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Menzel

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[54] **METHOD OF MANUFACTURING AN ELECTRODE FOR A GAS DISCHARGE TUBE**

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[30] **Foreign Application Priority Data**

Dec. 3, 1970 Germany ..... P 20 59 572.6

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[51] **Int. Cl.** **H01j 7/18**

[58] **Field of Search** 29/25.11, 25.17; 313/178; 316/25

[56] **References Cited**

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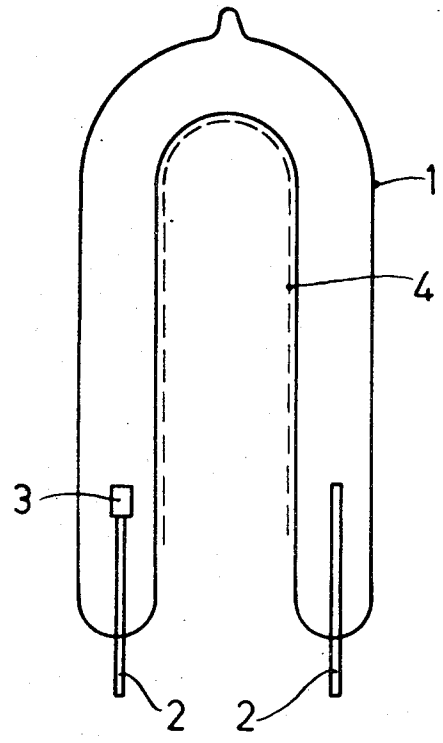
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[57] **ABSTRACT**

Quench tubes are switching which are used in electronic flash devices so as to reduce the quantity of light emitted by the flash lamp of that device. The electrodes of known quench tube became unusable after a short period. According to the invention a quench tube having a long lifetime and a reliable ignition is obtained when an electrode body consisting inter alia of sintered nickel powder is manufactured by means of a method in which the nickel powder is first mixed with a given material comprising an alkali metal or alkaline earth metal, whereafter the assembly is moulded to the desired form and is then sintered at a given temperature whereafter it is secured to a current supply rod and is subsequently activated by an electrical current pulse after it has been sealed in a discharge vessel.

3 Claims, 3 Drawing Figures



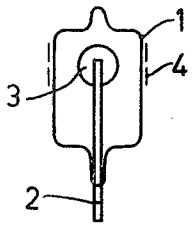


Fig.1

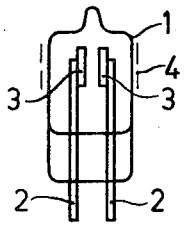


Fig.2

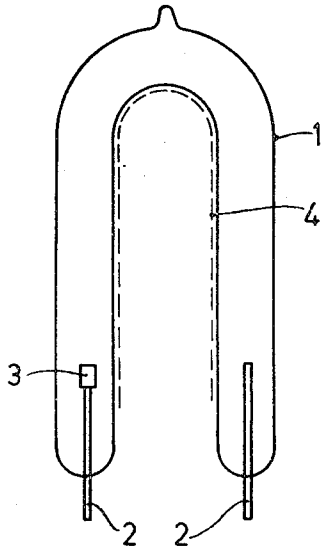


Fig.3

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METHOD OF MANUFACTURING AN ELECTRODE FOR A GAS DISCHARGE TUBE

The invention relates to a method of manufacturing a cold electrode for a gas discharge tube, which electrode consists of a metal rod of a material having a relatively high melting point and an electrode body of sintered nickel powder secured to said rod. The invention also relates to a gas discharge tube provided with an electrode manufactured by the said method.

In this connection a cold electrode is understood to mean an electrode which in the operating condition only receives heat originating from a gas discharge.

In given discharge tubes such as discharge flash tubes it is important that the discharge arch ignites reliably and that the flash emits a given amount of light within a given time interval.

It is to be noted that the flash in a discharge flash tube is generated with the aid of an electric discharge which is in contrast with an expendable flash bulb in which the flash is effected by the combustion of a material provided in the bulb. In a discharge flash tube flashes can be generated again and again. This is not the case for an expendable flash bulb.

Since in earlier days overexposure of the film material often occurred when taking photographs for which discharge flash tubes were used, it has been proposed to use also an extra discharge tube, a so-called switching tube or quench tube which after the emission of the desired quantity of light by the discharge flash tube becomes conducting so that the voltage between the electrodes of this discharge flash tube is greatly reduced and the flash is extinguished. As regards their structure these quench tubes are very much similar to discharge flash tubes. However, it has been found that the requirements imposed on quench tubes are more stringent and are partially different than those for discharge flash tubes. For example, the resistance of a quench tube, which is in the conducting condition, must be lower than that of the discharge flash tube with which this quench tube is connected in parallel in many cases and this to ensure that after the quench tube has become conducting the electric current flowing through the discharge flash tube is taken over by the quench tube. Quench tubes are also provided with electrodes which have an emitter so as to reduce the work function. Furthermore these quench tubes have an electrode distance which is generally shorter than that in discharge flash tubes (electronic flash tubes). Furthermore it must be possible to ignite quench tubes already at a relatively low voltage between the main electrodes.

The materials ThO_2 or BaO/Ba, which are sometimes used for the electrodes of flash tubes, have the drawback of a relatively high work function. Better results are obtained with the electrodes moulded from nickel powder. The moulded electrodes of sintered nickel powder may be immersed in a solution of a caesium salt so as to reduce the work function. In quench tubes or switching tubes whose electrodes had been manufactured in the manner described above, the reliability of ignition was at first very great, but after a considerable number of switching operations the ignition reliability had decreased.

As will be described hereinafter it is already known from prior art to use separate getter rings, getter pellets or getter wires in gas discharge tubes, which getters are brought to a condition in known manner by means of a field of high frequency, in which condition they take up the impurities. The embodiment using these separate getters led to a good improvement of the behaviour of the tube at the commencement of its life, but after a fairly short time the deterioration of the electrode surface led again to the poorer reliability of the ignition.

Moreover, with the further progress in miniaturizing the tubes it became more and more difficult to provide separate getters. The introduction of these getters also required extra operations during manufacture.

The occurrence of very high peak currents and the accompanying load of the electrodes and of the wall of the discharge space, which often consists of glass, greatly increased the risk of gas evolution in the quench tubes so that the reliability of ignition became poorer. With a requirement of small electrode losses being satisfied simultaneously, it was no longer possible to getter away the said evolving gases with the known means.

An object of the present invention is to obviate or at least to minimize the said drawbacks, inter alia as regards unreliable ignition.

Prior to stating how a method according to the invention is characterized, the following is stated about prior art.

In gas discharge tubes it was known to use a getter material consisting of a barium-aluminium alloy ($BaAl_4$) in a pulverant form, namely as a getterring or a getter pellet. In this connection reference is made to United Kingdom Patent specification No. 716,621 and French Patent specification No. 1,050,547.

A method of manufacturing an electrode for a discharge tube in which, for example, barium oxide is used was known from Austrian Patent specification 124,086. Alternatively it was possible to use iron oxyde and aluminium as well as magnesium. Then a satisfactory vacuum in the tube was obtained.

German Patent specification 1,132,241 described an electric gas discharge tube cold electrodes which was formed as a gas discharge flash tube. Each of the electrodes of this flash tube consisted of a metal rod of a material having a high melting point, while an emitter was provided on the rod which was protected from the discharge with the aid of some windings of a metal wire. The metal wire consisted of a core which comprised either an alloy containing an alkali metal or an alkaline earth metal or a compound of one of these metals with a reducing material, and an iron casing. During manufacturing this iron casing of the wire was ground off on the side facing the metal rod to such an extent that the core could engage the metal rod. The core could comprise an alloy of barium and aluminium ($BaAl_4$) in accordance with the last-mentioned patent specification.

A method according to the present invention will now be further described.

According to the invention a method of manufacturing a cold electrode for a gas discharge tube, which electrode consists of a metal rod of a material having a relatively high melting point and an electrode body of sintered nickel powder secured to said rod is characterized in that firstly nickel powder is mixed with either alloy containing an alkali metal or an alkaline earth metal or a compound of one of these metals with a reducing material, said mixture being moulded in the form desired for the electrode body, said moulded body being subsequently sintered in known manner below the activation temperature of the mixed constituants added to the nickel powder, the electrode body being

subsequently secured mechanically to and aligned on the metal rod likewise in known manner, the electrode being furthermore sealed in a discharge tube which is evacuated, heated and filled with a filler gas, whereafter the constituants added to the nickel powder are activated by at least one electrical current pulse.

In this connection activation is understood to mean: to make suitable for taking up impurities. An activation temperature is understood to mean a temperature at which activation occurs.

An advantage of a method according to the invention is that separate getters need not be introduced in the discharge tube.

In a method according to the invention the electrode body is preferably given a lower work function in known manner after sintering, by immersing said body into a solution of a caesium salt.

In a further preferred embodiment in which the mixed constitutants added to the nickel powder are constituted by an alloy, said alloy is a barium aluminium alloy ($BaAl_4$).

A method according to the inveniton is particularly suitable for manufacturing electrodes for quench tubes and discharge flash tubes. For the activation of the electrodes one or more electric current pulses will have to be used for the discharge flash tubes which pulses have a considerably higher ampere value than the current pulses to be expected later on in said tube.

It is found to be possible to carry out activation in such a manner that it only leads to a negligible blackening of the discharge tube.

Investigations which have led to the present invention proved that the large electrical currents particularly occurring in the switching-and quench tubes resulted in an intense heating of the electrodes. It was then found that in a method not according to the invention already small impurities in the nickel resulted in a decrease of the reliability of the ignition of the tube. Furthermore it was found that the deterioration of the electrodes, that is to say, the electrodes becoming unsuitable for taking up impurities was not effected from the exterior but from the interior. This also explained why separately provided getters, see prior art could not be effectively active because the electrodes were already liable to deterioration from the interior before the impurities could emerge from the electrode surface and reach the getter.

By intensively mixing the nickel powder with, for example, $BaAl_4$ getter powder, the inevitable impurities in the nickel powder are already bound in the interior of the electrode body after using a method according to the present invention. As a result they cannot bring about an unwanted interaction with the electrode surface which is provided, for example, with a material decreasing the work function. Consequently, the electrode surface remain clean.

Further advantages of a tube according to the invention and of the method according to the invention are the following:

The ignition reliability remains constant over a comparatively long period and is independent of the switching or flashing frequency. Mixing of nickel powder as a support with the getter powder consisting of, for example, $BaAl_4$ which is durable in the normal atmosphere can easily be effected on a large scale. The activation by means of high frequency heating which is relatively expensive and is not entirely safe in bulk manufacture is rendered superfluous by using electrode bodies manufactured by the method according to the invention. This high frequency activation was also one stage in the manufacturing process requiring bulky auxiliary equipment. The difficult securement of an additional getter pellet or getter ring in a narrow discharge tube is no longer necessary.

In order that the invention may be readily carried into effect, an embodiment thereof will now be described in detail by way of example with reference to the accompanying diagrammatic drawings in which:

FIG. 1 is a side elevational view of a quench tube according to the invention;

FIG. 2 is a front elevational view of the quench tube of FIG. 1;

FIG. 3 shows a discharge flash tube according to the invention.

In FIGS. 1 and 2 the reference numeral 1 denotes a glass envelope of a gas discharge quench tube. The reference numeral 2 denotes two metal rods of as many cold electrodes. An electrode body 3 which is, for example, sintered, is secured to the end of each of the two rods 2 located within the envelope 1. The rods 2 consist of, for example, tungsten. The dimensions of the components of the quench tube greatly depend on the required properties such as, for example, the desired ignition voltage and the starting current. The outer diameter of the disc-like electrode body 3 must always be at least some tenths of a millimetre smaller than the internal diameter of the envelope 1 of the quench tube in the case of rod-shaped tubes. The reference numeral 4 denotes an ignition electrode.

In FIG. 3 the reference numeral 1 deonotes a U-shaped glass envelope for a discharge flash tube which is formed as a discharge flash lamp. The reference numeral 2 again denotes two metal rods which consist of tungsten. An electrode body 3 which is, for example, sintered is secured to the end of one of the rods 2 located within the envelope 1. The reference numeral 4 denotes a conducting strip which serves as the ignition electrode. The filler gas for the quench tube shown in FIGS. 1 and 2 and for the flash tube shown in FIG. 3 consists of, for example, xenon.

What is claimed is:

1. A method of manufacturing a cold electrode for a gas discharge tube, which electrode consists of a metal rod of a material having a relatively high melting point and an electrode body of sintered nickel powder secured to said rod, comprising the steps of:

mixing nickel powder with either an alloy including an alkali metal or an alkaline earth metal or a compound of one of these metals, with a reducing material;

molding the mixture in the form desired for the electrode body;

sintering the molded body in predetermined manner below the activation temperature of the mixed constituents added to the nickel powder;

securing the sintered body to and aligning it on the metal rod;

sealing the electrode in a discharge tube which had been evacuated, heated and filled with a filler gas; and

activating the constituents added to the nickel powder by at least one electrical current pulse.

2. A method as claimed in claim 1, including the step of immersing said body into a solution of a caesium salt after the sintering step to give a lower work function to the electrode body.

3. A method as claimed in claim 1 in which the mixed constituents added to the nickel powder consist of a alloy, and wherein said alloy is a bariumaluminium alloy ($BaAl_4$).

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