignition system shown in FIG. 2; and

FIG. 4 is a schematic sectional view showing an exemplary one of conventional discharge tubes.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to FIG. 1, there is shown a discharge tube to which the present invention is applied. The discharge tube shown includes a hollow tubular casing 8 formed from an alumina ceramics, and a cathode electrode 11 and an anode electrode 12 secured to the axial opposite ends of the tubular casing 8 and sealed with a suitable means such as silver solder not shown so as to define a hollow spacing 13 in the casing 8. The cathode electrode 11 includes an electrode base 2 substantially in the form of a disk secured to the tubular casing 8. and an electrode member 1 having a generally semi-spherical shape and fitted on and secured to a hub portion 14 of the electrode base 2 by means of a metal ring 3. The electrode member 1 has a large number of perforations 16 of a suitable size formed at a suitable pitch thereon. Meanwhile. the anode electrode 12 includes an electrode base 6 substantially in the form of a disk secured to the tubular casing 8, and an electrode member 4 having a substantially flat surface and fitted on and secured to a hub portion 15 of the electrode base 6 by means of a metal ring 7. The electrode member 4 also has a large number of perforations 16 of a similar size formed at a similar suitable pitch thereon. A gas conduit 5 extends axially through the center of the electrode base 6. Upon production of the discharge tube, suitable inert gas is introduced into the inner hollow spacing of the discharge tube by way of the gas conduit 5 so as to replace with the air. After such replacement, an outer end of the gas conduit 5 is compressed to seal the conduit 5.

Each of the electrode members 1 and 4 is formed from a layered body in the form of a plate which at least includes, though not shown, a ground layer which may be, for example, a copper plate having a thickness of about 0.5 mm, and a thin surface layer formed on each of the opposite surfaces of the ground layer and having a significantly small thickness of 5 to 20 μm, preferably of 10 μm, comparing with the ground layer. The surface layer may be formed, for example, by electroplating of nickel.

Two different discharge tubes were produced actually in accordance with the present invention, and a performance test of them was conducted.

Example 1

A copper plate of a thickness of 0.5 mm having a large number of perforations of about 0.5 mm formed at a pitch of about 1 mm therein was prepared. The perforated copper plate was shaped by press work so as to be rounded at peripheral edge portions thereof, and electroplating of nickel was performed to a thickness of about 10 μm on the opposite inner and outer surfaces of the perforated copper plate. An electrode member 1 obtained in this manner was fitted on and secured to an electrode base 2 by means of a metal ring 3 to form a cathode electrode 11 as shown in FIG. 1.

Another electrode 4 having a substantially flat surface was produced in a similar manner and fitted on and secured to an electrode base 6, which had a gas conduit 5 extending therethrough, by means of another metal ring 7 to form an anode electrode 12.

Then, the cathode electrode 11 and the anode electrode 12 produced in this manner were assembled in an opposing relationship to each other to the opposite ends of a tubular casing 8 of an alumina ceramics and then sealed with silver solder. Then, inert gas was introduced for replacement with air into the internal hollow spacing 13 of the discharge tube by way of the gas conduit 5, and then an outer end of the conduit 5 was compressed for enclosure, thereby obtaining a discharge tube I according to the present invention.

Example 2

Instead of forming the electrodes 1 and 4 from perforated copper plates. they were formed by shaping similar perforated stainless steel plates by

press work and then performing electroplating of gold to a thickness of about 10 μm on the opposite inner and outer surfaces of the perforated stainless steel plates. Then, a discharge tube II of the present invention was produced by assembling the electrode plates 1 and 4 to a tubular casing 8 in a similar manner as the example 1 described hereinabove.

Performance Test

A performance test was conducted with such an ignition system with a series gap as shown in FIG. 2. Referring to FIG. 2. the ignition system shown includes an ignition coil T, a pair of discharge gaps G_1 and G_2 provided by a discharge tube and an ignition plug, respectively, and a floating capacitance C provided by a high tension cable, a distributor cap and so forth. An ignition signal is transmitted to the ignition coil T by way of a transistor Tr.

Using the device, discharge voltage characteristics of the discharge tubes I and II of the present invention and a further discharge tube III assembled using electrodes of the same shapes formed from stainless steel plates were tested. Results of such test are shown in FIG. 3. From FIG. 3, it can be seen that the discharge tubes I and II of the present invention present considerably small drops of the discharge voltage with respect an increase of the ignition frequency comparing with the discharge tube III.

Having now fully described the invention, it will be apparent to one of ordinary skill in the art that many changes and modifications can be made thereto without departing from the spirit and scope of the invention as set forth herein.

Claims

1. A discharge tube, comprising a hollow tubular casing, and a pair of opposing cathode and anode electrodes secured to the axial opposite ends of said tubular casing to define in said tubular casing an enclosed hollow spacing in which inert gas is filled such that a discharge can be started by application of a pulse voltage between said cathode and anode electrodes, each of said electrodes including an electrode base secured to said tubular casing and an electrode member securely mounted on said electrode base in said hollow spacing, said electrode member of said cathode electrode being composed of a layered metal body including a ground layer and a thin surface layer formed on a surface of said ground layer opposing to said anode electrode and having a considerably smaller thickness than said ground layer.

2. A discharge tube as claimed in claim 1, wherein the thickness of said thin surface layer of said cathode electrode is within the range from 5 to 20 μm.

3. A discharge tube as claimed in claim 1, wherein said electrode member of said cathode electrode has another similar thin surface layer formed on the other surface of said ground layer thereof.

4. A discharge tube as claimed in claim 1, wherein said electrode member of said anode electrode is composed of a layered metal body including a ground layer and a thin surface layer formed on one or each of the opposite surfaces of said ground layer.

FIG. 1

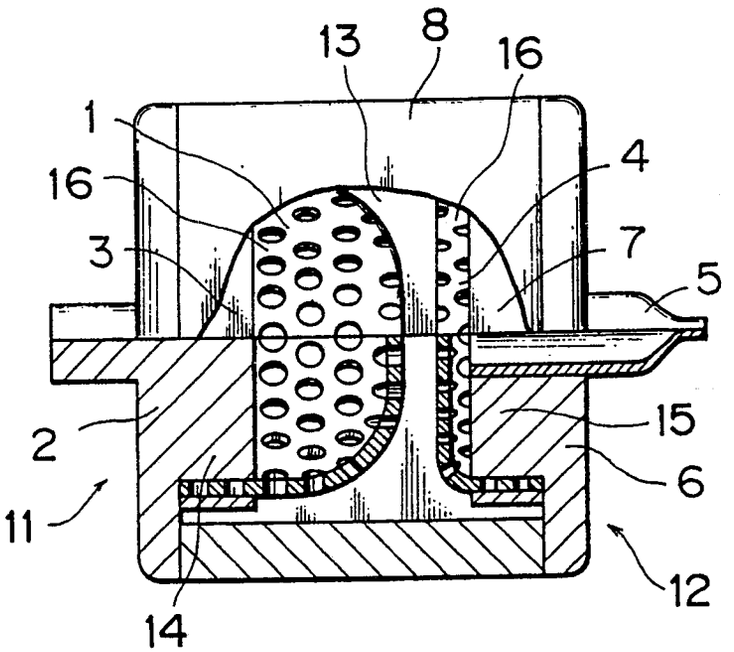

13
8
16
1
4
16
3
7
5
15
2
6
11
12
14

FIG. 2

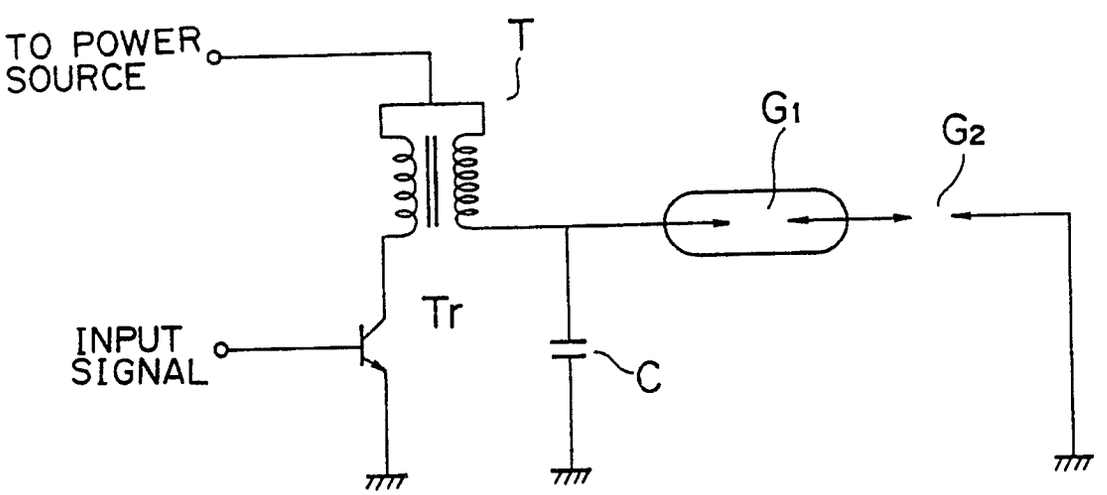

TO POWER SOURCE
T
G1
G2
Tr
INPUT SIGNAL
C

FIG. 3

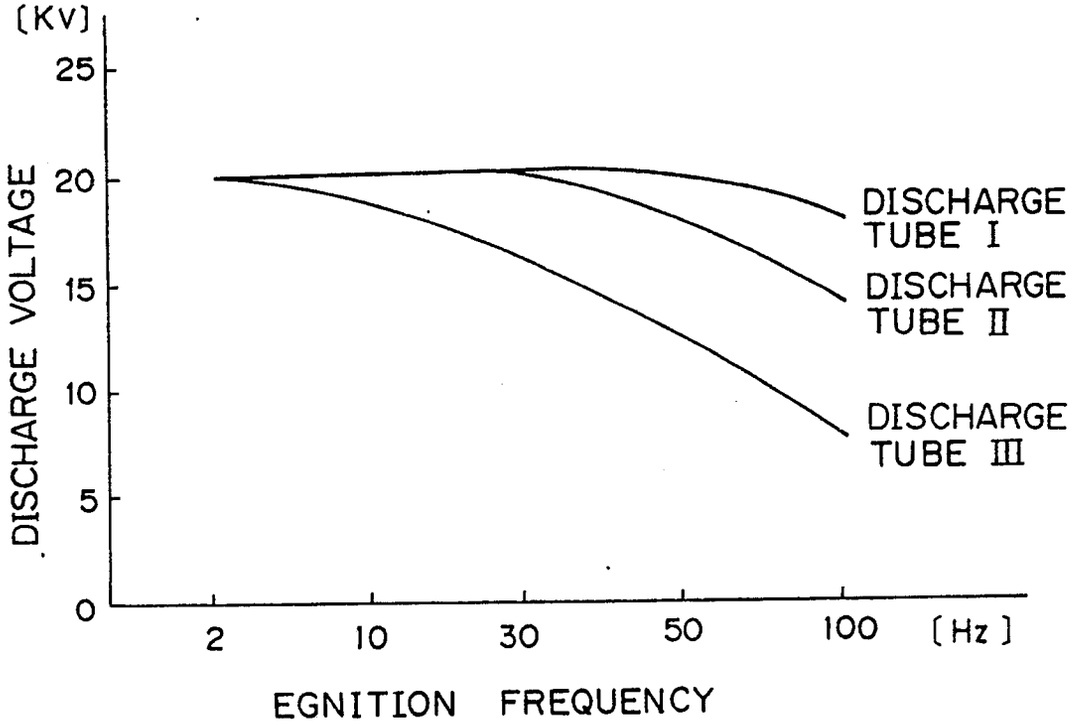
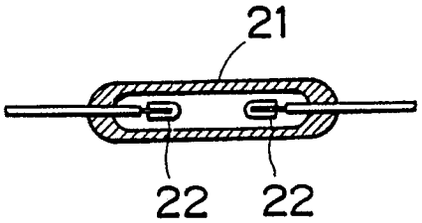


FIG. 4
PRIOR ART



European Patent Office

EUROPEAN SEARCH REPORT

Application number

DOCUMENTS CONSIDERED TO BE RELEVANT

EP 90101235.1

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.⁵)
A	US - A - 3 612 937 (SMIRNOV) * Fig. 1; column 2, line 50 - column 3, line 39; claims * --	1	H 01 J 17/02 F 02 P 15/00
A	SOVIET INVENTIONS ILLUSTRATED, section El, week D 29, August 26, 1981 DERWENT PUBLICATIONS LTD., London, X 12 * SU-765-918 (KHROMOI) * ----	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.⁵)

H 01 J 17/00
H 01 J 7/00
F 02 P 15/00
H 01 T 15/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	19-04-1990	BRUNNER

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO Form 1503 03.82